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COMPARISON OF HYDRAULIC AND ELECTRIC SPRINKLER SYSTEMS

Ed Shoemaker, Sales Manager
Rainy Sprinkler Sales
Peoria, Illinois

It is very significant that we are thinking about what type of automatic irrigation systems rather than whether or not our systems should be automatic. We are now in the "nuts and bolts" stage of development of automatic turf irrigation systems which indicates the growth and maturity of the turfgrass industry in this area.

A recent Harvard study indicates that the use of golf courses and other outdoor recreational facilities will increase 400% by the year 2000. This presents a real challenge to all of us in this industry. For us in the sprinkler industry, it means we will have to supply you with more sophisticated sprinkler systems. As a turf manager, you will need more education and training to operate these systems properly and to cope with the other problems of growing turf grass.

Buying an automatic sprinkler system may be one of your major problems if you are not familiar with all of the factors involved in getting a good system. Whether the system is to be electrically or hydraulically controlled is just one of many important decisions to be made.

After the necessary budget has been approved, your first big decision is to select a designer. You can spend any amount of money and purchase the best components available and still not get a good system if you don't start with a good plan. Whether you are building a house, building a car, or supervising any type of construction project, you must start with a well-engineered plan. You should check on the previous work of a designer to see if his jobs have been successful. After you have selected the designer, then you can work with him on the selection of the proper components. One of the most important parts of an automatic system, which is often short-changed, is the pumping plant and its controls. This is a very critical part of the system, and a person experienced in the pump and pump controls field should specify exactly what is to be used.

Another important decision is whether an electric or hydraulic control system should be used. In order to make an intelligent determination of this, we need to define the difference between these two methods of control. The major difference between an electric system and a hydraulic system is the method of sending energy from the controller to the valve to open or close the valve. In an electric system, electrical enery is transmitted through wire (irrigation control cable) from the controller to the valve. In a hydraulic system plastic control tubing (usually PVC) is used to transmit water pressure from the controller to the valve.

The electric valve operates as follows: The controller comes on and transmits electrical energy through the wire to the solenoid or coil on

the valve. The energized coil acts as a magnet and lifts the solenoid pin which allows water to flow out of the bonnet cavity faster than it enters through the small entrance passage. The water pressure on the bottom of the diaphragm now exceeds the pressure on the top of the diaphragm and the diaphragm lifts off the valve seat, allowing water to flow to the sprinklers as shown in Figure II (see page 5).

When the controller cuts off the power or energy to the solenoid, the solenoid pin drops and the water pressure builds up on the top of the diaphragm and causes the valve to close as in Figure I (see page 5).

The electric valve is a normally closed valve which means no outside energy is required to keep it closed. It is considered "fail safe" since an interruption of power or a rupture of the diaphragm will automatically cause it to close and shut off the sprinklers.

It can be operated manually at the valve by letting a small amount of water escape at the bleed plug.

The principle of operation of the hydraulic valve is as follows: The hydraulic valve remains closed whenever water pressure in the bonnet cavity above the diaphragm is equal to or greater than the water pressure below the diaphragm. Water pressure is maintained in this bonnet cavity by pressure exerted through a tube running from the water main via the automatic controller to the valve (see Figure III, page 5).

When the automatic controller is scheduled to open a valve, this pressure is cut off, thus eliminating the pressure on the top of the diaphragm. The water in this cavity is vented to the atmosphere through a drain at the automatic controller. The water pressure below the diaphragm, now greater than the pressure above the diaphragm, forces the diaphragm off its seat until the diaphragm bolt engages the flow adjusting stem. The value remains open until the controller allows water to re-enter the bonnet cavity, thus once again making the pressure above the diaphragm equal to or greater than the pressure below the diaphragm (see Figure IV, page 6).

The thermal (heat powered) electric valve, as shown in Figures V and VI (page 6), is a new type electric valve that was developed specifically for turf irrigation. The Thermal valve operates as follows: The controller comes on and transmits electrical energy to the resistor in the TH motor. The resistor slowly heats the hydro-carbon material in the motor. The expansion of the hydro-carbon material pushes the motor pin down to push the valve disc off the valve seat which puts the valve in an open position as shown in Figure VI.

When the controller cuts the power to the TH motor, the hydro-carbon material cools and contracts, allowing the valve spring to push the disc back onto the seat which closes the valve as shown in Figure V.

This slow opening and closing of the Thermal valve eliminates water hammer and protects the sprinkler heads and piping system.

The Thermal valve is completely different from any other valve used in turf irrigation, but the conventional diaphragm-type electric and hydraulic valves are very similar to each other.

To operate the hydraulic valve, water pressure is supplied from the water main through the controller and to the valve through plastic tubing. Today, this tubing is normally 3/16" I.D. PVC. Polyethylene was used extensively a few years ago, but PVC has proven to be much more reliable. Early failures of this tubing have given hydraulic systems a bad reputation in many areas.

The TYPE UF wire used for electric systems has proven to be very reliable. UF wire normally uses copper as a conductor, since copper has a very low resistivity (meaning it is a good conductor), and it is relatively low in cost. Copper has a very high tensile strength (ability to withstand stress without tearing apart), resists atmospheric corrosion, and has excellent physical characteristics for making connections. A 4/64" jacket of a tough PVC compound is used on the normal sizes used in sprinkler systems, and a 5/64" jacket is used on larger sizes (#8 and larger). TYPE UF wire must pass a 5,000 psi crush test, which means it will not be easily damaged during installation.

Over the United States, as a whole, electric systems are outselling hydraulics by a wide margin. This is partly because of the number of systems that are being installed in freezing climates. Before freezing weather, the hydraulic lines should be disconnected at each valve, and t the water purged from the lines. This can be done with an air compressor. The reverse procedure should take place in the spring, and the air should be purged completely from the lines with water.

Electricity travels through the irrigation control cable in an electric system at about 186,000 miles per second so there is no delay in response to the controller's signal. Elevation differences or air in a hydraulic line can cause a delay in response. Almost all of the sprinkler manufacturers are manufacturing both types of control equipment. In one area, the engineers of a given company may prefer hydraulic systems, and in another area the engineers may prefer an electric system. This is quite often due to their own experiences with a particular type of control. We, naturally, recommend and use what has proved most successful for us.

A factor which is more important than whether the system has hydraulic or electric controls is how well the system is installed. The selection of the designer and the selection of the contractor are probably two of the most important decisions. Check the previous work of a bidding contractor to see how his systems have worked. Has he followed up and corrected any problems that developed? You should expect some problems on a construction project of this size and nature. Every contractor, every

designer, and every manufacturer will have problems. The big difference between people in any business, including turf managers, is how they approach and solve their problems.

There was an excellent editorial in the June 1965 Golf Course Reporter by Bob Shields, President of the Golf Course Superintendents Association. Bob's editorial was entitled, "Pray and Hoe" and he repeated an old saying that goes something like this, "Pray for a good harvest, but keep on hoeing." I think the message for us today is that we can pray for good turf grass or pray for better jobs, but we had better keep educating and training ourselves to handle the new equipment and new technology that will be available for us in the next few years.

An executive in the aircraft industry recently said that if his company moved at the same pace as our educational system, they would be out of business in two years. This industry considers its newest planes obsolete by the time they come off the production line. We aren't even traveling commercially by supersonic planes yet, and they are making plans for hypersonic transports which will travel at 4,000 miles per hour. They are predicting that we will be able to travel from New York to Hong Kong in two hours during the 1990's.

By this time, I feel sure we will be using automatic devices which will record soil moisture, temperatures, humidity, and other factors which will be fed into a computer service (like your present electrical service). This data will be digested by the computer service, and magnetic impulses will be relayed to start your pump and tell your controller the amount of time for each sprinkler to run.

This will enable you to do a better job of growing turfgrass, but it certainly will not eliminated your job or even make it easier. Improved technology in equipment and materials will require that you and your staff become better trained and more highly skilled.

Your job as a turfgrass manager will require skills and know-how that none of us have today. Increased emphasis on outdoor recreation will provide you with a budget enabling you to compete in the market for more skilled personnel.

As a manager of more highly skilled people, your job will become more demanding and more interesting. I think this will make for a very exciting future.

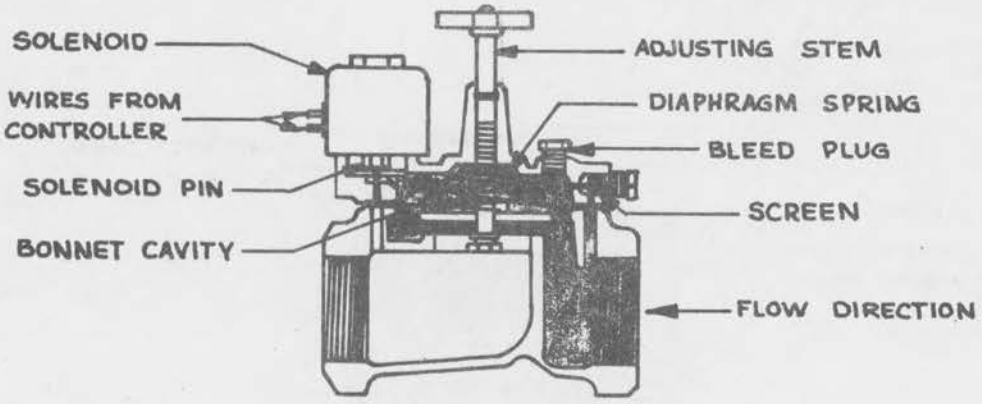

Figure I. Electric valve - closed position.

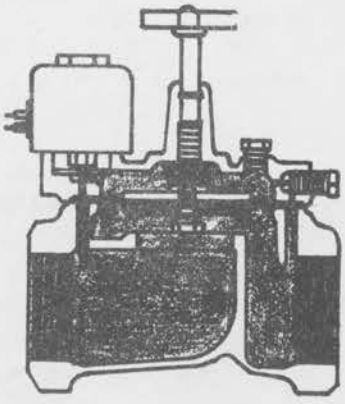

Figure II. Electric valve - open position.

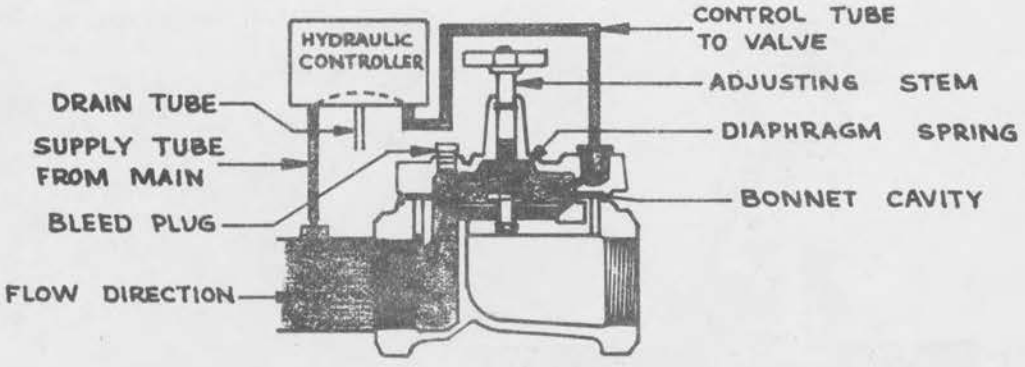

Figure III. Hydraulic valve - closed.

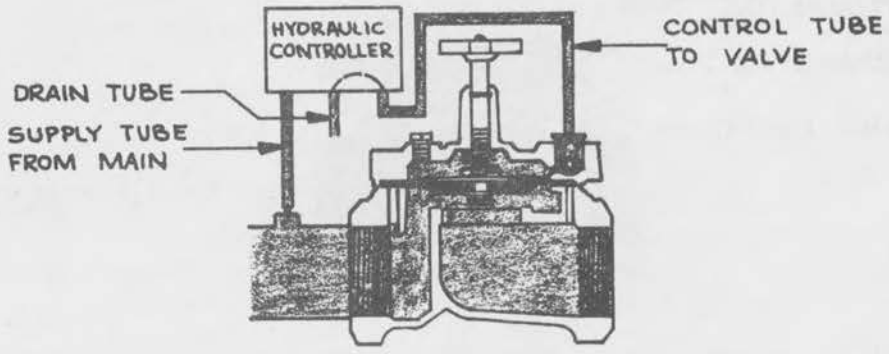

Figure IV. Hydraulic valve - open position.

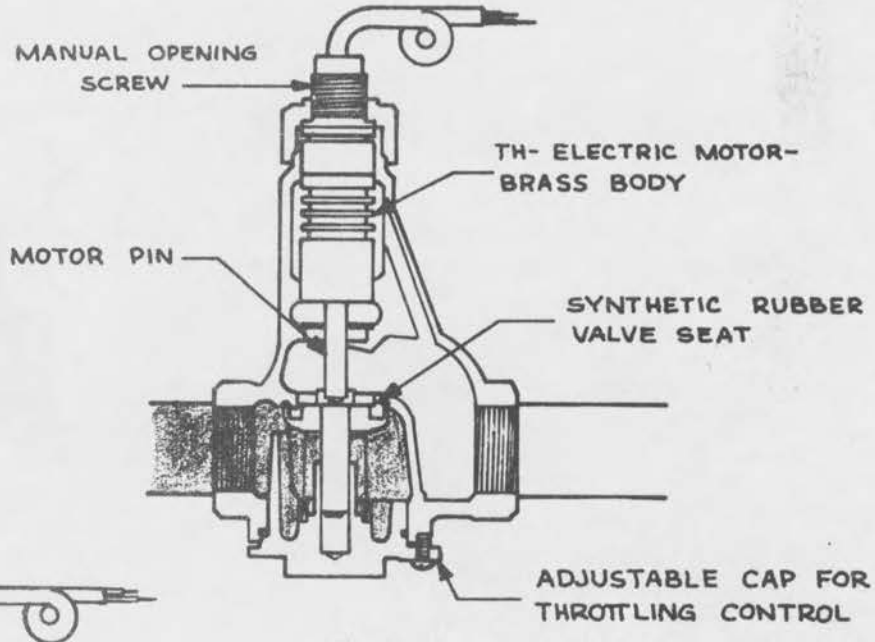

Figure V. Thermal valve - closed.

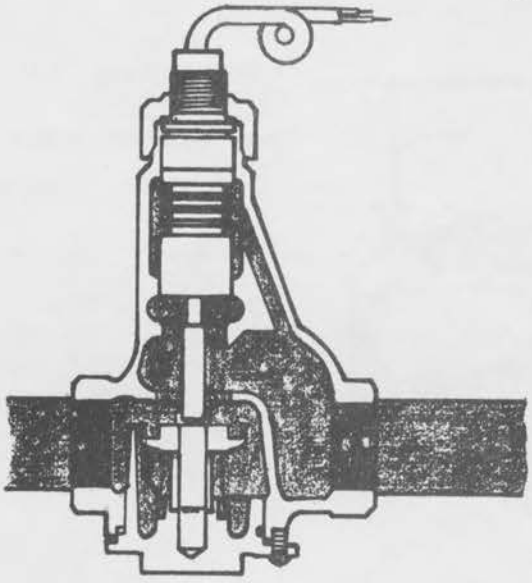

Figure VI. Thermal valve - open.

CARE OF TURF ON FOOTBALL FIELDS

J. R. Watson
Director, Agronomy Division
Toro Manufacturing Corporation
Minneapolis, Minnesota

Those charged with care of turf on football fields are concerned with three major areas. These are: condition of the grass, the firmness and uniformity of footing from a playing standpoint and color and grooming from a spectator's standpoint. The condition of athletic field turfgrass always reflects past management practices. Good or bad management shows up to a greater extent in the spring of the year than at any other time except perhaps on colored television.

From a playing standpoint, good athletic field turfgrass should be tough, wear-resistant and not easily torn by cleats. It should be soft enough to prevent abrasions when players fall, yet firm enough to permit good footing. It should be clipped short enough to prevent hanging of cleats, yet tall enough to ensure healthy plant growth and rapid recovery when torn by shoe cleats.

Firmness and uniformity of footing are usually present if the conditions of the turfgrass is satisfactory. But, with or without good grass, a firm, even, and resilient footing is absolutely necessary and should be mandatory on all playing fields. Skinned areas of baseball infields provide these conditions. The same general techniques and procedures may be employed to assure footing on football fields. Players recover from skin abrasions relatively easy - certainly more easily than from twisted knees and ankles. Dust may be controlled on bare areas by the use of water. Turf cover is, of course, preferred.

With the advent of colored telecasting of major sporting events, field color and grooming have taken on new significance. Spectators have come to expect uniformity, or at least, compatibility of color. Certainly color is important from an aesthetic standpoint and is apparently one criteria by which quality of turf is judged.

Mowing to produce a pattern or "ribboning" effect is becoming standard procedure on most major league baseball fields. George Toma, Groundskeeper at Municipal Stadium in Kansas City (home stadium of the Chiefs and of the Athletics until a couple of months ago) employs this technique to improve the appearance of the football field. Each five (5) yard strip is cut in an opposite direction. Another technique that is sometimes used after Bermudagrass goes dormant is to color alternate strips with a different colorant or a diluted solution of the same colorant. Both techniques enhance the appearance of the field and have earned well deserved praise and recognition for George.

Good turfgrass conditions, firm, uniform footing and a pleasing color are characteristics of a good football field. Poor fields are also readily recognized under most circumstances. Annual weeds, undesirable grasses and clover often make up the major part of the vegetation. The center of the field often is bare and the soil is bumpy, uneven and usually compacted and poorly aerated. Compacted and poorly aerated soil bears shallow-rooted, tender grasses that are easily torn by cleats during play. Injury to players, particularly around the ankles and knees, are more likely to happen on this type of turf.

Quite often weedy turfgrass indicates mis-management of water and improper fertilization in addition to reflecting soil compaction. Mismanagement of water occurs when it is applied at rates incompatible with soil properties - infiltration rate, percolation rate or storage capacity. Improper fertilization may mean the wrong pH, or too little total fertilizer, an improper balance of the major fertilizer elements - nitrogen, phosphorus and potassium - or a deficiency (or excess) of trace elements. Fertilization is a process of supplementation - supplementing the soil nutrients in accordance with the requirements of the grass for growth and for the prevailing use conditions. And, no element should be applied in excess of the needs of the plants. This is particularly true of the soluble or inorganic types of nitrogen such as ammonium nitrate, ammonium sulfate, etc. Soluble forms of nitrogen give the plant a quick start, but when supplied in excess, produce tender, succulent growth that increases the chances for player injury and increases susceptibility of the turfgrass to attacks of insects and diseases.

Grasses

Bermudagrass is the base grass for athletic fields in Texas. Improved selections, such as Tex-turf-10 or Tifway, may be planted where their extra vigor is needed to withstand heavy use. Ryegrass is a temporary grass but may be used to advantage on areas that tend to become thinned out by concentrated play or where late season color is required. Seed ryegrass at varying rates throughout the playing season (after each game) on these areas. Where it is necessary to reseed fields established to common Bermudagrass, the rate of seeding will vary, depending on the amount of cover present. Seed should be divided into two equal lots, one lot broadcast at right angles to the other. This method of seeding insures a uniform stand.

Turfgrass Maintenance Program

Good athletic field turfgrass must be cultivated (aerated), fertilized, watered and mowed properly. In addition, programs of disease, insect and weed control should be developed and used when needed. Attention to these fundamentals will insure the establishment, development and maintenance of tough, wear-resistant turfgrass. Cultivation, fertilization, controlled watering and proper mowing are so closely interrelated that it is difficult to separate their individual effects. These are the "essentials" in the production of good athletic turfgrass.

Improvement of Physical Condition

Cultivation (aeration): Cultivate the field with some type of aerating equipment at least twice lengthwise and once crosswise. Add sufficient weight to insure penetration to a depth of two to three inches. It may be necessary to sprinkle in order to bring the soil to the proper moisture level for maximum penetration. Soil should be moist, but not soggy. Cultivation alleviates oil compaction and aids the interchange of gases, particularly oxygen and carbon dioxide, between the soil and the atmosphere. Aeration, likewise, permits placement of phosphorus and potassium in the zone of root growth, thus aiding in the development of deep root systems.

Football fields that are cultivated in early spring do not necessarily require topdressing to fill in aeration holes. Roots and stems of the grass fill in these holes readily and by mid-summer there is no evidence of pitting. Cultivation of baseball fields will be determined by playing schedules and the rapidity with which the grass is growing.

Topdressing: On fields where topdressing is required, consideration should be given to the type of materials used. A mixture of two parts each of coarse sand and medium sandy loam with one part of a good high grade of organic matter may be considered a good topdressing material.

The best form of organic matter is raw sedge or cultivated peat. Other types of organic matter that may be used are well-decomposed leaves, sawdust, ground corn cobs, straw and any other eadily available dynamic sources of organic refuse. Manure or raw sewage sludge can be used; however, they decompose readily. When decomposing, these materials have an offensive odor that may make them objectionable in many cases. (Proper composting will eliminate this condition.) Neither of these should be used later than eight weeks prior to play on the field. Manures may be a potential source of tetanus, so their use as surface dressing should be avoided, unless the materials are sterilized.

The organic matter, coarse sand and medium sandy loam, should be thoroughly mixed with a grinder or mixer. After mixing, the material should be screened through a one-quarter inch mesh screen. Such a screen can be built from hardware cloth. Sterilization - chemical or heat - to kill weed seeds is desirable.

This topdressing mixture should be used to fill and level depressions during and at the close of the playing season. If used as a topping over the entire field, it may have to be applied in the spring. In this case, the field should be topped after cultivation and fertilization.

Fertilization: Fertilizers are applied to supplement the natural nutrient supplies in the soil rather than to constitute the only source of nutrients. In addition, another major function of fertilizer is to balance the soil nutrient supply with the needs of the plant. Fertilization of

athletic field turfgrass begins with the determination of the plant food supplies in the soil. Such is accomplished by obtaining a properly interpreted soil test. The soil test will provide a record of the soil reaction (pH) and the level of phosphorus, potash, calcium and magnesium. In addition, most tests will show soluble salts if they are present in toxic levels.

Knowledge of the soil reserves, coupled with the knowledge of the requirements of the turfgrass and the intensity of usage expected, will serve as a basis for development of the fertilization program. Keep in mind that turfgrasses require several times as much nitrogen as phosphorus and potash on a growing season basis. Soil tests usually do not give an accurate evaluation of available nitrogen; rather, growth, vigor and condition of the grass must be used as a guide for nitrogen fertilization.

In general, athletic field turfgrass should receive a total of six to eight pounds of nitrogen and two to four pounds of phosphorus and potash annually. Lime, if needed, should be applied in amounts indicated by soil tests. Lime (calcium) is an important plant nutrient and, in addition, renders other elements more available. Lime when pH reaches 6.2. A pH of 6.5 to 7.2 is most desirable for athletic field turfgrasses.

Timing of fertilizer applications needs to be keyed to growth activity and the necessity for obtaining color for special events. Complete fertilizers should be applied in early fall (four to six weeks before first killing frost). Organic (slow release) forms of nitrogen are suggested for supplemental feedings. Inorganic (quickly available) sources of nitrogen are suggested for use when the turfgrass needs a quick pickup in growth or color.

Watering: Controlled watering is one of the most important considerations in the development of good turfgrass. Water must be applied on the basis of turfgrass need (evapotranspiration) and in accordance with soil properties. Judicious use of water, coupled with aeration and proper fertilization, develops deep rooted turf that is wear-resistant, tough and not easily torn by player cleats. Removal of excess water by means of surface and internal drainage is necessary. Plants growing in waterlogged soil cannot function properly because of the reduced amount of oxygen available to the root systems.

On new seedlings, the field should be sprinkled lightly each day until the seed germinates and is well established. Thereafter, the amount of water applied should be increased in accordance with the grass need and the frequency of application adjusted to conform with soil characteristics.

Soils differ in their ability to absorb and hold moisture. Water should not be applied in excess of that which a given soil can take in and hold. When surface runoff is evident, water should be cut off. If the soil is not wet to the required depth (depth of root zone) wait until

the moisture has percolated downward and apply additional water.

Consideration should be given to the installation of automatic watering systems on old fields as well as new. The savings in labor and water cost as well as the control such a system permits, are sufficient justification to warrant installation.

Mowing: A sharp, well-adjusted mower is essential for the cutting of young turf. Mature turfgrass will be maintained in a far more satisfactory condition if the mower is kept properly adjusted and sharp. New seedlings should not be cut until they are approximately two inches in height. Only about one-quarter inch of leaf surface should be removed at any one clipping.

Mature football turf may be maintained at a height of one (1) to one and a half (1-1/2) inches. Sometimes, under unusual conditions, two (2) inches.

A few weeks prior to fall play, adjust the height of cut to that preferred by the coach and players. Do not make reductions in one clipping - reduce the height of cut gradually (1/4 inch) at successive mowings. Increase frequency of cutting if necessary. Generally, turf that has been properly managed will require mowing at least twice a week in early fall.

Vertical mowing to reduce thatch or mat may be required. Spring and early summer, when Bermudagrass is growing most actively, is the best time for this treatment.

Keep mowing equipment properly adjusted, oiled and greased. Rely on service facilities available from the manufacturer to see that equipment performs satisfactorily.

Programs for Disease, Insect and Weed Control

Disease: For the most part, control of disease on athletic fields and playing grounds is not practical. Leafspot is serious during spring months and may cause loss of grass. Chemicals are available if their use is deemed desirable. Check with your turfgrass distributor and follow manufacturer's recommendations for use.

Insects: Insects that attack grass may be classified in two groups: (1) surface feeders - those insects such as sodweb worms, cutworms and army worms that eat the leaves; and (2) sub-surface feeders such as grubs that eat the roots of grass.

Chemicals such as Chlordane, D.D.T., Heptachlor and Dieldrin may be used to control both groups of insects. For surface feeders, apply insecticide in the afternoon, leave the material on over night, then water it in thoroughly.

For a good general purpose spray, use a mixture of Malathion, Chlordane and D.D.T. Such will control most insects.

Chlordane provides an excellent control for ants and chiggers.

When spraying insecticides on shrubs and flowers, do not use a sprayer in which 2,4-D or 2,4-5T have been used. These latter materials are difficult to clean out of a sprayer and may damage shrubs and flowers.

Weeds: Chemicals are available for control of most weeds. All broadleaf weeds and crabgrass may be selectively removed from permanent grasses without damage to the desirable grass. Chemicals should be considered only as tools or aids in a permanent weed control program. Weeds invade turfgrass areas only when the grass is weakened for some reason. The first step in a successful weed-control program is to correct the basic cause or reason for the presence of weeds, then use chemicals to eliminate them. Grass may be weakened because of inadequate fertility, poor mowing, poor drainage or damage from disease or insects.

For control of dandelion, plantain, buckhorn and other broadleafed weeds, use 2,4-D as recommended. For control of clover, 2,4-5T must be used. A mixture of 2,4-D and 2,4-5T is desirable for knotweed and chickweed.

Treatment of all weeds in the early spring when they are young and growing actively is desirable. This is particularly true of knotweed and chickweed. Chemicals for both pre- and post-emergence control of crabgrass are available.

New chemicals are being developed constantly for control of disease, insects and weeds. Keep in touch with your local turfgrass supply house for new materials.

Summary of Recommendations For One Season

1. Cultivate the field twice lengthwise and once crosswise when grass is growing actively.

2. Break up soil plugs, fill, level and grade with topdressing mixture.

3. Apply fertilizer and lime in accordance with recommendations based on properly interpreted soil test. Use nitrogen to control the rate and level of growth.

4. Seed if necessary.

5. After seeding, top lightly with topdressing mixture. This is to cover seed and should be done unless the field has been aerated or scarified prior to seeding. Seed contact with soil is necessary for establishment.

6. Roll lightly to press seed in contact with soil and sprinkle slightly.

7. Water as per discussion.

8. Mow as per discussion.

9. Apply additional nitrogen as per discussion.

10. Develop programs of disease, insect and weed control and use when needed.

WEED CONTROL SPRAY TECHNIQUES

Turney J. Hernandez
E. I. du Pont de Nemours & Co., Inc.

It is a well established fact that any chemical is as good as the application. The emphasis placed by the manufacturers of weed control chemicals on good applications stresses this point.

The theme of the 1968 Southern Weed Conference, which is to be held at Miami Beach in January is "Proper Application - A Necessity to Good Weed Control." This theme further suggests the importance of the application in obtaining desired performance from a herbicide.

To a high degree, the type of application is determined by the weed control practice. As follows are the most important of these practices:

I. Type of Weed Control Treatment

A. Bare Ground (complete control of vegetation)
This treatment requires even distribution of a soil sterilant type chemical at a rate commensurate with soil type, rainfall, etc. Usually, it entails a high volume type application. In fact, spray volumes from 100 to 800 gals. per acre may be made. A flat atomizing type nozzle with a per minute velocity of 4 to 7 gals. per minute and spraying a swath width of 5 to 10 ft. is usually used. Complete wetting of the weeds as well of the soil is necessary.

B. Abatement Weed Control
This term denotes a high degree of control throughout the growing season without complete bare ground. It usually involves a spray volume of 50 to 150 gals. per acre with a spray boom or flat atomizing nozzle. Coverage of the plant as well as the soil is required.

A contact plus a long residual type herbicide are usually combined and a surfactant is often used.

C. Selective Weeding
This practice is used extensively on golf courses as 2,4-D, Banvel D or DSMA are often used to control certain plants without damaging the desired species. A spray volume of 25 to 50 gals. per acre is usually involved. A spray boom using cone type or flat spray nozzles is used. Careful calibration to assure proper volume and dosage is necessary.

D. Chemical Trimming
This treatment involves the use of a contact herbicide in

sufficient water to obtain complete coverage of the plants. Good wetting is necessary and a surfactant is usually used. A hand gun or hollow cone type of spray is used. However, a full cone spray pattern may also be applicable. The contact type of chemical produces a quick kill of the vegetation without damage to root systems of valuable trees. This treatment is used extensively around the home, on golf courses, or in drainage ditches to control undesired plants in close proximity to valuable vegetation. Two to three applications may be required to effect season long control.

E. Brush Control

1. Summer foliage application - This is a high volume type of treatment requiring 200 to 400 gals of total solution per acre. The height and density of the brush will determine exact spray volume required. Pressures of 300 to 400 lbs. per sq. inch and a disc size in the spray gun of 5 to 10 is required.

   During the application, it is important that stems as well as foliage are saturated with the spray. On tall brush, an upright oval type of spray gun movement is desired. The gun is aimed at the base of the plant then aimed up toward the tips, and moved in an "upright oval" type of motion until the plant is completely covered.

2. Dormant cane treatment - This requires the use of a hormone type brush killer in diesel fuel applied in 100 gals. or more per acre and directed to the base of the brush. It requires pressures of 100 to 300 lbs. per sq. inch and a broadcast or directed broadcast type of treatment.

3. Basal 2,4-D -- 2,4,5-T or 2,4,5-T disel fuel - This treatment is usually made with a hand sprayer using a cone type nozzle directing a spray concentrate to the lower 18 inches of woody plants. Pressures of 30 to 50 lbs. per sq. inch are usually adequate and the chemical is applied to saturate the bark so that it drips into the root crown area. A power sprayer may also be used.

4. Soil application of Bromacil - This application is very similar to the bare ground application but it is directed to the root crown area of brush on fence rows or in drainage ditches so that a strip 3 to 6 ft. wide is treated. A 65 to 80° flat atomizing type nozzle is used and a spray volume of 100 to 150 gals. per acre is applied. Even distribution of the chemical to the soil surface is necessary.

5. Frill treatment - In this treatment the chemical is applied in oil with a hand sprayer using a cone type nozzle directed into cups or frills made with a hand axe around the base of the woody plant.

II. Types of Applications

A. Foliage

This requires complete wetting of foliage used pressures of 50 to 150 lbs. per sq. inch. A hollow or full cone type of nozzle is often used. Flat spray nozzles may also be used. Both sides of the leaves, petioles and stems are completely wetted.

B. Broadcast

This treatment is used in selective weeding, bare ground, and abatement type of application so that complete coverage of all plants and the soil is obtained. A boom or flat type of nozzle may be equally effective. The nozzle size is determined by desired speed of travel and spray volume.

C. Directed Sprays

This type of application is involved in chemical trimming, dormant cane brush control, basal 2,4-D - 2,4,5-T, and brush frill type sprays.

III. Types of Nozzles

A. Hollow Cone

This type of nozzle may be used for application of insecticides or fungicides or foliage weed control sprays where complete coverage of the plants is required and a boom is utilized.

B. Solid Cone

These have limited usage similar to the hollow cone.

C. Full Square Nozzle

These nozzles put out a solid square spray pattern. They have had limited usage to date but in railroad type treatments where high speeds are desired, they are proving very satisfactory.

D. Flat Spray Nozzles

1. Flooding type nozzles - These are 180° nozzles and the spray is not atomized. They are not as accurate as flat atomizing type of nozzles but have been used extensively in broadcast type applications where single nozzles are desired and wide swaths are required.

2. Atomizing nozzles - These are flat nozzles which break up the spray so that good coverage can be obtained. They will vary in size and angle of spray.

3. Off-center - As the name indicates, they spray to the side. They are capable of spraying 10 to 20 ft. depending on the height, pressure, and angle of spray. They are particularly useful in spraying drainage ditches or when it is desirable not to walk into the treated area.

4. Boom jet nozzles - They are a reasonable substitute for a boom and are particularly useful when broadcast applications of low volume treatments are made in wooded areas or where obstructions prevent the satisfactory use of a boom. They are not as accurate as a boom and may present considerable drift problems.

E. Pneumatic Atomizing

Of academic interest only.

F. Fogging Nozzles

Of academic interest only.

IV. Nozzle Details

A. Spray Angle

Denotes swath width
110°
80
70
65
40

B. Nozzle Size

Determines volume in gals/min at X lbs. of pressure
08
10
20
30
40
100
200

C. Pipe Size

1/4, 3/8, 1/2, 3/4 inch sizes are marketed. These nozzles also come with female or male connections.

V. The Hand Gun

A. The disc size and pressure determines gallons per minute. Large discs and high pressures are desired in tall, thick brush or where heavy vegetation requires high gallonage. They also facilitate faster movement during the application.

B. A pistol grip is usually desired for quick cut off. However, the hand twist turnoff is also very common.

C. With most guns, by turning the barrel, it is possible to adjust the swath width and distance. You open the gun to shoot for distance and you close the gun for close up work or quick coverage.

D. Spraying with the hand gun - For broadcast type applications, the hand gun results in poor or uneven coverage, there is often wastage. It is also slow and hard work. But, it is ideal for spraying brush in foliage applications as discussed previously.

VI. Boom Spraying

This involves the use of multiple flat atomizing or hollow cone type nozzles spaced at regular intervals on a pipe or structure to facilitate spraying of wide areas. It is usually used on golf courses, lawns, drainage ditches, and other open areas for mass spraying at low volume. It is fast, gives good coverage and is easy to calibrate. The nozzles should be spaced to overlap 50% on each side, resulting in 100% overlap. They are impractical in wooded areas or on rough terrain.

It is important that when using a boom on a spray truck that a tachometer be used for calibration. Operating at a tach speed is more accurate than speedometer reading when using a tractor, the gear and throttle setting should be determined.

VII. Using Flat Spray Nozzles

These nozzles have proven very satisfactory for medium to high volume applications and where flat spraying or broadcast type applications are made. If wide swaths (upwards of 10 ft.) are desired, then 80° to 110° nozzles should be used. If swaths of 4 to 10 ft. are desired, then 65° or 70° nozzles might be utilized. These nozzles can be purchased in 1/4, 3/8, 1/2, or 3/4 inch sizes. Volumes of 1 to 20 gals. per minute sizes are common.

No booms are required, they are easy to use as the applicator moves at a pre-determined speed in paces per minute. They are light to handle, give uniform coverage, and are inexpensive to purchase. The size to best fit the application sould be purchased.

VIII. Mixing Instructions

The following procedure is suggested:

A. Fill tank 2/3 full with water

B. Start agitator

C. Add chemicals, turn off agitator

D. Finish filling tank

E. Add surfactant if any is to be used, start agitator

F. Spray

IX. How to Calibrate

A. Set operating pressure in gals. per minute.

B. Determine nozzle capacity by placing gun or nozzle in a 5 gal. can and determine the amount collected in 1/2 to 1 minute.

C. Set the volume per acre and per 1,000 sq. feet.

D. Determine the time to cover 1,000 sq. feet with this volume.

E. Using clear water, practice making an even application with this volume on 1,000 sq. ft. in this period of time.

A formula which has geen effectively used to determine the proper application, speed, nozzle size, gallonage per acre, or width of spray band when 3 of the 4 factors are known is as follows:

$$\text{Speed in ft./min.} = \frac{\text{Gals./min. of nozzle}}{\text{Gal/acre}} \times \frac{43{,}560}{\text{swath width}}$$

X. Summary

There is no reason for poor weed control today. Good spray equipment is available to do the job properly. The right nozzle is also available. And, there are plenty of people around who are trained to help the customer apply it properly.

We as suppliers must see that the customer is afforded this service so that he will get good weed control at an economical cost.

CUTTING LABOR COSTS IN TURF MANAGEMENT

J. R. Watson
Director, Agronomy Division
Toro Manufacturing Corporation
Minneapolis, Minnesota

In the past few decades, there have been many changes in outdoor recreation and activity. In the turfgras field, there are new grasses with somewhat different maintenance requirements, there are new materials to control old and new pests and there is new equipment to maintain and to groom turfgrass areas. From a use standpoint, there has been a dramatic increase in demand. To cite only one example: Grover Keeton, in the November, 1967, issue of TNT, reported that in 1927, when Jack Goforth took over as superintendent at Tenison Memorial Park, approximately 30,000 rounds of golf were played annually. Some four years later, (1966) 60,000 rounds were played on only one of the two 18 hole courses - 116,831 rounds were played on both! Concurrent with the increase in numbers of people using turfgrass facilities, has been an ever increasing, and very vocal, demand for continuing improvement in the quality of turfgrass. And there is every likelihood that changes and demands of equal or greater magnitude will continue. In fact, the pace of change - technological and sociological - in the world today practically guarantees a future greatly different from the past or the present.

The basic need for turf areas as places to relax, to play and to filter the atmosphere of our urban, suburban and perhaps even some rural areas will become increasingly important. Projections for population increases and availability of leisure time assure a continuing need.

The population of the United States reached 2000 million on November 20, 1967. This was an increase of 100 million since 1915 (52 years ago). Significantly, the next 100 million increase will occur in just 30 years - 1997. Today, most of us work an official 40 hours each week; however, there are groups working only 32 hours a week and there are predictions of only a 20-hour week in the next few decades. Yet, productivity continues to rise. Why? Obviously, industry as a whole has found ways and means of increasing output per machine per man. Basically, such has been accomplished by automating machinery and equipment. The resulting increase in production has given rise to unprecedented leisure time and a very significant increase in disposable income. Some of this, the individual spends on outdoor recreation directly as a participant and some indirectly as a spectator.

It seems then that we will have more people using recreational facilities and that each of them will have more time and money to spend on recreation. Chances are good that each will demand continued improvement in turfgrass quality. Such can only mean increasing pressure on existing facilities and a requirement for new facilities. Many cities

are already hard pressed for open land and are using areas for park sites and golf courses that were formerly considered unsuitable. Some of the marginal areas - dumps, swamps, peat bogs, gravel pits and severely gullied sites - will perhaps present unique maintenance demands.

The central problem facing the turfgrass and recreational field is to provide adequate facilities and to produce the kind of turfgrass that can stand up under the heavy usage to which it will be subjected. And, this has to be accomplished while all the business costs - labor, materials and taxes - are increasing. This is a real challenge! There may be many ways and means to meet this challenge, but as has been the case with industry, mechanization, automation and labor saving will play a very key role.

The turf industry has made much progress in reducing operating costs and, at the same time, improving the general quality of turfgrass areas. Yet, today labor costs are estimated to be 65 to 75 per cent of the annual maintenance budget on turfgrass areas, more specifically golf courses. Cutting labor costs provides the greatest opportunity for efficient operation. Efficiency in this case implies the development and maintenance of the highest possible degree of turfgrass quality and player acceptance commensurate with a given expenditure of time, energy and money.

Mechanization and automation of equipment to conserve costs - to reduce labor - will be major design criteria for turfgrass equipment of the future. Such represents a logical developmental program and will simply continue to emphasize the performance trends and design criteria of current equipment. These may be cited as: labor saving and, therefore, cost saving through greater capacity machines that handle more acres per day per man, increased maneuverability, greater durability and less fatiguing for the operator. Examples in three areas of maintenance of such equipment are the advanced automatic irrigation systems with individual head control, tractor mounted hydraulically operated mowers and the high lift, hydraulically powered, articulated aerial boom used in tree trimming.

This latter example when combined with the chippers, blowers and trucks used to reduce tree refuse - branches and trimmings - begins to approach a machine system and is only one example of the trend, and need, in development of debris collecting and disposal equipment. Another example of a labor saving machine system is the hydro-seeder-mulcher unit used in establishment of turfgrass areas. This unit is no longer restricted to just seeding operations. It handles seed, sprigs or stolons, fertilizer and mulch. It is being used for all types of turfgrass areas including golf courses. Use of such equipment aids substantially in cutting labor costs in turf management.

Another area of labor saving or cost reduction that needs to be explored has to do with effective use of presently available equipment.

To determine if equipment is being used effectively, one should ask certain questions. For example, what, when, why, where, and how is a job to be done. Who can do it best and how long does it take to do the job. If you can answer all these questions and be assured that you have given the best possible answer, then your equipment will be used effectively and labor costs will be minimized.

Good planning and adequate records are basic to effective use of equipment. Good plans will provide many of the answers to the above questions.

Planning for effective use of equipment begins with a detailed study of the layout of the turfgrass area or areas. Ideally, a scaled layout of the golf course, park, school grounds, etc., should be prepared. If more than one park, campus or cemetery is involved, all should be mapped individually and then brought together (on a reduced scale) on a master layout. Such a layout should show the various landscape and terrain features; roadways and bridges; and the location, size and shape of special features, such as ball fields. When a golf course is under study, it may prove advantageous to show the entire course. From a layout, coupled with a knowledge of the necessary maintenance practices and capabilities of the machines to be used, plans for effective use of equipment may be developed.

These plans should be developed along two lines - an "immediate" or "short-range" plan and a "long-range" program.

(Editor's note: These have been discussed at previous conferences and are included in this paper for clarification.)

Immediate Program

The objective of this program should be to determine if the area or areas concerned, in their present condition, are being maintained as efficiently as is possible with equipment on hand or available for purchase. This involves, among other things, an examination of the capacity, mobility, maneuverability, sturdiness, durability - as well as a study of the maintenance records on each piece of equipment to determine annual service and repair costs. When contemplating the purchase of new or replacement equipment, satisfy yourself that you are making a wise choice. Know the actual time involved in cutting and the transport time between cutting areas. Compare the performance of the old versus the new. Determine, for example, the time involved in cutting with pull type gange versus integrally mounted, hydraulically operated 30-inch cutting units. Replacement of inadequate and costly (from the standpoint of operation) equipment with units that will produce more work per man hour of operation will permit more effective use of equipment. However, since equipment purchases are essentially capital expenditures and certain types may last from five to fifteen years, no equipment should be purchased except within the framework of a long-range program.

In addition, the manufacturer or his representative should be consulted on the type of equipment needed. Information on new equipment and improved features, as well as the suitability of their equipment for the job at hand, is readily available from the reliable manufacturer. The availability of parts and service facilities is of prime importance when selecting equipment. If repair parts are not available when needed and a machine is inoperable for extended periods, it is of questionable value and certainly will contribute little to effective use of the equipment.

Long-Range Program

This approach is basically a modernization program. Many of our turfgrass areas were designed and constructed during an era when labor costs were negligible and mechanization of little importance, thereby creating many time-consuming operations requiring the use of low capacity, and often costly equipment. Landscaping may not have been planned. Instead, it may have grown haphazardly over the years and with little thought to the maintenance demands created. Shrubs and trees requiring specialized care in the way of spraying, trimming, etc., and often located in such a manner as to interfere with large capacity mowing equipment - thus requiring additional time-consuming operations to maintain surrounding turfgrass - to not contribute to efficient operation. Such areas should be due for a face lifting. Without such, the use of several small units or a combination of one large and one or more smaller units may be the more effective way to use equipment.

A long-range program of redesign in keeping with modern trends; landscaping calling for elimination of problem trees and shrubs; substitution of more hardy species requiring minimum maintenance and location to accomodate equipment with greater capacity; replacement of obsolete irrigation systems with modern automatic systems; and, perhaps most important, the construction of specialized, intensively used areas such as golf greens and athletic fields, employing the latest materials and techniques developed through research will, unquestionably, contribute to effective use of equipment and to efficient operations.

Work Plans

Plans and programs involving effective use of equipment should stimulate constructive thinking about the jobs to be done and cutting labor costs. For example, where is the job to be done? Obviously, a green has to be cut on the green, but the question is "which green"? If the job is cup setting, which holes are to be reset? This decision then determines where the employee goes to do the work. The sequence of greens cut or holes reset may be chosen to require the least travel time between holes or they may be chosen because a particular mower is more suitable for cutting the contours of certain greens. A scaled layout will help with the decision.

Maintenance work may be done on equipment in the field, in a shed, or in a well-equipped shop. The most economical answer may not be the most obvious. Do not be fooled into thinking that because a certain route or certain practice has always been done in this manner, that the job cannot be accomplished in a more efficient way if it is carefully analyzed and studied. The objective is to keep the equipment operating efficiently - then it is being used effectively!

How long does it take to do a job and how is it to be done? As you prepare plans and study employees' activities, the following two questions are going to keep coming up:

1. How much time should it take to do the job?

2. How much time does it actually take to do the job?

The second question can be answered by keeping records on how many man hours are required to cut a certain area or to perform any of the other projects and jobs. Such records do not usually tell how well the job was done or by what method it was done or how much idle time (for the machine and for the operator) occurred while the job was being done. Often, too often, there is a vast difference between how long it takes to do a job and how long it should take to do the job. Studies of industrial operations show that 10 to 50 per cent of a man's day may be spent in idleness or nonproductive work. An interesting fact about this idle or nonproductive time is that roughly two-thirds of the idleness is the result of inadequate supervision or management and on the average only one-third is chargeable to the man himself. To properly answer the question of how long the job should take, break it down into elements or steps and determine how long each takes by the best available method. Then, put together the necessary steps to arrive at the total time the job should take if there are no delays or wasted time.

A good supervisor must know what he wants his men to do with equipment, tell them what he wants done and help them to do it in the best possible way. By so doing, the operators will be properly instructed in why they are using a piece of equipment and what they are using it for. Effective use will result.

Maintenance

As we move into the development and use of more complex equipment, the need for more knowledge becomes imperative. Those charged with supervision and maintenance of this equipment must thoroughly understand its function, its design and its service requirements.

For the present, read and study service manuals. Attend manufacturer and distributor sponsored service schools. Train operators to handle routine service checks. Cut labor costs by training and developing competent and knowledgable crew members.

Keep Records

Consult with the manufacturer and his representative to see if your records of operation and performance conform to the expected levels for the particular unit. If not, why not? What phase of your operation or maintenance is contributing to a failure of the equipment to perform as designed? Only with adequate records showing hours of operation and annual service and repair costs will you be able to pin-point responsibility and to determine if the equipment is being used effectively.

Continued improvement in managerial skills, ability to recognize and to take advantage of new developments in mechanization and automation along with development of plans and programs to use current equipment effectively will provide the ways and means to meet the challenge of increasing costs and more intensive usage of our turfgrass facilities and to cut labor costs in turf management.

CHANGING BERMUDA VARIETIES ON GOLF GREENS WITHOUT FUMIGANTS

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

This paper will describe what we did at Houston Country Club to change our Gene Tift greens to Tifdwarf.

Some three or four weeks before we intended to play them we started work on our temporary greens. We used the fairway in front of our playing greens, and the best location we could. First, we cut all the grass we could with a greens mower; then we used a Rogers aero blade with two inch spacings, and cut the temporary two different ways. We then cut the green again with the greens mower followed up with lime and fertilizer and top dressed. Some three or four days after the topping was watered-in, we started mowing with our regular greens mower and continued mowing them the same as our regular greens.

The greens we were going to work were sprayed with MH30 seven days before the sod was to be removed. The Maleic Hydrazide (MH30) was sprayed at the rate of two gal. with fifty gal. of water per acre. We used only one gal. at a time with twenty-five gal. of water. With this amount we could spray two greens at a time. It is recommended that MH30 stay on the greens seven days before sod is cut. After seven days we cut and moved the sod from the greens. It took us 1-1/2 to 2 hours to cut the sod. This was done with a 24" sod cutter with cut off attachment. Sod was cut 2" deep. After cutting over the green one time we raised the cut off attachment and went back over the green; in doing this we ended up with sod cut in 1-ft. squares. With seven or eight men we were able to move a little more than 1000' of sod an hour. We cut and moved the sod off the greens for about $100.00 per green in labor. The greens averaged 8000 ft. and we cut an average of 10,000.

After the sod was removed work was started to smooth the green where we had been on it with our truck. We used a wood drag or float 6' × 8', with angle iron on the cross bars in which there were three on the drag, to level the green. The drag was pulled with a light golf tractor, until the green smoothed out or all the truck tracks were gone. We did not change the contour of the greens. We lowered the elevation 2", which is about what had been applied in topping since 1957. On the edge of the greens we used a hoe in some places to level or slope the edge back, and in other places we added topping to get back to grade.

We then applied lime and fertilizer. We used 30 lbs. of dolomite lime per 1000', 30 lbs. of 8-4-4 organic base fertilizer and 25 lbs. of milorganite per thousand. We are now ready to start planting. A verti-cut with 1/2 set of knives was used to cut the sprigs from our nursery. This gave us the type of planting material we wanted. Sprigs were cut, raked up with a leaf rake and put into containers so they could be moved

to the green. Some 5 to 6 bushels was planted per 1000 sq. ft. The sprigs had little opportunity to heat in view of their being planted within 20 minutes of being cut.

Sprigs were applied as uniformly as possible. The sprigs were dropped straight across the green, and the top dressing machine working as close behind as we could. Behind the topping we started the water. We used a 3/4" garden hose 75' long with a shower head to water and used only about 50 lbs. pressure so as not to apply the water too fast.

The topping was applied about 3/8' thick. This seems to be ample topping. We did find out that it is hard to put too many sprigs but they could be top dressed too deep. In starting the first greens the men running the topping machine overlapped some four or five inches, and where the double topping was applied we were much longer getting coverage.

We planted our first green June 28 and it was put into play August 19 or 7 weeks and 3 days later. No. 9 green was planted August 15 and put into play September 23, only 5 weeks and 5 days later.

Just a little about our nursery -- we have about 40,000' and it was planted June 1, 1967 with certified springs from Sea Island, Georgia. The area used for a nursery was the outer end of the driving range. Only 28 days after we planted our nursery we planted our first green. I feel sure the sprigs we harvested for the last greens were better than the first ones and believe this is one reason why we were able to play the last greens much quicker than the first ones.

I might tell you a little about the sod we took off the greens. It was stock piled to be reworked and used again. We are running it through the Royer. Picking it up again and running it back through the Royer and on to the Royer shaker screen which removed the grass (hay). The shaker screen dumped on to our truck to move it to our mixing area. The original greens and topping was a 3:1:1 (sharp sand:sandy loam soil and peat) mix. It is my estimate that the soil removed from the green was a 3:1:3, much higher than the original mix in organic matter. We mixed one part sand to two parts of this topping and back into our top dressing bins to be used again.

We were able to run about 4 yds. an hour over the shaker screen. If the material was a little drier we probably could run more. We use five men to run this material at a cost in labor of about eight dollars and twenty five cents an hour. I believe this material is much better than what I could mix due to the fact that it is composted and will not separate out like newly mixed material.

We converted 9 greens in 1967. We will convert the others during the summer of 1968. The procedure described here will be used in 1968.

NEW DEVELOPMENTS IN DISEASE CONTROL IN TURF

Robert T. Miller
Turf Specialist, Industrial and Biochemicals Department
E. I. du Pont de Nemours & Company
Wilmington, Delaware

It is a pleasure to attend the Texas Turfgrass Conference again. It is amazing the way turf conferences have grown the last few years, including your own which I last attended three years ago. However, when we realize that turf is now one of the largest agricultural crops in many states, and is continuing to expand, it is easy to understand why it attracts so much interest from many colleges and individuals.

Not too many years ago a person seeking information about turf or turf culture had a choice of only three or four schools. Today, practically every state university can provide excellent information on the subject. Texas A&M is no exception. In fact, as the state of Texas is a leader in many fields, Texas A&M is considered a leader in the turf field.

Because turf is a rapidly expanding field, there are constant questions about new developments in disease control or management practices. At du Pont, we are asked constantly, "What new products do you have this year?" I've often thought that this type of question is just a conversation starter, because anyone who is knowledgeable about the development of agricultural chemicals knows it is impossible to develop a new product every year.

On one of my trips a few years ago I had a conversation with a salesman selling women's clothing. He asked how often we introduced new chemicals. I explained we were constantly screening new materials, but that we considered ourselves most fortunate if we had a new product every five to ten years. He told me that in his business it was essential to have at least two model changes a year to keep current, and they actually wanted more. How would you, as a turf manager, golf course superintendent or supplier, become knowledgeable about products if we marketed a new fungicide, insecticide, herbicide or nematocide every year? This problem would be compounded if every manufacturer could do the same thing.

Some seem to think that it takes only weeks to move a new chemical from the laboratory to commercial product. This is not true. The development of a new product takes years of experimental work and study. In many cases, chemicals never become salable products, even after years of work.

Like many other companies, du Pont is constantly screening new chemicals for biological activity. In a year we will screen thousands of these compounds, but the odds against any of them becoming a salable product are very high. The odds on a hole-in-one in a major golf tournament might be a better gamble.

Before it becomes available to the golf course superintendent, farmer or commercial grower, a chemical must survive a series of increasingly complex investigations. Judgments and decisions must be made all along the way by people of many and varied backgrounds, both within and outside the du Pont Company. Many years may elapse before there is any assurance that a chemical will live up to its promise and justify the time and money expended in its development.

A product that some of you may be familiar with -- "Tersan" -- was in development several years before it was available as a commercial turf fungicide. In fact, turf tests and other work were so time-consuming that "Tersan" was sold as a commercial product under patent protection for only 10 of the usual 17 years. That was back in the early 1940s, and it is even more difficult to register a product today. More data are required now, and each year the standards get more exacting.

If I may interject a though here, let me urge you to please read and heed labels on all agricultural chemicals. The labels are provided for your information and protection, and the data they contain are based on extensive research and development work requiring much time, effort and money.

Although new agricultural chemicals do not appear as rapidly as styles change in ladies' fashions, there still is a constant flow of them from many manufacturers. In recent years, Chemagro has offered new products, Diamond Alkali has made contributions and Mallinckrodt has developed some new combinations. Du Pont now is testing a new systemic fungicide which looks most promising for turf. Starting with the introduction of the first turf fungicide -- an organic mercury -- in 1923, we have made rapid technological strides in the turf grass industry. It becomes more apparent each season that disease control in turf is accomplished through a complete program which uses the best product or combination of products. We believe this is true of practically all turf problems.

Many superintendents look for the cure-all, or perfect product, that will solve all their turf problems. There is no such thing. Do not expect the impossible, but rather develop a program which will make use of the best materials and equipment available. Apply them properly and with good judgment and your results should be favorable. Of course, you must define your problem correctly or no product can do the best job. For example, when 2,4-D was introduced it offered complete control of broadlead weeds. But when you kill one weed another will grow unless you have vigorous, healthy turf. In other words, the weed killer is only one part of an effective program.

Likewise, I have seen mowing equipment fail when it was not adjusted properly, or when it was used in areas where there were more stones than grass. These are instances where good judgment is essential.

In these examples, neither the equipment nor the chemical was at fault,

but, unfortunately, the manufacturer's reputation was in jeopardy until all the facts were learned and explained.

We have all heard the story about the superintendent who complained that a fungicide would not control dollar spot, when the problem actually was cut worm damage. Last summer we called on a golf course where the superintendent was complaining about this problems with dollar spot and the failure of fungicides. When we checked the area, we found his problem was melting out caused by Helminthosporium.

Let me reiterate, identification of the problem is always a necessity. No matter how effective equipment or chemicals are, they must be used properly to enable them to function at the limit of their effectiveness.

Over the years, we have many new developments in disease control and all phases of turf management. There will be many more and they will come from many sources. Manufacturers will produce new chemicals and equipment that will do a better job than those currently in use. However, they will have limitations and perhaps the user will have to spend more time and effort to get the most out of them. The experiment stations and turf schools will learn about and suggest the use of tools in better management programs. The competition between golf courses for competent superintendents or turf managers will increase -- "man" will become an increasingly important part of management.

The superintendent will face both a challenge and an opportunity. The challenge will be his willingness and ability to keep pace with rapidly changing developments. Opportunity will unfold for those having skills in these new technologies and the vision to apply them in new situations for greater overall work efficiency.

The need for professional turf specialists will increase. Not only will there be more golf courses, but competition between golf and other recreational activities will become more intense as man's leisure time increases. Many of these other activities will need professtional turf guidance and the superintendent who has stayed current with developments will be the logical candidate.

Gentlemen, there have been many new developments in all phases of turf management and these developments will continue -- new chemicals, equipment, cultural practices. But until problems are identified properly, the solution may well depend upon the man. Improved products and equipment are developed and offered for sale to aid in solving problems, they are not and cannot be a substitute for the "man" in management.

THE USE OF SURFACTANTS WITH HERBICIDES

M. G. Merkle
Department of Soil and Crop Sciences
Texas A&M University

Introduction. When applying herbicides, three factors make it important that we use the minimum amount possible. These factors are:

1. Minimum dosages reduce costs.
2. Minimum dosages reduce hazard to crops.
3. Minimum dosages reduce environmental pollution.

There are several means of reducing the required herbicidal dosage. Among these are proper placement, proper time of application and proper use of surfactants.

Definitions. The word surfactant was introduced as a shortened form of surface active agent. A surface active agent is defined as a material which alters surface tension. Surface tension is caused by the attraction of one molecule for another molecule of the same substance, i.e. a water molecule for another water molecule. This force causes a liquid to stay in the small possible area usually a sphere or a drop. Almost any material dissolved in the liquid weakens this surface force and could be considered as a surfactant. However, all substances are not equally effective in reducing surface forces and most of the efficient surfactants have certain properties.

Properties of surfactants. An efficient surfactant has two distinct portions. One portion is water soluble (hydrophilic) and the other fat soluble (lipophilic). Thus, if the surfactant is added to water, it forms a film around the water droplets with the hydrophilic portion turned toward the water and the lipophilic portion turned away from the water. This arrangement not only reduces the surface tension of water but also reduced interfaced tensions between water and oil, fat or wax.

How does the surfactant increase herbicidal effectiveness? The net effect of a surfactant at a water-wax interface is that the water does not form small spheres but is spread more uniformly over the wax surface. This increased wetting is one possible explanation of increased activity. A second possibility is that the surfactant aids in the penetration of the cellular membranes. These membranes are believed to have both water and fat barriers and the surfactant could assist in overcoming these barriers.

Types of surfactants. Surfactants can be non-ionic, anionic or cationic. Many of the commercial surfactants are a combination of two or even all of these types. The non-ionic and anionic types are most commonly used for agricultural purposes. In general, non-ionic types perform better in hard water while anionic types are best suited for cold, soft water. The cationic types are expensive but are sometimes used in invert emulsions.

Pre-formulated surfactants. Many herbicides are formulated to include the surfactant. In these instances the gallonage per acre is also usually specified. To be most effective the surfactant-gallonage ratio should be maintained. Since the gallonage per acre varies with aerial and ground application, many applicators prefer to add their own surfactant.

Effects of surfactants on herbicidal properties. The addition of a surfactant sometimes completely changes the herbicidal properties of a compound. For example, diuron and atrazine were widely used as pre-mergence herbicides but had little post-emergence activity. However, addition of a surfactant has enabled us to use the chemicals for post-emergence weed control in cotton, corn, and sorghum. In general, the addition of surfactants will increase the activity of ionic contact herbicides such as paraquat, DSMA and MSMA. Recently reports have been published that surfactants may also influence the adsorption of herbicides by soil. The significance of this finding has not been determined.

Cautions in using surfactants. Surfactants not only increase the activity of herbicides but they often decrease selectivity. Reports have been made that certain urea herbicides could be used to remove pigweeds from soybeans. However, when certain surfactants were added, the selectivity was lost and the herbicide was also toxic to the soybeans.

WATER CONSERVATION IN TURF IRRIGATION

Albert W. Crain
Agronomist, Goldthwaite's of Houston, Inc.

Introduction

All of us are concerned in one manner or another with water and turfgrasses. It is doubtful that I can tell you anything entirely new. I hope that this review will help you make more efficient use of water and result in better turfed areas and also stimulate your thinking and enthusiasm toward more efficient use of water.

Since plants are about 90% water and the soil underneath, when in good condition for growing plants, is 25% or more water maybe we should refer to water instead of turf management.

On Water Consumption

Water use in the U.S. in the last hundred years has increased from a few gallons to about 700 gallons per person per day; this will increase, plus the population doubling again in a few years.

Water consumption by hydroelectric power plants, water for food production, water for sanitary uses and others I'm sure to be classified as more essential than turf production. Thus, we in the turfgrass industry have a challenge to make efficient use of water. When the drilling of wells for municipal use becomes critical could the administrators tell their park people not to use water and further tell the country club within the water district that the one well is all they may have on their property?

Think with me during the next few minutes in terms of tools to use in conserving water.

Turf Itself Is A Soil and Water Conservation Tool

Turfed areas are the most practical means of slowing water runoff, holding soil as on hiway turf. Turfed areas are a means of purifying, not polluting it.

Water Quality Affects Quantity Needed

Any degree of hard water to salt water represents degrees of increase in water needs of a plant. High levels of salt accumulation affect plant growth in two ways. As salt accumulation increases water becomes less available to plants. Therefore, turf on salt affected soils needs more frequent irrigation than grass grown on a soil low in salt content.

Pesticides Are Moisture Conservation Tools

Weed, insect and disease control are grouped together here. Disease

laden and/or insect riddled turfgrass obviously is not a water conserving type of plant. Weed control cuts mowing costs, improves appearance and usefulness of turfgrass and other reasons and we seldom think in terms of water conservation in this regard.

Fertilization Cuts Moisture Requirements

Proper planning a fertilizer program may cut labor costs as well as conserve moisture. Fertilize in late spring after one or two months of spring growth on fairways or parks or other non-heavily used turf and weeds are not a serious problem. Initial spring growth is normally greater than one can keep up with without fertilization.

Fertilizer quality is another subject; suffice it to say that organic nitrogen fertilizers do not promote hay type growth normally resulting from use of soluble nitrogen materials. Organic fertilizer materials promote slow growth requiring less water. Light, frequent applications of soluble forms begins to approach efficiency.

Soil testing and soil fertility balance are important aspects of this efficient water use picture.

Lime is one of the greatest water saving tools available to the turfgrass manager. Dolomitic limestone on bermuda east of a line drawn from Corpus Christi to San Antonio to between Dallas and Fort Worth and on north across the U.S. is one of the least expensive and mose useful things a turfgrass manager can use to improve quality of turfgrass and decrease water consumption.

On Making Use of Soils As A Management Tool

Light and more frequent applications of water are necessary on sandy soils. Clay or heavy soils can take water at a much slower rate than lighter soils. Heavy soils are more difficult to manage because of slower processes as gas exchange, chemical breakdown of plant food, temperature and others all related to plant growth. They influence growth efficiency and moisture use.

Poorly drained soils make for poor efficiency in water use. Wet soil is oxygen deficient soil and this means poor water use.

Turfgrass Irrigation As A Tool In Conservation

Water applied faster than the soil can accept or take it is wasted water. We have been hearing, "Heavy infrequent watering is better than light frequent watering." This is a grass man or soil man's statement and there is nothing wrong with it. It is OK if one puts more emphasis on the first sentence in this paragraph.

When sprinkler manufacturers make what the soils man may think he wants, no one will use it. A sprinkler applying water at a low precipitation rate has too many bad features. One must consider a sprinkler system not a sprinkler.

Automatic Irrigation Conserves Water

The big factor with regard to differences between manual and automatic is control. In order for either to work the system must be adequate and properly designed.

Water absorption is maximized and run-off is eliminated.

Seasonal requirements are met by variable time cycles. Short cycles supplement spring rains. Repeated short cycling (with intervals for absorption) in hot dry summer prevents run-off on heavy soils and longer cycling can be used on lighter soils. With a system properly designed and installed, complete control over individual areas is possible with automation. But impossible -- impractical -- because of physical distances and labor involved in changing or moving sprinklers in a quick coupling or hose system.

The true value of an automatic system is in its constancy: always on duty; available and immediately available to supply needs according to demand or requirement. A practical means of preventing waste.

Complete control of irrigation and freedom from the problems of overwatering and underwatering may be built in an automatic system. The changing of a watering time is at the finger tip of the turfgrass manager directly not by him thru the night water man who lacks knowledge and appreciation for such change.

With automation the golf course superintendent becomes the night water man. The coach eliminates the high school student. The park man, cemetery man, the turfgrass manager becomes the water man and he is in position to appreciate the value of water.

We should wake up to the value of wasted water. The question has been can one afford the additional cost of automatic irrigation? If one considers the cost of water it would seem that we cannot afford to be without the water saving facilities of automatic irrigation. This economic aspect is one, but the main aspect of automatic irrigation is in the control afforded the superintendent. The ease with which he may change a program. If one does not appreciate the value of water, is not inspired to conserve water, or improve turfgrass or want to take command of facilities at his disposal then maybe he should not have an automatic irrigation system.

With so many factors involved and interacting on each other, it should be clear that a turf irrigation schedule must be flexible. It must be based on needs, changing needs, based on many things.

Factors Involved In Sprinkler System Design

This may have been what the program planners had in mind for me to cover in detail. They represent only one aspect of a properly designed sprinkler system.

Sprinklers distribute water in a circle. Assuming that a sprinkler is operating at the proper pressure; then the water pattern of distribution is a decreasing precipitation rate as the distance from the sprinkler increases.

If one drew circles 2 ft. and 6 ft. from a sprinkler then a circle 38 and 42 ft. from the sprinkler he would have two rings each 4 ft. wide. One ring is some 10 times further from the sprinkler than the other. The total area of the outer ring is some 10 times greater than the inner ring.

Combining two sprinklers improves the pattern and three makes an even more uniform pattern, note illustration. On single row systems, sprinklers are normally spaced closer than the radius of throw. With rectangular pattern of sprinkler distribution, they are normally spaced about 60% of the diameter and triangular spacings about 70% of sprinkler diameter. The most uniform and efficient distribution pattern with all factors considered would no doubt be one with spacing equal to radius.

An irrigation engineer commented in a nationally distributed magazine in 1967 that we will have to live with inequality unless someone develops a sprinkler capable of varying its distribution profile as it sweeps around its circle of coverage. Such is in existence, see illustrations.

More than one company makes sprinklers that vary in their speed of rotation. A sprinkler that has 60^{o} arcs opposing each other that travel half the speed of the other two parts of the circle makes for a more uniform pattern in a single row system.

A sprinkler that travels half as fast on one-half of the circle as it does the other has merit, yet it does not equal what could be attained in distribution pattern to the use of part circle sprinklers. But these find limited use due to initial cost of installation.

Operating Pressures

Generally as the nozzle size increases, pressure must be increased and increases in either or both means increased volume. The performance table of any given sprinkler and nozzle size shows this. If that sprinkler is operated at below desired pressure, a "donut" of water pattern results. That is little water near the sprinkler and at the outer fringe of coverage. Also, water from sprinkler is n very large droplets. The same sprinkler operated at too high pressure results in too much water near the sprinkler and water comes out in mist or real fine droplets.

Wind Distortion

A 5 MPH breeze is "windy"; 10 MPH is "very windy" and a sprinkler system should not be operated above this 10 MPH unless the system was designed for

such operation. Wind velocity in any section of the country is normally -- and fortunately -- calmer at night than during the day.

Wind makes a sprinkler distribute water in an egg shaped pattern rather than a circle. The cost of a sprinkler system properly designed increases as the velocity of the wind increases. This is true if one is to expect even distribution of water.

Summary

The turfgrass manager is involved in the use of many tools of management. This paper has brought togehter many tools at his daily disposal. Things he can do daily to increase efficiency in the use of water. It also covers some phases of irrigation to help him understand some of the limitations.

With all of the factors affecting plant growth at the manager's disposal and understanding some of how they interact to affect the plant puts the manager in position to push the button or use the tool or tools that best fits the circumstance.

This paper in no way reviews a new book you should have and study: Plant Environment and Efficient Water Use (Amer. Soc. of Agron., 677 So. Segoe, Madison, Wisc. 53711). It is mentioned here as a recommendation for you to have and study.

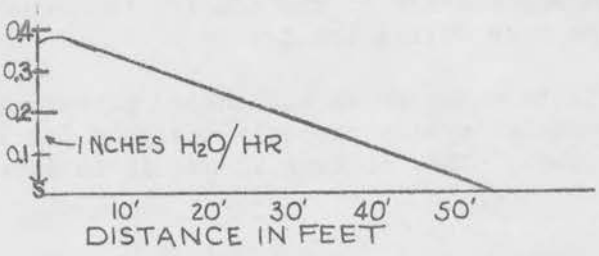

FIG 1. SPRINKLER DISTRIBUTION PROFILE

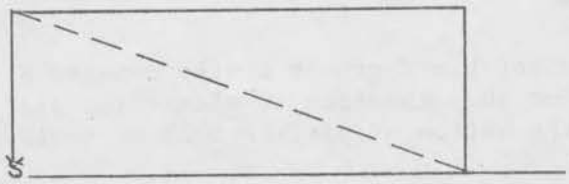

FIG 2. TWO SPRINKLER PROFILE

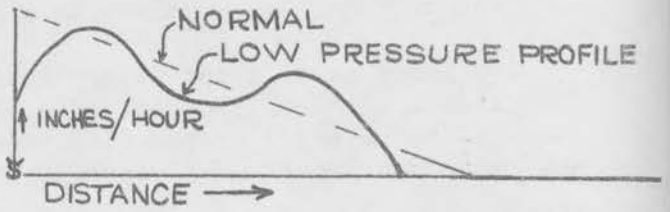

FIG. 4. LOW PRESSURE PROFILE

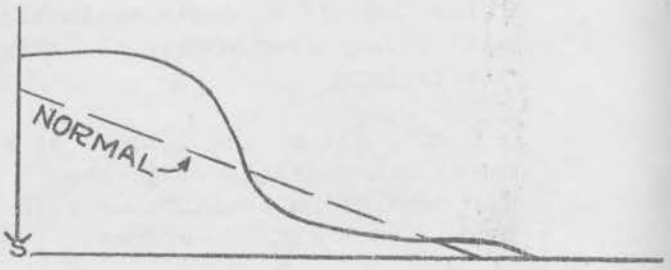

FIG 5 HIGH PRESSURE PROFILE

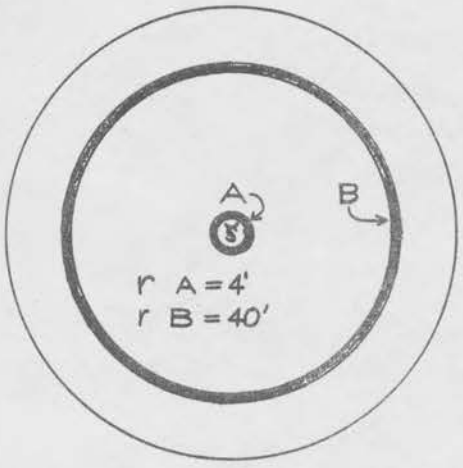

FIG 3. SPR. DISTRIB. CIRCLES SQ. FT. B IS 10 TIMES A

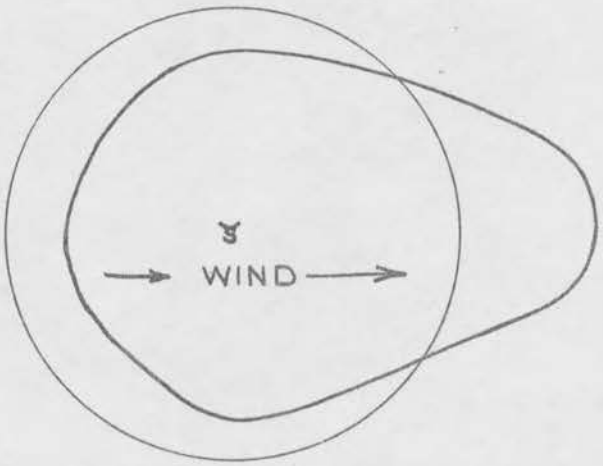

FIG 6 WIND DISTORTED PATTERN

SPRINKLER PATTERNS

WATER - WHY AND WHEN TO IRRIGATE

Eli L. Whiteley
Department of Soil and Crop Sciences
Texas A&M University

Why we irrigate.

Water is the most abundant material in the growing plant. It makes up from 70 to 90% of the plant. Since it comprises such a large part of the plant material it is necessary that we supply all the water the plants need for growth if we are to maintain a good turf on both the greens and fairways. For a better understanding of the role of water in plant growth it might be of some value to look at some of the functions of water in the plant and outside the plant.

1. Water serves as a solvent for mineral nutrients that are absorbed by the plant.

2. It serves as a solvent for the materials manufactured inside the plant.

3. Water is the transporting agent for all materials in the plant. It moves the raw materials from the roots to the leaves and the finished products to points in the plant where they can be used in plant growth or stored for future use.

4. Water serves as a raw material for the process of photosynthesis - the basic process underlying all life.

5. Water is the agent that maintains the equilibrium of salts and other dissolved products between various parts of the plant.

6. It acts as a temperature regulator in the plant in that transporation (the loss of water from the leaves) produces a cooling effect.

7. Water can also be considered as a structural agent in the grass plant. When plant cells contain ample water they are turgid and the plant stands erect. When there is a moisture deficiency, the cells are flaccid and the plant droops and wilts.

These functions of water in the plant are important from the standpoint of growing turf whether it is on the green, fairway, or in the rough. Water is also important in the soil and has several functions in the soil that are important from the standpoint of growing good turf that can be utilized to the maximum without damage.

Water occurs in the soil in three forms. Unavailable water or water held so tightly by the soil that it cannot be absorbed by the plant, available water or water that can be absorbed by the plant, and gravitational water. Water serves as a solvent for the nutrients in the soil. It also serves as the transporting agent for these nutrients. Soil water controls golf shots both on the fairways and the greens. On dry fairways and greens the ball will respond with long rolls while on wet fairways and greens the ball will stop with a very short roll. This difference in ball roll is about 30 yards between a dry and wet soil. These points are important to the golfer and many golfers complain more about how the ball "holds" on the green than any other factor influenced by water except the quality of the grass.

To sum up why we irrigate we can boil it down to two points:

1. To help the grass grow.
2. To condition the soil.

When to irrigate.

If the question of when to irrigate could be answered in concrete terms of time the golf course superintendent's problems would be cut in half. There is no method that I know of that will tell you that you need to turn the water on at 8:00 p.m. and cut it off at 10:00 p.m. There are too many factors involved in the growth of a grass, the condition of the soil (both fairways and greens), and the climate to allow us to formulate a set of rules that we can follow throughout the year. However, by using the available information we can do a good job of keeping the grass on the fairways and greens growing and keep the soil in good condition for good golf shots. A look at some of the factors involved in watering turf might help in making the decision of when to irrigate.

Since the plant is 70 to 90% water we must maintain adequate moisture for plant growth. Some grasses require more water than others for good growth. Most grasses can be grouped into three categories:

1. Moisture-loving, with little or no drought tolerance.
2. Intermediate drought tolerance.
3. Drought tolerant.

Some examples of grasses that can be placed in these groups are:

1. Moisture-loving-annual bluegrass, rough bluegrass, and creeping bentgrass.
2. Intermediate drought tolerance - fescuegrass, bluegrass, and Buffalograss.
3. Bermudagrass is classified as drought tolerant.

The whole point is that some grasses will go a long time without water while others must be watered often.

There are other factors that must be considered when deciding when to irrigate. Among these are: soils, temperature, humidity, wind, and the fertilizer program. A discussion of soils would take all of the time alloted for this talk. However, let me mention a few points concerning the soil. Clays hold more water and have lower infiltration rates than loams or sands. If your fairways are sandy they will require small applications of water frequently, if they are loams they can be watered less frequently with heavier applications of water, if they are clays they can be watered less frequently than loams with more water applied at each irrigation. The rate at which water can be applied to the soils is determined by the physical condition of the soil. Too much water leads to water-logged soils and run-off which costs you money and may result in the loss of grass from the fairways, increased diseases, encourage weeds, and compaction may increase under traffic.

The infiltration rate or the rate at which water moves into the soil determines how fast the water can be applied. The infiltration rate is determined by the amount of pore space in the soil. The larger the pores, the faster the water will move into the soil and conversely the smaller amount of water it will hold. A general figure to work from is to assume that the soil will take in about 1 inch per hour. By simple observation and using a soil probe, you can adjust the rate of application up or down to meet your soil's individual needs. You should apply enough water to wet the root zone to field capacity (the amount of water held against gravity). The soil should be allowed to dry out to a point near which the grass begins to wilt. This will allow for the exchange of gases in the soil. Some researchers have recommended 1 inch of water per week. This is a good starting point but must be adjusted to meet the needs of the individual fairway and green. Other factors besides the plant and soil may influence the rate of water use.

Wilting of grass may occur on hot, dry, clear, or windy days even tho the soil contains ample water. This means that the rate of transpiration exceeds the rate of absorption. Cloud cover, temperature, humidity, and wind velocity all have an effect on transpiration as well as evaporation from the soil.

Temperature is the climatic factor of greatest concern, since either extreme may cause a deficiency of water in the plants. At high temperatures the rate of water loss from the plant is high and unless soil moisture is adequate the plants will wilt. Syringeing the green will often keep the grass from wilting. This reduces the temperature of the grass and soil with small amounts of water. The purposes of syringeing is not to add water to the soil (except to seed or very shallow rooted plants) but to reduce the temperature of the grass and the soil. The reduction of the temperature will reduce the transporation rate and the amount of water the plant must absorb to remain turgid. It must be realized that climate has a great influence on water use by plants and the irrigation schedule must be adjusted to the water used by the plant and lost by evaporation from the soil.

The fertilizer program will influence the irrigation schedule. Fertilizers temporarily increase the need for water in plants. As the fertilizers go into solution the concentration of the soil solution increases and it becomes more difficult for the plants to absorb water from the soil. Due to osmotic pressure relationships, the plant could under certain conditions lose water to the soil. Therefore, after fertilizer is applied, irrigation water should be applied in amounts adequate to prevent wilting and water loss from the plants. Most of you are aware of this problem and we need not discuss it further.

The age of the grass will determine to some extent how long it will grow well between irrigations. Young grass seedlings have shallow root systems and require frequent irrigations while mature grasses with deep root systems can be maintained with a much less frequent irrigation schedule. Some grasses have naturally shallow root systems and will require frequent irrigations even tho they are mature.

I have discussed the subject of why and when to irrigate very lightly, but I hope that some of the facts presented will help to answer the question of "Why, When?"

TYPES AND USES OF PLASTIC PIPES

J. A. Caid
Area Manager, Johns-Manville Sales Corporation
Atlanta, Georgia

In 1932 a prominent gentleman of the golf world introduced a "product" that revolutionized golf, or at least one aspect of golf. The gentleman was Gene Sarazen and his "improved product" was the sand wedge. This heavy-soled club, once understood and employed properly, removed some of the more fearful aspects out of making a sandtrap shot. Many golf experts think this club, and the obvious following club, the pitching wedge, caused a bolder, more free-wheeling game.

The plastics industry's case is somewhat similar to Mr. Sarazen's. We came out with an improved product. Unlike Mr. Sarazen, we didn't totally understand its limitations and, unfortunately, plastic pipe was badly misapplied in its early American years. Today, due to much cooperation between government specification agencies, resin producers and the manufacturers, we have the knowledge necessary to correctly design and install plastic pipe.

Numbers are usually impressive and the growth of plastics, recorded in numbers by dollars and pounds, to me, is an impressive statistic. These numbers give credence to an amazing growth: and believability to an almost unbelievable future.

In the 1940's plastic pipe was introduced in the U.S. Plastic pipe in the early years, was used in the chemical industry and the food processing industry. By 1948 this product was being used for conduits, natural gas and water distribution. The total dollar sales in 1948 were less than 1/2 million dollars - maybe 75 golf courses worth by today's standards. This year, we expect the dollar volume to hit 150 million dollars; there are many industries that would like to match this time growth record.

In terms of pounds of resin consumed the plastic pipe field is small compared to the steel industry, the cast iron industry or another industry that is dear to my heart - the asbestos-cement industry.

These people record their production in tons - millions of them. The plastic pipe industry is speaking in terms of pounds, approximately 460 millions of pounds by 1970. Again, the growth rate is phenomenal: up from less than 5 million pounds in 1948.

There are many plastic pipe supplies today scratching at a relatively small available plastic market. The attraction is the vast potential pipe market. We obtain about 2% of a total pipe market that has been estimated at 5 billion dollars. Some of us optomists are shooting at a 20% figure by 1980. Granted, there are still many people that must be convinced that

plastic pipe will operate, under given conditions, for 50 years or more. But, because of our technical knowledge and manufacturing know-how have finally caught up with our feet, we think this 20% figure is not impossible to achieve.

One of the more remarkable achievements of the plastics industry is the degree of standardization that has been attained by the committees so many resin producers, manufacturers and specification agencies.

In the early 1950's, we had much confusion over such things as sizing, ratings, wall thickness, and resin design stress levels. Today, due to the committee work of the plastic pipe institute, the American Society for Testing and Materials, the American Water Works Association, the American Gas Association and the American Petroleum Institute, we have the framework for basic design and use of plastic pipe. The establishment of standard stress-rupture data allowed the industry to formulate standard dimension ratios for designing pressure rated pipe.

The hydrostatic stress committee of the P.P.I., in conjunction with other agency committees and the resin producers and the pipe manufacturers, have established through laboratory work and field testing, a 10,000 hour test to determine the stress-rupture level for the various resins. An extrapolation was made to 100,000 hours. The design stress of a pipe was established at one-half of this 100,000 hour figure. Continuing tests prove the validity of these figures and the stress rupture curves.

The industry also established a coding method for pipe based on the standard dimension ratio and a four number system to designate the type of plastic, grade or plastic and the design stress of the resin.

The standared dimension ratio, or SDR, is the ratio of the outside diameter of the pipe to the wall thickness. The SDR's for plastic pipe are established in increments of 25%.

The four number coding system was set up with the first number to designate the plastic type, the second refers to the grade and the third and fourth number pinpoint the design stress level divided by 100 with odd numbers left off. A purchaser, today, can specify a plastic pipe by "SDR-26 PVC 1120" and know that, regardless of the nominal inside diameter of the pipe, he is purchasing a diameter to thickness ratio of 26, assuring a pressure rated pipe, a Type 1, Grade 1 PVC resin, with a design stress of 2000 P.S.I.

There are standards to cover pipe sized by iron pipe schedules, but it is the general feeling of the industry that pipe rating by the SDR method gives the ultimate amount of benefits to the customer. He can utilize pressure rated pipe. The manufacturer has less inventory problems. In both cases, money is saved.

There are many types of thermoplastic resins produced today. The

four that account for the bulk of pipe produced are polyvinyl chloride, (PVC), polyethylene, (PE), acrylonitrile-butadiene styrene, (ABS), and rubber-modified styrene. The latter is utilized primarily for non-pressure services such as conduits. PVC resins will be used for about one-third of the plastic pipe produced this year. PVC resin usage in 1966 was close to 120 million pounds. This year, we expect PVC pipe production to exceed 150 million pounds. This dominating position in the market is caused by a low resin cost, a high design stress level and vastly improved extrusion rates.

For irrigation purposes PVC resin is, by far, the leading material for pipe. In the future, new resins such as polyphenylene oxide or polyacetal could challenge PVC's position on the strength of their excellent mechanical properties but today, these resin costs to strength ratios are too high, to compete with PVC.

Since PVC is the most important resin as far as we are concerned here, and because our time is limited, I would like to confine the rest of this portion of our discussion to PVC and its types and grades.

For the production of PVC pipe, the industry has available a variety of types and grades of compounds that are covered under ASTM and commercial standards. From these compounds, the manufacturer is able to select the compound best suited for a particular set of operating conditions. Currently, the most important of these are:

1. Type 1, Grade 1

   These compounds have the highest mechanical strengths and resistance to chemical attack. The impact strength is lower than Type 11 or Type 111 compounds.

2. Type 1, Grade 11

   These compounds have similar mechanical characteristics to Grade 1 compounds but have reduced chemical resistance. Seemingly, there is little difference between Grades 1 and 11. However, at a recent ASTM convention, a presented paper stated that Grade 1 exhibits about a 5% higher hoop stress based on extrapolated 50 year strength.

3. Type 11, Grade 1

   These compounds have higher impact strength but sacrifice chemical resistance and tensile strength in the process.

Another resin, Type IV or polyvinyl dichloride, has improved heat resistance but at the present has a cost that is approximately three times that of Type 1 and 11 compounds, and the resin has a lower design stress, thus necessitating a thicker wall, to achieve a similar pressure rating when compared to Type 1 or 11.

Compounding of PVC polymers is relatively straightforward in comparison to other resins, but still requires considerable technical know-how and experience to produce a compound which in turn will allow the extrusion of quality pipe on an economical basis.

Apart from the resin itself the essential ingredients are stabilizers, lubricants and pigments. The stabilizer imparts heat stability to the resin during extrusion and resistance to ultra-violet rays after extrusion. The common stabilizers today are tin or lead. The national sanitation foundation, a non-profit organization that carries out a testing program to check plastic pipe for toxic effects, taste and odors that may be imparted to water by a resin compound, requires tin as a stabilizer, for pipe to be used for carrying potable water. Lead stabilizers are used in compounding resins to be extruded for non-potable service.

Lubricants act as a processing aid, at the extrusion dies, to ease the flow of resin compound.

Pigments add color and further protection from ultra-violet rays.

Until a short time ago, PVC pipe was produced from compounds in the form of small pellets. The rate of extrusion was near 50 pounds per hour. Equipment improvements and the introduction of dry powder blends have changed this rate to over 500 pounds per hour. The dry powder blend has another advantage over pellets. Since thermoplastics are sensitive to heat, the long-term properties can be affected by the heat introduced during pelletizing.

The plastic pipe industry's goal is to provide the pipe market with a product that is resistant to corrosion, has a high strength to weight ratio and that is economical and completely reliable under given service conditions. The only way we can attain this goal is through further standardization.

Our accomplishments in the past must, and will, be exceeded in the future.

SELECTING AND OPERATING SPRAY EQUIPMENT

Victor M. Jouffray
District Sales Manager, John Bean Spray Equipment Division
San Antonio, Texas

The effectiveness of any spray program depends upon the application of the proper chemical at the proper rate, at the proper location, and at the proper time. Failure to give adequate attention to any of these factors will result in an unsatisfactory control program. Equipment selection basically, involves: a) Choosing the right type and size of sprayer, b) selecting an adequate pump for the volume and pressure needed, c) choosing suitable nozzle and placement facilities to get the job done.

There are many types of sprayers on the market, available in a wide range of sizes and prices. Low-pressure, low-volume sprayers basically designed for weed control work will not give consistently satisfactory results when used for insect and disease control work. General purpose, high pressure hydraulic sprayers are adaptable to a wide range of operating pressures and gallonages and satisfactorily meet the needs of most spray programs.

Before choosing any sprayer, these three questions should be answered:

1. What is the spraying job? The answer determines the type of sprayer that will be required.

2. How big is the job, and what is the required applicator rate? The answer will determine the sprayer's size.

3. How is the sprayer to be carried? This will determine the type and method of mounting.

In selecting a sprayer, one should make a list of all the major spray operations for which the machine could be used. Additional information should then be obtained, including such items as pressure ranges, rates of application in gallons per minute, and types of chemicals involved for each of the potential spraying jobs. With this information at hand, it is then possible to determine the type of pump necessary to perform under the most adverse conditions, and the type of sprayer best suited to meet the overall needs.

There are two basic types of general purpose sprayers - boomed equipped and boomless. Either is available with a variety of pumps and carriers. They may be trailer mounted or tractor mounted.

Whether the spray job calls for low or high pressure the boom sprayer will apply chemicals where they are wanted. Usually set up with nozzles on 20" centers, a 20 or 28 foot boom is ideally suited for all types of insect, disease, and weed spray programs. Booms up to 60 feet are available depending upon the spray requirements.

By adding a hand gun and a length of hose, the purchaser of a boom sprayer increases the use of his equipment many times. Not only is he equipped to spray turf, but he also has a unit which, with due consideration to pressure limitations, can be used to fight fires, disinfect buildings, clean equipment, spray trees and shrubs, or spot spray weeds, brush and mosquitos.

Boomless or air carrier sprayers are capable of delivering chemicals in either concentrated form or with high volume rates of application. The spray material is injected into the air stream by a manifold positioned in front of the air blast with a series of nozzles. The air stream assists in breaking up the liquid and in carrying it to the surface to be treated. Air-Carrier sprayers are made with capacities of from 40 feet to 90 feet swaths. Their broad spray swath permits faster coverage. Complete coverage and uniformity of coverage is more of a problem because of draft tendencies. However in the past few years several different drift control materials have been introduced that have increased the efficiency of the Air-Carrier method of spraying by reducing drift.

Easily set up by one man, the boomless sprayer with an added spray gun offers about the same variety of diversification as a boom sprayer.

There are four basic requirements to consider in selecting a pump:

1. The pump must be capable of handling the chemicals to be applied.

2. The pump must be able to produce the pressure required for proper breakup and pattern conformity of the chemical being used.

3. The pump must have a capacity to supply the sprayer with its "rate of application" requirements, plus maintaining a suitable agitation.

4. The pump must provide long, economical life with ease of servicing and maintenance, and parts must be available.

There are four types of spray pumps on the market, positive displacement piston pumps, nylon roller pumps, gear pumps, & centrifugal pumps.

If operating pressure in excess of 100 p.s.i. is required for continuous duty operation or if wettable powders and other abrasive materials are being used, then a piston pump should be the first choice, being sure that the pump selected has sufficient gallonage rating to perform the task assigned to it.

There are many types of piston pumps, some require more maintenance than others.

The most advisable selection of a piston pump is one designed to keep chemicals away from all of the working parts below the pump packing. The type that has proven most efficient in field use is the completely enclosed pump with a crankshaft designed much like an automobile engine crankcase. One that has a continual oil lubrication and a system of oiling patterned after the splash or dipper system of the automobile.

Piston pumps are positive displacement pumps. At a given R.P.M. speed they produce their recommended gallonage regardless of pressure settings. Nearly all piston pumps have replaceable plunger packings.

Nylon roller pumps are quite inexpensive easy to mount, and easy to service. They are used when a low cost pump is desirable, and when corrosive or abrasive chemicals are not to be used. Changes in pressure will vary the output capacity of these pumps greatly. As pressure increases the pumps ability to produce volume decreases. Conversely, as pressure decreases, volume increases. These variables must be taken into consideration when purchasing a roller pump.

For strictly weed control operations or when pressures over 50 to 60 p.s.i. are not needed the centrifugal pump may be very satisfactory. They are made of fiberglass or of different cast metals and will generally handle all types of chemicals, wettable powders and liquid fertilizers. They are non-positive displacement pumps, changes in pressures greatly effect volume output.

It is always a good rule to purchase a pump with more capacity than normally required.

There are several different methods of mounting a sprayer:

1. Trailer mounting
2. 3-Point hitch
3. Standard mounting

Of these methods, trailer mounting has become the most popular because it is quickly and easily attached or detached and a greater carrying capacity is possible.

Sprayer tanks are made in many different sizes and out of many different

materials. In choosing the proper size tank consideration should be given to the size that will accomplish a minimum of refill time in a daily operation.

In choosing the material the tank is made of consideration should be given to exterior strength as well as the ability of the tank to handle corrosive and caustic materials interiorly. The tank should also have some method of mechanical agitation for maximum efficiency of keeping chemicals to be applied in uniform mixture.

After the proper sprayer has been selected, it must be calibrated. Proper calibration of the sprayer is necessary to insure the application of the correct amount of chemical. Improper calibration may result in either over application or under-application. In either instance, spray materials will be wasted or adequate protection will not be obtained. The purpose of calibration is to determine the number of gallons of liquid being applied per acre, and thereby determine the quantity of chemical to be added each time the spray tank is refilled.

The rate of application in gallons per acre is determined by:

1. Nozzle spacing
2. Nozzle size of capacity
3. Operating pressures
4. Rate of travel

Calibrating hydraulic sprayers may be accomplished by a number of different methods. Within reasonable limit the method of calibration is unimportant as long as results are reliable.

Satisfactory calibration can be accomplished by filling the spray tank with <u>water only</u> to a given mark, and then, with the recommended nozzle tips, ioerating pressure, and ground speed, spray a measured acre of ground. Measure the number of gallons of water required to refill the spray tank to its original level. This gives the rate of application in gallons per acre. Minor adjustments in rates of application may be accomplished by varying operating pressure. Any significant changes, however, should be by changing nozzle tips, or changing ground speed. Time will not permit me to go into further detail on calibration methods at this time. Consult your sprayer dealer or sprayer owners manual for more detailed information on calibration.

Chemical suppliers furnish application instructions. Follow their recommendations to the letter. If these recommendations are followed faithfully, the spraying program will bring the desired results. If not, the best sprayer manufactured will be unable to do the job intended. Chemical companies spend thousands of dollars in research to provide the correct information on application rates that are acceptable. The importance of following directions cannot be over-emphasized.

A final word about care and cleaning of your sprayer. Just normal "good housekeeping" practices will help you enjoy long trouble-free service from your sprayer. Your sprayer is engineered and built to give you many years of satisfactory service. Good care and regular servicing pays dividends in terms of reduced operating costs.

Again, I want to say it has been a pleasure talking to you and if time permits I will be happy to try and answer any questions you may have. Thank you.

CONTROL OF WATER-BREEDING INSECTS

Weldon H. Newton, Associate Entomologist
Texas Agricultural Extension Service
Texas A&M University

Numerous water-breeding insects frequently become important as nuisances in parks, golf courses and other public recreation areas. Those of most importance are mosquitos, buffalo gnats, sand flies, biting midges and, occasionally, deer flies. All of these are blood-sucking flies which may cause considerable annoyance and are capable of transmitting various diseases to humans.

The nuisance problem is usually of concern to the recreation area supervisor and one which he may have to solve individually. Where disease transmission occurs, concerted efforts are usually initiated by various public health agencies, including area-wide control or eradication programs. This discussion will be limited to the nuisance aspects and what can be done to alleviate the problem by recreation area supervisors.

Water-Breeding Pests

Simulids (buffalo gnats, black-flies, turkey gnats, etc.)

Simulids are blood-sucking flies which generally prefer to breed in running streams but some species breed in standing pools, ditches, etc. The female *simulid* deposits 350-400 eggs on rocks, logs or vegetation near the water line, and some females deposit eggs directly on the water surface. The eggs hatch in about a week and development through the larval and pupal stages requires 3 to 9 weeks, depending upon temperature. Under favorable conditions the entire life cycle requires about 30 days. The adults are roughly twice the size of a common fruit fly "gnat," blackish in color and have a humped-back appearance. Their bite is not particularly painful, but it is quite annoying. Most common species belong to the genus *Simulium*.

Psychodids (sand flies, "sewer" flies, moth flies, etc.)

Psychodids (*Phlebotomus* sp. and others) breed primarily in moist soil, silt, etc., with high organic matter content. Females deposit their eggs on the surface and the larvae feed on organic materials in the soil. The entire life cycle requires about 30 days during warm seasons. The mature flies are roughly 1/16 to 1/8 inch long, of a smoky gray to brownish color, and the wings are roughly oval in shape and about as large as the body. Superficially, the flies resemble miniature moths. Adults are blood-suckers and are frequently attracted to lights in large numbers where they become a considerable nuisance.

Ceratopogonids (biting midges, punkies, black gnats, "no-see-'ums," etc.)

Most of the biting midges of importance belong to the genus *Culicoides*. Superficially, they bear a great deal of resemblance to the buffalo gnats, described previously, except for a less hump-backed appearance. These species are active primarily at night and are attracted to lights. The larval stages are acquatic or semi-acquatic. Eggs are deposited in masses in water or moist soil and in about 4 weeks adults emerge after passing through the larval and pupal stages. Adults are blood-suckers and have an annoying bite.

Deer Flies

Several species of deer flies belonging to the genus *Chrysops* occasionally become annoying pests. The adult females are about 1/2 to 3/4 inch long and are generally brownish-yellow in color. Females deposit 300-600 eggs near water, usually on the leaves of plants. The eggs hatch in a few days and the larvae drop into water or mud where they feed upon other small animals and develop for 2-4 months, completing the entire life cycle in 4-5 months. Blood-sucking female flies are active during hot, sultry periods and become quite a nuisance with their painful bites when they occur in large numbers. The flies feed readily on man as well as other warm-blooded animals.

Mosquitos

Numerous species of mosquitos are capable of developing large, annoying populations when conditions are favorable. Although specific habits of different mosquitos vary, they all require some type of water for larval development. Some spcies require stagnant water in which to breed; other species develop in relatively clean rainwater, for example. In general, most develop either in temporary pools, marshy areas or pond areas with considerable shallow water and/or vegetation. Most species develop from egg to adult in 10 days to 2 weeks under favorable conditions; however, eggs of some species may lie dormant for several months during dry seasons and hatch when inundated by rainwater, drainage, etc. Important genera in Texas are *Culex*, *Anopheles*, *Aedes*, *Psorophora* and others. Only the females are blood-suckers.

Control Measures

Mosquitos constitute the major problem of common occurrence among water-breeding species and are generally of most concern. Measures undertaken for mosquito control help to lessen problems with other water breeding pests. Under most conditions, extensive control efforts are not normally undertaken for water-breeding insects other than mosquitos. Effective control programs for any species, though, would include the following:

I. Cultural and mechanical practices

a. Elimination of breeding sites

1. Adequate drainage facilities to eliminate areas of standing water.

2. Alteration of ponds, if possible, to eliminate extensive shallow-water and vegetated areas.

3. Acquatic weed control.

II. Biological control of larvae

a. Introduction of *Gambusia* sp. predaceous minnows - contact Texas Parks and Wildlife Department, Austin, Texas for details.

III. Chemical control* -- from USDA Agriculture Handbook No. 331

a. Control of larvae in breeding areas

Insecticide	Active ingredient per surface acre	Safety Restrictions
Malathion	EC or soln., 0.5 lb.	Use with caution to avoid hazards to fish and wildlife. Consult supplier or company representative concerning toxicity to fish if used in lakes or ponds. Observe strictly all precautions listed on the label and apply only in accordance with directions.
Paris green	G, 0.6-1.5 lb.	
Abate	EC, 0.016-9.046 lb.	
DDT	EC, WP or soln., 0.05-0.4 lb.	
Lindane	EC, WP or soln., 0.1-0.15 lb.	
Dieldrin	EC or soln., 0.05-0.1 lb.	
Heptachlor	EC or soln., 0.1 lb.; G, 0.05-0.1 lb.	EC = emulsifiable concentrate
EPN	WP, 0.0375-0.075 lb.	WP = wettable powder
Fenthion (Baytex)	EC, WP or soln., 0.05-0.1 lb.	G = granules
Parathion	EC or soln., 0.063-0.1 lb.	Soln. = oil solution

* This listing is informative only and does not constitute an endorsement of listed materials to the exclusion of similarly effective chemical products.

b. Control of adults outdoors

Insecticide	Space spray or fog	Residual on vegetation	Safety restrictions
Pyrethrins	0.25% + 2% piperonyl butoxide or sulfoxide (0.01 lb/A	--	Use with care to avoid hazards to fish and wildlife. Consult supplier or company representative concerning toxicity to fish if used near lakes or ponds. DO not contaminate animal feed or human food. Observe strictly all precautions listed on the label and apply only in accordance with directions.
Malathion	0.1-0.5 lb/A ultra-low volume	--	
Naled (Dibrom)	0.1-0.25 lb/A	--	
Carbaryl (Sevin)	0.25-0.5 lb/A	WP, 1 lb/A	
DDT	0.2 lb/A	WP,1-3 lb/A	
Dichlorvos(DDVP)	0.05-0.1 lb/A	--	
Lindane	0.1-0.2 lb/A	WP,0.5-2 lb/A	
Ronnel	--	1% spray	
Dieldrin	--	WP,0.5-1 lb/A	
Helptachlor	0.1 lb/A	--	
Fenthion (Baytex)	0.1 lb/A	--	

c. Control of adults indoors

Insecticide	Space spray[1]	Residual spray[1]	Safety restrictions
Pyrethrins	0.25 + 2% piperonyl butoxide or sulfoxide	--	Use malathion as a residual spray in swellings for spot treatments only. Use residual sprays in dwellings for spot treatment only (except DDT or ronnel). Do not contaminate food or utensils. Observe strictly all precuations listed on the label and apply only in accordance with directions.
Malathion	2-3%	3-5%	
Methoxychlor	5%	5%	
Naled (Dibrom)	1%	--	
DDT	4-5%	5%	
Dichlorvos** (DDVP)	0.5%	0.5%	

Lindane	--	0.5%
Ronnel	--	1%
Dieldrin	--	0.5%
Heptchlor	--	0.5%
Fenthion (Baytex)	--	3%

---

[1] EC or oil solution

** Available also in a resin strip for use indoors

SOIL AMENDMENTS

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

Amendments are those things we add to the soil to change it. They may be either chemical or physical, but we normally refer to those things as amendments which change the soil physically.

Because large quantities of most materials are necessary to produce substantial physical changes, the use of most soil amendments is confined to relatively small but important areas such as putting greens.

An exception is lime. Where clay soils display poor structure because of an overabundance of ions of hydrogen or sodium, applications of lime or gypsum may sometimes bring about desirable changes. Restoring good structure by this means may improve aeration, drainage, and water infiltration. Lime or gypsum may be needed in relatively small quantities and because the price per ton usually is fairly low, such a treatment can be applied to larger areas such as fairways.

Materials such as organic matter, sand, and calcined clay are required in large quantities if appreciable changes in the physical nature of soils are to be accomplished.

Organic matter may behave in two ways. Larger particles of organic material may provide a cushioning effect between the mineral particles and aggregates. It provides resilience to a turf surface. This is the first noticeable effect, that of creating "looseness" and porosity.

As organic matter decomposes the residues perform another function. Organic gums or adhesives are formed which help to bind fine soil particles together into crumbs or aggregates. Such gums are important in the maintenance of good soil structure.

Organic matter from various sources may be useful as soil amendments. The continuing value of such materials depends upon their stability in the soil. Obviously, a rapidly decomposable product will disappear from the soil more rapidly than one which resists decomposition. Peat, bark, sawdust, cotton wastes and bagasse are some of the commonly used materials.

Calcined clay products have been widely publicized in recent years. These products provide porosity to soils and they appear to be fairly stable. They are however, required in rather large quantities. Used in topdressing, and worked into aerifier holes, calcined clay will improve infiltration and aeration, and in some cases the playing surface of a putting green may be improved. While calcined clay may be of some value in

soil mistures for putting greens, the quantity required usually is expensive enough to discourage its use.

Because soil amendments are expensive, their use must always be determined by evaluating the benefits to be derived in comparison with the accomplishment of good drainage, good infiltration, and good aeration by the use of cultivation methods.

GROWTH INHIBITORS

J. A. Long
Research Division, O. M. Scott & Sons Co.
Marysville, Ohio

If one were to announce before a group as in attendance here that a new growth inhibitor was available that would reduce mowing maintenance by at least 70 percent - such an announcement would no doubt cause a great deal of interest, excitement, and even frustration perhaps. To the golf course superintendent, the cemetery and parks maintenance people, landscape engineers and etc., a growth inhibitor providing a 70 percent reduction in mowing, would be of great interest particularly in regard to its impact on the reduction in equipment and labor cost. Many homeowners certainly would welcome the ideal growth inhibitor with excitement. Perhaps in contrast those concerned with our dynamic industry that produces turf mowing equipment may be frustrated.

The growth inhibitor that we described above is not yet available and perhaps it would be safe to say that it will not be available until sometime in the future. As we review the state-of-the-art on growth inhibitors a number of factors should partially explain why the application of growth inhibition in turf culture is very limited at this time.

Current Growth Retardants & Inhibitors

The first new class of compounds possession growth inhibitor or retardant action was introduced from the USDA's Growth Regulator and Antibiotic Laboratory in the late 1940's (4). This group of chemicals, the nicotiniums (2,4-DNC), were found to reduce stem elongation of bean plants without causing cell proliferation or other formative effects. In about the same period the growth inhibitor maleic hydrazide was introduced (5). This compound exhibited a somewhat different action than the nicotiniums. The quaternary ammonium carbamates were developed around 1950 and these also showed growth retarding properties. Amo-1618 and AmO-1619 were the two most active of this new class of compounds (6).

In the period from 1950 to 1960, BOH and phosfon were developed. A new group of quaternary ammonium compounds were reported in 1960 (9). The most active and well known of this group is CCC. This compound was of considerable interest as it was found to retard growth of a larger number of plant species than any of the previously reported compounds.

CO11 and B995 represented growth retardants developed after 1960 (7). Chemicals that were reported since 1960 that exhibit a similar mode of action as maleic hydrazide include hadacidin and the morphactans.

The growth retardants and inhibitors reviewed above are listed in Table 1.

Perhaps at this point it would be well to clarify terminology currently used to differentiate between growth retardants and growth inhibitors. Cathey (10) in his recent review on this subject suggests that the term "growth retardant" be used for chemicals that show cell division and cell elongation in plant shoot tissues and regulate plant height physiologically without formative effects. He considers "growth inhibitors" as including chemicals that stunt or completely suppress growth, reduce vigor, and produce malformations of plant parts.

In turf applications, it would be desirable to have a true growth retardant according to Cathey's classification, but as yet we have no effective chemical commercially available that falls within this classification. All chemicals other than maleic hydrazide (MH) and hadacidin presented in Table 1 are classified as growth retardants. Some are available today - commercially for use on chrysanthmums, lilies and poinsettias.

As of this writing MH is the only growth inhibitor available for use in turf areas. We are aware of a number of experimental chemicals currently in various phases of testing, however, it is not known at this time whether any will make the grade as commercial growth inhibitors.

In the discussion to follow, we will disregard the differentiation between growth retardants and growth inhibitors to avoid further confusion.

Growth Inhibitor Performance

Turf variety/species effect - Chemicals, both commercially available and experimentals have been found to vary quite widely in terms of their effect on different species of turfgrass. Table 2 shows the effect of several inhibitors on Bermudagrass and St. Augustinegrass. Note that on St. Augustine no inhibitory action was observed for S 34 while on Bermuda an excellent level of inhibition was recorded. Cathey and Stuart (1) reported CCC to be effective on 55 plant species while phosfon was effective on only 18 ornamental plant species. The same behavior has been observed for MH 30 on different varieties of Kentucky bluegrass (Table 3). Based on these findings it appears that testing of growth inhibitors will be required on all major turf species as well as turf varieties within species before application is considered.

Period of growth inhibition - Several factors influence the period of growth suppression of inhibitor chemicals. As indicated to some extent above, the period of growth inhibition will vary according to the turf species or variety treated. Condition of the plant - whether actively growing or partially dormant has a marked effect on period of inhibition. Inhibition has been reported (3) to extend for eight weeks or more with MH on roadside applications. In highly maintained

turf use areas, inhibition of turf generally has been observed to extend for periods of three to six weeks. In most applications the period of inhibition for MH falls in the three to four week time period. Table 4 shows typical results obtained with two growth inhibitors. Turf in this case was well maintained.

The difference we see in the period of inhibition on well maintained turf as compared to turf under low maintenance as on roadsides represents one of the most important factors relating to the performance of growth inhibitors.

Turf on highway rights-of-way generally would be considered, by standards used in the golf course areas, as low maintenance turf often under-fed and generally under moisture stress. Under such conditions the inhibitor essentially functions in further effecting plant dormancy, thus causing a cessation of growth. This may be demonstrated in part by data presented in Table 5. Note that growth of the check treatment, which was unfertilized, was about the same as the S 243 treatment.

Effect on turf density - One of the major problems found with inhibitors relates to effect on turf density. Inhibitor treatments that are made to turf that has high density and growing actively cause little or no effect on turf density, however, when treatments are made to open low density turf, increase in turf density usually will not occur. Tests conducted on Kentucky bluegrass showed inhibitors to significantly prevent turf from developing an adequate density when treatments were made in the early spring before new tillering occurred. Similar behavior was noted on Argentine Bahiagrass turf. Based on these observations, some caution should be considered when growth inhibitors are to be applied to low density Bermudagrass and St. Augustinegrass turf.

The use of inhibitors along roadways, in rough areas of golf courses, and along drainage ways where high turf density may not be required perhaps would not be objectionable.

Seasonal effects - Phosfon has been reported (1) to be most active in retarding growth during the summer than in the winter, while CCC was less effective in the summer than in the winter.

Test results from our laboratories have shown MH 30 to exhibit low growth inhibitory activity on Chewings fescue during the spring and summer period, yet was very active during the fall period. In contrast MH 30 was observed to be very active on Penncross bentgrass during the spring, summer and fall period. The data from these tests are given in Table 6.

Green (3) reported that the most effective times for treating turf with MH 30 was during the first two weeks in May or between September 15 and October 15th. If the spring treatment is delayed beyond mid-May, Green suggested treating and then mowing the turf a week later. He advised that turfgrass would retain the chemical from fall treatments

with the inhibiting effect being expressed the following spring.

Application factors - The method of application of inhibitor chemicals has a marked affect on their activity on turfgrasses. Data are presented in Table 2 which shows striking difference in inhibitor activity on Bermudagrass and St. Augustinegrass when applied as foliar sprays or in a soil drench. The data showed that MH 30 was not active when applied as a soil drench, but was very active when applied as a foliar spray. The same activity behavior for foliar versus soil application has been observed on Kentucky bluegrass.

Since we have Table 2 shown, there is one other point that can be made. Phosfon S, in previous reports has been shown to require a rate level of around 135 pounds per acre to produce acceptable turf inhibitory results. The rate used here was 10 pounds per acre. The approximate cost of phosfon S some two years ago was around $180.00 per pound. This would place the cost per application at that time at around $24,000 per acre.

Relative humidity, temperature, soil type, soil moisture, plant growth condition and light appear to influence the activity level of inhibitors. Smith et al (2) reported the uptake of maleic hydrazide to be reduced when plant turgidity was high, however, when plants were near the wilting point absorption rate was severely curtailed. In this study the results showed leaf absorption to be highest at 90°F with a relative humidity of 100%. Rapid absorption is important because the MH formulations will readily wash from leaf surfaces because of their solubility.

Guides to Using Growth Inhibitors

If a growth inhibitor is to be used on turf areas the following conditions would generally favor optimum inhibitor performance.

1. Turf should be growing actively.
2. Encourage high turf density before treating.
3. Maintain turf on a fertility level that encourages active growth.
4. Irrigate to maintain active turf growth.
5. Prevent turf damage from insects and diseases.

In general the results to expect in growth inhibitor performance on turfgrasses may be summarized as below.

1. Turf color, quality level generally will be below well fertilized turf.
2. Inhibition of turfgrass generally will not be evident until the first mowing after applying the inhibitor.

3. Low density turf will be slow to fill in when treated.
4. Mechanical damaged turf areas will be slow to recover.
5. Increased turf growth (often over fertilized turf) generally will occur after inhibitory action dissipates.
6. Turfgrass species and varieties react differently to different chemicals.
7. Growth inhibitors may be expected to vary in level of inhibition from season to season.

Maleic hydrazide is the only commercially available growth inhibitor currently for use on turf areas. Other inhibitors that we have discussed are available and for use on ornamental plants and generally are not promoted for turf applications.

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Table 1. Current growth retardants and inhibitors.

Common designation	
2,4-DNC	1-(2,4-dichlorobenzyl)-1-methyl-2,3-pyridyl pyrrolidinium chloride
Amo-1618	4-hydroxyl-5-isopropyl-2-methylphenyl trimethyl ammonium chloride, 1-piperiodine carboxylate
BOH	B-hydroxyethylhydrazine
Phosfon-D	2,4-dichlorobenzyl-tributylphosphonium chloride
CCC	(2-chloroethyl)trimethylammonium chloride
CO11	N-dimethylamino maleamic acid
B 995	N-dimethylamino succinamic acid
MH	1,2-dihydropyradzine-3,6-dione
Hadacidin	N-hydroxy-N-formyl sodium glycinate

Table 2. Relative effectiveness of different growth retardants and inhibitors applied at 10#/acre on Bermudagrass and St. Augustinegrass.

Chemical	Method of application	Percent inhibition	
		Bermudagrass	St. Augustinegrass
MH 30	foliar	58	60
	soil	0	0
Phosfon S	foliar	0	0
	soil	0	0
CCC	foliar	56	0
	soil	0	25
Hadacidin	foliar	54	42
	soil	0	0
S 34	foliar	32	0
	soil	49	0

O. M. Scott Research

Table 3. Variation in growth inhibition by two growth inhibitors on varieties of Kentucky bluegrass.

Inhibitor	#/Ac	Percent inhibition		
		Merion	Park	Windsor
MH 30	4	24	11	16
S 243	5	20	14	31

O. M. Scott research

Table 4. Days of effective growth inhibition on varieties of Kentucky bluegrass.

Inhibitor	#/A	Days		
		Merion	Park	Windsor
MH 30	4	29	14	20
S 243	5	30	21	14

O. M. Scott Research

Table 5. Comparison of S 243 inhibitor with fertilized turf and unfertilized turf.

Treatment #/Ac		
Inhibitor	Nitrogen	Yield of turf clippings
5	43	58
0	43	98
0	0	53

O. M. Scott Research

Table 6. Seasonal performance of growth inhibitors on Chewings fescue and Penncross bentgrass.

Chemical	Turfgrass	Season when active		
		Spring	Summer	Fall
MH 30	fescue			X
	bentgrass	X	X	X
S 243	fescue	X	X	X
	bentgrass	X	X	

O. M. Scott Research

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AERIFICATION OF TEES AND GREENS

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

WHAT, WHY, WHEN AND HOW

WHAT: Aerification of turf is the term meaning performation of turf and soil underneath and combining with common air with the greatest disturbance below ground level. In contrast, thatch removal and thinning is done predominately above ground level.

General: Soil is made up of three phases:

1. Solid phase-tiny mineral and organic particles.
2. Liquid phase-soil solution or soil moisture-(Gravitational, capillary, and hygroscopic water).
3. Gas phase-soil air of which CO_2 and O_2 are most important.

Soil texture refers to size of particle (sand, silt, clay).

Soil structure refers to the extent and type of aggregation depending upon clay and organic colloids present and their grouping together.

WHY: (all interrelated)

1. To correct a problem
   a. To improve internal drainage of water.
   b. To improve gaseous exchange (CO_2 and O_2).
   c. To stimulate root activity.
   d. To break up a layering condition.
2. For seedbed preparation
3. To provide a topdressing material that is the same as original seedbed

WHEN:

1. During growing season or just before optimum growth period.
2. Seedbed preparation especially when overseeding.
3. Usually following application of fertilizer.
4. Prior to application of wetting agents, pre-emergants, etc.

HOW:

1. Aerify to leave as much soil on surface whether using blade, knife, tine, spoon or fork.
2. Seed or fertilizer can be added at this time.
3. Break up pellets (or remove)-desirable soil should be left and smoothed out with a mat, broom, or drag.
4. Undesirable soil should be removed and soil amendments added such as calcined clay, peat, manure, sand, topsoil. Remove clippings, stolons, stems, etc. Leave green or tee playable.

Important: Maintain seedbed to as near original soil as possible.

5. Expect increase of soil insect activity and sod webworm possibly mole cricket activity.
6. Germination of undesirable weed and weed grasses usually more prevalent.

Equipment

Parker Thatchomatic

Ryan -- Spikeaire, Greensaire, Ton-o-thin, Mat-a-way, Tracaire, Renovaire, Motoraire, Lawnaire

Ohio Aerator

Power Disc Spiker

West Point -- Aerifier, Jr. & GL, Grasslan, Tractor-Lift Aerifier, Utilafier, Estate Model Aerifier, PM-2 Aerifier, VC-13, Verticut, Aeri-Forke, VC4 Verticut, Verti-Groove, Fairway Spiker, Verti-slicer, Aeri-spiker, Vertifier

Rogers -- Aero-spiker, Model 522, Aero-blade 548, Power Aerator 580, Self-powered Aerator 550, Thatcher-thinner, 509 & 504 Aero-blade

Jacobson Turf Groomer

Possibly many others. Each applicable to a particular job.

CARE OF MACHINERY

Pat Brower
Colonial Motor Company
Dallas, Texas

The care of a piece of equipment should begin immediately upon receiving it, together with the Owners Manual. Always be sure the owners manual accompanies it. In the event a piece of equipment is purchased that has been used, by all means contact the distributor that handles that piece of equipment and ask for an owners manual. Usually somewhere on the unit is a Model number and a Serial number. Give these numbers to the distributor and you will receive the manual promptly. I want to emphasize upon you that your owners manuals are definitely an essential part of equipment care. Hardly a day goes by, during the busy season of mowing, etc., that a piece of equipment doesn't break down. The only way to expedite parts ordering correctly and receiving prompt service is by ordering the correct part number found in the owners manual.

This might come to somewhat of a surprise to some of you, that in addition to the parts list, your manual includes: preparation or setting up instructions, maintenance and storage, specifications, lubrication, adjustments to carburetors, belts and chains and warranty responsibilities of the manufacture and the user.

Upon opening your manual, on the first page you will usually find this paragraph: quote, "This owner's manual is your guide to proper mower operation. The simple maintenance suggested on the pages of this handbook will prolong the life of your mower. It is suggested that you read this manual thoroughly in its entirety before your mower is operated. The more familiar you become with the mower and its operation, the better results you will have in its use." End quote.

One more thing about owners manuals is: how do you keep your manuals stored? How many times have you heard this statement or possibly said it yourself, when looking for it to order a part, well the blankedy blank things around here somewhere. I saw it just the other day. I know its around here somewhere. Fellows, really, wouldn't it be much simpler to keep your manuals neatly filed away perhaps in a loose leaf notebook such as this, or perhaps in some inexpensive manila folders such as this. In any event, please take good care of your manuals.

To enjoy a long life and a relatively trouble-free piece of equipment is dependent solely on the maintenance it receives. So, I suggest to you to set up a maintenance procedure for each piece of equipment. I say this because, as you are all aware of, some equipment requires more maintenance than others.

To me, cleanliness is by far the most important part of caring for equipment. Next to cleanliness would be lubrication, then proper

adjustments and regular inspection for loose parts, etc.

It seems to me that we have more trouble and/or problems with the engines on equipment, than the equipment itself. As I mentioned a few minutes ago, if you will read carefully the engine manual, you will find something like this; quote, "Keep engines clean. Always use clean, fresh gas and maintain proper oil level in crankcase. Caution: When operating under dry, dusty conditions, change oil in crankcase frequently, and check the air cleaner daily. A dirty clogged air cleaner is without a question of a doubt the main reason an engine begins to wear long before its time." End quote.

While we're on the subject of air cleaners, I want to read a paragraph of a letter we received this past Summer. Quote, "I'm afraid, Bob, that maybe a lot of this difficulty -- especially if it happened the second time -- is caused by negligence on the part of the operators. On some golf courses it can get pretty dirty, and if they don't service the cleaner, it might wear out the engine quickly. In fact, this is about the only thing that will wear out the engine, and it can be easily detected by the condition of the cleaner, and you know what the report was on that." End quote.

I attended a service school at the Jacobsen factory a few weeks ago and learned, among other things, that for every gallon of gas consumed through a carburetor, that 5,000 gallons of air is required for an engine to perform properly. So, with that thought in mind, I will ask you this question: how many of you fellows have checked the air cleaner lately on your own personal automobile?

And speaking of service schools, whenever a manufacturer or distributor is having a service school in your area, I urge you to attend and bring with you your key personnel. These service schools are conducted, usually by factory trained personnel, solely for your benefit. To better acquaint you with their products and the servicing of them. For example, a couple of years ago after a service school, a fellow told me he had saved his department about a $1,000.00 that he would have spent on parts had he not attended the school.

Caring for or servicing of equipment, one needs an adequate supply of tools. Among which, some should be of a special variety, such as: fly-wheel wrench, ring compressor, oil seal starter sleeve and a tachometer to mention a few. By the way, these special tools are available from your distributor. Had to get in a commercial somewhere.

In addition to tools for small engine work, your shop should include: a lapping machine, air compressor, steam cleaner, table saw, bench grinder, pipe threader, paint sprayer, welder, drill press, vises, and, of course, work benches. In other words fellows, proper tools are essential to maintain a good service operation.

According to the USGA Green Section, a maintenance building should meet the following requirements:

1. Superintendent's office
2. Toilet facilities
3. Adequate heating and ventilation
4. Paint spraying room
5. Herbicide-fungicide storage room
6. Fertilizer storage area
7. Adequate storage area for all equipment
8. Adequate maintenance area
9. An additional storage building is essential for the storing and mixing of topdressing materials. Topdressing should be kept in a dry area so that it will be available at any time of the season. A two-year supply should be stored at all times.

In conclusion then, in order to meet the demands of present day golf course maintenance, the most modern and up-to-date equipment is needed - together with good sound maintenance practices. However, regardless of the maintenance building and modern equipment, the work load cannot be carried out unless an adequate work force is available; a work force that can be depended on, day in and day out; men with responsibility to themselves, to the golf course they are working for and to the equipment they are handling.

COMPATIBILITY OF TURFGRASS FUNGICIDES AND INSECTICIDES

Eric G. Sharvelle
Purdue University
Lafayette, Indiana

The era of 1960-1970 will doubtless be recorded in the annals of man's trials, troubles and tribulations as the "atomic age, the scientific age or the era of the technological revolution." Irrespective of profession or avocation every individual in this troubled world has been profoundly affected by the relentless march of "science at work for man's progress."

On every side in the USA the influence of scientific progress can be seen in the incredible accuracy of soft landings on the moon, atomic powered submarines, supersonic intercontinental ballistic missiles, interceptors, disposable diapers, transistorized tape recorders, electric carving knives, and the regrettably widespread use and abuse of miracle drugs for both good and evil.

While the march of science purportedly speeds man's progress down the highway of accomplishment there have been those in high places who with foresight and wisdom have emphasized the vital need for recreation as a balance wheel for the fast moving life most citizens of the USA endure in these exciting 60's.

When men in conference discuss
Their welfare, oft we find them prone
To disregard or overlook
Man does not live by bread alone.
Theories more or less profound
Of so-called economic trends,
May miss the very human fact
Man also lives for other ends.

One of the most interesting and important recreational outlets has been those activities associated with improved turfgrasses. A dozen recreational activities may be listed as dependent on turfgrass such as football, softball, baseball, touchball, grass hockey, lacrosse, polo, golf soccer, tennis, bowling and croquet. To these must be added many thousands of acres of turfgrass necessary for residential lawns, municipal parks, schools and college campuses, airports, industrial landscaping and highway development.

Turf technology in 1967 has become a science, and the golf course superintendent, the highway agronomist, and the industrial and college ground maintenance superintendent are skilled artisans with professional status with a difficult and demanding assignment for a critical and often demandingly unreasonable public.

The economic importance of the turfgrass industry is brought into focus by the statistics recently assembled from surveys in California, Florida, Texas, New Jersey and Indiana, adjusted and corrected to current national estimates (Table 1).

Table 1. National Annual Turfgrass Maintenance Expenditures by Selecting Facility.

Facility	Annual National Expenditure	Percent of Total
Lawns - residential	$3,002,101,097	69.4
Highways	471,511,556	10.9
Cemeteries	363,366,704	8.4
Golf Courses	237,918,674	5.5
Parks - municipal	50,561,117	1.4
Public Schools	38,932,147	0.9
Airports	34,606,352	0.8
Churches	25,954,764	0.6
Industrial Lawns	25,954,764	0.6
Colleges and Universities	17,303,176	0.4
Miscellaneous	47,583,735	1.1
Total	$4,325,794,086	100.0

Like all other living biological things turfgrass is subject to the vagaries of a fluctuating unnatural environment and consequently falls victim to a multiplicity of ills which may spoil the appearance temporarily or destroy its usefulness permanently.

Since every fairway, green, lawn and turfgrass planting is comprised by thousands of living individuals consolidated into unnatural communities plant diseases all too frequently become destructive and expensive problems. The control of diseases of southern turfgrass must be placed high on the priority list of good turfgrass maintenance practices. An understanding of the nature and cause of these problems is a fundamental prerequisite for successful control or suppression of these problems.

There is no one magical method for the control of turfgrass diseases. As is the case with most disease problems, the effective and economical control of the "gremlins in the grass" can only be achieved by the application of sound principles and practices. These are like the spokes in a wheel - every spoke is important and a missing spoke will weaken the wheel and frequently causes it to fall apart and collapse. Nobody has yet invented a one-spoked wheel, and for this reason there is no simple single panacea for all of the ills that trouble turf. The use of chemicals for turfgrass disease control, the turf fungicides, is merely one of our weapons of defense against these

problems. When used in combination with other recommended practices fungicides will work - when used without consideration for good turfgrass maintenance methods they frequently fail.

Multiple Pesticide Combinations

In recent years chemical tools for better turf have become essential items in the toolbox of the professional turfgrass maintenance practitioner. The modern chemical pesticides for disease, weed, and insect control are a far cry from chemicals used prior to 1950. Today we have effective, specific, safe, and relatively inexpensive compounds with long chemical names and complicated structural formulae to do the job of restricting unwanted weeds, plant diseases, and other pests. So long as these are used in the right way, at the right time, and in the proper amounts they will do the job for which they were developed. Failure to observe "precautions on the package label" will usually get the operator into hot water in a hurry.

For reasons of economics the use of multiple combinations of pesticides is desirable in some instances. These combinations may be as follows:

1. Fungicides alone
2. Fungicides plus fungicides
3. Fungicides plus insecticides
4. Fungicides plus herbicides
5. Fungicides plus insecticides plus herbicides
6. Fungicides plus growth regulators
7. Fungicides plus insecticides plus growth regulators
8. Fungicides plus insecticides plus liquid nutrients and minor elements

Compatibility

When pesticide chemicals are used in combinations or in mixtures numerous problems may arise. In such cases the components of a mixture are said to be compatible or incompatible.

Compatibility is the ability of two or more components of a mixture to be used in combination without impairment of toxicity, physical properties or plant safety. Thus peaches and cream, beer and pretzels, corned beef and cabbage, and two Republicans in the same voting booth are said to be "compatible." They get along together.

Incompatibility is a condition that may occur when two or more pesticides are used in combination with resultant loss or impairment of effectiveness of either component, with the development of undesirable physical properties or the initiation of plant injury responses (phytotoxicity). Thus ice cream and ketchup, stewed prunes and horseradish, kippers and custard, a coon dog and a bobcat in the back seat of a

station wagon, and a Republican and a Democrat in the same voting booth are incompatible. They just con't get along together.

Physical Incompatibility

When two or more pesticides are mixed together with the resultant production of an unstable mixture, the production of excessive foaming or soapy flocculates they are said to be "physically incompatible." Thus talcum powder is physically incompatible with water, since like oil and water, they do not mix together. Most organic fungicides are formulated with wetting agents or other conditioning material. When such materials are forced through a screen with a high pressure stream of water they will occasionally separate or "butter out" and become physically incompatible. It is for this reason that most modern turf fungicides should be "prepasted" with a small quantity of water before adding to the spray tank.

Frequently physical incompatibility results when hard water from deep wells is used for the spray mixture. In such cases the fungicide will tend to separate and fall out of suspension - another case of physical incompatibility. This usually may be corrected by the use of soft pond water or the addition of commercial surfactants such as Santomerse, Igepon (sulfite lye), Wetanol, etc.

When excessive foaming occurs, when frequent clogging of sprayer nozzles and screens results, or when heavy residues are formed on the sides of the sprayer tank it generally suggests physical incompatibility which should be investigated and corrected.

Chemical Incompatibility

When two or more pesticides are mixed together with resultant loss or reduction of effectiveness of one or all components they are said to be chemically incompatible. Thus most organic fungicides and insecticides should not be combined with alkaline compounds with a pH higher than 7.0. Alkaline reactions will significantly reduce the fungitoxicity of carbamate fungicides and the insecticidal value of compounds such as Aramite, Lindane, Parathion and Malathion.

For this reason, lime for the control of algae should never be used in combination with maneb fungicides such as Fore, Manzate, or Dithane M22. This is also true for the fungicides Dyreme (Turf-Tox), zineb, thiram, captan and most organic insecticides.

Mercury fungicides are incompatible with carbamate fungicides and should be used with caution with malathion, parathion, morocide, trithion and EPN.

Dinocap (Karathane) suggested for the control of powdery mildew is chemically incompatible with Sevin, TEPP, and oil-base sprays. Cycloheximide (Acti-dione) suggested for the control of rust diseases of ryegrass,

zoysia, Bermudagrass and St. Augustinegrass is chemically incompatible with chlordane and should never be used in combination with this compound.

Chemical incompatibility is frequently the cause of poor performance of multiple pesticide combinations. Before combining any turfgrass pesticide with another compound it is important to read the label on the package or container. If information on compatibility is not specified it is wise to avoid combination of such products.

Phytotoxic Incompatibility

When two or more compounds used in combination result in injury to the grass they are said to be incompatible by virtue of phytotoxic effects. They may be perfectly safe when used alone but injurious in combination. For example, the organic mercury turf fungicides may cause injury when used in combination with emulsifiable concentrate (EC) formulations of insecticides. This is especially true of those EC insecticide formulations using xylene as a solvent. When combining fungicides with liquid insecticides check the label for compatibility and avoid problems of plant injury. When combining pesticides of unknown compatibility it is always a good suggestion to try them first on a non-essential or expendable turf area before general use on indespensable greens.

Placement Incompatibility

Incorrect placement of turf pesticides is frequently the explanation for poor disease and insect control. Placement incompatibility is less obvious and sometimes overlooked by maintenance personnel. When two or more chemicals are used in combination and applied in one operation each must end up in the proper place if it is to do the job for which it is intended. Thus, some fungicides are protectants and must be uniformly distributed over the leaf surfaces to protect against invasions of pathogens such as Piricularia (Gray leafspot) and Helminthosporium. Failure to establish and maintain a foliar blanket of fungicide protection will inevitably result in outbreaks of destructive turfgrass diseases.

In contrast with the above, mercury fungicides for the control of mushroom Fairy Ring (Agaricus campestris, Marasmius oreades, etc.) are ERADICANTS, and should be applied to the soil surface or within the upper soil levels to eradicate the soil-borne fungi responsible for mushroom Fairy Ring.

Some insecticides used for the control of turfgrass insects such as sod webworm would be ineffective if applied as foliar surface protectants and must be placed where they will destroy larval stages of the insect before emergence. Combinations of maneb for gray leafspot control and chlordane for sod webworm control would be ineffective because of placement incompatibility.

Another example of the need for correct chemical placement is the use of ferrous sulfate or iron chelate for correction of chlorosis (iron deficiency). Ferrous sulfate to be effective must be absorbed by the grass leaf. Fungicides are not absorbed by the leaf surface. Thus if too much water is used when applying ferrous sulfate some of it will be washed into the soil where it becomes tied up and ineffective.

Placement incompatibility is a most important consideration in the effective use of pesticides for turfgrass improvement.

General Precuations

1. Do not mix organic turfgrass fungicides with alkaline compounds.

2. Do not mix organic turfgrass fungicides with insecticide formulations using xylene as a solvent.

3. Use fungicide - ec. insecticide formulations with caution.

4. Nutrient sprays containing boron, magnesium, manganese, iron, zinc and urea should be applied separately. Compatibility of these materials with fungicides and insecticides is not known.

5. Growth regulators such as NAA, 2,4-D, 2,4,5-T, MH and Gibrel are physically and chemically compatible with most fungicides.

6. When in doubt - DO NOT USE COMBINATIONS OF PESTICIDES.

Conclusion

The control of turfgrass diseases must be considered by every professional turf specialist as essential for the establishment and maintenance of improved turfgrass. Effective plant disease control is just as important as the use of new improved grass species, the proper use of herbicides for elimination of unwanted weeds, the efficient control of insect predators, and the utilization of other accepted practices and principles for good turf husbandry.

Chemicals for turfgrass disease control are merely weapons of defense against destructive and expensive "problems on the green." Their effectiveness is determined by the degree with which they are integrated by other accepted essential practices.

Utilization of multiple pesticide combinations is a labor saving shortcut, but an understanding and knowledge of pesticide compatibility is essential for the avoidance of problems which may arise when pesticides are combined in "one-shot applications."

Table 2. Fungicides for Turfgrass Diseases.

Chemical	Trade Name	Brown Patch	Helminth	Leafspot	Fairy Ring	Rust	Curvularia	Nematodes	Chlorosis
PCNB	Terrachlor (L.G.) (WP)	x							
Maneb	Dithane M-22 (WP) Manzate (WP)		x	x		x	x		
Maneb + coordinated Zinc Iron	Fore (WP) Dithane M-45 (WP)	x	x	x		x	x		
Zineb	Dithane Z78 (WP) Parzate (WP)			x			x		
Thiram	Thylate (WP)			x			x		
Captan	Captan (WP)			x			x		
Acti-dione + PCNB	Acti-dione RZ	x				x			
Mercuries	Puraturf (L)	x	x		x				
Daconil	Termil (WP)		x	x					
Dyrene	Dyrene (WP)		x	x					
DBCP	Nemagon (L) Fumagone (L) Nema-X (G) Nema-Kill (G)							x x x x	
Iron Sulfate	Copperas								x
Iron Chelates									x

Table 3. Compatibility of Turfgrass Fungicides.

Chemical	Trade Name	Use	Compatibility
PCNB	Terrachlor (L.G. WP)	Brown Patch	Compatible with captan, dithiocarbamates, antibiotics, aldrin, dieldrin, endrin, toxaphene, DDT, Nemagon. Can be mixed with dinitros if they are mixed with water prior to adding PCNB. Will mix with most insecticides with a pH of 7.0 or below.
Maneb	Dithane M-22 (WP) Manzate (WP)	Helminth Gray leaf-spot Rust Curvalaria	Not compatible with lime, lime-sulfur, bordeaux, fixed coppers, paris green, calcium arsenate Tepp. DO NOT USE WITH MERCURY COMPOUNDS.
Maneb + coordinated zinc ion	Fore (WP) Dithane M-45 (WP)	Fading out Brown patch	Same as maneb
Zineb	Dithane Z-75 (WP) Parzate (WP)	Helminth Gray leaf-spot Rust	Same as maneb
Thiram	Thylate (WP)	Fading out	Can be used with most pest control chemicals
Captan	Captan (WP)	Gray leaf-spot Fading out	Not compatible with dinitros, oil, and alkaline compounds such as lime, bordeaux mixtures and fixed coppers.
Cycloheximide	Acti-dione RZ Acti-dione (WP)	Brown Patch Rust	Compatible with lead arsenate, DDT, nicotine, malathion, melhoxyclor, dieldrin, parathion, lindane, sulfur, captan, thiram, PCNB. DO NOT MIX WITH CHLORDANE.
Organic Mercuries	Ortho Lawn Fungicide Panogen (L) Puratized (L)	Brown Patch Helminth Fairy Ring	DO NOT USE WITH ALKALINE COMPOUNDS OR WITH DITHIOCARBAMATES. Use with CAUTION with malathion, parathion, morocide, trilhion and EPN.

Table 3. Continued

Chemical	Trade Name	Use	Compatibility
Daconil 2787	Daconil	Helminth Gray Leafspot	DO NOT USE WITH EMULSIFIABLE CONCENTRATES.
Dyrene	Turf-Tox D50 Kemate (WP)	Helminth Gray Leafspot	Compatible with chlorinated hydrocarbons and most fungicides. DO NOT MIX WITH BORDEAUX MIXTURES OR LIME.
Iron Sulfate	Sequestrene Nu-Iron (WP)	Chlorosis	Not compatible with most fungicides. Nu-Iron can be used with most pesticides except Pyrethrum, Nicotine, Aramite, Dibrom, Trithion and alkaline compounds
Dinocap	Karathane (WP)	Powdery Mildew	NOT compatible with oil base sprays, Sevin and TEPP.

L = Liquid

G = Granules

WP = Wettable powder

COOPERATIVE TRAINING IN AGRICULTURE

Leo Schreiner, I.C.T. Coordinator
Gayle Todd, Vocational Agriculture Teacher
Bryan Public Schools
Bryan, Texas

In Bryan's S F A High School we have three Cooperative Part-Time Training programs. These are programs which allow the student to attend regular academic classes for a part of the day and complete his daily schedule with three or four hours of on-the-job training in a place of business such as yours. We offer Distributive Education, which deals with retail and wholesale selling. The second program is Industrial Cooperative Training, which prepares a student for an industrial occupation. I teach the third program, Cooperative Training in Agriculture.

In Coop. Ag. we have twenty-five boys enrolled. They are training in such occupations as dairying, mechanicing, poultry farming, veterinary medicine, and in horticultural occupations. Those boys in horticultural work are training as grounds keepers, parks employees, greenhouse workers, and in special areas as Agricultural Research Aides.

These people, either boys or girls, must be at least 16 years of age and be a junior or senior in high school. Our students attend classes at school during the morning and are free to go to their training stations at 1:00 PM. They must work at least 15 hours per five day week. We like to see the boys work no more than 25-30 hours per five day week. We hope also that if you, the employer, need the help that these kids may work with you on weekends and during the summer.

At our school we examine aptitude and IQ test results, we talk to other teachers, we talk to the student, we check attendance and grade records, and then hope that when we send a boy or girl for a job interview that we have selected the right person for the right occupation.

There is no formal contract between the school and the employer. We, the teacher, draw up a training plan which will indicate what work experiences that you, the employer, can expose this person to while under your guidance. On this training plan the starting wage is indicated as well as the number of on-job hours per five day week.

We emphasize to the kids that this is a training program and not merely a part time job. We hope that you as an employer will feel that way about it. We do expect these people to be paid a wage for the hours they spend "on the job." In Bryan most of our Coop. Ag. students receive from $1.00 to $1.15 per hour. Some employers who operate under Interstate Commerce Rules pay minimum salary schedule as required by law. These student learners may be employed at 75% of I C C minimum salary in those cases if proper application is made.

Gentlemen, there seems to be a shortage of available labor in horticultural occupations. Here is an opportunity for you to help meet this shortage and at the same time help train a young person for a full time job immediately after completion of high school or to give a background for college work in this field. You need new people entering your occupation. This is a chance to "raise your own" employee.

In Industrial Cooperative Training we presently have 28 students, 15 boys and 13 girls. These students are placed with employers in some 13 occupations. The occupations are professional, skilled or semi-skilled by definition. Included are Dry Cleaning, Automobile mechanic, Automobile partsman, Bricklayer, Printer, Machinist, Tailor, Radio-TV Repairman and Welding for boys and Nurse aide, Dental Assistant, Floral Designer and Medical Laboratory Technician for girls.

Distributive Education currently has 40 members placed in distributive occupations. These students are employed by wholesale and retail stores in the selling field.

MAINTAINING TURF FOR BEAUTILITY

George W. Schell
Landscape Supervisor, Dallas Power & Light Co.
Dallas, Texas

To enable you to better understand the title of my talk, let me cite two definitions - first, the word beauty which may be defined as that quality or aggregate of qualities in a thing which gives pleasure to the senses or exaults the mind or spirit.

Next, is the word utility, which could be defined as the quality or state of being suitable for use or, secondly, an organization that sells a service to a community.

Dallas Power & Light Company is an investor-owned public utility company. We are in the business to make a profit, and we do it by generating and selling electrical power.

We budget over $300,000 each year to maintain the grounds in which we have invested over $2 million. We are careful with expenditures and try hard to obtain maximum results from our various practices. We try continually to evaluate our operation in search of improved techniques and efficiencies.

We have combined these two words and their respective meanings to coin the new word (beautility), the definition of which includes those of beauty and utility.

Now, without belaboring the point, I should state that on all of our properties DP&L strives for beauty. Thus, in the selection of our plant materials, a good turf heads the list. The purpose of my taking your time with the explanation of beautility is to be assured that you understand that all of our landscaping is done for both beauty and utility.

In 1955, due to Dallas Power & Light Company's interest and the public's response to beautification, a landscape section was formed. The responsibilities of this section were to landscape and maintain all installations. This consisted of mowing, watering, pruning, spraying, tree surgery and maintenance of equipment.

Since 1955 we have grown from three power plants, three service centers, fourteen substations and seventy miles of rights-of-way to four power plants, four service centers, fifty-eight substations and one hundred miles of rights-of-way. The total area we consider turf exceeds 2300 acres. This does not include the intensively maintained turf of the substations, service centers and power plants.

Fifty-eight employees and 100 pieces of equipment are used in our

operation. Twenty-two college students are employed in June, July and August to augment this force.

I would like to share with you some of our thoughts and practices which we have found helpful. Perhaps from them you might pick up a thought or two that would help you with your program.

We find that the success of having good turf is due primarily to the preparation of the soil. If the soil is not suitable new soil should be added.

When seeding, we usually fertilize lightly with an organic fertilizer, scratch the soil lightly and then sow the seed or plant vegetative material. When sodding, we use the same method. A quick coverage is obtained when seed or sod is watered at intervals short enough to eliminate soil crusting. Fertilizing of established turf is done differently than most. We start our fertilizing program in the latter part of March or early April. We apply approximately forty pounds of organic fertilizer, generally 12-8-4, to one thousand square feet. We fertilize again when the color of the grass lightens. Light applications are made, usually two or three times, during the summer months. We do not fertilize after the month of August. This may be contrary to most practices, but we feel we get the best results from this method.

Watering of the turf is done usually in the early morning hours. Most of our turf areas at our substations have Buckner Automatic or Manually operated sprinkler systems. When conditions demand changes, adjustments can easily be made.

A trained crew is used to spray turf for insect and fungus control. Also, they are trained to use herbicides, both post and pre-emergence, for the control of undesirable weeds and grasses.

For complete soil sterilization along fences and under our rights-of-way transmission towers, we are using Hyvar X-WS. Leaching has been at a minimum with use of this product.

In Dallas one, perhaps, can view dallis grass in more than one manner. While not exactly so, it is almost a namesake for our city and county. Thus, one may wish to let it flourish or he may wish to control it in his efforts to develop a more favorable turf.

We have made use of invert emulsion application of MSMA with bivert MSMA adjuvant for control of rough grasses and leaving Bermuda. We are anticipating greater usage of this application on our rights-of-way to reduce mowing frequency.

Thatch control is a must in our turf building program. Once each year, an aero-thatch machine is used to remove thatch on all company properties subjected to intensive maintenance. This equipment removes

thatch, promotes new root growth and aerates the soil. This allows fertilizer to enter aerated grooves and good results are obtained.

Turf management for a utility company does not lend itself to extensive turf grooming for the entire facility such as one may find in a park or gold course. We do feel, however, that with the combining of a practical maintenance program on our rights-of-way and field areas in addition to our well-groomed service center and substation lawns, we can achieve our goal of beautility.

LABOR RELATIONS AND NEW LAWS RELATING TO THEM

Clark Monroe
Director of Personnel
Albritton Engineering Corp.
Bryan, Texas

I appreciate this opportunity to talk with you about labor relations and some of the new labor laws that are having an impact on your operations and mine.

I must admit to the irony of my trying to counsel a group of grass experts. Usually, the shoe is on the other foot. I only hope that your labor relations will respond to my advice better than my grass has to yours.

I am certain of one thing. If the chinch bugs make their annual appearance on my lawn next summer, I will expect some expert consulting from Dr. George McBee.

Seriously, I appreciate your concern for labor legislation and labor relations. Many of you, I imagine, have been immune to some extent from the direct impact of much labor legislation. Some of this immunity was shattered, of course, with the recent amendments to the Fair Labor Standards Act which extended coverage to many additional types of organizations.

For example, schools, colleges and universities -- both state and private -- are now subject to the requirements of the Fair Labor Standards Act, or as it is better known, the Wage Hour Law. The legality of this coverage is still being challenged in the courts, but the direction is unmistakably clear. Organizations of all types increasingly are becoming subject to federal and state regulation. As this trend continues, even those few organizations that may remain largely immune from direct outside influence must learn to cope with the indirect influence.

Let me cite a case in point. The minimum wage was increased from $1.25 to $1.40 effective last February. This next February, it will go to $1.60. Even if your organization is not subject to the Wage Hour Law, which sets this minimum wage, the market for common manual labor is drastically changed. If you are going to get and keep a reliable work force in the future, you must be able to compete in the market with comparable wages.

And your competition is not limited to the low end of the pay scale. The inevitable result of a higher minimum wage is a higher scale throughout the range of positions which you must keep filled with competent people.

So I ask you to accept the premise that you are subject to the Wage

Hour Law and all its implications either directly or indirectly. Thus, you need to be familiar with this law; you need to know what it requires of you and what this law is forcing your competition in the labor field to do.

There is another piece of legislation now in Congress that will also have a significant impact on your operations. It is not considered labor legislation per se, but the proposed amendments to the Social Security Act are part of your labor problem. Let me explain.

If you are subject to the Social Security Act today, you pay $290.40 annually for each of your employees on a taxable wage base of $6,600.00. For employees making less than $6,600, you are still taxed at a rate of 4.4%. And, of course, your employees have equal amounts deducted from their pay checks.

Under the present Social Security Law, the tax rate will increase automatically to a maximum of 4.9% in five years. In dollars under the present Social Security Act, your tax outlay will rise from $290.40 to $323.40.

But are you aware that a change on Social Security was voted just two weeks ago by the Senate. If this change becomes law, then in that same five year period, the taxable wage base for you and your people will increase from $6,600 under the present law to $10,800. The tax rate will increase from 4.4% to 5.2%. And the maximum employee tax will go from $290.40 to $561.60.

Your cost of doing business will increase accordingly. Your employees will be expecting more take-home pay, but for you to give them a recognizable increase you must not only consider any merit increase they may have earned, but you must also make allowance for the increased deductions they face from the higher Social Security tax. And, from a budget standpoint, you must also plan for the matching increase that is the employers' contribution.

Some of you may represent agencies which are not covered by Social Security. Here, again, the impact on your operations will be indirect. But, it will be real just the same. The higher benefits under the proposed Social Security modification will make employment more attractive in those organizations or agencies which are covered. You will have another obstacle to overcome in hiring and retaining competent people.

Up to this point, I have mentioned only two pieces of legislation which you must consider in your personnel planning. Certainly, these two -- the Wage Hour Law and the Social Security Act -- are the most costly from first appearance. But there is a whole spectrum of other labor legislation which must be a factor in your management.

I would be less than frank if I did not say that there is a real need for labor law reform. My purpose is not to stump for that reform but, rather, to call to your attention some of the major issues which will affect you as they affect industry.

Time will not permit a detailed discussion because each of these areas is complex in itself. And labor legislation does not reduce well to readily understandable terms. Therefore, if you will allow, I would like only to mention for your consideration some of the labor law concerns that industry faces with the thought that, increasingly, our concern will become yours.

Pending now in Congress are these major pieces of labor legislation.

(1) Unemployment Compensation. A proposal has been made to increase benefits to unemployed persons to amounts equal to 2/3's of their weekly wage and to make mandatory the payment of unemployment compensation benefits to persons on strike. This legislation was introduced by a congressman from New Jersey. That state recently passed such a law. And in New Jersey, when a man goes on strike now he becomes eligible for unemployment compensation after one week. Taxpayers in New Jersey are, in effect, subsidizing strikers. The effect on the unemployment tax rates has not been fully determined, but there is every indication they are going to be substantially increased. The cost of doing business in New Jersey will increase. If this legislation were to become federal law, as has been proposed, your cost of business and mine would also increase.

(2) Right to Work Law. The repeal of the Right to Work Law, which is Section 14B of the Taft-Hartley Act, has long been a major goal of organized labor. Repeal was prevented only by a filibuster last year. Temporarily, at least, efforts toward repeal have been set aside, but we can expect to see a renewed action whenever the climate is right.

(3) Common Situs Picketing Bill. Unless you follow labor legislation, you may not have heard of the Common Situs picketing bill. Incidentally, one prominent attorney said that common situs is just a misleading Latin phrase that means "trouble." I could not agree more.

What the common situs bill would do is this. It would make the secondary boycott legal. In other words, if you have a construction project underway on your grounds and one man working for one subcontractor precipitated a strike against that subcontractor then union workers for all subcontractors would have to respect any picket line that was established. In other words, one disgruntled union employee could shut down an entire construction project with the obvious consequences. The Common Situs bill is dead-locked now in Congress, but it could be sprung loose easily.

(4) Equal Opportunity. This broad area of government interest is presently under the direction of the Equal Employment

Opportunity Commission. Legislation has been proposed that would give the EEOC the same powers that are now enjoyed by the National Labor Relations Board. This means the EEOC could, for instance, issue temporary restraining orders or enforce decisions that would tie your hands as an employer. Those of you who are familiar with the NLRB and its decisions can readily understand the apprehension with which industrial relations people and all management would view extension of NLRB type power to the Equal Opportunity Commission.

Let's look at the power of the NLRB.

(5) NLRB Powers. Organized labor is promoting introduction of legislation that would give the National Labor Relations Board greater freedom in dealing with unorganized laborers. Basically, the proposal is to limit the referral of NLRB decisions to the court. Decisions in many areas dealing with unorganized labor could not be appealed to the courts. This same legislative proposal would also provide the NLRB with federal funds, to pay employees who have filed grievances pending disposition of those grievances. In other words, if this legislation were approved, you as an employer of unorganized labor, could be placed in the position of having to, first, accept NLRB decisions without reference to the courts, or, if court procedures were allowed, the grieved employees would be paid federal funds and you could well be charged with the cost of those payments if the decision were not in your favor.

(6) Migratory Labor. There is a growing body of evidence that certain congressmen move with the fruit crop. Presently, there is considerable union pressure for legislation which would put farm laborers under the protection of the National Labor Relations Board. It does not take much imagination to compare turfgrass managers with industrial relations managers.

This legislation which I have listed hits only the high spots. My purpose is not so much to give you a capsule commentary on labor legislation, but rather to emphasize that there is an unmistakable trend to broaden and extend the directives and controls which you and I must live with from day to day as employers.

I have no hesitancy whatsoever to say to you that within a very few years there is a very strong possibility that each of you, even if you are part of a municipal government or a non-profit agency, will find yourselves facing all of the same labor restraints that we in industry face today.

Now, having painted this somewhat gloomy picture and alerted you, possibly, to some things which you had not considered before, let me conclude with some suggestions.

First, I recommend very strongly that each of you subscribe to a good

national service on industrial relations. Only in this way can you keep abreast of the legislation which will affect you, your people, and your planning. For example, Prentice-Hall offers several fine services which would be helpful to you. Two are particularly good. The first is Personnel Relations-Policies and Practices. The second is Industrial Relations-Union Contracts and Collective Bargaining.

If you do not have a union to cope with, then I suggest the Personnel Relations Service would be adequate for your needs. This service provides a bi-weekly report of current developments and furnishes you a completely indexed manual that is maintained on a current basis. It will give you a detailed reference to requirements of such major pieces of legislation as the Wage Hour Law, Walsh-Healy Public Contracts Act, Equal Employment Opportunity Act, and other government contract laws. This service costs about $125 a year. It could save you many times that amount.

Second, I urge you to take an active part in your Chamber of Commerce. If you are employed by a municipal agency which would not permit you to pay for a regular Chamber membership, then for a modest price you can join as an individual. I don't say this just to be a Chamber of Commerce promoter. Rather, I suggest it as a way to gain direct access to the publications of the Public Affairs Committee of the National Chamber of Commerce. This committee receives weekly reports on current labor legislation together with reports on other legislation of interest to you as a manager. These are invaluable.

Third, I would urge you to acquaint your supervisors with the labor relations services which I mentioned above and with the regular publications of the Chamber of Commerce dealing with labor matters. In this way, they can act from a knowledgeable basis. Their plans and their approach to labor problems will then be based on the same information that is used by your labor competitors.

Fourth, and I wish I had more time to dwell on this subject, I would recommend that you review critically the adequacy of your wage rates and your practices for handling merit and promotion increases. Frequently, this is left too often to chance. As a result, disparities develop and deserved rewards are not made on a timely basis.

It is my personal opinion that any job can be accomplished more effectively with fewer but better people. The only way you can get better people is to be competitive in your wage rates. And, while you cannot change overnight the practices of long standing, you can make plans now to move toward adequate wage levels and realistic compensation procedures.

Fifth, you and the supervisors who work for you will find that your responsibilities in the area of labor relations will become increasingly complex and time consuming. This is a fact of life. And I know that you would rather spend your time with your primary responsibility in the turfgrass area rather than wrestling with the problems of labor relations.

One way to insure that you can keep your labor-related administrative duties to a minimum is to try to be alert to developing problems and take remedial action before they become major problems.

Perhaps I would not be far off the target by comparing good labor relations with good turfgrass management. So, at the risk of exposing my ignorance of turfgrass management, I would say this to you in summary.

(1) Keep abreast of the newest developments in the field.

(2) Know your people with the same thoroughness that you know your turfgrasses.

(3) Cure your little problems before they become big ones.

(4) And, in a final analysis, if you suspect that your labor relations are not all they should be, then seek out the advice of an expert. Ask him to come in, to survey your operations, and to present you with specific proposals for improvements. But, one word of warning, there are many so-called "experts" in the personnel or labor relations field. If you should want to hire a consultant, the best thing you can do is to ask him for a list of clients and check with them first to see what kind of a job he did for them. The chances are that if he served them well, he will serve you well.

Thank you again for allowing me to talk with you. I wish you great success with your conference. And, if any of you should have any specific questions about labor relations and labor law as it applies to your situation, I will be most happy to talk with you and perhaps indicate where you might find information that would be of help to you. Thank you very much.

AQUATIC WEED CONTROL

W. G. Klussmann
Speciallist in Wildlife Conservation
Texas A&M University

Aquatic weed control should begin during construction of the lake or pond. A minor expenditure for deepening the shore line to a minimum of three to four feet at this time will be fully compensated for by years of relative freedom from weeds. The installation of a drain pipe is also a very important asset in controlling undesirable vegetation. Unless ponds are properly constructed and very carefully managed, eventually most ponds will become infested with weeds, many to the extent of severe interference with the primary water uses.

Basic to aquatic weed control is the identification of the plant or plants which are causing trouble. This is necessary in order to determine the proper treatment with which to eliminate or control the problem. It is well known that all plants of the many types and groups found in ponds do not respond to the same treatment. We get many phone calls and letters that ask simply, "I have 'moss' in my pond, how can I get rid of it?" We cannot answer this question without having more information. Most important, we need to know the identity of the plant.

Generally, water weeds can be divided into four types according to their relative positions of growth:

(1) Floating weeds - plants which float on the water surface with no attachment to the bottom. (Often, however, weeds that have floating plant parts but are rooted are included in this group. An example is the water lily group. An example of the true floating weed would be duckweed or watermeal.)

(2) Emersed (emergent) weeds - plants rooted in the pond bottom with leaf parts extending above the surface of the water.

(3) Submersed (submergent) weeds - plants growing entirely beneath the water with the exception of seed heads or flowers extending out of the water. The submerged weeds are generally the group referred to as "mosses."

(4) Algae - plants commonly referred to as "moss" or pond scum and may be either floating or submerged. This "moss" is composed of tiny single-celled plants growing either individually or together in long filaments. Certain algae are beneficial for effective management of fish ponds. Other forms are highly undesirable and probably should be eliminated. The filamentous types are usually the undesirable forms.

Extension Bulletin B-1018, Common Aquatic Plants, Identification -

Control, was developed to aid in identifying the most common problem plants. Usually, the description and illustration are sufficient to identify floating and emersed plants. However, the similarity of the fine leaf structure of submersed species will likely cause some confusion.

Through the years fishery workers have carried out much work on the control of water weeds. Generally, there are four methods of weed control which are more or less effective in specific situations.

(1) Water fertilization - fertilization with commercial inorganic fertilizers, if practiced consistently, can be effective in preventing weeds in addition to increasing fish production. It is important to remember that the only means by which fertilizer can control weeds is by causing dense plankton blooms which inhibit sunlight penetration, thereby shading out submersed vegetation. Through addition of necessary nutrients, tiny single-celled plants and animals are produced in numbers sufficient to limit light penetration into the water. This method effectively prevents new growth of aquatic weeds in water depths of approximately three feet or more. It is important to remember that fertilization generally is not effective in eliminating established weed infestations. This is primarily because once the leaf parts of the plants have reached the surface it is impossible to eliminate enough sunlight to kill the plant. The fertilization program, to be effective, must be initiated prior to and continued through most of the plant growing season. In Texas, this would be from about the middle of March through June. Current suggestions for rates and methods of fertilizing farm ponds is available in Extension Bulletin No. B-213.

(2) Manual removal - cutting or pulling is a slow but effective method of eliminating emergent plants. Cutting or pulling must be iniated and continued to prevent seed production. It can probably be used effectively around small ponds to eliminate the first plants of possible future problem infestations of such plants as cattails, rushes, willows, and similar shore line plants.

(3) Exposure of the pond bottom - exposure of the pond bottom is usually possible only in ponds having a drainage system. However, dry weather occasionally accomplishes this exposure. Exposure of the pond bottom is primarily effective in controlling some of the submersed weed species. Water from shallow areas can be drained in September or October and allowed to remain through the fall and winter. Initation of a fertilization program in the spring has worked effectively in eliminating submersed vegetation along with drawdown.

(4) Chemical treatments - chemical treatments have been used most successfully in eliminating major aquatic weed problems. No one

chemical has been developed which can control all aquatic weeds. Rather the different growth characteristics of several types of plants in relation to the water medium and the morphological differences in the two groups of plants make it necessary to carefully select the chemical which will control a given plant under its particular growth conditions. However, in light of all the existing problems, chemical control is probably the most effective and economic procedure available today. The remainder of this discussion will be devoted to chemical control of unwanted aquatic vegetation.

The control of water weeds with chemicals involves numerous problems which are entirely different from those which we encounter when using chemical materials in dry land situations. For this reason, few chemicals have been found which are suitable for use on aquatic herbicides. This has resulted in the bulk of control of aquatic weeds being done with the few effective chemicals that have given fairly consistent results. This is made more complex by the fact that the plants usually must be controlled without harming the fish in the water or the livestock or wildlife that drink the water. To this, add the fact that the effectiveness of various chemicals is effected by the water chemistry, making the chemical control of aquatic weeds quite a challenging, sometimes mysterious problem.

Chemical weed control can be most successfully accomplished by following a predetermined plan of action. First, the weeds must be properly identified. Second, the area or volume to be treated must be calculated. Third, the proper chemical must be selected and the amount determined and the method of application considered, and finally the treatment made. In treatments where the water is treated for submerged plant problems, it would be advantageous to know the chemistry of the water and to discern if the existing situation will likely effect the activity of the chemical.

Calculation of the area or volume to be treated can be accomplished by several methods. If engineering assistance was obtained in constructing the pond, the technician can probably furnish the exact area or volume figures. Often the local Soil Conservation Service office will have aerial photos of the pond involved, and they can determine the surface area by simply running a polar panimeter around the pond area. Procedures for determining the surface area and volume of a pond are available in County Agricultural Agents and Soil Conservation Service offices.

Application Methods

In instances where liquids are to be sprayed on exposed plants, a fine mist which will thoroughly cover and adhere to plant parts without running off is best. This requires a pressure-type pump with adjustable nozzle. When plants have been sprayed, they should not be disturbed to avoid shaking or washing off the chemical. Generally, it is quite important to use an effective surfactant when treating floating or

emersed plants since many species of aquatic plants are difficult to "wet." A good method to assure more even distribution of chemicals used for submersed weed control is to introduce the chemical directly into the propeller wash of a small outboard motor. Where pelleted materials are being used, even distribution over the weed infested area is essential. Crank or motor driven lawn seeding equipment has proven ideal for application of these materials. It is best to cover the entire area in one direction with one-half of the amount of the chemical and then apply the remaining one-half over the whole area at right angles to the initial application. This forms a cross-patch pattern and assures of fairly even coverage of the area to be treated.

In all types of applications, float or stake markers will aid considerably in making even applications. They will serve to indicate areas which have been treated and keep the applicator from treating the same area twice.

Of extreme importance is the caution which is necessary in the use of all aquatic herbicides. An overdose or careless handling can result in destruction of all fish and fish food organisms or endanger humans, livestock, and desirable plants which may be near or come in contact with the treated water. In making chemical treatments, the following precaution measures should be taken:

(1) Carefully follow manufacturer's recommendations on amounts to use and methods to apply the material. Of course, observe all danger warnings.

(2) Exclude livestock and humans from the treated ponds and adjacent areas if necessary.

(3) Avoid drift of materials onto desirable plants.

(4) Do not use 2,4-D in spray equipment which is to be used later on desirable broadleaf plants.

(5) If the weed infestation is heavy, treat only one-half of the pond per treatment to avoid fish kills from oxygen depletion. Treat the second half after waiting a period of about two weeks. The oxygen depletion problem generally can be avoided if application is made in the spring before plant infestations become dense and water temperatures become high.

A very important factor which should be considered is the time of the year to apply chemicals. Generally, most effective control can be accomplished by treating plants which are young, succulent, and growing rapidly. For this reason, treatments made in the spring, early in the growing season, are considerably more effective and require less materials to do the job properly. Also it is at this time of the year when water temperatures are lower than they will be during the summer, and consequently, the dangers of a fish kill caused by oxygen depletion are considerably reduced.

It cannot be overemphasized that at present there is no permanent "cure-all" for aquatic weed problems. Rather, their control is a continuing process. Herbicides erradicate some plants only for one season, while others are controlled for longer periods. In all instances, however, proper chemical control can be used to eliminate existing plant infestations, thus, minimizing the effort required to control the infestation in the following years. In most instances, regrowth can be discouraged through manual removal as it appears, particularly in shore line plants, or by initiating a proper fertilization program where feasible. In some instances, usually in ponds which cannot be fertilized or in shallow water ponds, it may be necessary to treat chemically for one or possibly two seasons following initial plant elimination in order to destroy reinfestation from weeds with prolonged germination periods. Probably the most important factor in successful aquatic weed control is persistence. A persistent follow-up program after elimination of initial weed infestation will assure every owner a weed-free pond with a minimum of effort.

STOCKING AND MAINTENANCE OF PONDS AND RESERVOIRS FOR FISHING

W. G. Klussman
Specialist in Wildlife Conservation
Texas A&M University

Construction

Efficient management of a pond or reservoir for fishing begins with construction. Basically, there are just two considerations which make a pond designed for fishing different from a reservoir in which only the water holding capacity is considered. The first and most important consideration is to eliminate shallow water areas. In this paper, "shallow water" should be interpreted as water that is less than three or four feet in depth. At the time construction is planned, consideration should be given to the correct construction of the dam and spillway and also where the expected water line will be to determine the amount of the pond area that will be covered with water that is less than three feet deep. Often the spillway level or pond size can be varied or the shore line can be sloped to eliminate large areas of shallow water. Weed problems in fishing ponds almost inevitably begin in shallow water areas. Shallow water is also a major contributor to fish populations that favor small fishes. Thus, a few more dollars spent when the pond is being constructed will certainly be repaid in many ways through less problems with aquatic weeds and an easier job of managing the fish population.

The second important construction feature is the installation of a drainage system within the pond. Obviously, this is most easily done when the dam is being constructed. Local Soil Conservation Service technicians can help with the engineering necessary to install an effective drain pipe in a pond. In areas of median or high rainfall such as in central and east Texas, drain systems can be used to eliminate aquatic weed problems in shallow water areas, to control spawning of unwanted species of fish, and to reduce the volume of water when treatment is necessary. Ideally, then the only difference between a fishing pond and a simple water reservoir would be a minimum of shallow water and a drainage system.

Stocking

Now that we have our ideal pond constructed and are lucky enough to get water in it, then the next step in management is correct stocking of the pond. It is in this area that our ideas have changed in the past few years. We are often asked the question, "What kind of fish should I put in my pond?" Our usual reply is, "Stock the kind of fish you like to catch." Certainly there are limitations to this statement, but basically, it is the most important consideration when deciding upon the kinds of fish to put in the pond. In other words, if you are a bass fisherman, there is no reason to stock other species with the bass. If you are a catfish fisherman, we know that catfish do well in ponds stocked with only catfish. Of course, if you are a sunfish fisherman there is no reason to stock other species. However,

most people are interested in some combination of fish so that the potential catch will be a little bit larger. For many years, the stocking combinations for Texas waters was bass, bluegill, and catfish. One thing learned through many years of stocking ponds in Texas, it is that these three species stocked together in small ponds seldom end in a pond in which you can catch bass, catfish and sunfish of edible or desirable size for more than a year or two. The reasons for the failure of this combination are several: (1) Bluegill (sunfish, perch), the most common species stock, spawn a number of times during the long warm season in Texas and with low fishing pressure on the sunfish it is impossible to keep the bluegill population in check. The bluegill does not seem to be the ice cream in the bass' diet and consequently, he is not a good forage fish which adds to the overpopulation problem. (2) We have learned that bass seem to be cannibals by preference and can usually produce enough offspring of their own to serve as a forage fish. (3) We know that when bass and catfish, particularly channel catfish, are stocked together that eventually the catfish will be more or less eliminated from the pond because the bass and/or sunfish are better competitors. In other words, if you stock bass and catfish together you will be able to catch a number of catfish stocked, but even though they spawn there is no reason to believe that the young catfish will reach adulthood. A pond stocked with bass, sunfish, and catfish will usually be dominated by bass and sunfish in two or three years. Bass and catfish are a good combination to stock in ponds, however, it appears that you must be prepared to accept the fact that eventually you will have a bass pond unless you are willing to buy larger catfish to restock the pond.

It is particularly important when stocking bass in ponds that the stocking be fingerlings of one size. This is easiest when you use only the fingerling bass from a state or federal fish hatchery. Do not introduce larger bass from any source since they will prey upon the smaller fish. Thus, eliminating most of the fingerlings stocked.

When stocking bass and catfish in combination, it is very important to stock the catfish first, probably in the fall, followed by stocking of bass in the spring. This will give the catfish a chance to grow before the bass fingerlings are introduced. If you reverse this procedure and introduce the bass first, they will be large enough to eat the catfish by the time they are delivered in the fall.

There are questions about other species in small ponds, particularly on crappie (white perch) and flathead catfish (yellow catfish). Experience has shown that crappie and flathead do best in larger ponds (5-10 acres of more). Apparently crappie are very prolific and somehow this is most evident in small ponds. The flathead is a predator and is not suitable in ponds except in those that are overstocked with bullheads or sunfish.

To summarize stocking considerations, put in the kinds of fish you like to catch and observe the limitations necessary. Bass and catfish

are probably our best combination. If you want sunfish fishing, of course, you can stock them by themselves or in any combination. Probably the best species to use is the redear sunfish. The redear spawns only once a year compared to numerous spawnings of other sunfishes, and consequently, is less likely to overpopulate a pond in a year or two.

Fertilization

The next subject to be discussed briefly is how fish are produced in the pond and what can be done to produce more pounds of fish per acre per year. There is a direct comparison or relationship between productivity in water and on land. The pounds of fish a pond will support is directly related to the fertility of the water and to the surface area of the pond just as quality and quantity of grass is related to animal production on a given area of land. There is little relation between fish production and the depth of the pond. In other words, a pond that averages five feet deep will produce just as many fish per surface acre as a pond that averages 20 feet in depth. The first link in the food chain of any animal is plants. All of you have seen a pond or lake that appears to be green or brownish in color. This color is caused by numerous little floating one-celled plants and animals that are commonly referred to as plankton. Plankton in water is like the vegetation on land. Plankton is the first link in the fish food chain that eventually leads to the adult bass. Obviously then, there is also a direct relationship between plankton production and fish production.

Logically this brings us to consider ideas which will enable us to most economically produce the largest amount of fish per surface acre. Experience and research to this date have shown that the use of inorganiz commercial fertilizer is the best and most economical way to increase the pounds of fish produced in most ponds. However, it is important to mention that fertilization is not to be considered as a recommendation for every pond. Normally in a pond that is not fertilized, we can expect production to vary from 50 to 150 pounds of fish per surface acre per year. In fertilized ponds, we can expect production to vary from about 100 to as much as 300 to 400 pounds of fish per surface acre per year. The problem to consider is that many times we do not harvest the crop we produce in our ponds and lakes. There is no reason to fertilize a pond that is fished only once or twice a year. If the pond is fished heavily and you want to produce the most fish possible, then fertilization will help.

If you decide then that fertilization is a necessary part of your pond management program the next questions are when, what kind, and how much to use. First, let's look at when to fertilize. Normally the first application should be made about the first of April. Water in most parts of Texas will be between 60° and 70° at this time of the year and this seems to be about the best temperature at which to begin the fertilization program. In bass ponds there will be many small bass present when water is at these temperatures and fertilization will insure them of a good food supply.

How much fertilizer should you use is probably the next question. This is more difficult because water is different from soil in that the nutrients

are continuously tied up and water analysis is not likely to give us any concrete information. Where fertilizer is introduced, it is taken up and "stored" by the plankton organisms in the pond so that a chemical analysis of the free chemicals in the water is misleading. Therefore, the technique we have had to adopt is to pick an arbitrary amount to begin and watch the water. The water should change to a green color in a week or two which indicates a good plankton population. This green color is usually referred to as a plankton bloom.

Usually a fertilizer that is high in nitrogen and phosphorus and contains a small amount of potassium will give good results. When we know little about water chemistry of the pond involved we usually suggest beginning with about 50 to 100 pounds of a fertilizer such as 20-20-5 per surface acre. Certainly it is not mandatory that you use an analysis such as 20-20-5. This simply means that any combination of nutrients that would give you about 20 pounds of nitrogen, 20 pounds of phosphorus, and 5 pounds of potassium per surface acre would be a good fertilizer to use in a pond. Since this fertilizer is being put into water, the materials or forms of nutrients should be readily soluble. At the present time the use of liquid fertilizer is not well known, it may be one of the ways that will be in use in the future for pond fertilization. However, regular granular fertilizer can be applied in manners that will assure dissolving of the nutrients in the pond.

How do you apply fertilizer to get the best use of the material? Applying fertilizer to a pond is about the only job I know where a "lazy method" might be better than one that requires a lot of work. In the past, we suggested broadcasting the fertilizer evenly over the pond which as you can imagine is quite a job. Now we find that any method by which you can get the fertilizer dissolved into the water is probably more efficient than spreading it evenly over the pond. Broadcasting provides the opportunity for chemical binding of the nutrients with the bottom soil. Fertilizer can be applied on a small platform set in the pond 6 to 8 inches below the surface of the water. Pour the fertilizer on this platform allowing the wave action to dissolve the materials. Another way is to build a small wooden frame with a screen wire bottom. This frame is placed just beneath the water surface. The nutrients poured into this frame will dissolve and diffuse through the screen wire bottom. An equally good method seems to be simply loading the fertilizer into a boat and pouring a heavy line or spots around in shallow water of the lake. In effect, there will be numerous piles or a row of fertilizer will dissolve and diffuse over the pond.

Follow-up applications of about half the original amount, are determined by watching the water. Once a good plankton is established, it is not necessary to apply additional fertilizer until the water begins to clear. The easiest way to test whether you have sufficient bloom would be to attach a tin can lid onto a broom stick and mark it about 18 and 24 inches. If it disappears between 18 and 24 inches, the plankton bloom is adequate. If the can lid can be seen down to about 24 or 30 inches, more fertilizer should be added. Usually a fertilization program will require from 150-250 pounds of fertilizer per acre per year.

Normally we recommend stopping the fertilization program about the middle or end of June. This is not because fertilizer will not do its job during the summer but because of oxygen depletion problems associated with fertile water during hot weather. Warm water holds little oxygen, and plankton takes oxygen from the water during darkness. Therefore, a fish kill is probable in July, August, or September following hot, windless cloudy weather. This oxygen depletion problem can usually be avoided if the fertilization is stopped around June 15 or 30.

Fishing

When to begin fishing a pond is another question that deserves a comment. You may start fishing the pond as soon as each species stocked has had one opportunity to spawn. If you stock bass in the spring, you can start fishing the following spring. Or if you stock catfish in the fall, you can start fishing the following fall. However, there is no real harm in starting to fish the pond as soon as the fish have reached a desirable size. It is not possible to completely fish out a pond and to eliminate the reproductive population. Apparently, there is confusion about how much a pond should be fished. Generally, it is difficult to overfish a pond but there is one exception, particularly concerning bass in small ponds. We have had some success in bass ponds when only large bass in the 4 or 5 pound class are taken and the small, 2 and 3 pound fish, are returned to the pond. Usually the breakdown in a bass pond is the over population of fish in the 6 to 10-inch class. A virtual food impass can develop among this size class, and consequently fish may remain this size for as long as they live. By returning the larger predators, we are able to keep predation on the 6, 8 and 10-inch bass. This technique has worked in several ponds but is not presented as a thoroughly researched recommendation.

Undesirable Fish

Finally, one remaining subject deserving consideration is controlling undesirable fish populations. Rotenone is still the most acceptable fish toxicant we have available at the present time. It does a fair job of eliminating the majority of most species from lakes. It is not very effective on bullheads. New products are on the market such as antibiotics and can effectively take out shad, suckers, and sunfish. It is not toxic to catfish. We are doing some applied research with anhydrous ammonia as a fish toxicant, but we are not in a position to be able to supply adequate information on this material at present. We hope to get basic research started on this in the very near future. Anhydrous ammonia appears to be a fish toxicant that is selective and that does not leave toxic residues.

In summary, it is most important to emphasize that there is no "cure all" or easy road to effective and efficient pond management. Probably the best recommendation is that you be persistent. Watch the pond closely. When the problem begins to appear, take action before it becomes acute. The normal cycle for a pond in nature would be for it to fill with vegetation, to silt in, to eventually become a marsh and finally dry land again.

Therefore, if you are trying to maintain a clean pond for fishing, boating, or swimming, you are fighting natural cycles and it will be a continuous battle. However, many pounds of fish can produce efficiently and economically in a well-managed pond. The pond manager, however, will be much less frustrated when he realizes that pond management is an annual job with recurring problems.

NOTE: Aquatic weed control was not discussed as it is covered in a separate paper presented during the panel sessions of this conference.

WHY AND WHEN TO USE MACHINERY

Gene Bockholt
Watson Dist. Co.
Houston, Texas

The day and time of "doing it cheaper by hand" is over. The rising cost of labor alone behooves every turf manager to study his operation and determine where and how equipment can best be used. Equipment should be used to increase effiencies in time and labor, to do a better and more uniform job, to cut costs and to reduce labor.

It is recognized that few golf courses can afford to have all the necessary tools to do each and every job on the golf course. When a need for a specific piece of equipment arises, look into the possibilities for renting the equipment. You will find that essentially all of the various pieces of equipment required can be rented. Another good source of equipment is a neighboring golf course. Many golf courses today assist each other with exchange of equipment. In many instances two golf courses have pooled their resources to buy an item such as a green aerifier which they then share.

The slides shown show severe layering problems in samples taken from some old greens. If the right equipment, namely a composter, had been used to properly mix the seed bed materials this problem could have been prevented. The other slides shown depict the right equipment for each job, namely, a Viking roller blade for final level and seedbed preparation, a topdresser to uniformly spread a dressing of seedbed materials on a newly planted green.

The slides shown indicate the value of a sodcutter in uniformly removing the old grass and thatch layer when resurfacing a green or changing types of grass.

Mechanized leaf pick-up has been made practical and economically feasible with the large blowers and excellent sweepers available today. Boom equipped power sprayer make large area weed, disease and insect control practical from the standpoint of time and labor required. A good golf course manager must keep abreast of the new equipment items available to provide modern-day standards of maintenance for his golfers.

Plan your equipment replacement. Make a list of your equipment, work out a depreciation and replacement schedule. Don't be caught with all of your equipment wearing out in the same year as few clubs can finance any such substantial equipment replacement in any one year.

Include in your plans some money for new equipment items as well as standard equipment replacement needs. Sell your club on the benefits to be gained from equipment replacements and additions.

Get the best piece of equipment for the job. Ask to see the equipment demonstrated prior to purchase. Don't buy a bad piece of equipment just because you "just like ole Joe better." Be sure the equipment can and will do the job.

Get the right piece of equipment - then use it!