POTATO CULTURE IN COLORADO

By E. P. SANDSTEN
The Colorado Agricultural College
FORT COLLINS, COLORADO

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POTATO CULTURE IN COLORADO

By

E. P. SANDSTEN

The potato crop is rapidly becoming one of the leading crops in Colorado. The soil and climatic conditions in many sections are ideal for the normal development of the plant and for the production of a high quality. Cool nights and moderately warm and sunny days favor a gradual growth with a maximum development of the starch content, together with firmness and cooking qualities. Poor quality in Colorado potatoes is not due to soil or climatic conditions, but to methods of irrigation and culture.

The past year’s experience has shown that the potato can be grown successfully as a garden crop and on city lots and gardens, and we may expect in the future that a large share of the city gardeners will plant potatoes in place of the more perishable vegetables.

The success of potatoes as a garden crop will depend largely upon the grower’s ability to rotate his crops so that potatoes will not be grown oftener than once in three or four years in the same soil; also to his ability to provide the soil with the needed fertilizer in the form of humus materials. The problem of rotation is more difficult in garden work than under field culture, due to limited area of the garden plots. But, where well rotted stable manure or rotted street sweepings are obtainable, the problem of rotation is easily solved.

So far as food values are concerned, potatoes will yield more for a given space than any of the common vegetables grown, and have the additional advantage of keeping qualities.

Under field conditions, the potato crop fits well into a rational system of rotation and has the advantage of leaving the land in the best possible condition for other crops.

Success in potato growing is never obtained by hit and miss methods nor by constantly changing from small to large acreage, and vice versa, in order to “catch the market.” The farmer should adopt a standard rotation for his farm and hold to it from year to year. This implies that the acreage devoted to potatoes in settled communities should be about the same from year to year. If this method were uniformly followed, we should not have the large fluctuation in acreage nor in price. This would stabilize prices, and at the same time make for better farming methods.
POTATO PRODUCTION IN COLORADO FOR THE YEAR 1917

The year 1917 was a banner year for potato production in Colorado. The total acreage was, in round numbers, 45,000, and the average yield for the state about 200 bushels to the acre, a total of 9,000,000 bushels. The yield per acre for the state is the highest recorded and places Colorado near the top in the yield per acre. Figuring the consumption of potatoes for the State at 3,000,000 bushels, we have a surplus of 6,000,000 bushels for outside shipments.

The high yield per acre in Colorado this year is due to a number of factors. Chief among these were favorable climatic conditions, better cultural methods, crop rotation, seed selection, seed treatment, and a more intelligent use of irrigation water. While the grower has no control over climatic conditions, he can, to a great extent, modify his cultural methods so as to offset the effect of unfavorable weather. This would imply that a grower can not lay down a definite cultural program to be followed from year to year, but rather he should have a general plan that can be modified to meet the variable climatic conditions as they occur from time to time.

From these figures, one gains an idea of the importance of the potato growing industry in the State.

While the above figures are imposing and show a gratifying increase both in acreage and yield over previous years, the possibilities for further increase is practically unlimited. With better transportation facilities and with the settling up of the western part of the State, thousands of acres of the finest potato land in the world will come into production.

The growing of seed potatoes for the southern planter is a new and unexplored field for Colorado potato growers which offers practically unlimited possibilities. The soil and climatic conditions of Colorado make it possible to grow seed potatoes of high quality and vitality.

THE POTATO PLANT

A knowledge of the general nature of the potato plant is essential to an understanding of the requirements of the plant and to the production of a maximum crop of high quality.
While most agricultural crops, like the cereals, are grown principally for the grain (seed), the potato is grown for its tubers or underground stem. The tubers are essentially a vegetative part of the plant which have become modified into a storage for food material by which the plant is able to pass through a period of rest and to start another season's growth. The potato being a modified underground stem, it is capable of functioning as a stem and developing chlorophyll or green coloring matter, stems and leafbuds. When we speak of potato seed, we do not really mean seed, but a stem or a vegetative cutting, the same as a cutting of a Geranium or Coleus. From this one can readily see that for the best development of this cutting, certain soil and climatic conditions are necessary. The ability of the plant to produce tubers is in direct ratio to the soil conditions, fertility, and climatic conditions with which we surround the plant. To make a success of potato growing, the growers should know the nature and requirements of the plant. These requirements will be discussed under different headings.

**SOIL**

While potatoes may be grown on most types of soil, a sandy
loam soil well supplied with vegetable matter and containing all
the elements of fertility will give the best results both in yield
and quality. The heavier types of soil have a tendency to puddle
after heavy rains and after irrigation, which greatly impedes
the development of the tubers. Potatoes grown on heavy lands are
apt to be rough and ill shaped. This is due to the fact that when
the growing tuber comes into contact with hard and lumpy soil,
it yields and grows in the direction of least resistance.

Heavy soil, as a rule, is difficult to aerate, that is, to get a
supply of air into the soil which is necessary for the normal
development of the root system and the tubers. When there is
no choice and potatoes have to be planted on heavy land, fall
plowing and the turning under of green crops in the fall is helpful
in loosening up the soil. Under a regular system of rotation,
where alfalfa precedes the potatoes, the last crop of alfalfa should
be turned under to increase the vegetable content of the soil, thus
making the soil looser and more friable.

FERTILIZERS

Commercial fertilizers are not used to any extent in Colorado
and for the present, at least, there is little call for their use. In
general farming, where a regular system of rotation is followed,
soil fertility and proper soil conditions are maintained by the
plowing under of alfalfa or clover, and, with the application of
barnyard manures. In the non-irrigated sections, a longer system
of rotation should be followed, together with the plowing under
of any green crop that can be grown. Often a crop of weeds may
be grown and turned under. The raising of livestock in the non-
irrigated sections is now looked upon as necessary to success in
order to provide the much needed fertilizers.

One crop farming has proven a failure as a permanent type
of farming in every section of the country. It not only robs the
soil of its fertility, but it also burns out the vegetable matter and
leaves the soil dead and unproductive. Rotten stable manure is
the best fertilizer for potatoes in Colorado. Fresh stable manure
should not be applied on the land immediately before planting,
as it generally has too much straw in it and tends to dry out the
soil, and, further, it takes a full season under our arid conditions
for the strawy manure to decompose and during this period it
does more harm than good. This is particularly true under dry
farming conditions. Under irrigation, there is less objection to
the use of strawy manures, as the decomposition is more rapid.

The custom of applying fresh manures to the land in the
fall and early winter is less objectionable, as it has a chance to
be acted upon by the rains and snow before the crop is planted.
In the plowing under of green crops, the decomposition is more rapid and the potato plants get the benefits, not only of the fertilizer element in the green crop, but also the benefits of the improved soil conditions. It can not be emphasized too strongly that the proper soil conditions for the potato are as important as the elements of fertility, and soil fertility in its broadest sense includes proper soil conditions.

**PREPARATION OF THE LAND**

**Plowing.**—Deep plowing is necessary on most kinds of soil, especially on lands which have a tendency to bake and become hard, either after rain, or after irrigation. The potato plant is a deep feeder, and for the maximum production the soil should be plowed 10 to 12 inches deep. The plowing under of alfalfa should be done in the fall. The fall plowing should be just deep enough (about 4 or 5 inches) to kill the alfalfa plant. In the early spring, the land should be cross-plowed to the depth of 10 or 12 inches, and harrowed and thoroughly pulverized. It is an excellent practice on heavy soils to follow the alfalfa with a small grain crop, fall plow the land to the depth of 10 to 12 inches, and then cross plow in the spring, fit the land and plant potatoes. The potato crop will then receive a greater benefit from the plowed-under alfalfa, as the roots and stems have had a chance to decompose and the soil is in better physical condition for the potato plant.

**ROTATION OF CROPS**

All successful potato growers now agree that potatoes should not be grown more than once in succession on the same land, and that a potato crop should be preceded with the plowing under of a crop of alfalfa or clover. Whether the potatoes should follow immediately after the alfalfa or clover, or the year following, depends upon soil conditions. Equally good results have been obtained from both methods. On the heavier land, the soil undoubtedly would be in better condition for potatoes if an intervening crop of grain were planted between the alfalfa and the potatoes. On the lighter soils, this is not necessary. Usually the second or the third cutting of alfalfa is plowed under, or the second crop of clover. Clover is now extensively planted in higher mountain valleys in place of alfalfa, and is giving excellent results. It is easier to kill out, and the soil can be put into perfect condition with less expense than after alfalfa.

A crop of potatoes puts the soil in best possible condition for small grains, and the labor expended in the preparation of the land for potatoes is repaid, not only from the potato crop,
but from the higher yield of small grains planted on the land. Clover lends itself better to short crop rotation than alfalfa, and, for this reason, the farmers in the higher mountain valleys can place their farms on a four-year system of rotation, while in the warmer valleys and in the irrigated sections of the plains, a five- or perhaps six-year rotation is better.

While at present the plowing under of alfalfa and clover has been a main source of soil fertility, the time will undoubtedly come when this will have to be supplemented with the application of stable manures, and this is already done to a great extent by our best growers.

**SEED**

During the last two years, more attention has been devoted to the question of seed selection and type than to any other phase of potato growing. Gratifying results, both in yield and quality, have been obtained. While seed selection is important to success, it is only one of the grower’s problems. No matter how good the seed may be, the returns will not be satisfactory unless the grower is willing and able to perform the cultural work, and provide the right kind of soil conditions to enable the plant to make a satisfactory growth. The grower must first see to it that

Perfect type of Rural seed. The kind to plant
a plant has the proper conditions for full development, and then provide the proper kind of seed. There is a tendency to over-emphasize seed selection, and substitute good seed for proper cultural methods. This does not mean that the grower should neglect the seed end of the business, but rather that we should aim to provide the best possible condition for seed planted. When we speak of pedigree seed, we do not really mean pedigree in the sense that is used by the plant breeder, for we are not dealing with seed in the proper sense of the word, but we are dealing with a cutting.

While the cutting will produce a plant like that from which the cutting was taken, insofar as the general character of the plant is concerned, the potato or tuber is an underground stem for the purpose of storing up food for another season's growth, and, if we remember that the storing up process is dependent upon the soil, climate, and the general conditions that surround the plant, we can readily realize that the cultural side of potato growing is the most important factor in the production of a larger crop.

_Hill Selection._—This method of obtaining good seed is now recognized to be the most effective. It consists in going over the field during the month of August, and marking the strong, vigorous hills, such as the grower considers ideal in both growth, habit, and in yield. These marked hills are dug in the fall previous to the digging of the main crop, and, if at digging time they measure up to the requirements set, they are saved, kept separately for seed, and planted in a separate plot the following year. All tubers from these selected hills are saved, as a small tuber from a good hill is better than large tubers from a poor hill.

_Bin Selection._—Many growers practice bin selection, that is, the grower picks his seed from the stock of potatoes on hand, either during the winter or in the spring before planting. This method is good, but is subject to some objections, for often poor productive hills, and even diseased hills, will produce smooth and true-to-type tubers, and these are selected with others and planted.

_Screenings._—A large share of potato growers use the screenings for seed, and claim that they are justified in so doing both by reason of economy and yields obtained. The practice is not advisable under the best system of potato growing. It may be tolerated in years of seed shortage, but it should never be made a main practice. A modified method of using screenings for seed is adapted by some growers. It consists in selecting the best
potatoes from the screenings, and using these for seed. This method is preferable to the former, but is not recommended in good farming.

**Seed Plots**

The question whether the farmer should grow his own seed or purchase the same from the seed grower is open for discussion. Personally, we believe that every potato grower should grow his own seed, and have his own seed plot. This will enable him to give his seed plot different treatment from the main crop without much additional expense.

**Whole Versus Cut Seed**

Whether whole seed is better than cut seed depends upon the conditions under which the grower is operating. In districts where the fusarium disease is prevalent, and where conditions are such as to require the farmer to irrigate up his seed, whole seed is preferable. Whole seed will, as a rule, under these conditions, give a better stand, as the seed is not so apt to rot when whole. In sections where the soil conditions at planting time are favorable, cut seed will give equally good results. There is one objection to whole seed, namely, many varieties have numerous eyes, especially at the seed end, and are apt to produce a hill with numerous weak shoots, which invariably produce small tubers, while with cut seed, where only one or two eyes are left to the piece, the shoot or shoots are stronger, more vigorous, and more productive. More seed is also required in planting whole seed and when seed stock is high it adds considerable to the total expense.

Under dry farming methods, whole seed is preferable to cut seed, since a whole seed does not rot as readily as a cut seed, thus giving the plant a better chance to establish itself, and a longer time during which it can obtain food supply from the seed. The question of the size of the whole seed is one of importance to the grower. In general practice, the seed should not weigh less than 1 ounce or 1½ ounces. If too small, the growth from the seed is weak and the plant produced lacks vigor and productiveness. Seed about the size of an average hen egg is best. The size of the cut seed will depend somewhat upon the soil conditions, though pieces weighing not less than 1½ ounces should be used in general practice.

**Treating Cut Seed**

Experienced potato growers have found it advantageous to cut the seed three or four days before planting, and sprinkle the seed with air-slaked lime. This has a tendency to dry off the
cut surface, and, in a measure at least, stop the premature rotting of the cuttings; even leaving the cut seed for a few days untreated seems to have the same result.

**Mature versus Immature Seed**

Much has been said and written as to the relative value of immature seed as compared to mature seed, but no definite conclusion has been reached by the practical grower. The favorable results obtained by potato experts with the use of immature seed would indicate there are some advantages in the use of this kind, but in most cases the immature seed had been grown in seed plots from hill selection, and naturally would show the result of such selection, rather than from the intrinsic value of the immaturity. It is undoubtedly true, as one would expect, that in an immature seed the buds or eyes are relatively more active because they are younger and would start to grow more quickly than eyes from a well matured tuber. Whether there is any particular gain in the rapid development of the sprout is questionable. However, what is often termed immature seed is not immature seed at all, but seed that is full matured in every respect, except that the tubers are below medium in size, and this is obtained by closer and late planting of the seed plot. Under average farm conditions, the mature seed has given satisfaction, and we are not yet ready to advocate a new departure.

**Greening the Seed**

The practice of exposing the tubers intended for seed to the sunlight and air for a period of one or two weeks before planting is advocated by some growers in Colorado. It is particularly valuable in the South in connection with the planting of the second crop of tubers, as it hastens the growth of the plant. When potatoes are exposed to the air and light, the tuber begins to function in the same manner as the green branch or a leaf. In other words, it turns green, showing the development of chlorophyll, or a green coloring matter, and with this begins to sprout. This sprouting is equivalent to the new growth on trees and bushes in the early spring, so that the greening process is simply a method of stimulating the growth activity of the buds. When this is obtained, the tubers are planted, and the shoots will soon come out of the ground. In Colorado, this practice may sometimes be resorted to, especially if unseasonable weather delays the planting. Progress can then be made by greening the potatoes, so as not to lose too much time after planting before the potatoes come up. Under average normal conditions, it is questionable whether there is any real advantage in this practice, and further,
it places an additional expense on the grower. If greening is resorted to, the potatoes should be placed in shallow boxes or crates, and exposed to the full influences of sunlight. The temperature also must be such as to stimulate growth activity.

**PLANTING**

The time of planting depends entirely upon the season and the locality. In some sections of the State, planting is delayed until early in June. This delay makes the season rather short for potatoes, and, as a result, the crop is often immature and low in quality. Under average Colorado conditions, we believe that earlier planting will give better results, not only as to yield, but in the quality of the crop produced. The latter part of May is about the right season for most sections of the State. This refers to the main crop. Seed plots, or potatoes intended for seed, may be planted as late as July.

**Depth of Planting**

Soil conditions generally determine the depth at which potatoes should be planted. On the average land in irrigated districts, potatoes should be planted about 4 inches deep. The rows should be from 36 to 40 inches apart, and the seed dropped 12 to 14 inches apart in the row. On the more level land, it is important that the rows be at the maximum distance apart, in order that the hilling may be deep enough to carry off the water without coming into contact with the potato plants. On land having a good fall or slope, the rows may be closer together, as high hilling is not necessary. In the dry-farming sections, the rows should be 4 feet apart, and the seed from 18 to 24 inches apart in the row.

**Potato Planters**

There are numerous makes of potato planters on the market, most of which are generally satisfactory to the grower. We believe, however, that the picker type of planters are less satisfactory than the disk type. While it requires an extra man or boy to watch so that each compartment in the disk has its seed, it insures a perfect stand, while the picker type of planter often misses the seed, and sometimes spears the eye, resulting in an imperfect stand of plants. Farmers, as a rule, pay little attention to this phase of the operation, but the loss from missing plants in a field is considerably greater than one expects. We have found that, taking the State as a whole, the growers are losing on the average of 15 percent of the crop through imperfect stands, generally caused by the failure of the planter properly to
perform its function. This item alone amounts to many thousands of dollars, and even on individual farms is often sufficient to decide whether a crop is raised at a profit or at a loss.

**CULTIVATION**

After potatoes have been planted, the spike-tooth harrow should be put in use and kept going so that the field will be harrowed at least once every week or ten days, until the potatoes are about 4 inches above the ground. If there is danger of tearing the young plants during the last harrowing, the teeth may be set so as to slant away from the draft, which will result in less injury to the plants. As soon as the plants are large enough to permit of cultivation between rows, the first cultivation should be as deep as possible. Eight to ten inches is not too deep. This will loosen the sub-soil, and permit the soil to become aerated. As the plants increase in size, with a corresponding development of the root system, the cultivation should be correspondingly shallow. In the right kind of potato soil, the roots of the plant will often penetrate to the depth of 2 feet, and laterally 2 or 3 feet. The more thorough and frequent the cultivation, the better will be the soil conditions for the development of the root system and the tubers. On non-irrigated land, the cultivation should be shallow throughout the season.

**Hilling**

On level land, deep hillimg, is necessary, as standing water should not be permitted around the potato plant. On land having a good slope, so as to insure perfect drainage, the hillimg should be less extensive. It is better at least, on land having a slope, to hill gradually, as it will keep the soil cooler, and permit the breaking up of the crusts by cultivation between irrigations. On the level land, little or no cultivation can be done after the hilling. Where high hilling is practiced, there is considerable danger of over-heating the soil, due to the extensive exposure of the soil in the hilling. The undue raising of the temperature in the hill creates favorable conditions for very rapid growth of the plant, and also very favorable conditions for diseases. The cooler the soil can be kept during the warm season, the more normal and the more healthy will be the plant. Also, it will be less susceptible to disease attack.

On non-irrigated land, hilling is detrimental, as it tends to dry out the soil, and thus deprive the growing potato plant of the much needed moisture. Generally all that is needed in the way of hilling is accomplished by using a broader tooth in the rear of the cultivator, which will throw a small amount of soil
toward the plants. Even this is unnecessary if the seed is planted deep enough to keep the growing tubers from pushing out of the soil.

**IRRIGATION**

The Horticultural Department is frequently called upon to give advice as to when and how potatoes should be irrigated. To answer such questions intelligently, a knowledge of soil conditions is absolutely necessary. Many growers believe that potatoes should not be irrigated until the vines are setting the tubers, even though the vines are actually suffering from lack of water. This may work out all right, but one may well question the wisdom of following such a rule. It is a universal rule that when a growing plant needs water and shows signs of wilting, water should be applied, so that the normal growth will not be checked. When the tubers have once set, it is necessary to irrigate so as to keep the soil in best growing condition possible for the balance of the season, or until the crop is matured. In other words, there should be no check to the growth of the plants after the tubers have once started to develop. If a check is given during this period, and the plant resumes its growth afterwards, knobby and gnarly tubers result. Hence the importance of keeping the young potatoes growing without check throughout the season.

Second growth of tubers caused by improper irrigation

In irrigating potatoes, it is much better to apply enough water thoroughly to saturate the ground, rather than small amounts of water at frequent intervals, as frequent applications of water will puddle and harden the soil to a much greater extent, and there is danger that some plants will not get enough water. A small stream running for a long period is better than a large stream for a short period.
On the Eastern slope, it is preferable to apply the water during cloudy days or at night time. When the potatoes have reached their full growth, which depends largely upon the season and locality, it is advisable to withhold the water so that the skin of the tubers may ripen and harden. Otherwise, the keeping quality of the potatoes will be impaired. Keeping the tubers growing up to the harvest time results in poor quality.

There is a tendency in some potato-growing sections to crowd the growth and development, or, as some express it, to make the crop "in the shortest possible time," during the month of August and half of September, by the liberal use of water. This practice may be advantageous during favorable seasons, but such practice invariably results in a poorer quality of the crop produced, and the tubers are watery and soggy, with poor keeping qualities. Further, seed potatoes grown in this way lack vigor. A normal growth development when the plant is not forced is preferable, so far as quality is concerned. It is also probable that undue forcing of the plants make them more susceptible to disease attack.

**HARVESTING**

The harvesting of a potato crop may appear to be a simple operation which can be performed by anyone. As a matter of fact, the harvesting is one of the most important operations that a grower has to perform. The question of damage, due to the digger, and the problem of curing the potatoes so that they will stand up in storage, have to be looked after. Generally, a considerable percentage of the crop is injured by not having the digger set deep enough, thus cutting or mutilating the tubers. On heavy land, not properly prepared, it is difficult to get the digger below all the tubers. On sandy lands, this difficulty should not exist. The tubers injured by the digger are very apt to decay in storage, and besides, they will spoil the salability of the crop.

Again, the practice of picking up the potatoes immediately after the digger is not good. In the first place, it is difficult to sort thoroughly the potatoes, and the diseased ones are apt to go with the good ones. Further, a small percentage of soil generally adheres to the tubers, and is carried along with them. If possible, the potatoes should be left on the field for several hours, so that they may become thoroughly dry. This will help in hardening the skins, and improve the keeping qualities of the potatoes. Potatoes cured in this manner in the field will keep much better and make a more salable product.

In many irrigated sections, where the growing season is relatively short, and when the vines are growing vigorously up to
the time they are killed by the frost, the tubers are not mature, but are watery, and the skin peels off readily. When this condition exists, the curing of the tubers after digging is very important. Where the best grade of potatoes are grown, and where they are wanted for storage, a good plan is to pick up the tubers after they are dry, and place in piles of 40 to 50 bushels, and cover slightly with straw. Where heavy frosts are apt to occur, the covering should be increased. After a few days, the potatoes will have gone through a curing process which will make their keeping qualities much better. This practice is not advisable where the potatoes are sold directly from the field and where the question of labor enters in.

**GRADING**

Ordinarily, the hand potato grader is the only grading machinery used on the farm. In many cases, no grading is done apart from the slight separation in the picking up of the potatoes after the digger. Where the hand grader is employed, the workers are usually so busy that the grading or screening is not thorough and little good is accomplished by it.

The time has come when the potato grower must conform to some standard of grading for his potatoes in the same manner that the fruit grower conforms to the standard of grades in apples. It can be truthfully said that there is more waste in the potato crop due to poor handling and grading, than any crop raised on a farm. A conservative estimate of the waste shows that from 15 to 25 per cent of the total potato crop harvested is wasted. This does not mean that the waste of the actual product is this high, for a portion of the waste is represented in dirt or soil which adheres to the tubers, and which is never separated from them. Though this waste is not equally large in all sections, yet the total figure is enormous. The largest waste comes from the presence of small, ill-shaped, and decayed tubers which cannot be utilized for food purposes, but on which the farmer is paying for containers, railroad freight, and commission charges. This waste should be left on the farm, and utilized for livestock feed. Further, the presence of small, gnarly, and diseased tubers gradually decrease the consumption of the potato and is the source of dispute between the commission man and the farmer. For the farmer's own protection, the potatoes should be properly graded and marked, and the grade should be standardized so that interstate shipments would be uniform. The State Potato Growers' association endorsed and adopted the U. S. standard of grading as recommended by U. S. Department of Agriculture, and the U. S. Food Administration. It is as follows.*
U. S. Grade No. 1

*"This grade shall consist of sound potatoes of similar varietal characteristics, which are practically free from dirt or other foreign matter, frost injury, sunburn, second growth, cuts, scab, blight, dry rot, and damage caused by disease, insects, or mechanical means. The minimum diameter of potatoes of the round varieties shall be one and seven-eights (1¾) inches, and of potatoes of the long varieties one and three-fourths (1¾) inches. In order to allow for variations incident to commercial grading and handling, 5 per centum by weight of any lot may be under the prescribed size, and, in addition, 3 per centum by weight of any such lot may be below the remaining requirements of this grade.

U. S. Grade No. 2

This grade shall consist of potatoes of similar varietal characteristics, which are practically free from frost injury and decay, and which are free from serious damage caused by dirt or other foreign matter, sunburn, second growth, cuts, scab, blight, dry rot, or other disease, insects, or mechanical means. The minimum diameter shall be one and one-half (1½) inches. In order to allow for variations incident to commercial grading and handling, 5 per centum by weight of any lot may be under the prescribed size, and, in addition, 5 per centum by weight of any such lot may be below the remaining requirements of this grade."

VARIETIES

Experience has shown that certain standard varieties do better in some localities than others, and this preference or adaptation to soil and climatic conditions is now fairly well established for Colorado. With these facts known, the grower need not experiment with new varieties or with old ones, but can take up the work at once without passing through the period of experimentation. For the convenience of potato growers, we may divide the State into districts, based upon climatic conditions, geographical location, and soils, and assign varieties to these districts which have proven best adapted to them. Number 1, the Greeley district, comprising Northeastern Colorado, with Greeley as a center; No. 2, Divide district, comprising Douglass, Elbert, and El Paso counties; No. 3, Northwestern district, comprising Moffat and Routt counties; No. 4, Intermountain district, including the valleys and mesas of Garfield, Eagle, and Pitkin counties; No. 5, Western Slope district, including Mesa, Delta, and Montrose counties; No. 6, Southwestern district, including Montezuma and La Plata counties; and No. 7, San Luis Valley.

District No. 1 is the oldest potato-growing section in the State, and the crop is grown as a part in the regular rotation.
Types of the Rural variety, a standard late variety. Widely grown in many districts of the State.

The two standard varieties grown are the Pearl and the Rural. The Pearl leads to the extent of 75 percent of the total planting; though many growers are beginning to plant the Rural more extensively. The Pearl variety out-yields all others, and seems to be particularly adapted to the soil and climatic conditions obtaining in the district.

District No. 2, comprising what is known as the rain belt of the Eastern Slope, occupies the central elevated portion of the Eastern Slope from the mountains towards the plains. Little or no irrigation is practiced in this section, the rainfall being from 14 to 20 inches, and fairly well distributed. The altitude varies from 5,500 to 7,000 feet. The fact that potatoes are grown without irrigation makes it necessary that the crop mature early in order that it may not be damaged by the late summer drought. Early maturing varieties are mostly planted, and these have proven a success. The Early Ohios, the Chicago Market, and Six Weeks are most extensively planted, Early Ohios being the leading variety. In the sections where the rainfall reaches 18 to 20 inches, the Pearl variety is grown with success.

District No. 3, the Northwestern district, is characterized by a short season, due to its high elevation and cool nights. Late maturing varieties should not be planted. Russet Burbank, Early Ohios, and the Rural are leading varieties.

In District No. 4, which is the Intermountain district, the soil is medium heavy and admirably adapted for the growing of high
Good types of Early Ohio—A desirable early variety for the dry farming sections.
Perfect type of the Peach Blow variety. This variety grows to perfection in the Eagle and Cachonda districts.
quality tubers. Varieties grown are the Peachblow and the Russet Burbank. The Rural and the People's are grown to a limited extent, but possibly 80 percent of the acreage is devoted to the first-named varieties.

District No. 5, comprises the valleys of the Grand, Gunnison and Uncompahgre rivers, together with the irrigated mesas adjoining. These valleys have some excellent potato soil, and the
industry is developing rapidly. Leading varieties are the People's, Rural, Russet Burbank, Downing and Cobbler. This district grows a greater range of varieties with success than any other district.

Pearl tuber showing typical characteristics. A great favorite in the Greeley district

A perfect specimen of Brown Beauty potato, a variety especially adapted to the San Luis Valley
District No. 6, which takes in the irrigated sections of Montezuma and La Plata counties, grows principally Russet Burbank, Rural, and Early Ohios.

District No. 7, which includes the San Luis Valley, is one of the largest potato-growing sections of the State. The leading variety for the valley is Brown Beauty, Russet Burbank, People's, and the Rural. These are planted in the order named.

Typical specimen of the People's variety, grown extensively in the Gunnison and Uncompahgre valleys. A heavy yielder and fine shipper. Shows a tendency to grow rough.

It is not remarkable that each section should have developed somewhat different cultural methods, which in turn are based on the experience of the grower. When one considers the great diversity in soils, altitude, and climatic conditions of these different sections, one can readily understand why this diversity in cultural methods should occur. Any prospective potato grower locating in any of these sections should follow the methods and practices of the best potato growers in the district, rather than rely upon information obtained elsewhere. The effort of the Horticultural Department and the State Potato Growers' Association to standardize varieties for each district has met with a ready response from the growers, and there is a marked tendency in all districts to reduce varieties planted to one or two leading sorts. This tendency is having and will have a marked influence upon the marketing of the crop for the different districts. The buyer will be assured of uniformity in variety and quantity. The
growing of numerous varieties always has a demoralizing effect upon the market and upon prices.

**THE RUNNING OUT OF VARIETIES**

It is a common complaint among potato growers that a given variety, after being grown for a series of years in the same locality, or at least on the same piece of land, runs out, that is, shows a decrease in vigor and productiveness. Investigations tend to confirm the common opinion that varieties decline under the ordinary methods of culture and seed selection. It is undoubtedly true that a good variety grown on a certain type of soil tends to show a decline, especially when no efforts are made to keep up the production through the selection of seed. The common practice of using the small potatoes or the screenings for seed must inevitably lead to a decline in yield, as poorer stock is being planted from year to year. Undoubtedly, the system of cultivation may have something to do with the decline, also the climatic conditions under which the grower is farming. On the other hand, we have abundant evidence that with proper seed selection, proper cultural methods, the right kind of soil and climatic conditions, a given variety does not decline, neither in vigor nor productiveness, but on the other hand shows an actual increase. This would indicate that the decline in yield, as commonly believed, is due to preventable causes over which the grower has control. We know personally of several growers in the State who have been growing the same variety for the last twelve or fifteen years, and during this time there has not been any decrease in production, but on the contrary a considerable increase. These growers, however, practice seed selection by the hill method, and grow the potatoes for seed separately in seed plots. With these facts before us, we are inclined to dissent from the general opinion that the varieties run out, but believe that the running out is due to the lack of seed selection and the lack of proper cultural methods and soil conditions.

**TRUENESS TO TYPE**

The standard varieties of potatoes grown in Colorado are recognized by a certain type or form that the tuber assumes when grown under normal conditions. While this statement is true, it should be born in mind that elevation, soil and climatic conditions influence the type to a marked degree, and that the grower can only hope to maintain a perfect type of the variety grown when he practices the best cultural methods and careful selection of seed that is true to type.

In heavy soil, it is difficult to maintain the type of the variety, as in growing the tuber yields to the pressure exerted by the soil,
and will expand in the direction of least resistance. This causes the tuber to grow irregular and rough. It is easier to maintain the type in loose and open soils where the tuber can expand without unequal pressure from the soil. Ill-shaped or knotty tubers generally occur when the growth of the tuber is checked, usually on account of lack of water, and then starts the second time, the knobs representing the second growth. From this, it will be seen that it is necessary to keep the soil conditions such that the tuber can continue a normal development without check.

**SEED CERTIFICATION**

With the development of the potato-growing industry in this State, some provisions are necessary to secure the purchaser of seed potatoes against an inferior product. To obtain this condition a system of seed certification is necessary. It is true that here and there are seed producers who make a specialty of producing high-grade potatoes from which the average grower may obtain high-class seed. But these seed growers are few and far between, and as the welfare of an industry depends upon the intelligence and standards of the average grower, it is necessary that the largest possible number of them should have access to high-grade seed.

A system of seed certification by properly qualified officials who can certify to the quality of the seed is necessary. This would tend to raise the general standard of the product, and also furnish an incentive to many growers to produce certified seed.

A system of certification was formulated by the Colorado State Potato Growers' Association and incorporated in its constitution and by-laws. This certification calls for two inspections of the growing field during the summer, and a bin inspection after the harvest. In the field inspection, special attention is paid to the health and vigor of the plants, the absence or presence of disease, the fullness of the stand and the uniformity of the plants in the field. The two field inspections should be made at intervals of four to six weeks. The last inspection should be made as late as possible before the harvest, so as to detect the most dangerous diseases.

The bin inspection gives the inspector an opportunity to determine the trueness to type of the variety grown, the freedom from scab and the general quality of the tubers. If after inspection, the inspector finds that the product measures up to the standard, a certificate to this effect is granted to the grower. This certificate states the variety, the results of the inspection, and in fact all possible information connected with the potatoes. The grower may then use his certificate in advertising his product
and the fact that his potatoes have passed the necessary inspection gives the grower a prestige over those who do not hold such certificate. Application for seed certificate should be made to Horticulurist, Colorado Agricultural College, Fort Collins, Colo., not later than June 15 each year.

It is a fact that the Colorado potato growers every year find considerable difficulty in obtaining first-class seed. This is especially true during a year like the present one when prices were abnormally high and where the grower disposed of his product regardless of standards. A year of extremely high prices tends to demoralize standards, but the grower should bear in mind that extremely high prices are the exception rather than the rule with a standard crop like potatoes, and the success of a grower is not based alone upon the large profit obtained in a single season. We must provide for the average years and average prices and raise the standard of the product so that during the year of average prices the grower still can make a profit and find a market because of the excellency of the tubers produced.

A State law fixing standards both as to grading and seed would be beneficial to the grower, but it is doubtful if such law could be passed until there is a greater demand for it. Meanwhile, it is the duty of organizations and individuals to do everything possible to raise the general standard of the crop.

Our potato growers do not realize the future before them in the production of high-grade potato seed for the Southern planters. This phase of potato growing has unlimited possibilities, as the demand for high-grade seed is constantly growing. Colorado is the natural territory to supply the seed for this section of the country, not only because of the advantages in soil and climate, but also because of the nearness to the markets and the lower transportation charges.

The demand for seed potatoes from the South calls for the growing of varieties that are not now grown to any extent. The varieties in demand for seed are the Cobbler and the Triumph. Both of these can be successfully grown in most parts of the State. From all indications, the Triumph is well adapted to the conditions in the San Luis Valley, while the Cobbler can be grown successfully in every section of the State.

This department has had numerous requests for seed potatoes of these two varieties from the South, and these requests have been more numerous during the last two years than before, indicating that the Southern growers are beginning to learn the value of Colorado-grown seed.
POTATO DISEASES

Late Blight.—This disease, so destructive in the East, does not occur in Colorado. The climatic conditions of the State do not favor the development of the disease, as it requires a humid atmosphere with high temperature. The reported occurrence of late blight in Colorado has in every case turned out to be the fusarium disease. It is indeed fortunate for the State that the late blight does not find a congenial home here, as the fighting of this disease entails considerable expense.

Early Blight.—It occurs in the State, especially in the warm, heavily irrigated valleys of the Western Slope. Some seasons when rainfall is above the normal and when the temperature is relatively high, it causes considerable damage to the grower. It occurs during the month of July, and is easily distinguished by dark brown patches or rings on the foliage. In extreme cases, the whole foliage becomes affected, and the leaves drop off, and often kill the plant. In milder cases, it reduces the yield and the potatoes produced are small and worthless.

Spraying with Bordeaux mixture is effective, but it should be done before the disease has made any headway. If the weather conditions are such as to encourage the development of the disease, the grower should spray before the disease makes its appearance. Its rapid spread over the field and the rapid progress of the disease makes the application of the Bordeaux of little effect if the disease has gained a firm foothold. During the last five years, in only one season has this disease done any damage.

Fusarium.—This disease is present in every potato growing district of the State, and is the most destructive disease with which the grower has to deal. It remains in the soil for a number of years, and there is probably not a potato field in the State where the disease cannot be found. It is favored in its development by high temperature, moisture, and poor soil drainage. In heavy soils, the disease appears to be particularly bad. It may be introduced into the soil either by previous crops, or, we believe, by the seed. The fact that the disease remains in the soil for a number of years makes the subject of crop rotation important to the grower, and is one of the main reasons why we advocate the growing of potatoes only one year on the same piece of land without the intervention of other crops.

The presence of the disease in seed potatoes can easily be ascertained by the cutting off of a thin slice of the potato at the stem end. A dark circular discoloration just inside of the skin
indicates the presence of the disease. Seed potatoes showing the presence of the disease should not be planted, as a matter of safety. While it is true that seed potatoes showing the presence of the disease often produce healthy, normal plants with a satisfactory yield, the fact is that the disease is present and may, under favorable conditions, develop and attack the growing plants. It is also believed, though not proven by careful experiments, that cut seed is more apt to become infested with the disease than whole seed. This may be due in some cases at least to the lack of vigor of plants grown from small seed pieces. It would seem that where the disease is prevalent and where the conditions are favorable for its development, that whole seed would give better results. The planting of whole seed, however, does not insure the grower against loss by this disease, as it may attack the growing sprout and cause great losses.

The disease being internal, it cannot be reached by any remedy that we may use against it. Precautionary methods, such as planting of disease-free seed, crop rotation, and the best cultural methods, will be in the main effective in preventing the disease from doing great damage.

The appearance of the disease in the field is in many cases identical with that of the early blight, with the exception that the leaves turn a paler shade of yellow, and do not show the brown patches and circles. The stem of the plant is first attacked, and if a cross section is made of the stem close to the ground, dark areas will be found in the bundle or the fiber portion of the stem. These dark areas indicate the presence of the disease, and its presence greatly interferes with the transportation of food materials.

**Curly Leaf.**—This is a disease of unknown origin, which occurs some seasons in the State. As the name would indicate, the leaves assume more or less of a curly outline, and the plant becomes more or less stunted in its growth. It is believed that this disease is transmitted or carried by the seed tuber. The fact that the plant does not show any marked discoloration is responsible for the fact that this disease is often passed over by the grower and no attention is paid to it, although the loss from the disease may be considerable. The grower should be on the lookout for plants showing the symptoms of the disease, and destroy them at once.

**Rhizoctonia.**—This disease is present in practically all of our cultivated fields, and, under favorable conditions, does consider-
able damage. It is more destructive in the higher mountain valleys than on the plains. Its presence on the vines can easily be distinguished by the brown lesions that occur along the base of the plant. In some cases, these wounds or lesions extend around the whole plant, and completely shut off the food supply from the leaves to the tubers. In most cases, only one side of the stem becomes diseased, and in such cases the plant continues to grow, though the yield is considerably decreased. The disease may occasionally be found on the tubers in the form of small black spots, or wart-like growths all over the skin. These little dark areas vary in size from a pin-head to that of a dime. They are known as "sclerotia," and contain the "seed" which is carried over in this manner from year to year. During some years, the disease is particularly bad and causes considerable damage. If the spots on the tubers are not large or conspicuous, they do not interfere with the salability of the crop.

This disease can be controlled so far as dissemination from diseased tubers is concerned, by means of disinfection. While this method of treatment is efficient against the disease, it does not prevent infection from the soil, and hence the seed treatment against this disease does not always show satisfactory results. In this connection, it should be borne in mind that this disease is native to the soil, is always present, and under favorable conditions will attack the plant whether the seed has been treated or not.

The most effective method of seed treatment is with corrosive sublimate, using 4 ounces of corrosive sublimate to 30 gallons of water. The solution should be made up in wooden vessels, such as a barrel, and the potatoes to be treated suspended in a gunny sack for one and one-half to two hours. This solution will penetrate the "sclerotia" and kill them. The treatment should be made before the potatoes are cut. The potatoes treated cannot be used for livestock, as the solution is exceedingly poisonous, and care should be taken to protect livestock against drinking the solution. The solution can be used only three times, after which a new mixture should be made up.

Potato Scab.—This well-known disease is common in every section of the State, and during some years does considerable damage to the crop. The disease is external, penetrating the tubers only to a very small extent. Its greatest damage is to the appearance and keeping quality.
There is very little excuse for the existence of this disease, as it can easily be controlled by treating the seed potatoes. The same treatment as recommended for Rhizoctonia disease should be used, that is, the potatoes, before cut, should be dipped into a solution containing 4 ounces of corrosive sublimate to 30 gallons of water. The easiest way of treating the seed is to make up the solution in a barrel holding about 50 gallons. The barrel should contain about 30 gallons of the solution and the potatoes placed in a gunny sack and suspended in the solution for an hour and a half, after which the seed may be cut and planted. Precautions should be taken not to feed the treated seed to livestock, as the poison is very deadly.

Numerous complaints have been received that the scab has occurred in some fields in spite of treatment, and often when clean seed has been used. In such cases the presence of the scab fungus is undoubtedly due to the feeding of cattle on the field the season before planting. This disease propagates very readily on the manure dropped by the cattle, and in this way the land becomes infested. If the disease is in the soil, the treatment of the seed potatoes cannot be effective against it. Clean land, as well as clean seed, is essential for the production of clean tubers.

**Dry Rot**—Dry rot is caused by one of the fusarium organisms and is essentially a disease of the cellar or storage. It has been particularly bad in the western valleys where it has caused serious losses to the growers. The dry rot should not be confused with the fusarium wilt disease, common in the field where it attacks growing plant and tubers. As a rule, the dry rot disease does not attack perfectly sound tubers, but tubers which have become bruised or cut in harvesting, or in handling. The disease is favored with high temperature and high moisture contents of the cellar or storage, and spreads rapidly from tuber to tuber under these conditions.

Last season a large percentage of the crop was stored under unfavorable conditions, and the tubers in many instances immature and the skin peeled easily in handling. The potatoes contained a relatively high percentage of water. Due to the heavy frosts, the potatoes were placed in storage rapidly, giving the tubers little or no chance to dry out, or cure, before being stored. The cellars were also utilized to the fullest capacity, and potatoes were piled high in the bins.
Potato cut by digging machine and infested with dry rot in storage

Most of the cellars have ventilators placed at the roof, and few, if any, have an intake or ventilator opening at the floor. When only one set of ventilators are provided there is no circulation of air, and the condition of the air in the storage is not changed. Few storages or cellars have floors. Proper ventilation of the storage will, to a large degree, eliminate the dry rot, and most cellars can, with slight modification, be properly ventilated. An extra intake or ventilator should be provided for either at the base of the door, or at the side of the door, one in each end of the storage. These ventilators should be so constructed as to permit the operator to close them when not needed. When a large quantity is stored, the bins should have the false floor, so as to permit a circulation of air from below. There should also be ventilators made of slats in the shape of tiles, but perforated so as to permit a circulation through the middle of the bins. If proper ventilations are provided for, the disease is not apt to make much of a progress.

More care should be exercised in the sorting of the potatoes before storing, since the dry rot affects potatoes injured or bruised and the grower should eliminate potatoes that are cut in digging, so as not to infect the sound ones. Potatoes infested with the dry rot should not be used for planting. The disease is believed to be a native of the soil, and may be perpetuated from year to year though sound tubers taken from an infested cellar may be planted. Cellars in which potatoes are infested with dry rot should be fumigated before another crop is stored.
STORAGE

Every potato grower should have farm storage for his crop. The lack of proper storage often compels the grower to market his crop at a harvest time when there is a glut in the market, and when transportation facilities are difficult to obtain. Potatoes marketed direct from the field are, as a rule, poorly graded and of inferior keeping qualities. Proper storage permits of proper grading and the work can be distributed over a longer period of time. Storing facilities also permit a more even distribution of the crop.

A battery of adobe potato storage—an ideal storage for the San Luis Valley

The kind of farm storage depends upon the growers’ location with reference to building materials, topography, and water table. The common type of storage in Colorado is the half-underground cellar, usually constructed of round timber and poles. It is a cheap storage when timber can be obtained from the forest reserve, and ordinary farm labor is used. In many sections, the natural soil is used for side walls with post for roof support. The two ends may be made of planks or cement. Where conditions permit, the hill-side cellar properly constructed is ideal, as the drainage is generally perfect, and the cellar itself is better protected against cold.

In San Luis Valley, where the water table is close to the surface, adobe cellars are largely used. These are built entirely
above ground, and when rightly constructed are both durable and economical. They are easily ventilated and retain an even temperature during winter.

The main thing in building a storage is to provide for adequate ventilation, and two sets of ventilators should be provided. Most potato cellars have only top ventilators. These will do little or no good unless there are one or more intakes to create a current or circulation of air. The intake should be at the base of the cellar. The bins should also have a false floor to permit a circulation of air from below through the bin. If the potatoes are piled high in the bins, perforated stacks should be placed at intervals so as thoroughly to aerate the tubers. Cellar rots or decays can, in most cases, be prevented by proper ventilation.

**CELLAR FUMIGATION**

One of the fertile sources of loss in potato storage is due to poor and disease-infested cellars. The cellar should be cleaned out and fumigated every spring after potatoes and other stored articles have been removed.

The best method of cellar fumigation is undoubtedly the formalin permanganate method. The following formula is recommended:

For every 1,000 cubic feet of cellar space use 3 pints of formaldehyde and 23 ounces of potassium permanganate. The permanganate is placed in a shallow dish or earthen vessel and the
formaldehyde solution is poured over it. The operator must leave the cellar immediately and close it up tightly to escape the fumes. If the cellar is large and requires large quantities of chemicals, several vessels or dishes should be used, placing them in different portions of the cellar so that the fumigation may be more uniform. The cellar should be left closed for 48 hours, or longer.