FERTILIZERS FOR VARIOUS CROPS

AMONG the factors to be considered in determining the composition and quantity of a fertilizer to meet the specific requirements of a certain crop are the nature of (*a*) the soil, (*b*) the local climatic conditions, and (*c*) previous treatment of the land.

The Soil.—Clay soils are naturally more plentifully provided with the mineral plant food substances than are sandy soils. Peat and muck soils, consisting essentially of vegetable matter, are liable to be deficient in mineral matter; though rich in organic matter and in latent nitrogen they may still derive benefit from the application of farm manure. The manure contributes bacteria which, under conditions favourable to their development, promote the decomposition of the muck or peat, liberating therefrom plant food substances, especially nitrogen. In the fertilizer treatment of muck soils, phosphoric acid and potash are particularly important, though nitrogen in available form may be required to encourage early growth.

Information in regard to both surface and subsoil is most helpful in deciding on the fertilizer treatment of crops to be grown thereon. This information should include a knowledge of their texture, drainage, reaction and, if possible, the amounts of available plant food constituents present as determined by rapid soil tests or field trials. For instance, it was found that of two light sandy soils, one (overlying a gravelly subsoil) responded in a very marked degree to potassic fertilizers, whereas the other soil (overlying a silty subsoil) gave only a meagre response.

Climatic or Seasonal Conditions.—Moisture and temperature are potent factors in determining the size and quality of the crop, and, incidentally, the kind and quantity of the fertilizers that may be applied profitably. For example, certain potato growers in the Maritime Provinces find it profitable to apply a ton of fertilizer to the acre. In Western Ontario the maximum profitable application of a suitably compounded potato fertilizer would probably be 1,000 pounds per acre.

The cooler, moister climate of the Maritimes is the factor above all which gives that province pre-eminence over many sections of Ontario in the yield of potatoes per acre. On the other hand, the warmer, drier climate of Western Ontario is more favourable to the growth of corn, alfalfa, fall wheat, etc.

Reprinted from Publication 585, Manures, Fertilizers and Soil Amendments, Their Nature, Function and Use.

thority of Honourable J. G. Gardiner, Minister of Agriculture, Ottawa, 1940

Previous Treatment of the Land.—This may be considered chiefly in respect to manuring, fertilizing and cropping.

Speaking generally, when the soil has been enriched by liberal applications of manure the supplemental fertilizer may be smaller in quantity and need not contain such large proportions of nitrogen and potash as would be desirable where no manure has been, or is being, applied.

If a liberal application of fertilizers has been made for a hoed crop, the succeeding grain crop—if it is deemed desirable to stimulate its early growth—may require only a small top-dressing of a fertilizer supplying available nitrogen.

In deciding the nature and quantity of the fertilizer applications to be given, the draft made on the available plant food substances in the soil by previous crops might well be considered.

Fertilizer Treatment for Various Field Crops

The following suggestions are based on extensive experience in the use of fertilizers and on a knowledge of the special requirements of different crops and their varying abilities to procure their plant food from the soil. For example, experience has shown that small grains, mangels, grasses and leafy crops in general respond well to applications of nitrogen, whereas turnips give their greatest response to applications of phosphatic fertilizers.

The limit of profitable application of fertilizers is determined by the value of the resultant increase in yield and quality of the crop, and, further, whether increases in the quantity of the fertilizer applied result in profitable increases of the crop. Thus, an application of 1,000 pounds per acre of a fertilizer may give a profitable increase of the crop, but raising the rate to 1,500 pounds, though still further increasing the yield, will not prove profitable unless the value of this additional increase in yield is greater than the cost of the extra 500 pounds of fertilizer applied.

The fertilizer formulae which follow may be regarded as approximating normal requirements of the crops cited when grown on soils of medium fertility under good farm practice, and are applicable chiefly to Eastern Canada and British Columbia. They are based largely on the results of experimental work conducted by several divisions of the Dominion Experimental Farms and by provincial agricultural institutions and are very similar to the recommendations of the provincial fertilizer boards and councils.

The fertilizer materials recommended are obtainable from most fertilizer dealers and are employed in the preparation of mixtures commonly found on the market.

Fertilizers for Grain

(Eastern Canada and British Columbia)

Under a good system of farm management by which there is available an adequate supply of farm manure and in which the growing of legumes is included in the crop rotation, the employment of commercial fertilizers for grain crops may not be necessary, though there are special cases in which phosphoric acid or nitrogen or both may be profitable. When the grain crop follows a hoed crop for which manure has been applied, or is sown on a legume sod ploughed under, the application of nitrogen seldom results in a profitable

return, though phosphoric acid may be necessary for maximum yields. On very light sandy loams an application of potash may be desirable, especially for malting barley.

Under certain conditions, the application of one or more of the essential elements of plant food may be desirable, as in the following examples:—

The soil may be deficient in only one element of plant food. In many districts of Canada the soil is naturally low in phosphoric acid, and applications of phosphatic fertilizers are usually followed by profitable results. Again, nitrogen may be the limiting factor, calling for a dressing of a nitrogenous fertilizer.

When the soil is of low fertility naturally, or due to a limited manure supply or to heavy cropping, the application of a complete fertilizer mixture such as 2-12-6 (or a 2-12-10, or a 5-10-5 on poor sandy loams) may be required for satisfactory grain production.

Poor growing conditions in early spring may warrant a top-dressing of a nitrogenous fertilizer such as nitrate of soda or sulphate of ammonia to encourage a more vigorous vegetative growth at that stage.

When seeding down with a legume and timothy the application of a complete fertilizer mixture (as above) for the nurse crop may ensure a good catch and benefit the following hay crop.

On muck and peat soils, liberal applications of phosphoric acid and especially of potash are very often essential for good growth and satisfactory ripening of the grain.

FERTILIZER FORMULAE SUGGESTED FOR GRAIN

Type of soil	Fertilizer materials in pounds per acre				Equivalent (approximately) to
	Choice of		Superphosphate (20%)	Muriate of potash (50%)	
	Sulphate of ammonia	Nitrate of soda			
Sandy loams	25	33	150	50	250 lb. of 2–12–10
"	63	84	125	25	250 " 5–10–5
Clay loams	25	33	150	30	250 " 2–12–6
Peat and muck	.....	.....	240	120	400 " 0–12–15

The formulae in the table are suggested as liberal dressings of fertilizers for grain on soils of different types, the mixtures to be drilled in with the seed with a combination seed and fertilizer drill or by a special attachment to the seed drill. When applied broadcast the rate of application should be increased by one-third to one-half. In these recommendations, if the grain follows a well manured crop or a clover sod, the nitrogen of the mixture may be omitted.

For fall wheat the superphosphate and muriate of potash should be drilled in with the seed, and the nitrogenous fertilizer applied as a top dressing in spring if the appearance of the crop indicates this need. However, on soils of low fertility it is advisable to apply the complete fertilizer at seeding time.

Fertilizer for Grain

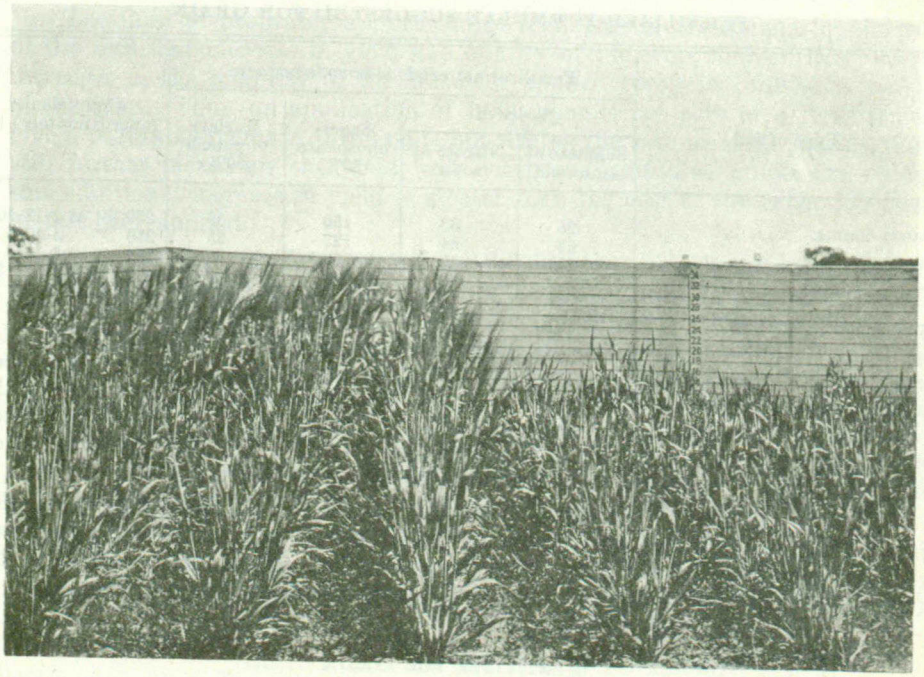
(*Prairie Provinces*)

For spring grain crops on summer-fallow land in the Prairie Provinces an application of from 25 to 75 pounds per acre of treble superphosphate or ammonium phosphate drilled in with the seed has in many districts given considerable increases in yield. The effect of applying 30 to 50 pounds per acre of ammonium phosphate to wheat at seven different stations in the Prairie Provinces is shown in the following table.

THE EFFECT OF COMMERCIAL FERTILIZER ON WHEAT FOLLOWING SUMMER-FALLOW IN THE PRAIRIE PROVINCES

Station	Years average	Yield of wheat (bu. per acre)	
		No fertilizer	Ammonium phosphate (11–48) at 30–50 lb. per acre
Brandon, Man.	4	19·7	21·3
Indian Head, Sask.	5	16·8	22·5
Scott, Sask.	9	12·7	16·6
Melfort, Sask.	3	16·6	24·7
Swift Current, Sask.	5	18·7	19·6
Lethbridge, Alta.	4	18·6	20·1
Lacombe, Alta.	6	18·1	25·3

The increase in the yields of grain crops by the use of fertilizers, especially in the Prairie Provinces, is dependent to a large extent on the moisture content of the soil at the time of seeding and on the amount and distribution of the rainfall during the growing season. Thus the effect of fertilizer varies from year to year, depending upon the rainfall and, as is shown in the table, considerable variations occur at different stations. The response to commercial fertilizer at Swift Current, Sask., and Lethbridge, Alta., has been relatively



Drilling commercial fertilizer in with the seed of wheat, oats or barley has been a most satisfactory method of application. One hundred pounds of complete fertilizer drilled in this way has been equal to 200 pounds applied broadcast. Photograph shows: left, fertilizer drilled; right, no fertilizer for barley.

insignificant. At Melfort, Sask., and Lacombe, Alta., the fertilizer has been much more beneficial. Greater response from fertilizer may be expected on farms which have been cropped for relatively long periods. On weedy land the fertilizer enables the crop to get a quicker start and hence it is better able

to compete with the weeds. Increases in most cases are not due to any marked deficiency in the total plant food in the soil but rather to the fact that the fertilizer supplies available food to the young plant, thus giving it a quick start—an advantage which is maintained throughout the growing season unless severe drought is experienced during the latter period of growth.

Fertilizers for Hay

The fertilizer treatment for hay crops depends to a large extent on the previous treatment and cropping. When a four-year rotation of hoed crop, grain, clover hay, and timothy hay is followed, the clover crop (first year hay) may not require any further application of fertilizers than that given to the first two crops of the rotation (See section on Fertilizers for Grain).

Results of experimental work have shown that *clover* and *alfalfa* on many of the soils in Eastern Canada respond in particular to applications of phosphoric acid and lime. Where there is a deficiency of lime, resulting in an acid soil, conditions are unfavourable for the satisfactory growth of most leguminous crops. The application of lime (in the form of ground limestone, slaked lime, marl, etc.) and phosphoric acid (superphosphate or basic slag) may be made for the nurse crop. On old stands of alfalfa some response may be obtained from phosphatic fertilizers applied directly to the crop.

On *timothy* hay, a top dressing of a nitrogenous fertilizer such as nitrate of soda or sulphate of ammonia frequently proves profitable when applied during the early weeks of growth at the rate of 50 to 100 pounds per acre. If a good rotation of crops has not been followed, resulting in low fertility of the soil, or if the soil is naturally of low productiveness, a complete fertilizer mixture of the following nature may be justified.

	Pounds per Acre
Nitrate of soda*	70
Superphosphate (20%)	150
Muriate of potash	30

*Sulphate of ammonia at 50 pounds per acre may be used in place of nitrate of soda on soils well supplied with lime. The above mixture is equivalent, approximately, to 250 pounds of a 4-12-6 fertilizer.

Fertilizers for Pastures*

Experimental work of recent years has shown that fertilizers have an important place in the economic production of high quality pasture herbage. The degree to which fertilizers can be profitably used on pastures depends a good deal on the nature of the land, i.e., whether it is rough and stony and plentiful, or whether it is tillable and highly productive. Generally speaking, the higher the productive capacity of the soil the greater the amount of fertilizer which may be applied with profit. The kind of fertilizer to be used depends greatly on the composition of the soil and on the nature of the herbage desired. Fertilizers high in nitrogen tend to encourage the growth of grasses, whereas dressings of the mineral constituents of plant food—phosphoric acid, potash and lime—tend to bring in the legumes and thereby to increase the protein content of the herbage.

Before rough pasture land is fertilized, all undesirable shrub and weed growth should be removed, and if the herbage is poor a suitable seed mixture should be sown. Tillable lands on which the sward is very thin may require ploughing, reseeding and fertilizing.

Owing to its limited supply on the average farm, manure is not often available for fertilizing pastures. When there is manure to spare it may be applied to pastures at the rate of 8 to 10 tons per acre; it will probably give better results if supplemented with 200 to 300 pounds of superphosphate.

*For more detailed information, the reader is referred to Publication 602, Dominion Department of Agriculture: "Pasture Improvement in Eastern Canada".

The recommendations below are based on the results of experimental work conducted by the Divisions of Field Husbandry, Animal Husbandry, and Chemistry, C.E.F., Ottawa.

FERTILIZERS FOR PASTURES

Character of soil and herbage	Fertilizer materials in pounds per acre			Alternative treatments
	Sulphate of ammonia applied annually	Superphosphate (20%) every four years	Muriate of potash applied every four years	
Grassland pasture—				
Clay loams	100	400	50	or 500 lb. of 2–12–6 every four years with 100 lb. sulphate of ammonia in the intervening years.
Sandy loams	100	400	100	or 500 lb. of 2–12–10 every four years with 100 lb. of sulphate of ammonia in the intervening years.
Clover pasture—				
Clay loams	.....	400	.....	or 500 lb. of 2–12–6 or 0–16–6 every four years.
Sandy loams	.....	400	100	or 500 lb. of 2–12–10 or 0–12–10 every four years.

Under some soil and climatic conditions it may be found more profitable to apply the mineral fertilizers for pastures every two years but at a smaller rate, as for example, two-thirds the amounts suggested above for every four-year period.

Nitrate of soda 130 pounds or cyanamid 100 pounds may be substituted for 100 pounds of sulphate of ammonia in the above recommendations.

Spring applications are preferable for nitrogenous fertilizers, but superphosphate, basic slag and muriate of potash are advantageously applied in the fall.

Fertilizers for Potatoes

Of all ordinary farm crops the potato is probably the most profitably responsive to liberal feeding. The acceptance of this statement does not in the least ignore the fact that there are several other factors that play a very important part toward success in potato growing—type of soil, character of season and cultivation and spraying of the crop—but it means that with these factors favourable potatoes are very responsive to liberal applications of plant food.

It is generally conceded that there is no better preparation for this crop than a clover or alfalfa sod well manured (15 to 20 tons per acre) and ploughed in the late summer or early autumn. The practice of fall ploughing ensures the decay of the sod and manure and provides a good supply of humus, which helps to retain moisture, and at the same time favours the conversion of unavailable plant food to forms available for the use of the crop. It is claimed that spring dressings of fresh manure tend to encourage the development of scab. For the same reason applications of ground limestone, marl, slaked lime or wood ashes should not immediately precede the potato crop.

On fairly good soil from a well-manured sod as described, from 600 to 800 pounds per acre of a 2-12-6, or on very light sandy loams of a 2-12-10, fertilizer is to be considered a liberal dressing. When manure is not to be had or if the soil is poor 800 to 1,200 pounds of a 4-8-10 or 5-9-8 mixture is recommended. In many of the potato-growing districts of the Maritime Provinces, where fertilizers are relied upon to furnish the greater part of the plant food required by this crop, as much as 2,000 pounds per acre have been used with profitable results.

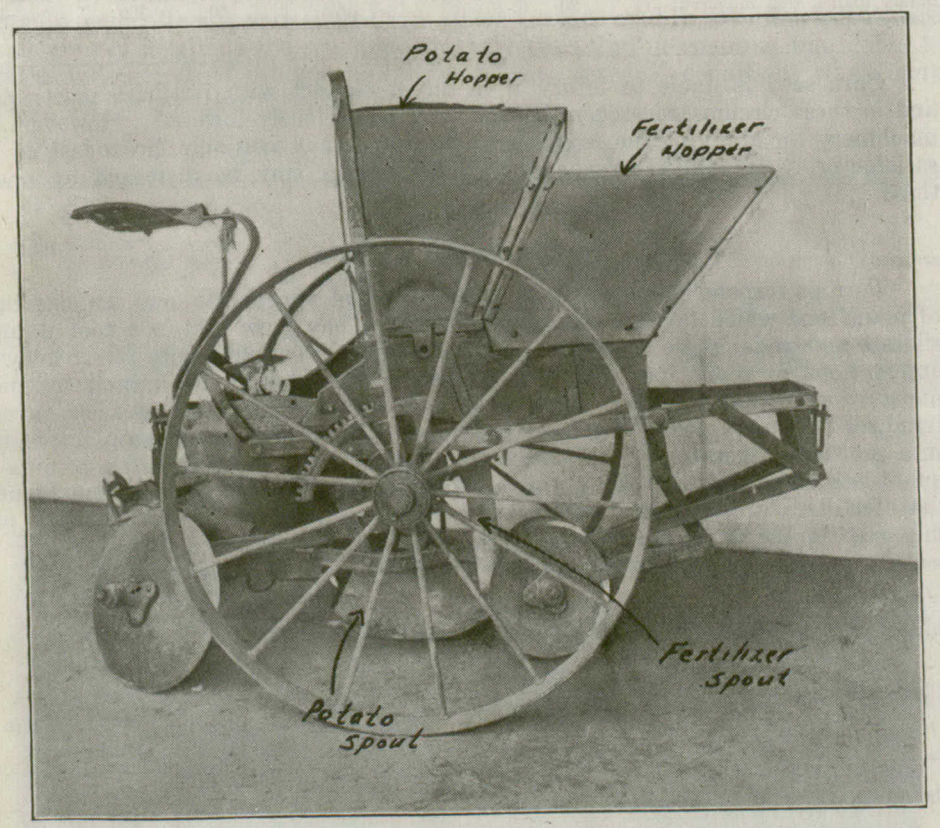
On clay loams the potash may be reduced slightly. On very light sandy loams it may be increased with profitable results.

FERTILIZERS SUGGESTED FOR POTATOES

(On average sandy loams)

Character and previous treatment of soil	Fertilizer materials in pounds per acre				Equivalent (approximately) to
	Nitrate of soda	Sulphate of ammonia	Superphosphate (20%)	Muriate of potash	
Clover sod liberally manured....	40	30	360	70	600 lb. of 2–12– 6
Small dressing of manure.....	50	40	480	100	800 " 2–12– 6
Clover sod—no manure.....	65	50	600	200	1,000 " 2–12–10
No clover or manure.....	160	120	480	240	1,200 " 4– 8–10
or	200	150	540	200	1,200 " 5– 9– 8

On peat and muck soils the fertilizer mixture should be high in phosphoric acid and potash—for example, a 2-8-10. In this type of soil the potash content is sometimes very low, and in such cases a fertilizer mixture with a higher potash content, such as 2-8-16, is to be preferred.



A combination potato planter and fertilizer distributor. The fertilizer is placed in bands or strips on each side of the row of seed and level with or slightly below the seed The fertilizer spouts may be adjusted to place the fertilizer at various distances from the seed; 2 to 3 inches is recommended.

Fertilizers for Corn

Barnyard manure is the most satisfactory source of plant food for corn, and on many farms the greater part of the manure produced is used for this crop. Manure contains high amounts of nitrogen and potash as compared with its content of phosphoric acid; consequently it may be found advantageous to

supplement the manure with a phosphatic fertilizer such as superphosphate. If the supply of manure is limited or if the soil is low in fertility a complete fertilizer in which phosphoric acid and potash predominate is to be recommended. On light sandy loams, potash is an important element of plant food for the corn crop, and unless the land is heavily manured the application of a complete fertilizer having a fairly high content of potash may be desirable.

FERTILIZERS SUGGESTED FOR CORN

Character and previous treatment of soil	Fertilizer materials in pounds per acre				Equivalent (approximately) to
	Nitrate of soda	Sulphate of ammonia	Superphosphate (20%)	Muriate of potash	
Loams and clay loams well manured	15	15	150	30	250 lb. of 2–12– 6
Loams and clay loams, lightly manured	30	30	300	60	500 " 2–12– 6
Sandy loams, well manured	20	15	180	60	300 " 2–12–10
Sandy loams, lightly manured	80	60	240	120	600 " 4– 8–10

Corn seed is liable to injury if in direct contact with fertilizer materials, and in these circumstances germination may be seriously lowered. However, if machinery for applying the fertilizer in the row is not available, broadcasting is satisfactory. If applied broadcast the above rates may be increased by one-third.

Fertilizers for Turnips

Turnips respond particularly to applications of phosphoric acid, an element of plant food which favours root development. They grow best in a cool, damp climate and under these conditions may be profitably supplied with fairly heavy applications of plant food. In dry seasons the yield may be limited by the moisture supply and in these circumstances a small to moderate application of fertilizer is usually found the most profitable. While the turnip crop responds in a marked degree to an application of phosphoric acid, the addition of small quantities of nitrogenous and potassic fertilizers is advisable; it has been found that fertilizer dressings are particularly useful in forcing the development of this crop in the early stages of growth, thus in some measure furnishing protection against the attacks of injurious insects.

FERTILIZERS SUGGESTED FOR TURNIPS

Character and previous treatment of soil	Fertilizer materials in pounds per acre				Equivalent (approximately) to
	Nitrate of soda	Sulphate of ammonia	Superphosphate (20%)	Muriate of potash	
Clay loams—manured	20	15	180	35	300 lb. of 2–12– 6
unmanured	40	30	360	70	600 " 2–12– 6
or	100	75	300	60	600 " 5–10– 5
Sandy loams—manured	25	20	240	50	400 " 2–12– 6
unmanured	55	40	480	160	800 " 2–12–10
or	130	100	360	130	800 " 5– 9– 8

Fertilizers for turnips, in most cases, give best results when used in conjunction with a dressing of barnyard manure. They may be applied broadcast before seeding or preferably at the time of seeding with a seed and fertilizer drill.

For this crop, on average loams which have been dressed with 8 to 10 tons of manure, an application of from 300 to 500 pounds of superphosphate per acre may be found sufficient, or the mixtures in Table 33 may be used.

In districts where "club-root" of turnips occurs the grower is advised to obtain information on the control of this disease from the Division of Botany and Plant Pathology, Science Service, Central Experimental Farm, Ottawa.

Fertilizers for Mangels

Mangels respond to liberal feeding; for best results they require a plentiful supply of available plant food, particularly in the early stages of growth. The employment of commercial fertilizers which furnish readily available plant food aids greatly in giving the seedlings an early start and in enabling the plants to withstand periods of drought and other adverse seasonal conditions which may occur during the later stages of growth.

FERTILIZERS SUGGESTED FOR MANGELS

Character and previous treatment of soil	Fertilizer materials in pounds per acre				Equivalent (approximately) to
	Nitrate of soda	Sulphate of ammonia	Super-phosphate (20%)	Muriate of potash	
Clay loams—well manured.....	25	25	240	50	400 lb. of 2-12- 6
lightly manured...	50	40	480	100	800 " 2-12- 6
or	130	100	360	130	800 " 5- 9- 8
Sandy loams—well manured....	25	25	240	80	400 " 2-12-10
lightly manured..	100	80	320	160	800 " 4- 8-10

Mangels—Fertilizer Experiment—Agassiz, B.C.
Left—Plot fertilized with nitrate of soda, 125 lb. per acre; superphosphate, 250 lb. per acre; muriate of potash, 125 lb. per acre. Right—check, not fertilized.

Barnyard manure is most valuable in supplying nitrogen, phosphoric acid and potash, but the plant food of manure is liberated somewhat slowly and, for this reason, larger yields are usually obtained if a moderate dressing of commercial fertilizer is used in conjunction with the manure.

On the average loam which has been dressed with manure at the rate of 10 to 15 tons per acre, the fertilizers shown in the table, applied either broadcast or by drilling at planting time, may be expected to give profitable returns. On unmanured land larger dressings may be profitably employed, especially if the soil is low in fertility and of a sandy nature.

Fertilizers for Sugar Beets

The manurial treatment for this crop should encourage a rapid and continuous growth in the early part of the season and a satisfactory ripening of the beet in the later stages of growth.

The fertility and character of the soil determine to a large extent the best kind of fertilizer to apply for sugar beets. When manure is available it should be applied in the fall; when heavily manured the application of from 300 to 400 pounds, per acre, of 20 per cent superphosphate will probably supply the plant food requirements of the crop.

FERTILIZERS SUGGESTED FOR SUGAR BEETS

Character and previous treatment of soil	Fertilizer materials in pounds per acre				Equivalent (approximately) to
	Nitrate of soda	Sulphate of ammonia	Superphosphate (20%)	Muriate of potash	
Clay loams—manured	20	15	180	35	300 lb. of 2-12-6
unmanured	35	25	300	60	500 " 2-12-6
Sandy loams—manured	20	15	180	60	300 " 2-12-10
unmanured	35	25	300	100	500 " 2-12-10

The application of the fertilizer may be by broadcasting or in the row by an attachment to the planter. If the latter method is followed the machine should be designed so that the fertilizer does not come in contact with the seed. Where time permits it may be found advantageous to apply half of the fertilizer broadcast before seeding and the remaining half in the row when seeding.

Dressings of ground limestone or marl are recommended on soils which are strongly acid.

Fertilizers for Market Garden Crops

Mineral Soils

In market gardening, the quality and yield of the products grown are determined largely by the rapidity of growth and development of the crops. Certain crops, such as carrots, beets, etc., require a continuous supply of plant food throughout the growing season. With others, such as tomatoes, where early ripening is important, it is desirable to induce early rapid growth, which is slowed up later in the season to enable development and ripening of the fruit. For leafy vegetables and certain root crops, which require a short season of rapid growth, it is obvious that quickly available fertilizers are the most valuable.

The importance of well-rotted manure in market gardening, as a source of plant nutrients and organic matter, is well known. However, the declining supply of this material has led gardeners to depend more and more on commercial fertilizers for maintenance of soil fertility and the utilization of garden refuse and green manure crops for the upkeep of soil organic matter.

Cabbage—Fertilizer Plots—Central Experimental Farm, Ottawa.
Left—Check plot, no fertilizer. Right—Plot fertilized with 1,000 pounds of 4-8-5 per acre.

In general, no one fertilizer mixture can be expected to meet all conditions with all crops, but, bearing in mind the requirements of the various vegetable crops, the two most useful commercial fertilizers at present readily obtainable are the 4-8-10 and 2-12-6 mixtures. With average soil conditions the 4-8-10 may be used in conjunction with green manure crops, but without barnyard manure, for many kinds of vegetables, provided it is supplemented as necessary with nitrogen in a readily available form, such as nitrate of soda and sulphate of ammonia. For very light soils or those known to be very low in potash, additional potash in the form of buriate or sulphate of potash may be necessary. Also, for a tomato crop or other crops with high phosphorus requirements, additional phosphorus, as in superphosphate, bonemeal, etc., may be necessary. Where a moderate quantity of barnyard manure is available, a 2-12-6 will correct the low phosphorus content of manure and thus provide a fair balance of nutrients for most vegetable crops.

The following recommendations for market garden crops have been taken from those prepared by the Advisory Board for Ontario. Similar recommendations have been published by other provinces, and are available for distribution.

Recommendations of the Advisory Fertilizer Board of Ontario, 1939

Light and Sandy Loam Soils

Leafy Crops: Lettuce, spinach, chard, asparagus, and

Heading Crops: Celery, cabbage, cauliflower, Brussels sprouts. Use 4-8-10 at the rate of 1500 lb. to 2000 lb. per acre, plus additional nitrogen as required.

Root Crops: Onions, beets, parsnips, early potatoes. Use 4-8-10 at the rate of 1500 lb. per acre.

Fruiting Crops: Tomatoes, peppers, eggplant. Use 2-12-10 at the rate of 500 to 1000 lb. per acre. Clay loams—use 2-12-6 at the rate of 500 to 1000 lb. per acre.

If there has been no clover or manure previous to the tomato crop, increase the rate of application and supplement with a 200 lb. per acre side-dressing of nitrate of soda or sulphate of ammonia, a week or ten days after planting.

Cucurbits: Cucumbers, squash, melon, etc. Use 4-8-10 at the rate of at least 1500 lb. per acre, plus 400 lb. sulphate of ammonia or its equivalent in nitrogen as an additional application.

Miscellaneous: Sweet corn, green beans, garden peas, carrots. Use 2-12-10 at the rate of 1500 lb. per acre, broadcasted before seeded.

NOTE.—On soils of high acidity and in the case of heading crops, calcium cyanamid, applied from one to two weeks prior to planting, has given good results.

Where club-root is present in the soil, calcium cyanamid, used according to directions, has given a satisfactory measure of control in many cases.

Asparagus: Apply 4-8-10 immediately after cutting season, at 1500 lb. per acre.

On Heavy Soils

On heavier soils a lower rate of application of fertilizers carrying a higher phosphate content is recommended.

ORGANIC SOILS

Organic soils in general are high in nitrogen and low in minerals, particularly potash. For this reason the fertilizers usually found most satisfactory on these soils are those low in nitrogen, high in phosphorus and still higher in potash.

Roughly, organic soils may be divided into two groups, muck and peat. With the muck soil, the top layer of six inches to a foot, is well decomposed and in excellent physical condition for the production of crops. With peat, decomposition has not progressed as far and the original plant remains are visible in the surface layer. On this latter type, success in crop production depends largely upon the degree of decomposition of the soil. Raw or undecomposed peat is of little value for crop production, but as decomposition progresses the value increases. Accordingly, to hasten decomposition and the release of plant food, as well as the improvement of the physical condition of the soil, applications up to ten tons per acre of well-rotted barnyard manure, in conjunction with high potash fertilizers, have been found very effective. This has been the case at the Dominion Illustration Station at Caledonia Springs, Ontario, where experiments have been conducted for six years on the area known as the Alfred peat bog.

Such treatment inoculates the soil and at the same time provides nutrients so that micro-organisms increase and hasten decomposition of the peat. When the point has been reached where further response in crop yields cannot be obtained from applications of manure, the surface will have reached an advanced stage of decomposition which may, from a practical standpoint, be considered as similar to muck and treated accordingly.

At the Dominion Experimental Sub-station at Ste. Clothilde, Quebec, the soil is a high quality wood carex muck typical of large areas in western Quebec. Analysis by the Quebec Soil Survey from a point near, and similar to the Sub-station property, shows the following composition.

Chemical Analysis *Oven Dry Basis*

Ste. Clothilde Muck Soil

	Surface 12"	Subsoil 12"-24"
pH value	6·32	6·36
Ash	12·27 p.c.	10·34 p.c.
Lime (CaO)	4·42 p.c.	4·12 p.c.
Magnesia (MgO)	0·62 p.c.	0·49 p.c.
Manganese oxide (Mn_3O_4)	0·040 p.c.	0·020 p.c.
Potash (K_2O)	0·109 p.c.	0·101 p.c.
Phosphoric acid (P_2O_5)	0·231 p.c.	0·128 p.c.
Sulphur trioxide (SO_3)	1·63 p.c.	2·94 p.c.
Nitrogen	2·69 p.c.	2·62 p.c.

This analysis indicates a soil very high in nitrogen and sulphur and correspondingly low in essential mineral elements with the exception of calcium.

During the four years that experiments have been conducted at this Substation, it has been found that it is impossible to make a general recommendation to cover vegetable crops as a whole for this soil type. From the experience to date it has been amply demonstrated that applications of potash are rapidly rendered unavailable and for certain crops, such as late celery, supplementary applications are necessary during the later part of the season. Fertilizers containing sulphur such as sulphate of potash, have been found actually detrimental to most crops. This is due, no doubt, to the high sulphur content of the soil. On the other hand, heavy applications of muriate of potash to the potato crop have invariably produced chlorine injury symptoms in the foliage and depressed yields. It is also apparent that applications of copper are essential for the onion crop which usually fails to ripen on this soil unless 50 to 100 pounds per acre of copper sulphate have been applied with the normal fertilizer application.

In general, it would not seem advisable for growers on these muck lands to invest in additional machinery for the row placement of fertilizers. Experiments at Ste. Clothilde for three years with six vegetable crops, four mixtures of fertilizers and three rates of application have shown that no increase in yield may be expected by row placement of fertilizer over similar amounts applied broadcast.

FERTILIZER RECOMMENDATIONS FOR VEGETABLE CROPS ON MUCK SOILS IN WESTERN QUEBEC AND EASTERN ONTARIO

Late Celery.—Apply 1,000 lb. to 2,000 lb. of 3-8-15 or 2-8-16 per acre, supplemented by summer side application of 100 lb. to 200 lb. of muriate of potash per acre.

As a source of potash, the sulphate form is unsuitable for celery on this type of soil, and should not be included in the fertilizer mixture.

Potatoes.—Apply 800 lb. to 1,500 lb. of 2-8-16 or 3-8-15 per acre. Where it is desirable to use amounts in excess of 1,500 lb. per acre, not more than two-thirds of the potash should be in the muriate form.

Onions.—Use 800 lb. to 1,500 lb. of 2-8-16 or 3-8-15 lb. plus 100 lb. per acre of pulverized copper sulphate. Where the crop follows a heavily fertilized crop, such as celery, or potatoes, the nitrogen should be omitted from the formula and 300 lb. to 400 lb. of superphosphate and 100 lb. to 150 lb. of muriate of potash per acre used instead or, if available, 0-12-15 at 600 lb. to 800 lb. per acre.

Cabbage and Cauliflower.—Use 500 lb. to 1,000 lb. of 2-8-16 or 3-8-15 per acre. If following a crop where nitrogenous fertilizers have been used, additional nitrogen may result in the production of heads too large for market requirements. Under such conditions, use 300 lb. to 400 lb. of superphosphate and 150 lb. to 250 lb. of muriate of potash per acre. or, if available, 0-12-15 or 0-8-16 at 500 lb. to 800 lb. per acre.

Spinach and Lettuce.—Apply 800 lb. to 1,500 lb. of 2-8-16 or 3-8-15 per acre. With head lettuce, where moisture conditions are satisfactory, heading may be delayed by excess of available nitrogen. Under such conditions, an 0-12-15 at 500 lb. to 1,000 lb. per acre is recommended. If 0-12-15 is not available 300 lb. to 600 lb. of superphosphate and 150 lb. to 300 lb. of muriate of potash may be used.

Carrots.—Except on virgin land, nitrogen in the fertilizer application is apparently unnecessary as quantities as low as 2 per cent in the fertilizer mixture will induce excessive splitting. Accordingly, applications of superphosphate up to 400 lb. and muriate of potash up to 200 lb. per acre is recommended for this crop. If available an 0-8-16 or 0-8-24 at 500 lb. to 1,000 lb. per acre may be used.

Boron Deficiency.—In many instances boron deficiency symptoms have been observed in crops growing on muck soils. Probably the most serious losses have occurred with celery and turnips. Where such symptoms occur, apply up to 30 lb. of borax per acre. This application should not be repeated until deficiency symptoms are again observed.

Where muck soil has been utilized for crop production for a number of years, available nitrogen is usually not as high as in the soils for which the above recommendations are intended, and more of this element may be used to advantage. For such soils the recommendations of the Advisory Fertilizer Board of Ontario are applicable. These are as follows.

RECOMMENDATIONS OF THE ADVISORY FERTILIZER BOARD OF ONTARIO, 1939, FOR VEGETABLE CROPS ON MUCK SOILS

Late Celery.—1,500 to 2,000 lb. 2-8-16 or 2-8-10. Additional applications of water-soluble nitrogen may be required in cold or wet periods during growth. Where soil analysis supplemented by the appearance of the crop indicates the need of high potash, 2-8-24 may be used instead of 2-8-16.

Early Celery.—1,200 to 1,500 lb. 2-8-16 or 2-8-10. Additional applications of water-soluble nitrogen may be advisable, depending upon the appearance of the crop.

Lettuce, Spinach, Swiss Chard.—500 to 1,000 lb. of 2-8-16. The fertilizer should be broadcast and disked in before seeding. Side-dressing with water-soluble nitrogen may be necessary during growth.

Cabbage, Cauliflower.—1,000 to 1,500 lb. of 2-8-16 or 2-8-10; 400 to 500 lb. of this may be applied in the row, four inches deep, and the remainder broadcast and disked in.

Onions.—1,000 to 1,500 lb. of 0-12-15 or 2-8-16; 300 to 500 lb. may be applied two inches below the seed, and the remainder broadcast and disked in. In some cases 100 lb. of copper sulphate, mixed thoroughly with the fertilizer, may improve the colour and quality of onions.

Beets, Parsnips, Carrots.—500 to 1,000 lb. of 0-12-15 or 2-8-16. For root crops apply with fertilizer drill or broadcast and disk in.

Potatoes.—500 to 1,000 lb. of 0-12-15 or 2-8-16. To avoid hollow tubers, plant closely.

Fertilizers for Raspberries and Strawberries

(Recommendations of the Horticultural Division, Central Experimental Farm, Ottawa)

Both raspberries and strawberries require a soil high in organic matter, retentive of moisture. Unless the soil is naturally well supplied with humus, it is necessary to build up the supply for a year or two previous to planting.

Barnyard manure, green manure crops or mulch, for example, hay or straw, must be the basis of the soil fertility program. Maintenance of fertility in a raspberry or strawberry plantation is very simple if plenty of barnyard manure

is available. Where manure is not available, it is necessary to resort to the use of green manure crops or mulch. Commercial fertilizers are beneficial as a supplement.

RECOMMENDATIONS FOR RASPBERRIES

On a normal or well balanced soil, the supply of nitrogen appears to be the main factor limiting growth and fruitfulness.

1. Apply barnyard manure, 15-20 tons per acre, previous to setting out the plantation. Annual applications should be made thereafter in late fall or early spring, the rate of application varying with the needs of the plantation as evidenced by growth, fruitfulness and hardiness.

2. When manure is not available, green manure crops should be grown in advance of planting and annually thereafter during the life of the plantation. Supplement annually with a complete commercial fertilizer applied in early spring, at the acre rate and the approximate proportions of: 400 lb. nitrate of soda, 180 lb. 20 per cent superphosphate, 100 lb. muriate or sulphate of potash; equivalent to 700 lb. of a 9-5-7.

RECOMMENDATIONS FOR STRAWBERRIES

The application of 20 to 25 tons per acre of manure applied for a hoed crop one year before planting is strongly recommended.

Nitrogenous fertilizers applied at planting time are liable to cause injury to the plants; therefore, the application at this time of commercial fertilizers should be limited to those supplying mineral plant food, such as a 0-12-10 or 0-12-15, at the rate of 150 to 250 lb. per acre.

If a complete fertilizer is considered preferable, its application should be deferred until one month after planting and may consist of 600 lb. per acre of a 9-5-7.

In all cases in late summer, that is, late August and early September, two applications two weeks apart of 100 to 125 lb. each of nitrate of soda should be made to stimulate the formation of fruit buds.

Fertilizers for Tree Fruits

(Recommendations of the Horticultural Division, Central Experimental Farm, Ottawa)

An adequate supply of organic matter, whether supplied as barnyard manure, green manure crops or mulch material such as hay or straw, must form the basis of the orchard soil management program. The following fertilizer recommendations should, therefore, be regarded as supplementary to a satisfactory organic-matter content in the soil. No good rule-of-thumb method for yearly and general fertilizer applications can be made. It is only by watching growth and foliage appearance that growers will ultimately maintain an approximately correct relationship in their fertilizers.

As a general practice in most orchards the application of the minerals separately from the nitrogen is a very good practice. A lack of nitrogen is very quickly expressed by the tree in the form of light green foliage and, fortunately, this condition is quickly corrected by the application of a quickly available nitrogenous fertilizer. It is safer to supply a large amount of nitrogen to a soil known to be well stocked with mineral nutrients than to one which may be low in these elements. With yearly applications of mineral fertilizers, nitrogen may be employed as a balancer, using the foliage and growth characters to indicate whether a heavy or light application should be made. Ordinarily 400 lb. of ammonium sulphate per acre or its equivalent would be considered

a moderately heavy application and should only be employed on soils not high in nitrogen. An application of 300 lb. would be a moderate application. If the available mineral content of the soil is high the heavier application would be satisfactory; if low it would doubtless do as much harm as good. Since many orchards are not solidly planted and contain trees of different ages, growers often prefer to apply the fertilizer only to the soil area occupied by the tree roots. An application of $\frac{3}{4}$ lb. of ammonium sulphate for each inch of trunk diameter would constitute a moderately heavy application. Orchards in sod generally require heavier applications of quickly available nitrogen than orchards which are cultivated. This is especially true in areas where the mulch material does not decompose rapidly owing to the lack of sustained adequate moisture conditions. On the other hand, the maintenance of organic matter, the source of more slowly available nitrogen, is more difficult in cultivated orchards. Decomposition of organic matter often occurs at such a rate and at such a time that the trees are unable to make full use of the liberated nitrogen and considerable loss occurs through leaching and erosion.

To accomplish its purpose nitrogen should be applied early in the spring well in advance of tree growth. On cultivated orchards mineral fertilizers should be applied either in the spring or fall at a time when it is possible to immediately work the soil.

The following annual applications are suggested on soils which are at present producing satisfactory results without any foliage symptoms indicating lack of any individual element.

1. Use 200 lb. per acre of 20 per cent superphosphate; 125 lb. per acre of either sulphate or muriate of potash; nitrogen as needed and in the form preferred by the grower. On alkaline soils, a nitrogen fertilizer with residual acid reaction, such as sulphate of ammonia, should be used.

If it is desirable to apply the fertilizer only to the soil area occupied by the tree roots use $\frac{1}{2}$ lb. of 20 per cent superphosphate and $\frac{1}{4}$ lb. of sulphate or muriate of potash for each inch of trunk diameter.

2. Where a complete fertilizer is desired, a 9-5-7 is suggested at the rate of 700 lb. per acre or $1\frac{1}{2}$ lb. per each inch of trunk diameter. It must be noted that this is to be considered as a maintenance fertilizer on soils in which the plant foods are in a well balanced condition.

3. Where leaf scorch due to potassium deficiency is present, it would be well to eliminate the nitrogen for a season at least and rely solely upon minerals, applying superphosphate at 200 lb. per acre and sulphate or muriate of potash at 350-400 lb. per acre until the deficiency is corrected. On such soils a 4-8-10 should prove a good maintenance fertilizer.

4. Where manure is available it may be employed successfully. On the average, most barnyard manure is about correct in its proportion of nitrogen, phosphorus and potassium for orchard use. Annual applications of 6 to 7 tons per acre should be sufficient to provide the equivalent of 700 to 800 lb. of a 9-5-7. Since the nitrogen in manure is rendered available rather slowly it may be necessary to supplement manure with a quickly available nitrogenous fertilizer early in the spring. Excessive quantities of manure may delay the trees hardening off in the fall, rendering them susceptible to winter injury.

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