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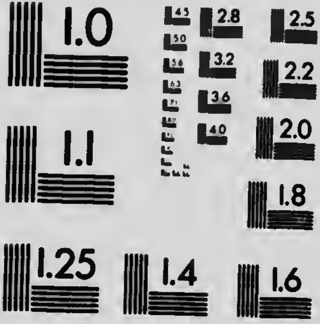

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PROVINCE OF BRITISH COLUMBIA.

DEPARTMENT OF AGRICULTURE (HORTICULTURAL BRANCH).

FERTILIZERS FOR FRUIT AND VEGETABLES.

By R. Hoy, B.S.A., Assistant Horticulturist.

COMMERCIAL FERTILIZERS.

THE use of commercial fertilizers is becoming more general among the farmers of this country, and the question of fertilizing the soil economically and efficiently is very much discussed. It is an established fact that commercial fertilizers, when used properly, are of value in increasing the revenue from many farms and orchards; this is especially true in the case of market-gardens and farms where special crops are grown from year to year on the same soil. Continuous cropping, without replacing any of the essential elements of growth or replenishing the supply of organic matter as it is used up, eventually results in a decided decrease in the size of the crops grown. This has been the history of all agricultural countries.

Ten chemical elements are necessary for the growth of plants—carbon, oxygen, hydrogen, nitrogen, sulphur, potassium, magnesium, calcium, iron, and phosphorus. Seven of these elements, all plants, with the exception of the legumes, gather from the soil, and three of them from the air and water. Carbon and oxygen are secured from the air and hydrogen from water. Nitrogen, one of the seven elements taken from the soil, can be appropriated from the air only by plants belonging to the legume family—clovers, peas, beans, vetches, etc. These plants have the power of taking in atmospheric nitrogen through their leaves and storing it in nodules on the roots; all other plants get their supply of nitrogen from the soil.

Of the seven elements taken from the soil, only three of them are liable to exhaustion—nitrogen, phosphorus, and potassium, and sometimes calcium (lime). These are liable to exhaustion sooner than the rest, because they are usually in the soil in smaller quantities and are more soluble. The fertility of any soil is measured by the amount of available plant-food in the soil. Plants cannot grow without any one of the above-mentioned elements. If the soil is lacking in any one of them it must be supplied artificially, or if any one is in the soil in an unavailable condition it must either be supplied to the soil by artificial means in an available form, or else the soil must be so treated as to make it available.

To use artificial fertilizers with success a knowledge of the general influence of the three main plant-foods on plant-growth is required. Nitrogen, one of the most important and most costly to purchase in the artificial state, promotes large stem and leaf growth, and is essential to the formation of protein, the most valuable part of any plant. Without nitrogen plants usually make slow growth and their leaves are of a pale-green colour. Fertilizers rich in nitrogen are especially valuable in the production of crops where the leaf is the valuable portion of the plant, such as spinach, lettuce, cabbage, rhubarb, etc. They must be grown quickly in order to get the fine crisp texture desired. An oversupply of nitrogen or an excess over the other fertilizing constituents promotes a rank, late growth of foliage and twigs of fruit-trees at the expense of fruit-production. An oversupply of nitrogen is detrimental to all crops where early maturity is desired.

Potash is of importance in the formation of carbohydrates such as starches and sugars, and is therefore an important constituent in fertilizers for potatoes, beets, and fruit. It is especially important in fruit-growing, since it aids in developing colour and is the base in combinations with the acids of fruits. It also forms about 50 per cent. of the ash of fruits and constitutes a large proportion of the ash in the wood of fruit-trees. It adds to the quality and flavour of fruits, and in some districts is used extensively on strawberries, and is said to prolong the keeping qualities of the berries.

Phosphorus tends to promote fruitfulness and maturity, helps to form protein, and indirectly starch, fats, and sugars. It also is of importance in the development of seeds of plants.

Besides knowing the functions of the different plant-foods in the growth of plants, it is necessary to be acquainted with the special characteristics of the crops cultivated. The composition of the crop is not always a sufficient guide to the kind of manure that should be applied, even when the composition of the soil is known. The power of the particular crops to assimilate the different materials should form the basis of judgment under ordinary conditions. In the case of a very unfertile soil that only contains a low percentage of plant-food a complete fertilizer is necessary, but such soils are rarely [illegible] Usually, by applying one or two constituents of the crop, as good [illegible] secured as by applying a complete mixture. It is, as a rule, poor [illegible]o buy complete mixtures, for rarely are all three constituents [illegible] Crops that are fast growers and mature in a short period must [illegible] plant-food in a readily available form; those having a longer period [illegible]wth have a greater command on the plant-food in the soil, and slower-acting fertilizers can be used for them.

The form in which to apply the fertilizer will depend on the availability and cost of the material.

NITROGENOUS FERTILIZERS.

The forms of nitrogenous fertilizers commonly found on the market are nitrate of soda, sulphate of ammonia, and dried blood and tankage.

Nitrate of soda contains about 16 per cent. nitrogen and is one of the best sources of nitrogen. It is found in large quantities on the west coast of South America. It is the most soluble of any of the artificial manures, and leaches out of the soil very rapidly if not used by the plants. For this reason small amounts should be applied throughout the growing season to obtain the best results. The first application should be when the plants first appear above ground. For fruit-trees, as the blossoms are opening.

Sulphate of ammonia contains about 20 per cent. nitrogen. It is prepared from ammoniacal products of gasworks, coke-ovens, bone-distilleries, etc. It is valuable for its nitrogen only, and is not as soluble as nitrate of soda, as it must be converted into a nitrate form before it is available to plants. The best results are obtained from it when it is ploughed or harrowed in. In wet seasons the loss by leaching is not so great as with nitrate of soda. For good results with sulphate of ammonia the soil must contain a fair quantity of lime.

Dried blood, tankage, and other slaughter-house refuse vary in their nitrogen-content from 4 to 15 per cent., and are much slower-acting manures than those mentioned, as they contain their nitrogen in an organic form which is insoluble. These materials also contain a small percentage of phosphoric acid.

Other sources of nitrogen are calcium cyanide, guano, fish-manure, ground leather, bone-meal, woollen refuse, soot, oilcake, etc., but these are rarely used in this country.

POTASH MANURES.

Potash manures are chiefly products of the Stassfurt mines in Germany, and are sometimes designated as German potash salts. The muriate of potash (potassium chloride) and sulphate of potash are the two most important potash manures used in British Columbia. They contain about 50 per cent. of actual potash, which is in a fairly available condition. The muriate of potash should not be used for potatoes, because it tends to make them grow very waxy.

Wood-ashes are an old source of potash, but are a scarce commodity. They contain only a small percentage of potash and a great deal of lime. They are especially valuable on heavy soils, for, in addition to their fertilizing value, they improve the physical condition of the soil and set potash free. Wood-ashes should always be bought subject to analysis, owing to the variability in the percentage of plant-food they contain.

PHOSPHATIC FERTILIZERS.

Superphosphate, or acid phosphate, contains from 12 to 18 per cent. phosphoric acid, depending upon the character of the material it was made from. It is made by treating rock phosphates or ground bones with sulphuric acid. That made by treating ground bones is often termed dissolved bone. The dissolved bones differ from the mineral superphosphates in containing a small percentage of nitrogen in addition to the phosphoric acid.

Basic slag, or Thomas's phosphate, contains from 15 to 20 per cent. phosphoric acid and 30 to 40 per cent. lime. It is produced in large quantities in England, France, and Germany, and used quite extensively in those countries. It is the waste product from the manufacture of steel from phosphatic iron-ores. The phosphoric acid in basic slag is not very readily available, and should be applied in the fall of the year to get results the following season. To give best results it must be very finely ground. It is generally sold so that 80 per cent. of the fine powder will pass through a sieve containing 10,000 meshes in a square inch.

Bone-meal contains about 23 per cent. phosphoric acid and about 8 per cent. nitrogen. Bone-meal made from steamed bone contains a larger percentage of phosphoric acid and less nitrogen than that made from green bone. As bones decompose in the soil slowly, their effect is carried over a number of years. The finer the bones have been ground, the more immediate is their effect.

INDIRECT MANURES.

Lime (calcium-carbonate) and gypsum (sulphate of lime or land-plaster) are materials that are often applied to the soil. They do not supply any appreciable amount of plant-food direct, but are valuable in setting free the locked-up plant-food in some of our soils.

Liming generally produces the best results on heavy clays and peaty soils inclined to be acid. In the former case it ameliorates the soil, making it easier to work, less liable to bake and puddle, and sets potash free. In muck or low-lying soils it corrects acidity, making it possible for nitrifying bacteria to work, hastens the decay of organic matter, and accelerates the production of carbonic acid, which acts upon mineral plant-food in the soil, making it available to plants. From ½ to 1 ton of lime every five or six years is sufficient. Liming too often and not supplying other forms of plant-food to the soil would soon lessen the productive power of the soil.

LIBERATION OF PLANT-FOOD IN SOIL.

Chemical analysis of the soil gives the actual amount of plant-food contained in the soil analysed, but the rate of liberation is governed by many factors. Besides the necessary amount of lime, decaying organic matter is a great factor in the liberation of plant-foods in the soil. It has been found out by experiment that the presence of lime in the soil, especially when associated with decaying organic matter, increases the availability of both potash and phosphoric acid.

Good cultivation is also necessary for the liberation of plant-food. By cultivating moisture is conserved, better aeration of the soil is secured, the soil is warmer, and the rate of decay of organic matter is increased. This is why it is so essential to grow cover crops in orchards where clean cultivation is practised and barnyard manure cannot be obtained in sufficient quantities.

When the supply of organic matter is depleted, the yield per acre is reduced and fertilizers cannot be used as economically. To obtain the best results from commercial fertilizers, the soil must contain a fair amount of lime and organic [illegible]er and receive good cultivation.

A great deal [illegible]k is heard of how commercial fertilizers ruined the soil on farms in [illegible] New England States. The soil became unproductive through the lack of using fertilizer and using it without an intelligent understanding of soil-management. Many farmers sold or destroyed their barnyard manure and bought commercial fertilizer. The result was the soil became depleted of its organic matter and soon reached a very unproductive state.

When fertilizer is applied to the soil, the amount of plant-food is increased and the soil is richer than before. Where by spending a few dollars an acre to buy fertilizer the crop can be increased more than enough to cover the cost of the fertilizer supplied, it is a paying proposition.

EXPERIMENT TO SHOW DEFICIENCY IN SOIL.

As chemical analysis does not show the availability of plant-food in the soil, a practical test is important and will well repay the user of commercial fertilizers for the time and money spent. This is (though to a certain degree characteristics of growth give suggestions) the only way to determine accurately what element is lacking.

A fairly complete plan is to divide a portion of the field where soil conditions are uniform into plots of about one-twentieth of an acre, two rods wide and four rods long, and apply fertilizer to them in the following manner:—

Plot 1—Unfertilized.
„ 2—Complete (potash, phosphoric acid, and nitrogen).
„ 3—Without nitrogen (potash and phosphoric acid).
„ 4—Without potash (phosphoric acid and nitrogen).
„ 5—Without phosphoric acid (pota[illegible] and nitrogen).
„ 6—Apply lime.

These experiments will be influenced in some degree by the weather conditions, but they will give a fairly accurate idea of the deficiencies of the soil. The amount of fertilizer to apply will be determined largely by the kind of crop grown. For test purposes they may be applied at the rate of 200 lb. nitrate of soda, 200 lb. muriate or sulphate of potash, and superphosphate 300 lb. per acre.

PURCHASING FERTILIZERS.

When purchasing fertilizers it is not bulk that counts, but it is the actual amounts of nitrogen, phosphoric acid, and potash. These are what you pay for, and the fertilizer giving the greatest number of pounds of these substances per ton at the lowest price per pound is the cheapest to buy. A fertilizer guarantee should always be insisted upon, and then with a proper understanding of the terms used, the number of pounds of actual nitrogen, phosphoric acid, and potash per ton can be estimated. The following table, taken from Prof. Vorhees's book on fertilizers, shows the terms used, their equivalents, end the factor to use in multiplying, in order to convert the one into the other:—

To convert the Guarantee of		Multiply by
Ammonia	an equivalent of	Nitrogen 0.8235
Nitrogen		Ammonia 1.214
Nitrate of soda		Nitrogen 0.1647
Bone-phosphate		Phosphoric acid 0.458
Phosphoric acid		Bone-phosphate 2.183
Muriate of potash		Actual potash 0.632
Actual potash		Muriate of potash..1.583
Sulphate of potash		Actual potash 0.54
Actual potash		Sulphate of potash..1.85

To give an example of how [illegible] the above table, take a guarantee quoting the nitrogen in dried blo[illegible] as animal ammonia 5 per cent. The actual amount of nitrogen would be [illegible]×0.8235=4.1175, or 4.12 per cent. To convert this into pounds, multiply by [illegible]0, as 20 lb. is 1 per cent. of a ton. This would make 4.12×20=82.40 lb. [illegible]tual nitrogen in a ton of fertilizer.

Another example is taking a gua[illegible]tee quoting bone-phosphate 15 per cent. Multiply this by 0.458, and the pr[illegible]t will give the actual amount of phosphoric acid present.

A farmer wishing to compound his own mixtures can do so. Suppose a fertilizer containing 4 per cent. nitrogen, 9 per cent. potash, and 9.12 per cent. phosphoric acid is desired. The procedure would be as follows:—

2,000 lb. mixture analysing	4	per cent.	nitrogen	= 80	lb. nitrogen.
2,000 „ „ „	9	„	potash	= 180	„ potash.
2,000 „ „ „	9.12	„	phosphoric acid	= 182.4	„ phosphoric acid.

Or,

80 lb. nitrogen	= 500 lb. nitrate of soda	analysing 16 per cent.	nitrogen.
180 „ potash	= 360 „ muriate of potash	„ 50 „	potash.
182.4 „ phosphoric acid	= 1,140 „ superphosphate	„ 16 „	phosphoric acid.
442.4 lb. total plant-food	= 2,000 lb. mixture.		

In a fertilizer composed of the same material, but in smaller quantities, a make-weight would be necessary.

Take a formula analysing 3 per cent. nitrogen, 6 per cent. phosphoric acid, and 4 per cent. potash:—

2,000 lb. mixture analysing	3	per cent.	nitrogen	= 60	lb. nitrogen.
2,000 „ „ „	6	„	phosphoric acid	= 120	„ phosphoric acid.
2,000 „ „ „	4	„	potash	= 80	„ potash.

Or,

60 lb. nitrogen	=	375 lb. nitrate of soda (16 per cent. nitrogen).
120 „ phosphoric acid	=	750 „ superphosphate (16 „ phosphoric acid).
80 „ potash	=	160 „ muriate potash (50 „ potash).
		1,285 lb. fertilizing material.
		715 „ filler.
		2,000 lb. total mixture.

Any one buying a fertilizer of the composition of the latter would be paying for freight and handling of the make-weight or filler. Where freight rates are as high as in this country, only brands that are high in plant-foods or the separate materials should be bought.

ANIMAL AND CHEMICAL MIXTURES.

There is much discussion about these two different kinds of fertilizers, and the question, which one is the better, is often asked. The chief difference between the two is that animal fertilizers generally become available slower than chemical fertilizers. A purely animal fertilizer contains practically no potash, but this is made up for in the brands generally put on the market by the addition of either the sulphate or muriate of potash. The chief factor in determining which one to buy is the amount of actual plant-food in the mixture offered for sale. Good results are obtained from high-grade animal fertilizers as well as high-grade chemical mixtures. For early crops the chemical mixtures are generally the best, because they are available to the plant early in the spring; but for late crops and fruit-trees slower-acting materials are just as efficient when the soil is in good physical condition. On low, cold soils chemical mixtures generally give better results than animal mixtures.

APPLICATION OF FERTILIZERS.

The crop, soil, and availability of the fertilizer will determine the time and manner in which the fertilizer is to be applied. Most of the high-grade mixtures are applied early in the spring, either broadcast or in rows as the crop may warrant. Nitrate of soda, because of its availability, should not be applied until the plants have started growth. Potassic and phosphatic manures can both be applied in the fall of the year without any danger of loss by leaching.

Fruit-trees need a different system of fertilizing to most of the other crops; they occupy and take the same plant-foods out of the soil each year. A fast growth as in vegetable crops is not to be desired; a slow, steady growth produces the best results and an excessive growth generally results in poor crops and an inferior quality of fruit. Studies in fertilizing fruits show that more potash is removed from the soil than any other of the plant-foods, and soils deficient in potash generally produce small crops of poorly coloured and inferior fruit.

On soils in good physical condition the following amounts of fertilizer are giving good results when supplemented by cover-cropping: 200 to 250 lb. muriate of potash and 300 to 400 lb. of bone-meal, basic slag, or acid phosphate. If the growth the trees are making is very small, a nitrogen fertilizer can be used. Dried blood is one of the best forms of nitrogen for orchard purposes, because of its lasting effect. Nitrate of soda acts quickly, but its effect is soon over. Where nitrogenous cover crops are grown no nitrogenous fertilizer is necessary.

The source of fertilizer used in orchards does not make much difference, and more will depend on the price of the materials than anything else. This is true because the trees require the same plant-food from year to year, and where the supply of organic matter is kept up and good cultivation practised, slowly-acting forms will become available fast enough to supply the wants of the trees. The amounts of fertilizer given in the above formula will have to be varied according to the soil. Where irrigation is practised or the summer rainfall is heavy, the slower-acting fertilizers are the most economical to use.

FERTILIZERS FOR VEGETABLES.

Success in vegetable-growing can only be obtained when the soils are well supplied with the necessary plant-foods and a good supply of organic matter. It is a well-known fact among gardeners that good barnyard manure as a general garden fertilizer cannot be beaten when supplied liberally to the soil. The virtue of barnyard manure lies in the fact that, while it supplies plant-foods in a fairly available form, it supplies organic matter also. Where barnyard manure cannot be obtained to supplement commercial fertilizers, green crops should be grown and turned under whenever there is an opportunity. It is absolutely necessary, if the most profitable returns are desired, that garden produce should be on the market as early as possible. For this reason, the use of highly concentrated, quick-acting fertilizers is advocated.

The manurial requirements of vegetables divide them into two main classes:—

(1.) Those which are grown chiefly for large leaf production, as spinach, cabbage, and lettuce;

(2.) Those which are grown for root or tuber production, as beets, carrots, potatoes, etc.

All vegetables use all the elements of growth, but in varying quantities in different crops, so the use of any particular brand of fertilizer for all crops would be neither satisfactory nor profitable. For vegetables in the first class mentioned, manures containing a large percentage of nitrogen are used with best results, while those in the second class are benefited by less nitrogen and more potash and phosphoric acid; an excess of nitrogen would stimulate leaf and stem production at the expense of tuber-formation.

Beets, carrots, etc., respond to a fertilizer containing the following ingredients: 7[illegible] lb. actual potash (K_2O); 64 lb. actual phosphoric acid (P_2O_5); 23 lb. actual nitrogen.

Beans and peas also respond to this formula, with the nitrogen left out unless the soil be exceptionally deficient in nitrogen.

Cabbages and other succulent vegetables: 80 lb. potash actual; 80 lb. phosphoric acid (P_2O_5) actual; 40 lb. nitrogen actual.

For celery and onions the following is a good one: 80 lb. potash actual; 70 lb. phosphoric; 30 lb. nitrogen.

These formulas are only given as those from which good results have been obtained. They are general, and on ordinary soils in good physical condition will produce good results.

The source of material from which the ingredients are obtained will depend on the crop grown. For early crops, quick-acting, readily available fertilizers should be used to supply the crop, while on late crops the source should be from those materials that become available gradually throughout the season. Many vegetable-growers prefer to use the animal and chemical mixtures in conjunction. When used in this way, a complete mixture is applied in the spring (harrowed in when the land is prepared), and the needs of the growing crop are met by applications of readily available fertilizer. When applying nitrate of soda after the leaves are out, care should be taken that it does not get on the leaves.

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