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
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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 preemergence chemical controls, postemergence 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
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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