POTATO CULTURE

The potato is one of the most widely known and used vegetables, as a food for man and a source of cheap starch and alcohol. From the time when it was first adopted as a food plant in the seventeenth century until the present, the acreages devoted to potato growing have increased enormously. Fluctuations in production occur from year to year, but in the main, production is fairly constant. The potato has become a staple food the world over where the white races of people are found.

Improvement in the size, shape and quality of the potato of to-day has been brought about by the origination of new varieties and by careful selection and better cultural methods.

Reference to statistics obtained from the Monthly Bulletin of Agricultural Statistics, January, 1940, gives some interesting figures that show the trend in potato production. The average for the period 1932 to 1936 was not deviated from very greatly. In 1939 the acreages were smaller and the yield per acre reduced by nine hundredweight per acre from the average for 1932 to 1936, but with better prices the gross farm value of the crop was greater than the average and better than that of the two previous years, as shown in the accompanying table:—

ACREAGE, PRODUCTION AND VALUE OF POTATOES IN CANADA

Year	Area	Yield per acre	Total production	Average farm price	Gross farm value
	acres	cwt.	cwt.	per cwt.	$
Average 1932 - 1936	525,400	79.0	41,708,000	0.76	31,563,000
" 1937	531,200	80.0	42,547,000	0.63	26,650,000
" 1938	521,900	69.0	35,938,000	0.75	27,079,000
" 1939	517,700	70.0	36,390,000	1.07	39,040,000

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Climatic and Soil Requirements

The influence exerted by climatic conditions on the potato crop is considerable. It is known that the potato does best where the growing season temperatures range from 60° to 75° F. Northern New Brunswick, Prince Edward Island and other sections of Canada where cool growing conditions prevail are ideal for maximum yield.

While the soil is important, it is of less importance than the effect exerted by the proper climatic conditions. Soil influence is measured in yield, earliness of maturity, eating quality, keeping quality, and loss by disease. The ideal soil is a rich, deep friable, medium loam inclined to be slightly acid or pH. of 5·2 to 6·5. The light or sandy soils are as a rule lacking in humus content and also lacking in sufficient moisture to meet the normal requirements of the potato. The heavy soils should be avoided since there is greater danger of rot developing in the tubers during wet years. Under dry conditions, the heavy soils render digging very difficult and produce potatoes of inferior quality and lacking in smoothness and uniformity. After all, the best soils are those that are of glacial drift origin, such as are found in Northern New Brunswick.

Soil Managements and Sanitation

It is very important that the land used for potato production be kept in a satisfactory state of fertility. This can be best accomplished by following a rotation wherein the potato crop occurs in a regular cycle. Without doubt the best method of maintaining ideal conditions is by following a three-year rotation, as follows: First year, grain seeded with clover; second year, clover hay and third year, potatoes. After the removal of the hay in the second year, top dress the land, preferably with rotted manure, applying ten to twelve tons per acre. Fresh stable manure may be used but is not recommended because of weed seeds. The second-growth clover should be allowed to grow so that by the autumn a heavy crop will be ready for ploughing down.

Filling a double role, clover has been found to be one of the most useful of the soil improvement crops to employ. In the first place, it is a true legume that gathers nitrogen during the period of growth, and this nitrogen is added to the land in which the crop grows. In the second place, the second-growth clover, when ploughed down, adds humus to the land which acts as a splendid soil improver.

In addition to the above commendable features of clover in a short rotation for potatoes, it also discourages the development of insects, such as wire worms and white grubs which feed on the grass roots.

The practice of rotating crops also aids in decreasing the annual losses sustained from diseases that frequently become troublesome when potatoes are grown on the same land for two or more years in succession.

Thorough preparation of the soil will not only ensure a perfect seed-bed, but will help to maintain satisfactory conditions of moisture, aeration, and temperature. These conditions influence the value of the plant food available in the soil, and have a direct bearing upon the yield, shape and quality of the potatoes harvested. The easily worked soils suited to potato growing offer few physical difficulties, and under proper management will produce profitable crops. More difficulty is found where soils are heavy and require treatment to produce friable conditions. The use of green manure crops, such as rye, barley, or buckwheat ploughed down tends to improve the texture of such soils. Rye is a rapid-growing hardy crop that will do well on acid and poor soils, producing a heavy tonnage of succulent green growth. Barley also is a very rapid-growing crop that produces a heavy succulent growth. Buckwheat produces a rapid heavy growth, coupled with a strong tap-root system that penetrates the sub-

strata and tends to produce greater openness in the subsoil, in addition to improving the general texture of the upper strata of soil. Fall ploughing is usually employed where the soil is of a heavy nature or where coarse litter or corn stubble is to be turned under. As a general rule, spring ploughing is employed since the greatest acreage of potatoes is grown on the lighter soils that are easy to handle. The shallow, light soils, that have hardpan substrata, can be improved by gradually ploughing a little deeper, thus incorporating a little of the hardpan at each subsequent ploughing with the upper layer of good soil.

Preparation of the ploughed land prior to planting can hardly be overdone. Pre-planting tillage, thoroughly done, will do more to ensure a good crop than a great deal of inter-row tillage during the season of growth. In fact, delayed planting, to allow for thorough harrowing, will often do more to control troublesome weeds and ensure a better net return at harvest time. The potato responds, like other crops, to a well-prepared seed-bed.

Fertilizers

Late Potatoes—On sandy loam soils without manure or without a preceding crop of clover, use 4-8-10*. Where clover or manure has been ploughed down, use 2-8-10 or 0-12-15. On heavier soils 2-12-6 may be used. Rates of application, 750 to 1,000 lbs. per acre.

The fertilizer should be placed slightly below and in two bands, separated from the potato sets by approximately two inches of fertilizer-free soil. If a planter with fertilizer attachment is not used, the fertilizer should be applied in the bottom of the plough furrow and covered with about one inch of soil before dropping the sets.

Green manure crops improve the soil by increasing the humus content, water-holding capacity, and physical condition. They also make a temporary increase in the acidity of the soil, which is important in the control of scab. The following practice gives good results: Manure a clover sod and plough down; then sow to fall rye. In the spring, when the top growth is about ten inches high, plough down the rye and plant potatoes. Buckwheat and barley may also be used but must be ploughed under before hard freezing in the fall.

Method of Applying Fertilizers

The most economical method of applying fertilizer for the crop is by means of a potato planter. Commercial fertilizer should not be allowed to come in contact with the seed pieces in the soil on account of the danger of reducing the stand of plants. This injury is what is known as fertilizer burn.

The modern type of potato planter is equipped to place the fertilizer in the soil on either side of the sets, in strips or bands two inches wide, two inches distant from the sets and just level with, or slightly below, the level of the sets. This is considered to be ideal.

Old-style planters were made to deposit the fertilizer in the soil below, or in very close contact with, the sets. New attachments may be obtained for many of these planters that will make it possible for the fertilizer to be deposited in the proper manner, or to broadcast part or the whole amount. Where the planter is equipped with a satisfactory distributor attachment, the whole amount of fertilizer can be most economically applied in one application.

* See the Advisory Fertilizer Board recommendations published by the various Provincial Departments of Agriculture.

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Seed

With the potato, as with other crops, only the best seed procurable should be planted. Because of the peculiar characteristics of a great many of the diseases to which the potato is subject, disease-free seed is of special importance. Certified seed represents the best obtainable; it is as free as possible from seed-borne diseases, particularly virus diseases, present in the tubers but not visible to the eye, which are the chief causes of degeneracy in the potato. Reference to these will be found in the section dealing with diseases. Common diseases, externally borne on the tubers and hence easier to detect, call for simple control measures prior to planting.

From experience it has been found that medium-sized tubers make desirable seed. Tubers of medium size will be found to cut into better sets more economically than tubers of large size. Where certified seed is used, small-sized tubers may be utilized with confidence. The use of small potatoes from the general bin run, however, is a dangerous practice to follow, as it frequently happens that these small potatoes are the result of some of the physiological diseases having been present, and the use of such small seed would result in heavy loss in yield. The use of very large tubers as seed is not advisable, since the large tubers, due to their bulk, will produce fewer sets of a desirable size. In other words, a bushel of large potatoes will produce fewer sets than will a similar quantity of medium-sized tubers.

Immature Seed.—In tests conducted at the Dominion Experimental Farm, Agassiz, B.C., where the average date for planting the main crop is May 15, interesting results were obtained by planting potatoes (for later harvesting as seed) at various dates, starting as early as soil and weather conditions permitted and making the last plantings June 15. Seed from the latter plantings or from plots planted a month after main plantings are ordinarily made, gave consistently high yields when planted at the usual time next year.

The cost of producing seed in the above manner is quite high, but the increased yield obtained from the use of immature seed might be found profitable.

Seed potatoes that have been stored under warm conditions and have sprouted while in storage will not produce as vigorous plants as seed that has been kept dormant until near planting time. The first sprouts from the eyes are much more vigorous than the secondaries.

The best storage temperature for seed tubers is 35°F. They may be stored in well-constructed pits where the temperature will remain fairly constant or in a frost proof storage where the temperature can be carefully regulated and the interchange of air controlled.

In the spring, the seed tubers should be moved from the storage cellar to a moderately warm place for the purpose of starting the buds. This should be done about two weeks prior to planting time. By this means a more uniform stand of plants can be obtained. During this period treating for scab and rhizoctonia can be done. Since the varieties Katahdin and Chippewa appear to have weaker eyes at the stem end, the practice of warming up the seed or slightly sprouting will ensure an even stand of crop.

Size of Sets.—The most satisfactory size of sets for planting is from one and a half to three ounces and containing from one to three eyes. The sets should be cut so as to be blocky in form rather than thin or shallow pieces. During the period of growth, the potato plant is dependent upon the food supply in the seed piece to maintain it until the root system has become established. Cut seed is used to a very great extent in the large potato-growing areas, but to get best results the cut seed should be planted as quickly as possible after cutting.

Cutting the Sets.—Several good makes of mechanical potato cutters are available. When properly used, these do rapid work and *cut the tubers* into good blocky sets. Some growers, however, prefer to cut the potatoes by the old hand method. While the sets may be cut more carefully by hand, a given number of workers can cut a larger amount of seed in a given time by the mechanical method.

Where it is found necessary to cut the seed pieces some time in advance of planting, provision should be made to avoid undue loss of moisture from the seed pieces. Sets that are cut for use several days prior to planting should be treated to promote rapid corking-over of the cut surfaces. This may be done by spreading the cut seed pieces out thinly where good ventilation and a moderately warm temperature is available. Another method is to coat the cut surfaces over with land plaster or flowers of sulphur. Once the cut surfaces are dried by any of the above methods, the sets may be stored in slatted bushel crates, in a cool place. Large containers should be avoided for fear of the sets heating.

It should be borne in mind that where cut seed is used, best results have been obtained where the freshly cut sets are planted in warm, moist, well-prepared soil.

Whole Small Seed.—A considerable number of growers use whole small seed and obtain good crops. Whole small potatoes that weigh from two to three ounces give good results, provided of course they have been selected from healthy hills or stock. This type of seed will be found to give a more uniform stand of plants where planting is done in soils that are hot and dry. It has been shown by experiment that whole seed potatoes produce the largest yield, but the proportion of small unmarketable tubers is, as a rule, too great. The tendency is for a great many stalks to develop, which usually results in a struggle for plant food and moisture; and this, under crowded conditions, results in the production of too great a proportion of unmarketable tubers.

Seed potatoes taken direct from a cool storage cellar and planted in cold wet soil are more liable to rot. It is a good plan to warm seed potatoes prior to planting. In fact, if the buds are showing signs of slight development, much quicker and more uniform growth will result after planting.

During the past few years there has been an increasing demand for seed by growers living at a distance from potato seed centres. To meet this, parcel post offers possibilities but excess weight has to be eliminated. Single-eye sets, known as potato eyes, consisting of cylindical pieces $\frac{3}{4}$ of an inch in diameter cut by means of a cutter resembling an apple corer, have been found satisfactory. These pieces contain one eye each and are cut completely through the tubers. After cutting, land plaster is immediately applied to the moist cut surface. Packed in slightly moist moss, they may be shipped successfully. If planted in well-prepared warm soil in the same manner as the regular type of sets, good results may be obtained.

The Best Time to Plant

Regional conditions will govern the time when planting can be done to best advantage. The occurrence of late spring frosts must be considered, as well as the condition of the soil. It has been found that the earliest possible date at which planting can be done, climatic and soil conditions considered, has given the largest yields. This fact has been demonstrated by tests conducted in the Division of Horticulture, Central Experimental Farm, Ottawa.

The early, or first, planting in this experiment was made and from it 337 bushels 28 pounds per acre of marketable potatoes was the average yield for a six-year period. The second planting was on June 9, and from it 269 bushels 43 pounds per acre of marketable potatoes was the average for a six-year period. The third planting, made on June 24, yielded 187 bushels 53 pounds per acre of marketable tubers for a six-year average. This would indicate that early planting is an important factor in influencing yield per acre. In the above test early varieties were used.

A further test was made with late varieties to find if the plantings made at the same dates would produce similar results on the crop returns. The first planting yielded 319 bushels 9 pounds of marketable tubers per acre. The second planting yielded 227 bushels 51 pounds per acre of marketable tubers. The third planting yielded 160 bushels 4 pounds per acre of marketable potatoes.

From the above yields it is indicated that the early planting gave the best results and that with lateness of planting the yield per acre diminishes. In regions where a long frost-free period occurs in the autumn, however, late planting may be employed with satisfactory results.

Distance Apart to Plant

For average conditions 30 inches apart between rows is ample space, but where high ridging is practiced, 36 inches or more between rows will be found more satisfactory.

The most satisfactory distance between sets in the row is 12 to 14 inches. These distances have been found to give the best average yields. However, the early maturing varieties that do not make large foliage growth may be planted closer together in the row.

Amount of Seed

The amount of seed required to plant an acre will vary with the distance apart of the rows, the distance apart of the sets in the row, and the size of the sets.

With the rows spaced 30 inches apart and the sets dropped 10 inches apart, it would require 35 bushels per acre; 12 inches apart, 29 bushels per acre; 14 inches apart, 25 bushels per acre; and 16 inches apart, 22 bushels per acre. Where the rows are spaced 36 inches apart, from four to six bushels less seed per acre would be required.

Planting

The amount of potatoes planted by machines has increased greatly during the past few years. A considerable acreage is planted by hand, but in the highly specialized potato growing sections machine planting is relied upon to a very great extent. Several satisfactory makes of planters are available. These embody two distinct principles, the picker type, and the cup and sprocket wheel spacer type. In the smaller models there are the one- and two-man machines. The one-man machine is cheaper to operate, but the two-man machine, while costing more to operate, can be relied upon to produce a very uniform stand of crop, provided of course that good seed is available and other things equal. Where very large acreages are planted, the two-, three- and four-row platform machine planters are used to advantage.

Where hand planting is done, the land should first be ribbed up with a lister plough, also known as a double mouldboard plough. The single mouldboard walking plough may be used but the work is not, as a rule, as evenly done. Dropping the sets by hand from a bag slung around the shoulder should be done while the soil is still moist. The sets are then covered by means of the lister plough, by splitting the ridges, or the ordinary single mouldboard plough may be used.

The methods of planting used prior to the advent of the mechanical planters are still in use by gardeners and growers of small acreages. In any event the pre-planting land preparation should be carried out as previously outlined. The planting can be done to advantage in gardens by means of a hoe. Broad holes should be made to a depth of five or six inches, and spaced 13 to 15 inches apart, with the rows 30 to 36 inches apart. If commercial fertilizer is to be used, it can be spread in the bottom of the holes, using one and a half tablespoons per hole. This is approximately a 700-pound-per-acre application. To

prevent what is known as fertilizer burn, one or two inches of soil should be placed on top of the fertilizer. One set or seed piece, containing two or three eyes, is placed on the soil in each hole and covered to a depth of four inches.

Early Potatoes

Different Dates of Digging.—There is a time to dig potatoes for early market to ensure obtaining the best returns from the plantation. This has been shown quite clearly by the results reported by the Dominion Experimental Station, Agassiz, B.C. In this experiment, whole, small sprouted seed of the Early Rose variety was used. It has been found that the first marketable-size potatoes are formed at approximately the time of full bloom. In this experiment, digging was done at intervals of a week apart for eight weeks. It was found that there was a marked increase in yield from week to week until the tops died, but for profitable early potato marketing the most satisfactory returns were two weeks after the period of full bloom, or when the blossoms have practically all withered. By the end of the eight-week period, which is around the end of July, the yield per acre is much higher but the prices paid for early potatoes, as a rule, have decreased.

Variety Recommendation and Yield

Too much importance cannot be attached to the choice of varieties. In the past the tendency was for farmers to grow a great many varieties. This practice has been discontinued to a considerable extent, and this is to the advantage of the producers of the best stocks. Zoning of varieties is to be recommended; that is, a certain number of growers in a locality should select one variety and grow that to the exclusion of all other varieties. Thus a certain locality will become well known for that variety of potato, or the growers may decide to grow two varieties, an early and a late crop variety.

The following recommendations concerning varieties and yields for the various regions in Canada have been made by the Dominion Experimental Farms and Stations and are based upon the results of extensive variety trials conducted for many years.

Charlottetown, P.E.I.—Irish Cobbler is a very popular early-maturing white variety. Spalding Rose also does well as an early pink variety. Green Mountain is the best of the main crop varieties.

The fourteen-year average yield from Irish Cobbler is 268 bushels per acre.

Fredericton, N.B.—Irish Cobbler has proved the most satisfactory early white variety to date. Green Mountain is a good main crop white variety and is grown extensively in the province of New Brunswick.

Ste-Anne de la Pocatière, Que.—Two white-skinned varieties are recommended: Irish Cobbler as an early variety, and Green Mountain as the main crop variety.

Lennoxville, Que.—Three white-skinned varieties are recommended: Irish Cobbler for an early variety, and Green Mountain and Dooley as the main crop varieties. The Dooley variety is gaining in popularity.

Ottawa, Ont.—Irish Cobbler is considered one of the best early varieties to grow. Gold Nugget, a yellowish-white-skinned variety of recent introduction, has shown considerable promise. Warba is an important new variety that resembles Irish Cobbler in shape, differing by having pink eyes and maturing one week earlier. The keeping and cooking qualities are good. Green Mountain and Dooley are important late varieties, but are being superseded by the new smooth, white varieties Katahdin and Chippewa. In addition to being good yielders, these two new varieties are resistant to mild mosaic.

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Harrow, Ont.—In this part of southwestern Ontario the early potato crop is of more importance to the growers. Irish Cobbler is used almost entirely. Early Ohio is also used in a limited way. Warba is proving useful. Two main crop varieties are used to some extent, Dooley and Green Mountain (farther east in western Ontario), but are being superseded by Katahdin and Chippewa.

Kapuskasing, Ont.—Irish Cobbler is considered one of the best general purpose varieties for both the early and main crops. While Green Mountain yields very well, it is not considered as satisfactory as the former.

Morden, Man.—As early varieties, Early Ohio, and Early Favourite are two of the leaders. Warba is becoming popular. Early Ohio, although an early variety, is also used for the main crop, while Burbank Russet or Netted Gem is also a very good main crop variety.

Brandon, Man.—The recommendations include Early Bovee and Early Ohio, two pink-skinned varieties for early cropping, and Green Mountain and Gold Coin as the main or late crop varieties.

Rosthern, Sask.—Irish Cobbler and Early Ohio are used for the early crop, while Irish Cobbler is also used for the main crop.

Scott, Sask.—Early Ohio and Bliss Triumph are the most satisfactory early varieties. For the main crop, Irish Cobbler is recommended. During a five-year period, the average yield from Irish Cobbler was 127 bushels per acre.

Indian Head, Sask.—Irish Cobbler, Bliss Triumph, Warba, and Early Ohio are satisfactory early varieties. Peach Blow, Gold Coin and Green Mountain are very satisfactory main crop varieties. Columbia Russet, originated at the Dominion Experimental Station, Windermere, B.C., has proved very productive.

Summerland, B.C.—Irish Cobbler, Early Rose, Early Ohio, Epicure and Bliss Triumph are the leading early varieties. Netted Gem is a good main crop variety.

Agassiz, B.C.—The best early varieties are Early St. George, Early Ohio, Epicure, and Early Rose. The main crop varieties that have given best results are Green Mountain, Burbank, and Netted Gem.

Improvement

Constant vigilance on the part of the potato seed stock producers is necessary to maintain the most productive stocks. If yield in the seed stock falls off, yields in general crop production based on this seed will likewise be reduced.

Special seed plot maintenance for the purpose of eliminating poor-yielding and diseased progeny is the most satisfactory method known. There are five methods of maintaining the stock seed: (1) mass selection; (2) mass-hill selection; (3) pedigree-hill selection; (4) tuber-unit selection; and (5) Certified Foundation seed.

Mass selection of the tubers from the field rows at digging time, or from the bins in the storage cellar, has been employed far too extensively and is not recommended. Too much is left to chance when the particular parent plants from which the tubers were selected are not known.

Mass-hill and pedigree-hill selection are steps in the direction of recorded performance for each hill, during the season of growth, with regard to health of the growing plant and also the size, quality and yield of tubers from each hill. The presence of diseases in the plants can be detected in the leaves of the plants and also by the vigour of the plants. Where such hill selection is done, the progeny of the best hills is used for multiplication the following year, using the seed as a bulk lot. It is also a good plan to save stock from the best producing hills, to be planted as in the former year, thus perpetuating the process of eliminating poor-yielding material.

The tuber-unit system consists of selecting desirable tubers from the healthy, high-yielding hills and dividing each of these tubers into four sets which are planted in their respective order and given a number. Notes are taken on habit of growth, disease—freedom and vigour of plants, during the season of growth, as well as on the type of tubers and the yield produced.

These seed plants should be isolated from all other potato stocks to remove the possibility of the spread of disease. Should the progeny of one hill from a tuber show the development of disease or undesirable characters, the progeny of the whole four hills from the parent tuber must be discarded. By this system of elimination only the very best stocks will ultimately reach certification and become the basis for general field crop production. When this method of stock seed production is followed, hill selection from the general field crop is discontinued.

The latter two methods are recommended where disease-free, high-yielding stock is to be produced ultimately for certification.

For inspection and certification of seed stock, application should be made to the Plant Protection Division, Production Service, Department of Agriculture, Ottawa, Ontario. Special Pamphlet No. 43, Certified Seed Potatoes, deals with the various phases of this work.

Cultivation

Like all other inter-row tilled crops, the potato gives response to careful and thorough cultivation. The use of the light harrow or weeder twice after planting, but before the young potato plants come through the ground, for the purpose of levelling the ground and destroying small weeds, will save much cultivation later and help to conserve moisture. Tillage may be overdone; more frequently it is too inefficiently and insufficiently done to be of greatest value to the crop. Weed control and conservation of moisture are the two primary functions of tillage. Of the two, weed control is the more important, since weeds use up the soil moisture and plant food. Cultivation also provides a soil mulch that aids in soil moisture conservation. The early season cultivation is probably the most beneficial, since the tilth of the soil is improved and the soil moisture supply necessary to the young plants maintained. Deep and frequent tillage should be provided in the early part of the season, gradually becoming shallower as the plants become larger and shade the soil. The shading of the soil by the leaves tends to reduce the rate of evaporation of moisture from the soil. Deep cultivation at this stage of plant growth would injure the surface feeder roots. Tillage given late in the season, or after the tubers have formed, may be injurious to the crop. Hence, the time that cultivation is given is more important than the frequency or depth.

Ridging

Many growers ridge up the potatoes after the last cultivation. Ridging tends to provide drainage and, during cool seasons, helps to warm up the land. In sections where lack of moisture occurs in the mid-season, severe ridging may be of doubtful value, except for the fact that it provides friable loose soil in which the tubers can form. The crop may be dug with greater ease where ridging has been done.

The ridging of the crop may be quickly and efficiently done by means of the lister double-mouldboard plough, or with the implement known as a horse-hoe. The latter mentioned implement may be fitted with scraper mouldboards or with revolving disks. These implements gather the soil up on both sides of a row and can be adjusted for different depths of ridging.

Tillage Machinery

Several types of cultivators are used. The single-row cultivator, with an adjustment lever to regulate the width and another lever attached to a wheel at the front and a shoe at the back to regulate the depth that the teeth may enter the ground, has been in use for many years. This type is quite satisfactory where a small acreage has to be handled. When equipped with the harrow-teeth irons, a very satisfactory job can be done. With the wing feet attached to the rear ends of the bars of this implement, the soil can be moulded up to the potato plants. Some growers prefer to use the long wings that extend from the front to the back of the cultivator.

The spring-tooth single-row cultivator is also very useful.

The two-row cultivator, built on wheels and provided with a seat for the operator, is one of the most efficient machines to use where a large acreage is grown.

Control of Insects and Foliage Diseases

Since the yields per acre may be reduced severely if insects and diseases are not kept under control, a power sprayer should be used for applying the combined insecticide and fungicide. A four-row sprayer, equipped with three nozzles for each row and capable of maintaining from 200 to 300 pounds pressure per square inch, will give the most satisfactory results. In the second section of this pamphlet, control measures for insects and diseases are discussed.

Harvesting

Where the soil is well drained and conditions are fairly ideal for the crop, digging can be deferred until quite late in the autumn; but where the land is on the heavy side and inclined to be wet, digging should be done before the autumn rains set in. Where the crop has been free from blight, it has been found that the digging can be done to advantage during late September or early October. At any rate, digging should be done before the ground freezes during the nights.

If late blight has been present, digging had better be deferred until the latest possible date. The tubers that are diseased can then be easily detected and left in the field. Early digging of a diseased crop and piling in the field or placing in a storage cellar encourages the spread of the disease to healthy tubers.

Diggers

Several efficient makes of potato diggers are now on the market. These machines vary in principle from the plough type, with steel prongs at the back to raise the tubers out of the ground, to the rotating-sprocket two-prong type and the endless-chain elevator type. More recently, power-driven diggers with bagger attachment have made their appearance.

Mechanical diggers have to be operated with discretion to prevent unnecessary injury to the tubers. The rods of the apron shaker at the rear of the digger should be padded with pieces of old rubber hose to avoid unnecessary bruising.

The potato, like all other vegetable crops, should be handled carefully so as to avoid mechanical injury.

Digging by means of a four-tined fork is still done where a small area is to be handled. One good man can dig about a half an acre in a day, while a mechanical digger can lift from three to five acres in a day.

Ploughing out by means of a single-mouldboard plough with coulter removed is still employed by some farmers. Four-tined potato digging grapes, made in a hoe-like shape, are then used to get the tubers out of the loosened ground.

Where diggers are used, the usual practice is to dig every second row so as to avoid damaging the tubers already on the surface of the ground. After the tubers already dug are picked up, the remaining rows are dug.

Some growers use the spring-tooth harrow on the land directly after the digging is done, to drag out tubers that have remained slightly covered in the soil.

Storing Potatoes

When going into storage, the tubers should be as dry as possible. All diseased or damaged tubers should be sorted out. The best storage temperature for seed stock is 33° to 38°F., but for table stock 38° to 42° F. will give best results. Lower temperatures tend to cause a sweet flavour. Storing potatoes in the basement of a dwelling house is not, as a rule, satisfactory owing to the difficulty of providing proper ventilation. Many thousands of bushels of potatoes are lost each year through storing in faulty cellars, closely-constructed bins, or where the temperature is too high.

For sections where very severe conditions are experienced during winter, a storage cellar built entirely in the ground and provided with intake and outlet ventilation will be found satisfactory. An ideal location for this type of storage cellar is in a hill side, where good drainage can be had. Where cedar poles, posts and logs are available, such a cellar can be built quite cheaply. On the other hand, if these materials are not available, a more durable concrete construction would possibly be more satisfactory. The potatoes will keep much better when placed in slatted bins. A false floor and walls made of boards six inches wide, with half-inch cracks between, will allow air circulation. The false floor and false walls should be six inches from the floor and walls of the cellar. A cellar 14 feet wide and 30 feet long, provided with bins as described, should take care of 1,000 bushels.

Towards spring, when the air is warm, it may be necessary to open the ventilators and doors at night, when the air is cool, and to close them again in the morning. By this means the potatoes can be kept dormant for a much longer period.

Temporary pitting in the field at digging time is sometimes done. Fifty to sixty bushels are piled up and covered with straw and earth. Should frost threaten, more earth should be applied as a covering for the pile. Diseased potatoes, when dug late, should be placed on the barn floor in a shallow flat pile and, if necessary, covered with hay or straw to protect them from frost. All light must be excluded, as potatoes deteriorate in quality very rapidly when exposed to it.

Pitting Out-of-Doors

When storage cellar space is not available, satisfactory temporary pits may be made. Select a well-drained location. To store 500 bushels of potatoes, dig a trench 4 feet deep, 14 feet wide, and 15 feet long. Line the sides with boards or small poles to keep the earth from falling in. Fill in with about 3½ feet of potatoes. Then place logs around the sides to serve as a wall plate and to keep the soil from caving in. To support the covering, a strong log is placed lengthwise down the centre. Small poles, 7½ to 8 feet long, are placed with one end resting on the central log and the other end on the logs at the edges of the pit. The whole roof of the pit is covered on both sides in this way. Then place two ventilators made of lumber 6 by 6 inches square and 4 feet long, one at each end of the pit. The roof poles are then covered with a foot or so of straw to prevent the soil from falling through. Sods are placed over this and some soil spread over the sod to make about one foot of soil covering. Rotted, dry horse-manure, to the depth of one foot, is placed over the soil.

The space between the roof of the pit and the potatoes is not filled with straw. A thermometer is lowered, by means of a string, into the pit through one of the ventilators. The temperature should remain at 40° F. During cold weather, the ventilators may have to be plugged with burlap bags.

Grading

To produce a uniform product for the market, one should use a mechanical grader. These machines can be made to grade in accordance with the regulations laid down in the Fruit, Vegetables and Honey Act. For those with only a small crop to handle, a hand-power machine is quite satisfactory; but where a very large quantity is to be graded, a power-driven grader will prove a great advantage.

Growers should follow the practice of having new sacks with their name stencilled on them.

The most commonly used type of commercial package is the burlap bag. This type of a container facilitates shipping and storing, and there is less danger of the potatoes being damaged by handling, when put up in the burlap bags.

The new legal-standard weights for table potatoes packed in cotton, jute, or mesh bags for sale are: 100 pounds, 75 pounds, 50 pounds, 25 pounds, and 15 pounds. The weights for potatoes pre-packed in paper bags are 10 pounds and 15 pounds.

Where special trade is being catered to, such as for baking potatoes, the selected tubers may be put up in attractive containers which may take the form of special cartons or small bags.

The Fruit, Vegetables and Honey Act should be complied with when preparing potatoes for market. Copies may be obtained from the Publicity and Extention Division, Dominion Department of Agriculture, Ottawa, Ontario.

Cost of Production

There is a great deal of difference in the cost of production of potatoes in the different parts of Canada. Various factors have to be considered. Cost of labour varies in different sections, as does the cost of insect control and disease control. Then there is the cost of fertilizers, and the question whether the total amount of fertilizer should be charged up to the potato crop or divided amongst all the crops in the rotation. The cost of production, worked out by the Division of Field Husbandry for Eastern and Western Canada, will give a very fair idea of this problem.

The average cost of producing potatoes on three eastern experimental farms, during the eight-year period from 1923 to 1930, is stated as follows: "With an average yield of 257·8 bushels, the total cost of producing potatoes has been $74.96 per acre, or 29 cents per bushel."

INSECT CONTROL

The Colorado Potato Beetle

The Colorado potato beetle is well known to most growers. The adult is a hard-shelled beetle, about $\frac{3}{8}$ of an inch in length, having the wing-covers marked with yellow and black stripes. It winters in the soil, and in the spring, often before the new crop of potato plants is up, may be seen wandering over the soil waiting for its favourite food plant to appear. The eggs are laid on the undersides of the leaves, and the young, as soon as they hatch, attack the foliage; both adults and larvæ are destructive, but the latter do the most damage. Tomato, egg plant, tobacco, and nightshade are also attacked. The beetle is found in every province of the Dominion.

CONTROL

Eastern Canada.—This insect can be satisfactorily controlled by spraying or dusting the plants with an arsenical. Since potatoes are frequently attacked by fungous diseases, it is customary to dilute the poisons in Bordeaux mixture rather than in water, in this way controlling both insects and diseases in the one operation. Spraying perhaps is the most generally accepted method of applying the insecticide, although dusting is almost as effective. Control measures should be undertaken as soon as the first eggs hatch; the operation should not be delayed until the plants commence to show signs of injury. Make the first application early and repeat when necessary. Treatments are usually made at intervals of 10 days to 2 weeks, depending on weather conditions and the seriousness of the attack; 5 or 6 applications during the season are commonly given. Spray or dust thoroughly, covering the upper and lower surfaces of the leaves. If spraying, use 100 to 120 gallons of spray per acre at each application in the case of fully grown plants and proportionately less where full growth has not been attained. At least 50 pounds of dust should be used where dusting is practised.

When spraying, use either 2 pounds of arsenate of lead, 1½ pounds of arsenate of lime, or ¾ of a pound of Paris green to 40 gallons of 4-4-40 Bordeaux mixture. Directions for making Bordeaux mixture will be found on page 17. If the arsenicals are diluted in water instead of Bordeaux, 2 or 3 pounds of hydrated lime should be added when Paris green or arsenate of lime are used, since this prevents any possibility of burning.

The best dust to use is one composed of 12 pounds of dehydrated copper sulphate, 8 pounds of arsenate of lime, and 80 pounds of hydrated lime. This dust has a fungicidal value as well as being a good insecticide. If fungous diseases are not a factor of importance, a dust made up of 8 pounds of arsenate of lime and 92 pounds of hydrated lime will give good results against the beetle.

Prairie Provinces.—On the prairies, a dust composed of 1 part of arsenate of lime or Paris green to 10 parts of hydrated lime is recommended. In areas where there is no dew, white arsenic can be substituted for arsenate of lime and used at the same strength. In Alberta, arsenate of zinc has given excellent control when diluted with hydrated lime or flour, at the rate of 1 to 10. Sprays of arsenate of lime or Paris green diluted in water as recommended for Eastern Canada can also be used with good results.

British Columbia.—Spray or dust with any of the arsenicals as advised for Eastern Canada.

The Potato Flea Beetle

The potato flea beetle, a tiny insect which commonly passes unnoticed, frequently causes severe injury to the foliage of potatoes by eating small round holes through the leaves. In severe cases of infestation the holes become sufficiently numerous to cause browning and death of the foliage. The beetle itself is only about $\frac{1}{16}$ of an inch in length and is black with brown legs. It is able to jump very actively and due to this habit, is elusive and difficult to see. The adults feed readily on a wide range of vegetables and weeds, the larvæ living in the soil, where they attack the roots. In the case of the potato, the tubers are sometimes attacked, resulting in the formation of small, brownish, corky areas. In some instances these are flat or slightly sunken, in other cases definite depressions or tunnels into the flesh are formed while, less frequently, tiny pimples are produced. The faintly brown, corky tissue is evident, however, under all circumstances. If these areas are cut through, it will be found that usually this corky tissue is projected into the flesh in the form of a fine sliver-like structure.

CONTROL

Eastern Canada.—This insect is easily controlled by spraying the foliage with 4-4-40 Bordeaux mixture as described on page 17. Make the first application as soon as the insects are seen and repeat in 10 to 12 days, or when necessary.

Prairie Provinces.—Treat the plants when the injury first becomes apparent, with a dust composed as follows:—

Paris green	1 part
Copper carbonate	1 part
Hydrated lime	4 parts

Repeat the application as soon as the work of the beetles is again noticed.

British Columbia.—Spraying with Bordeaux mixture alone acts as a deterrent. Paris green or arsenate of lead may be added to the Bordeaux to make it more effective, or these may be used alone; 1 pound of arsenate of lead or ½ pound of Paris green and 4 ounces of casein should be used to each 40 gallons of water. In the latter case, ½ pound of freshly slaked lime should be added. Arsenate of lead or Paris green may also be used dry and should be mixed with hydrated lime, at the rate of 1 pound of the poison to 20 pounds of hydrated lime, and the mixture dusted over the plants in the early morning when the dew is on. In the case of tomato plants, protection may be secured by the same treatment or by dipping the whole plant except the roots, before planting, in a mixture of 1 pound of arsenate of lead in 10 gallons of water.

The Potato Leafhopper

The potato leafhopper is a small, green, very active insect, commonly found on the under surfaces of potato leaves. It feeds by sucking the juices out of the foliage, causing it to change in colour from dark to pale green and, in severe infestations, to yellow. Frequently the margin and tips of leaves attacked by this insect, turn brown, and in cases where the insect is very abundant defoliation takes place. The nymphs resemble the adults in colour and shape but are wingless and, except when fully grown, are considerably smaller in size. Although present in all provinces of Canada, the potato leafhopper is a pest of importance only in the east.

CONTROL

Use 4-4-40 Bordeaux as advised previously for flea beetles. Spray particularly the undersides of the leaves, making the first application when the leafhoppers commence to attack the plants. Repeated spraying should be given at 10-day intervals as needed.

White Grubs

White grubs are the young of June beetles and, like wireworms, are more numerous in freshly broken land. The mature grubs are about 1½ inches in length, greyish-white, with brown head and legs. When at rest they usually lie curled in a half circle. These insects commonly attack the potato, eating out small, wide-spreading excavations which usually have regular and even margins. Definite chambers or holes are found only in the case of severe infestations. The jaw marks of the grubs are easily discerned in the eaten-over area and resemble the teeth scars made by mice. Rotting of the tissue seldom follows the feeding of white grubs, although this is sometimes noticed when the tubers are lying in wet soil, but in most cases the exposed area heals over, forming a roughened scar.

The eggs of June beetles are laid preferably in sod, and the resulting white grubs require three years in which to mature. During this time they live in the soil, where they feed on the roots of grasses and a wide range of other plants. The most destructive feeding takes place in the second year of their life. They are found in all the provinces but are of greatest economic importance in Quebec and Ontario.

CONTROL

In districts where white grubs are prevalent, care should be used in selecting a field in which to plant potatoes. Fields with a grub population of three or more per square yard should be avoided where possible and only those fields chosen which are known to have a small number of these insects present. Clay or heavy clay loam soils standing in stubble or from which a hoed crop has just been removed are usually comparatively free of white grubs. Such soils should be fall-ploughed and thoroughly worked up in the spring before planting, as such practices assist in reducing the numbers of insects present.

Where it is not possible to select a piece of ground free from white grubs and where only heavily infested fields, such as old pasture or two-year-old meadow, are available, extra preparation of the soil becomes necessary. Plough in late September at a comparatively shallow depth, and follow with a thorough disking. In the spring, disk the ground four times before planting, or three times where a tractor is used. Such a cultural program should reduce the number of white grubs to a point where little injury to the tubers will result.

Sod land, which may be so situated as to become infested regularly with white grubs, can be protected from infestation. This can be brought about by scattering superfine sulphur, broadcast by hand or seed drill on the grass about May 24 at the rate of 300 pounds per acre. This practice should be of particular value where, for one reason or another, it is known a year in advance that a certain piece of sod, likely to be infested, will be desired for potatoes.

The treatment should be undertaken in the year of June beetle flight; it will serve to protect the potatoes the following year, when the grubs would be most destructive, by repelling the beetles when attempting to lay their eggs in the sod.

June beetles are only in flight in important numbers in most districts every third year. Their flight years are known for most parts of Canada, so that if any difficulty is encountered in determining this in any locality, the information can be secured by applying to the Dominion Entomologist, Department of Agriculture, Ottawa.

Slugs

Potatoes growing on heavy land are sometimes attacked by slugs, which not only feed on the foliage but also injure the tubers. When the tubers are attacked, the slugs eat their way through the skin and, once inside, clean out a cavity which, in some cases, may be almost as large as the potato itself. Frequently the skin remains intact, with the exception of the entrance hole, while in other cases it breaks away, leaving a ragged, irregular opening fringed with fragments of skin. Traces of slime secreted by the slugs are usually found inside the tuber, and, in storage particularly, rotting and blackening of the tissue frequently takes place.

While the vines remain green, the slugs confine their attack to stems and leaves of the plants, but as soon as the tops die down they turn their attention to the tubers, which are injured in the manner already described.

CONTROL

There is no specific remedy for slugs when feeding on tubers, but if the vines are kept thoroughly sprayed or dusted with Bordeaux mixture throughout the summer little trouble will be experienced from this pest. Dusting infested plants

with hydrated lime in the late evening will also kill many of the slugs. Since the slugs confine their attack to the foliage as long as it remains green, the shorter the time elapsing between the dying down of the tops and the removal of the tubers from the ground the better.

Recently a promising new remedy for slugs has become available, namely, metaldehyde mixed with bran and placed in small piles where slugs are known to be present. The material is particularly attractive to slugs and appears to have the power of luring them from considerable distances. Its value under field conditions has not yet been definitely established and is still under investigation. The mixture may be obtained at seed stores; the exact method of application is outlined on the container.

Wireworms

As wireworms are found naturally in sod and grassland, potatoes planted on freshly reclaimed ground are frequently attacked by these insects. They enter by way of the skin, and in feeding make numerous tunnels through the tubers. The tunnels are about $\frac{1}{8}$ of an inch in width and are usually surrounded by darkened tissue. If the tubers are heavily infested, the flesh breaks down and rotting quickly sets in, which renders the potato unfit for market purposes. Heavy, damp soils are usually more severely infested than sandy, well-drained land.

Wireworms are the young of click beetles, which lay their eggs, preferably, in sod. The larvae, or wireworms, live in the ground throughout their life, feeding on the roots of grasses. They take at least three years to mature. These insects attack a wide range of wild and cultivated plants and are present in every province of Canada.

CONTROL

There is no satisfactory control known for these insects, although growers may do much to lessen their destructiveness by proper farming methods, care in the selection of their land, and in the choice of crops planted. Soil known to be infested with wireworms should be avoided and land free of this pest selected when choosing a spot in which to plant potatoes. Freshly broken sod should be carefully examined, since wireworms are frequently abundant in such situations. It is also well to remember that these insects prefer damp, poorly drained land. Encourage quick growth of plants through proper tillage and the liberal use of fertilizers. On land known to be infested, grow such crops as buckwheat, flax, alfalfa, clover, beans, peas, field peas, rape, turnips, mangels, sunflowers, and squash. Then, when the soil is freed of these insects, susceptible crops, such as potatoes, corn, and strawberries, may be substituted. When grain is planted on land in which wireworms are present, seed somewhat more heavily than normal to provide for loss of some plants. Short rotations will be found helpful and should be practised on all infested farms.

DISEASE CONTROL

The diseases which attack the potato plant manifest themselves by a variety of symptoms, which may be confined to the foliage, stalk, or tubers, or to any combination of these plant parts. The diseased condition may be caused by microscopic plants known as fungi, by bacteria or germs, or by infectious principles known as viruses.

In brief, potato diseases may be divided into three groups, according to the important method of control used against them. The first group includes foliage diseases, which are controlled by spraying or dusting operations; the

second group includes tuber-borne diseases, against which seed treatment offers some measure of control; while the third group includes virus diseases, against which roguing practices have proved effective.

The standard wet spray used to combat foliage diseases is Bordeaux mixture of the well known 4-4-40 formula. This solution contains 4 pounds of copper sulphate and 4 pounds of hydrated lime in 40 gallons of water. Where much spraying is to be done, it is advisable to prepare a stock solution of copper sulphate, made by suspending 40 pounds of copper sulphate, contained in a burlap bag, just below the surface of 40 gallons of water contained in a barrel. When the copper sulphate is all dissolved, every gallon of this solution contains 1 pound of copper sulphate. In making up a 40-gallon tank of spray, first run 34 gallons of water into the sprayer, then add 4 gallons of the stock solution of copper sulphate. Now prepare in a bucket the lime solution by slowly adding, with constant stirring, 2 gallons of water to 4 pounds of hydrated lime. Pour this suspension through the strainer into the spray tank. The preparation is now ready for use.

Foliage Diseases

The two important foliage diseases controlled by spraying or dusting operations are late blight and early blight.

Control of Late Blight.

Late blight is one of the most serious diseases of the potato. During hot, dry seasons it rarely occurs, but in wet, cool seasons it becomes very prevalent and destructive. The disease commonly makes its appearance on the lower leaves or stem of the plant shortly before blossoming time. This infection is usually overlooked until late in July or August, when cool nights and heavy dews enable the fungus to become established on the upper leaves of the plant. The blight shows on the leaves as dark, water-soaked areas which bear on their under surfaces a white mildew. Sometimes the disease first attacks the main stalk and branches, on which it produces elongated, brownish-black areas. The disease also attacks the tubers, where it appears externally in the form of irregular, sunken, dark purplish discoloured areas. Within the flesh, under these areas, a reddish-brown rot is produced. The following control methods should be practised:

(1) Plant only healthy seed stock.

(2) Spray the growing plant, at intervals of 1 week or 10 days until maturity, with Bordeaux mixture, beginning when the plants are about 6 inches high. At least 80 gallons of the spray mixture should be applied to an acre at a pressure of 250 pounds or more. Where dusting is employed, use a 20-80 copper-lime dust, beginning with applications of about 20 pounds to the acre, and gradually increasing the amount until 35 pounds per acre are being applied when the vines are large.

(3) Keep the developing tubers adequately covered with soil.

(4) If necessary, kill the vines prior to digging, with a spray containing 1¼ pounds of sodium arsenate to 100 gallons of water.

(5) Do not dig blighted potato fields until 1 week after all the vines are dead.

(6) Do not cover harvested tubers, whether in piles or barrels, with potato foliage.

(7) If conditions allow, let the harvested tubers dry off, and discard the blighted tubers before placing the crop in winter storage.

Control of Early Blight.

Early blight principally attacks the leaves, on which it produces oval or irregular dark-brown spots, showing concentric ridges. During warm humid weather this disease may cause serious damage by defoliation of the plants. The most susceptible varieties are Irish Cobbler, Early Rose, and Early Ohio. The disease occasionally attacks the tubers, on which it produces small, slightly sunken, circular, decayed lesions. To control early blight, spray with Bordeaux mixture as for the control of late blight.

Tuber-borne Diseases

Certain diseases of potatoes are caused by organisms which are carried on the tuber surface. Seed treatment destroys the surface-borne organisms of these diseases, thus effecting a higher and more uniform germination, a more vigorous stand of vines, and a notable increase in yield. However, seed treatment will not assure a rhizoctonia-free or scab-free crop, if the treated sets are planted in soil infested with the organisms of these diseases. Potato seed treatment should be preceded by a careful selection of the seed stock, with the elimination of all misshapen, bruised, and rotted tubers. The following seed treatments are recommended:—

1. Standard Corrosive Sublimate Treatment. Dissolve 4 ounces of bichloride of mercury (corrosive sublimate is a deadly poison) in 1 gallon of hot water. When the crystals are all dissolved, add this solution to 24 gallons of cold water contained in a wooden cask. Immerse the whole potatoes, preferably loose, in this solution for 1½ hours. At the end of the treatment remove the potatoes, allow them to drain, and then spread them out in a clean, airy place to dry. Before the second lot of potatoes is treated, add ½ ounce of corrosive sublimate, previously dissolved in hot water, to the cask. Repeat with a similar addition of corrosive sublimate before the third and fourth treatments. After the fourth treatment, discard the solution and prepare a fresh one. Cut seed cannot be treated by this method.

2. Acid Corrosive Sublimate Treatment. Dissolve, in a glass container, 7 ounces of bichloride of mercury (corrosive sublimate) in 1 quart of commercial hydrochloric acid. Slowly add this solution to 25 gallons of cold water. Immerse the whole potatoes, contained in wooden crates or asphaltum-painted wire baskets, in this solution for 5 minutes. After the treatment, withdraw the tubers, allow them to drain, and then spread them out in a clean place to dry. Sufficient unused solution should be kept on hand to adjust the dip to its original level after each treatment. After 50 bushels of potatoes have been treated, discard the solution and prepare a fresh one. If the potatoes are sprouted reduce the strength of the original solution, using only 5 ounces of corrosive sublimate to the quart of acid in 25 gallons of water.

3. Cold Formalin Treatment. Add 1 pint of formalin to 25 gallons of water. Immerse the potatoes in this solution for 2 hours. The solution may be used over and over again as it does not deteriorate rapidly. This treatment is not as effective against scab and rhizoctonia as the mercury treatment. After treatment, spread the tubers out in a clean place and allow them to dry. Cut seed cannot be treated by this method.

4. Organic Mercury Treatment (Improved Semesan Bel). Add 1 pound of Semesan Bel to 6 gallons of water and stir thoroughly. Place the whole tubers or cut sets in wire baskets and immerse them in this solution for 1 minute. Withdraw the baskets and allow them to drain. Materials not intended for immediate planting should be spread out and allowed to dry in a clean airy place. Avoid piling treated sets to a depth greater than 4 inches. When about two-thirds of the solution has been used (60 to 80 bushels of

potatoes treated), discard the solution and prepare a fresh one. The cut seed treatment is recommended to those growers who have had, or suspect the presence of, bacterial ring rot disease in their stock. This treatment may reduce the amount of infection transmitted by cutting knives.

Potatoes which have been treated with mercury compounds are poisonous, and treated potatoes cannot be used for human or stock consumption. Dispose of used or unused solution with care.

The common tuber-borne potato diseases are rhizoctonia, common scab, blackleg, and bacterial ring rot.

Control of Rhizoctonia

The rhizoctonia disease produces irregular, brownish cankers on the underground stem or stolons of the potato plant. Young sprouts may be attacked before they emerge from the soil. When such a condition occurs the sprouts are often completely rotted off, resulting in misses or the development of weak plants. When older underground stems are attacked, elongated, sometimes shaggy brown lesions develop which partially or completely girdle the stem. As a result of this condition, the top of the plant takes on an abnormal appearance, characterized by an enlargement and purpling of the stalk, a rolling of the leaves, and the development of reddish or purplish tubers in the axils of the leaves. During moist weather, affected stems are covered with a grayish-white bloom at the point where they emerge from the soil. Severely affected vines usually produce a large number of small poorly shaped tubers. Moderately affected plants produce normal-shaped tubers which bear on their surfaces numerous brown or black superficial bodies of various sizes. These bodies serve to disseminate and overwinter the disease. Rhizoctonia may be controlled as follows:—

(1) Treat the contaminated seed with any one of the recommended seed treatments.
(2) Avoid planting potatoes in the same soil year after year.

Control of Common Scab.

Common scab is a disease which attacks only the tubers, on which it causes the development of more or less circular, irregularly margined, brownish lesions which may be raised or sunken. Ordinarily only the skin and a few layers of cells below the lesions are affected. This disease does not produce a tuber rot. Common scab may be controlled as follows:—

(1) Disinfect the tubers by any one of the seed treatments.
(2) Practise a crop rotation.
(3) Avoid soils which have been heavily limed. Preferably the soil should not exceed 5·3 in pH value.
(4) Do not apply to the immediate crop heavy dressings of manure.

Control of Blackleg

The blackleg disease usually makes its appearance some time before the blossoms appear. Affected plants may be recognized by their erect, stiff habit of growth, the yellowish colour of their foliage, the upward rolling of the leaves and by the blackening and rotting of the basal portion of the stalk. Tubers from diseased plants may show a black or brown rot, usually located at the stem end of the tuber. The rotted area is sharply delimited from the healthy tissue by a dark line. When the conditions are favourable, the disease rapidly spreads in the tuber and reduces it to a soft, black, foul-smelling mass. Under some conditions, however, the tuber is only partly destroyed, in which case the rotted area on drying becomes firm and shrunken. Blackleg may be controlled as follows:—

(1) Carefully select only sound tubers and discard all diseased tubers.
(2) Treat the seed tubers with any one of the recommended seed treatments.

Control of Bacterial Ring Rot

Bacterial ring rot manifests itself on both the foliage and tubers of affected plants. The foliage symptoms do not usually appear until late in the growing season, although during dry, hot seasons diseased plants can be detected about 55 days after planting. The first symptom of the disease is a slight wilting of one or more of the basal leaves of the plant. The affected leaves turn yellow and eventually die. As the disease progresses, the wilt involves the higher leaves of the plant until eventually the whole stalk wilts and dies. Tubers from diseased plants may show no apparent infection or may show various degrees of discoloration or decay. Diseased tubers show a rot extending from the stem end towards the outside, in which region a crumbly or cheesy rot is produced which is creamy yellow or light brown in colour. Under favourable conditions the disease may rot out the entire centre of the tuber, leaving only a hollow shell. Externally diseased tubers often show deep cracks. Secondary infections may reduce infected tubers to slimy soft masses. Bacterial ring rot may be controlled as follows:—

(1) The only practical method of control is the exclusive use of disease-free seed.
(2) Safeguard the crop by seed treatment with any of the recommended dips.
(3) Eliminate all tubers showing internal blemishes.
(4) Keep the cutting knives disinfected when seed cutting, by immersing them in a weak solution of formalin or Semesan Bel.
(5) Avoid replanting fields in which diseased plants were present the previous year.

Virus Diseases

The virus diseases of potatoes are distinct from those due to bacteria and fungi. They are caused by an infectious principle called a virus which is carried in the sap of diseased plants. Owing to the fact that virus diseases are found in all areas where potatoes are grown, they are one of the most important limiting factors in the production of this crop. These diseases may reduce the yield of tubers from 10 to 50 per cent in one season, and are largely responsible for the " running out " of potato stocks.

Since the sap of diseased plants is infectious, these diseases may be spread by the leaves of such plants rubbing against those of healthy ones, or by the hands of workers who have handled diseased material. Seed-cutting knives, as well as the pickers of planting machines, may also serve as means of passing on the disease to healthy seed pieces. A number of insects are capable of transmitting one or more viruses by feeding on diseased and then on healthy plants. Plant lice or aphids are the most common carriers or vectors.

When a plant becomes diseased, the virus passes readily from the stem to the tubers, where it remains active as long as the tubers are alive. When infected tubers germinate, the virus enters the sprouts, and later the stems, leaves, and tubers of the new plant. There is no known method of destroying the virus in the infected foliage or tubers without injuring these structures. Spraying with Bordeaux mixture and other fungicides is therefore of no value in the control of these diseases.

Although most potato viruses are carried in the tuber, none are known to live in the soil, except in infected tubers allowed to remain in the field over winter. Volunteer plants arising from such tubers may serve as potential sources of infection the following year, especially if potatoes are planted in the same area or nearby. Certain weeds and cultivated plants, such as the tomato, pepper, bitter nightshade, eggplant and petunia will harbour some of the potato viruses, from which sources they may be spread by insects to potato plants.

The most important potato viruses occurring in Canada are as follows:—

The *mosaic* group includes a number of diseases with symptoms ranging from a faint mottling to a distinct mottling accompanied by a severe crinkling of the leaflets. The mottling associated with these diseases may become masked when the temperature rises above 80° F., rendering it difficult to detect these diseases during a period of hot, dry weather and bright sunshine. The mottling may also become obscured by using sprays which have a heavy lime residue.

Leafroll causes an upward rolling of the margins of the lower leaves followed by a yellowing and dwarfing of the plant. In severe cases there may be a reddening of the margins of the leaves, and, in certain varieties, there may be a brownish discoloration in the form of a network just under the skin of the tuber, known as " net necrosis."

Spindle tuber manifests itself in both the foliage and the tubers. The foliage is darker green than normal, and the whole plant is dwarfed and has a staring upright appearance. Infected tubers are abnormally elongated with numerous protruding eyes, and are often pointed at the ends.

In the case of the *yellow dwarf* disease, the affected plants have a stocky dwarfed appearance, and the foliage assumes a yellowish green colour. The plants die from the top downwards, and brownish coloured areas may appear in the pith of the stems. The tubers are small, cracked, and may show a brownish discoloration in the flesh.

Plants affected with *witches broom* are extremely dwarfed and bushy, due to the large number of spindling stems arising from the same seed piece. The foliage is light green and, in advanced stages, the margins of the leaves may assume a yellowish hue. The tubers formed, if any, are extremely numerous and small, often not larger than a pea.

Control of Virus Diseases

Since virus diseases are tuber-borne, the most effective method of control is to use seed with a minimum of disease. This quality of seed is assured if Canadian Certified seed potatoes are used. Some growers may find it desirable to purchase their entire supply each year, while others consider it more satisfactory to produce their own foundation seed in a seed plot. This seed plot should be located at some distance from other potato fields, especially from table-stock areas, where virus diseases are likely to be prevalent. Even Certified seed potatoes will not remain free from virus disease indefinitely, unless there is a careful and continuous effort on the part of the grower to remove all diseased plants as soon as they appear. The seed plot should therefore be " rogued " several times during the growing season. The first roguing should take place as soon as the plants are large enough to show typical symptoms. Mosaic will become evident when the plants are from 2 to 3 inches high, but leafroll may not show until the plants have reached from 6 to 8 inches. At the first roguing, the old seed pieces should always be removed, otherwise they may produce new sprouts which may serve as further sources of infection. In later roguings the newly formed tubers should also be removed to prevent them from getting mixed with the healthy tubers at harvesting. The diseased plants should be placed in a canvas bag, or other suitable closed container, as soon as they are removed, in order to prevent any aphids adhering to the diseased plants from falling on healthy plants. Diseased plants should never be piled at the ends of the rows or near healthy plants. All diseased plants, including tubers and seed pieces, should be destroyed, preferably by burning. The roguing of diseased plants is facilitated when the seed plot is planted in tuber units; that is, placing all the seed pieces of a tuber in adjoining hills, and leaving a space between these and those of the next tuber. According to this method, even when only a single diseased plant is detected, all the remaining units from the same tuber should be promptly removed.

The main potato field should also be carefully rogued several times in order to remove all diseased plants. This should be done before insects become sufficiently prevalent to spread disease. Table stock growers are particularly advised to use Certified seed, or seed grown from carefully managed seed plots, in order to reduce the amount of virus disease and to obtain better yields. Special precaution should also be taken when choosing the seed, particularly when cutting the sets, to remove all tubers showing symptoms of spindle tuber, leafroll, and yellow dwarf. These are recognized by elongation of the tubers, pointed seed or stem ends, and by any internal discolorations such as rusty spots or brownish network in the flesh of the tubers. Spread of virus disease during the cutting of seed may also be reduced by dipping the knife, after cutting each tuber, into a 5 per cent soap solution. Certified seed should never be stored in the cellar where turnips and other vegetables are kept, or near other potatoes known to be affected with virus diseases. Aphids brought into the storage house or cellar on vegetables may serve as a means of spreading disease from infected to healthy sprouts.

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