The A B C of Turf Culture

Functions of Plant Elements and Characteristics of Various Groups of Fertilizer Materials

By O. J. NOER

THE rational use of fertilizers must be based upon a knowledge of the functions of the plant food elements—nitrogen, phosphoric acid and potash, and the effect of these on clover and weeds must be considered also. These secondary effects, due either to the plant food elements themselves or some other non-essential constituent of the raw fertilizer material deserves particular attention. Their injudicious use may require careful management and considerable time to overcome the bad effects produced.

Functions of Specific Plant Food Elements

Nitrogen is the most important plant food element in turf maintenance, and is most largely used by turf grasses. It is responsible for dark green color and active vegetative growth. Deficiencies of nitrogen are easily recognized. If the turf is thin, light green in color and not growing actively, the need for additional nitrogen is unmistakable, provided other conditions such as good drainage, proper physical soil conditions, favorable climate and sufficient moisture exist. Abundant clover on fairways points to a *limited nitrogen supply*. Clover is a legume and by virtue of the nitrogen fixing bacteria contained in the nodules or sacs present on the roots can utilize atmospheric nitrogen. Turf grasses cannot draw upon this inexhaustible supply of nitrogen, but must depend upon the soil to satisfy its demand. Consequently the clover satisfies its nitrogen needs, becomes more aggressive, and may predominate in the turf.

The large amounts of nitrogen removed from greens in clippings is rarely appreciated. Analyses made last year showed the nitrogen content of dry clippings vary from 1½ to 3 per cent. The higher nitrogen content was from turf fertilized with quick acting nitrogenous fertilizers, yet the average green receives more nitrogen than was applied to this turf. Three hundred pounds of clippings removed from a green contain about one hundred pounds of dry matter. If the nitrogen content is only two per cent, two pounds of nitrogen are removed. Since nitrogen constitutes one-fifth the weight of sulphate of ammonium this is equivalent to ten pounds sulphate of ammonium. If the nitrogen content is three per cent, three pounds of nitrogen, equivalent to fifteen pounds sulphate of ammonia are removed. These amounts are exclusive of any losses due to leaching in the drainage water. Is it any wonder that greens require constant applications of nitrogenous fertilizers?

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Turf grasses require only limited amounts of phosphoric acid. It is an essential constituent of the living protein or protoplasm of the plant cell. Root development is stimulated by the presence of abundant phosphoric acid, so it is essential to provide this plant food element on new seedings to insure rapid root development and obtain a uniform stand of turf. Unlike nitrogen, the need for phosphoric acid is not easily recognized, but in established turf it is rarely necessary to provide very much phosphoric acid in fertilizers. On greens apparently the top-dressing mixture contains sufficient phosphoric acid to satisfy the demands of the turf.

In the presence of abundant phosphoric acid, particularly if the source is bone meal or acid phosphate, the growth of clover may be greatly encouraged. The extensive use of fertilizers high in phosphoric acid are unnecessary on established turf and may defeat any program designed to rid the turf of clover.

Potash is essential to the formation of a class of substances called carbohydrates. There are three groups as regular constituents of plants namely, starch, sugar and cellulose. Sugars are built in the green leaves under the influence of active rays of the sun from simple substances. The sugars are one of the raw materials from which other complex organic compounds are built in the plant. Cellulose is the material which makes up the cell walls and hence gives form to the plant. The wood of trees and shrubs is almost entirely cellulose.

Clovers require abundant potash. Hence repeated applications of potash may result in increasing the amount of clover in turf. Most soils are supplied with sufficient potash to maintain normal growth of turf grasses, and it is doubtful if benefits from its use will be obtained except possibly on light sandy soils, peats and mucks. Because of the danger of encouraging

clover, potash fertilizers should be used sparingly and only when soil conditions indicate its possible need.

Sources of Plant Food

There are a variety of plant food materials which can be used as fertilizers. Some contain only one plant food element, while others may supply two or more. Their value and efficiency depend upon the amount, kind and availability of the plant food they contain. The choice is also affected by local soil conditions. On sandy soils some materials are rapidly lost in the drainage waters, others are slower acting and provide for longer feeding.

When mixed fertilizers are purchased the plant food constituents of necessity cost more than where the various raw materials are procured. The manufacturer must be reimbursed, for the cost of mixing. The value of mixed fertilizers depends primarily upon the percentage of plant food content. These are expressed in figures which represent the percentage composition of nitrogen, phosphoric acid and potash, and are expressed in that order. Thus a 6-3-2 contains six per cent nitrogen, three per cent phosphoric acid and two per cent potash. Nitrogen is usually reported both as nitrogen and its equivalent in terms of ammonia. Thus sulphate of ammonia contains approximately twenty per cent nitrogen or twenty-five per cent ammonia. These can be converted into one another by using the factors .82 or 1.215. To convert nitrogen into ammonia multiply the percentage of nitrogen by 1.215 and if expressed as ammonia multiply by .82 to obtain the percentage of nitrogen.

Ordinarily best results on established turf will be obtained by selecting mixtures of higher nitrogen content and lower phosphoric acid and potash content such as 6-3-2, 12-6-4 etc. On new fairway seeding a larger proportion of phosphoric acid usually produces better results.

There are three different classes of nitrogen containing materials depending upon the kind of nitrogen they contain, namely, organic, ammonia and nitrate nitrogen. Eventually any form of nitrogen is converted to nitrate nitrogen when applied to the soil. The mechanism of this process was explained in a previous article.

Nitrogen is the only one of the three plant food elements subject to loss. Any nitrogen existing as nitrates in the soil or converted to this form by soil processes dissolves in the soil water and is not retained by any soil constituent. Consequently it is lost in the drainage water unless taken up by the plant. Nitrogen is the most expensive plant food element so the danger of loss must be constantly considered, especially since it is the most critical element in turf culture.

The general characteristic of the different classes of nitrogenous materials deserves special consideration.

Organic Nitrogen

Materials containing organic nitrogen are derived from animal or plant residues. Some of the common materials are the various manures either fresh or dried, bone meal, cottonseed meal, soy bean meal, dried blood, tankage, fish scrap, Milorganite, etc. They vary in their nitrogen content and in the rate at which the nitrogen becomes available to the plant.

Most of the nitrogen contained in these materials is not soluble in water, and all of it must be converted into other forms before the plant can use it. When added to the soil the bacteria decompose the organic matter and liberate nitrogen in the form of ammonia. This is subsequently converted to nitrate nitrogen by a specific group of soil bacteria. The rate at which decay takes place determines how rapid results will be obtained from their use.

The advantage of organic fertilizers accrue from the fact that decay takes place over a considerable period and thus a uniform and continuous supply of available nitrogen is assured. Such a supply is essential if uniform and continuous growth of turf is to be obtained.

There is less danger of burning or injuring turf with organic forms of nitrogen than any other. The different materials differ in this respect. If decay takes place rapidly the danger increases. Dried blood in particular is apt to burn because decay is very rapid.

The effect of organic materials on soil reaction depends upon the individual material, particularly the amount of lime or other basic material which they contain. Thus bone meal due to the large amount of lime it contains decreases the acidity of the soil. Analyses of manure show that it contains about four per cent lime, so a ton contains about eighty pounds which is equivalent to about one hundred fifty pounds lime carbonate, (ground lime stone). Dried blood on the other hand contains very little lime and since the nitrogen is converted to nitric acid its use will eventually increase acidity.

Ammonia Nitrogen

The two principal sources of ammonia nitrogen are ammonium sulphate and ammo-phos. The nitrogen in both these materials exists as ammonia. Both are water soluble and quick acting. They must be used with caution on turf because of the danger of burning or scorching the grass.

When applied to the soil the ammonia is taken up and held by the clay particles. This tends to hold the nitrogen temporarily in the shallow surface layer where maximum root development occurs and may explain why ammonium sulphate sometimes serves as a more effective source of nitrogen than nitrate of soda even when applied to give equal amounts of nitrogen. The nitrate nitrogen is not held and may move down into the lower soil layer below the root zone.

Even though ammonia nitrogen is applied to the soil it is converted into nitrate nitrogen by soil bacteria, just

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the same as the ammonia produced by decay of organic nitrogenous materials.

As is well known both the above materials increase soil acidity and thus their use aids in the control of clover.

Nitrate Nitrogen

The main source of nitrate nitrogen is nitrate of soda, often called Chili saltpeter. Nitrate nitrogen is the form preferred by most plants, but as we have already seen all other forms are converted to nitrate in the soil.

Nitrate nitrogen is water soluble and quick acting. It must be used carefully because of the danger of burning turf grasses.

The general use of nitrate containing fertilizers now on the market is being discouraged on turf grasses. They tend to make the soil less acid and encourage coarse grasses, weeds and clover. Their continuous use also has a bad effect on the physical condition of heavy soils.

Sources of Phosphoric Acid

The commercial sources of phosphoric acid are limited. Bone meal, acid phosphate and ammo-phos are the chief materials, although basic slag is extensively used in Europe.

Any of these materials can be used without danger of burning the turf except ammo-phos. Bone meal and basic slag are very slow acting and also contain considerable lime so they unduly encourage clover.

Phosphoric acid is fixed in the soil and hence can be used without danger of loss by leaching.

With the exception of ammo-phos all phosphate fertilizers tend to make the soil less acid due to the liberation of lime, when added to the soil. The effect is least with acid phosphate. Because of the greater availability of the phosphoric acid, it is better to use acid phosphate than bone meal on new seedings.

Sources of Potash

The main source of potash is mureate of potash, derived from the Stassfurth mines in Germany. It is water soluble and liable to burn the turf. Potash fertilizers increase soil acidity and are not subject to loss by leaching because the clay and humus in the soil hold the potash and gradually release it to the soil solution.

Since potash is the least important of the three plant food elements it need not be further considered.