Education Never Stops in This Business

By **EMILIO STRAZZA**
Superintendent, Round Hill Club, Greenwich, Connecticut

The Northeastern region was subjected to a very severe drought during the spring and summer of 1962. Our Round Hill Club seemed to be in the center of the area most severely affected by the absence of rainfall. To cite an old cliche, "It's an ill wind that blows nobody good" and this was indeed true in my case. In past years it was my practice to irrigate fairways frequently, and I tried to put on the equivalent of approximately ½ inch rainfall per application. Although this method was never entirely satisfactory, it appeared to be the best that we could do with the fairway watering system that we had. The sum total of our output is 150 gallons per minute.

The severity of the early spring drought in '62 prompted me to re-examine standard irrigation practices of former years as it appeared evident that we could not hold our turf to the satisfaction of our membership or our workers if the drought were prolonged. After 40 years as Superintendent at the Round Hill Club I felt I could afford to gamble a bit so after some discussion with two trusted employees of long standing, Gus Powell, foreman, and Francis Chiappetta, mechanic, I decided to alter our former technique by watering deeper, but watering less frequently. We therefore changed our technique to put out four sprinkler heads at night for nine hours at a setting. This provided the equivalent of 3 inches of rainfall per irrigation. To the surprise and satisfaction of both the club members and ourselves we found this deep, infrequent watering resulted in a uniform penetration of moisture to a depth of 15 inches. The turf and soil was never overly wet or soggy after irrigation, on the contrary the soil was loose and friable and roots were white, vigorous, and healthy to a depth of approximately 10 inches. This deep irrigation apparently helped maintain a more uniform soil moisture and temperature, and an improved capillarity provided roots with needed moisture for extended periods. Initially 20 days elapsed before we returned to the same setting between irrigations, and as the season progressed we were able to extend the interval to 26 days before the turf showed tell-tale signs of wilting.

Since our experiment worked so well

in 1962, we now feel that we have progressed beyond the trial and error method of irrigation at Round Hill. This technique worked very well under our conditions during a year when climate was extremely favorable to cool-season grass growth. Whether this technique will work again this year under different climatic conditions only time will tell. However, I feel it will.

I also feel that more adequate liming in recent years has also had a tremendous influence on the more efficient use of water. If I had the past 40 years to do over again there are two phases of a management program that I would study more thoroughly. I am confident that I would use limestone more generously and I would strongly pursue a program of less frequent but more thorough (deeper) irrigation.

"Molly" Strazza examines soil moisture penetration in a fairway. The soil core removed to a depth of 15 inches indicates moisture present at that depth.

Water and Turf Diseases

By HOLMAN M. GRIFFIN
Agronomist, USGA Green Section, Southwestern Office

Plant diseases have been a problem to man since the dawn of history, and there has been a constant effort to find methods of alleviating or preventing them. Blight and mildew were known in biblical times, and Aristotle described wheat rust in 350 B. C. During these early times the causes of disease were unknown and accordingly many superstitious explanations were offered. At least one of the explanations was that the diseases were caused by demons or angry gods inflicting punishment on the people. In order to frighten away the demons or appease the gods, complex rituals were performed or prayers were offered. This was somewhat like the witch doctor approach some backward nations still use for curing human disease, and it constitutes the first-known attempts at plant disease control.

The following directions for plant disease control date back to 1790 and are a good example of some of the earlier experimentations in this field. Take one bushel of fresh cow dung, one-half bushel lime rubbish from old buildings, one-half bushel wood ashes, one-sixteenth bushel pit or river sand. The last three are to be sifted fine before they are mixed. Then work them together with a spade and afterward with a wooden beater until the stuff is very smooth like fine plaster used on ceilings of rooms. The mixture was made to the proper consistency with soapsuds or wine; and after its application to the plant, it was dusted over with dry powder of wood ashes mixed with the sixth part of the same quantity of burnt bones.

Experiments with mixtures such as these were the forerunners of the successful experimentation that has resulted in modern controls for plant diseases. Extensive research has now given us chemical as well as cultural methods for combating turf diseases, but these principles and controls must be logically and systematically applied to be of value.

Since our discussion is primarily concerned with water's relationship to plant disease, I would like to define the word **disease** in such a way that it encompasses all detrimental effects of moisture to turf. This is using Webster's definition of disease rather loosely, but in many ways we may think of any condition which impairs health as being a disease.

For years the subject of altering the susceptibility of turfgrass to disease by manipulation of the water and fertility management programs has interested pathologists and management specialists. Today, there are many opinions along these lines but few facts. There is certainly a great void in our knowledge of the relationship of water to plant disease and in most cases we are left to draw our own conclusions.

Water's Influence

Essentially, there are only three ways in which water can influence disease and affect turf. Our troubles come from either too much water, not enough water, or impurities in water. Again, this is treating our subject rather generally, but I believe we can give some specific examples which fall into each category.

First, we will consider overwatering as a major cause of unhealthy turf. This practice is found rather frequently on golf courses in spite of all that has been said and written about the subject.

Golfers sometimes get the idea that the more water that is applied to a green, the better it will hold a shot. This is neither good golf nor good greenkeeping. What actually occurs with many soils is that they become harder with the addition of excess water. The combination of water and traffic on the greens causes the soil to puddle on the surface, and there is a lack of oxygen in the root zone for the grass. Under these conditions the turf cover is lost, and the soil is further compacted by the lack of a cushion of turf above it; and it becomes increasingly difficult to hold a shot on the green.

Also, a soggy condition of the turf aids disease development. The fungi which cause disease need abundant moisture for their best growth; and when the soil is kept saturated, they develop readily to cause turf injury. Watering is too often a routine rather than an effort to supply the needs of the grass. By watering on schedule rather than according to need we invite trouble from many sources.

Irrigation is not the only source of too much water, however; and rainfall, high humidity, dew and guttational water are closely related to disease incidence.

Rainfall gathers as many as 5 million organisms per square yard on the way to earth, and the figure for snow is even higher. Disease organisms are carried so well by raindrops and run-off water that the activity of disease can actually be closely correlated with annual rainfall in areas of similar cli-

COMING EVENTS

February 25-26
Southern Turfgrass Conference
Peabody Hotel,
Memphis, Tennessee

February 27-28 - March 1
Minnesota Educational Conference
Lowry Hotel
St. Paul, Minnesota

February 27 - March 3
Cornell Turfgrass Conference
Cornell University
Ithaca, New York

March 4-5-6
Midwest Regional Turf Conference
Purdue University
Lafayette, Indiana

March 7-8
University of Massachusetts Turfgoss Conf.
University of Massachusetts
Amherst, Massachusetts

March 12-13-14
Annual Turfgrass Short Course
Iowa State University
Ames, Iowa

March 21-22
Michigan State Turfgrass Conf.
Michigan State University
East Lansing, Mich.

March 27-29
Ontario Turfgrass Conference
Ontario Agricultural College
Ontario, Canada

mate. The higher the rainfall, the greater the disease activity.

Rain Often Aids Disease

Often the action of raindrops is the means by which certain spores are liberated. Rain in large drops or driven by wind breaks the disease spores from their stalks or from within an enclosed layer and sets them free.

Relative humidity acts in two ways. During periods of high relative humidity most disease organisms reproduce freely and are able to infect healthy plant tissue. On the other hand, low relative humidity can cause partial wilting of the host tissue in dry air and apparently aids the penetration of certain fungi.

Even though the air around us feels dry, the microclimate surrounding the grass may contain ideal moisture conditions for disease germination. This is sometimes accounted for by dew or the guttation from grass leaves. Many diseases also tend to be autocatalytic in that a certain amount of moisture is produced by the decomposition of the spent disease organisms to provide moisture for new ones.

Watering in the early morning is considered best for dispersing dews and allowing the grass leaves to remain dry as much as possible. Threshing the greens with a limber bamboo pole or dragging a clean water hose across the green surface also helps to disperse dew and moisture otherwise collected on grass leaves.

Another common malady of grass caused by excess water is scald. This condition may or may not be accompanied by disease organisms, and its real cause is somewhat questionable. All too often the term **scald** is used as a "catch all" classification to describe any unidentified turf injury. It is doubtful that grass is ever actually scalded by water that has been overheated by the sun's rays; but we do know that when oxygen is excluded from the soil by overwatering, plants take on a scalded appearance. Low oxygen supply leads to impermeability of the cell walls in roots and they are no longer able to absorb water in proper quantities. This leads to a moisture deficit in the plant and causes the plant to wilt even though it may be in water.

Because most people fail to associate a wet soil with a lack of moisture in the plant, the condition is not recognized as wilt and is called scald.

A lack of water may be associated with turf disease in that it weakens the plant making it all the more susceptible to disease organisms. A good example of this is the **Curvularia sp.** organisms which usually attack only plants that have first been weakened by adverse environmental conditions.

Fairy ring is a different type of disease which actually denies moisture to the grass. A very dense mass of fungus filaments called the mycelium are produced in a circular pattern in the soil. Because of this dense mycelium, which acts very much like compressed felt in its ability to absorb moisture, the soil cannot be properly wetted by normal watering; and the turf dies or is weakened from lack of moisture.

Mat and thatch also deny moisture to the turfgrass and provide an excellent place for disease to breed. The dead and decaying organic matter in thatch or mat is actually what most fungi pathogenic to turf feed on. Water and air are restricted from the grass roots by an impervious layer of undecomposed organic material, and we have almost ideal conditions for weak grass and strong fungi.

Watch For Warnings

The last and most inexcusable reason for lack of moisture is the failure to apply it when it is needed. The warning signals are always there for those who take time to notice. The grass turns a blue-gray or slate color and begins to footprint. In many locations during the summer a period of 15 to 20 minutes is the difference between live and dead bentgrass.

By all means we should try to learn and use good watering habits. In this way we will be helping to overcome disease by maintaining vigorous turf.

The third way in which water affects turf is through impurities it carries. Water with an extremely high or low pH can have an effect on bacterial action in the soil, and any detrimental effects should be alleviated by correcting the pH of the soil.

Other impurities in water which may cause trouble are certain salts which are injurious to turf. When water containing a high quantity of injurious salts is used, management of both soil and water is essential. Good drainage is necessary to wash the accumulating salts downward and out of the root zone, and it is therefore necessary to have a permeable soil with a high infiltration rate. Quite often, some relief may be obtained by the use of soil conditioners such as gypsum which replaces the undesirable salt in the soil and allows it to be leached out.

Last of all, the amount of water used as a solvent or carrier for fungicide in a spray solution affects turf. When used in the proper amounts with the proper pressure, it is effective. If large quantities are used, the chemical may become too dilute and have little, if any, effect. If too little water is used, the resulting burn may sometimes be worse than the disease.

Now, let us look to the future. It is possible that someday our whole concept of water may be changed, and we will be better able to use it and understand it. Only in the last three years was powdered water developed by the National Cash Register Company and put to use industrially. Someday this may be the answer to golf course watering problems whereby exact quantities can be applied with little waste. This may seem ridiculous now, but so did a lot of other things which we now accept as commonplace in our present Space Age.

There is a lot to be learned about water and its relationship to our environment. We know the basic composition of water, but we have not yet measured all its properties. It is so essential we cannot live without water, but we can live better with it if we learn more about it.

Role of Proper Management Practices in Weed Control

By DR. MARVIN H. FERGUSON

Mid-Continent Director, National Research Coordinator, USGA Green Section

Management seeks to eliminate the causes of troubles before the troubles arise. It makes use of all the available tools for the manipulation of the environment of turfgrasses so that these desirable plants are favored and the undesirables (weeds) are hampered. To control weeds one must get rid of basic problems.

It may also be said that the manipulation of practices such as moving, fertilizing, and watering are of themselves inadequate to control weeds. The successful turf grower makes use of the new technology which encompasses pre-emergence chemical controls, post-emergence chemical controls, and mechanical methods.

If we recall the era prior to World War II when weed control technology was very limited we may remember that dandelion seed heads sometimes obscured golf balls in fairways and that crabgrass was not nearly so bad a pest because it provided playable turf despite its undesirable characteristics. It may provide some small comfort to us to recognize that our most serious weed pests in 1962 were practically unnoticed in 1942 because there were so many more serious pests that are now quite easily controlled. It is a measure of our progress in the weed control battle. The situation may be likened to a man with a pebble in his shoe. He never will notice the grains of sand until he removes the pebble. Then the grains of sand can become extremely annoying.

Weed control efforts may be characterized in three categories. These are isolation, protection (prevention), and eradication.

Isolation is practiced by establishing turf in clean ground where there are likely to be few weed seeds, and by using sterilized soil in topdressing. Our seed laws have provisions which prevent the spread of noxious weeds to uninfested areas through seed contamination. Isolation is an important part of a weed control effort, but because our practices are imperfect and because outside agencies such as wind, water, and animals transport seeds, attempts at complete isolation almost always fail.

Protection, or prevention, encompasses the use of pre-emergence materials which halt germination or development of the weed. It also includes environmental manipulation. Irrigation practices, fertilization, mowing techniques, cultivation practices, the use of insecticides and fungicides are matters that affect the well-being of the turf and its resistance to weed invasion.

Eradication may be accomplished by hand weeding, by mowing (in some cases) or by the use of post-emergence chemical controls. This is the most spectacular phase of weed control and it is extremely important. However, when one has completed a program of eradication, he must then resort to attempts at isolation, and eventually to prevention. The capable turf grower must use all the tools and techniques available to him.

It is important for the turf grower to know the weeds he deals with. If one knows the characteristics of growth and the life cycle of a weed, he can determine where and when the weed is vulnerable. He must also know his grass. He then is in a position to relate his management practices to the strength of his turf and the weaknesses of the weed.

Timing is Important

Timing of operation often is extremely important. An application of fertilizer and water on Kentucky bluegrass at a period when it is heavily infected with leafspot and when crabgrass is germinating will almost certainly result in a turf that appears to be 100 percent crabgrass. But an application of fertilizer and water in the fall when crabgrass is dying out and bluegrass is entering a period favorable for growth will do much to increase the density and vigor of the bluegrass in the following year. There are many other examples which may be less obvious but which are, nevertheless, important.

Enumeration of the management practices conducive to weed control is difficult because the different methods employed and the timing of practices may sometimes be such that they favor weeds rather than turf. There are, however, a few things that seem almost universally applicable. We should eliminate, or at least modify, excessive thatch, excessive compaction, and excessive shade. We should control insects and diseases. We should provide adequate drainage, adequate fertility, and adequate moisture.

The final admonition is to **learn.** The successful turf grower must learn as much as possible about the plants he is dealing with, about new management techniques, and about new chemicals. He should do some experimenting with his own equipment on his own turf. With all the new technology, and new materials, one should not allow himself to forget the old, proven, time-tested methods. We have seen people spray greens with a potentially dangerous herbicide for the purpose of controlling a sparse infestation of weeds that could have been hand-picked in the time required to prepare the material and the sprayer for the chemical application. Knowledge that is up-to-date and judgment that is down-to-earth are the two keys to proper management and adequate weed control.

Fertilizers - Basic Information

By DR. MARVIN H. FERGUSON
Mid-Continent Director, National Research Coordinator, USGA Green Section

The fertilizer user today has more choices than ever before with respect to grade, to physical condition, and to nutrient availability. There are many basic facts that are useful in selecting and applying fertilizer. We shall consider this subject under three headings. They are (1) analysis, (2) physical condition, and (3) nutrient availability.

Analysis

Fertilizer analysis is usually expressed as 12-6-6, 13-13-13, 0-14-14, etc. These are known as fertilizer grades. The figures refer to the percentages of the nutrient elements, nitrogen (expressed as N), phosphorus (expressed as P_2O_5 equivalent), and potash (expressed as K_2O), respectively, contained in the fertilizer. Fertilizer grades which may be marketed are usually fixed by the state regulatory agency, and they may vary from state to state.

Ratio is another term that is used with reference to fertilizer analysis. This is simply an expression of the relative amounts of plant food elements present in fertilizer. Thus, a fertilizer of the 12-6-6 grade is said to be a 2-1-1 ratio because it has two parts of N to one part of P_2O_5 and one part K_2O. Likewise a 13-13-13 grade is a 1-1-1 ratio, because the nutrients are contained in equal quantities.

The nutrient elements which are considered in expressing the analysis of a fertilizer are certainly not the only ones which are important to plant growth. There are 15 elements that are essential to plant growth, and there is considerable evidence to cause us to suspect the essentiality of at least three more. Some of these essential elements are contained in most mixed fertilizers but are not shown in analysis. Examples are sulfur, which is contained in sulfate of ammonia and superphosphate, calcium which is contained in superphosphate, etc.

The analysis of fertilizer is limited to some degree because of the fact that all the fertilizer elements occur in compounds. They are useless as fertilizers in the elemental state. Furthermore, most fertilizers have conditioning agents added for the purpose of providing the proper physical qualities, to keep fertilizer from caking and to promote free-flowing capabilities in the spreader.

Let us digress from the subject momentarily to consider the figuring of application rates. How much 0-14-14 do you apply if you want to apply 70 pounds per acre each of phosphorus and potash? How much 12-6-6 is required to provide 2 pounds of nitrogen per 1000 square feet to a putting green? Both questions can be answered by use of the same formula.

$$\frac{\text{Rate} \times 100}{\%}$$

Substituting, the rate in the first case is 70 pounds and the percentage of the elements is 14. Therefore,

$$\frac{5 \times 100}{1} = 500$$

500 pounds of 0-14-14 per acre will

supply 70 pounds each of P_2O_5 and K_2O.

In the other problem, the percentage is 12, and the rate is 2 pounds per 1000 square feet. Applying the same formula,

$$\frac{2 \times 100}{12} = \frac{200}{12} = 16\tfrac{2}{3} \text{ lbs. of fertilizer}$$

required per 1000 square feet to supply 2 pounds of N. the same formula will show that the 12-6-6 will supply 1 pound of P_2O_5 and 1 pound of K_2O per 1000 square feet.

PHYSICAL CONDITION

A fertilizer adaptable to your method of application is quite important to the efficiency of its use. For instance, if you depend upon a broadcast type spreader with a rotating pan, you will be much happier with a pelleted type material. On the other hand, if your spreader is the conventional drill type, the powdered or crystalline types of fertilizer material may fit your needs.

The fertilizer user is quite fortunate in having a wide choice of materials and methods of application. The three major classes of fertilizer types with respect to physical characteristics are liquids, powdered or crystalline materials, and granular or pelleted materials. All have certain advantages and disadvantages and the choice would depend upon the application equipment available, the effects you wish to achieve and, of course, the price.

Any soluble fertilizer material may be used as a liquid upon being dissolved in water. Most liquid materials which contain all the three major fertilizer elements are based upon ammoniated phosphoric acid. Most nitrogen materials are readily soluble as are most salts of potassium. Advantages of liquids are that they may be mixed in the spray tank with fungicides or other materials to be sprayed. In some cases, liquid fertilizers may be injected into the irrigation system and applied with the regular watering of turfed areas. Disadvantages are chiefly connected with problems of shipping, storing, and corrosion of metal containers or application equipment.

The powdered or crystalline materials such as sulfate of ammonia, ordinary superphosphate, etc. are perhaps the most common and the cheapest sources of plant nutrients. These materials have the advantages of familiarity and low cost. Disadvantages are associated with tendencies toward bridging, dustiness, and sometimes caking. The curing processing involved and the conditioning of materials used are extremely important to the physical qualities of these traditional fertilizer products.

Granulated or pelleted fertilizers are becoming more common. The manufacturing steps involved in granulation or pelleting will sometimes add to the costs of these products, but they have other advantages which may offset the cost. Pelleted materials may be used in broadcast spreaders, dustiness is reduced, and the free-flowing characteristics are desirable. There is no problem of caking or bridging and wind does not seriously effect distribution.

NEW SUBSCRIBERS TO THE USGA GREEN SECTION VISITING SERVICE

EASTERN REGION

Del.	Rehoboth Beach Country Club Rehoboth
N. Y.	Transit Valley Country Club East Amherst
	Muttontown Golf & Country Club Muttontown
Fla.	Palmetto Country Club Association Miami
N. C.	High Hampton Inn and Country Club Cashiers
	Pine Brook Country Club Winston-Salem

MID-CONTINENT REGION

Ky.	Hopkinsville Golf and Country Club Hopkinsville
Mich.	Signal Point Club, Niles
Colo.	North Glenn Golf Club, Denver
Kans.	Rolling Hills Country Club, Wichita
N. M.	Silver Golf Club, Silver City
Texas	Lions Municipal Golf Course and Golf Course #3, Austin

WESTERN REGION

Ore.	Illahe Hills Country Club, Salem

Availability of Nutrients

Whether or not nutrients are quickly or slowly available is often quite important in the choice of fertilizers. There are sometimes advantages in favor of either quick or delayed availability.

Nitrogen is the element with which turf growers are most frequently concerned with respect to availability. Nitrogen may be characterized as the growth element insofar as grass is concerned. Since it controls the rate of growth and the softness or succulence of turf, the grower must gauge the size of his nitrogen applications by the speed with which it becomes available to the plant.

Nitrogen is not "fixed" by the soil except for that part which may be utilized by microorganisms and temporarily tied up. Therefore, the form in which nitrogen is applied affects its availability to the plant.

Most of the inorganic materials are soluble and therefore are quickly available. Nitrogen is taken into the plant either as nitrate or ammonia. Therefore, materials such as ammonium sulfate, ammonium nitrate, sodium nitrate, etc. are immediately usable.

Organic forms of nitrogen are more slowly available. They must undergo some chemical changes in order that the nitrogen may be converted to a form usable by the plant. Examples of organic nitrogen carriers are processed sewerage sludge, the oil seed meals, and tankage. Manures used in composts and applied as topdressing are another organic source of nitrogen.

In recent years "controlled release" products have been developed. The urea-formaldehyde products have been widely tested and are in use on some golf courses. With these materials it is possible to provide for prolonged release of nitrogen following one large application.

A more recent type of material in the developmental stage involves the use of plastic coatings of varying thicknesses over pellets of inorganic nitrogen compounds. Theoretically it should be possible to blend batches of materials with differing coating thicknesses in such a way as to provide for controlled release of nitrogen (or other soluble elements) over a long period.

Phosphorus may be fixed by reacting with other soil materials. Therefore, the application of soluble compounds will not necessarily guarantee that the phosphorus will remain in a form available to the plant. Ammonium phosphates are soluble. Superphosphate and treble superphosphate contain some phosphorus in a form which is available and some which may be relatively slowly available. Rock phosphate is a slowly soluble form of phosphate.

Most potassium salts are soluble, though some potassium enters into the base exchange phenomena of the soil and may be fixed. Usually there is a good balance between the available and fixed potassium, if any ample quantity exists in the soil and if the soil has a high base exchange capacity. Fritted potassium is a slowly available form and is sometimes useful under artificial soil conditions.

Fertilizer is one of the golf course superintendent's most important tools in turf management. He should give a great deal of thought to the choice of materials. He must secure a fertilizer which has an analysis suited to the needs of his turf and apply it in the correct quantity. He must choose a material with a physical condition which is correct for his application equipment. He must fit rates of application to the nutrienti availability as well as the the analysis and the needs of his plant.

Don't Build Trouble

In the construction of new greens or the rebuilding of old greens, provide for adequate surface and subsurface drainage. Well drained greens are damaged considerably less than poorly drained ones when covered with ice.

ANNUAL INDEX TO USGA JOURNAL AND TURF MANAGEMENT
Volume XV — April, 1962, Through February, 1963