

MISSOURI

# Potato Grower's Guide



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UNIVERSITY OF MISSOURI  
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# Potato Grower's

## Potatoes Require Good Care of Soil

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### **Begin With Good Soil**

To meet competition, commercial potato crops need to be grown on soil that is well suited naturally to potato production. Production costs are high and profit margins relatively narrow. Most of Missouri's commercial crop is grown in the sandy loam soils along the Missouri River in Jackson, Ray, and Clay Counties.

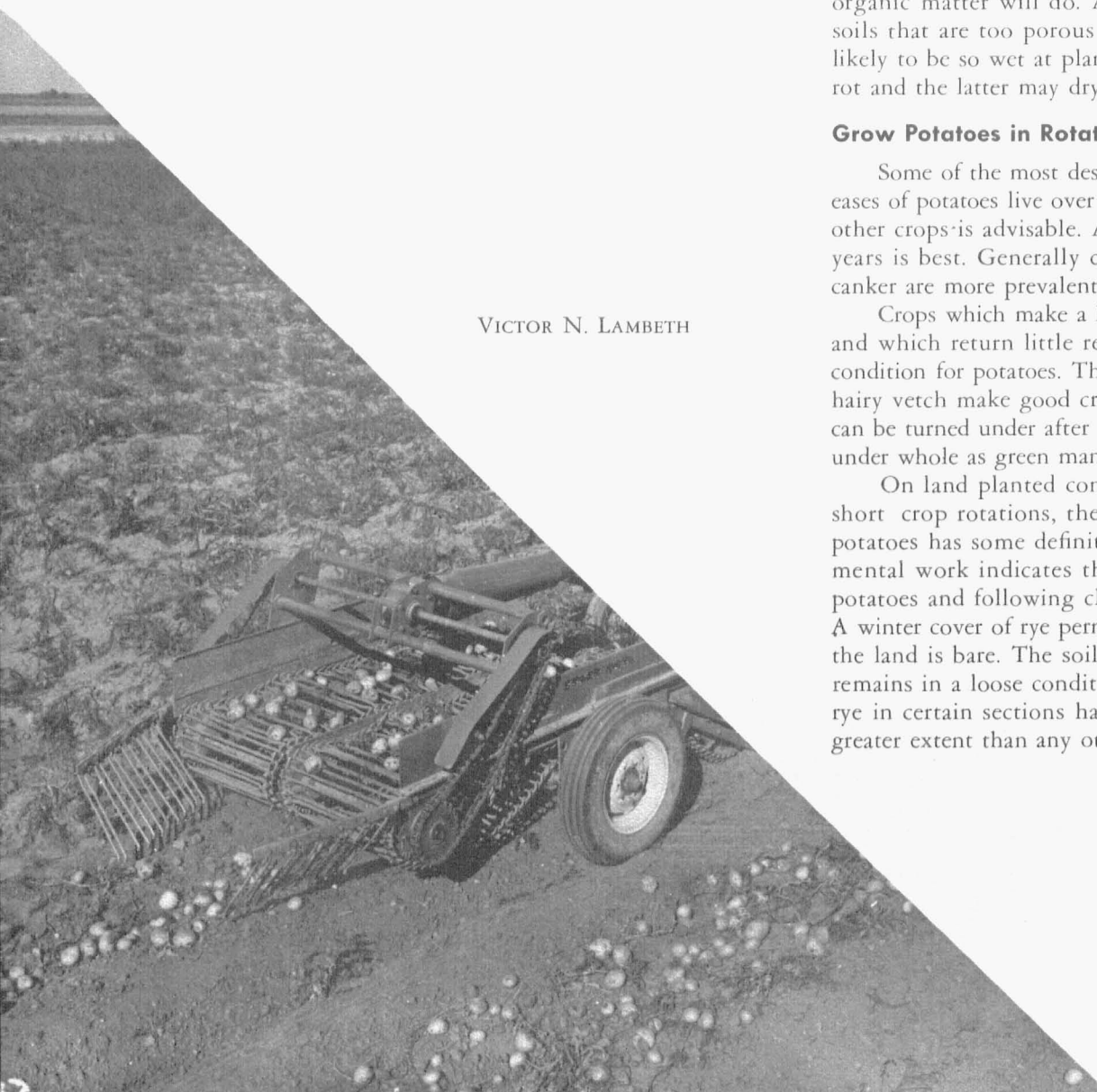
But to grow good crops for family use and local markets soil requirements are not so exacting. Any well-drained loam which can be kept high in fertility and organic matter will do. Avoid tight subsoils and subsoils that are too porous and gravelly. The former are likely to be so wet at planting time that the seed pieces rot and the latter may dry out too rapidly in summer.

### **Grow Potatoes in Rotation**

Some of the most destructive organisms causing diseases of potatoes live over in the soil. Thus rotation with other crops is advisable. A long rotation of four to five years is best. Generally common scab and rhizoctonia canker are more prevalent in the short rotations.

Crops which make a heavy demand upon plant food and which return little residue leave the soil in a poor condition for potatoes. The clovers, alfalfa, cowpeas, and hairy vetch make good crops to precede potatoes. They can be turned under after removing a hay crop or turned under whole as green manure crops.

On land planted continuously to potatoes, and in short crop rotations, the use of winter rye preceding potatoes has some definite advantages. Recent experimental work indicates that the use of rye preceding potatoes and following clover reduces damage by scab. A winter cover of rye permits plowing earlier than when the land is bare. The soil containing the rye roots also remains in a loose condition longer. Spring plowing of rye in certain sections has increased potato yields to a greater extent than any other improved practice.



# Guide

The rye is planted late in the summer and pastured throughout the fall and winter. It is turned under just before potato planting time in the spring. The rye should not be allowed to develop past the jointing stage. Addition of a nitrogenous fertilizer such as ammonium nitrate, at the rate of 125 pounds per acre, before plowing, will speed up decomposition of the green manure.

Potatoes, as a rule, can be used in almost any good rotation instead of the regular cash crop. A rotation that has been found practical for potatoes is:

**First year**—corn, followed by fall seeding of wheat.

**Second year**—wheat and sweet clover (or red clover)

**Third year**—sweet or red clover for hay or pasture, followed by rye as winter cover.

**Fourth year**—potatoes, followed by green manure and winter cover crop.

Where the soil is very valuable for potato production, a shorter rotation can be used. Example:

**First year**—small grain with lespedeza or red clover.

**Second year**—clover for hay or pasture, followed by rye as winter cover.

**Third year**—potatoes, followed by soybeans, cowpeas, or Sudan. Seed to wheat in the fall and seed lespedeza or clover in the wheat in spring.

A satisfactory system in alfalfa producing sections is to follow old alfalfa stands with potatoes. In such a combination, merely replace a definite acreage of alfalfa each year with potatoes and establish a new stand of alfalfa the size of the one plowed for potatoes.

Soils that have been in sod for several years should be followed with a cultivated crop before planting potatoes in order to lessen the danger of injury from white grubs and wireworms. Sod-land soil should also be chemically treated with aldrin or heptachlor prior to planting.

Use of rye following alfalfa also was recommended. In addition to lessening the danger from soil insect in-

jury, this generally gives a higher percentage of scab-free U. S. No. 1 size potatoes. The alfalfa is plowed down the latter part of June. The field is fallowed until September and then drilled with rye. The rye is plowed down early the next spring before planting of the potato crop.

In vegetable and truck crop sections a very good combination is the growth of potatoes one year and such crops as tomatoes, cabbage, sweet corn, or other vegetables the next year. A satisfactory turnover of organic matter can be maintained by following the potatoes and truck crops with a green manure crop and by heavy applications of barnyard manure preceding the truck crops.

## **Use Green Manures and Animal Manures**

A good rotation alone will not maintain a satisfactory state of fertility and soil structure for economical potato yields. A high turnover of organic matter must be provided. This can be done through the use of green manures. Legumes, because of their nitrogen fixing ability, are generally preferred.





The most desirable crops are the clovers and the large seeded legumes which produce a high tonnage, have a short growing season, and can be grown during the season when commercial crops do not occupy the soil. The crop to be turned under should be fertilized to secure maximum growth.

Use of barnyard manure is recommended where it is available. However, manure applications should always be made to other crops in the rotation before potatoes; application just preceding the potato crop encourages the development of scab. The manure should be fortified with superphosphate (45%) at the rate of 50 pounds per ton of manure. Rates of application of manure as high as 10 to 15 tons per acre are frequently justified by increases in yield.

### Add Commercial Fertilizers

The application of liberal amounts of commercial fertilizers is a profitable practice. On some soils, however, the increase in yield from heavy fertilization is limited by an unbalanced nutritive condition in the soil. Where this is true, (as determined by soil test) the balance should be restored before complete fertilizers are applied. Regardless of the fertilizer application, the yield in some years is limited by adverse climatic conditions.

The fertility program for potatoes should include the use of commercial fertilizers in addition to barnyard and green manure applications. The kind of fertilizer and the rate of application will obviously depend on such factors as the fertility of the soil, the cropping system, and weather conditions. Generally a complete fertilizer containing nitrogen, phosphorus, and potassium is recommended.

For Missouri River bottom soils, the fertilizer element generally needed in greatest amounts is nitrogen. It is needed especially early in the season to promote growth and to aid micro-organisms in releasing nitrogen held in the organic matter.

Since most Missouri soils are deficient in phosphorus, potatoes respond well to applications of phosphate. The element is "fixed" to a great degree by the soil and, therefore, should be placed well below the soil surface where

the plant roots can reach it. Application by a plow sole attachment at the time of plowing or by side dressing attachments at planting time has proven satisfactory. Potash is present in sufficient amounts in most Missouri soils to mature a good crop. However, much of this element is present in unavailable forms, so some readily available potash should be added.

County agents have laboratories for testing soil. They will furnish you with directions for collecting soil samples, test your samples, and make recommendations for soil treatment. For highest potato yields, the mineral levels shown in the soil test should be brought up to those given in the following table.

Where the soil test calls for appreciable quantities of fertilizers to establish these levels, *at least half* should be broadcast before plowing (or plowed-down) and the remainder applied in a band 2 to 3 inches to each side of the seed pieces and slightly below them. Avoid heavy applications of high-potassium fertilizers by banding, as injury to seed pieces and stand may result.

On soils already testing in the fertility range depicted in the table, a plow-down application *equivalent to* 400 pounds per acre of 5-10-10 followed by band placement (see above) of 400 pounds per acre should be adequate with additional nitrogen feeding in later stages of development. Top or side dressings of nitrogen fertilizer to supply 30 pounds nitrogen per acre should generally be made when the plants are 8 to 10 inches high and again after the tubers start to form (bloom stage).

Lime (calcium) applications should be watched carefully on potato soils. This is particularly true in alfalfa-producing sections where frequent heavy applications of lime are made. The potato crop does not require as much calcium as is necessary for growth of legume crops. Soil containing enough lime to support clovers will not require additional amounts for the potato crop. In fact, some bottom-land soils have been over-limed for the best potato yields.

*Never apply limestone in sufficient quantities to bring the soil above a pH of 6.5* (county agents will record the pH when they test your sample). Where soils have been

RECOMMENDED NUTRIENT LEVELS BASED ON MISSOURI SOIL TEST\*

	Phosphorus P <sub>2</sub> O <sub>5</sub> Lbs/A.	Exchangeable Potassium Lbs/A.	Exchangeable Magnesium Lbs/A.	Exchangeable Calcium Lbs/A.
Light sandy or gravelly loam 8-11 M.E./100 gms.*	280-300	325-400	200-225	2000-3000
Medium Silt Loam 12-16 M.E./100 gms.*	300-350	425-550	275-400	3000-4500
Heavy loam and clays above 16 M.E./100 gms.*	375-425	500-650	475-650	5000-7500

\* County Agricultural agent will run this test for you, measuring capacity of the soil for nutrients in M.E. (milli equivalents) per 100 grams of soil. Pounds of each nutrient are then recommended, based on a balance of the nutrients within this capacity.



found deficient in magnesium, the use of dolomitic limestone is recommended in the place of regular limestone.

Heavy limestone applications immediately preceding the potato crop may disturb the fertility balance and stimulate activity of the potato scab organism. Where possible, make limestone applications to other crops in the rotation.

Every commercial grower should take advantage of the benefits to be gained from frequent soil tests. Soil testing, together with grower experience on a particular soil, provides the best basis for fertilizer recommendations. Frequently, unbalanced conditions are detected which, when corrected, permit higher yields and better quality.

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## *Planting* *and* *Caring for*      *Potatoes*

### **Plant Early For Large Yields**

As a general rule potatoes should be planted as early in the spring as the soil can be prepared. In central Missouri this will occur between March 20 and April 1. Conditions will generally be satisfactory for planting potatoes two weeks to a month earlier in the southeastern part of the state. Experiments and observations extending over a period of years have shown that both yields and quality are generally increased by planting as soon as the soil and weather conditions will permit. The yield is greatly reduced if planting is delayed much after April 1.

### **Use Early-Maturing Adapted Varieties**

Irish potatoes are grown in Missouri almost entirely as a spring crop. Because of the hot dry summers, only the early varieties can be depended upon to produce satisfactory yields consistently.

The commercial demand for Missouri-grown potatoes is strongest during the latter part of June and the first two weeks of July. With the advent of hot weather, the demand for potatoes falls off sharply. Most of the early crop from the south has been shipped by this time. Missouri potatoes shipped during August must compete unfavorably with the early crop from the northern states. Hence, only the early varieties should be planted for commercial purposes.

Descriptions of the varieties are included at the back of this bulletin to help you select a good kind for your conditions.

### **Select the Seed Carefully**

One of the most important steps toward successful potato production is the selection of good seed. And the grower has almost complete control over seed selection. Purity of variety and freedom from defects and surface-borne diseases can be readily determined by visual inspection of the seed stock. Other qualities, which have the greatest effect on yield, such as strain, vitality, and the internally-carried diseases, cannot be discerned by examination.

Strains can be identified only by knowing the past history and performance of a certain lot. Vitality is determined by the conditions under which the potatoes were grown and stored. The presence of internally-carried diseases is evident only when the plants are growing. If a seed stock is to be kept relatively free from such diseases, it must be inspected at intervals during the summer and the affected plants removed.

*Plant Northern-Grown Certified Seed:* Potatoes produced in the northern states have been proven by many trials to be better for planting in Missouri than home-grown seed. The reason for this is that the growing conditions in the North are more nearly ideal for the growth

of the potato plant. Since the crop matures during cool weather in the North and can be stored under almost ideal conditions, the natural vitality is better preserved until planting time. Also, the symptoms of virus diseases are more apparent in the cooler climate, making diseased plants easier to detect and rogue out. The maintenance of healthy stock is easier because of fewer insect broods. Generally, the farther north the crop is grown, the better the quality for seed.

Once a seed stock becomes infected with a degenerative disease, the virus will gradually spread until so many tubers are infected that it becomes worthless. Methods have been developed whereby a disease-free stock can be built up through the increase from healthy tubers. When these foundation stocks have been grown under prescribed conditions and both field and crop have passed inspection by a licensed inspector, the seed is certified as being practically free from internal disease and other factors which might make it unsafe for planting.

Seed certification is carried out by state governmental agencies. Every bag of potatoes that has been produced from inspected and approved fields carries a certification tag which states that the seed has passed these inspections.

Occasionally, misleading brands and tags are used on seed potatoes to convey the impression that the stock has been certified. Labels stating that the seed has been "northern grown," "selected for seed," or "certified to be grown under irrigation" are not true certifications. The truly certified seed carries a tag on which is printed the *state seal*, the *signature of the state inspector*, and the *name and address of the grower*.

Most of the certified seed used in Missouri comes from the states of North Dakota, Minnesota, and Wisconsin, largely because of the advantage in freight rates. Certified seed usually sells slightly higher than table stock. The difference in price is justified from the increased yield of 50 to 75 bushels per acre in favor of certified seed. Only certified (blue tag) seed can be recommended for planting in Missouri.

### Treat the Seed

There is much confusion in the mind of the average grower concerning seed treatment and certified seed. No method of seed treatment will free seed stock from the diseases carried *inside* the tubers. Purchase of certified seed is the insurance against these diseases.

On the other hand, certified seed may carry appreciable quantities of scab and black scurf (*Rhizoctonia*). Seed showing black scurf will give a serious loss from seedling blight unless the seed is treated. If the stock is free from these surface diseases, there is nothing to be gained by treating the seed. However, since most seed, even if certified, carries these diseases, it is safest to treat all seed.

The only equipment needed is a barrel or tank, a drain board, and baskets. To keep two cutters busy, use half of a wooden barrel with a 3 by 10-foot drain board

made of 1-inch lumber covered with roofing paper, and a dozen 1-bushel stave baskets. This equipment is adequate for a field of 20 acres or less. Metal containers and wire baskets may be used if they are coated with asphaltum paint. The drain board should be placed so that after treatment the excess liquid will drain from the potatoes and back into the barrel.

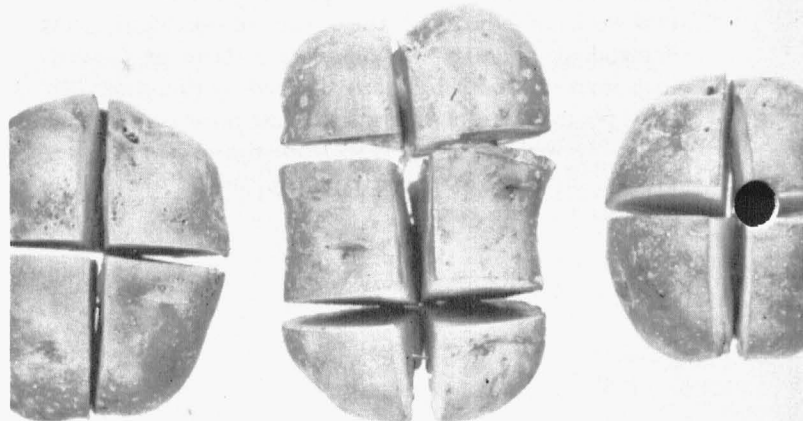
*Organic Mercury Dip:* There are several organic mercury compounds sold on the market under various trade names. One of the more commonly used compounds is available under the trade name, "Semesan Bel." These organic mercury materials are simple to use and are quite effective against surface-borne tuber diseases. Since no soaking period is required and unpainted metal containers can be used, this method of treatment may prove especially satisfactory for the small growers and the home gardener. In using, follow the instructions on the container label.

*Caution: All treating solutions are poisonous, and should be carefully disposed of after use.*

### Things To Do when Cutting the Seed

1. Use tubers that have just recently come out of the rest period. These potatoes should have started to sprout but the sprouts should not exceed a quarter of an inch in length. To promote sprouting, the dormant tubers should be removed from storage and held at about 65° F. for ten days to two weeks prior to cutting. This promotes a uniform rate of emergence, rapid establishment of the plants and earlier maturity.
2. Discard diseased and abnormal tubers and seed pieces. The desirable seed piece weighs from 1¼ to 1½ ounces, contains at least one healthy eye, and as little cut surface as possible. Long wedge-shaped pieces rot more readily and are not handled uniformly by the planter.
3. Disinfect the cutting knives frequently using the same materials used for treating the seed.
4. When possible, delay cutting the seed until immediately before planting. Where this isn't practical, provide storage conditions that facilitate proper healing of the cut surfaces: Store the cut seed in shallow layers in a well ventilated place at a temperature between 60° and 70° F., and away from strong sunlight and drying

**Cut blocky seed pieces, each containing at least one healthy eye.**



winds. Maintain a high humidity, preferably 90 percent. Turn the seed pieces over once or twice the first day, then several times during the next 5 to 7 days.

5. Provide sufficient seed. The amount of seed required will vary with the variety, size of stock, and planting distances. If the seed pieces are planted 12 inches apart in rows 36 inches wide, approximately 20 bushels of seed will be required for each acre. When closer spacings or larger seed pieces are used a proportionately greater amount of seed will be needed.

### **Make the Seedbed Deep and Mellow**

Special attention to soil preparation will increase the quality and yield of the early potato crop. The special requirement of this crop is a deep, loose seedbed. Any operation which has a tendency to firm or pack the soil must be avoided.

Plowing is probably the most important of all soil preparation practices. The potato field should be plowed as deeply as possible. If the plowing has been shallow in the past, the plow sole should be lowered until the tilled area is at least 9 inches deep. On shallow soils this will have to be done gradually since a large amount of subsoil thrown on the surface is detrimental. Some of the most successful potato growers regularly plow as deep as 12 inches or as deep as the plow can be made to work. Spring plowing has come into favor for the crop since the soil does not have a chance to become compacted from winter rains and snows.

The soil should not be plowed when it is too wet. The only other preparation required is a light harrowing to level the surface. Potatoes do not require a firm or fine seed bed. Any further preparation will only compact the soil to the detriment of the potato crop.

### **Watch Planting Depth and Distance**

Tuber formation under ideal conditions takes place about 4 inches under the soil surface. Since some soil must be thrown over the rows when cultivating, 3 to 3½ inches is probably the proper planting depth. This will vary somewhat with the nature of the soil. Planting can be deeper on light sandy soils than on the heavier types. A ridge is usually thrown over the row, so the seeds are covered with 6 inches of soil. This ridge is removed by harrowing and the ground is level by the time the plants emerge.

Potatoes are planted in Missouri in rows varying from 30 to 42 inches apart with the seed pieces spaced from 8 to 16 inches in the row. The close planting distances require more seed per acre; they usually increase the yield but frequently cause a decrease in size. It is common practice in this state, as well as in most potato producing areas, to space the plants 12 inches apart in 36-inch rows.



**A potato plant six weeks after planting. Note the extensive shallow root system.**

### **Cultivate to Control Weeds and Loosen Soil**

The primary object of potato cultivation is to control weeds. Cultivation of the crop should be as shallow as possible for many of the roots of the potato plant are near the surface of the soil. A cultivation practice that seems to have some merit is deep cultivation of the centers of the rows before the plants emerge. This procedure is used universally in the commercial potato districts and is timed just as the sprouts start to grow, which is usually the second week of April. This cultivation loosens the soil that has become compacted by planting operations and spring rains, thereby increasing aeration and bacterial activity.

During the latter part of April when the sprouts are about 2 inches long, the ridge is worked down by harrowing diagonally across the field. A second harrowing is frequently possible about a week later. The land is practically level by the time the plants emerge.

The first cultivation can be with a weeder if the soil is in good condition by driving with the rows. This cultivation may be deep and fairly close to the row, but later workings should be shallow and far enough from the plants to make certain that no roots are cut. Three cultivations are usually all that can be given before the plants occupy the ground. During the last cultivations, some soil is thrown toward the row to form a broad ridge. This ridge helps prevent sunburn, aids drainage and makes digging easier.

### **Mulching Successful for Home Supply**

The growing of Irish potatoes under a straw mulch has proven successful most years under Missouri conditions. The seed pieces are covered with a thin layer of soil and about 8 inches of wheat straw.

Chief advantage of growing potatoes under a straw mulch is that it aids in the control of weeds. This helps conserve the soil moisture. It also lessens the possibility of sunburning, which sometimes occurs on potatoes



which are exposed to the sun during the latter part of the growing season.

One disadvantage of growing potatoes under straw mulch is the increased labor and time necessary to apply the straw.

To avoid nitrogen tie-up by microorganisms in decomposing the straw, apply ammonium nitrate or other high-nitrogen fertilizer to the mulch at a rate of 1 pound for 40 feet of row.

### Irrigation

The amount of irrigation water needed to supplement the natural rainfall during the potato season and the benefits to be gained from irrigation are quite variable from year to year. Generally, too little rain falls during the month of June when the tubers are sizing; timely application of 4 to 5 inches of water can be expected to increase yields from 80 to 150 bushels per acre. However, high temperatures (90s during day, 70s at night) may limit tuber growth and development even with adequate moisture.

Soil moisture should be checked at least twice weekly during late May and early June, and water applied before the available supply is depleted. Approximately 1½ inches of water each week are required at this stage of development. If the preceding week's rainfall is less than 1½ inches, make up the difference by irrigation.

Irrigation during June will also improve the soil tilth and make digging easier.

### Control of Insects

*Aphid* (plant lice) infestations of potatoes generally occur early in the season soon after the sprouts emerge. You can control most aphid species by applying a 4% Malathion dust at the rate of 25 to 35 pounds per acre or by spraying 15 ounces of Malathion per acre.

Other troublesome insects, including the *Colorado potato beetle* and *leaf hoppers*, can be controlled with 1.5 pounds DDT per acre. Dust formulations containing 3 to 5% DDT should be applied at the rate of 20 to 25 pounds per acre for small plants and 30 to 35 pounds per acre for large plants. For sprays, use 2 pounds 50% wettable DDT per 100 gallons of water and apply at rate of 150 gallons per acre. Beetles which have developed resistance to DDT can be controlled by spraying or dusting with Sevin according to manufacturers recommendations.

The first insecticide application should be made as soon as the first Colorado potato beetle eggs hatch and the grubs start feeding. Another application in 2 to 4 weeks will likely be needed to control the second generation of the potato beetle and other insect pests. In case of very heavy insect infestations, additional dustings (or sprays) may be needed at intervals of a week to 10 days until plants close the space between the rows.

*Soil Treatment for Wireworms:* Wireworms, grubs, and other soil insects are frequently troublesome, especially

in sod land or soil which has not been tilled recently. These insects can be easily and effectively controlled by chemical treatment of the soil prior to planting.

Use aldrin or heptachlor at the rate of 2 pounds per acre, spread evenly over the surface after it has been plowed. Spraying the insecticide on the soil with a field power sprayer will assure even distribution of the small quantity required. Disk it in immediately.

### Control of Diseases

Missouri growers are indeed fortunate in that the disease problems are less serious in this area than in most of the other potato producing states. Commercial growers can usually control the diseases by using certified stock, seed treatment, and careful soil management.

The potato growers have to deal with three types of diseases: (1) those which are carried within the tuber, such as mosaic and spindle tuber; (2) those usually carried on the surface of the tuber, such as common scab and rhizoctonia; and (3) those that affect the foliage of the plant, such as tip burn.

*Fungicides for Foliage Diseases:* The use of fungicides to control foliage diseases of the potato is not a common practice in Missouri. The infrequent occurrence of the two leaf diseases, early blight and late blight, is probably the reason that spraying with fungicides is not generally required. When a fungicide is needed, copper-lime dust may be used. This dust is formulated as follows:

Copper sulfate (monohydrated), 20 pounds  
Hydrated lime 80 pounds

This dust is applied at the rate of 25 to 35 pounds per acre, always when the plants are wet with dew. It is important to hit the under side of the leaves as well as the tops. Copper-lime, in addition to being a good fungicide, is also somewhat effective in controlling leafhoppers, flea beetles, and aphids.

*Spray If Late Blight Threatens:* Dusting with copper-lime mixtures has not given adequate protection to potato plantings during attacks from late blight. Consequently, spraying is highly recommended over dusting when attacks are anticipated.

Low-soluble or fixed compounds such as basic copper sulfate, and tri-basic copper sulfate are now available under various trade names. These materials compare favorably with bordeaux mixture in the control of blight and have the advantage of being easier to prepare. Since the formulations differ as to strength, the recommendations of the manufacturer should be followed. Among the new organic fungicides, zineb (sold as Dithane Z-78 and Parzate) and maneb (sold as Manzate and Dithane M22) are highly recommended.

*Control Tuber-Borne Diseases by Clean Seed and Soil:* The more important tuber-borne diseases affecting potatoes under Missouri conditions are: Rhizoctonia,



A common symptom of *Rhizoctonia*. Formation of aerial tubers.

common scab, bacterial ring rot, wilt, mosaic, and spindle tuber.

*Rhizoctonia (Black Scurf)*: The fungus which causes this disease is responsible for such common symptoms as black scurf, dry stem rot, russet scab, aerial tubers and "dwarf rosette." The most common form is the black scurf which is characterized by the small black dirtlike masses on the surface of the potato. This stage is believed to be the main source of infection under Missouri conditions.

The form of *rhizoctonia* which causes the greatest damage in this state is the dry stem rot. This stage is characterized by a small sunken area of a brownish black color which attacks the surface of the underground stem, often girdling the plant at the surface of the soil. Missing hills and small sickly plants are often caused by this disease.

**CONTROL MEASURES**—Use only seed which is free from *rhizoctonia* and treat the potatoes before cutting, as described under seed treatment. Although the main source of infection is diseased seed, the fungus also lives over in the soil.

Allowing the potato field to lie fallow from harvest time until fall is an important factor in reducing the carry-over of this disease. Crop rotation is also advised. This disease also attacks hairy vetch and alfalfa, which may become sources of infection for the potato crop.

*Potato Scab*: Potato scab is one of the common potato diseases with which most potato growers are acquainted. It can be distinguished by its rough, corky brownish areas on the surface of the tubers. In severe cases these corky areas may form a crust over the entire potato. Although the effects of this disease may not be noticeable on the growing plant, the blemishes and roughening of the tubers greatly reduce their market value and often make them unsaleable.

**CONTROL MEASURES**—Seed treatment kills most of the scab spores on the seed stock but has little value when the soil is already infected. Scab is most severe in

slightly alkaline soil. Therefore, it is wise to avoid the use of land that has been heavily limed recently. If several crops of alfalfa or clover have been removed since liming, the soil may be quite satisfactory for potatoes. Commercial fertilizers should be used as a source of plant food rather than manure, unless the manure can be applied long enough before potato planting for it to at least partially decay. Use of legumes as green manure crops and crop rotation will aid in controlling scab.

The use of scab-resistant varieties offers the most practical means of control. Varieties with scab-resistance include Tawa, Onaway, and Norland.

*Fusarium Wilt*: This disease affects both the plant and tuber. On the plant it is characterized by the gradual rolling and discoloration of the lower leaves. This condition continues until the whole plant wilts. Affected tubers show characteristic discoloration of the water vessels of the tuber. A cross section of the stem end of an infected tuber will show the discoloration, which extends through the potato toward the "seed" end. The extent of the discolorations will depend on the severity of the infection. The organism causing the disease is carried in the tuber and is known to live over in the soil.

**CONTROL MEASURES**—Use disease-free seed and rotate crops.

*Bacterial Ring Rot*: This is a disease that has caused serious losses in certain potato districts. The organism survives the winter in the seed tubers but does not live over in the soil. The disease attacks the entire plant, causing wilting and yellowing of the foliage and rotting of the tubers. The bacteria may be spread from diseased tubers to healthy seed pieces by the cutting knife. For this reason a small percentage of bacterial ring rot in the seed may cause a great many diseased plants to develop in the field.

**CONTROL MEASURES**—The only known practical means of control is the use of disease free seed; this means seed from fields where the disease did not occur. Seed, therefore, should come from inspected and certified fields.

*Degenerative Diseases*: Potato growers have long recognized that potato strains grown for several years degenerate or "run out". Scientists have shown that this is not due to climate, cultural practices, senility or bacterial or fungous parasites, but that it is caused by an infective agent termed a virus. This agent is present in juice of all "run out" potato plants, and when any of the virus is transmitted to healthy plants by sucking insects such as aphids and leaf hoppers, they become diseased.

These diseases live over winter in the seed tubers. There is the possibility that weeds related to the potato plant carry the diseases from one year to the next in their root systems. Fortunately, the virus does not live from year to year in the soil. The degenerative diseases called



This series pictures steps in a typical commercial harvesting operation. (1) Vines are destroyed a few hours before harvest with a mechanical vine beater. (2) Two-row digger windrowing tubers into a single

Leaf Roll, Spindle Tuber, Mosaic and Giant Hill are the ones most commonly seen in Missouri.

**CONTROL MEASURES**—The control of these diseases lies in the use of disease free seed since the disease is perpetuated only in the tubers. No form of seed treatment is effective and no sprays are beneficial. The infected tubers cannot be distinguished from healthy stock until the plants have developed. Fields from which seed are secured must be inspected carefully and all of the diseased plants removed. The symptoms of these diseases are more easily identified in the northern states. Also the insects causing their spread are less numerous so that they are much easier to control. This is the chief argument for planting *northern grown certified seed*.

## HARVEST TO MARKET

# Handle with Care

Potato tubers continue to grow until the vines are almost dead. The commercial crop is marketed as new potatoes and is frequently dug as soon as profitable yields can be harvested. Some sacrifice in yield is justified in order to take advantage of the higher price on the early market.

Digging usually begins around the first of July but may start two weeks earlier in favorable seasons. If pota-

atoes can be dug during the first part of July, they will be on the market before the bulk of the crops from the Northern districts.

Potato buyers frequently complain that the Missouri potato crop is dug before it is sufficiently mature to reach the market in good condition. The grower should make a careful study of his market. The best prices are paid for the maturity and quality most in demand. A determined effort should be made to supply the consumers with the kind of potatoes they want to buy.

On the average farm where potatoes are being grown for home use, it is better to leave them in the ground until they are fully mature. If the skin no longer slips when pressed with the thumb, the tubers have stopped growth and are considered to be matured. When the vines are almost dead, there is nothing to be gained by permitting the potatoes to remain in the ground. Therefore, they should be dug, cured, and placed in the best storage available. The soil is a poor storage place during the hot summer months.

Power-driven elevating diggers are favored by commercial growers, but a large acreage must be planted to justify the purchase of a machine. A side digger is most practical for small acreages. The machine is constructed like an ordinary plow with the mouldboard replaced by steel rods.

Potato combines with picker and bagger attachments, have found favor among some growers because of a saving of labor. They are most practical on large acreages, level topography, and on land free from stones and trash.

Regardless of the type used, the digger should be run deeply enough to carry over considerable soil to reduce bruising and cutting to the minimum.

Freshly dug potatoes should not be allowed to lie exposed to direct rays of the sun for any length of time. Pick them up as soon as the soil dries. When the temperature is high and the soil dry, they must be picked up





row. (3) Potatoes are then elevated and bulk loaded for transport to grading shed. (4) Vines, clods, and other debris are removed in the field by a crew riding on the elevator.

as soon as they are dug. Handle carefully; while they are immature they are easily scuffed, bruised, or cracked. Caution pickers and handlers of the importance of careful handling and constantly supervise their work. Conditions are very favorable at the time of year when potatoes are dug for the growth of rot-producing organisms which gain entrance through breaks in the skin.

### Market Preparations

A commercial crop must be handled rapidly and carefully to get the product to market in the best possible condition. The potatoes should be removed from the field immediately after digging, and graded, washed, dried, bagged, loaded into cars and pre-cooled during the day in which they are dug. Many growers start digging early in the morning and have the cars ready by mid-afternoon.

Commercial crops are graded in special sheds built along a railroad siding. The grading operations consist of mechanical separation on the basis of size, and picking out the defective tubers by hand. From 5 to 30 percent of the potatoes may have to be thrown out to bring the product up to grade. Any defect which detracts from the appearance, table quality, and keeping will lower the market value. The standard U. S. grades are recognized on all central markets. The commercial grower should familiarize himself, and the grading crew, with the requirements of the various grades. This information can be obtained at your county agricultural extension agent's office.

A grower who desires to build up a reputation for his product will have to put up the highest grade possible. Some seasons are so unfavorable that the higher grades cannot be packed. Such crops should be graded as highly as possible and true claims made about the actual quality.

Washing has become popular largely because of the premium paid for clean stock. This practice permits

earlier digging and digging during wet weather. The washed stock must be dried and pre-cooled or the product will decay rapidly.

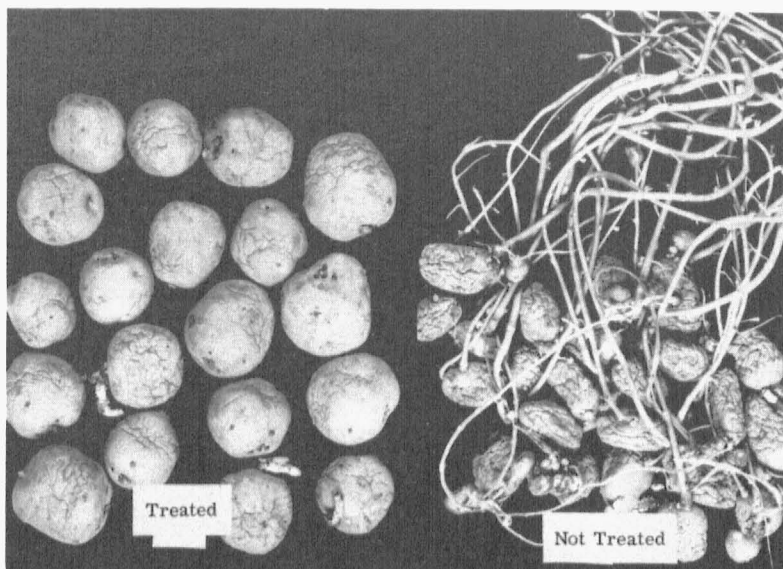
It is quite evident that washing will not improve the appearance of poor stock but even makes the defects more prominent. Such potatoes will not keep as well when washed since decay organisms are washed into the openings in the skin. Moreover, they are difficult to dry. Some drying is accomplished by pre-cooling the cars with dry cold air.

Practically all of the commercial potato crop is marketed in new 100 pound burlap bags carrying the brand, name and address of the grower. A few new crop potatoes have been sent to market in adjoining states in small mesh bags. This container can be used for the Missouri crop if market demand warrants its use. Washing and the use of small bags may aid in the marketing of a high quality product but may become a distinct disadvantage in handling low grade potatoes.

**Potatoes grown in home gardens under "straw culture" (planted just below soil surface and mulched with straw) are easier to dig and are usually cleaner.**



# Essential Points in STORAGE



**Chemical treatment reduces sprouting and shrinking. Potatoes at left were treated at beginning of storage period; those at right had no treatment.**

## **Cure Before Storing**

The potatoes after digging should be cured before placing in storage. During this period a cork formation takes place over wounds which protects the contents of the tuber from the invasion of rot producing organisms. The conditions optimum for cork formation are a high temperature of 70° to 80° F. and a very high humidity. The potatoes must be held in the dark away from strong winds, and should be kept in shallow piles to avoid heating. After curing, the potatoes should be removed to the best storage available.

## **Chemical Treatment to Prevent Sprouting**

The sprouting in storage of Irish potatoes and root crops can now be prevented by treatment with a product known chemically as the methyl ester of naphthaleneacetic acid. This new chemical material is non-poisonous and can be used with perfect safety. It is sold in three different forms; liquid, dust, and treated shredded paper. All forms are effective when properly used. In using, make sure the potatoes are relatively clean and that the material is distributed evenly throughout the storage container. Each tuber should receive some of the material but need not be entirely covered as the chemical slowly gives off a gas which is absorbed by the tuber (or roots).

One treatment is sufficient for the entire storage season unless excessive air circulation carries the gas away. The potatoes should be treated as they are put into storage or at least before they start to sprout. The chemical

will not effectively stop the growth of sprouts that start before the chemical is applied and will not prevent rot. The tubers should be cured in the usual manner and stored as outlined below. A lower humidity may be necessary with the restricted ventilation to prevent condensation of moisture.

The commercial brands of the ester (such as Bar-sprout, Sprout Inhibitor, Potato Fix, Stop Sprout, Spud-Keep, and others) are usually sold in small amounts sufficient to treat 8 to 12 bushels. The cost generally ranges from 10 to 15 cents per bushel. Since the concentrations of the active ingredient vary with the brand, the specific directions on the container label should be followed.

Potatoes to be used for seed stock should not be treated. Treated potatoes cannot be expected to sprout regularly the next spring or fall.

## **Storage Structure**

An outside storage cellar is much better than a storage pit. If the storing of a quantity of potatoes is a yearly practice, it will pay to erect a permanent storage cellar. A pit is for temporary use only. Unless it is made and handled carefully, including good ventilation, the potatoes will not keep properly in it.

Storage pits are simple to construct. Select a well drained spot and remove the soil to a depth of 1 to 3 feet. Place a 6 to 8-inch layer of straw in the bottom of the pit to keep the potatoes from coming into direct contact with the soil.

If a large quantity of potatoes is to be stored in the pit, the pile should be narrow and the potatoes should not be piled over five feet deep. Openings or ventilators should always be left in the top for ventilation. These ventilators may generally be left open, but when the temperature is low it is well to close them with burlap bags or other material.

The potatoes should not be placed in the pit until late fall or until the days have become fairly cool. The first covering should be coarse straw or hay. As cold weather approaches an inch or two of soil should be placed over the straw. It is a good plan not to put all the soil on at one time but to add soil at intervals so that the potatoes will be covered with a 10-inch layer of soil before hard freezing weather occurs.

### Fall Crop Potatoes

During favorable seasons, potatoes can be planted in late summer to mature just before frost. The plants make little growth during warm weather, but after the days become cool, they grow rapidly. Success with a fall crop is frequently limited by the dry summers and an early frost. Fall production is most successful in the extreme southeastern portion of the state where the rainfall is more evenly distributed and the growing season is longer.

The choice of variety is an important consideration. Bliss Triumph is generally used for the fall crop since seed saved from the spring crop can be replanted later in the summer. If potatoes of this variety are held in a warm, dry, well ventilated storage for a month after digging, they will usually grow readily when planted. The Red Warba also has a short rest period and can be used for the fall crops.

McCormick, commonly known as Peachblow, is a favorite in some sections as a fall potato. Since it is a late variety, a good keeper, and stays dormant under common storage conditions until late spring, many growers save their own seed from year to year.

If the Irish Cobbler or any of the other late varieties is used, either the seed from last year's crop must be kept in cold storage until time for planting or the new seed must be treated chemically to break the rest period. (See previous section on chemical treatment).

The fall crop seed is treated and prepared for planting in the same manner as seed for the spring crop.

The best date for planting varies from June 25 in Northern Missouri to July 15 for the southeastern district. The soil should be in the best of condition and amply supplied with moisture. The seed will rot before it can grow if planted in dry soil.

Growers contemplating a fall crop should do so with the knowledge that the yields as a rule are much

lower than those secured in the spring and that total failures are frequent.

### Chemical Treatment to Break Dormancy

Frequently home gardeners desire to use the spring-grown tubers (new crop) for planting a fall crop. Since most potato varieties have a rest period of two months or longer, chemical treatment of the tubers is necessary to hasten sprouting. This can be accomplished for small quantities of seed as follows:

Make up a 1½% water solution of potassium or sodium thio-cyanate. Use three-fourths pound of the chemical to 6 gallons of water (or equivalent ratios).

Soak the freshly cut seed in the solution for 1½ hours, keeping the seed pieces just covered with the solution. Plant the seed in moist soil directly after treatment.

The solution can be used several times but should not be stored any appreciable length of time. *Since it is highly poisonous to humans and livestock, take safety precautions and dispose of solution after use.*

Many growers of potatoes for home use make the mistake of allowing the crop to remain in the ground exposed to the torrid heat of late summer.

The ideal storage for potatoes is a cool, dark place where a high humidity and adequate ventilation can be maintained. The temperature should be as low as possible with one of 40° F. being best.

If such conditions are not available, the potatoes should be placed on the coolest, best ventilated place available. The Irish Cobbler is the best of the early varieties for storage because of its long rest period. It can be carried through the summer without serious loss from shriveling and sprouting.

The crop intended for storage should be allowed to become fully mature before digging. It must be handled carefully since only potatoes that are entirely free from mechanical injury are suitable. Tubers showing deep scab, worm holes or other disease injury must also be sorted out.



# Descriptions

## WHITE-SKINNED VARIETIES

### Irish Cobbler

The Irish Cobbler is the best of the early white varieties for Missouri. It is of good quality, matures early and will produce a yield equal to any variety tested in the state. The stocky vines are medium in size. The dark green foliage is vigorous, resistant to leaf hopper injury and foliage diseases, and stands up well during hot weather.

The few tubers that set, develop to marketable size even during adverse seasons. They are roundish to roundish-flattened or slightly oblong-flattened with a rather deeply notched stem end. The eyes are moderately deep and the skin is smooth, creamy in color and sometimes slightly netted. Because of its long rest period, cobbler are less susceptible to sprouting and shriveling during the fall than most varieties. Irish cobbler keep well in storage.

### Nordak and Norgleam

These two new white-skinned varieties are similar in many respects, and differ slightly in plant type and maturity. Both produce smooth white-skinned tubers, round to oblong in shape, with shallow eyes, and superior cooking quality.

Nordak (formerly ND 457-1-10) is as early as Red Warba, whereas Norgleam (formerly ND 457-1-16) resembles Irish Cobbler in maturity. The plant growth of Norgleam is spreading while that of Nordak is erect. Because of short stolons, both are susceptible to sun-greening unless adequately hilled.

Nordak and Norgleam possess field resistance to virus Y but are susceptible to scab, late blight, and virus X. Under some conditions they are susceptible to internal necrosis and vascular discoloration.

Both varieties yield approximately the same as Irish

Cobbler; however, the tubers may be smoother and more attractive. The total solids content is higher than in Red Pontiac but comparable to that in Cobbler. Nordak and Norgleam make acceptable potato chips after a period of storage and reconditioning.

### Tawa

Tawa (formerly I-830-3) is a white variety in the medium-early maturity group. Tubers are smooth, round to oblong, with some tendency to become tapered (pear shaped). Eyes are shallow. It yields somewhat below the Cobbler. Tawa is *resistant to scab*, late blight, and mild mosaic. Chipping and cooking quality are good.

### Onaway

Onaway (formerly Michigan 1363) is an early white-skinned variety, with *high scab resistance*. Tubers are oval in shape with deep eyes on the apical end. Yields approximately same as Cobbler. Has not been tested sufficiently in Missouri, but appears to justify limited planting on scab-infested soils.

### Antigo

Antigo (formerly Wisc. D 27-50) is a medium-late white variety with excellent scab resistance. It is probably too late in maturity in Missouri for satisfactory commercial yields. Tubers are smooth, round with occasional tendency toward irregular tuber shape.

## RED-SKINNED VARIETIES

### Bliss Triumph

This is an extra early variety that matures from a week to ten days ahead of the Irish Cobbler. The vines make an upright growth but branch very little. The foliage is light green, rather sparse and highly susceptible

# of Varieties

to hopper burn and heat injury. The tuber is small to medium in size, of a blocky shape and slightly shouldered at the stem end. The eyes are frequently deep near the apex. The lenticels (pores) may become quite large and detract from the appearance during wet seasons. The skin has a light red color in demand on certain markets. The susceptibility of the foliage to injury frequently results in low yields.

There are several strains of this variety, differing in earliness of maturity. Only the very early strains should be grown in Missouri since early maturity is the chief merit of this variety.

## **Red Warba**

Red Warba matures just ahead of the Irish Cobbler. During an average season, it will yield as high as Cobbler, but under unfavorable conditions it may set more tubers than the vines can grow to marketable size. The vines are vigorous and resemble those of the Cobbler. The medium-sized tubers are not as flattened and their shoulders are not as pronounced as those of Cobbler. The eyes are few but may be fairly deep around the apex. The table quality is superior to that of the Triumph. The skin color is a bright lustrous red but may be blotchy under certain conditions. This is not objectionable if the potatoes are marketed as new potatoes. Since the rest period is very short, seed from the spring planting may be replanted for a fall crop. This variety is well worthy of consideration for the home supply or for sale to local markets.

## **Red Pontiac**

Although considered to be in the late-maturity group, Red Pontiac has been among the highest-yielding varieties during recent tests, and appears to possess some heat tolerance. Foliage has resistance to hopper burn, but the plant is susceptible to virus diseases and the tubers to scab. The tubers are oblong to round, blunt

at the ends; the skin is dark red, generally smooth; eyes are medium in depth; flesh is white. Grades out a high percentage of tubers free from defects. Specific gravity slightly below average; cooking quality satisfactory. Appears to be increasing in popularity in Missouri.

## **Waseca**

A very early red-skinned variety ranking with Cobbler in yield and producing a high percentage of No. 1 tubers. The tubers are smooth, medium to large, oblong to round, eyes medium shallow in depth, flesh white.

The dry matter content is generally lower than that of Cobbler or Red Warba; however, the cooking quality is usually considered good.

Waseca is not superior to regular varieties in disease resistance.

## **Norland**

A new promising red-skinned variety with early maturity and *moderate resistance to common scab*. Maturity is similar to that of Waseca and Red Warba and approximately 15 days earlier than Red Pontiac. Tubers are very smooth, shallow-eyed, red-skinned, and conspicuously free of irregular shapes, and external and internal defects. This results in a high percentage of No. 1 tubers.

The combination of earliness and moderate scab resistance makes Norland a useful variety in scab-infested soils of this area. It is susceptible to infection by the common potato viruses and to the fungus causing late blight. The tubers have good cooking and chipping qualities.

## **Redbake**

Redbake (formerly Nebr. 26-44-1) is a new red variety of midseason maturity. Tubers are oblong and somewhat flat with shallow eyes. Skin is smooth or slightly netted. Yields are significantly lower than those of Triumph or Pontiac and tuber size is likely to run small under Missouri conditions.

Specific gravity of Redbake is above average and chipping quality is good.

### Excel

Excel (formerly Nebr. 82-49-1X) is a new red variety of medium-late maturity, probably too late for this area. It produces tubers of good type, bright light red, with very white interior color, and high specific gravity.

Excel yields considerably lower than Pontiac with many tubers undersized. While not considered scab resistant, it is not as susceptible to scab as most varieties. It has very good cooking qualities.

### Red Beauty

This is a medium-maturing potato resistant to Verticillium wilt. Tubers are bright red but somewhat rough in appearance. They are not scab resistant. While

as yet incompletely tested in Missouri it appears to yield lower than Triumph or Pontiac.

Since verticillium wilt is not recognized as a problem in Missouri, it is doubtful whether this variety has a place in the state.

Numerous other excellent varieties have been introduced which, unfortunately, are not suitable for main crop production under Missouri conditions. For example, the varieties, Chippewa and Katahdin, are vigorous, disease resistant and of high quality but mature so late that production is limited by summer temperatures. These varieties may be grown for winter storage but the grower will have to contend with low yields except in very favorable seasons. The popular market varieties, Russett Burbank, White Rose, and Green Mountain, are not adapted to climatic conditions in the midwest and cannot be recommended to Missouri growers.

## PERFORMANCE OF NEWLY INTRODUCED VARIETIES

The Missouri Agricultural Experiment Station has assisted in the evaluation of newly developed breeding material since 1955 by participation in the North Central Regional Irish Potato Trials. Numerous breeding lines are tested annually by comparison with older established varieties; however, only a small percentage of the breeding lines

become named varieties. In the table the performance of only the varieties *named* since 1955 is given along with the check varieties. The data on numbered breeding lines that have not been released as named varieties have been omitted.

SOME OLD AND NEW VARIETIES COMPARED

Variety	1955			1956			1957			1958		
	Yield No. 1 Tubers (Bu/A.)	No. 1 as % of Total	Average Specific Gravity	Yield No. 1 Tubers (Bu/A.)	No. 1 as % of Total	Average Specific Gravity	Yield No. 1 Tubers (Bu/A.)	No. 1 as % of Total	Average Specific Gravity	Yield No. 1 Tubers (Bu/A.)	No. 1 as % of Total	Average Specific Gravity
Tawa	359	95.46	1.059	---	----	----	233	73.23	1.073	---	----	----
Norgleam	471	93.90	1.067	488	94.31	1.065	---	----	----	---	----	----
Nordak	415	94.11	1.071	513	94.58	1.065	---	----	----	---	----	----
Antigo	416	95.95	1.065	---	----	----	---	----	----	---	----	----
Onaway	441	95.95	1.064	---	----	----	---	----	----	---	----	----
Norland	---	----	----	481	96.59	1.057	335	76.13	1.066	378	78.13	1.054
Red Bake	---	----	----	352	76.37	1.066	221	70.43	1.071	---	----	----
Red Beauty	---	----	----	305	78.54	1.065	---	----	----	---	----	----
Excel	---	----	----	---	----	----	290	67.24	1.082	261	60.78	1.059
Triumph	372	89.09	1.060	462	90.59	1.059	145	50.96	1.061	439	71.01	1.060
Red Pontiac	522	94.83	1.059	491	90.82	1.058	398	84.86	1.064	316	64.90	1.054
Cobbler	450	93.95	1.068	494	91.15	1.069	343	80.74	1.076	403	79.64	1.060