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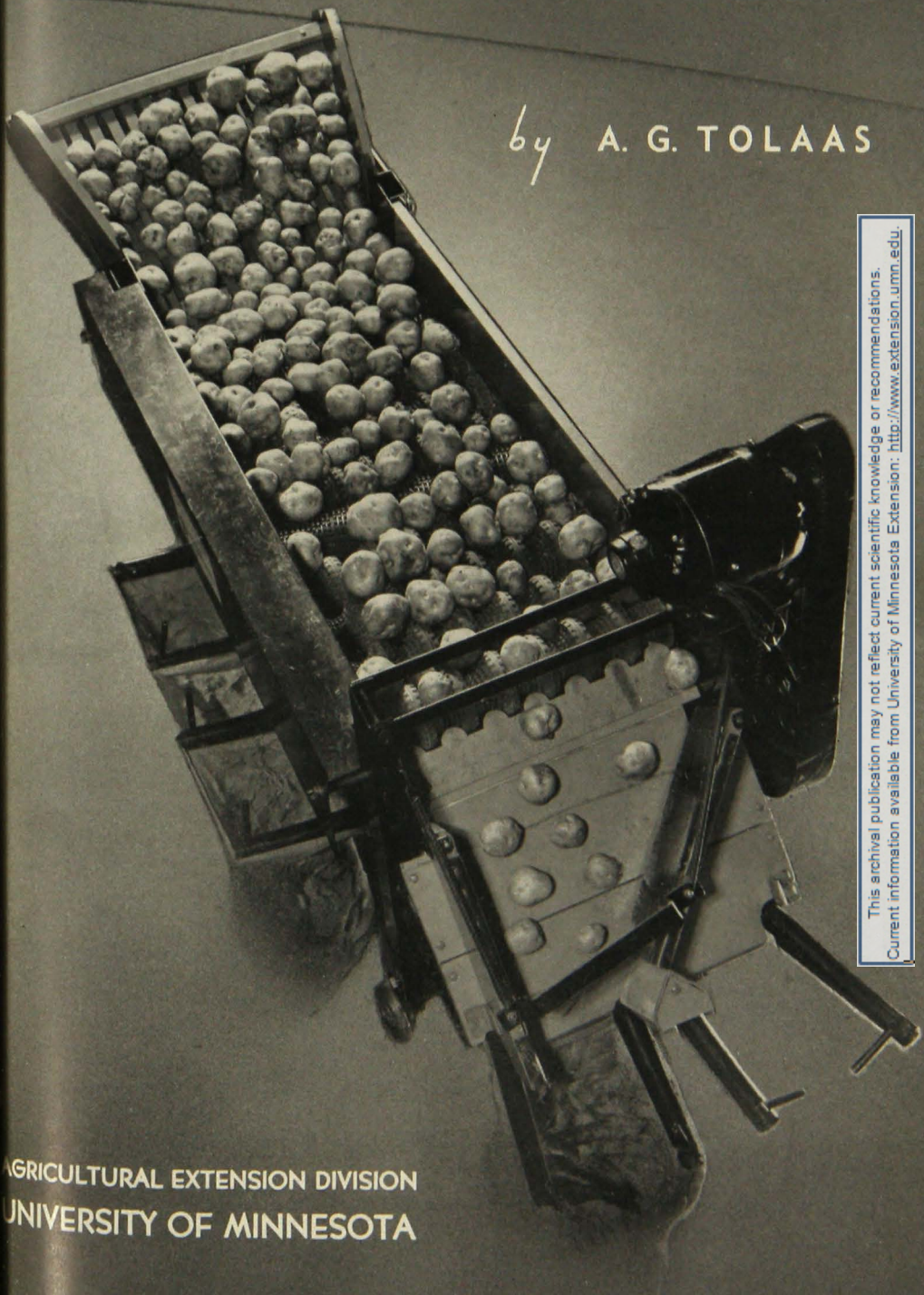
POTATO POINTERS

by A. G. TOLAAS



AGRICULTURAL EXTENSION DIVISION
UNIVERSITY OF MINNESOTA

Potato Pointers

A. G. Tolaas

THE POTATO is grown in every state in the Union. Its chief requirement is a cool growing season. This fact has brought about its extensive culture in the northern half of the United States and in the high altitudes of the western states, altho it is grown successfully in the southern and central states when planted early enough to allow the tubers to form before hot weather sets in. The average annual production in the United States is about 400,000,000 bushels, and the average annual acreage is about 3,218,000. Two-thirds of the annual crop is grown in the northern and western states. Following is a list of the six leading potato-producing states and the average acreage and production of each for the three years, 1932-1934:

	Acreage	Production in bushels
Maine	162,667	46,246,666
New York	206,667	28,500,000
Pennsylvania	194,666	25,602,333
Michigan	264,333	28,291,333
Wisconsin	253,333	23,556,666
Minnesota	349,000	25,218,000
	1,430,666	177,414,998

The six states named grow almost one-half of the potatoes produced in the entire country.

The map in Figure 1 shows that in Minnesota potatoes are grown most extensively north of the Twin Cities. Potatoes grown in the southern part of the state are generally for home consumption, except in Freeborn County, where peat bogs provide conditions favorable to commercial production.

THE POTATO REGIONS OF THE STATE

A mellow, sandy loam soil is considered best for potatoes, but the soils in the commercial potato-growing areas of the state are of many types. The 12 or 15 counties immediately north and northwest of the Twin Cities comprise what is known as the sand-land region. The texture of the soils in this area, in general, varies from light sand to sandy soils containing varying admixtures of clay. The same region also contains some 500,000 acres of high-lime peat, a desirable soil for such varieties as the Bliss Triumph, Irish Cobbler, and Russet Burbank. Limiting factors on peat are scab in dry years and the possibility of frosts in late spring and early autumn.

In the Red River Valley—for the most part, the bottom of ancient Lake Agassiz—the soil is glacial silt, spoken of as gumbo. It is black, and of exceedingly fine texture, with varying admixtures of sand and clay toward the eastern side of the valley. Early Ohios, Irish Cobblers, and Bliss Triumphs are particularly adapted to the Red River Valley soils, and excellent seed potatoes of these varieties are grown there.

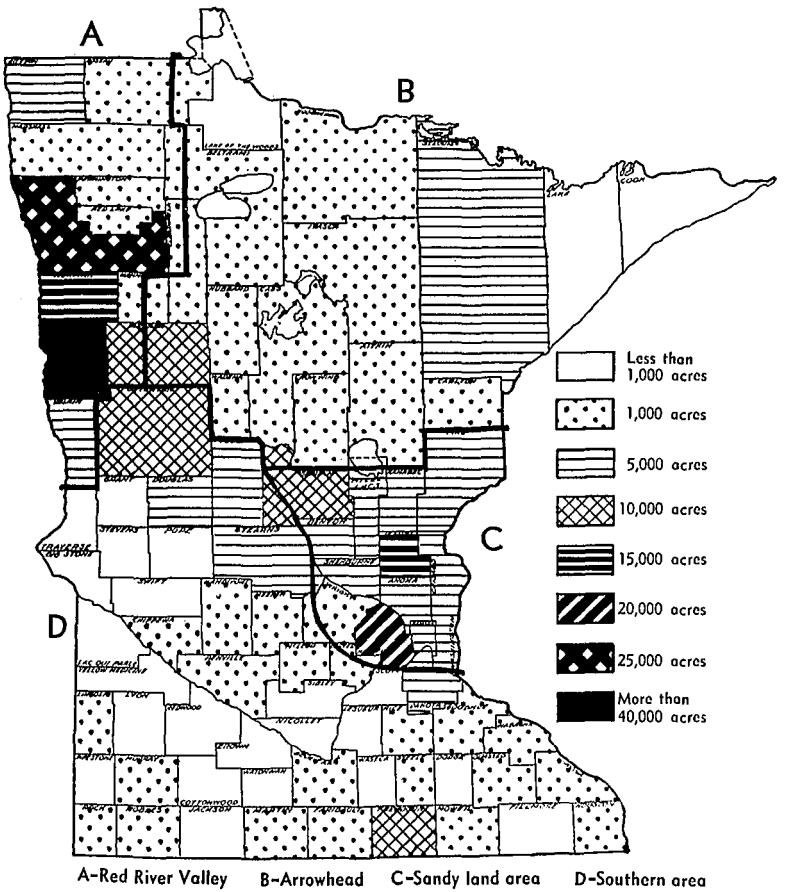


FIG. 1. THE POTATO IS AN IMPORTANT CROP IN MANY COUNTIES OF MINNESOTA

East of the Red River Valley and north of the sand-land area, in the Arrowhead country, soils vary from light sands to heavy clays. The farms are not as extensive there as in the Red River Valley, but potato growing has proved so successful that it has become part of the farm program with most of the farmers. Bliss Triumph, Irish Cobbler, Green Mountain, and Russet Burbank varieties do especially well in that part of the state.

In the southern part of the state, potatoes are grown mostly for home use. In a few southwestern counties, however, and especially in Freeborn County where several large, high-lime peat bogs have been developed, potatoes are produced profitably on a commercial scale. Irish Cobblers are grown almost exclusively on the Freeborn County bogs, while the Rural New Yorker is probably the most commonly grown variety for the region as a whole.

The potato thrives best in a moderately cool climate, and in the commercial potato-growing areas of Minnesota the long summer days with cool nights, followed by shorter and cooler days at the time of tuber formation, afford ideal temperature conditions for potato production. Considerable moisture is required to mature potatoes properly, but when we consider that the average rainfall ranges from 18 to 20 inches in the Red River Valley to 28 or 30 inches in the southeastern part of the state, it is apparent that potatoes are being grown in Minnesota under a wide range of rainfall. Tubers develop best at a soil temperature of 68° Fahrenheit or less. A high soil temperature, when the potatoes are developing, lowers the yield and tends to cause both poor table and seed quality. The hot dry seasons of 1931, 1932, 1933, and 1934 were especially injurious to the quality of the early potatoes grown on the lighter soils. Excessive moisture during tuber formation might be equally disastrous, especially on the heavier soils, which might become waterlogged and hence cause the potatoes to rot.

Altho varieties to be grown are determined by such factors as use intended and adaptability to the soil, the choice is somewhat dependent on the length of the growing season. Some later-maturing varieties do not set tubers until late summer, and it would be unwise to grow such varieties in regions subject to early autumn frosts. The possibility of early autumn frosts on peat bogs is a considerable hazard, but the risk can be reduced somewhat by planting early-maturing varieties, and by certain cultural practices.

VARIETIES

Several factors govern the choice of the variety or varieties to grow: First, the adaptability of the variety to the locality and soil; second, the purpose for which it is to be grown; third, the demand for the particular variety; and fourth, the decision of all growers in a given community not to grow too many varieties. One of the problems confronting the potato industry of the state some years ago was the conglomeration of varieties being grown within its borders. At present, six varieties which have stood the test of time are being grown in the state, altho these varieties were all originated in the East under conditions considerably different from those existing in our own state. The potato breeding work being conducted at University Farm has resulted in the introduction of an extremely early variety which, according to growers' tests in representative regions in the state and a number

of such tests in other states, seems to have a wide adaptability. Two other varieties recently introduced by the Office of Horticultural Crops and Diseases of the United States Department of Agriculture and tried out in Minnesota seem adapted to certain localities.

Bliss Triumph

Maturity: The earliest maturing red variety in the state.

Market: Fairly good table quality; chiefly grown for the southern seed trade.

Tuber: Pink to deep red, depending on soil. Round, blocky; eyes medium deep. Sprouts pink.

Plant: Stems light green tinged with pink; leaves light green; flowers lavender, fading to white in bright sunlight.

Adaptation: Grows well in gumbo soils of the Red River Valley and in the northern part of the state. One of the best varieties for peat or muck soils. Not recommended for southern part of state; suffers severely from drouth.

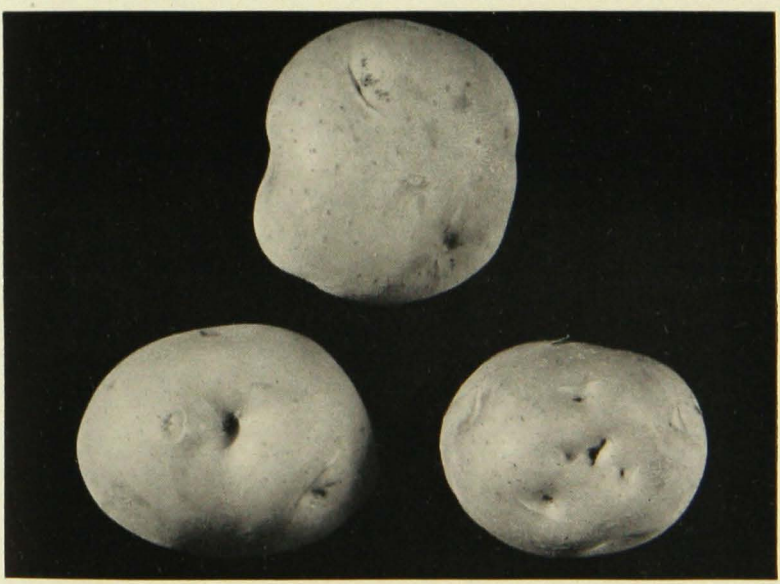


FIG. 2. BLISS TRIUMPH

Early Ohio

Maturity: About 10 days later than Bliss Triumph.

Market: Good table potato demanded by trade in Illinois, Ohio, and Indiana markets. Grown for early market in the sand-land area. Produced in the Red River Valley largely for the seed trade.

Tuber: Pink to light red. Oval, slightly flattened, with numerous moderately shallow eyes. Flesh sometimes tinged with pink. Sprouts light green with pinkish tinge.

Plant: Stems medium light green, slight pink color at base; leaves light green; flowers white.

Adaptation: Well suited to the Red River gumbo soils. The chief variety grown in the sand-land area.

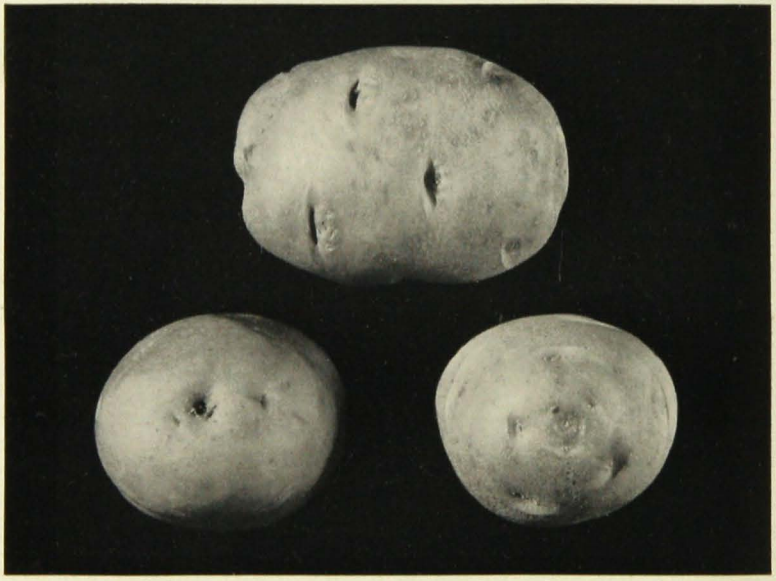


FIG. 3. EARLY OHIO

Irish Cobbler

Maturity: About one week later than the Early Ohio.

Market: Excellent table potato, but has rather deep eyes. Grown largely for southern seed trade, especially of Kansas, Missouri, Illinois, and Kentucky.

Tuber: White, roundish, slightly flattened, blocky, deeply recessed at stem end and seed ends. Eyes deep. Sprouts green, tinged reddish-pink.

Plant: Stems medium light green, tinged with purple at nodes and base. Leaves medium light green, glossy, broad. Flowers light rose-purple; under intense heat may be almost white.

Adaptation: Particularly adapted to peat soils where it is inclined to be somewhat flatter than when grown on mineral soil. An excellent potato for the Red River Valley or other regions where clayey soils prevail.

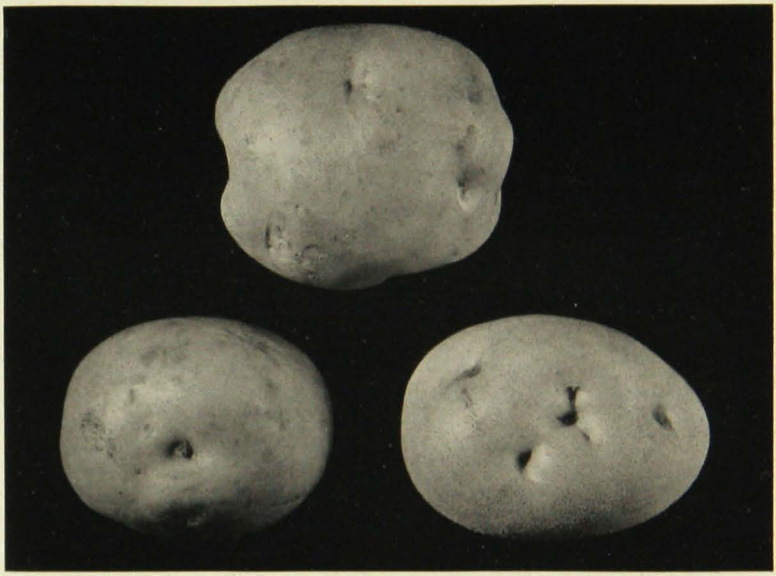


FIG. 4. IRISH COBBLER

FIG. 5. GREEN MOUNTAIN

Green Mountain

Maturity: Medium late.

Market: Good all-round table potato; keeps well.

Tuber: Creamy white; oblong, flattened with square shallow ends. Skin usually flaked at stem end; eyes comparatively shallow. Sprouts greenish-white.

Plant: Stems and foliage light green. Vigorous grower. Flowers white.

Adaptation: Particularly recommended for north central and northeastern Minnesota. Altho recommended for heavy soils, it does remarkably well on the lighter soils of the northern sections with application of fertilizers.

Rural New Yorker

Maturity: Late.

Market: Good all-round market potato. Keeps well.

Tuber: White. Nearly round to round-oval, somewhat flattened, with rounded ends. Eyes comparatively shallow. Sprouts purple.

Plant: Stem and foliage dark green. Stem heavily tinged with purple. Spreading growth. Blossoms deep purple with white at tips of petals.

Adaptation: Recommended for southern half of the state, altho it will do well in the northern counties in seasons when autumn frosts are late. Drouth resistant.

FIG. 6. RURAL NEW YORKER

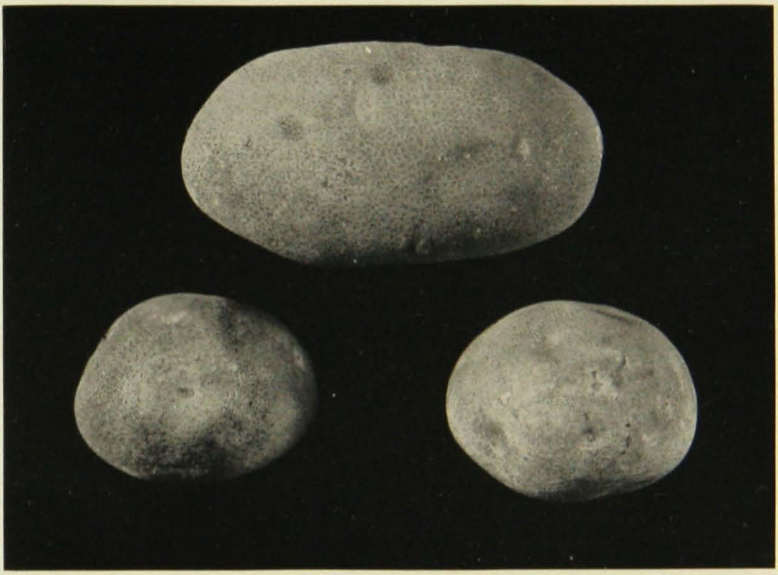


FIG. 7. RUSSET BURBANK

Russet Burbank

Maturity: Medium late.

Market: Very fine baking potato.

Tuber: Yellowish to brown russet. Long, elliptical, with rounded ends, slightly flattened. Eyes shallow. Sprouts greenish-white with a pinkish tinge.

Plant: Stems and foliage light green; somewhat spreading. Flowers white.

Adaptation: Requires a rich loamy soil.

Warba

Maturity: Slightly earlier than Bliss Triumph.

Market: Because of its earliness, should make an excellent early market potato, or for home garden.

Tuber: Creamy white suffused with pink around eyes. Blocky, similar to Irish Cobbler. Eyes deep, especially when grown on heavy or peat soil. Set numerous.

Plant: Stem green tinged with red. Foliage light green. Plant medium to large, rather bushy. Apparently resistant to mild and crinkle mosaic. Flowers light pink; few in number.

Adaptation: Wide adaptability, but has tendency to coarseness on extremely heavy or peaty soils.

Note: Introduced by Minnesota Experiment Station in 1933.

FIG. 8. WARBA

FIG. 9. CHIPPEWA

Chippewa

Maturity: Somewhat earlier than Green Mountain.

Market: Should make an excellent table market potato.

Tuber: White, smooth, elliptical to oblong, medium thick, eyes few and shallow. Sprouts white, tinted with pale rose-purple.

Plant: Medium to large, spreading. Stems green with internodes slightly reddish-purple. Leaves long and broad. Flowers light lilac with white tips. Resistant to mild mosaic.

Adaptation: Better adapted to northern Minnesota conditions than the Katahdin because of its earlier maturity. Yields well on peat, but inclined to flatness when grown on such soil.

Note: Introduced by the Division of Fruit and Vegetable Crops and Diseases of the United States Department of Agriculture.

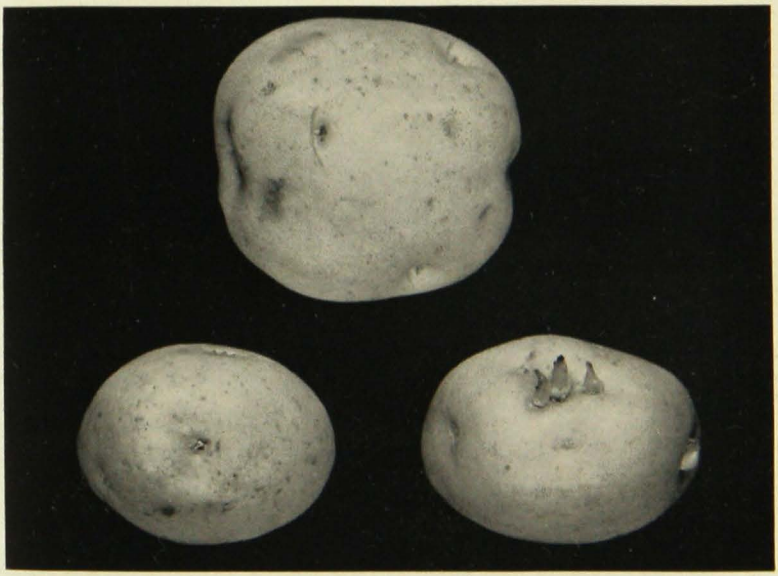


FIG. 10. KATAHDIN

Katahdin

Maturity: As late as the Rural New Yorker.

Market: Should make an excellent table market potato.

Tuber: White, smooth, elliptical to roundish, medium thick, eyes few and shallow. Sprouts greenish-white.

Plant: Stem and foliage medium green; slight tinge of purple at internodes. Plant spreading. Leaves large and smooth. Flowers light lilac. Resistant to mild mosaic.

Adaptation: Wide adaptation, but a little too late for northern part of state. Does especially well on peat when early autumn frosts do not occur. Recommended for the southern half of the state.

Note: Introduced by the Division of Fruit and Vegetable Crops and Diseases of the United States Department of Agriculture.

SOIL

The physical texture of the soil, its chemical composition, and proper management have a considerable bearing on the success of growing potatoes. The subsoil also is important. A sandy soil with a gravelly subsoil, altho not the most desirable for potatoes, can be made to produce excellent crops. The fine-textured black clay soils, such as are found in the Red River Valley, are excellent for potatoes if they can be kept mellow. Sweet clover plowed under in the fall will do much toward keeping such soils mellow, and, besides, affords a source of nitrogen to the growing plants. Much the same result is accomplished by summer fallowing of potato ground, and experience has shown that this is an excellent practice, particularly during dry seasons. Summer fallowing also aids materially in killing weeds.

Avoid heavy low-lying soils unless adequate drainage can be provided. Our extensive high-lime peat bogs are excellent for growing potatoes if properly drained and fertilized.

The degree of acidity or alkalinity of a soil may have a direct bearing on successful potato production. Soil alkalinity has a direct bearing on the prevalence of scab in fields infested with the organisms of this disease. Experiments have shown that a neutral, slightly alkaline or slightly acid soil will produce potatoes of better table quality than will very strongly acid soils.

ROTATIONS

Every systematic farmer practices a crop rotation designed to fit his needs. A well-worked-out crop rotation benefits every crop included in the rotation. The potato requires considerable amounts of potash and phosphorus as well as some nitrogen. Clover also removes some of these elements, but it replaces a considerable amount of nitrogen. If, therefore, the second crop of clover is plowed under instead of being harvested, it puts nitrogen into the soil, and also adds organic matter which is necessary on heavy soils as well as on sandy soils. Alfalfa and sweet clover do the same thing. The three crops mentioned, furthermore, play a very important part in checking weed growth, thus making subsequent care of the potato field far easier than if potatoes are planted immediately after cereals. In the sand-land region, where potatoes constitute the chief crop, rye is planted immediately after the potato crop is harvested and plowed under the following spring prior to planting potatoes again. The chief value of rye on light, sandy soils is that it checks the blowing of the soil and adds a small amount of humus.

In the large, grain-growing sections of the state, the potato, as the chief cultivated crop grown, plays an important part in the cropping system. It provides a valuable cash crop, and yields of grain from land in potatoes the preceding year are generally larger.

A rotation in which potatoes are not planted more than once every five or six years on the same land also aids somewhat in checking such soil-borne diseases as scab and Rhizoctonia. Some growers plant potatoes on the same field only once in eight years, letting the ground lie fallow the year previous to the potato crop. Keeping this fallow ground stirred with a disc or other suitable tool has proved very advantageous in controlling weeds.

FERTILIZERS

To obtain a good crop of well-shaped potatoes, plenty of plant food must be available.

A 200-bushel crop of potatoes will remove approximately 42.5 pounds of nitrogen, 17 pounds of phosphoric acid, and 57 pounds of potash. Other elements seem to be necessary, but in very small amounts. In general, these other elements, with the possible exception of calcium, are present in sufficient quantity in Minnesota soils. When necessary, this latter element is applied in the form of lime for alfalfa or sweet clover. Only acid soils need such treatment. Our high-lime peat bogs are well supplied with calcium.

Plant food can be supplied in three ways: (1) Green manuring or the turning under of leguminous crops, as clover, sweet clover, and alfalfa, (2) barnyard manures, and (3) commercial fertilizers.

Green manures.—These have been discussed under "Rotations." In his book, "The Potato," Stuart has stated that a crop of alfalfa yielding 20,000 pounds green matter contains 120 pounds nitrogen, 30 pounds phosphoric acid, and 160 pounds potash, while a crop of red clover yielding 12,000 pounds green matter contains 66 pounds nitrogen, 16 pounds phosphoric acid, and 60 pounds potash.

Barnyard manure.—Any barnyard manure may be used, but the quantity will vary with the type of soil and its fertility. Fresh manure should be applied in the fall. For spring application, well-rotted manure is preferable, as fresh manure is more likely to promote the development of scab. Well-rotted sheep manure is suitable for spring application as it acts quickly and stimulates rapid plant growth. Because of its richness, sheep manure should be applied more sparingly than cow or horse manure. An application of 10 tons of fresh barnyard manure on the average will furnish approximately 100 pounds of nitrogen, 50 pounds of phosphoric acid, and 100 pounds of potash. Besides supplying plant food, a generous application of barnyard manure also improves the structure of some soils. Manure helps hold moisture in sandy soil, and it assists in making heavy soil friable. Plowing under a clover, sweet clover or alfalfa sod in the fall, accompanied by a

fall application of barnyard manure on a heavy soil, will go a long way toward producing the mellow seedbed needed for potatoes. Whether a soil be light sand or heavy clay, it needs organic matter or humus, and this results from the decomposition of plant material and stable manure. Our peaty and muck soils consist almost entirely of organic material, and need only the proper mineral fertilizers.

Commercial fertilizers.—The foregoing discussion points out that plowing under certain crops and applying barnyard manure supplies considerable amounts of plant food, particularly nitrogen. The potato requires more phosphoric acid and potash in proportion to the nitrogen supplied by the practices suggested, and deficiency of both these elements may be supplied through commercial fertilizer mixtures. Owing to the great diversity of soils and to variations in the fertility of different fields, recommendation of any definite mixture can be made only after consideration of these factors. On alfalfa or clover land or on land that has been well manured, any nitrogen applied in a commercial fertilizer mixture may be wasted. A fertilizer consisting entirely of phosphate or potash or both might produce the desired results. On the black clayey soils of the Red River Valley, applications of phosphate only have proved very beneficial.

Both phosphorus and potash are very essential to the production of high-quality potatoes. In fact, there is some question as to the value of potatoes for seed if they have been produced on a potash-deficient soil. Our high-lime peat bogs seem to be fairly well supplied with nitrogen, but they are deficient in phosphate and potash. On such soil, annual application of 500 to 700 pounds of the mixture known as 0-9-27, (no nitrogen, 9 per cent phosphate, 27 per cent potash), seems to meet the requirements of potatoes. Any benefit from commercial fertilizers depends on having moisture in the soil. Because peat soils hold moisture very well, they give full returns from commercial fertilizers even during such dry years as 1931-1934. Since plowing under legumes and applying barnyard manure makes soils hold moisture better, fields so treated usually give better results from commercial fertilizers than fields on which grain preceded potatoes.

Applying fertilizer.—For best results, commercial fertilizer must be applied at the right time and depth. Numerous experiments in states where growers regularly use generous applications of fertilizer show that it can be applied most efficiently and economically at planting time by means of a fertilizer attachment on the planter. This places the fertilizer on a level with the seed piece or slightly below it in bands about two inches away. Another plan is to spread the fertilizer with a lime drill and work it into the soil immediately before planting. Commercial fertilizer can be broadcast by hand, but either of the other two methods is more satisfactory. If the fertilizer comes in direct contact with the seed pieces it may cause injury.

SOIL PREPARATION

Potatoes require a well-prepared seedbed. On the heavier types of soil, deep fall plowing is best. Any stubble, alfalfa, or clover land must be turned over deep enough to cover all vegetation. In the spring, the land should be disked as early as possible, preferably twice. Then the field should be harrowed at least twice with a spring-tooth or spike-tooth harrow. All of these spring operations cut up clods and stir and pulverize the soil to form a nice mellow seedbed and make it easier to care for the crop later on. In light sandy soils where potatoes are to be planted on land sown to rye the previous fall, and on shallow soils, spring plowing is proper. On the lighter types of soil, one disking and harrowing should be enough.

Summer fallowing heavy land makes an ideal seedbed for potatoes.

Peat or muck soils are best plowed in the fall because they are late in thawing out in the spring. Virgin peat should be plowed as deeply as possible and thoroly disked lengthwise and crosswise with a cut-away disk as often as possible before winter sets in. New peat will need several additional diskings in the spring. Virgin peat is difficult to tear apart, and if preparation is not thoro there will be difficulty both in cultivating and harvesting. Peat should be rolled before and after planting with a heavy roller. Four feet of 30-inch culvert, filled with cement, makes a very satisfactory roller. Rolling improves moisture conditions, enables early cultivation and helps to keep off frost.

PLANTING

Locality and the purpose for which the potatoes are to be grown help determine the best time to plant. Potatoes should not be planted until the soil is warm enough to allow rapid germination and quick growth. In the southern half of the state and in the sand-land area, planting usually is under way by April 15 on the upland soils. Peat farmers in this region will do well to hold off planting until the first of May. In the northern half of the state, planting begins about May 15 and runs through the first week of June.

Two systems of planting are practiced in the state—in hills and drills. The hill method, in which the land is marked off in three-foot rows both ways and seed pieces dropped at the intersections, is particularly adapted to the poorer, drier soils because each plant has a larger area from which to draw the plant food needed. It also permits cultivation both ways, thus aiding in the control of weeds, particularly quack grass. The hill method necessitates hand planting, either by dropping the seed pieces in holes hoed out at the intersections or by the use of a small hand planter which is pressed into the soil with the foot.

In drill planting, the rows are usually 36 to 42 inches apart. On most of the mineral soil farms, rows are three feet apart. The distance between the hills varies from 12 to 16 inches for early varieties, and from 15 to 20 inches for late varieties. On rich soil, the seed pieces can be

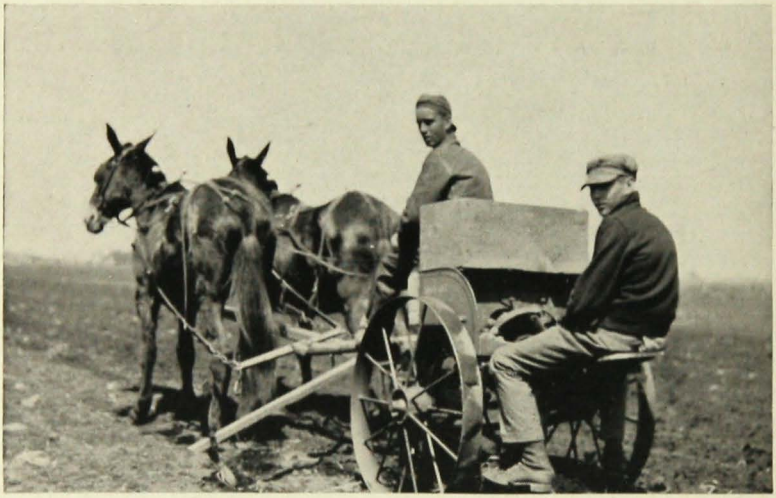


FIG. 11. USE A GOOD PLANTER
Regulate spacing according to the fertility of the seedbed.

planted closer together than on thin soil. Larger seed pieces call for more room between the hills. On peat soils, the average distance between rows is 40 inches, with 7 to 9 inches between hills. Close planting in rows is practiced because early varieties are grown almost exclusively on such soils and because it avoids the production of overly large potatoes. With the drill system, some hand planting is done on the smaller acreages, but more commonly machine planters are used. In planting by hand, the seed pieces are dropped in furrows made by a

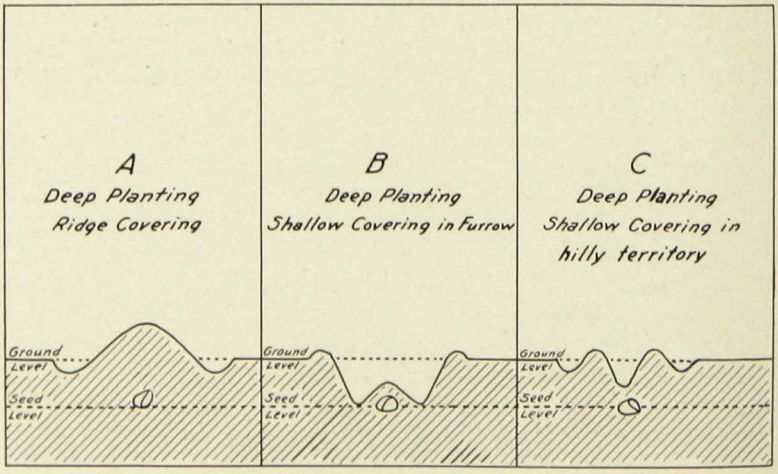


FIG. 12. DEPTH OF PLANTING IS IMPORTANT

wing shovel plow. Used on larger potato farms are two types of horse- or tractor-drawn planters, containing hoppers holding approximately two bushels of seed pieces which are automatically fed into the dropping attachment. The one-man or picker type of planter most commonly used in Minnesota picks up the seed pieces from the hopper by means of prongs attached to a revolving disk. Attachments then strip the seed pieces off the prongs and deposit them into the dropping tube. Several companies make this type of planter which does satisfactory work, if the prongs are kept sharp and the stripping attachments in order. For best results with this type of planter, seed pieces should be of generous size and blocky. Another satisfactory type of one-man planter has a series of cups on an endless chain which pick up the seed pieces and dump them into the dropping tube.

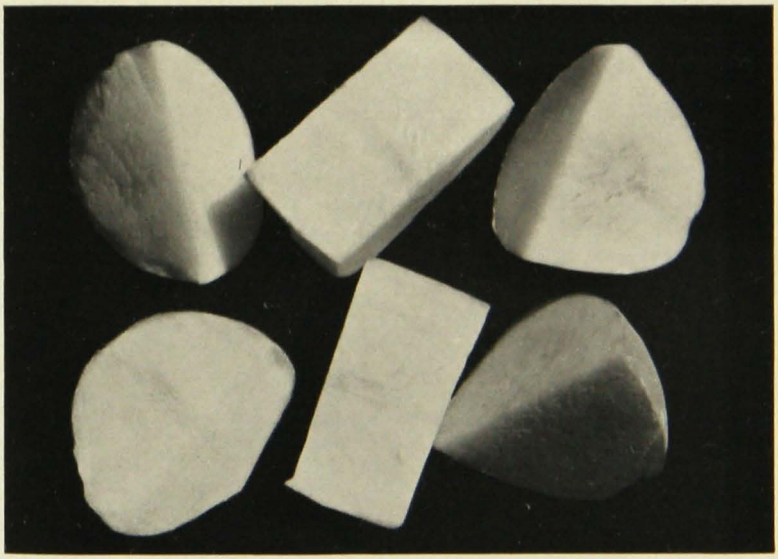


FIG. 13. BLOCKY SEED PIECES GIVE BEST RESULTS

The two-man planter conveys the seed pieces from the hopper and deposits them in the slots of a revolving disk, from which they fall into the dropping tube. This machine requires an extra operator to sit behind the revolving disk and make sure that every slot contains a seed piece when it reaches the dropping tube. When correctly operated, this machine will plant 100 per cent perfect.

Depth of Planting

Potatoes should be planted deep enough so that the new tubers will develop far enough beneath the surface to avoid sunburning. The exact depth will depend somewhat on the nature of the soil and the condition

of the seedbed. A well-prepared seedbed will warm up quickly and will allow plenty of aeration. Under such conditions the cut surfaces of the seed pieces will cork over quickly; this is important in preventing the development of rots. Experiments have shown that planting deep and covering shallow, particularly on a heavy soil, will aid materially in checking both Rhizoctonia and blackleg infection. (See illustration.)

From three to four inches is a good depth to plant on most clayey soils. On light soils and on peat the depth should be five to six inches.

Cutting and Size of Seed Piece

Cut the seed potatoes in blocky, uniform seed pieces. Such pieces will work better in planters and give a more uniform stand than if cut in long, thin or uneven-sized pieces. Altho one eye per seed piece is enough, the pieces should be large enough to provide a good reserve of food material for the young sprouts to draw upon until they are thoroly established. Each seed piece should weigh approximately one and one-half ounces. In a variety like the Early Ohio, seed pieces of this size will contain more than one eye each. In such varieties as the Irish Cobbler, however, the eyes are less numerous and if seed pieces are cut smaller, some may not have any eyes. Do not plant small, whole tubers unless they have been produced on a tuber unit or hill unit seed plot, or in a field known to be free from virus diseases such as mosaic, spindle tuber, and leafroll.

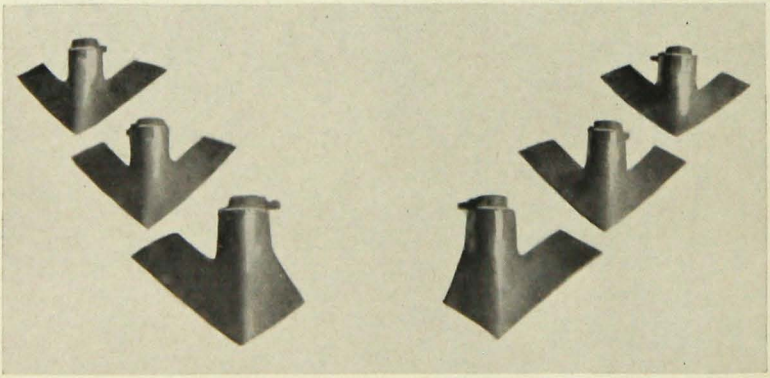


Fig. 14. Weeds Do Not Thrive Where the Duckfoot Shovels Are Used Properly

The seed pieces should be planted as soon as possible after cutting. Cut seed that cannot be planted immediately should not be put in sacks or in a wagon box, but spread out in a cool, well-ventilated place in layers not more than six inches deep. Dusting the cut seed with hydrated lime or pulverized sulphur takes up the moisture on the cut surfaces, thus minimizing decay, and helping to prevent drying of the seed pieces.

Cut seed left in sacks or in a wagon box for several days may be injured by heating, or rot infection may start which will later kill many of the sprouts before they come out of the ground. If potatoes are planted in a dry soil and dry weather continues after planting, a poor stand will result, as the cut seed pieces will not cork over properly. If the soil is moderately moist and fairly warm, sufficient corking over to prevent decay of the cut surfaces will take place in about 48 hours. The callus formed when seed is allowed to air-dry gives no protection from rots and drying. Potatoes showing any internal discoloration on being cut should be discarded.

Seed potatoes are usually cut by hand with either a free or fixed knife. Hand cutting insures all seed pieces having eyes. Automatic seed cutters do very well if the operator is careful when cutting varieties with few eyes, such as the Cobbler and the Rural New Yorker. Automatic cutters reduce labor costs and save time, particularly when a large acreage is to be planted.

Amount of Seed Required Per Acre

Spacing of rows and seed pieces	Weight of seed pieces and amount of seed required per acre in bushels		
Rows 32 in. apart:	1 ounce	1.5 ounces	2 ounces
Bushels required, 10-in. spacing	20.4	30.6	40.8
" " 12 " "	17.0	25.6	34.0
" " 14 " "	14.6	21.9	29.2
" " 16 " "	12.8	19.2	25.6
" " 18 " "	11.3	17.0	22.7
Rows 36 in. apart:			
Bushels required, 10-in. spacing	18.1	27.2	36.3
" " 12 " "	15.1	22.7	30.2
" " 14 " "	13.0	19.4	25.9
" " 16 " "	11.3	17.0	22.7
" " 18 " "	10.1	15.1	20.2
" " 36 " "	5.0	7.6	10.1
Rows 40 in. apart:			
Bushels required, 8-in. spacing	33.2	51.0	67.7
" " 10 " "	27.3	40.7	54.5
" " 12 " "	22.8	33.2	45.4

CULTIVATING THE CROP

The objects of cultivation are to control weeds, to keep the soil friable, and, in heavy clay soils, to close up cracks through which moisture might evaporate. Since weeds remove plant food and moisture, they must be thoroly controlled. If weeds get a good start early in the season, the job of keeping them down is well-nigh hopeless. In our customary methods of planting, the rows can be followed before the plants are up. Cultivate rather deeply immediately after planting,

setting the shovels to throw a small ridge toward the rows. One week later, go over the field crosswise with a weeder or spike-tooth harrow to level the ridges and check weeds. About a week later, harrow again lengthwise with the spike tooth. Thoroness in these operations will save much hand hoeing later on, for weeds are killed much easier in the seedling stage than after becoming firmly established. When the potato plants are six inches tall, cultivate as deeply as possible, setting the outside shovels slightly shallower to throw a little soil into the rows. See that this first cultivation loosens up the soil thoroly. Potato roots grow near the surface, so late cultivations must be more and more shallow to avoid root pruning. When the plants cover half the row, set the cultivators narrower and do not run them deeper than two or three inches. The number of cultivations will depend on the type of soil and the weather. A light soil will need fewer cultivations than one inclined to bake. If rain falls immediately after a cultivation, another working will be desirable as soon as satisfactory work can be done, particularly on a heavy soil.

As a general rule, do not ridge more than necessary to protect the tubers from sunburn and early frosts. Heavy ridging causes much loss of moisture and is not necessary except on heavy, poorly drained soils during a wet season.

Cultivation on peat soils is the same as outlined for the earlier cultivations on mineral soils. Deep cultivation is not necessary on peat; in fact, it is questionable whether any cultivation should be given after the plants come up, if a thoro job of weed killing has been done earlier. It may be necessary to throw some soil toward the rows later in the season to prevent sunburning of the tubers, but great care should be exercised in not going deep.

SELECTING SEED AND THE SEED PLOT

Numerous degeneration (virus) diseases are now known to affect the producing power of potatoes. All are transmitted through the seed piece, some being spread by means of the cutting knife. Many are spread from plant to plant by certain insects. Learn to recognize these diseases on the plants for most of them do not show up on the tubers altho transmitted through them. As every commercial variety grown in the state is subject to one or more of these diseases, it is important to know whether the seed stock is infected. For certified seed growers it is absolutely necessary to control these destructive diseases, but all growers should be interested in keeping up the vigor of their seed stock. Seed potatoes known to be appreciably infected with virus diseases should be discarded and good foundation stock secured.

Good seed stock can be maintained by means of an isolated tuber unit or hill unit seed plot.

Before planting time, select from the bin a considerable number of six- to eight-ounce tubers. With one lengthwise and one crosswise

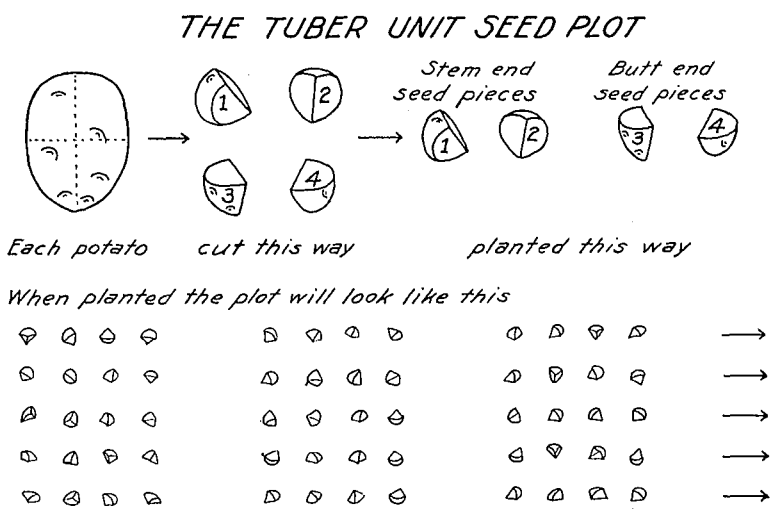


FIG. 15. THE TUBER UNIT SEED PLOT

cut, divide each tuber into four seed pieces. Plant each group or unit of four seed pieces as shown in Figure 15. Any diseased tubers planted will be detected early in the growing season as the disease will appear on all four plants of the unit. Carefully inspect the plot several times during the growing season and remove all units which show disease or a lack of vigorous uniform growth. Early removal of diseased plants will prevent possible spread by insects. During the growing season, stake the best hills so they can be harvested separately. After examining the new tubers from these hills, keep only the best hills. Put all of the tubers selected from one plant into a separate No. 10 paper bag and store carefully. Each bag will then constitute a hill unit to be planted the following season as shown in Figure 16.

After sacking up the best hills, the grower may wish to select individual tubers for a tuber unit seed plot. The remaining potatoes are then saved as seed for the commercial crop. For starting a so-called

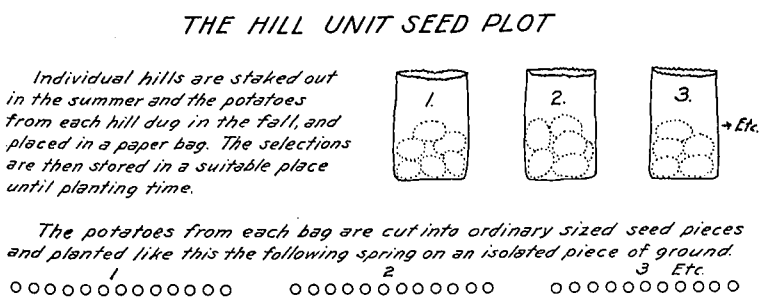


FIG. 16. THE HILL UNIT SEED PLOT

"strain," the tuber unit method is ideal. To get a strain started, the grower eliminates all but one unit which meets his requirements. After the single unit has been selected for developing the "strain," hill unit selection is used from that point on. The tuber or hill unit plot should be maintained annually as it is the most practical method known to control virus diseases.

One of our well-known certified seed growers takes the tubers from each unit selected and plants them whole, believing this increases the vigor of his seed. Altho this method gives less seed than cutting seed pieces, it might be worth trying. After selecting the units for his next season's seed plot, he saves the rest for an increase seed plot, the tubers from which are planted for certification. He has continued this method for several years and at present has some of the most dependable seed stock of Irish Cobblers grown in the state.

The tuber unit or hill unit seed plot should be isolated at least 20 rods from other potatoes. In sections where potatoes are grown so extensively that seed plots cannot be adequately isolated, the grower would do well to purchase each year foundation seed for a seed increase plot. Such foundation seed should come from growers maintaining isolated tuber or hill unit plots.

There is no such thing as too much emphasis on the value of good seed.

DISEASES

Diseases are one of the most important limiting factors in growing potatoes. They may be classified as parasitic and non-parasitic. Parasitic diseases are caused by small living organisms, known as fungi and bacteria, and by viruses. Diseases caused by viruses are most commonly known as degeneration diseases. The virus or infective agent is too small to be seen by the most powerful microscope. Fungi or bacteria can be seen quite easily with an ordinary microscope. Non-parasitic diseases are caused by unfavorable conditions during the growth of the plant or may affect the tubers in storage. Much experimental work at the Minnesota Experiment Station and other similar institutions has shown that some diseases can be controlled quite easily while others are complex and difficult to control.

Learn to recognize these diseases and to know their causes. Wherever machinery is used in disease or insect control, be sure that it is in working order so as to do the job thoroly.

Tip burn.—Tip burn is the drying of the leaves, beginning at the tips and edges.

Cause: Unfavorable conditions; most prevalent on light, sandy soils during hot, sunny weather, especially following a period of wet, cloudy weather.

Control: Thoro spraying with 4-4-50 Bordeaux mixture, and thoro cultivation to conserve soil moisture.

Early blight.—Early blight produces dark brown spots, circular or irregular, with concentric rings. Spots increase in size and may unite, eventually destroying entire leaf. Rarely produces a dry rot in the tubers.

Cause: A fungus—*Alternaria solani.*

Control: Thoro spraying with Bordeaux mixture or copper lime dust, beginning as soon as spots appear.

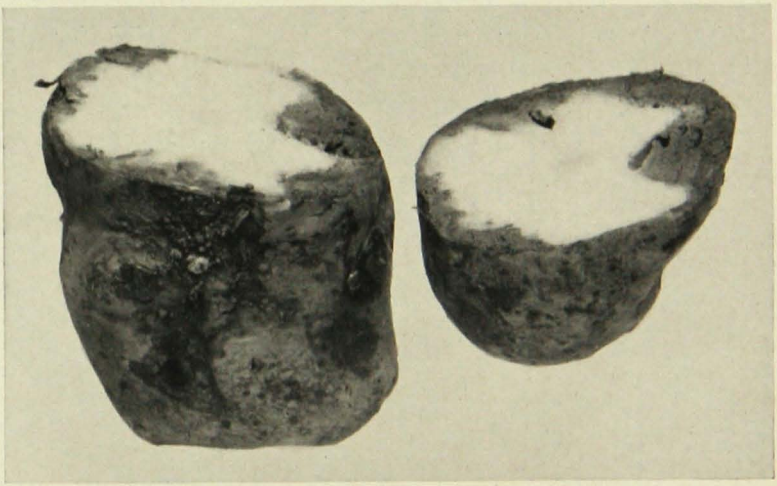


FIG. 17. LATE BLIGHT ROT

Late blight.—Late blight produces purplish, water-soaked spots on leaves in wet weather, with white mold on underside. Occurs in cool, muggy weather during late summer. Under such conditions may destroy an entire field in 48 hours. Dry weather checks the disease. Causes a very destructive tuber rot, both in field and storage.

Cause: A fungus—*Phytophthora infestans.*

Control: Thoro spraying with 4-4-50 Bordeaux mixture or copper lime dust, beginning the latter part of July. If blight has killed vines, postpone digging for about 10 days. If any potatoes are affected at digging time, be very careful in picking. A few diseased potatoes put into storage may lead to destruction of entire lot. Potato buyers who are familiar with this disease will not buy potatoes from areas where they know late blight rot exists. *Late blight rot, when it is present, is the most destructive storage rot.*

Rhizoctonia.—Rhizoctonia produces a reddish-brown dry stem rot on the vines and black scurf on the tubers. It is very destructive on young seedlings if weather is cool and wet immediately after planting, completely girdling and killing many of them before they are six inches high. The stems of older plants may be partially girdled, and, as a result, large stiff-looking vines are produced. The stolons or tuber-

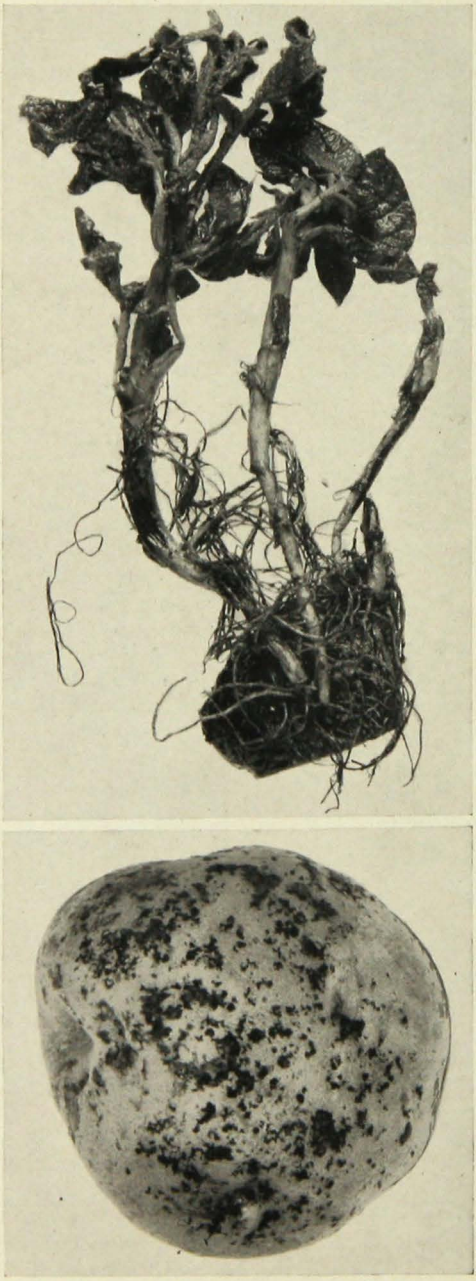


FIG. 18. RHIZOCTONIA ON PLANT AND TUBER

bearing stalks may be rotted off, resulting in many small potatoes being produced in the branches and close to the main stem, underground. On tubers the fungus may produce black scurf, a russet scab, and cracking of the skin. The fungus masses of the black scurf may spread to other potatoes under damp poorly ventilated storage.

Cause: A fungus—*Rhizoctonia solani.*

Control: Difficult to control because *Rhizoctonia* is a common soil fungus which grows on a large number of other plants. Avoid planting before ground is thoroly warmed up. (See paragraph on planting.) Treat seed with acid mercury dip solution, first discarding all tubers which contain black scurf bodies larger than a quarter of an inch in diameter. Practice a five- to seven-year rotation. Potatoes allowed to remain in the ground for any length of time after the vines have dried down may become badly infected, especially if the ground is cool and wet.

Blackleg.—Blackleg causes a soft stem rot varying from a greenish-brown to black color and destroys the roots. Usually before the rot is evident, the leaves turn yellow from the margins inward and begin to wilt and droop. If seed pieces are

infected, plants may be killed before they are six inches high. Late infection may destroy older plants and extend into the developing potatoes causing white, gray, or brown to black rot, often followed by slimy, foul-smelling secondary rots. Blackleg is prevalent in wet seasons, particularly on heavy soils.

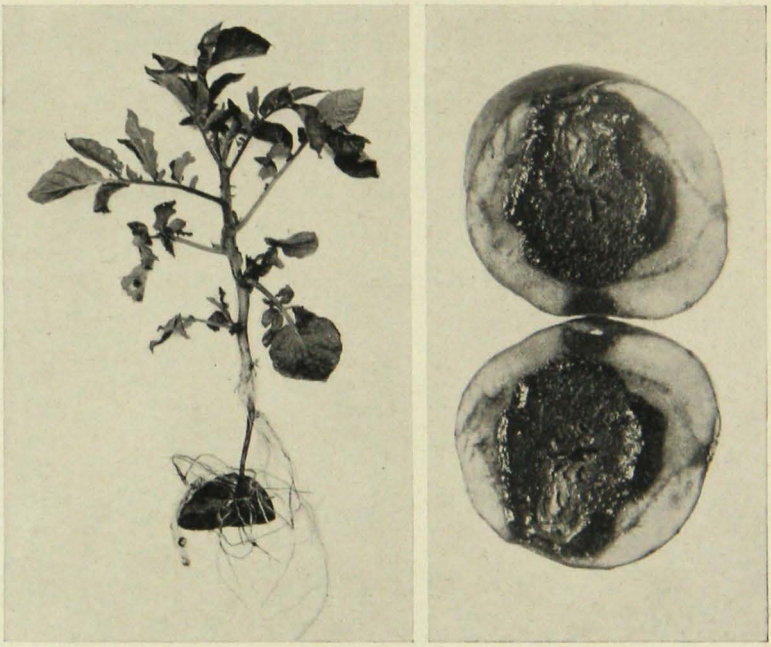


FIG. 19. BLACKLEG ON PLANT AND TUBER

Cause: A bacterium—*Bacillus carotovorous*. The bacteria causing blackleg overwinter in the soil. The seed-corn maggot fly is also responsible for inoculating the seed pieces at planting time and for spreading the disease in the field.

Control: Complete control is impossible, but the following practices will aid in reducing losses:

1. Use certified seed or seed from fields known to be free of blackleg. If disease appears in the field being grown for seed, remove all diseased plants and their tubers.

2. Disinfect all seed potatoes with acid mercury dip or some other efficient disinfectant.

3. Plant seed as soon as possible after cutting. Do not let treated and cut seed stand around uncovered. The seed-corn maggot flies are busy laying eggs at planting time, and clean seed may become infected in this way. A well-prepared seedbed enables the cut surfaces of the seed to form protective cork.

4. Plant shallow if soil is heavy or likely to be wet, as deep planting interferes with the corking-over process.

5. Rotate crops. The rotation should be so planned that the potato field will not be adjacent to one on which potatoes were grown the previous year.

(For a detailed discussion of Blackleg disease, see Special Bulletin 144, University of Minnesota, Agricultural Extension Division.)

Fusarium wilt.—Affected vines become yellowish, leaves roll upward along the veins, the entire plant appears spindling and finally wilts and dies. Vines do not wilt as rapidly as those infected with blackleg, and there is no external dark discoloration. The sap tube area or starch line in both stems and tubers is brown, as are also the roots. The disease proceeds from the stems through the stolons (tuber stalks) into the tubers. It produces a slow dry rot of the tubers in storage, which is followed by more rapid storage rots. May be particularly serious on the lighter soils. It is more prevalent in hot dry weather than in cool wet seasons.

FIG. 20. FUSARIUM WILT

Cause: A fungus—*Fusarium oxysporum.* This fungus is present in many soils, often occurring in soils which have never been cropped.

Control: Do not plant potatoes that have brown ring discoloration in the stem end unless the discolored portion has been cut off. It is safer to discard completely tubers showing discoloration.

Immediately remove any wilted plants found in a seed plot, together with their tubers.

Rotate crops so that potatoes are not grown on the same soil more than once in four or five years.

Common scab.—Common scab affects the tubers only, producing rough, corky spots occurring singly or running together and sometimes

covering the entire tuber. Wireworms or grubs often help in producing deep sunken or corky areas causing a pit scab. Common scab is more prevalent if the soil is hot and dry when tubers are forming, as infection takes place when the skin of tubers is thin. It is present in many soils, particularly those that are alkaline. It renders potatoes unsightly and in severe cases produces considerable waste in paring. Scab also attacks other root crops.

Cause: A bacterium—*Actinomyces scabies.*

Control: Complete control is impossible. Scab-infected tubers should be treated with acid mercury dip and planted on soil that has not grown a scabby crop. Avoid the use of fresh manure unless applied in the fall. Practice a four- or five-year rotation. Plow under green manure crops.

FIG. 21. SCAB

VIRUS DISEASES

About 26 virus or degeneration diseases are known to affect potatoes, and some are destructive in Minnesota. As far as now known, none of these diseases are soil-borne. However, they are readily transmitted from plant to plant in the field, usually by certain insects. Each virus disease produces definite symptoms, but several may be present in the plant at the same time, producing a

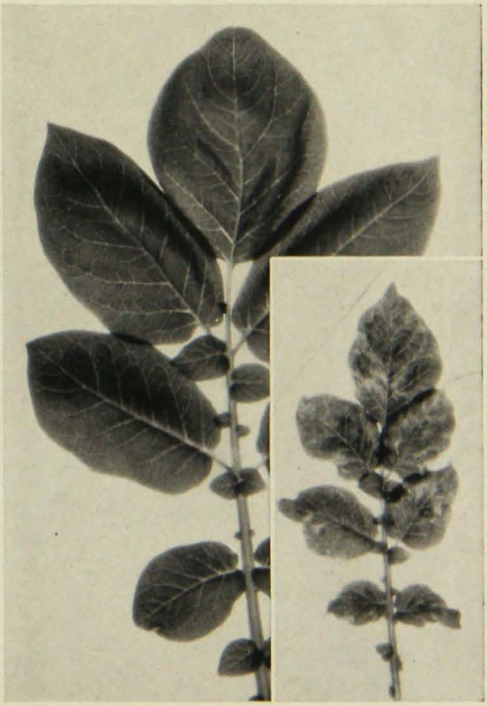


FIG. 22. HEALTHY LEAF AT LEFT; MOSAIC LEAF AT RIGHT

combination of symptoms. Following is a list of virus diseases, all of which, with the exception of Aucuba mosaic, potato calico, and witches broom, are of importance in Minnesota. The name of each disease is quite descriptive of its appearance. All reduce yields and, because of the ease with which they are spread, are a major problem for potato growers, particularly those who raise seed potatoes. All of these diseases are transmitted through the tubers.

Mild mosaic	Potato calico	Yellow dwarf
Crinkle mosaic	Leafroll	Giant hill
Rugose mosaic	Apical leafroll	Witches broom
Aucuba mosaic	Spindle tuber	Streak
Leaf-rolling mosaic		Unmottled curly dwarf

Mild mosaic.—Leaves are mottled, yellowish areas alternating with the normal green; some ruffling. Infected plants may be slightly dwarfed. Symptoms masked in hot sunny weather. Transmitted from plant to plant by aphids (plant lice) and may be transmitted by contact.

Crinkle mosaic.—Leaves mottled and crinkled. Causes more dwarfing than mild mosaic. Transmission same as in mild mosaic.

Rugose mosaic.—Diffuse mottling, wrinkling of leaves, plants spotted or streaked, brittle. Leaves drop, beginning with the lower ones. Transmitted by aphids.

FIG. 23. LEAFROLL

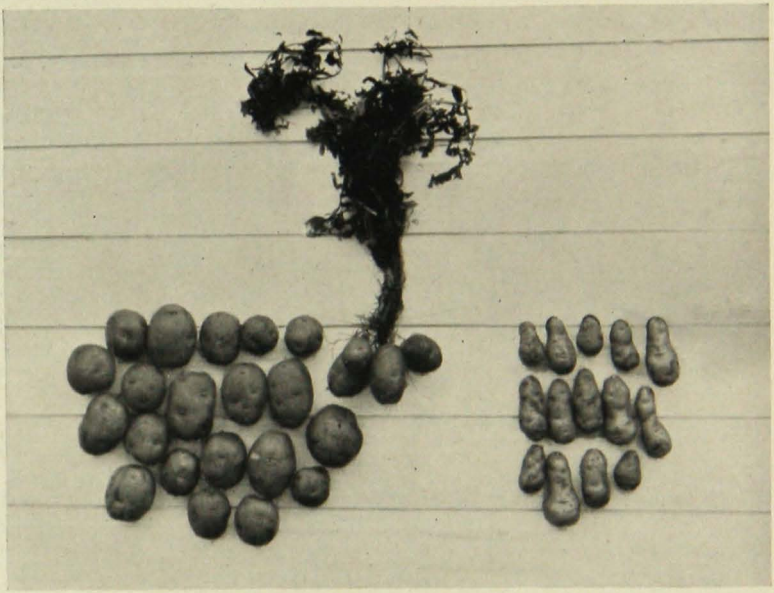


FIG. 24. SPINDLE TUBER: HEALTHY TUBERS AT LEFT; SPINDLE TUBERS AT RIGHT

Leaf-rolling mosaic.—Diffuse mottling, very slight wrinkling and ruffling. Upper leaves show an upward rolling. Dwarfing slight. Transmitted by aphids.

Potato calico.—Irregular yellow blotches on leaves.

Aucuba mosaic.—Yellowish round spots on leaves. Transmitted by aphids.

Leafroll.—Leaves roll upward, beginning at the base; tough, leathery in texture; light green to yellowish in color. Plants dwarfed. Net necrosis sometimes evident in tubers. Transmitted by aphids.

Apical leafroll.—Plants resemble somewhat those attacked by *Rhizoctonia*. Become erect and highly colored with a reddish tint. Small tubers formed in axils of leaves and stems as in *Rhizoctonia*. Differs from *Rhizoctonia* in that stems are free of brown lesions.

Spindle tuber.—Plants upright, branches coming off main stem at sharper angles than on healthy plants. Leaves have slightly wavy margins and are dull in appearance. Tubers become long, cylindrical and spindle-shaped, with numerous prominent eyes. Red-skinned tubers become pale in color. Transmitted by aphids, grasshoppers, Colorado potato beetles, flea beetles, tarnished plant bugs.

Unmottled curly dwarf.—Plants dwarfed, upright; leaves dark green, wrinkled or curled, sometimes streaked or spotted. Tubers cylindrical like in spindle tuber, often gnarled and cracked lengthwise. Transmitted by grasshoppers, flea beetles, tarnished plant bugs, Colorado potato beetles, and aphids. This disease might possibly be associated with spindle tuber.

Yellow dwarf.—Dwarfing and yellowing of the plants. Tubers irregular, sometimes knobby and cracked. Transmitted by clover leafhoppers.

Giant hill.—Coarse over-grown plants; leaves slightly lighter in color than normal plants. Root system fibrous and heavy. Tubers misshapen, somewhat like spindle tuber. Frost-resistant. Does not seem to spread rapidly.

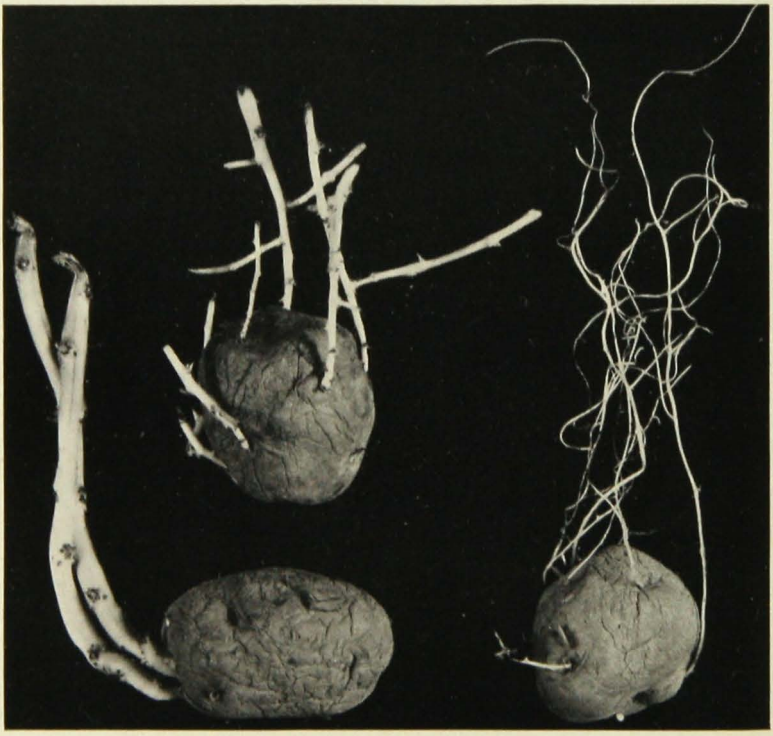


FIG. 25. SPINDLING SPROUT

Note lack of apical dominance on the affected tubers. Tuber in lower left-hand corner is healthy.

Witches broom.—Apical buds lose their dominance, which results in the formation of many fine shoots. Leaves light green; much branching of tops. Numerous small tubers produced in axils of leaves and stems and underground. Spread in field unknown.

Streak.—Dwarfed, spindly plants. Leaves wrinkled and curled. Brown spots on leaves and brown spots or streaks on stems. Plants die early. Transmitted by aphids.

Spindling sprout.—(There is some question as to whether spindling sprout should be included in this group of diseases.) Weak, spindly sprouts on apparently normal and healthy tubers. Apical dominance

lacking. Cause not definitely known. Can only be determined when sprouting begins. Is likely to occur in tubers subjected to heat and drouth toward end of growing season.

Control

From this brief account, it is evident that aphids are important in spreading many of these virus diseases and that such insects as grasshoppers, possibly leafhoppers, flea beetles, tarnished plant bugs, and Colorado potato beetles are instrumental in spreading spindle tuber and unmottled curly dwarf. Such plants as ground cherries, tobacco, tomato, Buffalo bur, nightshade, and Jimson weed also are hosts to mosaic viruses. Hence, it is important that both insects and weeds require consideration in controlling these diseases. All of these diseases can best be controlled by the isolated tuber unit or hill unit seed-plot method. The seed plot should be given the best of care throughout the growing season and should be thoroly sprayed to control insects and leaf-destroying diseases. Remember that the plants growing in the seed plot should be given every opportunity to produce a good crop of vigorous seed potatoes free of disease.

INSECTS

Insects levy a heavy annual tax upon the potato growers of the state. Some work above ground, destroying the foliage, while some work both above ground and in the ground rendering the potatoes unfit for sale. Besides the damage they do by chewing and sucking, some of them are instrumental in transmitting virus diseases.

Colorado potato beetle.—The most familiar insect to potato growers, who recognize the beetles as hard shells and soft shells. The hard shell, or adult beetle, overwinters in the soil, and shortly after emerging in the spring begins laying eggs in clusters on the undersides of potato leaves. These yellow eggs hatch in about a week, and the young larvae —often called slugs—feed on the leaves and grow rapidly. Two broods are produced each year. A single female will lay from 1,500 to 4,000 eggs per season. The Colorado potato beetle also spreads spindle tuber.

Control: Thoro spraying with arsenicals, such as lead arsenate or calcium arsenate. These two poisons are not as rapid in killing the slugs as Paris green, but are just as effective if applied as soon the eggs begin to hatch. Calcium arsenate, two pounds to fifty gallons of water, is the spray most widely used in Minnesota at present. Lady-bird beetles and stink bugs may aid materially in controlling the potato beetle by devouring the eggs and slugs.

Flea beetle.—Small, black, oval-shaped, about one-tenth of an inch long. The adults pass the winter under leaves or other litter, emerge the following spring and begin feeding on the underside of the leaves, making the leaves look as if punctured with fine shot. The eggs are laid in the soil, and when they hatch the young, worm-like larvae may

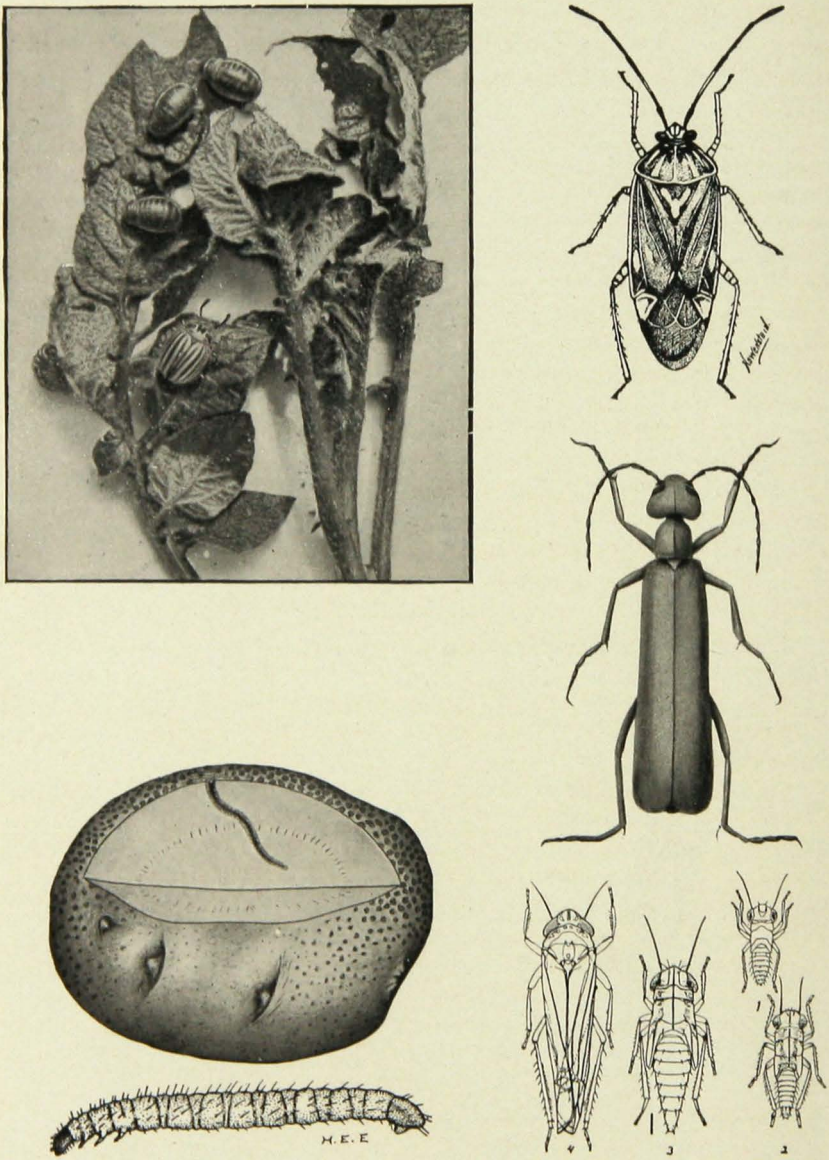


FIG. 26. SOME COMMON POTATO PESTS

Top: Left, Colorado potato beetle; right, tarnished plant bug.
Middle, right: Blister beetle.
Bottom: Left, flea beetle injury in tuber and larva; right, leafhopper.

burrow into the developing tubers, causing pimply potatoes. Flea beetles spread the spindle tuber disease. Recently it has been shown that flea beetle larvae may carry the scab organism from the soil to the tubers.

Control: Cannot be effectively controlled with arsenicals. Partial control can be accomplished by thoro spraying with Bordeaux mixture under high pressure, so that the spray strikes both sides of the leaves.

Blister beetle.—There are several kinds of blister beetles. They are slender, gray, black, or striped yellowish-brown in color. The striped beetle is the one commonly known as the "old-fashioned potato bug." Not as widespread as the Colorado potato beetle, but occasionally may attack a field, coming in large swarms. In this case, the adults do the damage. Altho the adults are destructive, the larvae may be beneficial in that they destroy grasshopper eggs.

Control: Same as for the Colorado potato beetle.

Grasshoppers.—Grasshoppers occasionally cause considerable damage in potato fields. There are two general types, those which migrate from place to place and those which do not. The grasshopper epidemics of 1930 and 1931, besides ruining grain and flax fields, were very destructive on potatoes in some sections of the state. They also spread spindle tuber in the fields.

Control: Thoro spreading of a poison bait consisting of 100 pounds coarse wheat bran, 5 pounds crude arsenic, 2 gallons black strap molasses, and 10 gallons water. Scatter this wet mixture at the rate of 15 pounds per acre where grasshoppers are most abundant. For details concerning control of this pest, see Circular 17 of the Agricultural Extension Division, University of Minnesota.

Leafhopper.—Leafhoppers cause injury to potato foliage somewhat similar to tip burn, puncturing the undersides of the leaves along the veins. The areas between the punctures and the margins of the leaves dry out, turn brown, and roll upward. The leafhopper is a sucking insect and, therefore, impossible to control with a stomach poison such as Paris green or calcium arsenate. The adult leafhopper is a slender, pale green, winged insect and difficult to reach with a contact insecticide. The immature forms are wingless. They can be found on the plants in the southern part of the state early in July and somewhat later further north. When present in large numbers, they can have a very pronounced effect on the yield.

Control: Spray thoroly with Bordeaux mixture before the insects have reached the winged stage. Apply the spray from below the leaves as well as from above. Bordeaux mixture will not only repel the insects, but will kill many that feed on the sprayed leaves.

Tarnished plant bug.—A small, brassy-brown, winged, sucking insect which attacks foliage. Immature forms are wingless. Transmits the spindle tuber disease in the field.

Control: Same as for Aphids.

Aphids (plant lice).—There are a number of species which attack potatoes. In contrast to the leafhopper, aphids are plump and are yellow-green or dark green in color. When numerous, they may cause considerable injury by sucking the juices of the plants, causing stunting and a downward curling of the leaves. They also spread many of the mosaic types of virus diseases. Many broods may be produced in a single season on potatoes.

Control: Early and thoro spraying with nicotine sulfate or Pyrethrum spray to get the early broods.

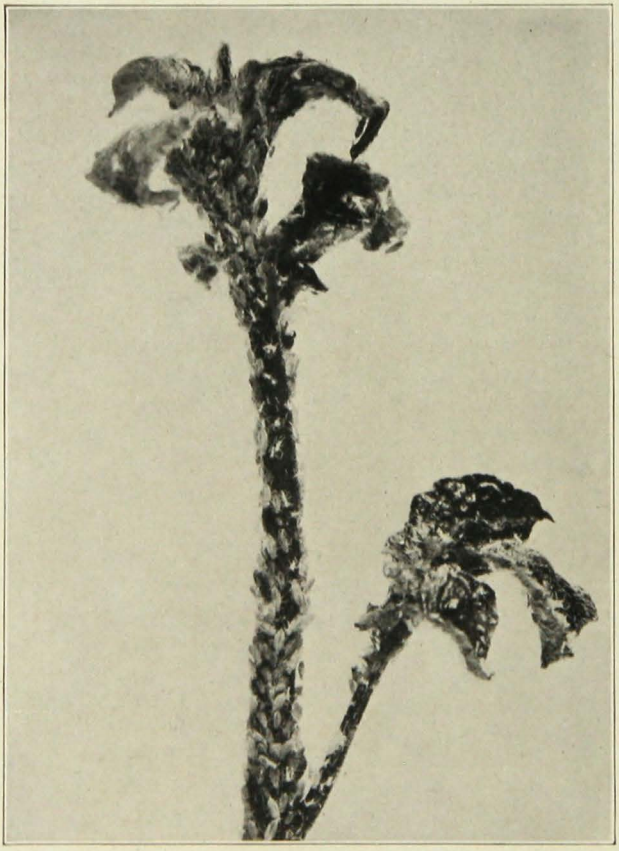


FIG. 27. APHIDS

White grub.—White grubs are the larvae of the May beetle (June bug). They are the worst of the underground insects feeding on the roots and tubers. White grubs cause unsightly depressions in the potatoes, making them unfit for sale. The adult May beetles after emerging in the spring lay the eggs here and there in the fields, preferably in grass land. The white grubs hatch out and begin to feed on

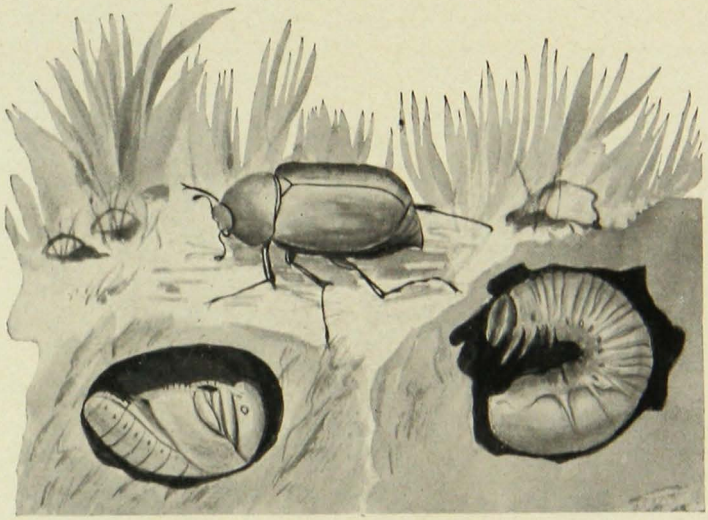


FIG. 28. WHITE GRUB

young roots, wintering over in the soil. In the second year grubs are very destructive to potatoes. The third fall the grubs go into a resting stage and emerge the following spring as adult beetles. Hence, in a field having become heavily infested one year, potatoes planted on that field for the next two years might suffer considerable injury.

Control: Avoid planting potatoes on sod land. Altho many of the grubs may go below the plow line, early fall plowing and thoro disking will kill a great number. Planting potatoes on summer-fallowed ground or on sweet clover or alfalfa ground is a good practice. White grubs avoid such crops as sweet clover and alfalfa. Practice crop rotation.

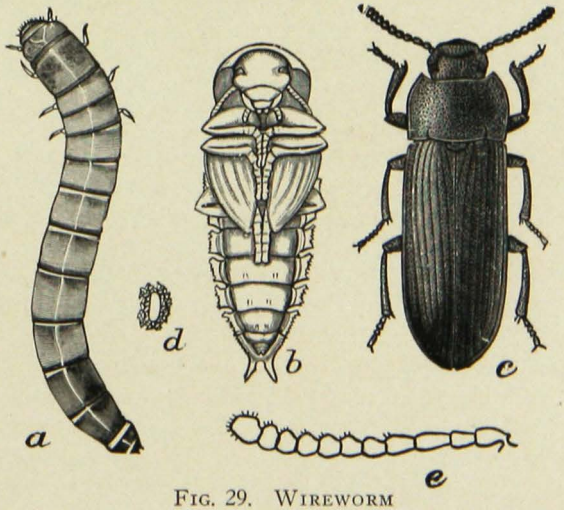


FIG. 29. WIREWORM
a, larva; b, pupa; c, adult; d, egg; e, antenna.

Wireworm.—Wireworms are the larvae of the Click beetle. They are slender, hard, and yellowish to dark brown in color. They injure potatoes principally by boring into the tubers, and may continue their work in storage by going from one tuber to another. The life history is quite similar to that of the white grub (May beetle).

Control: Avoid planting potatoes on sod land. Wireworms do not thrive in land that is frequently disturbed. Practice crop rotation. If potatoes are known to be infested with wireworms, they should not be put into storage, but sold directly from the field.

FROM FIELD TO STORAGE

Harvesting is the point at which too many growers lose money. Much of the time, labor, and money spent in producing the crop can be lost through careless digging and handling. Every grower should aim to get his potatoes into storage in the best possible shape so he can sell them without having to throw out half the crop because of defects resulting from careless harvesting.

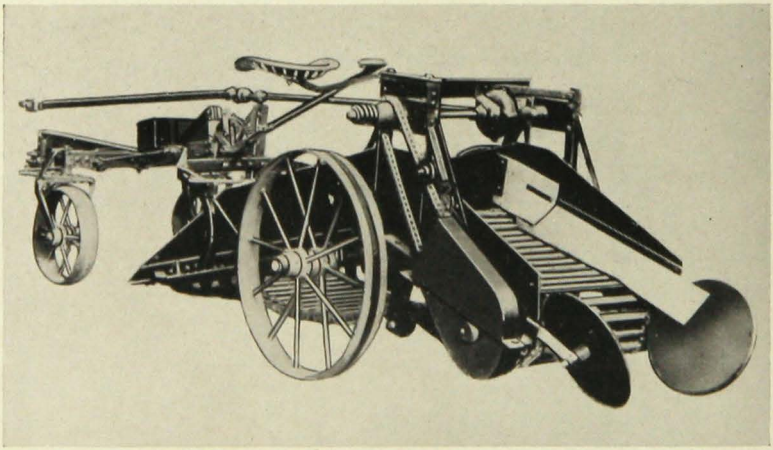


Fig. 30. A New Type of Digger Designed to Avoid Bruising

Buying and selling potatoes on well-defined commercial grades is now a standard practice. Wholesalers, brokers, dealers, and consumers, all prefer and demand a well-graded product. A poorly graded car of potatoes reduces prices, means additional expense for reconditioning (if the lot can be sold at all), lowers the general price level for the district, and may even affect prices paid in the state. Just a few poorly graded cars from a given locality or state may lead buyers to discriminate against all potatoes from that area. Minnesota growers and dealers alike have plenty of competition in the potato business, and to get their share of the business must sell what the market wants.

Grading, after all, begins at digging time, and the succeeding operations on up to loading for shipment will determine just how difficult it is going to be to put up a well-graded product. In general, most potatoes in the state are dug by machinery, and under certain conditions much bruising will take place which at the time may not be noticed. The potatoes go into storage, and two months later every bruised potato may show storage rot. Setting the digger so that a cushion of earth goes over with the potatoes may greatly reduce the number of cut and bruised tubers. The type and condition of soil will determine the speed at which the digger should be run. If the soil is dry so that it falls through the digger rods as soon as it leaves the blade, a great deal of bruising can be expected, particularly if the digger is run at too great a speed. Bruised potatoes may not give any trouble if marketed immediately after digging, but if they are put into storage, *watch out!*

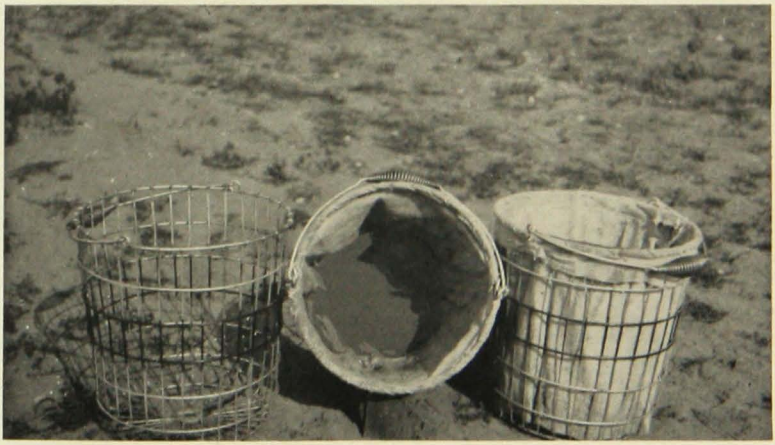


FIG. 31. LINE PICKING BASKETS TO AVOID BRUISING POTATOES

Reversing the digger chain so that the ends of the rods are down instead of up, replacing the agitators with rollers, removing the rear apron, and covering the deflectors with old inner tubing will do much to prevent bruising. The front and rear aprons can be combined into one continuous chain, or the rear apron chain can be covered with soft rubber tubing, and beveled strips of wood covered with belting projecting over the ends of the rods can be bolted to the sides of the conveyer apron. The digger point should be set deep enough to avoid cutting the potatoes.

Further bruising takes place if pickers are careless. Potatoes should lie an hour or two after digging before they are picked up. Pickers' baskets should be lined on the inside with gunny sacking or similar material. Basket tops can be covered by sewing a double thickness of sacking or rubber tubing around the rim. Do not allow the pickers to

throw the potatoes into the baskets. Freshly dug potatoes are brittle and will crack or bruise if thrown against the wire mesh of the basket or on top of other potatoes. Empty potatoes gently from the baskets to the sacks, and do not bounce the sacks up and down to make the potatoes settle. Grasping the top of the sack and applying a twisting motion from side to side will give the same results and minimize bruising.

Potatoes usually suffer very little bruising when being put into pits for storage, but when put directly into a storage cellar may be severely bruised if dropped through the hatchways and allowed to fall several feet. Many certified growers use extreme care in putting their crop into storage. One grower places a long 12-inch plank lengthwise of the bin so that the far end is raised not more than two feet from the floor. The potatoes are carried in through the doorway in sacks, up the plank, and dumped until the potatoes are level with the upper end of the plank. The further end of the plank is then raised again and the process repeated. When the rear of the bin is full, the plank is dragged forward and the entire process repeated until the house is filled. At no time does anyone walk on the potatoes. Some growers attach a chute made of gunny sacks to the hatchways, and a man stands on a barrel at the side of the chute and regulates the flow of potatoes as they are dumped through the hatch. As the height of the pile increases, a bag half-filled with straw can be used in place of the barrel to stand on. When a bin is filled, the chute is moved to another hatchway and the process repeated. Adjustable chutes made of sturdy canvas with offsets can now be purchased. In some cases two men work in the cellar, one standing on a support, taking the loaded sacks through the hatches and relaying them to the second man who dumps the contents carefully. The slanting plank can be used in combination with this method to good effect. If any walking is to be done on the piles, sacks partially filled with straw can be used to step on.

If several thousand bushels are to be put in storage, it would pay to buy or make a conveyor which can be run by hand, as such a device will save both labor and time, and if properly handled, will cause but very little bruising.

Remember that every bruised potato may rot in storage.

Storage

Some storage facilities are needed on every potato grower's farm. With the exception of the sand-land region, where potatoes are sold as fast as harvested early in the season, it will often pay the grower to be able to store at least part of his potatoes for sale at some future date. This is particularly true for the certified seed grower and for growers with large acreages. The small grower can often store his crop in the basement of his house (a space 10 ft. $\times$ 10 ft., 6 ft. high, will hold about 400 bushels), but the large-scale grower will find it worth while to provide a special root cellar or house in which to store at least part

of his crop. If the fall price is good, it might pay to sell the entire crop, but if digging should be delayed by unfavorable weather, having a good root cellar will avoid a great deal of anxiety and possible loss. Potatoes stored temporarily in a barn or shed may freeze before they can be transferred to safer quarters, whereas having a root cellar makes the potatoes safe from frost as soon as they are put away.

Storage Factors

Good storage involves the control of temperature, aeration, and humidity. First of all, it is important that the potatoes to be stored are fully mature and sound. Potatoes bruised in handling may become infected with fungus or bacterial rots, and some loss can be expected even under favorable storage. If the temperature is kept between 35° F. and 40° F. during the storage period, tuber rots will not develop very rapidly, shrinkage will be less, and sprouting will be held back following the normal rest period. When potatoes first come out of the ground and are put in piles, they go through a sweat and give off considerable moisture. Maintaining a fairly high temperature—65° to 70° F.—for the first 8 to 10 days of storage will hasten the formation of wound cork which is important in healing bruised and cut potatoes and preventing rot. When the "sweating" is over, the temperature should be lowered as quickly as possible. The normal rest period varies from 70 to 90 days, depending on the variety. During this period, respiration is almost at a standstill, but afterwards sprouting will take place quite rapidly at temperatures above 40° F.

The storage cellar should be kept relatively moist to reduce shrinkage, but too much moisture favors the organisms causing decay. A relative humidity of 85 per cent is the most desirable. Ventilation is important, regulating both temperature and humidity. Thoro ventilation is necessary during the "sweating" period to carry off moisture and toward the end of the storage period to keep the temperature down and retard sprouting.

Types of Storage

House storage.—Several hundred bushels may be successfully stored in the basement of the house. If the cellar has a concrete floor, a false floor of boards placed about one inch apart on two-by-fours, and a false wall set four inches away from the foundation wall, will provide insulation against possible freezing and at the same time insure ventilation. If there is a furnace in the basement, the storage area should be completely walled off.

Pit storage.—The pit is the cheapest form of potato storage, but the inconvenience of removing potatoes in unfavorable weather may be a serious drawback if a sudden price rise occurs during the winter. The first essential to consider in pit storage is good drainage. Little or no excavation is necessary if only temporary storage is required. For

a permanent pit, the excavation can be two or more feet deep, six feet wide, and as long as necessary. The potatoes are piled into the pit in the form of a rectangular pyramid and immediately covered with sufficient straw or coarse hay to exclude light. Such a covering will suffice as long as there is no danger from frost. During this time, the potatoes will be sweating, after which more straw can be added to make a layer about six inches thick when covered with soil. A six-inch layer of soil is placed over the straw, leaving uncovered at the ridge a space about a foot wide and the length of the pit to provide ventilation. As soon as the soil begins to freeze, an additional heavy layer of straw is placed over the entire pit. Another layer of soil on top of this second layer of straw may be advisable. If the ridge of the pit is not left open, it will be necessary to provide some other means of ventilation. Ventilator shafts six inches across and long enough to stick out of the pit at least a foot can be made out of inch lumber. In the bottom half of each shaft, bore numerous holes one inch in diameter on all sides. The top of the shaft should be capped. For a pit 10 feet long, only one shaft is necessary. In large pits, place shafts eight feet apart. These shafts should be placed along the center line of the pit and should extend from the floor to about two feet above the covering of straw and soil.

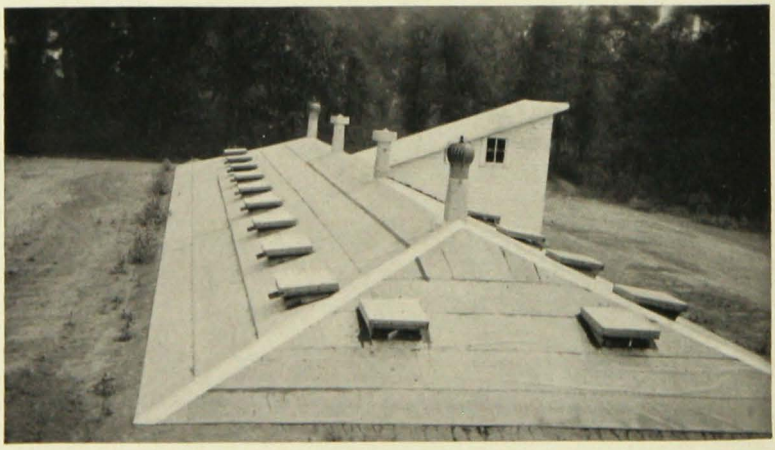


FIG. 32. A GOOD FARM POTATO CELLAR

The dugout or "root cellar".—This is the most common type of potato storage in the state. It is both cheap and efficient. If a side hill or knoll is available, locate the pit there because of better drainage and because entrance can be made on the ground level. A side hill storage should be dug about eight feet deep and as long and wide as required. A cellar 40 × 20 feet will easily store 4,000 bushels without piling too deep. It is advisable not to pile potatoes more than six feet high. When the side hill excavation has been made, rough timber or poles can be

set endways around two sides and the rear end on a concrete footing about one foot wide by 18 inches deep. Poles may also be used for the roof and laid close enough to permit covering the entire roof with a thick layer of straw. The dirt from the cellar can be used for banking and for covering the straw on the roof.

In the Red River Valley, where knolls and side hills are rare, satisfactory storages are made at very small cost by excavating a cellar, usually about four feet deep, with walls slanting inward from the top. The dirt taken out is piled around two sides and one end, heavy sills are laid around these three sides, and the whole is covered with a permanent shingled roof. The nature of the soil is such that the earthen banks of the excavation serve as a wall. Heavy poles or square timbers are used for roof supports and may serve as anchors for partition walls. A vestibule is built on the entrance and thoroly banked with earth. Two sets of tight doors are attached, one at the entrance and one where the vestibule joins the cellar. There is no floor covering. The potatoes are loaded into the house through hatchways spaced at equal distances on both sides of the roof. Vents, 6 × 6 inches of one-inch boards and capped, are spaced at about eight-foot intervals along the ridge of the roof. The hatchways have loose covers which are left off during the sweating period. In winter, the roof can be covered with straw and the vents regulated by a sliding valve or by gunny sacks which can be stuffed into them or taken out, as necessary. A fresh-air intake, built out of tile and extending under the vestibule to the center of the floor, can be provided at little expense.

SEED DISINFECTION

Seed disinfection destroys the organisms causing scab, Rhizoctonia, and blackleg when present on the tubers. This does not necessarily mean that disinfected seed tubers will produce a disease-free crop. If the soil in which the treated seed is planted is infested with the organisms causing these diseases, the resulting crop may become infected, depending a great deal on environmental conditions.

Materials Used

Hot formaldehyde.—One pint to 15 gallons of water at a temperature of 125° F. Soak the potatoes for three minutes, drain, and cover for 24 hours. Precaution: Do not let the temperature go below 125° or above 131° F.

Acid mercury dip.—Six ounces of corrosive sublimate dissolved in one quart of hydrochloric acid (muriatic acid). Pour the hydrochloric acid containing the corrosive sublimate into 25 gallons of water. (Use nonmetallic containers. If a metallic container is used, paint the inside thoroly with asphaltum paint.) Let the potatoes remain in this solution for five minutes. If cut potatoes are treated, plant immediately after

treating. Do not store treated potatoes while they are wet. Twenty-five gallons of solution will treat approximately 40 bushels of potatoes.

Acid mercury dip can be obtained ready to use under the name "Mercurnol."

Remember, corrosive sublimate is a deadly poison and must be handled with care. Keep livestock away from treated potatoes. When through treating, empty all containers holding the solution.

Improved Semesan Bel.—This is an organic mercury which can be purchased ready to mix with water. Full directions for use are given on the package.

Copper sulphate (bluestone) solution.—One pound of copper sulphate dissolved in 10 gallons of water. This solution is effective in disinfecting storage cellars and bins. Can be applied with a hand sprayer. A small quantity of lime added to the solution will color it sufficiently so that one can readily see where the material has been applied.

Spraying and Dusting

Thoro spraying at the proper time with Bordeaux mixture will control tip burn, early and late blight, and such insects as the leafhopper and the flea beetle. The formula commonly used is that known as the 4-4-50, (4 pounds copper sulphate [bluestone], 4 pounds chemically hydrated lime, 50 gallons water).

Instant Bordeaux is made by a comparatively new method which is much quicker and easier than the old standard method. A finely pulverized copper sulphate powder, known on the market as "snow", will dissolve in water in 1½ minutes when thoroly agitated. This method also requires a chemically hydrated lime.

FIG. 33. THIS GROWER BELIEVES IN HIGH-PRESSURE SPRAYING EARLY WITH BORDEAUX MIXTURE AND "BUG POISON"

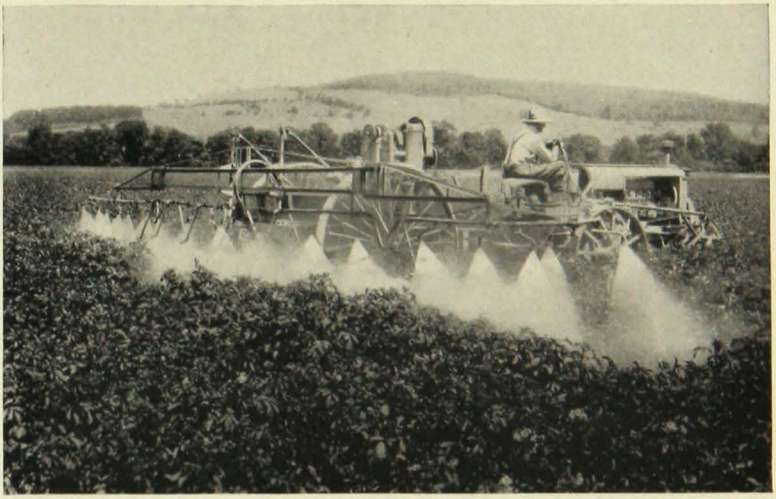


FIG. 34. IDEAL SPRAYING EQUIPMENT FOR THE LARGE POTATO GROWER

To make a 4-4-50 Bordeaux mixture in a 100-gallon sprayer:

Fill the spray tank one-fourth full of water.

Pour eight pounds of copper sulphate (snow) on the intake strainer and allow the inflowing water to wash it into the tank.

Agitate the solution while adding the water.

When three-fourths full, add eight pounds of dry chemically-treated lime, pouring it slowly through the intake strainer with flowing water, while the contents of the tank are being agitated. The lime can be made into a creamy paste before pouring it into the tank.

Paris green, calcium arsenate, or lead arsenate can be added to the Bordeaux mixture to control chewing insects. First make into a thin paste, adding the amount of poison recommended on the package.

Fill the tank with water.

Caution: Do not mix copper sulphate solutions in metal containers. Use Bordeaux mixture immediately after it has been prepared.

Copper lime dust, like Bordeaux mixture, will help to control losses from late blight, early blight, leafhoppers, and flea beetles. Apply with or without poison used for the Colorado potato beetle.

Preparation.—Use a 20-80 dust prepared by mixing 20 parts monohydrated copper sulphate with 80 parts hydrated lime. Monohydrated copper sulphate is usually sold in 12½-pound bags. One 12½-pound bag mixed with a 50-pound sack of hydrated lime will make 62½ pounds of a 20-80 mixture. For controlling beetles, replace 6½ pounds of lime with 6½ pounds of calcium arsenate.

When plants are small, 20 to 30 pounds of copper lime dust will be required per acre for each application. Fifty pounds per acre are required when the plants are large.

Mixing.—Thoro mixture of the copper sulphate and the lime is necessary, and can be readily accomplished by using a homemade barrel churn similar to those used in treating seed grain.

In localities where the water supply is a problem, dusting with Bordeaux dust in which the insecticide is usually included will do satisfactory work. High-power dusters with two nozzles to the row are essential for thoro work.

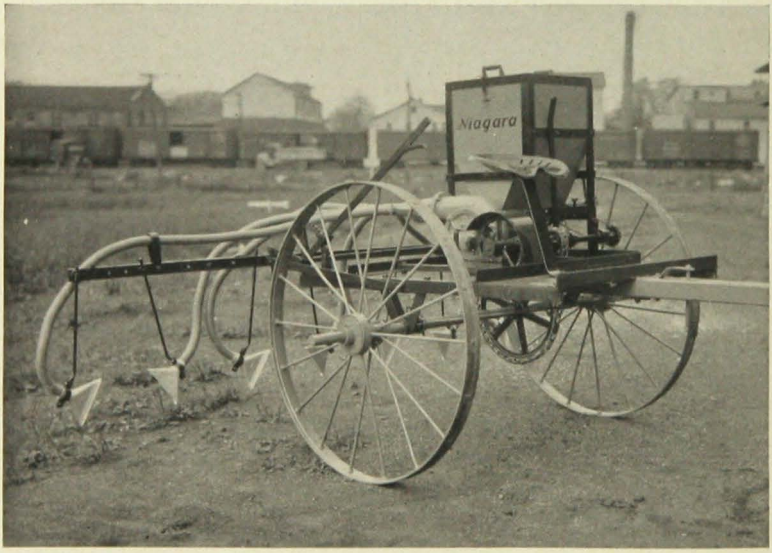


FIG. 35. WHERE WATER IS SCARCE THE HIGH-POWER DUSTER, WHEN PROPERLY USED, IS VERY EFFECTIVE IN CONTROLLING BLIGHTS AND INSECTS

Wet spray should also be applied with a high-pressure sprayer, using three nozzles to the row, set so that the plants are covered underneath as well as on top. Traction sprayers can now be purchased capable of developing 250 to 300 pounds pressure. Applying Bordeaux mixture or insecticide with low-pressure sprayers is a waste of time and material.

Altho late blight rarely occurs in Minnesota and early blight seldom does much damage, leafhoppers and flea beetles are usually present and sometimes in great numbers. Bordeaux mixture is the most effective spray for both of these insects, and since the poisons used for controlling the Colorado potato beetle can be mixed with the Bordeaux, they should be used in combination as soon as the eggs of the Colorado beetle start hatching. The leafhoppers and flea beetles also begin to make their appearance about this time.

Note: Watch the disks in the nozzles. The hole in a new disc is very small and makes a fine, misty spray. Worn disks should be replaced as a disc with a large hole will waste material and give a poorer spray.

If dusting is preferred to wet spraying, it should be done during the late afternoon and evening or early in the morning. Do not dust during the day. Some of our certified seed potato growers who use high-power dusters do all of their dusting at night.

Whether spraying or dusting, keep the vines thoroly covered with spray material from the middle of July until the vines start drying up. If the latter part of the season is favorable for late blight, keep the plants covered until the end of the season.

A good high-pressure sprayer or a good high-power duster will last for many years with proper care. Both are expensive pieces of machinery and should be thoroly cleaned and put under shelter after each spray job.

SEED POTATO CERTIFICATION

Seed potato certification is now carried on in 22 states and provides an official means for determining the value of potatoes for seed purposes. It also serves as a stimulus and reward for producing high-class seed potatoes.

Many potatoes are shipped out of Minnesota each year, a considerable share being planted in states where it is impractical for growers to raise their own seed stock. Because of varietal mixtures and the presence of seed-borne diseases, much of this stock should never leave the state. Growers, Experiment Station workers, and dealers in the seed-potato–consuming states recognize the value of certified seed potatoes, and in some states steps have already been taken to prevent the importation of seed that is not certified.

Some of the diseases discussed in this bulletin seriously reduce yields and are easily spread in the field. Therefore, it is almost impossible for the growers in our larger potato-growing areas to keep their seed stock healthy for more than two or three years. By starting with good seed, growers in more isolated areas can provide the larger growers with seed which is practically one hundred per cent perfect. There is a need for growers so situated to go into seed production. Whether a grower is raising certified or table stock, he should plant the best seed available.

A copy of the Rules and Regulations governing the growing of foundation and certified seed potatoes can be obtained from the office of Seed Potato Certification, University Farm, St. Paul, Minnesota.

SELLING THE CROP

The marketing season for Minnesota potatoes is a long one, starting with the harvesting of the sand-land Ohios, early in August, and extending as late as the following May. Many of the factors involved in the growing, harvesting, and storing of the crop directly affect the difficulty or ease with which the potatoes can be prepared for the market. The term "market quality" refers to the general appearance of the pack of potatoes, and is of prime importance in selling. A well-graded pack of bright-skinned potatoes, mature, clean, free from blemishes, decay, and

disease or insect injury, and properly sized, attracts the purchaser. The following grades are recognized in Minnesota: U. S. Fancy, U. S. No. 1, U. S. No. 2, Unclassified, and Certified. The provisions of the certified seed grade allow only 3 per cent defects and certain percentage tolerances of diseases such as scab, Rhizoctonia, and spindle tuber. Complete information on this grade is contained in the Rules and Regulations governing the growing of certified seed potatoes.

Most table potatoes are sold on the basis of U. S. No. 1 grade, and it might be far better for the potato industry as a whole if such grades as U. S. No. 2 and Unclassified were eliminated.

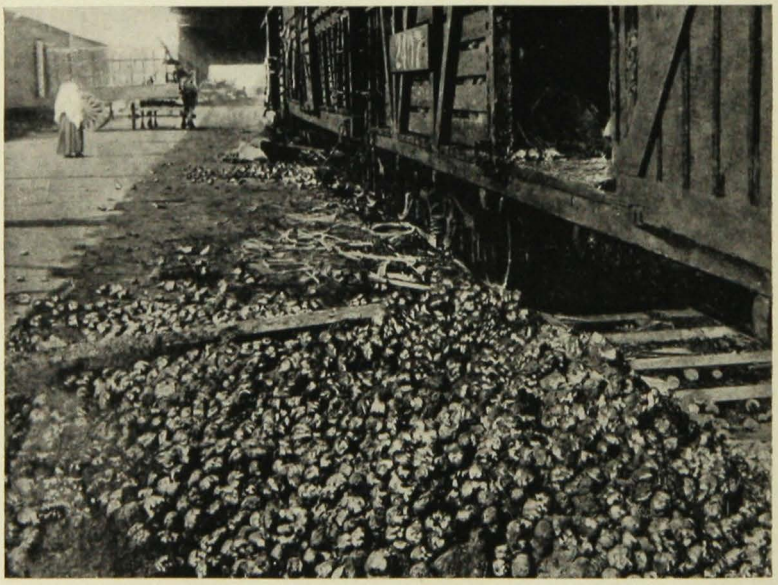


FIG. 36. POOR GRADING RESULTS IN LOSSES

There is plenty of room for improving the market quality of Minnesota potatoes. The responsibility for selling properly graded potatoes rests squarely upon the shoulders of potato shippers, whether they be dealers who operate potato warehouses or potato growers who ship their own stock. In the first place, all poor potatoes should be left at home. It is true that in unfavorable growing seasons many potatoes are going to be difficult to grade properly, and the growers whose potatoes are inferior because of poor growing conditions cannot be blamed too severely because they desire to get something out of their crop. However, if numerous cars of ungraded or poorly graded Minnesota potatoes go into the larger marketing and distributing centers together with well-graded potatoes from competing states, it does not take a great deal of imagination to see what will happen to the price

for the Minnesota product. The continual influx of poorly graded Minnesota stock establishes a reputation for Minnesota potatoes among the trade which is not deserved by our better shippers and generally serves to depress the price for our potatoes.

Many shippers have adopted certain brands which are intended to represent potatoes of fine market quality, but instances have occurred where potatoes of questionable quality have been marketed in branded sacks. Such brands are harmful rather than beneficial to our potato industry, unless the contents of the branded sacks are properly graded.

Recent investigations show that in our own Twin Cities approximately 40 per cent of the potatoes consumed, not counting potatoes shipped in from the South after our own potatoes are off the market, originate in other states, principally from those in the West. Not only that, but they command a higher price than do our own home-grown potatoes. Why should the consumers in one of the largest potato-growing states in the country be obliged to eat potatoes grown in other states? The answer lies in the fact that the imported potatoes are always well graded. It is true that many well-graded cars of potatoes leave Minnesota each year, and it would seem fitting and proper that Minnesota consumers should also have the privilege of buying well-graded Minnesota potatoes. If individual growers and shippers are not interested enough in supplying potatoes of good market quality, it might be advisable for groups of growers who are willing to put up a quality pack for Minnesota consumers to organize local co-operative units and go after the business. It is important to keep in mind that market quality can be most easily secured by careful handling of the tubers during harvest, storage, and shipment. Carelessness in these operations may undo all of the work involved in growing the crop.

Following are some of the defects which must be removed in grading potatoes to meet U. S. No. 1 grade specifications:

Bruises.—Bruises may occur through harvesting operations when they are usually unnoticed or they may be caused by reckless handling in grading and loading operations. Bruises afford ideal entrances for dry- and soft-rot organisms in storage, and if the conditions during the first few days of storage are such as to prevent rapid wound cork formation, heavy losses from rot will follow. Any bruise which in itself is bad enough to cause wastage in paring is considered a grade defect.

Rot infection may take place in either. Infection in either tuber would make it a grade defect.

Digger cuts.—Large digger cuts cause waste in paring and may also be a source of rot infection. Small well-healed cuts are not considered defects. Such cuts can be avoided by setting the digger blade properly.

Second growth.—Second growth is largely due to certain growing conditions and may be more prevalent on some varieties than on others. Heavy rainfall late in the season following a long dry spell may cause considerable second growth. Ohios seem to be particularly susceptible.

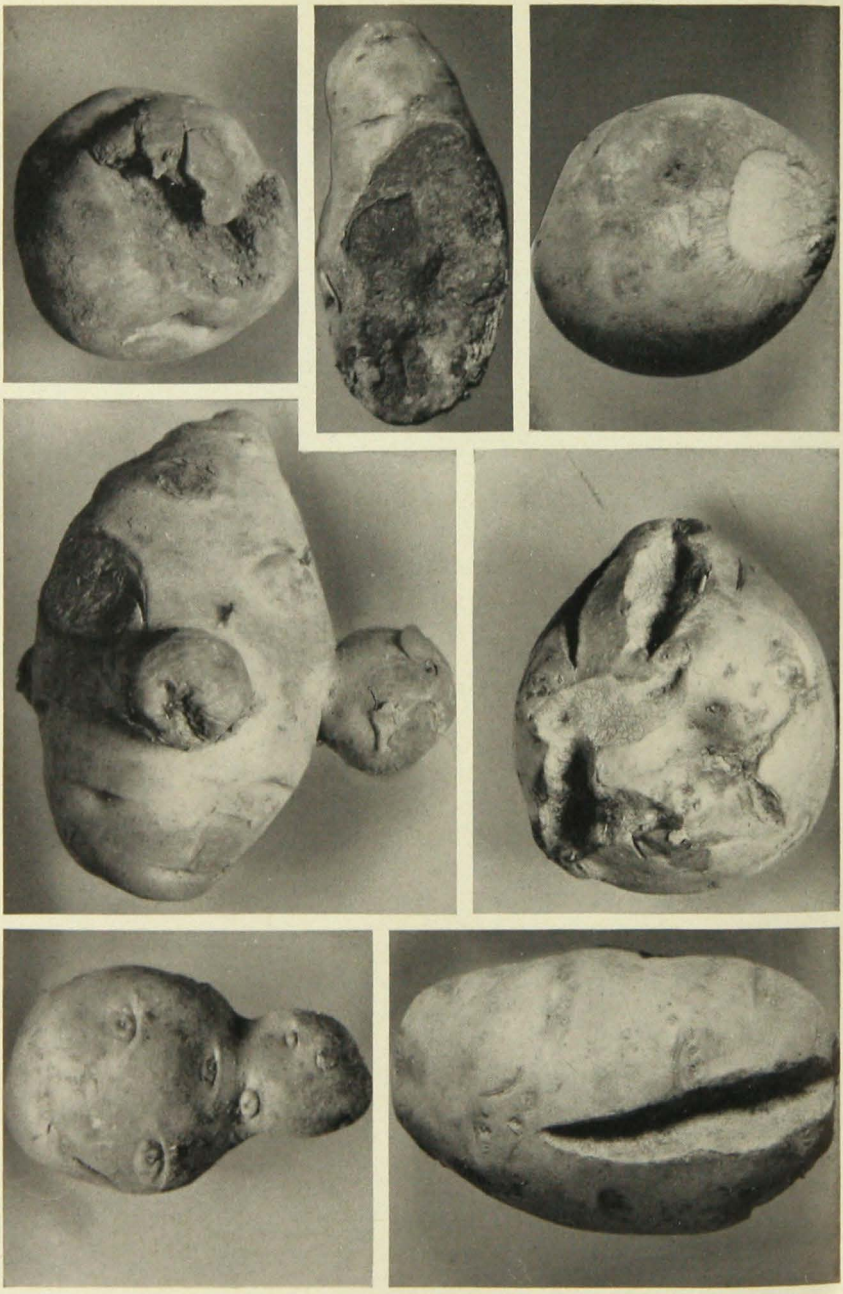


FIG. 37. GRADE DEFECTS

Top, left to right: Shatter bruise, digger cuts.
Middle, left to right: Second growth, severe growth cracks.
Bottom, left to right: Misshaped tuber, growth crack.

Knobs large enough to be readily broken off constitute grade defects. Scars left by broken-off second growths may become infected with rots.

Growth cracks.—Growth cracks may vary from tiny cracks, so small that the potato takes on a russet appearance, to large deep cracks extending from one end of the tuber to the other. The Early Ohio seems to be more susceptible than other commercial varieties. Large, deep, growth cracks are responsible for considerable waste in paring and are grade defects. The cracks may be very prevalent during seasons of long alternate dry and wet periods, especially in heavy soils.

Tuber rots.—There are a number of different types of tuber rots affecting potatoes in storage, which, for the sake of convenience, may be divided into the dry and wet types. The organisms causing these rots can gain entrance to the tuber only through bruises in which the skin of the potato is broken. The extent of damage due to such rots will depend a great deal on the care with which the potatoes are handled during harvesting operations and storage conditions. See pages 23, 25, and 50. Rot on any tuber is considered a defect because it will continue to destroy the potato.

Scab.—Surface scab covering a large area of the potato and pitted scab are considered grade defects. Both are unsightly and involve considerable waste in paring. Slight infection consisting of a few scattered surface pustules and causing relatively little waste in paring does not constitute a grade defect. (See Fig. 21.)

Sunburn.—Sunburn is caused by exposure to light when the potatoes are in the ground. It may be avoided by so adjusting the cultivator as to throw the dirt toward the center of the rows. Sunburned areas affect the appearance of potatoes and may extend rather deep into the tissues, involving considerable waste in paring. Shallow sunburn or a slight greening on one end of the potato is not considered a defect unless many of the tubers are affected.

Sunscald.—Sunscald is caused by exposure to strong sunlight if the potatoes are allowed to remain on the ground for more than one-half hour after being dug during hot weather. Its presence is not noticed until several hours, or even several days, after digging, when a complete breakdown of the tissues takes place. If potatoes must be dug during hot, sunshiny weather, they should be sacked within half an hour after they have come over the digger and hauled out of the field into the shade as quickly as possible.

Internal discoloration.—There are a number of different types of internal discoloration, each with different causes. Obviously, these various discolorations are not apparent without cutting the tubers, but they are all grade defects because they either cause waste in paring or may be so bad that the affected tubers are a total loss.

Internal brown spotting.—This condition seems to be associated with hot, dry growing conditions, particularly on the lighter types of soils. Such tubers are unfit for either table use or seed. The net necrosis

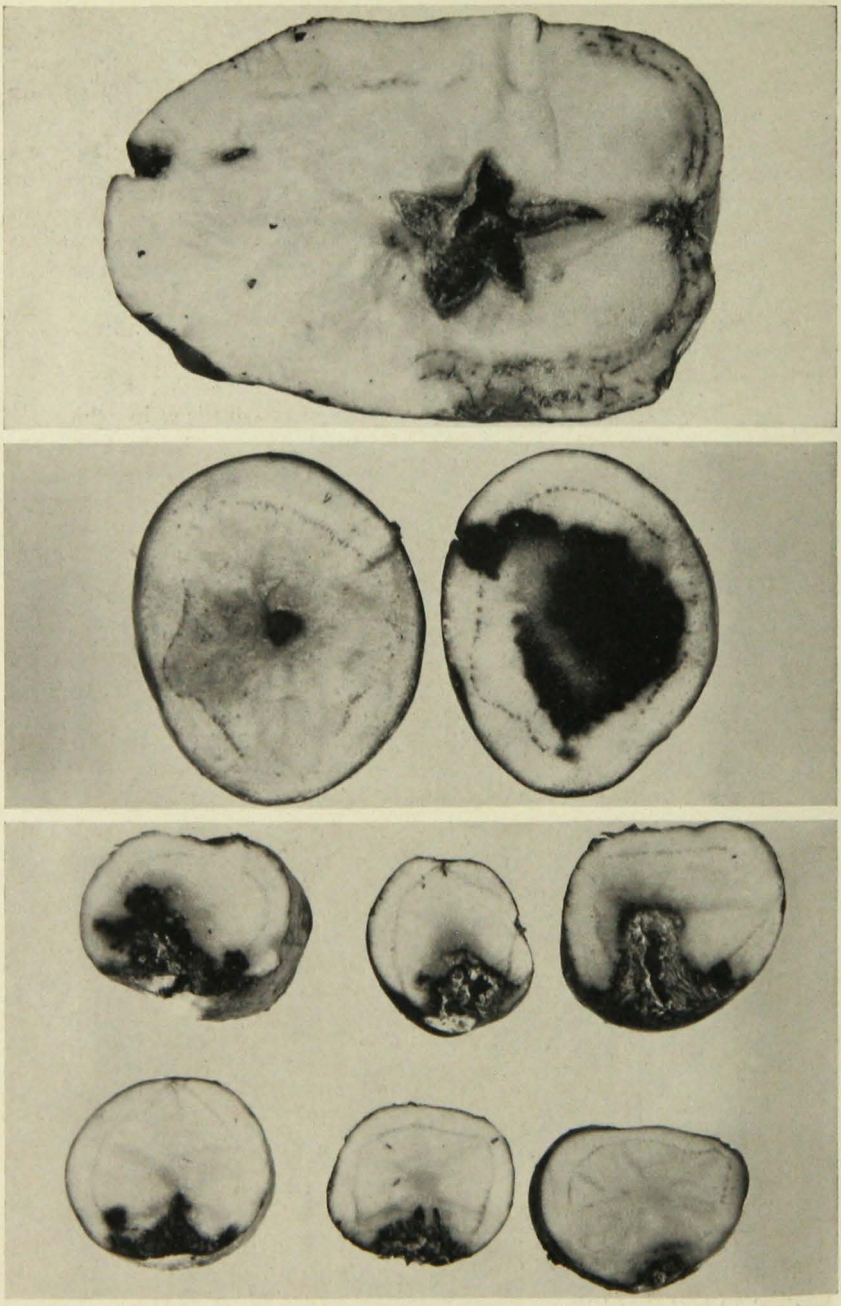


FIG. 38. GRADE DEFECTS

Top: Hollow heart and internal discoloration.
Middle: Black heart.
Bottom: Dry rot showing progressive stages.

type is sometimes the result of leafroll disease. If the growing season has been hot and dry, it would be advisable before attempting to market the potatoes to cut a considerable number of tubers to see whether internal brown spotting is present. If many of the tubers are affected, it would be folly to attempt to market them.

Stem end discoloration.—This condition may be due to the presence of Fusarium wilt in which it is progressive, or to premature killing of the vines by heat or frost. If due to the two last mentioned factors, it is not progressive, but the tissues may be injured sufficiently to allow the entrance of rot-producing organisms. If due to Fusarium wilt, its presence is manifested by the discolored skin around the stem end of the tuber. The presence or extent of any type of stem end discoloration can be determined by cutting the ends of the tubers.

Black heart.—As the name indicates, the center of the potato is a purplish-black. It is caused by high temperatures or by lack of proper ventilation. This is one good reason for not piling potatoes too high in the storage cellar without providing ventilation shafts at regular intervals.

Leak.—Altho leak occurs rarely under Minnesota conditions, it has been observed a number of times when potatoes have been dug during extremely hot weather. It is caused by a soil-inhabiting organism which gets into the potatoes through injuries, producing water-soaked lesions on the tubers. The fungus works extremely fast and may destroy a tuber in a few days at temperatures of 60° to 90° F., causing a complete breakdown of the tissues. The water in the tissues of a potato affected with leak varies from a clear yellow to brown. If potatoes are hauled to the storage cellar or car immediately after being dug, its presence may not be noticed until the potatoes are in storage or ready for shipment. Careful harvesting will aid considerably in reducing losses from this cause.

Hollow heart.—Hollow heart or hollow center is caused by rapid or irregular growth of the tubers. Altho it may sometimes occur in small potatoes, it is more likely to be found in extremely large ones. A large percentage of hollow heart affects the market quality. U. S. No. 1 grade has a separate tolerance of 5 per cent for this trouble. Inasmuch as growing conditions have a direct bearing on the presence of hollow heart, it is difficult to control. Any measures tending toward maintaining uniform growing conditions after the tubers have formed will reduce the amount of hollow heart to a minimum. Hollow heart does not injure potatoes for seed purposes.

Freezing injury.—A few frozen potatoes may necessitate reconditioning a whole carload before the load can be made salable. Freezing injury may take place in the field, in storage, or in transit. A badly frosted potato will break down as soon as the temperature gets above 32° F. Freezing affects the tissues which make up the "starch line" first, and if only slight freezing has taken place, a sort of net necrosis,

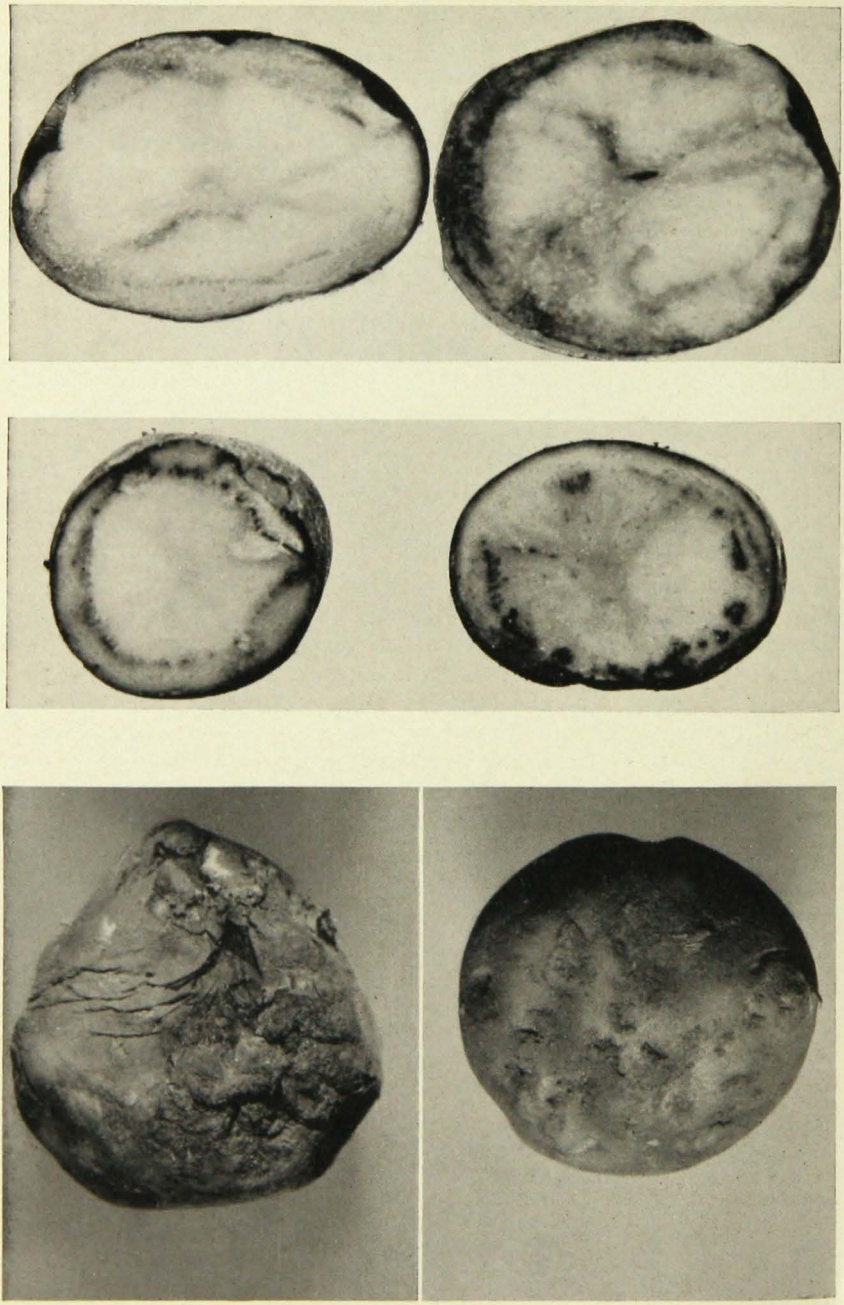


FIG. 39. GRADE DEFECTS

Top and middle: Different types of freezing injury.
Bottom, left to right: Badly frozen tuber, dirt.

confined chiefly to the starch line tissues, ensues on thawing. Externally, such potatoes may be firm, but on cutting the frost necrosis will be readily apparent. Freezing injury is difficult to eliminate when present in stored potatoes, and every precaution should be taken to avoid it.

Sprouting and shriveling.—Any load of potatoes containing over 10 per cent of sprouted tubers cannot qualify for U. S. No. 1 grade, when the sprouts are over ¾ of an inch long.

A potato more than moderately shriveled, spongy, or flabby is a grade defect.

Late blight rot.—Late blight rarely occurs in Minnesota. However, when present in the potatoes, it can cause a lot of trouble because the organism can penetrate the sound skin of the tuber. A few affected potatoes in storage may destroy all of the tubers, unless the temperature is kept between 35° and 40° F. It is a very serious grade defect because the rot may spread rapidly both in storage and transit. Control measures are discussed on page 42.

Insect injuries.—Any injuries caused by such insects as flea beetles, wireworms, or white grubs that materially affect the appearance of the potatoes or that involve considerable waste in paring are grade defects. See discussion under "Insects."

Dirt.—Potatoes smeared or caked with dirt or stained with decay residue from other tubers are considered as grade defects. More or less dirt is always taken into the storage cellar from the field, depending upon digging conditions. If the dirt is of a fine, clayey texture, much of it brought into the cellar will adhere to the potatoes when the sweating period is over. The presence of much dirt increases the difficulty of sorting. If possible, avoid digging potatoes under wet conditions, particularly if the soil is of a heavy nature.

Misshaped potatoes.—U. S. No. 1 grade requires that potatoes should be of similar varietal characteristics and fairly well shaped. Badly deformed potatoes, as illustrated, are grade defects because they involve waste in paring, and they materially affect the appearance of the load.

POTATO SHOWS

The importance of potato shows lies primarily in their educational value. A potato show, whether it be local, county, regional, or statewide, affords an opportunity for healthy competition and creates a stimulating interest among all those engaged in the various phases of the potato industry who attend such events. It provides a means for establishing neighborly contacts and for an exchange of ideas on all phases of potato culture which are necessary for progress.

As a rule, most shows, as far as the exhibition itself is concerned, are confined to a display of ideal tubers of the different varieties, altho in the larger shows real or utility exhibits play an important part from the commercial standpoint. Utility exhibits are intended to show what the grower can sell and should represent true samples as to grade. This type of exhibit should be of particular value in showing properly

graded lots of certified seed, especially when such lots are accompanied by copies of the field inspection records.

Selecting Show Potatoes

Selecting show potatoes is not particularly easy and requires a knowledge of varietal characteristics. Each variety has certain general characteristics which may be modified according to environmental conditions, and the potato showman must consider this factor when he selects his sample. Before selecting a show sample, it is well to have in mind an ideal tuber in which type and size are given chief consideration. Show potatoes cannot be successfully selected out of a bin, but can best be taken at digging time. If the conditions for digging are good and the digger so adjusted and padded as to minimize bruising, a good selection can be made in a comparatively short time. Careful digging by hand is probably the best method, but very laborious.

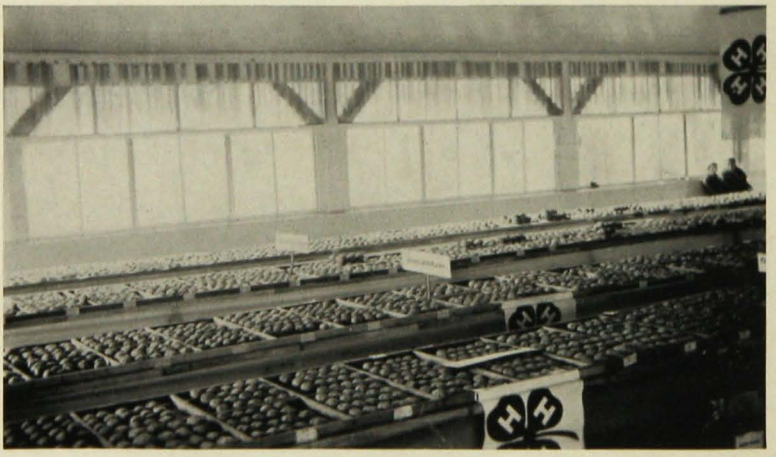


FIG. 40. POTATO SHOWS STIMULATE INTEREST IN BETTER POTATOES

Select a tuber which you consider ideal as to type and size, then pick a hundred or more tubers as nearly like it as possible. The number of specimens usually required for show purposes varies from 20 to 32.

Show samples should always be handled very carefully to avoid bruising. Avoid all tubers which have scab, Rhizoctonia, or evidence of any other disease.

After the potatoes have dried off sufficiently, wrap each tuber in a separate piece of paper, pack securely in a box or basket, and store in a cool place until the show.

How To Prepare And Exhibit

First, secure a premium list and rules of the show at which you are to exhibit.

Just prior to the show, carefully unwrap the potatoes selected at digging time and brush off all dirt with a soft brush.

Lay all of the potatoes in the form of a square on a table, pick out your most ideal tuber, and then select enough other potatoes for the exhibit as nearly like the ideal tuber as possible. It is advisable to include a half-dozen extra tubers.

Be sure that there are no blemished tubers in your final selection.

If washed potatoes are allowed at the show and you feel that your sample would be improved by washing, do not overdo the job by scrubbing the potatoes. A washed potato will blemish much more quickly than one which has been carefully brushed. As a rule, most judges at shows prefer unwashed exhibits, and if the potatoes were carefully selected, dried, and wrapped in the fall, they will only require a final light brushing to appear at their best.

Wrap each tuber in paper and pack the wrapped samples securely in a box or paper carton. If the potatoes are to be shipped, put your name and address on a card inside and also on the outside of the package, indicating the class in which you want them exhibited. If you desire the exhibit returned, notify the show authorities by letter.

Factors To Consider In Selecting A Show Sample

Some shows use score cards which allot so many points to each of the factors considered in judging. Whether a score card is used or not, a judge considers the potatoes under two general headings, namely, "Conformity to type" and "Condition and quality." In general, conformity to type counts 55 to 60 points out of 100, while quality is weighted at 45 to 40 points.

Under "Conformity to type" are included:

Shape—Correct for variety and uniformity.
Size—Within desired limits and uniformity.
Color—Correct for variety, smoothness and uniformity.
Skin and eye characters—Evenness, smoothness, uniformity. Eyes correct for variety, uniformity, freedom from knobs, etc.

Under "Condition and quality" are included:

Clearness and brightness of skin—free from blemishes, sunburn, and checks.
Quality of flesh—Color, texture, firmness.
Freedom from diseases—Scab, Rhizoctonia, tuber rots.
Freedom from blemishes.

The purpose in writing this bulletin has been to point out the importance of numerous factors involved in growing and marketing a crop of potatoes, and to suggest certain practices which make for more economical production. Every potato grower recognizes that profits are not necessarily measured by the acreage he grows, but by how many bushels of good-quality potatoes he can produce per acre.

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