

CHAPTER III

FERTILIZERS

THE term "fertilizers" is an extremely broad one, having been applied generally to all substances that are added to the soil for the purpose of improving its capacity to produce plant growth. Almost every common substance has at some time or other been used for this purpose, but since 1840, largely as the results of Liebig's investigations, the number of substances used as fertilizers has been restricted to those containing relatively high percentages of nitrogen, phosphorus, and potassium, except in the case of organic manures, which have always been used extensively.

The functions of fertilizers are not clearly known, but they are probably very much more complex than is commonly supposed. In addition to supplying nitrogen, phosphoric acid, and potash to the soil in forms available to plants, some of them, at least, act as correctives or disinfectants ameliorating toxic conditions, while others, of which

barnyard manure is an example, in addition to these functions supply organisms that are highly beneficial to plant growth. Hundreds of carefully planned pot, plot, and field experiments have been conducted within recent years, but as yet no highly scientific practice has developed with regard to the use of fertilizers, so that "cut and try" methods are still very largely necessary.

Commercial fertilizers may be divided into two general groups, organic and inorganic. To the former belong bone-meal, cottonseed-meal, dried blood, and hoof-and-horn-meal. To the latter belong nitrate of soda, sulfate of ammonia, acid phosphate, raw rock phosphate, basic slag, and muriate and sulfate of potash. In addition to these there are many others of less importance in each group. The fertilizers most commonly used for grass are ground bone in some form, nitrate of soda, sulfate of ammonia, cottonseed-meal, acid phosphate, and muriate and sulfate of potash.

ORGANIC FERTILIZERS

Organic fertilizers consist of dead plant or animal materials. As a class they are relatively slow in action and correspondingly long enduring. In gen-

eral, their function is to supply nitrogen, although some of them contain a high percentage of available phosphoric acid.

Bone-meal.

In the comparatively long list of organic commercial fertilizers bone-meal is the most popular at the present time for use on grass. This is very largely due to the fact that it is relatively cheap and can be depended on to produce reasonably consistent results. For putting-greens it has three distinct advantages: it is a fertilizer to which grass responds very readily; it can be applied at any season of the year with little or no injury to the finest turf grasses; and there is no evidence of its producing unfavorable residual effects in the soil. The common objection to its use on putting-greens is based on the belief that it unduly encourages the growth of White Clover by virtue of its relatively high percentage of phosphoric acid. While it doubtless benefits clover, nevertheless the extreme prejudice on the part of golfers apparently is not well founded.

There are two kinds of bone-meal found on the market: "raw bone" and "steamed bone." In the case of the former no treatment is given the

bone before grinding, while in the latter case the bone is subjected to superheated steam until the fat and the scraps of meat have been removed. Steamed bone is said to be somewhat more readily available than raw bone; but whether raw or steamed, the value of bone-meal depends to a very large extent on the degree to which it is pulverized. The finer the particles, the more quickly the substance becomes available to the plants.

A good grade of bone-meal contains from 3 to 5 per cent of nitrogen, and from 18 to 20 per cent of phosphoric acid. For top-dressing putting-greens twenty pounds to 1000 square feet are recommended. When used at the time of seeding, somewhat heavier applications can be made to advantage. It is the common practice to apply bone-meal in the spring, but there is some evidence to indicate that when applied during the winter it is more beneficial to the grass when growth commences. Late spring or summer applications, while no doubt somewhat efficacious, produce results that are only slightly noticeable, at least in the appearance of the grass. No scalding or other injurious effects have ever been observed from the use of this fertilizer, no matter when applied. Its

offensive odor can be considered only a slight objection to its use, since it is not long in evidence after application.

Cottonseed-meal.

Highly satisfactory results have been obtained in many cases from the use of cottonseed-meal as a top-dressing for grass turf, but whether it is to be recommended for putting-greens in preference to bone-meal is open to question. Thus far there is lack of sufficient definite data to warrant a positive statement in this connection. Cottonseed-meal contains more nitrogen than does bone-meal, and its nitrogen is more quickly available. Furthermore, its low percentage of phosphoric acid eliminates any theoretical objections to its use on the ground of encouraging White Clover. A suitable application when used as a top-dressing for greens is approximately twenty-five pounds to 1000 square feet. It frequently happens that a scorching or burning effect results when cottonseed-meal is applied to grass. The reason for this is not well known, but the scorching may be due partially to the heat which is generated by fermentation when the meal becomes moist or wet. Therefore, it should be distributed as evenly as possible and

worked into the turf with a coarse brush or broom, or it may be mixed with equal parts of sand or soil before applying. This obviates the danger of large quantities accumulating and injuring the grass. Masses of cottonseed-meal, if thoroughly wetted, become hard and almost impervious to moisture upon drying. Under such masses the grass is almost invariably killed. For the above reasons, caution should be exercised in connection with its use, especially in summer, since its scorching effect is apt to be greater at that time than at any other period of the year.

Cottonseed-meal is manufactured from the de-corticated seed from which the oil has been expressed. It ordinarily contains approximately 7 per cent of nitrogen, 1.5 per cent of phosphoric acid, and 2 per cent of potash. It is desirable that it be given a thorough trial as a spring top-dressing for putting-greens.

Dried blood.

As a top-dressing for turf, dried blood has not given very consistent results. This may be due partly to the fact that the availability of its nitrogen is somewhat uncertain, depending very largely on the character of the soil to which the fertilizer

is applied. In soils deficient in lime it is frequently not more than one-half as available as nitrate of soda, while on soils well supplied with lime the availability is increased to a point more nearly approximating that of nitrate of soda. A good grade of dried blood contains from 10 to 13 per cent of nitrogen, 0.5 to 1.5 per cent of phosphoric acid, and 0.6 to 0.8 per cent of potash. It can be used with safety on the finest turf, and this seems to be its most commendable feature, since its use is not economical, and it is neither lasting nor consistent in its action. A normal application consists of approximately twenty pounds to 1000 square feet of putting-green.

Hoof-and-horn-meals.

Meals composed of ground hoofs or horns, or a mixture of these two, have sometimes been suggested for putting-greens in preference to bone-meal, owing to the comparatively low percentage of phosphoric acid which the substances contain. Experience, however, indicates that only a small portion of the nitrogen in these meals is available, even though the material is finely pulverized. Furthermore, the nitrogen becomes available very slowly, and while a good grade of these meals contains approximately

13 per cent of nitrogen, their use on turf has not given very satisfactory results.

INORGANIC FERTILIZERS

There occur in natural deposits in the earth substances that contain to a high degree of concentration the principal elements of plant-food. Nitrates and potash compounds are found in impure chemical salts, while phosphates exist in a much less concentrated form in rocks, many of which are composed very largely of fossil animal remains.
Nitrate of soda.

The most important inorganic nitrogenous fertilizer is nitrate of soda. It occurs in a crude state in large deposits in South America, and is refined there before being exported. In its commercial form it contains between 15 and 16 per cent of nitrogen, which is equivalent to 18 to 19 per cent of ammonia. Nitrate of soda is readily soluble, and its nitrate becomes immediately available without undergoing any chemical decomposition. It produces the quickest effect of all the commercial fertilizers when applied to grass, and is fairly consistent in its results. Its effects, however, are not very lasting, and because of this it is

not very generally recommended as a fertilizer for the fairway.

On account of its pronounced caustic effect, nitrate of soda must be used with extreme care on putting-greens. It is preferable to apply a small quantity at frequent intervals rather than large quantities at one time. Five pounds for every 1000 square feet of green is a sufficient quantity for one application. It should be pulverized thoroughly, and it is preferable to mix with sand before applying and to water thoroughly afterwards. Nitrate of soda may also be put in solution at the rate of one pound to ten gallons of water and sprinkled on the green, but even when used in this way thorough watering afterwards is necessary. Still another method which renders its use less likely to cause injury is to mix a saturated solution of it with bran, sawdust, or a similar substance before applying to the grass. This method reduces the burning to a minimum. It can be used to advantage during the spring and autumn, but its use in the summer is not recommended. Agricultural chemists have classified nitrate of soda as physiologically basic, and there is considerable evidence that it has a tendency to correct soil acidity as the

result of the formation of sodium carbonate. However, residual effects of considerable quantities of sodium carbonate on heavy clay soils deficient in humus are far from beneficial, and in addition to these deleterious effects the constant application of nitrate of soda, paradoxical as it may seem, has a tendency to impoverish the soil of its supply of nitrogen. These objections should be given careful consideration, since in the case of putting-greens applications of fertilizers are very much heavier than are made in ordinary farm practice.

Sulfate of ammonia.

Sulfate of ammonia is another inorganic salt that carries a high percentage of nitrogen, and is in a measure a competitor of nitrate of soda. It is a by-product resulting from the distillation of coal, as in the manufacture of coke and gas. It appears on the market in the form of a fairly fine whitish salt, and contains approximately 20 per cent of nitrogen, or 24 per cent of ammonia. Unlike nitrate of soda, sulfate of ammonia is acid in its residual reaction, and its continued use may result in producing such an acid condition in the soil that fertility is greatly reduced. For this reason, if for no other, nitrate of soda is to be preferred.

It frequently has been stated that one or two applications of sulfate of ammonia will eradicate white clover from putting-greens. However, the evidence on this is far from convincing. The tendency of continued applications of this fertilizer to create an acid condition in the soil is certain to be unfavorable to the growth of clover, but it is also unfavorable to the best growth of grass. The deleterious effects of sulfate of ammonia are neutralized by sodium, potassium, and calcium carbonates, but unless it is with the view to eradicating clover, this fertilizer possesses no known advantage over nitrate of soda. If it is desired to try it for the above purpose, ten pounds to 1000 square feet of green is considered a normal application. While not as readily available or as burning in its action as nitrate of soda, the same precautions are necessary with regard to its use.

Acid phosphate.

The phosphorus-carrying inorganic fertilizer in most common use is acid phosphate. It is prepared chiefly by treating phosphatic rocks such as are found in large deposits in several of our southern states with sulfuric acid to render the phosphorus content more available to the use of plants.

The good commercial grades contain from 14 to 16 per cent of phosphoric acid.

The effect of acid phosphate on grass is generally quite beneficial, especially when applied with some form of nitrogen, but it also stimulates the clovers, and for this reason few favor its use on putting-greens. For the fairway it may be used advantageously in many cases as a constituent of a complete fertilizer in the absence of suitable manure or compost. In such cases applications should be made preferably in the early spring at the rate of approximately 1000 pounds to the acre. For the greens it appears to possess no advantage whatever over finely ground bone-meal. In fact, this is true of all mineral phosphates. However, if for any reason it is desired to use it on greens, the application should be attended with considerable care, inasmuch as the free acid which it commonly contains readily injures grass which is in an active growing condition.

Muriate and sulfate of potash.

Muriate and sulfate of potash are by far the most important potash-bearing fertilizers now in use. They occur in impure deposits in Germany, and, when refined, yield salts containing 80 to 85

per cent potassium chloride, and approximately 90 per cent potassium sulfate, respectively. Most of the clay soils of this country are believed to contain an adequate supply of potash to produce a good growth of grass, and while experiments have shown that comparatively small quantities of potash salts in combination with nitrates and phosphates may increase the growth of turf grasses, these fertilizers are seldom recommended for putting-greens, except in cases where the soil is very sandy. Like the phosphates, potash fertilizers appear to increase the abundance of clover in the turf. In fact, their tendency apparently is more pronounced in this respect than is that of either acid phosphate or bone-meal. Five pounds for 1000 square feet of green is an ample application when combined with other fertilizers.

Mixed fertilizers.

It is a common practice of commercial fertilizer companies to mix fertilizing materials in different proportions with the view to selling them for special conditions. These ready-mixed fertilizers are extensively advertised under various trade names such as "Turf Grower," "Grass Grower," "Lawn Fertilizer," and the like, and the opinion seems to

prevail in the minds of many that they are just what is required. While these mixed fertilizers are very generally used, they are not to be recommended. Commercial concerns possess no special information regarding the action of fertilizers on grass that an intelligent greenkeeper cannot soon acquire, and, therefore, there is nothing mysteriously beneficial in their formulas.

When mixed fertilizers are desired, it will be found cheaper and generally more satisfactory to buy the ingredients separately and combine them in suitable proportions. By so doing the purchaser does not have to pay a high price for a considerable quantity of inert filler that is commonly present in ready-mixed fertilizers. The proportions for a good complete fertilizer for turf are as follows: nitrate of soda or sulfate of ammonia, 250 to 300 pounds; phosphoric acid, 350 to 500 pounds; muriate or sulfate of potash, 100 to 150 pounds. Twenty pounds of this mixture for 1000 square feet is ample for a single application, and three such applications are sufficient for a season. Inasmuch as this mixture is a concentrated fertilizer, precaution is necessary in connection with its use in order to avoid scalding the grass.