The A B C of Turf Culture

Composition and Properties of Individual Fertilizer Materials

By O. J. NOER

THE functions of the individual plant food elements and general characteristics of the larger groups of fertilizer materials were discussed last month. The individual materials vary in their plant food content, the rate at which the plant food is made available, and in their secondary effects upon the soil. The more important characteristics of the principal materials deserve consideration because a knowledge of these properties must serve as a guide in the choice of fertilizers for greens and fairways.

O. J. Noer

Editor's Note: For the past four years Mr. Noer has investigated the value of various fertilizers in relation to golf turf at the Soils Department, University of Wisconsin. under a fellowship established by the City of Milwaukee.

Organic Nitrogenous Materials

MANURE—While barnyard manure varies greatly in composition, good manure has the following average composition:

	Percent	Pounds per ton
Nitrogen	.5	10
Phosphoric Acid	.3	6
Potash	.6	12
Water	72.0	
Ash	8.3	
Organic Matter	19.7	394

About one-half of the nitrogen and three-quarters of the potash are water soluble. Manure contains about 4.5 percent of lime, which is equivalent to about twenty pounds of lime carbonate per ton.

During composting the non-nitrogenous organic matter (straw, etc.) breaks down, and the availability of the plant food elements is increased. There are some losses of nitrogen, but these can be largely prevented by keeping the pile compact and moist. Composting improves the mechanical condition of the manure due to the de-composition of the straw and kills the weed and clover seeds voided by the animal.

So far as plant food is concerned it is often possible to supply these more cheaply from other materials. One of the chief benefits of manure results from the beneficial effect of the organic portion on the physical condition of the soil, and is best secured when the manure can be incorporated with the soil. This is not possible on established fairways.

While manure does not contain large amounts of plant food, applications are usually heavy so that the total amounts of plant food applied may be considerable. A ten-ton application furnishes about 100 pounds nitrogen. 60 pounds phosphoric acid and 120 pounds potash. Poor results from substituted materials are often due to failure to appy sufficient quantities of plant food.

MUSHROOM SOIL—This material is the spent soil from the mushroom beds. Originally it consisted of a mixture of 7-12 parts manure and 1 part soil. The heat developed in the benches results in loss of moisture so the final product usually contains from 35 to 50 percent moisture. The amount of plant food varies considerably depending on the ratio of manure to soil originally used, the extent of decomposition and the moisture content. Samples obtained from the Philmont Club at Philadelphia contained the following percentages of plant food:

	No. 1		No. 2	
	Percent	Pounds per ton	Percent	Pounds per ton
Nitrogen	.80	16	1.32	26.4
Water soluble nitrogen	.08	1.6	.29	5.8
Total phosphoric acid	.56	11.2	.61	12.2
Total Potash	.81	16.2	.97	19.4
Ash	43.66		25.58	
Moisture	37.98		50.04	
Organic Matter	18.36	367.0	24.38	497.0

Sample number two looked like the better material which is borne out by the chemical analysis. The original mixture evidently contained much less soil per ton of manure than in the case of sample number one.

While mushroom soil contains larger total amounts of plant food per ton than good barnyard manure the proportion of water soluble nitrogen is less. The chief value of mushroom soil is as a source of organic matter, yet the results show that each ton contains about the same amount as good manure.

There is danger of introducing weeds. Mushroom growers are finding it difficult to obtain abundant supplies of manure. Consequently the proportion of manure used in the benches is less than was formerly employed. Sufficient heat does not develop during fermentation to kill all weed seeds.

Considering all items of cost, plant food can be supplied usually cheaper from other materials, and the use

of mushroom soil should be confined to situations where the organic matter is needed and cannot be obtained cheaper from other sources.

POULTRY MANURE—Dried poultry manure can be procured from a number of manufacturers. The following plant food content is guaranteed.

	Percent	Pounds per ton
Nitrogen	4.9	98
Phosphoric Acid	2.5	50
Potash	1.3	26

The nitrogen is in a form which is quickly converted into available forms. Due to the rapid decomposition, burning of the turf may occur if too heavy applications are made.

SHEEP MANURE—While large amounts of dried sheep manure are sold for use on lawns, it is not extensively used on golf courses, probably due in part to the high cost per ton. The guaranteed composition is as follows:

	Percent	Pounds per ton
Nitrogen	2.00	40
Phosphoric Acid	1.25	25
Potash	2.00	40

DRIED BLOOD—There are two kinds on the market, namely red and black blood. They are obtained by drying blood carefully by super-heated steam and hot air. The black blood results from charring due to too high temperatures. Red blood contains about 13.5 percent nitrogen, while the black blood is a more variable product containing about twelve percent nitrogen. Dried blood contains traces of phosphoric acid.

Blood decomposes very rapidly in the soil and is a source of quickly available nitrogen. It must be used carefully because it will burn the turf.

The limited supply is in great demand for use as a cattle food and blood is consequently an expensive source of plant food nitrogen. For this reason it will never be extensively used on golf courses.

COTTONSEED MEAL—The composition of cottonseed meal varies greatly. Where it is not adulterated with hulls the variation in composition may be due to the season, nature of the soil or the climate. Cottonseed meal is in great demand for feed for live stock and the bright yellow meals are used for this purpose. The darker meals are usually sold for fertilizers. The dark color may be due to over-cooking, to fermentation or storing in a damp or wet place. If there is no loss of nitrogen, the product is not injured for fertilizing use. Cottonseed meal has about the following average composition:

	Percent	Pounds per ton
Nitrogen	6.2	124
Phosphoric Acid	2.5	50
Potash	1.5	30

Very often the nitrogen content is not given on the sales tag, but the protein content instead. The nitrogen content can be obtained by dividing this figure by 6.25. Thus a 43 percent protein meal is equivalent to 6.8 percent nitrogen.

Cottonseed meal is an excellent source of nitrogen for fairways and greens to supply the more slowly available nitrogen. It provides for a long continuous feeding. Due to its demand as a live stock feed it is often high priced, and other equally good materials can usually be obtained at lower cost.

TANKAGE—Tankage is the refuse from slaughter houses and consists of meat, blood, bone, etc. Animals condemned as unsuitable for food are made into tankage. The nitrogen is derived primarily from meat and blood. When the percentage of bone is large the phosphoric acid is high and nitrogen low, and when there is an excess of blood and meat the nitrogen is high and the phosphoric acid low.

There are a number of grades on the market containing about 6.5, 7.5 and 8.0 percent nitrogen. The phosphoric acid content varies from 3 to 6 percent.

Concentrated tankage is another grade and the richest of all. It contains more nitrogen and is a very uniform product. It is made by evaporating wastes which contain animal matter in solution. It contains 10 to 12 percent nitrogen and small amounts of phosphoric acid.

The tankages are usually high priced because of the demand for use as cattle feeds.

In the soil the nitrogen is quickly converted into forms which the plant can use. There is danger of burning the turf if heavy applications are used. The continued use of tankages high in phosphoric acid tends to encourage clover.

SEWAGE SLUDGES—There are two types of sludges produced in sewage treatment plants, depending upon the method of purification. Most plants use the older Imhoff tank processes, and only one plant located at Milwaukee, uses the new activated sludge process. In the Imhoff tank process air is excluded so as to promote liquefaction of the organic matter contained in the sewage. This results in loss of the most quickly available nitrogen. The resulting sludge is partially dried on sand beds, and has the following approximate composition:

	Percent	Pounds per ton
Nitrogen	.70	14.0
Phosphoric Acid	.33	6.6
Potash	.24	4.8

These sludges are of low value, and in poor physical condition. When used they should be thoroughly composted to improve mechanical condition and render the nitrogen available.

Activated sludge is a product produced by the activated sludge method of sewage treatment. In this proc-

ess air is constantly passed through the sewage. The so-called activated sludge which settles out is filtered and dried. A product of uniform chemical composition and physical condition is produced which is free of weed seeds and harmful bacteria. The only marketable product is produced by the Sewerage Commission of the City of Milwaukee and is sold under the trade name Milorganite. It has the following average composition:

	Percent	Pounds per ton
Nitrogen	5.4	108
Phosphoric Acid	2.5	50
Potash	.3	6

The nitrogen is in organic form, and when applied to the soil the nitrogen is gradually released in available forms. It is slow acting but provides for long feeding, and can be used with practically no danger of burning the turf.

TOBACCO DUST—A number of greenkeepers use tobacco dust regularly. This material has the following average composition:

	Percent	Pounds per ton
Nitrogen	1.8	36
Phosphoric Acid	.6	12
Potash	2.9	58

The potash content may be as high as 6 to 8 percent, and the nitrogen content occasionally runs as high as 4 percent.

RAW BONE MEAL—This product is derived from raw bones, which contain considerable organic matter much of which is in the form of fats. The fatty constituents tend to decompose slowly and make the nitrogen slowly available.

Raw bone contains about 3.5 percent nitrogen and 22 percent phosphoric acid. It also contains from 4 to 8 percent of lime carbonate.

At present market prices plant food can be obtained better from other materials at lower cost. Furthermore the proportion of phosphate to nitrogen is too high. When sufficiently large applications are made to supply needed nitrogen much more phosphate than is needed by the turf is added to the soil. This together with the lime carbonate tends to encourage clover.

STEAMED BONE MEAL—Raw bone is steamed to remove the fat which is used to make soap. The resulting steamed bone contains about 2.25 percent nitrogen and 25 to 27 percent phosphoric acid. The plant food is more quickly available than in raw bone because of the removal of the fat, yet even steamed bone meal is a slow acting material. The same objections apply to its use as raw bone meal.

UREA—This is a new product produced in Germany. It is a synthetic nitrogen product and contains 45 percent nitrogen. Urea is water soluble, and will burn the turf if too heavy applications are made. It is quick acting resembling sulphate of ammonia in this respect. The nitrogen costs more per pound than in sulphate of ammonia due to the imposition of an import duty. The manufacturers claim that Urea has little effect on soil reaction.

Ammonia Containing Nitrogenous Fertilizers

AMMONIUM SULPHATE—This is the most widely used nitrogenous fertilizer on golf courses. It is produced as a by-product at coke ovens. Each ton of coking coal yields about twenty pounds of ammonia. The final product contains twenty-five percent ammonium which is equivalent to twenty percent nitrogen.

It is water soluble and quick acting. When applied to the soil the ammonia is held temporarily by the fine soil particles in the shallow surface soil layer. This may be the reason why equal amounts of nitrogen from sulphate of ammonia prove more effective than from nitrate of soda on bent grasses which have such a shallow root system.

Sulphate of ammonia makes the soil acid, although repeated applications are often required to effect considerable change, particularly on heavy soils. The increased acidity is produced in two stages. The sulphate combines with the calcium of the soil and leaches out in the drainage waters. The ammonia, which is temporarily held by the clay particles is gradually converted to nitric acid by groups of soil bacteria. This nitric acid combines with more calcium and may be taken up by the plant or leached out of the soil.

The repeated use of sulphate of ammonia tends to decrease and eliminate clover and weeds, probably due to the increased acidity of the soil.

If an acid soil is desired sand and soil used in top-dressing mixtures should be tested for lime carbonate. Frequently they contain sufficient lime carbonate to more than counteract the acid producing properties of the sulphate of ammonia.

AMMO-PHOS—This is a water soluble material containing twenty percent ammonia, equivalent to 16.4 percent nitrogen and twenty percent phosphoric acid. It is very similar to sulphate of ammonia in its action, being quickly available and liable to burn the turf if too heavy applications are made.

Ammo-Phos also tends to make the soil more acid but is probably less effective than sulphate of ammonia. In an acid soil the phosphoric acid tends to unite with iron rather than calcium and thus has little effect in removing lime.

Unless the turf requires additional phosphoric acid there is little advantage in using ammo-phos rather than

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From Local Viewpoint

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such combined applications have a tendency to check the growth of the grass for several days thereafter, which was noted by the much smaller amount of clippings in evidence after mowing. In his investigations, Mr. Stanley Aldrich, greenkeeper at Madison Golf Lakelands, made five applications of corrosive sublimate combined with sulphate of ammonia this season, and the results after each application showed a decided slackening of growth.

Late in the afternoon the elective meeting was held. Fred Burkhardt, Westwood Country Club, was elected president, succeeding Mr. Morley. B. G. Sheldin of the Country Club accepted the vice-presidency, and Frank Ermer of Ridgewood Golf Club, was elected secretary-treasurer.

Mr. Burkhardt announced that the new Advisory committee will be appointed at the first indoor meeting, to be held at the Hotel Winton the afternoon of November 14.

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sulphate of ammonia. This can be determined only by trial.

Nitrate Containing Nitrogen Fertilizers

NITRATE OF SODA—This material is also called Chile saltpeter. It is obtained from large deposits in Chile and contains about 15.5 percent nitrogen, equivalent to nineteen percent ammonia.

Nitrate of soda is water soluble and very quick acting. When too large applications are made it burns the turf. Unlike sulphate of ammonia it is never held by the soil, but leaches away in the drainage waters unless taken up by the turf.

The continued use of nitrate of soda encourages the growth of undesirable grasses and weeds. It has a tendency to make the soil less acid, and when used repeatedly may eventually produce a bad physical condition on heavy soils.

Because nitrate nitrogen is the form preferred by most plants, early spring applications of nitrate of soda frequently show quicker results than any other nitrogenous material if the weather remains cool. All experimental results on turf seem to indicate that nitrate of soda should not be used regularly as the main source of nitrogen.

Phosphoric Acid Containing Fertilizers

BONE MEALS—As previously stated bone meal contains from 22 to 27 percent phosphoric acid. They are all slowly available because none of the phosphoric acid is water soluble. Due to the high lime content they make the soil less acid and encourage clover. Because of the slow action, high cost and tendency to encourage clover it is probable that very little bone meal will be used on golf courses in the future.

ACID PHOSPHATES—The acid phosphates are made by treating rock phosphates (mined in Florida, Tennessee and the Carolinas) with sulphuric acid. They can be obtained in at least three grades containing 16.20 and 44 percent phosphoric acid. Generally the higher the content of phosphoric acid the lower the cost per pound of phosphoric acid.

The treatment with acid converts the insoluble rock phosphate into soluble acid phosphate, and hence this is the most readily available phosphate fertilizer obtainable. When added to the soil the soluble phosphoric acid is precipitated as very finely divided calcium or iron phosphate. In this condition it dissolves rapidly in the soil solution when the turf roots make heavy demands. Phosphoric acid does not leach from the soil.

The name acid phosphate is a misnomer, because it refers to the process of manufacture and not its effect upon soil reaction. Acid phosphates have a slight tendency to make soil less acid due to liberation of calcium (lime) when the phosphoric acid unites with the iron always present in acid soils.

Acid phosphate should not be used in larger quantities

than are required by the turf grasses, because of the stimulating effect of phosphoric acid on clover, particularly if the soil is not acid.

BASIC SLAG—This material is seldom used in this country but is a very common phosphate fertilizer in Europe. It is produced when phosphoric iron ores are used in the basic process of steel manufacture, an excess of lime is used to combine with the phosphoric acid and remove it in the slag.

Basic slag contains about 15 percent phosphoric acid and large amounts of lime. It is a slow acting material and makes the soil less acid due to the high lime content.

Potash Containing Fertilizer Materials

MURIATE OF POTASH—This is the most widely used potash containing fertilizer. It is mined in Germany and the newly acquired provinces of France. The principal grades imported into this country contain fifty percent potash.

Muriate of potash is completely soluble in water and hence may injure the turf if heavy applications are used. Although water soluble, potash is not lost from the soil by leaching because the potash is taken up and held by the clay particles of the soil in the same manner that ammonia is held. When the potash is taken up muriatic acid (hydrochloric acid) is released. Consequently muriate of potash tends to increase the soluble acidity in soils.

Clovers have a high potash requirement and are generally greatly stimulated by applications of potash fertilizers. If clover is not desired potash applications should not be made in amounts in excess of the requirements of the turf grasses.

Clubhouse Gardening

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"gardener" deferred the pruning till after the flowering period all might have been well. Forsythias in conjunction with many other shrubs, flower on wood of the previous year's growth. Thus to prune early in spring would be to remove most of the inflorescence.

Just to create a little diversion from the general theme and by request I hope to deal more fully with shrubs, perennials, etc., hoping that these subjects may be of interest to our readers.

Brother Members, Let's Hear from You

As we shall all too soon be looking forward to the long nights of winter ahead, and few can have the excuse of being busy, o'er fairway and hazard, may I make an appeal to a whole lot of brother greenkeepers, and remind them that whilst they are reading of others, the others are not hearing from them. Remember this, boys, you cannot begin any younger, so open up and do not hide your light under a bushel.

Wanderings of a Greenkeeper

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No. 5 green I put in creeping bent stolons—and then built nine holes more. The soil on the new nine was very poor, so in the fall I ploughed it all up and sowed it in winter rye. In the spring I ploughed this under, and drilled in soy beans, which in turn were ploughed under the first of September. I then put on three tons of crushed limestone to the acre, with a ton and a half of bonemeal, and seeded it down. In a year I had a splendid stand of grass. All the new nines are bent stolons.

Last year I built nine holes for the Brookside Country Club, Barberton, Ohio.

Clay Gumbo and Silt Need Constant Watering

The first of March of this year found me at the Hillcrest Country Club. The soil here is a heavy clay gumbo and silt. It requires constant wetting. It does not matter how wet the sub-soil is—a few hours of sunshine, and the top is as hard as concrete. For example, this summer we had three successive days of rain—then the sun shone for one day—and lo, we had to water again.

So I quite agree with Mr. McNamara that it pays to move around to different courses, profiting by the knowledge gained in contending with the diversifications of climates and soils. Truly, the old adage, "A rolling stone gathers no moss" certainly was not intended for a greenkeeper.