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

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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

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,

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

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.

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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.