

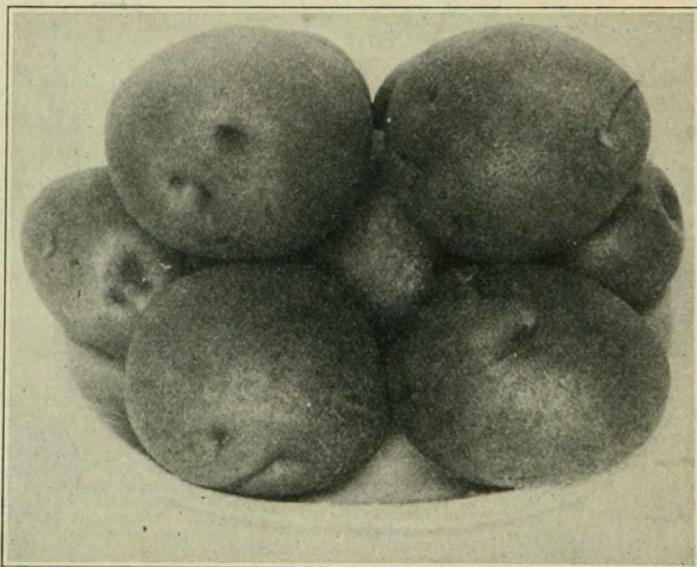
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POTATO GROWING IN COLORADO

BY
E. P. SANDSTEN



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POTATO GROWING IN COLORADO

By E. P. SANDSTEN

FOREWORD

The Horticultural Department has received numerous requests for information on the various phases of potato growing in the State. These inquiries cannot be answered fully nor adequately in personal letters, as the subject covers too extensive a field. To answer these inquiries and to furnish reliable information upon the fundamental problems of the grower, this bulletin is written.

While the information contained within is fundamentally correct for the State as a whole, local peculiarities in soil, situation, and climate may necessitate modifications in details, and the grower must meet these modifications as they occur.

The soil and climatic conditions of Colorado are admirably adapted for the growing of high quality potatoes. The development of the industry has not measured up to the possibilities. The present acreage devoted to potatoes is less than it was five years ago. This is particularly true in the Greeley district where diseases have been destructive. With better methods of farming, especially along the line of rotation, and with better seed, the outlook for the future is very encouraging. The acreage devoted to this crop in the State has varied from year to year, generally with the prices obtained. The State may be roughly divided into two general sections known as the Eastern Slope and the Western Slope with the Inter-Mountain Valleys. On the Eastern Slope the most prominent region is the Greeley district in Weld County. The acreage in this section has varied from 6,000 to 20,000 acres annually. The varieties grown are the Pearl and the Rural. These are late standard white potatoes, and have proven well adapted to the conditions in this section.

The Western Slope and the inter-mountain valleys produce a very high quality of potatoes, and these general sections bid fair to become the best potato producing regions of the United States. The soil, taken as a type, is a mellow, sandy loam which permits perfect root development, and offers no resistance to the normal growth and expansion of the tubers. With a perfect system of rotation and the plowing under of clover or alfalfa, the vigor and yield of the plants can be not only maintained, but also enormously increased. The principal varieties grown here are the Russet Burbank, Rural, Peoples, Cobbler, and Downing. In the high mountain

valleys, the Peachblow is grown to perfection, and in the San Luis Valley, Barklay's Prolific or Brown Beauty is extensively grown.

The total acreage devoted to potatoes in Colorado in 1916, was, in round numbers, 29,000, somewhat less than in 1915. The U. S. Census has in the past credited the State with as high as 70,000 acres. If these figures are correct, they show a heavy decline in the total acreage, but we are inclined to believe that the estimates were excessive to begin with.

Present indications point to a revival in potato growing, due to a better understanding of the fundamental requirements of the crop. While the acreage devoted to potatoes is less than formerly, the yield per acre is higher and the net returns to the grower, larger.

SOIL AND CLIMATIC REQUIREMENTS

The potato is naturally a North Temperate crop. The highest yield, as well as the highest quality, is obtained in the northern states and in the cool high valleys in the Mountain States. In warm climates, the potatoes suffer greatly from the summer heat and seem to be unable to produce a satisfactory crop. When grown in the South the crop must be matured before the warm summer weather sets in, and the later crop may be planted in the autumn, maturing during the fall and early winter months.

There is at least one native species of potato found in southwestern Colorado around an altitude of from 6,000 to 8,000 feet, showing conclusively that the mountain sections of Colorado are naturally better suited for the growing of this crop than are the plains sections where the summers are usually hot, and where the plants are subject to diseases occurring in these soils.

The Greeley district has been an exception to the general failure of growing potatoes on the plains, and here potato growing has been carried on ever since the district was first settled, with uniform success, up to within the last four or five years. During the last five years, considerable trouble has been experienced from the presence of diseases, which have caused great losses to the growers. The season of 1915 was very favorable to potato growing, and a normal crop was obtained. Whether this favorable turn in the industry is permanent or not, only the future can tell.

The mountain sections of the State have large acreages in mountain valleys and mesas which have ideal soil and climatic conditions for the highest development of the plant, and these areas should develop into typical potato growing sections, both for the production of seed for the Southern states, and also for high grade market potatoes. Political economy should teach our farmers to

grow those crops that are best adapted to a given section, and not endeavor to grow them where the conditions are unfavorable.

The failure in growing potatoes on the Eastern plains is due to several causes: First, the soil is too heavy and puddles badly under irrigation. This puddling and subsequent baking of the soil prevents proper aeration of the soil and prevents the normal development of tubers. Second, the day temperature during the summer months is generally too high and imparts a correspondingly high temperature to the soil. Third, potato diseases, due to unfavorable temperature and soil conditions are very prevalent and destructive. On the lighter soil, and in long rotation with alfalfa, potatoes may be grown. On virgin soil and in rotation with grain crops, potato growing should not be attempted.

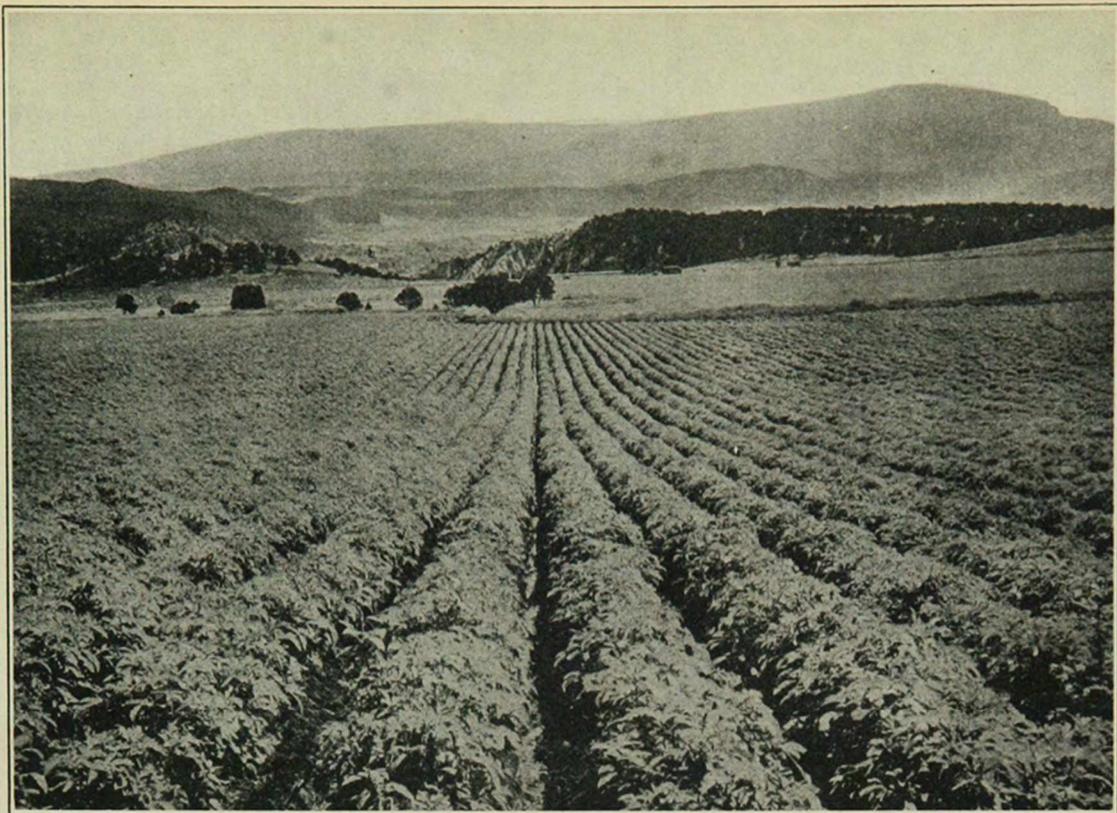
POTATOES AS A CROP IN FARM ROTATION

Many of our farmers have ruined their land by a one crop system, and many of the complaints about the failure of potato growing on a given area are due, not to unsuitable soil and climatic conditions, but rather to the presence of diseases which have been introduced thru continuous cropping of potatoes, and also to the burning out of vegetable matter in the soil, which is greatly hastened by the continued growing of cultivated crops. It is a safe rule to go by that potatoes should not be planted on the same land more than once, or, under extremely favorable conditions, twice in succession. In other words, rotation with other crops is necessary.

The potato requires an open, porous soil, perfectly drained, and rich in vegetable matter. For this reason, it fits in well with the rotation of other farm crops, and should always follow a crop of alfalfa, either immediately or the second year after. The turning under of alfalfa adds to the soil the needed fiber and improves the condition so that potatoes can develop normally. There is a tendency to grow potatoes on the same land year after year, especially if the land was originally well suited for this crop, but such practice generally brings disastrous results. It is far better to reduce the acreage of potatoes than to plant land that is not in the right condition for the production of an average crop.

In Colorado, where alfalfa is easily grown, potatoes should follow it in a five to six years rotation. The rotation system should be as follows: Potatoes first year, followed with grain and seeding alfalfa the second year; third, fourth and fifth years in alfalfa, and the sixth year, back to potatoes. On the small farm this would mean a reduced acreage, but the grower will find that the net returns would be much greater because of increased yield.

In many of the higher mountain valleys, where alfalfa cannot be grown so successfully, clover and timothy should be substituted



Showing a typical Mountain Valley potato field at Carbondale, Colorado.

and the rotation period may be shortened to four years. In this case, larger acreages may be planted to potatoes. Not only would the average yield of potatoes per acre be greatly increased, but a corresponding increase in the yield of grain per acre would be attained following a crop of potatoes.

If this system of crop rotation could be extended from six to eight, or even ten years, leaving the land in alfalfa for a longer period, even better results would be obtained. Long rotation period is only suited for large farms in combination with extensive live-stock operations.

PREPARATION OF THE LAND

The preparation of the land intended for potato growing should be thoro, as the potato develops its crop below the ground, and needs a loose, open soil so that the tubers can expand normally, and also to give the root system a chance to develop to its fullest extent. On the heavier soils, deep fall plowing is necessary, as it gives the elements a chance to act upon the land during the winter. Then again, the land should be plowed a couple of weeks before planting and kept cultivated so as to conserve the moisture stored in the soil during the winter months. When alfalfa is turned under, this may be done in the fall, but shallow plowing in this case is necessary, just deep enough to cut the crown of the alfalfa plants. Deep plowing will not kill all the alfalfa roots. The field should be cross-plowed again in the spring to the depth of eight to ten inches. Deep plowing is a very important factor in the preparation of potato land, so as to give the roots the largest possible feeding area. Where the soil conditions are favorable, the potato plant will send its roots down to the depth of three feet, while if the soil conditions are unfavorable, the root system is confined to the top soil and the food supply curtailed, and the yield will correspond with the food supply. If the spring plowing is done early, the land should be kept harrowed to keep it in fine tilth until planting time. The preparation of the land is really one of the most important factors in potato production, and unless a grower is willing to take the time and perform this work thoroly, he cannot expect a large return.

PLANTING

The depth at which potatoes should be planted varies with the character of the soil, locality and method of culture. When high hilling or ridging is practiced, the planting is shallow—about two inches below the level of the field. On heavy soil the planting may be more shallow. When low hilling is practiced, the planting should be from three to four inches deep, depending upon the character of the soil—the lighter the soil, the deeper the planting.

The time of planting necessarily depends upon the season and

whether early or late crops are wanted. It generally requires four months to grow a crop of late potatoes normally. This time may be shorter, but if shortened it is generally at the expense of quality. It is better to let the plant develop normally than first to stunt the growth and afterwards hasten it.

Planters.—There are two general types of planters on the market, and in use,—one known as the “picker” and the other as the “disk” type. Both of these types have their advocates. The picker is perhaps less accurate, as it will not always spear a seed—or it may spear the seed in the only bud or eye of that particular seed, thus causing a miss in the stand.

The disk type of machine has to be operated by two persons—one driving and one sitting behind and seeing to it that each compartment in the disk has a seed. In this way, there can be no miss, if the person behind attends to his business.

It costs more to plant a given acreage with the last mentioned type of machine, but if the seed is good and other conditions are favorable, a perfect stand may be obtained.

The importance of a perfect stand is hardly ever realized by the grower.

The average stand of hills in the potato fields in Colorado is only between 75 and 80 per cent. The losses from this neglect alone is fully 20 per cent of the total yield of the State. Practically, a perfect stand is rarely possible, tho at least a 90 per cent stand should be obtained.

SEED POTATOES

The importance of good seed is too often overlooked by potato growers, and more failures result from the planting of poor seed than from any other cause. We speak of seed potatoes in the same sense that we do of seed grains, while in reality we are not planting seed, but cuttings. The potato, itself, is an underground stem greatly enlarged, and serves as a storehouse in which food for the future plant is stored up, and this underground stem or potato is either planted whole or in pieces. The eyes of the potato are equivalent to the buds on the stem of a plant. They perform the same functions in plant economy. When potatoes are exposed to light for a considerable length of time, the green color, or chlorophyll develops.

The common method of obtaining potato seed is well known. Generally, it is the small potatoes which go thru the grader, or, in some cases, the potatoes left over in the cellar or pit at planting time that are used. These methods of obtaining seed for planting are to say the least, poor. It reverses the practice that we are following in the selection of seed grain and in the selection of breed-

ing of stock for animals. It also reverses the common practice of gardeners in taking propagating stock from the best plants, instead of taking them from the poorest.

The common complaint that potatoes "run out" is due not to the potatoes "running out" of themselves, but to the planting of tubers from the poorest hills and the poorest potatoes of good hills. When this process of selection downward has been continued for a few years, the result is disastrous to the grower, and instead of blaming himself for the result, he blames it to the "running out" of the potatoes. The potatoes do not run out—it is really the farmer who runs the potatoes out. It stands to reason that if a given variety is adapted to the soil and climatic conditions of a given section, that that variety, if proper care is taken in seed selection, will continue to give good results, and instead of showing a decrease in yield, actually show an increase. This is especially true where the soil and climatic conditions are favorable for the development of the potato plant. It is not true in sections where the soil and climatic conditions are not favorable to the plants. In these sections the importation and the planting of seed from more favorable sections is always advisable.

MATURE SEED vs. IMMATURE SEED

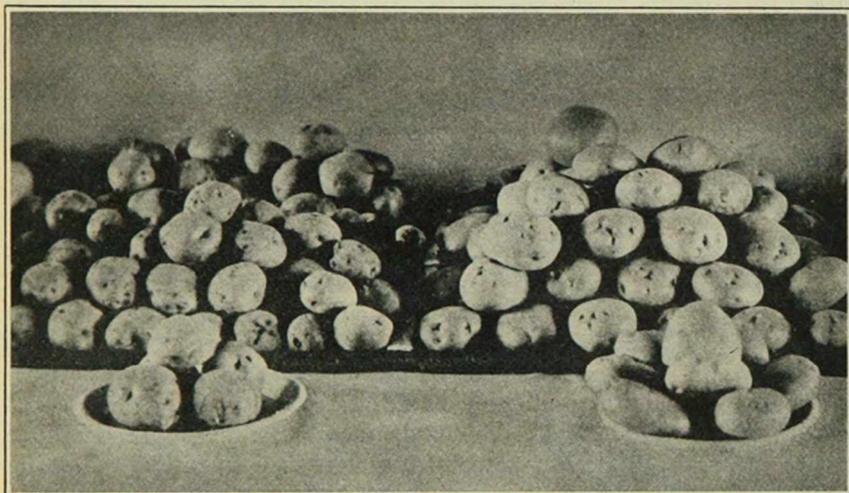
The potato being botanically an underground stem, has perhaps a greater bud activity before maturity than after. This has led many to believe that immature seed, that is, seed that has not reached its full growth, but ripened off before this has been attained, is better for seed purposes than seed that has matured in the normal way. While theoretically, the buds may be more alive or more active in partly matured potatoes, it is not true so far as the value for seed is concerned. It is true that the terminal bud and cluster of buds in the immature potato are more active than in the fully mature one, but the eyes or buds located on the stem half of the immature tubers are really less developed than on a fully mature tuber, and this is the real reason why an immature tuber has, in many instances, given better results than fully mature tubers, for seed. In other words, immature tubers planted whole will develop one strong shoot, the terminal one, while the rest of the buds or eyes may never reach the top of the soil, thus producing a strong vigorous plant with one main shoot—an ideal plant for the grower. Where such seed can be obtained, it is undoubtedly preferable to use fully mature seed.

The development of a prominent terminal bud is especially noticeable in certain varieties of potatoes, particularly potatoes of the Peachblow type, and, so far as this particular variety is concern-

ed, whole seed is preferable to cut seed, and immature seed preferable to mature seed. But where soil and climatic conditions are favorable for potato culture, this is less important, and mature seed may be used with equal success.

WHOLE SEED vs. CUT SEED

During the last few years, considerable emphasis has been placed upon the value of whole seed as against cut seed. It is undoubtedly true that in planting whole seed a better stand is obtained. Whole seed naturally has more eyes and hence capable of producing a larger number of shoots. Then, too, in planting whole seed, the terminal eye is most active and will invariably produce a strong shoot. Further, under our uncertain climatic conditions



Seed Potatoes, Peachblow Variety, from Selected Seed; Note Uniformity and Trueness to Type.

at planting time, it is sometimes difficult to obtain a good stand when cut seed is used. This is especially true in dry, poorly prepared soil, when the cut seed has a tendency to decay, resulting in a poor stand. Under such conditions, whole seed is preferable.

The spring of 1916 was very dry and warm in the Greeley district and in some cases the land was in poor state of preparation. Under these conditions, a large percentage of the cut seed rotted, and very poor stands were obtained. On the other hand, where whole seed was used, the stand of plants was normal. These facts would lead us to believe that whole seed should be used where sufficient soil moisture at planting time is uncertain. On the other hand,

where soil and moisture conditions are normal, cuttings containing one to two eyes are to be preferred above the whole seed, especially when the whole seed are small potatoes obtained from the screenings.

It is universally recognized that hills having a large number of sprouts produce a larger number of small potatoes and a fewer number of marketable potatoes than hills having one or two main sprouts. From this discussion, the question whether the grower should plant whole seed or cut seed will depend upon his local climatic conditions and upon the preparation of the land, and no exact rule can be laid down.

METHODS OF SEED SELECTION

Bin Method.—This method is commonly used by potato growers who wish to keep up the standard of a given variety without



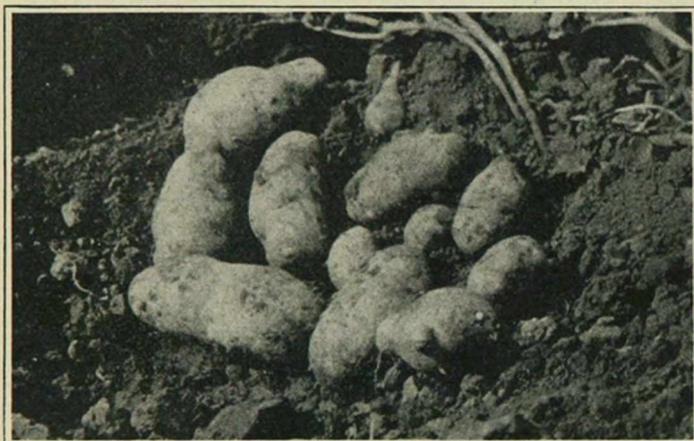
Field Demonstration in Potato Seed Plot, Carbondale, Colorado.

going to the trouble and expense connected with the more thorough method of hill selection. The essential thing to bear in mind in selecting seed potatoes from the bin is to have the correct type for the variety clearly in mind. As a rule, very few growers grow potatoes that are true to name. In most cases, the potatoes are badly mixed, and instead of one single variety, the grower generally has several, and without the knowledge of the standard and type of the different varieties he cannot hope to make an intelligent selection, but by knowing the type and color of the particular variety

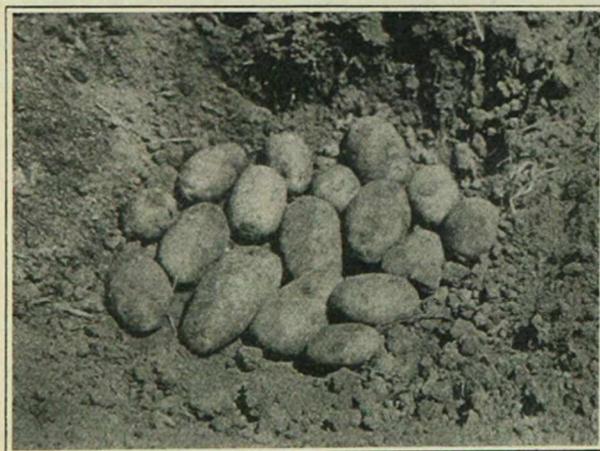
which he wishes to plant he can select from the bin. Those tubers should be selected which most closely correspond with this type.

In making the selection, medium sized potatoes should be chosen, as these will most nearly show the true type. Large, overgrown tubers, as well as small ones, should be discarded. The selection should be done early and before the potatoes have been picked over and the best ones removed. After selection, they should be kept separate until planting time.

While this method will show a noticeable increase in stand and yield above average seed potatoes, it is not a method to recommend



Poor hill and type to select from



Good hill and type to select from

for those growers who wish to make a more thoro selection and who wish to continuously improve the variety grown. For such growers, the "hill method" is recommended.

Hill Method.—As the name indicates, the selection is made in the field while the potatoes are growing. Hills which are strong and vigorous are selected and staked. At digging time, but before the main field is dug, these hills are dug by hand, and if the potatoes in the hill correspond with the vigor and growth of the vine in the number and size of tubers, they should be saved and kept separately for seed.

If a grower will select 500 hills in this manner and keep those for planting the following spring, he will have a supply of seed potatoes that should be true to type and variety and be superior in vigor and yield to any seed that he can obtain. This method necessitates the use of a seed plot which is described elsewhere in this bulletin.

In hill selection, both large and small tubers should be saved, since a small potato from an otherwise good hill is better for seed than a large tuber from a poor hill. A good potato grower should continue this method of hill selection from year to year, improving the variety both in quality and in yield.

The expense connected with this method of selection is relatively small for the benefits derived. If our growers would follow this method, they would eliminate the necessity of changing seed and the extra expenses connected with the buying of new seed every few years. It may be stated, that under favorable soil and climatic conditions potatoes can be grown continuously in rotation in a given section and will continue to improve and become better adapted to this section if proper seed selection is pursued to keep up the quality and yield of the varieties.

SEED PLOTS

Every potato grower should grow his seed potatoes separately and distinct from his general crop. It need not be a separate field, but they should be planted separately, so that the seed plot can be under special observation during the growing season. Careful watch should be kept over the seed plot and all weak growing plants and plants showing any tendency to attack from diseases should be removed at once, leaving only the best hills to mature. This is a secondary step in selection and will do much towards bringing up the high standard of the seed. Ordinarily, at the end of the first season of the field grown seed, enough should be on hand to make the entire planting from it. Then hill selection should start from this planting. In other words, in order to obtain best results, hill selection should

be practiced once every two years, so as to keep up and improve the standard in yield and in quality. This may seem an expensive practice, but since the grower has to provide seed for next season's planting, the extra trouble and cost in selecting and keeping the seed separate is small in proportion to the benefits derived. If every grower should follow this practice, we would hear less of run-out seed, and less of poor yields and diseased fields.

In planting potatoes for seed, especially if the seed is to be used for planting whole the following year, it is better to have the seed dropped from eight to ten inches apart in the rows and the rows three feet apart. This will somewhat crowd the plants and will cause them to produce a larger number of seed potatoes of relatively smaller size, that is, of a size best suited for seed purposes. It is also well to delay the planting of the seed plot until the rest of the crop is planted, in some instances, two weeks later than the main crop. The soil for the seed plot need not be better nor be given



A promising Seed Plot of Ed. Clamson, Carbondale, Colorado
Note the strong and vigorous growth of vines

better treatment than that given to the main crop. The main purpose of having a separate seed plot is to keep the behavior of the individual potato plants under close observation.

Roguing.—While the seed plot represents a definite stage in the improvement of a given variety, it does not follow that the grower should rest satisfied with the results obtained. No matter how careful the hill selection has been and how much care has been taken in preparing and planting the seed plot, there will always be a certain number of individual plants that show weakness, either along the line of disease or in lack of growth vigor. These undesirable hills should be removed during the growing season or whenever they are found. The grower should watch his seed plot and

see to it that all hills that do not come up to the standard, or to the average, are removed and destroyed. This is the most effective method of keeping up the purity of the seed, as well as the productiveness. Further, it eliminates diseased plants and those that show a predisposition to become infected. In fact, it is advisable to follow the method of roguing not only in the seed plot, but in the general field, for considerable improvement can be brought about by a system of roguing in any field of potatoes, whether grown for seed exclusively, or for the general market.

The time and effort expended on this work will be more than repaid in a higher grade of potatoes, besides eliminating diseases in the field and tubers.

CULTIVATING AND HILLING

There is no crop grown on the farm that requires better cultivation or that responds more readily to good cultivation and favorable soil conditions than potatoes. Being a tuber-producing plant, the shape and size of the tubers are adversely affected by a hard, lumpy, and poorly prepared seed-bed. The practice of preparing the soil after planting and during the growing season should be discouraged—as no amount of after-cultivation can properly prepare the land without disturbing the growing crop. Not only should the surface soil be in fine tilth, but also the soil below, to the depth of ten inches. In loose, mellow soil, the feeding roots of the potatoes will often penetrate the soil to a depth of from twenty-four to thirty-six inches.

Cultivation should start soon after planting, using an ordinary spike-toothed harrow, going over the land every few days. When the potatoes are above ground, harrowing should be continued, but the teeth of the harrow should be set slanting so as not to tear up the sprouts. This harrowing will keep the soil in fine tilth and conserve the moisture in the soil, besides keeping the field free from weeds. Ordinarily, at planting time, the soil should contain enough moisture for the potatoes to come up, without resorting to irrigation, especially if the land has been properly handled up to this time. However, there may be seasons when this is impossible, and irrigation has to be given.

Cultivation is more important than irrigation, and the grower should never substitute irrigation for cultivation. After the potatoes are up and too tall for the harrow, the cultivator should be started and kept going until the vines interfere.

Hilling.—Hilling is almost universal among potato growers in the State. This is especially true on the plains east of the mountains where this practice is possibly carried to an extreme. The prac-

tice of high hilling has grown out of the conception that the potatoes should not come into direct contact with irrigation water, but that the water should be applied from below, and thence move upward into the soil by capillarity. One might argue that it makes no difference whether the tubers get moisture from below or from the side, so long as they are not in contact with the free water.

The writer is inclined to believe that less hilling or lower ridges is preferable to the high ones, as high ridges invariably raise the soil temperature around the tubers to several degrees above that of level soil, thus creating a condition that is not the most favorable for the normal development of the plant. This is especially true of the Eastern Slope where the summer days are hot and the soil temperature becomes correspondingly high. In the mountain sections, the grower does not hill his potatoes to the extent done on the Eastern Slope, yet no one would question that the results obtained by those growers are less satisfactory than those obtained on the Eastern Slope.

In the Greeley section, high hilling is almost universally practiced, and is looked upon as essential to success. While high hilling may be successful during certain seasons, it is also true that during a warm, dry season, lower ridges would tend to keep the soil temperature lower and thus furnish better conditions for the potato plant.

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 tho 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 universally the 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 thruout the period.

In irrigating potatoes, it is much better to apply enough water to thoroly 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. Also, 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.

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," generally 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 unduly forcing the plants makes them more susceptible to disease attack.

HARVESTING

For the main crop, harvesting should not be done until the vines are dead and the skin of the tubers hardened or ripe, so as to stand the necessary handling before reaching the consumer. If the skin is not hard, it will peel and bruise, and wherever the bruises occur, there will be dark areas which have to be pared away before the potato can be consumed as food. The keeping qualities, too, are greatly impaired from immaturity, as the bruised areas invite the attack of fungi, causing decay.

If the vines are still alive and growing when frost occurs, the potatoes in the ground at this time are necessarily in the growing stage and are not fit for harvesting. They should be left in the ground as long as possible, so as to give the tubers a chance to ripen. The digging should be done when the weather conditions are most favorable and the soil is not water-logged. It is advisable to leave the potatoes on top of the ground for two or three hours to permit them to dry off before they are sacked. Where the potatoes are placed in cellars, the importance of field curing cannot be over-emphasized, as a considerable portion of the losses occurring in storage is due to poor grading and to imperfectly dried potatoes when placed in storage. Whether sold directly from the field or

placed in storage, the small and bruised potatoes should be eliminated.

In digging the potatoes, enough horse-power should be utilized so that the digger will get under the hills—otherwise, many potatoes will be cut and spoiled. It is much more economical to use an extra horse, or even two, so as to be able to have the machine go to the required depth. The extra cost is more than repaid, first, in getting all the potatoes out of the ground, and second, in eliminating cut or bruised tubers which cannot be sold. Practically all of the potato digging machinery now on the market is satisfactory, if properly used. We do not recommend any particular make over others.

GRADING (STANDARDIZATION)

Less attention has been paid to the grading and standardizing of potatoes than any other agricultural crop. Most of the agricultural products are bought and sold on grades or standards, while in the case of potatoes, each grower seems to establish his own standard, and, as a consequence, the purchaser does not know what he is getting until he has an opportunity of inspecting his purchase. There is more waste in this crop than any other grown on the farm, and this waste could be entirely prevented by the grower. It has been estimated that from 15% to 20% of the total potato crop placed on the market is below commercial standards and should never have left the farm. This would mean that out of the total yield of 350,000,000 bushels in America, 15%, or 52,500,000 bushels are virtually thrown away. Besides this waste, the grower, in addition, is paying for containers, railroad freight, and hauling and cost of marketing in handling these 52,500,000 bushels, and finally, he is lowering the actual value of the whole crop, by selling inferior products. It is a great economic loss, since this 15% is not utilized for any purpose, but is thrown away by the consumers, while if left on the farm it could be utilized as a food for livestock. There should be a standard grade or grades of potatoes the same as we have standard grades for the grains, and the crop should be priced on these standards. In order to accomplish this, the grower must pay more attention to the grading side of his work. At present, most of the potatoes are graded in the field, being run over a grading machine. The machine, under the best conditions, will not grade the potatoes properly, but under the conditions that the grading is done in order to follow up the digger, the potatoes are poured over the grader and only a small proportion of the undersized potatoes are taken out. More than half of the small tubers go into the sacks, together with gnarly, cut, and diseased tubers.

In some instances, the grower, in order to swell the total yield per acre will go to the trouble of stretching gunny sacks over the grader so as to prevent any of the smaller potatoes from getting thru. In such cases, it would be more economical if the grading were entirely dispensed with.

The potatoes should be graded at least into two sizes—from four to twelve ounces, and from twelve ounces up. This would not mean that the potatoes would have to be weighed individually any more than in grading apples, but it would produce a uniform product, so that the buyer would know what he was getting, and the consumer would not have to buy small potatoes and earth with the marketable tubers. The extra cost for grading would be more than compensated for by the higher prices obtained, and in the utilization of inferior potatoes as food on the farm.

There are commercial graders of the improved type now on the market, and should be utilized by the grower. The only way to obtain uniformity in grading and packing would be to have a community grader where all potatoes in a community could be graded at one place before being loaded on board a car. By such method, the whole crop could be taken from the field and hauled to the grader, and run thru the same, returning to the grower the inferior product to be taken back to the farm for feeding purposes. In most cases, the community grader should be located at the loading station.

So long as grading is left to the individual grower, so long will the present confusion and disorganization exist, and so long will the grower obtain a lower price for his product. There are a great number of instances that have come under our observation where buyers have re-sorted or re-graded the crop bought from the grower and sold them at a higher price—more than paying for the cost of grading and the loss in weight.

The question of uniform packages is also important. There is no reason why a sack of potatoes should not have a standard weight, either 100 or 120 pounds. This would eliminate considerable trouble and make it easier to keep track of sales, as each sack or each container would weigh the same.

The question of using boxes as containers for potatoes has been agitated and met with more or less favor. Personally, we believe in the box as a package for potatoes, especially if special grades are put up in this way. The potatoes will suffer less in handling, and besides, would provide a convenient package for the small household to buy. But the box is not the proper package for the average grower under the present conditions, as the potatoes, in some cases, would not be worth more than the box. Where the

box has been used to put up high grade potatoes for fancy trade, it has been a success.

One of the aims of the Colorado State Potato Growers' Association is to establish standard grades and containers so that the buyers will know what they are buying. The importance of the potato crop as a universal human food makes it all the more necessary that it should be marketed and sold under certain required standards.

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 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 the 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.

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 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.

QUALITY OF COLORADO POTATOES

It is generally understood that quality in potatoes is gauged on the character of the cooked product. Mealiness and uniformity in cooking being the two important points. Mealiness is more or

less associated with the starch content of the tubers, and the amount of starch present in turn dependent upon soil and climatic conditions, especially those of rainfall.

From determinations made of Colorado potatoes and those grown in other states, it would seem to indicate that the Colorado potatoes have a higher starch content, and hence should have better quality, tho this may not always be true, as quality may, to a large degree, be determined by local conditions during the growing season. Too much rain or too much water in irrigation will invariably produce a soggy potato, and hence a potato of low quality.

The climatic conditions of Colorado are eminently adapted to the production of high quality potatoes if proper precautions are taken in the use of irrigation water. Records show conclusively that over-irrigation here is just as harmful against the production of high quality of potatoes as an excessively rainy season is in the Eastern states, and that the Colorado grower may, and sometimes does, produce potatoes of inferior quality.

DEGENERACY OF POTATOES

During the last few years, a considerable amount of investigational work has been done to determine what factors are responsible for the general decline of a given variety in a given locality. These experiments seem to agree that the different varieties as generally grown in a section do show a decline in productiveness and in type. This degeneracy or decline was not confined to any particular variety, nor to fields where poor seed was used in planting. In many cases degenerate hills were found in fields that were planted to the best seed obtainable. This seems to indicate that the potato is more or less variable even under the best conditions, and calls for a greater care in selecting seed, especially in the selection of hills for future seed production.

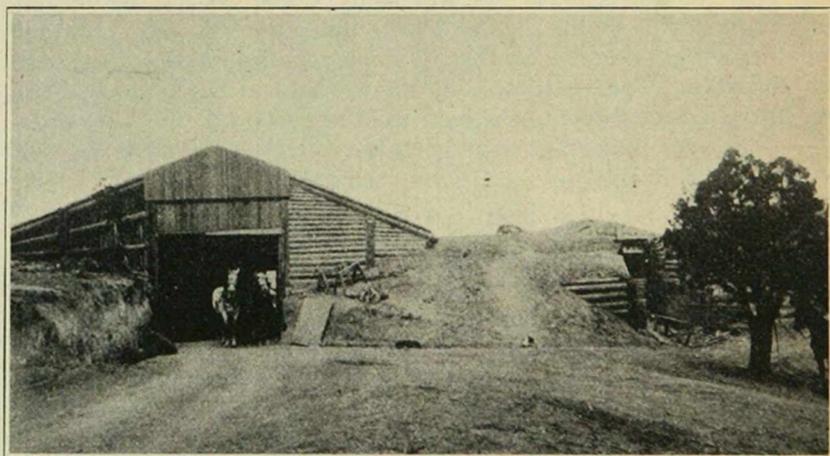
This universal tendency towards degeneracy or decline may possibly be due to a physiological condition inherent with the potatoes. The fact that the tuber is a highly specialized part of the plant and one that has developed by repeated selection and breeding, and further, its development being dependent upon factors of soil and climate, would make the question of retaining a permanent type of a given variety difficult, and by the very nature of the plant, variable. This undoubtedly being a fact, the question of careful selection by the hill method becomes more important, if we are to retain the essential qualities we wish to perpetuate. A given variety cannot be made to retain its desirable qualities without constant care in selection and cultural methods.

STORAGE

Pits and Cellars.—Pits are not utilized in the West to the extent that they are in the East. Many of our potato growers have now regular cellars for storage which fulfill all the requirements. Storage cellars are really necessary structures in connection with potato growing, as they enable the growers to avail themselves of higher prices which usually follow harvest time. Where potatoes are grown on a smaller scale, the pit can be utilized without any material loss of the crop. In fact, potatoes stored in pits properly made are as good, or better, in the spring than potatoes stored in cellars.

The following method of pit construction has been employed by the writer, with complete success:

Level off a piece of ground of sufficient size to hold the potatoes intended for storage, then excavate to the depth of four inches, and



An Up-to-date Potato Cellar; Capacity 25,000 bushels; at Carbondale, Colorado.

use the earth taken from the excavation as sides, that is, heap the dirt up along the edges of the cleared space. This cleared space should then be firmed down and the potatoes piled into this area. A convenient size for the pit is ten feet in width, making it any length needed. The ten feet should measure from embankment to embankment.

The potatoes should be piled up in the shape of a pyramid, or like the roof of a house, making the pitch to the sides as steep as possible, and yet keep the potatoes in place.

It is necessary to do a little hand work in finishing off the sides after the potatoes have been dumped into the pit.

When the potatoes are in proper position, they should be covered with a layer of clean, dry straw, or clean, dry marsh hay, not less than two feet in thickness, and just enough earth put on the same to hold the straw in position. In some cases, it is advisable to use poles or rafters to hold the straw down, instead of earth. The pit should be left in this condition until cold weather sets in. The straw is sufficient to keep out ordinary frost, and it will keep the pile ventilated and permit surplus moisture to escape. As cold weather approaches, a thin layer of earth is added. Every three or four feet at the apex of the pile, openings in the earth should be left to permit moisture to escape. It is also advisable to keep openings at the base of the pit, but these openings should be covered with straw so that the frost will not get in, and before winter arrives, more earth covering should be applied, the amount depending upon the severity of the weather. When regular winter sets in, more earth should be added to the covering. If very cold weather should occur, a coating of stable manure on top of the earth is advisable. The ventilators at the top and at the bottom should be entirely closed during the cold weather.

It is very important that the potatoes be dry and free from rot when stored in pits.

VARIETIES OF POTATOES

In a State like Colorado where the soil, altitude and climatic conditions are so varied, the choice of varieties to plant becomes, to a great extent, a local question.

In the Greeley section, the Pearl and the Rural are grown almost exclusively for the main crop and the Early Ohio for the early crop. The rural variety is better adapted to the heavy soils and to plains conditions than the Pearl. The latter is inclined to grow rough and ill-shaped on heavy soil, while on lighter or loamy soils, the Pearl is preferred.

In the San Luis Valley the Barklay's Prolific, Russet Burbank, Rural and Pearl are the leading varieties. Barklay's Prolific is grown most extensively and is admirably adapted to this section. It is a heavy yielder, is of excellent cooking qualities, and stands shipment better than almost any other variety grown. It will be more extensively planted in the future than in the past. This variety is not true white, but has a golden brownish tint that does not in any way detract from its salability. Barklay's Prolific is probably only a local name. Early varieties are not grown to any extent in this section, due to late spring frosts. The Irish Cobbler is admirably adapted and is grown to a limited extent. The Triumph

has also been grown to a very small extent and indications are that this variety will do well. The San Luis Valley has a future before it as a seed-growing center for Southern trade. Cobbler and Triumph for this trade always bring a high price and are in great demand.

In the Carbondale and Eagle River district, Peachblow, Russet Burbank, Rural and the Peoples are the late varieties grown extensively. The Peachblow reaches its highest perfection in this section and is grown extensively. There is some objection to a colored potato for the main crop as the market is somewhat limited, especially for markets outside of the State. On this account, the acreage planted with this variety is on the decline. Irish Cobblers are grown for an early crop.

Grand River Valley, Gunnison and Uncompahgre Valleys devote a large acreage to early potatoes. The varieties grown are the Irish Cobbler, Downing, and Early Ohio. Late varieties are the Pearl, Russet Burbank, and Rural.

In the Northwestern section the main attention is paid to medium early varieties, due to the shortness of the growing season. Russet Burbank and Pearl are the leading varieties. Few, if any, early varieties are grown in this section.

It will be noticed from the above discussion that relatively few varieties are grown in commercial quantities in the State. This is an encouraging condition, as it eliminates a mixture which is undesirable in commercial shipments. It also aids in keeping the varieties true to name so that a definite standard can be obtained for each section.

While a number of other varieties have been tried in different sections of the State, our growers realize that by paying attention to proper seed selection, a satisfactory yield can be obtained from year to year without introducing new varieties. There is a considerable difference in the adaptability of different varieties to different types of soil. For example, it is not advisable to grow the Russet Burbank on heavy soils, nor on soil that is extremely fertile. For, under such conditions, this variety produces over-grown and ill-shaped tubers which are not desirable, while on light, mellow, and moderately fertile soil it is very satisfactory.

Farmers who expect to grow a large acreage in any of our potato growing sections should make careful inquiries as to varieties and the type of soil on which they are grown, so as to eliminate losses from growing varieties ill-suited to the locality.

POTATO DISEASES

Late Blight.—This disease so destructive in the East does not occur in Colorado. At least it has done no damage so far as we know.

Early Blight.—It occurs in the State, and, under favorable conditions, does considerable damage. The favorable conditions are, high temperature accompanied with high humidity. The disease generally occurs late in July and early in August, and is easily distinguishable by dark brown patches and rings on the foliage. In extreme cases, the whole foliage of the plant becomes affected and may drop off and kill the plant so far as future growth is concerned. This greatly reduces the yield, as the potatoes do not have time to develop to their normal size. So far as we know, the disease is confined to the foliage in this State and does not seem to attack the tubers.

Spraying with Bordeaux Mixture before the disease appears will, if thoroly done, prevent its appearance, but after the disease has once gotten a foothold and becomes distributed over the field, the application of Bordeaux will not eradicate it. Bordeaux Mixture is not a cure, but a preventative. Due to the fact that Early Blight does not occur annually, but only during favorable seasons, our growers, as a rule, do not spray to insure their crop against losses from this trouble, tho yearly application of Bordeaux to the potato vines would insure against its appearance and the losses caused by it.

Fusarium Disease.—This disease is found in every potato growing section of the State and is the most destructive disease with which the potato grower has to deal. The disease is favored by high temperature, moisture and poor soil drainage. In heavy adobe soil, the disease appears to be particularly bad. It is introduced into the soil either by a previous crop, or thru diseased seed potatoes. The fact that the disease may remain in the soil for more than one year makes the subject of rotation important to the potato grower, and it is one of the reasons why we advocate growing potatoes only one year on the same piece of land without the intervention of other crops.

The most common way of dissemination of this disease is by the seed. The grower can easily ascertain for himself whether the seed potatoes are free from *Fusarium* or not by cutting off a thin slice at the stem end. (See figure 8.) If the meat on the cut surface of the tuber shows a dark circle extending around it, this indicates the presence of the disease, and such seed should not be planted, as it will work its way thru the seed potato up to the stem and

destroy the whole plant. Such seed may be used for feeding animals, but should under no circumstances be planted.

There is no known remedy that is effective against this disease; only precautionary measures can be taken, such as rotation of the crop and the planting of seed free from the disease.

The appearance of the disease in the field is, in some cases, almost identical with 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 is also attacked, and if a cross-section is made of the stem close to the ground, dark areas will be found in the bundle or fiber portion of the stem. These dark areas indicate the presence of the disease, and greatly interfere with the transportation of food materials up and down these fibers or vessels in the stem. It is also maintained that the curling of the leaves sometimes present in many of our potato fields is caused directly or indirectly by the same fungus. Undoubtedly other factors contribute to the presence of the trouble known as the "Curly Leaf Disease."

Rhizoctonia.—This disease is present in practically all of our cultivated fields, and under favorable conditions will do considerable damage to the crop. The presence of the disease on the vines can be distinguished by dry rot or lesions that occur at the base of the stem from the ground upward. In some cases these lesions or wounds extend around the whole stem and completely shut off the food supply. In other cases, the disease attacks only one side of the stem and does not completely cut off the supply of food to the roots, but curtails the food supply and lessens the production of tubers. The disease may occasionally be found on the potatoes in the form of black spots or wart-like growths all over the skin. (See figure No. 9.) These little areas vary in size from a pin-head to the size of a dime. They are black and corky in structure and are known as sclerotia. These structures carry the spores over from year to year and reinfest the crop. A careful examination of potato fields in the State this year show that this disease is very prevalent. In one section of the State the writer was unable to find a single tuber that did not have some sclerotia present on it. This disease seems to thrive on dry land as well as on that which is irrigated, but seldom develops to a dangerous point on the dry lands.

The disease can be controlled, so far as disseminating it from diseased tubers is concerned, by means of disinfection. The most effective method is a corrosive sublimate treatment, using 4 ounces of corrosive sublimate in 30 gallons of water. The solution may be made up in a barrel and the potatoes placed in a gunny

sack and kept suspended in the solution for from an hour and a half to two hours. This solution will penetrate the sclerotia and kill the spores, after which the seed can be planted with safety, so far as this disease is concerned. The potatoes treated cannot be used for feeding livestock, as the solution is exceedingly poisonous. The solution may be used three to four times, after which a new mixture should be made.

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 the *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 fifty gallons. The barrel should contain about thirty 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.

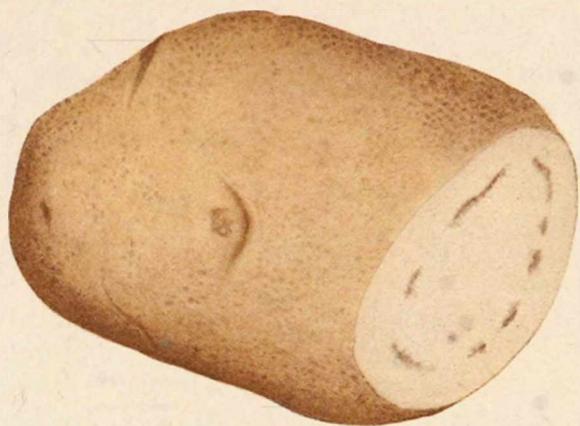
Numerous complaints have been received that the scab has occurred in some fields in spite of treatment, and often when clean seed has been used. In such cases the presence of the scab fungus is undoubtedly due to the feeding of cattle on the field the season before planting. This disease propagates very 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.

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, 3 pints of formaldehyde and 23 ounces of potassium permanganate. The permanga-



FUSARIUM DISEASE



RHIZOCTONIA DISEASE

nate 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.

ACKNOWLEDGMENT

The writer wishes to thank Mr. Lou D. Sweet, of Denver, for the loan of several of the illustrations in this bulletin.

AVAILABLE BULLETINS

Any of the following bulletins will be sent free to those who request them so long as the supply lasts. C. P. GILLETTE, Director.

- No.
- 150 Measurement and Division of Water, by L. G. Carpenter.
- 183 Deterioration in Quality of Sugar Beets Due to Nitrates Formed in the Soil, by Wm. P. Headden.
- 189 Cost of Beef Production on Enclosed Range, by G. E. Morton.
- 190 Variation Studies in Brome Grass, by Alvin Kezer.
- 192 Home-made Cider Vinegar, by W. G. Sackett.
- 193 Nitrifying Efficiency of Certain Colorado Soils, by W. G. Sackett.
- 194 Frictional Resistance in Artificial Waterways, by V. M. Cone.
- 195 Small Fruits for Colorado, by E. P. Sandsten.
- 196 Some Soil Changes Produced by Micro-organisms, by W. G. Sackett.
- 198 The Onion in Colorado, by E. R. Bennett.
- 199 Vegetable Growing in Colorado; Hot Beds and Cold Frames; Common Insects of the Garden, by R. A. McGinty and C. P. Gillette.
- 200 Silos and Silage in Colorado, by H. E. Dvorachek.
- 201 Some Colorado Mushrooms, by B. O. Longyear.
- 202 Testing and Handling of Milk and Cream, by Roud McCann.
- 203 Costs on the Colorado Agricultural College Farm, by Alvin Kezer.
- 205 Yellow-berry in Wheat, by Wm. P. Headden.
- 206 Spur Blight of the Red Rasperry Caused by *Sphaerella rubina*, by W. G. Sackett.
- 208 A Study of Colorado Wheat, Part I, by Wm. P. Headden.
- 209 Irrigated Agriculture in the San Luis Valley, by V. M. Cone and A. Kezer.
- 210 Insects and Insecticides, by C. P. Gillette and G. M. List.
- 211 Colorado Plants Injurious to Live Stock, by Geo. H. Glover and W. W. Robbins.
- 213 Poultry Raising in Colorado, by W. E. Vaplon.
- 214 Forage Crops for Colorado Plains, by Alvin Kezer.
- 216 Studies of Health in Potatoes, by C. L. Fitch.
- 217 A Study of Colorado Wheat, Part II, by Wm. P. Headden.
- 218 A Bacterial Stem Blight of Field and Garden Peas, by W. G. Sackett.
- 219 Study of Colorado Wheat, Part III, by Wm. P. Headden.
- 220 Potato Growing in Colorado, by E. P. Sandsten.
- 221 Hot Beds and Cold Frames, by T. F. Limbocker.
- 222 Forcing of Strawberries Under Glass, by Florence I. Kinnison.
- 223 A Fruit Survey of Mesa County, by E. P. Sandsten.
- 224 Native Vegetation of Colorado in Their Relation to Agriculture, by W. W. Robbins.