PROCEEDINGS

of the

THIRD ANNUAL TURF CONFERENCE

held on the campus

of the

STATE COLLEGE OF WASHINGTON

March 29 and 30, 1950

Foreword

The 1950 Turf Conference was the third held at the State College of Washington.

The first one was held during May, 1948, at the suggestion of four greenkeepers of golf courses - Wilfred Brusseau, John Harrison, Glenn Proctor, and Louis Schmidt. These men came to the College and told of the need of greenkeepers for information in developing and maintaining better turf.

Following the pattern set by the earlier conferences, the 1950 conference dealt with such topics as soils, irrigation, weeds, insect control, turf diseases, equipment, the care of trees, and laying out of golf courses. Featured speaker was Dr. G. O. Mott, Professor of Agronomy at Purdue University, and Secretary of the midwest Regional Turf Foundation. The program was planned particularly for golf course greenkeepers, superintendents of parks, and cemetery superintendents, but also for others interested in turf improvement.

The conference was regional and people attended from Oregon, Montana, Wyoming, Idaho, British Columbia, and Washington.

Steps were taken to organize the Northwest Turf Association and the following Directors were elected: E. P. Townsend, Edward Fluter, H. T. Abbott, Phil Page, Mavor S. Boyd, James O'Brian, Glen Proctor, Milton Bauman, E. G. Schafer (Honorary), and Everett Potts.

Many persons wanted the proceedings of the conference published so that the information would be available for reference. It has been impossible to get all of the talks and discussions that occurred, so this report is less complete than desired.

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Attendance list of the Third Annual Turf Conference held at the State College of Washington, March 29 and 30, 1950.

Name	Address
Harold T. Abbott	Spokane, Washington
G. A. Amsbury	Spokane, Washington
F. M. Aueho	Burquillam, B. C.
C. A. Baker	Bremerton, Washington
Milton Bauman	Kellogg, Idaho
Norris Beardsley	Spokane, Washington
Pat Bearss	Billings, Montna
B. R. Bertramson	Pullman, Washington
Mavor S. Boyd	Billings, Montana
Wm. C. Brusseau	Spokane, Washington
W. K. Buckley	Colville, Washington
Fred Calhoun	Leavenworth, Washington
Earl Carlson	Tacoma, Washington
Henry G. Chambers	Spokane, Washington
Ray Coleman	Maple Valley, Washington
C. A. Cooley	Spokane, Washington
Robert Dickey	Helena, Montana
Don Douglas	Pullman, Washington
Lambert C. Erickson	Moscow, Idaho
Clifford Everhart	Spokane, Washington
Henry Fiske	Helena, Montana
Edward Fluter	Portland, Oregon
Maynard S. Grunder	Puyallup, Washington
Arthur R. Gurkette	Seattle, Washington
John Harrison	Hayden Lake, Idaho
L. R. Hart	Leavenworth, Washington
C. S. Holton	Pullman, Washington
Joe Johnston	Pullman, Washington
W. H. Johnson	Pullman, Washington
Sarfield Keane	Helena, Montana
Ernest G. Kletz	LaGrande, Oregon
A. W. Lange	Spokane, Washington
Al Law	Pullman, Washington
Thomas S. M. Lease	Great Falls, Montana
Joe Leonard	Lewiston, Idaho
Vernon Macan	Victoria, B. C.
Hubert C. Manis	Moscow, Idaho
P. M. Masterson	1103 W. 54, Seattle, Washington
Frank G. Matthews	Spokane, Washington
Harold A. McMiller	Cheney, Washington
H. M. Mitchell	Helena, Montana
Roy Moe	Spokane, Washington
Aldert Molenaar	Pullman, Washington
Bert Niles	Seattle, Washington
J. O'Brian	No. Vancouver, Washington
R. Olson	Bremerton, Washington

Name	Address
Phil Page	Spokane, Washington
Evart R. Potts	Sheridan, Wyoming
Glen Proctor	Seattle, Washington
Lowell C. Rasmussen	Pullman, Washington
L. B. Reynold	Sheridan, Wyoming
E. G. Schafer	Pullman, Washington
Louis Schmidt	Spokane, Washington
John L. Schwendiman	Pullman, Washington
A. C. Smith	Victoria, B. C.
Loyd R. Storlie	Spokane, Washington
Charles L. Stover	Seattle, Washington
W. H. Strahl	Seattle, Washington
Willard S. Summers	Pullman, Washington
O. P. Townsend	Gresham, Oregon
Joe Virant	Butte, Montana
Rolland Wade	Walla Walla, Washington
L. C. Wheeting	Pullman, Washington
Sam Zook	Pendleton, Oregon

MAINTENANCE OF POWER EQUIPMENT USED IN TURF MANAGEMENT

W. H. Johnson, Assistant Professor, Agricultural Engineering,
The State College of Washington

A question frequently asked by farmers is "How can I make my tractors and machinery last longer?" Long life of equipment and power units is, of course, not the only important factor in a mechanized operation. Life of equipment certainly affects costs. But other factors similarly are related to money spent or money saved in such operations.

Other fixed costs would include taxes, housing, insurance, and interest on investment. Operational costs for power equipment would include fuel, repairs, and lubrication. Of these costs, the four generally comprising the greatest part of the total--depreciation, fuel, repairs, and lubrication--are all affected substantially by maintenacne. Although proper operation of equipment depends upon well trained, competent personnel, it has been conclusively proved that well planned, detailed maintenance checks will assist personnel in doing a better job of keeping equipment on the line and ready for the job, and will avoid costly time-consuming breakdowns.

A detailed maintenance check sheet is good insurance against letting things slide, waiting until tomorrow and--in the long run--spending money on repairs that shouldn't have had to be made. An example of such a check sheet will be found in the instruction manual that should be kept with each piece of equipment.

Let me elaborate on this 10 hour interval check. I have heard the air cleaner called the "Achilles Heel" of an engine. This is a very good description, The internal combustion engine uses 90 per cent air and only 10 per cent fuel. This means, in the case of an ordinary four cylinder tractor using 1,000 gallons of fuel a year, nearly 45 tons of air would be drawn into the cylinders. For each gallon of fuel an engine uses, 9,000 gallons of air are used. Since present day engines employ tolerances in thousandths of an inch, there will be severe and rapid wear if air cleaners are not functioning properly. Tests have shown that engines that can be expected to provide 3,000 hours of service with air cleaner protection can be ruined in as short a time as 15 hours in very dusty conditions.

The crankcase of an engine needs to breath just as you and I. The movement of the pistons in an engine constantly displaces air. A plugged breather cap will interfere with this pulsating of air in the crankcase and may result in back pressures which can cause failures of oil seals. On some engines, oil fumes from the crankcase may find their way to parts of the ignition system and cause failures.

Crankcase oil level should also be checked at the 10-hour interval, if the engine is using oil, check at a more frequent interval. For a specific tractor or power unit, the instruction book may indicate other items to be checked at this interval. Lubrication fittings on machines may have even more frequent intervals recommended and should certainly not be overlooked in a daily inspection of equipment. Often the compromise between the designer who may want the best in lifetime sealed bearings, and the sales department of a manufacturer who must sell the product in open competition, will result in bearings which require more frequent servicing for touble-free performance.

Using the same illustration, a tractor engine; a 120-hour check might be as follows:

1. Water pump inspected for leaks. If necessary tighten or replace.

2. Fan belt checked--particularly if overheating has been noticed.

3. Brakes inspected--too often not checked periodically, especially on units which have several operators.

4. Sediment bowl cleaned, if necessary.

5. Change oil. Recommendations of manufacturers should be followed, however, if a different schedule is indicated. But be regular unless a fixed schedule or interval system is used--errors may be made either in replacing perfectly good oil or in allowing oil to be operated too long and not remain as effective a lubricant as it should be.

6. Oil filters cleaned, so the oil pump will supply enough lubricant to the bearings.

7. Tires need frequent and regular inspection. Correct inflation pressure affects tire wear very markedly. Grease or oil are also enemies of tires. They destroy rubber. Chemicals used for weed control or fertilizers may be injurious to rubber tires and should be washed off promptly.

8. Battery checked for water level. Refill with distilled water if low.

9-10. Both the transmission and the final drive are very apt to be overlooked in ordinary operation if a maintenance check chart is not used.

In addition to the 10- and 120-hour maintenance checks, a 240-hour check should also be made. These items might be inspected at this interval:

1. Cylinder compression. This will indicate any need for major repairs on pistons and valves.

2. Spark plugs. Cleaned, carefully inspected, and the clearance set. Automotive engineers say an inefficient spark plug--one not providing a clean, uniform spark for the proper duration--can waste as much as 1 gallon of fuel in 10.

3. Radiator flushed.

4. Breaker points. Cleaned if necessary.

5. Ignition cable. If badly worn, replace it.

6. Front wheel bearings repacked.

7. Clearance of the valve tappets.

8. Fuel strainer in the carburetor and in the fuel pump cleaned.

9. The air cleaner screen. If dirty, clean it.

This type of periodic checkup will go a long way toward preventing trouble. All of these operations suggested for an engine are relatively simple operations and are jobs which would take very little time. But to put such a plan into practice, you need accurate information on hours of operation of equipment.

These same principles of preventative maintenance can be applied to machinery. If several operators used the same machine, for example, the relatively small amount of time spent to prepare a daily, weekly, and possibly monthly, maintenance check list should pay off big dividends in lowered repair costs. Make check lists for equipment by examining the instruction manual provided with the machine.

Both power units and machinery have one other characteristic in common. This is an annual cycle of use. It includes some prolonged interval during the year when the equipment is not used. Good storage for equipment when it is idle is a wise investment.

If stored machinery must be exposed to moisture, investigate the use of commercial rust proof compounds. Such materials are now available in grades suited to outside use or for application to machinery under cover. Some of these compounds need to be brushed on. Others may be sprayed on with an ordinary insect spray gun.

Equipment having sharp cutting edges such as some types of harrows, discs, and reciprocating or cylinder type mowing machines should have wearing edges protected. They then will remain sharp and ready to use. Fertilizer distributing machinery is also subject to rust and corrodation. These preventive measures will give excellent protection.

"How can I make my tractor and equipment last longer?" Four things. First, scheduled maintenance of all power units and equipment. Second, employment of careful, skilled operators. Third, follow manufacturers' recommendation for service. Know the instruction book for your equipment. Fourth, careful storage and protection of equipment during the idle part of the year.

WHAT A GOLFER EXPECTS IN COURSE CONDITIONING

Roy Moe, Golf Professional
Spokane Country Club

The greenskeepers and the golf professionals both want to help the golfer enjoy his game. Your interest is in the conditioning of the course. Let me assure you that it helps the professional untold measures when the course is carefully groomed. A golfer who is upset because of the course will not be able to play his regular game.

The golfer who starts out to play golf on the first tee expects an orderly tee not cluttered with rubbish. Provide a suitable receptacle conveniently located for disposing of candy wrappers, ball wrappers, etc. He also expects a bucket of clear water with a clean towel to wash golf balls and a sturdy painted bench to sit on while waiting to tee off.

Line tee markers up for the placement of the drive. This is very important and should be carefully done. Markers should be moved every day to reduce wear spots on the tee. Every tee should have a sign stating the number of the hole, yardage, and par if possible.

Tees should be even and firm under foot. This is a big help in hitting the tee shots far and straight. The grass on the tees should not be too long. Otherwise, it interferes with control of the tee shot. The player may sky his tee shots or, if the grass gets between the ball and the club face, the shot may go astray.

The golfer expects the fairways to be green and have as few weeds as possible. Have grass that leaves the ball setting up. A ball that nestles in grass will slide off the club face and give the player trouble in controlling the shot. Sink holes should be leveled off so that the ball can be hit squarely. The course should be watered at night or early morning so as not to interfere with play.

The golfer expects the rough to be short enough. Long rough makes the ball too hard to find and slows up play. Trim branches of trees overhanging near the ground and remove dead branches.

The golfer expects the traps to have plenty of fine sand. They should be raked and the banks trimmed.

The golfer expects a green to have a free putting surface. This enables him to stroke the ball. A heavy matted surface makes it difficult to hold the line and to judge the distance. A grainy green is the worst bugaboo of the golfer. The green must be soft enough to hold a shot, because the golfer prides himself in being able to put stop on the ball when it hits the green. However, it should not be so soft that golfers leave footprints on the green after putting.

Have the cups in a fair place for putting. Keep them from knolls or extreme slopes. Move them often. That will keep the putting surface truer. The golfer expects the aprons to the greens to be fairly level and to be cut a little shorter than the fairways. Then he knows his ball is not going to hit an unseen bump or heavy bunch of grass.

In closing, it is a good idea for the greenkeeper to play golf and thus learn the golfer's problems firsthand.

IRRIGATION PRACTICES

Aldert Molenaar, Associate Professor, Agricultural Engineering
The State College of Washington

Irrigation is the artificial application of water to soils whenever rainfall becomes insufficient to meet the full moisture requirements of the growing plants. Effective irrigation depends on an understanding, or at least an appreciation, of fundamental soil, moisture, and plant relationships.

Soil plays a very important part in irrigation. Every soil has a capacity to retain moisture, but some will retain more than others. Soil texture mainly determines how much water can be stored in a soil. Texture refers to the various-sized particles making up a soil. It serves as a basis for classifying soil as a sandy, silty, or clay soil.

In a broad sense, the moisture occurrring in a soil may be classified in relation to plant growth as unavailable, available, or excess. From the standpoint of the soil itself, moisture occurs in the following forms:

Hygroscopic Water. Moisture held so closely and with such great force by the soil particles that it is entirely unavailable to the plants.

Capillary Water. Moisture held in thin films around the soil grains and in wedges between the grains. Most of this is water available to plants. Capillary water cannot be removed by drainage. It leaves the soil by evaporation from near the surface and as moisture used by the growing plants.

Gravitational Water. Water in the soil in excess of maximum capillary capacity. It is free to move through the soil pores by gravity. In well-drained soils, this water usually moves too rapidly to be considered a soil moisture property.

Whenever moisture is applied to a soil, either as rainfall or as irrigation water, it tends to sink into the soil due to the combined forces of gravity and capillarity. The capillary capacity of the surface layer is quickly reached. Additional water applied penetrates deeper into the soil and brings the moisture content of successive layers up to capillary capacity. The most moisture a soil will hold against the force of gravity is the maximum capillary capacity of "field capacity."

Plants growing on a soil will remove most of the capillary water. When plants wilt permanently, the available moisture has been used up. The percentage of moisture remaining in the soil when wilting occurs is called the permanent wilting percentage of the soil.

Both field capacity and permanent wilting percentage vary in different soils. In coarse, sandy soils they are both lower than in the finer-textured silt and clay loams. Generally, the available range is considerably greater in soils of fine texture.

In the irrigation of well-drained soils, the capillary or available water is of major concern. The amount of this water held in a unit depth of soil depends on the texture of the soil. Total useful storage capacity in any particular soil, however, depends on the depth of the rootzone of the crop.

Turf is shallow-rooted. The major concentration of the roots probably occurs in the top 4 or 6 inches of the soil. The problem, therefore, is to keep these roots supplied with moisture. This calls for frequent irrigation in the summer months. Some authorities suggest that a good, healthy turf requires 1 inch of water applied once a week. They suggest that the rate of water application to turf should not exceed 1/4 inch per hour. If applied faster, run-off may occur.

The 1 inch of water required per week can fall in the form of rain, or it can be applied mechanically by sprinkling. The capacity of the sprinkler system must be ample to supply sufficient water without rain. One inch of water on 1 acre is the equivalent of 27,150 gallons.

More and more interest is being shown in irrigation of fairways. The average 18-hole golf course has fourteen fairways, averaging 300 yards long and about 60 feet wide--approximately 52 acres of fairway. (Usually there are no fairways on the four shorter holes.) One inch of water of 52 acres will require approximately 1,415,000 gallons of water weekly. The usual practice is to do the sprinkling in a little over 7 hours per night, 7 days a week. If a sprinkler system were operated 50 hours per week (3,000 minutes), the pumping rate would need to be 472 gallons per minute.

It is apparent that an average golf course may require a pump with a capacity of about 500 gallons per minute for fairway watering. A flat course will require 100 to 115 pounds per square inch pressure(230 to 266 feet) at the pump. A hilly course may require as much as 180 pounds (414 feet) of pump pressure.

Single stage centrifugal pumps can be used for heads up to 300 feet. For higher heads, it is desirable to go to multistage pumps.

The cost of a complete fairway irrigation system may run somewhere between $20,000 and $30,000, depending on quantity of pipe and fittings needed and the size and type of pumping plant required.

Cost of operating an irrigation system for golf courses varies considerably. A survey of clubs in the Chicago area showed that it was costing them from $2,000 to $3,000 a year forfairway sprinkling.

The equipment and facilities needed for the irrigation of fairways, parks, airports, and cemeteries usually include a buried pipe distribution system. The way turf in these public areas is used generally precludes the use of portable surface pipe such as that often used in the irrigation of pastures and farm crops. A permanently installed system requires much more pipe than the portable installation, and is therefore much more expensive to put in. Once installed, however, the labor requirements for operating the permanent system are much less.

SOIL STRUCTURE, AERATION, AND DRAINAGE

G. O. Mott, Professor of Agronomy
Purdue University

First of all, let us discuss the requirements for healthy grass. A continuous supply of oxygen has to be provided for most grass roots of our turf areas in order to maintain a healthy turf. A water-logged soil--containing more water than needed for the best growth of grass roots--usually means that the oxygen supply in the soil will become critically deficient for the growth of grass roots. These waterlogged soils may be due to poor construction of the turf area, non-functioning tile, or to a water table which is too close to the surface of the soil. Many of the difficulties encountered today by the turf superintendent can be traced to poor aeration and a lack of adequate drainage.

Turf grasses short on oxygen for a long period of time are unhealthy. This leads to diseased turf and many other difficulties. Algae are found growing on many turf areas. The growth of this green scum on our soils is frequently caused by waterlogged conditions. Algae do not grow on soils which are well drained and which absorb water readily. On putting greens which are mowed frequently and where many of us make daily application of irrigation water, the surface soils are kept constantly above their "field capacity"--the most moisture needed for the growth of grass roots.

The microorganisms--bacteria, the fungi, and the mold--are frequently inhibited in their growth by an excess of water. And perhaps the growth of microorganisms producing toxic substances in the soil will be encouraged by an oxygen deficiency. In other words, it is highly essential to maintain a healthy well-aerated soil, not only to assure healthy growth of the grass but also to have a healthy condition for the growth of the proper microorganisms in the soil.

As all of you know, the grass plant depends on a continual supply of plant nutrients. Some of these are released from the soil complex by microorganisms. For example, there are certain microorganisms that convert ammonia and complex nitrogen compounds to nitrates available to the grass plants. Under certain waterlogged conditions, we actually may get a reversal of this process. Then the nitrates ordinarily present in a well-aerated soil are converted to other nitrogenous compounds, which may be unavailable or actually toxic to the grass plants. A high concentration of nitrites may actually be one of the main causes of sunscald and may be very injurious to some turf grasses.

Another effect of insufficient oxygen was discovered in Dr. Hoagland's laboratory a number of years ago at the University of California. He found that potash was not readily absorbed by plants where there was a deficiency of oxygen, even though enough potash was available in the soil solution. In the Middle West, we have found several instances where grasses on putting greens, for example, lacked potash even though there was plenty in the soil. The soils were badly waterlogged and were not able to absorb the potash from the soil solution. Spraying on a very weak solution of muriate of potash helped some of these cases. Apparently the plants were able to absorb some of this potash through the leaves or through the surface feeding roots. This, of course, is just a temporary way of taking care of the situation. A permanent solution would be to provide better aeration so that the potash available in the soil becomes more readily available to the plants.

The reasons for poor aeration are many. A few are: The use of heavy clay soils in the original construction of a putting green or the use of a top dressing high in clay content frequently results in an impervious layer of soil. Thus leads to the development of a water table that will prevent proper aeration and drainage of the soil. This condition prevails here in the Northwest. A compacted zone of soil on the surface has been known to prevent the absorption of water, even under high rainfall conditions. This makes it extremely difficult to maintain turf because of a very shallow root system development. Here we may find the thin layer of surface soil waterlogged. A short time later, it may be entirely too dry for the growth of the grasses. This is a condition that frequently prevails on putting greens where we have the so-called "dry spots." This is very puzzling to many greenkeepers, because these areas are dry in spite of the heavy watering or heavy rainfall.

Another frequent situation on turf areas, and one less well understood, is the presence of a layer of various porous materials such as sand, gravel, cinders, or other similar materials within a few inches of the surface. Most of us have been led to believe that a layer of porous material aids drainage of our soils on turf areas. This may or may not be the case.

All of you who are familiar with the maintenance of turf on golf courses are very familiar with the building up of a soil profile through annual applications of top dressing. No doubt you have seen numerous cases where layers of sand, clay, and other materials are built up very close to the surface of your putting greens. In some cases, these layers are as much as 1/2 to 1 inch thick.

What happens to such greens? If two sponges are saturated with water and allowed to drain suspended on a ringstand until no more water drips from them, then we would say in soil terms they were at their maxiumum water holding capacity. They are saturated with water. Now if you place one of these sponges on top of the other so that they just touch each other, water begins to drip from the bottom of the lower one. Why does this happen? The same forces of nature are acting upon these water-saturated sponges as previously.

Yes, the forces are the same except now with one sponge above the other we have water columns, or capillaries, extending up through both sponges. Now these columns are twice as long. Just as a long piece of string is heavier than a short piece, so are these long capillaries heavier. The sponges cannot hold the water in these longer columns and it runs out the bottom, thereby reducing the water content of the upper sponge.

In the same way a continuous column of water in the soil to a depth of 1 foot will draw down the water content of the surface 6 inches of soil to a greater extent than if there were only the 6 inches of soil there with a sand layer directly underneath it. This better drainage effected by a longer water column or deeper soil may be just enough to provide the additional bit of aeration that is so vital to the successful root development of your turf.

The thing we must remember is that a layer of sand, gravel or other coarse material carries off only the gravitational water which will run through and not be held by the surface soil. The water will move neither downward nor upward by capillary action through the soil profile broken by a layer of coarse material. It is possible to have 1 or more inches of good top soil on a putting green almost continuously waterlogged because a sand layer is close to the surface. The only water going into the sand layer is that in excess of the maximum waterholding capacity of the surface. (For good root growth, the wet soil should drain quickly to its field capacity, thereby providing adequate aeration.) Where the coarse material is to be found close to the surface, you will find the root zone of the grasses to be entirely in the surface soil. There will be no deep penetration of the roots through a waterlogged zone, and the grasses will be entirely dependent upon the top most soil for their supply of moisture. This is one of the underlying causes of sunscald and the so-called dry spots that occur frequently on putting greens.

Coarse materials such as sand or gravel do have a place in the construction of turf areas. But layers of these materials should be at a sufficient depth so as not to intercept the capillary pull in the surface 12 to 18 inches. Porous materials are extremely valuable around the tile drainage system, because they afford a collecting basin for the water to enter into the tile. This means, therefore, that the coarse material should be used for back filling a tile, but should not come closer to the surface of the soil than 12 to 15 inches. The remainder of the back fill should be good soil of the type which has adequate drainage characteristics. This soil also should maintain a plentiful supply of oxygen for the best root growth.

A tile drainage system carries off only the gravitational water, or that water which is in excess of the soils water-holding capacity. It is therefore highly essentail to maintain an active drainage system and one which will take care of the excess water. Otherwise, the water will replace the air supply in the soil. Tile properly spaced and installed can be very effective in providing for proper aeration of the surface.

If, on the other hand, an impervious layer or a layer of coarse material has been allowed to develop in a turf soil, then water may never reach the tile or the tile will be ineffective in reducing the moisture content of the surface to its optimum level. It doesn't make much difference just how good the surface soil may be if the water column is broken. The free water or the gravitational water does not have an opportunity to get to the tile drainage system or some other natural drainage. I have been on putting greens during the rainy season in the Middle West where excellent tile drainage systems were not carrying any water, merely because of faulty conditions above the tile. If your course is dependent upon a tile drainage system, I would suggest that you make certain that these drains are functioning properly in removing the excess water. Otherwise you may have developed a condition in the surface of your putting green which prevents the water from reaching the tile.

The logical question follows, "How can the situation be remedied where you have some of the conditions that I have just mentioned?" The "spiker" and other similar tools have been used in the past with varying degrees of success.

A more recent piece of equipment is the "aerifier," which will remove rapidly cores of soil to a depth of 5 to 6 inches. This equipment also cultivates soil beneath the turf and provides better aeration than is obtained with the spiker. The removal of plugs or cores of soil permits air to enter the soil and also frequently permits more rapid absorption of water and plant material. On putting greens, where top dressing is necessary, use a top dressing with a moderately high sand content to permit continued access of air into the soil. If the layers developed by repeated top dressings over a period of years are not more than 5 or 6 inches deep, then the aerifier is a valuable tool for providing aeration and more adequate drainage.

Where the layering of soil is more than 5 or 6 inches deep, more drastic measures are needed. It may be necessary to remove the turf in as thin a layer as possible and then to mix thoroughly the layers resulting from the prior top dressings before re-laying the sod. Depending upon the material present in the layers of top dressing, it may or may not be necessary to add any other soil amendment, such as sand, peat or other materials. It is very important, however, that the resulting mixture should have adequate drainage characteristics assuring an adequate air supply to the grasses. During this overhauling is an excellent time to mix into the soil any heavy fertilizer treatments that may be desirable to encourage vigorous growth of the grass.

Our efforts to overcome the conditions which we have described here have not been completely successful from the standpoint of a cut and dried method of improvement. Each area has its own soil and moisture conditions, its own maintenance practices, and--the human element being what it is--its particular corrective measures.

Examine your soils more critically with regard to the drainage and aeration factor. You will be able to solve some of these problems in a more intelligent manner by considering the aeration and moisture requirements of your turf. Remember that a deep-rooted turf usually means a healthy turf. A deep-rooted turf cannot be developed except where the soil conditions are optimum from the standpoint of soil structure, aeration, plant food, and all the other factors which make for a healthy soil. Many thousands of dollars in maintenance can be saved through decreased costs of fertilizer, chemical disease control, and top dressings if you will give adequate attention to these soil conditions.

Improve your soil conditions, and you will improve your playing conditions, which are the prime requisites of our club player. He pays the bill, give him the best for his money.

SOIL ALKALI ON TURF AREAS

L. C. Wheeting, Research Professor of Soils
The State College of Washington

"Alkali soils" is an old expression used to designate soil which had become less productive because it contains too much salt. In modern language, we use "saline" and "alkali" to express the soil conditions in a more precise way. Saline soils are the ones containing an excess of salts. Alkali soils are those with a harmful amount of sodium in the clay complex. Alkali soils may also have excessive amounts of salt. Then they are called saline-alkali soils. Sometimes even acid-alkali soils may occur, though rarely. Soils may be alkaline in reaction without being either saline or alkali soils.

Plant symptoms indicating a possible alkali condition are: browning and often death of the tissue at the leaf tips; a slow growth of distorted character and, in severe cases, complete killing of the plants--especially during the hotter, drier periods of the year. These symptoms are sometimes mistaken for a disease of some kind. Usually examinations of the locality will show that seepage water or clogged drains has encouraged the accumulation of salty materials at the footslopes of hills immediately below irrigation ditches or in the low spots in the fairways and greens. Poorly drained areas are likely to accumulate salts.

Sometimes the accumulation is encouraged by not watering such areas, since they are thought to be wet enough at all times anyway. In regions of the Northwest with a low annual rainfall, there is a greater possibility of salt accumulation when irrigation is started than is the case in the more moist coastal areas. Alkali and saline soils tend to limit the species of plant that will grow. Their presence can be taken as an indication of unfavorable conditions.

Where do Alkali Salts Come From?

The major part of a soil consists of minerals and rocks in various sizes and stages of decay. Most of it is silica, the chief constituent of window glass. Attached to the silica are the basic substances such as calcium, magnesium, potassium and sodium, together with variable amounts of aluminum and iron. The mineral part of a soil can be expressed in a formula as follows:

$$[Ca \cdot Mg \cdot K \cdot Na \cdot Fe \cdot Al \cdot (SiO_3)x]$$

When organic remains of the plants growing on the soil begin to decay, acid compounds such as carbonic acid, sulphuric acid, nitric acid, and even hydrochloric acid are produced. Moreover, sulphuric acid and nitric acid may come to the soil as a result of the rainwater dissolving gases from the atmosphere.

In any event, the soil minerals are attacked by these acid compounds and the bases dissolve to form salts. In this way Ca may join with carbonic acid and make $CaCO_3$ (limestone). Calcium will also combine with sulphuric acid to make $CaCO_4$ (gypsum). Similarly, $Ca(NO_3)$s and $CaCl_2$ may be formed. This process occurs with each of the other bases and a series of magnesium salts and of potash and sodium salts is produced.

This process is called weathering and takes place naturally and constantly in all mineral soils. Under sufficient rainfall (plus snowfall), these salts disappear from the soil in the drainage waters and eventually reach the sea to make it salty. Under low precipitation, however, the salty products of weathering may not be removed from the soil profile. Or they may be transported over short distances to low ground where they accumulate. This is how alkali soils are produced.

Usually, the amount of salt in a soil under arid conditions is small enough to permit plant growth, because the weathering activity is low when the soil is dry and seldom results in an accumulation of salt within the profile that will make the soil unproductive. To develop a saline soil that is unproductive, it generally takes some process of gathering together in one place of the salts produced in a considerable volume of soil. Seepage waters carry the salts into low pockets and foot slopes where the water evaporates and leaves the saline material. Thus, poor drainage contributes to the development of salty soils.

What are Excessive Amounts?

Several workers have set up limits to separate saline and non-saline soils. A common figure much quoted is 0.2 per cent. Crops vary greatly in their resistance to salt concentration and any one value is not always satisfactory. The present standard for an alkali soil is when more than 15 per cent of the clay bases is sodium. The reason sodium is so important is that it destroys the good physical properties of soils. Potassium acts in a similar way.

The U. S. Salinity Laboratory has published a chart showing the relationship between salt concentration and crop growth as follows:

0	0.28% 2800 ppm	0.56% 5600 ppm	1.0% 10,000 ppm
All Crops Thrive		Sensitive Crops Suffer Tolerant Crops Grow	All Crops Growth Restricted. Yield Poor

What To Do About Alkali

Since the chief contributing factor in the accumulation of harmful quantatives of salt is poor drainage, the first step in reclamation should be to improve drainage. Where seepage occurs on footslopes, the use of intercepting drains is recommended. When a high water table in a low area is present, a drain is needed. Drainage is always the first step. It will do no good to add fertilizers or amendments to an undrained salt-saturated soil.

Secondly, when tests show a saline soil, excessive irrigation alone will dissolve the salt and carry it away in the drains. When an alkali-saline soil is to be treated, it may also require the application of sulphur or gypsum to get the leach water through the soil. The use of all methods of improving the organic matter supply must be encouraged.

For the first season after reclamation is started, the more salt-tolerant grasses should be grown. As the salt concentration goes down, a wider choice is available. Tillage to open up the soil and permit deeper penetration of the leach water helps. Great care is necessary, however, to avoid working heavy soils when wet. For grasslands, flood irrigation may be more satisfactory than furrow irrigation.

SELECTION, TRANSPLANTING, AND CARE OF TREES FOR GOLF COURSES

Willard S. Summers, Landscape Architect
The State College of Washington

The selection of trees for the golf course should be made with three things in mind: (1) use or purpose, (2) growing conditions, and (3) maintenance. The uses of trees are mainly: (1) screens or background planting, (2) shade with open spaces beneath, and (3) indicators of changes in direction or possibly a hazard.

Almost any of the native trees common to the particular area may be used for screens and background plantings. Some of those that do best in climates found in the Pacific Northwest are:

1. Acer ginnala - Amur maple
2. Acer negundo - boxelder
3. Acer rubrum - scarlet maple
4. Acer Saccharum - hard or sugar maple
5. Acer pseudoplatanus - sycamore maple
6. Betula populifolia - Native white birch
7. Caragana arborescens - Siberian pea tree
8. Crataegus mollia - Hawthorn
9. Juniperus virginiana - red cedar
10. Larix decidua - Europan larch
11. Morus alba - white mulberry
12. Picea canadensis - Picea glauca - white spruce
13. Picea excelsa - Norway spruce
14. Pinus strobus - white pine
15. Pinus resinosa - red pine
16. Pinus rigida - pitch pine
17. Pinus sylvestris - Scotch pine
18. Populus alba - white poplar
19. Populus deltoides - northern cottonwood
20. Prunus serotina - wild black cherry
21. Salix alba - vitellina - golden willow
22. Salix fragilis - crack willow
23. Thuja occidentalis - American arbor-vitae
24. Tsuga canadensis - Canadian hemlock

Shade trees with high branches.

1. Acer platanoides - Norway maple
2. Platanus acerifolia - London plane tree
3. Quercus rubra - red oak
4. Quercus velutina - black oak
5. Tilia cordata - European linden

6. Tilia Americana - American linden
7. Quercus Robur - English oak
8. Ailanthus glandulosa (female) tree-of-heaven
9. Ginkgo biloba - ginkgo or maidenhair tree
10. Gleditsia triananthos inermis - thornless honeylocust
11. Quercus palustris - pin oak
12. Quercus coccinea - scarlet oak
13. Ulmus Americana - American elm
14. Ulmus campestirs - English elm
15. Fraxinus Americana - white ash
16. Acer saccharum - hard maple
17. Aesculus galabra - Ohio buckeye
18. Carya ovata - hickory
19. Celtis occidentalis - hackberry
20. Castanea dentata - chestnut
21. Fraxinus lanceolata - green ash
22. Jaglans nigra - black walnut
23. Liquidambar styraciflua - sweet gum
24. Pinus strobus - white pine

Forest trees for mass planting.

1. Acer saccharum - hard maple
2. Acer saccharinum - silver maple
3. Acer platanoides - Norway maple
4. Betula lutea - yellow birch
5. Carpinus caroliniana - ironwood
6. Carya glabra - pignut
7. Castanea dentata - American chestnut
8. Fraxinus Americana - white ash
9. Fraxinus lanceolata - green ash
10. Juglans cinerea - butternut
11. Morus alba - white mulberry
12. Morus rubra - red mulberry
13. Pinus strobus - white pine
14. Pinus sylvestris - Scotch pine
15. Prunus serotina - wild black cherry
16. Quercus alba - white oak
17. Quercus velutina - black oak
18. Quercus robur - English oak
19. Robinia pseudacacia - common locust
20. Tilia Americana - American linden

If maintenance is a problem, avoid trees in the open areas that have litter of various kinds, such as:

1. Catalpa bignonioides - common catalpa
2. Juglans nigra - black walnut

3. Gymnocladus dioica - Kentucky coffee tree
4. Gleditsia triacanthos - honey locust
5. Ailanthus altissima - tree of heaven
6. Salix fragilis - crack willow
7. Diospyros virginiana - persimmon
8. Platanus occidentalis - sycamore sometimes
9. Aesulus hippocastana - horsechestnut

TRANSPLANTING

The success of a transplanted tree depends mainly on the care exercised when the tree is moved to its first location.

Remember the following points:

1. Mark out a circle in the sod twice as large as the tree roots.
2. Remove the sod for use on another part of your grounds.
3. Spread a canvas on the lawn to keep sod from being filled with soil.
4. Plant 1 inch deeper than previously planted.
5. Keep the good soil in a separate pile. It is too valuable to mix with the poor subsoil.
6. Sometimes add a layer of well-decayed manure or commercial fertilizer.
7. Prune roots to remove damaged parts and freshen root cuts.
8. Hold tree in place and gradually place good soil about its roots. (Be sure that tree is held in position formerly occupied in the nursery as to direction or orientation.)
9. Tramp the soil about the roots as it is added.
10. When the hole is three-quarters full, fill remainder of hole with water.
11. Continue to add soil, leaving it loose on top.
12. It may be well to make a ridge around the base of the tree.
13. Trim the tree back about half to two-thirds to offset the loss of roots.
14. Do not trim the leader in the oaks.
15. Wrap the trunk with burlap as a preventive of sun scald.
16. Stake the tree with a strong stake.

CARE OF TREES

FEEDING - When the leaves of the tree are undersized and discolored (yellowish or brown), the foliage is thin or sparse, the tips of the branches are dying back and the tree is full of dead branches, the tree needs feeding. Most trees may be successfully fed, and should be fed at least every 5 years. A quick rule to find how much to feed a tree is to add the height of the tree in feet, the spread of the tree in feet, and the circumference of the trunk in inches. This sum will give the number of pounds of fertilizer needed. The type of fertilizer used depends upon the soil conditions and may best be determined by a soil test. However, a 10-6-4 commercial fertilizer will satisfy the demands of most trees.

In feeding trees, find the drip of the tree (on the ground under the tips of the branches) and dig holes 2 inches in diameter 12 to 18 inches deep slanted in toward the tree at the bottom, and from 18 inches to 2 feet apart around the tree. If one circle around the tree is not enough to use up the fertilizer, then use concentric circles around the tree. Fill the holes not closer than 2 inches of the top. Then fill that 2 inches with soil.

PRUNING - Pruning is done for several reasons:

1. To shape the tree and to facilitate traffic of vehicles and man.
2. At planting time to offset the loss of roots.
3. To promote vigor and healthfulness and to prolong their lives.
4. To modify flowering.
5. To make plants grow in a way best suited to our purpose.

CARE OF EVERGREENS

In many instances evergreens need more care. The following are pointers that pertain particularly to evergreens.

PRUNING

1. General - Remove dead and diseased wood. Make cuts in early spring or winter for use inside as decorations. Should include 1- and 2-year growth.

2. Tall Upright Plants - Never remove entire branch - preserve tapering symetry. May remove terminal buds to control height, develop side buds, and therefore make plant more dense.

3. Informal Junipers - Prune to keep within bounds. Cut long branches just above a vigorous side shoot in second- or thire-year woods. Avoid having all branches same length.

4. Mugo Pines - Prune by removing terminal buds of stronger branches to keep the plant dense and within bounds.

5. Yews, Arbor-Vitaes, and Junipers - May be sheared to form an even growth. Shear when new growth appears.

CULTIVATION

1. Keep cultivated 1 foot beyond branches for at least 2 years to conserve moisture and aid in weed control.

2. May use peat moss or other mulch.

3. Be sure to water thoroughly every 10 days.

4. Mulch--particularly for winter--6 inches deep. But don't contact trees or branches.

SOIL REQUIREMENTS

Do best in loose, sandy loam, that is well drained. Except for Larch and arbor-vitae, evergreens will not grow when soil is wet, soggy, or poorly drained.

FERTILIZATION OF EVERGREENS

1. Soil test is best.
2. Require pH 6.0 - 6.5.
3. Make soil acid by adding 10-6-4 fertilizer at the rate of 1/2 to 1 pound per plant, twice a year. Shrubby type specimen trees 2 to 2 1/2 pounds per 1 inch of trunk diameter.

INSECT CONTROL IN TURF

H. C. Manis, Entomologist
University of Idaho, Moscow, Idaho

We are fortunate here in the Northwest in having very few serious pest in turf. There are, however, a number of insects which do cause some damage to lawns, golf greens, and fairways.

Probably the most serious are the two species of white grubs we have. The adults are commonly called the 10-lined June beetle and the carrot or muck beetle. The 10-lined June beetle has a 3 year life cycle. The carrot beetle has a 1 year cycle.

Both species cause similar damage. They feed on the root system of grasses of all kinds. Ordinarily first sign or damage is the appearance of irregular dead areas in the turf. The grubs cut the roots off underneath at a depth of about 1 1/2 inches to 2 inches. When such turf is rolled back, large white grubs with brown heads will be found.

Another pest of turf which does similar damage is the bluegrass billbug. The adult billbugs have snout-like mouth parts and fairly small. The larvae or grubs are small and white with brown heads, and will be found fairly close to the soil surface. Billbugs also cause turf to dry out in irregular areas.

Sod webworms are the young or larval stage of small moths. The larvae feed upon the leaves of the grass. First signs of injury are closely cropped areas which gradually take on a ragged, unhealthy appearance. Large areas may be killed out. Severe injury often takes place in a few day's time.

Close examination of such areas will reveal webbing and tunnels or burrows made out of bits of dirt and debris and lined with silk. The young larvae or caterpillars stay inside these tunnels most of the time and come out only long enough to cut off a blade of grass and drag it back inside of the tunnel. The larvae are very active, quite slender, and covered with a fine hairy coating. The adults are small moths which can be found hiding in grass or weeds in the daytime. When disturbed, they fly short distances fairly close to the ground. To prevent serious injury from webworms, control measures must be applied immediately or as soon after the damage is noticed as possible.

For the control of white grubs, billbugs, and sod webworms, DDT or chlordane can be used. They can be applied dry to the turf or mixed in water and sprayed on the turf. For grub-proofing an established turf, use:

Material	Per cent	Amount of Material Per 1000 Square Feet	Per Acre
DDT	5	10 lbs.	500 lbs.
	10	5 lbs.	250 lbs.
	50	1 lbs.	50 lbs.
Chlordane	5	4-5 lbs.	200 lbs.
	10	2-2 1/2 lbs.	100 lbs.
	50	5-7 ounces	20 lbs.

To control sod webworms, the application should be made immediately. For the control of white grubs and billbugs, a spring or fall application is usually preferable. It is wasteful to make applications to areas having no immediate danger of insect damage. But it is important to make applications before extensive damage results from an existing infestation.

In applying the materials to the turf, a uniform distribution is essential. Pre-mixing 1-, 5-, or 10- pound quantities with one or two pails of dry screened sand or loam will provide more bulk for easier distribution by hand. A hand fertilizer distributor can be used in adjusting the material in proper amounts by making test runs over measured areas. If kept agitated to prevent settling out, the wettable power can be placed in 5 gallons or other convenient amounts of water and then sprayed or sprinkled over the area. Thoroughly wash the insecticide into the turf immediately after its application to hasten the time when it becomes effective and to remove any possible danger to pets and children.

Other less important insects that may occasionally cause damage to turf are collembola or springtails, grasshoppers, cutworms, mole crickets, false chinch bugs, and ants. All of these pests can be readily controlled by the application of a 5 per cent chlordane dust at the rate of about 20 to 25 pounds per acre. Or the infested area can be sprayed with chlordane, using a regular row-crop spray rig.

Angleworms, although usually considered very beneficial, occasionally may be somewhat of a problem on lawns--particularly on golf greens. In working the soil, angleworms or night crawlers come to the surface and build up small mounds of earth. This makes lawns--and particularly golf greens--very rough. Usually the damage is most severe on lawns in the spring and early summer. However, on golf greens or fairways that are kept well-watered, angleworms will work throughout the spring, summer, and fall.

Where angleworms are a definite problem and you desire to get rid of them, they can be controlled by the application of mercuric chloride (corrosive sublimate). Mercuric chloride can be applied in dry form, or mixed with water and applied as a spray, or sprinkled on the area to be treated. In using the material, mix 2 to 3 ounces of finely ground crystals with 2 cubic feet of dry sand and scatter evenly over the 1000-square-foot area. Or dissolve 3 ounces in 50 gallons of water and apply to a 1000-square-foot area. In making the application, the soil should be moistened prior to treatment so that the water will soak in quickly and so that the worms will be attracted to the surface. It should not, however, be loaded with water. Immediately following the application, wash the material into the ground by generous watering or sprinkling. Dead angleworms found on the soil surface following such soil treatment should be removed immediately to prevent poisoning of birds.

Q. Can angleworms be controlled by applications of arsenate of lead?

A. Apparently so. Where lead arsenate is applied for grub control or sod webworm control, angleworms do not cause trouble.

Q. How do you control ants in lawns?

A. Use chlordane. Locate the ant hills and apply the chlordane there. If the nests cannot be located, the entire area should be dusted or sprayed. Use 5 per cent chlordane dust at the rate of 20 pounds per acre, or spray the area with 4 pounds of 40 per cent chlordane wettable powder in 100 gallons of water. One application will usually last for a month or more.

Q. How can grasshoppers be controlled?

A. Use chlordane or toxaphene either as baits, sprays or dusts. Probably the most practical method is to dust with 5 per cent chlordane or 10 per cent toxaphene at the rate of 30 and 20 pounds per acre, respectively. Where grasshoppers are migrating in from adjoining wastelands, treating a 30- or 40-foot strip along the area of migration will usually be all that is necessary.

USING IRON SULPHATE AS A WEED KILLER

John Harrison, Greenkeeper
Haydon Lake Golf Course, Haydon Lake, Idaho

In 1947, I used a solution of 2,4-D on the greens at the Hayden Lake Golf Club and did an excellent job of killing dandelion and plantain. In 1948, pearlwort started to show up in small spots all over most of the greens. Whether this was due to the weakening of the best grass by the application of 2,4-D, or the result of a wet season, I could not be sure. In 1949, there was a rapid development in the size of the patches of the pearlwort. I had the choice of trying to cut it out and patch the greens or trying some other treatment such as dusting or spraying.

A greenskeeper in Vancouver, B. C. told Mr. Rucker of Spokane that he had used iron sulphate to control pearlwort. I had used it in about 1935 to control clover in greens and practically all the pearlwort disappeared. At the time I thought it was the result of treating with mercury and arsenate of lead.

I bought a 400-pound barrel of iron sulphate at .04 1/2 cents per pound when bought in barrel quantities. It costs about .18 cents in lesser amounts. Using a power sprayer and 100 pounds of iron sulphate to 100 gallons of water, I covered five greens of about 5,000 square feet each. I found the best way to get the iron sulphate into solution was to knock the bottom out of a water pail and crisscross the hole at the botton with four pieces of hay wire. Then put a piece of window screen in the bottom of the pail. Put this pail in the filler hole of your power sprayer, fill the pail with iron sulphate, and wash it through the screen with water from a hose. You can dissolve 100 pounds of iron sulphate with about 75 gallons of water. Then add enough water to make up the 100 gallons of solution.

Best results come from spraying on a warm or hot day. Don't water the grass for 1 day. The grass and weeds will turn black in several hours. In a few days, the black will turn into a beautiful dark green. The treatment killed flantain, dandelion, chickweed, yarrow, and 75 per cent of the pearlwort. The grasses, including the bents, were not injured. There's lots of grass in the pearlwort. This will spread and eventually heal the spot where the pearlwort was. I think that with two treatments a year apart, a green will be quite free of pearlwort.

In 1935, I added about 20 pounds of ammonia sulphate to 100 pounds of iron sulphate. It gives the grass a little boost. I think that 5 pounds of iron sulphate per 1,000 square feet would not be too strong. Three pounds would be as mild a solution as would do any good. If you use a hand sprayer it is a good plan to mark off your greens with string so you have a 3- or 4-foot lane to follow. This will eliminate skipping and double dosing.

Iron sulphate immediately rusts any metal with which it comes in contact. You should wash out your sprayer at the end of the day and each time you finish. There seems to be nothing that will counteract this rusting.

CONTROL OF CERTAIN TURF WEEDS WITH CHEMICALS

Lambert C. Erickson, Associate Agronomist in Weed Research
University of Idaho, Moscow, Idaho

Since that eventful day in 1945, when the publicity on the miracle weed killer, 2,4-D, was released, more progress has been made on weed control than in all preceding history. For at last we realized we could do something about weeds. Since that time, weed control has become a science comparable with other phases of agricultural science. In fact, this field is developing so rapidly that no one individual can be fully informed on all phases and, of course, any one individual's experiments contribute only a small segment to the larger field.

We are finding the answer to some of our weed problems.

Dandelion, the universal lawn weed, is of course a nation-wide lawn problem. Studies on dandelion control have been going ever since 1946. There is a very important secondary reason for studying the control of dandelion. Its root system is such that results from the toxic effects of herbicides can be measured and detected much more accurately than with plants having complex root systems. Accordingly, information gained in dandelion control experiments can be transposed to apply to plants more difficult to test. Use the dandelion as a test plant. It will serve as a partial measure of how you might expect the herbicide to react systemically to another plant.

We started out to test the reaction of dandelion to some of the following factors:

1. Amount of 2,4-D or other herbicides required to kill dandelions.
2. Comparative efficiency of various 2,4-D compounds and herbicides.
3. Effects of date (season) of treatment.
4. Efficiency of herbicide-fertilizer mixtures.
5. Efficiency of dust applications and liquid sprays.
6. Influence of soil fertility levels upon toxic efficiency of 2,4-D.

Here are some of the results of these experiments:

1. September 2,4-D treatments are more efficient than May treatments. Example: On one set of plots, we had thirty-three plants per square yard on May 15 before treating. On September 1, we had ninety-one plants per square yard on this same area despite the fact we had killed about 90 per cent of the original dandelions. Why? Because we had created great open spaces which dandelion seedlings soon filled. We had not applied a fertilizer to stimulate the grass in filling these spaces left vacant by the dying dandelions.

On the September treated plots, we had ninety-one dandelions per square yard at the time of treatment. On the following May 15, we had ten plants per square yard. On September 1, we had twenty-three plants. These results demonstrate that most dandelion seeds germinate in late spring and early summer, and that bluegrass does most of its spreading in early spring or late fall. Therefore, do not leave midsummer vacant spaces in a lawn unless you can keep grass growing vigorously.

2. We found that there was little consistent difference between the efficiency of the various chemical compositions of 2,4-D. I refer to the amines, the esters, and the inorganic salts. All the common materials on the market at the present time are highly acceptable. But do not use the esters on areas adjacent to shrubbery or flowers. These standard esters are volatile and injury can result because their vapors move around.

3. Our experiments have indicated that rates of 1/2 to 1 pound of 2,4-D per acre are required to get a good dandelion kill. The average bluegrass lawn owner in Idaho will probably get most satisfactory results applying 1 pound per acre. On small areas, the application rate will be 2 teaspoons of 40 per cent amine 2,4-D per square rod of lawn, or about 7 teaspoons per 1,000 square feet of lawn. In all instances, the spray rate is governed by the amount of water the sprayer requires to cover the area twice.

4. We found the liquid spray treatments to be more successful than dust treatments of 2,4-D. Lawns are no place to be spreading dusts that may injure your own or your neighbor's ornamentals.

5. The problem of the relationship of soil fertility to the toxicity of 2,4-D to plants still remains to be answered. Since we do not have the answers we are recommending that the fertilizers be applied well in advance of the 2,4-D treatment so that the grasses will fill in the open spaces left by the dying weeds.

By repeated treatments over a period of 2 to 3 years, we have been able to eradicate two weeds commonly classed as resistant--mouse-eared chickweed and yarrow. Common chickweed is not difficult to control, but the abundant seed supply where such patches have been makes several applications necessary before any results become real and lasting.

During the next year, you will read and hear more about new chemicals. There is great activity in this field at the present time and undoubtedly we will see some improved and new materials replacing some that have by now become old standards.

There is a renewed effort to find uses for the British relative of 2,4-D called Methoxone. Our results indicate that Methoxone is less injurious to grains but is also less efficient in killing weeds.

The two potential grass killers, TCA and IPC, are still with us. At the present time, neither are good enough to recommend nor bad enough to throw away.

Several so-called "reverse selectives" are being worked with. Among these are Maleic hydrazide, dichloral urea, and ethyl zanthate. Where and if any of these will fit into weed control will not be determined for some time.

A recent real contribution is the addition of the two chemicals mercuric phenol and potassium cyanate for killing crabgrass in lawns. Some mercuric phenols have been fortified with 2,4-D to aid in killing crabgrass seedlings and also to remove some broad leaved weeds simultaneously. Since 2,4-D is toxic to very young grass seedlings, it alone will control crabgrass. The problem is that several applications are required in short succession, and this becomes hazardous to the lawn grasses. Regardless of what treatments are used, numerous re-applications are usually necessary to obtain crabgrass control.

If you are inclined to use any of these so-called new materials, it is advisable to use some of the following guideposts:

a. Obtain all the information available on the subject. Take no one man as full authority.
b. Treat only a small area. Choose a location where hazards of after-effects can be held to a minimum.
c. Read the directions on the containers. Make your calculations well in advance of treating. It gives you more time to discover errors.
d. Check your information with your State College. Let them work with you on what you are doing.

PARK IMPROVEMENT THROUGH BETTER TURF

P. M. Masterson, Seattle Park Department

Seattle park system is comprised of approximately 3,600 acres, at least two-thirds of which is in turf. Turf is grown in various types of soil ranging from heavy clay to pure sand. All this soil is slightly acid, averaging pH 6. Before sowing any grass seed or preparing the seed bed, the park department's technical staff puts in adequate drainage and irrigation facilities. The department believes in adequate irrigation and it is installing semiautomatic systems in all of the new plantings. Hose systems are becoming obsolete.

We have found snap-on heads quite adequate, being spaced at 50 to 60 foot intervals. Seven or eight to a battery on a 2-inch line works out well. There are several types of sprinkler heads that have proved very good, such as the Thompson, Buckner, and Economy. A Seattle man has invented an automatic valve that turns these batteries of sprinklers on and off at chosen intervals.

The only large installation of full automatic sprinklers is at the Woodland Park Zoo, where the attendants cannot enter the animal pens.

The Seattle Park Department believes in permanent sprinkler systems. The cost of maintaining inadequate irrigation facilities can prove very expensive. All new installations are carefully mapped and recorded for future reference. This saves much wasted effort in probing for lost water lines due to change of personnel.

LAWNS IN PARKS

Grass forms the setting for the landscape picture. It is important to choose the seed carefully in order to have a lawn that is a complement to the over-all picture.

After assuring proper drainage, we prepare the seed bed 3 to 4 inches deep. The ideal soil condition in this top layer is a light sandy soil, high in organic content.

Different mixtures of grass seed for varying conditions are:

SHADE		TERRACES-SLOPES		SANDY SOILS	
Kentucky blue	40%	Rhode Island bent	40%	Kentucky blue	25%
Alta fescue	40%	Crested dogtail	25%	Creeping bent	30%
Crested dogtail	20%	Canada blue	25%	Rhode Island bent	30%
		Kentucky blue	10%	Fine leaved fescue	15%

REGULAR LAWN

Bluegrass	40%
Red creeping fescue	20%
Colonial bent	20%
Red top	20%

In preparation of the seed bed, we don't use peat soil. There is danger of toxic soil poisoning if it is not properly aired. We have found 90 to 125 pounds of grass seed per acre sufficient.

In regards to feeding, the organic fertilizers are preferable in open lawns. Through the cooperation of the Seattle Engineering Department, we are able to obtain prepared sludge in sufficient quantities to take care of most of our fertilizer needs in the parks. We use 700 pounds to the acre on open lawns. If we use an inorganic fertilizer, we limit it to 200 pounds to the acre. We have had very little weed seed contamination in the use of organic fertilizer.

Proper cutting height for regular lawns is 1 1/2 to 2 inches.

Have good mowing equipment. Avoid complicated machinery. The more gadgets a mower has the more things that can go wrong. Sturdy construction and availablility of spare parts are very important. Also, have a first class man operating your tractors and mowers. The finest equipment in the world will not stand up under abuse. It pays to have the operator of a gang mower responsible for its care. We allow him 15 minutes before quitting time to check over his mowers and to see that they are properly lubricated and adjusted.

Construction and Maintenance of Bowling Greens:

At Jefferson Park, we have a double bowling green, each one measuring 120 x 120 feet. This allows us to keep one in perfect playing condition at all times without inconveniencing the players when fertilizing or top dressing. These greens have been in operation for a year and are drawing much favorable comment.

They were constructed on a gravely hilltop, allowing for good natural drainage. During the heaviest rain, there is very little water visible on the surface of the greens. Around the sides of the greens, about 12 inches below the surface we made a concrete wall with bolts protruding. This allowed us to bolt on 4 x 12 inches removable planks for sidewalls. Bowling greens have to be perfectly level. The only way we could do this was by placing 1 x 4 inch boards at 20 inch intervals across the greens and filling between with soil. Then we ran a straight edge down each section. It is much like the leveling of a sidewalk.

We did not remove these wood strips until after the grass was well established. Grass seed mixture for these greens was 60 per cent chewing fescue and 40 per cent colonial bent. Cutting height desirable on a bowling green is 3/16 of an inch. To obtain an even bowling green surface, there is a tendency to over-roll the greens. This should be discouraged. It packs the surface and limits the growth.

Football Fields:

Seattle has one major football field in the park system. It is located in west Seattle. The field is rounded in the middle to allow for surface drainage. Our experience leads me to believe a sowing of straight seaside bent or straight creeping fescue makes the best football turf. These grasses are quick healing and allow for good footing for the players.

Irrigation is taken care of by a traveling rainmaker sprinkler. Water pressure is sufficient to pull this sprinkler the entire length of the field. This method is quite satisfactory. Naturally you cannot put sprinkler heads on a football field without risk of injury to the players.

Three fertilizations a season are sufficient on this field. Cutting height of grass is 1 inch.

Golf Courses:

Grass seed mixtures for golf courses:

Roughs - Canadian blue, sheep fescue

Fairways - 60% Arlington bent, 30% creeping fescue, 20% Kentucky blue

Tees - Creeping bent, Alta fescue and Poanna

Greens - 60% Colonial bent and 40% chewing fescue

We sow very heavily on the greens. In fact, about 75 pounds to every 5,000 square feet. This discourages weed growth.

A few facts that stand out in the use of 2,4-D. It is best to apply it when the temperature is about 60 degrees, on a windless day. Pressure on the pump should be from 40 to 50 pounds. We have found chlordane very effective on rodents.

The advent of caddy carts has created a problem that should be rectified in future construction of golf courses. Narrow wheels on the carts cut the turf around the greens--especially where there is only one exit from the greens. This has become so prevalent around Seattle that there is some talk of barring caddy carts. However, I feel this problem could be minimized by having several exits from every green.

Control of traffic on the golf courses in Seattle also is quite a problem. Uniformed patrolmen are stationed at each course to speed up play. Since we try to make the golf courses self-sustaining, we must limit our patrolling. However, by spot checking methods, we can keep control of our play.

Signs on the golf courses are very important, but the public usually pays very little attention to them. By having a humorous cartoon on each sign, we have gotten people to notice them and obey them.

Seattle has expanded into the driving range field. We've found it appeals to the golfers and it has proved a good source of revenue.

OLD AND NEW GRASSES FOR TURF USE IN THE NORTHWEST

J. L. Schwendiman, Manager
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The soil conservation nurseries of the Northwest have, in cooperation with other Federal and State agencies, tested some 10,000 grasses and legumes for conservation use since 1935.

Many superior plants, including turf grasses, were found. They were not all hay or pasture grasses. Some produced good ground cover, some were heavy root producers, others withstood alkali or were adapted to low capability lands.

The common grasses need Class I land for best performance. This is also true of old turf grasses. The principal turf grasses--Kentucky bluegrass, bentgrasses, and red fescues--did not do an adequate job on Class III, IV, and VI land. For turf use on good land, these grasses have been improved. There are now many named varieties. "Delta" and "b-27" Kentucky bluegrass are being propagated. "Weibulls primo," "Fylking," "Svalof 120," and "Kenon" are in various stages of increase. Still others are being tested.

To the old Rhode Island, Seaside, and Highland bentgrasses have been added some new varieties and a whole new group of creeping bentgrasses, such as C-1 Arlington, C-7 Cohansy, C-15 Toronto, C-19 Congressional, C-27 Arlington, and others. Many of these propagate only vegetatively. To the creeping red fescues have come "Olds," a Canadian strain; "S-59," a Welsh strain; and "Illahee," and "Rainier," west coast varieties. These new varieties are specifically adapted, require excellent culture, and for the most part still need Class I sites.

On golf tees and greens where areas are small, it is possible to modify the soil or culture so Class I grasses can be used. On fairways, parks, airport runways, ditchbanks, roadsides, and extensive areas turfed for erosion control, soil modification is less possible. There inherently tough grasses must be used. It is important to fit the capability of the grass to the capability of the land and the intended culture.

Trials on the Pullman Soil Conservation Service Nursery have shown that root production of a grass is important in building soil, resisting wear, providing adequate ground cover, and stopping erosion. The factors which produce a healthy top growth also produce good root growth. Good fertility, good drainage, and restricted removal of top growth increase root production. From pure stand and mixture seedings, we have found that nitrogen stimulates root growth about the same as it does top growth. Most grasses produce more roots under moderate rainfall in a dryland area than under irrigation. The frequency and amount of irrigation helps determine root growth.

Prostrate or semierect and sod-forming grasses withstand clipping better than those of an erect growth habit. Reduction in vigor and root growth is proportional to the number of, the interval between, and the closeness of clippings. Dwarf and log-growing grasses are ideal for low cover because close and frequent cutting does not upset them. Each grass species has its own root-top ratio for any given set of conditions. Some outstanding grasses suitable for rough turf in the Northwest have been or are under test.

For water logged soils and poorly drained areas use meadow foxtail, creeping meadow foxtail, or alta fescue, which has wider range of moisture adaptation. On wet acid soils, stay with the creeping bentgrasses.

On Class I soils where adequate water is available, good drainage occurs, and there are no specific restrictions, use improved disease-resistant strains of the class I grasses--Kentucky bluegrass, bentgrasses, or creeping red fescues.

For dry-land sites of 10 to 20 inches of rainfall on Class III to VI soil, use some of the proven conservation grasses of which crested wheatgrass is the most common. Russian wildrye gives equally good ground cover and stays green longer into the summer. There have been added two heavy root-producing strains of sheep fescue. A dwarf variety with short basal leaves produced in 6 years nearly 9 tons of roots in the surface 8 inches of soil. Clipping close every time plants reached an 8-inch height reduced root accumulation by 30 per cent.

Another strain called hard fescue which grows taller produced almost 8 tons of roots but showed a reduction of 50 per cent in root growth when clipped. Hard fescue seeded 50-50 with crested wheatgrass will give complete ground cover and suppress the crested wheatgrass within 3 years. Sherman big bluegrass grows well on dry soils. It is drouth escaping. It matures early and reseeds itself. A new bunch type Canada bluegrass gives excellent cover on low fertility soils in 15- to 20-inch rainfall areas.

Some excellent dryland sod-forming grasses are: pubescent wheatgrass, which is strictly a low fertility level conservation grass; and streambank wheatgrass, which gives a dense, smooth, fine turf on dry sites. It gives good cover without production and requires little care.

For sand dunes, Volga wildrye has been developed for inland sites. American and European beachgrass are better adapted for coastal dunes. These three grasses are all propagated and used vegetatively.

Using these new and old adapted species--the proper capability grass on its respective land capability class with good cultural practices--it should be possible to have better turfs and more complete conservation than ever before.

Notes

Others who contributed to the program are:

Wilson Compton, President, State College of Washington, Pullman, Washington

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The following persons were chairmen for the different sessions of the conference:

E. G. Schafer, Assistant Dean, College of Agriculture, the State College of Washington, Pullman, Washington

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