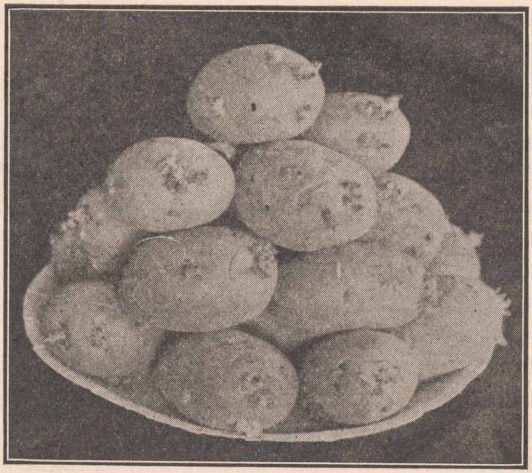
Idaho
AGRICULTURAL
Experiment Station

POTATO CULTURE



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IDAHO EXPERIMENT STATION

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The regular bulletins of this station are sent free to persons residing in Idaho who request them.

INTRODUCTION.

BY W. L. CARLYLE.

The potato has been one of the leading crops in Idaho for several years, and should continue one of the most profitable crops in the future. The statistical report for 1912 shows the production of 6,475,000 bushels and for 1913 the production of 5,780,000 bushels. There appears to be no good reason why the production of potatoes in Idaho should not be greatly increased. This is particularly true of the northern part of the state. There are large areas of land within this section that would produce large yields of potatoes of excellent quality, and there is a possibility of developing a splendid demand for the potatoes grown in this section for seed supplies in the irrigated regions. Idaho potatoes are quoted as such in all of the eastern markets where the demand is strong, and it remains for the farmers of this state to supply the constantly increasing demand for this crop. The wide variation in types of soil and the extremes of climate due to the influence of altitude, rain-fall, forests, lakes, etc., are so great within the state that successful practice in potato growing in any given section must of necessity be greatly modified from the practice in each of the other sections. For this reason the state has been divided into three sections for the studies in potato production, namely: The Northern Section, including the Palouse, Clearwater, Camas Prairie and the timbered regions; the Irrigated Section, including all that portion of South Idaho where irrigation is practiced; and the Dry-Farm Section, which includes large areas particularly in southeastern Idaho where irrigation cannot be practiced and where the precipitation is less than 20 inches per annum. Conditions governing the production of potatoes, as well as other crops, are widely different in these three sections, and methods of cultivation especially must vary greatly.

The potato is not a crop that requires exacting climatic conditions. It can be grown under almost any conditions which will

produce a small grain crop. The time required to mature the crop varies with the variety, but there are few areas within the state which have too short a growing season for successful culture. The water requirements are also very similar to those of the small grain crops. Judicious cultivation and consequent conservation of moisture will in years of normal precipitation in northern Idaho obviate any difficulty from the moisture standpoint. Late spring and early fall frosts cannot be controlled but care in the selection of the field with reference to the air drainage will aid greatly in this respect.

POTATO CULTURE FOR NORTHERN IDAHO.

BY F. L. KENNARD.

The ideal soil for the crop is a sandy loam. Any soil, however, which is reasonably friable will produce good yields and good quality. Heavy clay soils which are subject to baking and running together will not grow potatoes successfully. Such soils can in a measure be improved by the use of barnyard manure or any organic material plowed under and incorporated in them. North Idaho, however, is practically free from such soils. Only in restricted areas are they found and it is a fact that the addition of organic matter will improve them for any of the other farm crops. The North Idaho soils are well adapted to potato growing. While not sandy, they are exceptionally friable when handled right. It is merely a matter of good judgment as to the implements and the time of using them to prepare the soil to maintain it in ideal condition.

PREPARATION OF THE SEED BED.

While the general practice in North Idaho is to spring-plow for the potato crop, it is found from experiments carried on at the Central Station at Moscow, that an additional plowing in the early fall preceding is better. The object is two-fold. Stubble land, if left from the time of harvest until the following spring, becomes very firm and even packed or run together so that chemical and bacterial action are to a great extent suspended, principally through lack of air; aside from this there is some danger of loss of moisture through run-off and evaporation from the hard, smooth surface found after a crop of grain has been grown and harvested.

The best procedure is to thoroughly disk as soon as the grain crop has been removed from the field. This breaks up the crust and produces a mulch two or three inches deep which aids materially in absorbing and retaining the early fall rains. It also

covers most of the wild oat and other noxious weed seeds which may be present and many of them will germinate and will be killed by the plowing later in the fall. This mulch will make the plowing much easier and it will be found that the land thus treated will be in much better physical condition and will be in a condition to plow earlier than that not so handled.

The fall plowing need not be deep—six to seven inches is sufficient. The land may be harrowed each day as the plowing is done, or it may be left rough. Much depends upon the date. If rains come early so that it can be done in September or early October it is advisable to harrow, so as to check excessive evaporation. If plowing is done late in the season there is nothing to be gained by harrowing.

As early the following spring as moisture and soil permit this land should be double disked. The object is the same as in the fall disking. The crust should be broken to prevent evaporation and to admit heat and air to the soil. Foul weed seeds will germinate and bacterial and chemical activities will be quickened. Any crust that may form before the plowing is done may be broken with a harrow.

The spring plowing should be done any time before May first. This should be at least eight inches deep and the subsurface packed. An expensive packer is not necessary. The double disk, if weighted and run nearly straight, will do excellent work. A spike-toothed harrow should follow and if necessary double it so that the surface is left free from lumps. Both these operations should be done the same day the land is plowed so that no clods form. Clods once formed are very hard to pulverize and they can be avoided if the disk and harrow is run over each day's plowing before leaving the field. The harrow should be used as often as a crust forms until planting and once or twice after, depending upon the number of rains of sufficient amounts to form a crust. The harrow can be used after the plants are three to five inches tall, if care and judgment are exercised. This is one of the cheapest ways of cultivation and is very effective both from the mulch and weed standpoint.

VARIETIES FOR NORTH IDAHO.

Only two years' tests have been made at this station and the results given below are not to be taken as conclusive. They are given for the reason that so many inquiries are made as to the varieties to grow. For better comparison, the varieties have been grouped as early and late. They are arranged in the order of average yield of marketable tubers for the years 1912 and 1913.

TABLE I.

Early Varieties	1912				1913				
Name of Variety	Total Yield per Acre	Yield of Culls per Acre	Yield Marketable Tubers per Acre	Per cent Marketable	Total Yield per Acre	Yield Culls per Acre	Yield Marketable Tubers per Acre	Per cent Marketable	Avr. Marketable for 1912 and 1913.
	Lbs.	Lbs.	Lbs.		Lbs.	Lbs.	Lbs.		Lbs.
Early Rose	14,892	2,143	12,749	93	11,400	4,000	7,470	65	10,110
Early Ohio	11,996	3,214	8,782	73	10,700	3,400	7,380	69	8,081
Peachblow	11,068	2,214	8,854	81	8,700	3,500	5,260	50	7,057
Earliest of All	8,937	1,429	7,508	78	10,600	4,700	5,970	56	6,739

From the table it will be seen that, in point of yield, the Early Rose is easily the best of the four early varieties grown. The Early Ohio, second in yield, is perhaps the better of the two as it is slightly earlier and this is essential in an early type. The earlier it can be put on the market the greater the profits. It must be borne in mind that these potatoes were dug at maturity and not at the early market stage.

TABLE II.

Late Varieties	1912				1913				
Name of Variety	Total Yield per Acre	Yield of Culls per Acre.	Yield Marketable Tubers per Acre.	Per cent Marketable	Total Yield per Acre	Yield Culls per Acre.	Yield Marketable Tubers per Acre	Per cent Marketable	Avr. Marketable for 1912 and 1913
	Lbs.	Lbs.	Lbs.		Lbs.	Lbs.	Lbs.		Lbs.
Delmany Beauty	23,209	3,215	19,994	86	11,600	4,200	7,470	64	13,732
Mortgage Lifter	18,400	2,426	15,974	87	15,500	4,700	10,810	69	13,393
Pride of Multnomah	16,530	1,790	14,740	89	12,000	3,500	8,560	62	11.650
Rural New Yorker	16,587	1,926	14,661	89	11,700	4,500	7,230	62	10,945
Netted Gem	13,210	2,000	11,210	85	10,900	2,700	8,240	75	9,725
Gold Coin	12,770	2,500	10,270	82	10,500	3,000	7,520	71	8,895
Delmany Challenge	12,423	3,215	9,208	73	8,700	4,000	4,760	54	6,984
Burbank	11,280	3,214	8,066	78	9.400	4,400	5,020	53	6.543

Of the above late varieties the Rural New Yorker, the Mortgage Lifter, Gold Coin and Netted Gems are to be preferred. The Delmany Beauty on account of the color of the skin and the keeping qualities is not an ideal market variety. The Pride of Multnomah while third in yield has not proven a satisfactory potato here. It has a great tendency toward irregular shapes and deep eyes.

The Rural New Yorker is very similar, if not identical, with the Rural of South Idaho. It is an excellent keeper and cooker, has oval shape, shallow eyes and white skin.

The Mortgage Lifter is somewhat similar in shape and general characteristics, but has a slightly rougher and darker skin and is not quite so much flattened. It is also an excellent table variety and a good keeper.

The Gold Coin was slightly disappointing in its yield. It is widely grown in North Idaho and as a general rule is considered good. It has the oval to round, slightly flattened shape, white, slightly netted skin and shallow eyes, good keeper and fair table tuber. It has a tendency toward breaking to pieces when boiled. As a baker it is excellent.

The Netted Gem, otherwise known as the English Russet and Russet Burbank, has also been slightly below expectations in the matter of yield. The seed was introduced from the Yakima country and it is hoped that it will become acclimated and prove a better yielder in the future. The skin is russet in color and has the netted appearance from which it gets its name. It is a long or Burbank type, has shallow eyes, and is without doubt the best table potato produced in North Idaho.

These tests were started for the purpose of finding the best potato for North Idaho conditions, both from the point of yield and market demands. It is hoped that at the end of from three to five years this purpose will have been fulfilled and that we can then recommend one or at most two late types to the farmers and be able to do this so strongly that all other local varieties will be discarded. So long as a dozen or more varieties are grown in a locality, the question of marketing will be a serious one. What must eventually be done is to grow not more than two types and preferably only one and grow it to such excellence and in such quantities as to attract outside buyers. Such

buyers will never be attracted to a locality where there is known to be many varieties grown. He cannot afford to waste his time trying to pick up carlots of pure varieties.

From the foregoing table two types are to be recommended. For the round or oval type, the Rural New Yorker or Gold Coin, and for the long type, the Netted Gem. This work, as previously stated, should not be taken as conclusive by any means. As an example the Rural New Yorker out-yielded the Gem practically 35 sacks in 1912 and the Gem out-yielded the New Yorker by 10 sacks in 1913. It was to clear up this apparent discrepancy that the statement relative to acclimatization of the Gem was made.

SEED SELECTION.

The matter of seed selection has to a great extent been neglected. The potato responds as quickly to selection as any farm crop. The fact that "like tends to produce like" should not be lost sight of in the improvement of the potato crop. When culls or unmarketable potatoes are used for seed, even though the ones selected approach the ideal as to shape and size for planting, it should be borne in mind that some hills contain 90 per cent marketable and that others contain but 50 per cent marketable tubers, the balance in one case 10 per cent, in the other 50 per cent being culls or unmarketable, go into the seed bin. In other words, sixteen and two-thirds per cent of the seed tubers come from high producing hills and eighty-three and one-third per cent come from low producing hills. The farmer is not especially interested in producing potatoes too small for market and yet by the above described method of selection he is imposing just those conditions which should produce a crop with a large per cent of culls and a corresponding low per cent of marketable tubers. Only favorable soil and climatic conditions produce the opposite result.

There is only one certain, yet simple way of improvement. This is the hill selection method. By this method is meant the selection of seed from hills which have proven themselves capable of producing high yields of salable tubers, and which have proven themselves also resistant to any disease which may be in the

locality. It is not intended that the farmer should select the seed for his entire crop in this way. What is recommended, however, is that he go into his field before the crop is entirely mature and dig enough seed to plant one or two acres from vigorous plants, with a large percentage of salable tubers that are true to type and conform with the market demands of that variety. These should be planted separately in what may be called the seed plat. The following fall repeat the selection but this time and in the future make the hill selection from the seed plat. The balance of the plat is to be used as seed for the main crop each year. An effort should also be made to remove any plants which show a tendency toward weakness or low vitality. This prevents the introduction into the main crop of seed which shows a weakness of any kind and which would be almost certain to produce weak plants and low yields in the main crop. It means but little labor and the exercise of good common sense and judgment. The results of a few years of such selection will not only increase the yield, but will fix the type and very materially improve the quality from a market standpoint.

The investigation of Waid of the Ohio Station brought out the following yields per 100 hills:

High yielding seed	138 lbs.
Unselected seed	110 "
Low yielding seed	73 "

The gain in favor of the high yielding plants over the unselected and low yielding seed was 25.4 and 89 per cent respectively.

In a similar test carried on at Moscow the hill selected seed produced an average of ten sacks per acre over the unselected seed. In this case, however, the same sized tubers were used and they were cut to the same size seed piece as shown in the following table:

	Wt. Tubers	*Wt. Seed Piece*	*Yield*
Hill selected seed	11 oz.	1.7 oz.	7,200 lbs.
Bulk selected seed	11 oz.	1.7 oz.	6,200 lbs.

The weight of culls or unmarketable potatoes was the same in each case. Other results could be cited, but they all point to the same effect of the selection on the succeeding crop or crops.

Much data has been collected relative to the whole and cut seed. To a great extent results are conflicting, much depending upon the grade of seed used. If, as stated above, the seed is graded from the culls of the general crop the tendency will be toward producing a high per cent of unsalable tubers. If large seed is selected in the same way and cut to the same size seed-piece, it would be expected that a higher per cent of salable tubers would be produced for reasons previously stated.

The conclusions reached after going over the results of various experiment stations is that the size of the seed-piece has a greater influence on the production than the fact that it is cut or uncut. Within limits, the larger the seed-piece, the higher the yield, the ideal size for North Idaho being one and one-half to two inches in diameter and weighing from two to two and one-half ounces. Whether or not the seed be cut will depend upon local conditions. If disease is prevalent then whole seed should be used as the cut surface of the tuber makes an excellent media for the growth of bacteria and fungi.

PLANTING.

Where a considerable area is grown, the machine planter should be used. Planting by hand is too expensive and laborious. There are two types of planters offered on the market, the "picker" and the "non-picker." The former is automatic and requires only the driver. The latter requires two operators, the driver and a second one who corrects the drop of the machine.

Either type will do good work under favorable conditions. The "non-picker" will plant an absolute stand if the second operator performs his duty. This cannot be said of the "picker" types.

When disease is prevalent the "non-picker" is to be recommended as no marks or perforations are made on the seed-piece. If the whole seed is used, it goes into the ground without having been pierced. This is essential, for as remarked above, the cut or bruised potato offers a place for disease growth and when the

picker of the machine pierces a diseased tuber it carries the infection to not only the next one it picks up but possibly to many succeeding ones, thereby actually planting the disease within the seed tubers where it may develop under almost ideal conditions.

The time of planting will depend upon the soil and climatic conditions—no definite date can be set. In a general way it may be said that as early as the soil will permit and still avoid the danger of spring frosts. For north Idaho this will not occur earlier than May 1st to 10th.

The rate of planting should be governed somewhat by fertility of the soil and the local precipitation. For the Palouse country the common distances are fifteen to twenty inches in the row and rows thirty-six to forty-two inches apart. It is better to have them too thin than too thick. This is assuming a perfect stand. In other words, if an unfavorable season follows, it would be better to have the plants spaced twenty inches than fifteen inches.

The depth of planting should approximate four inches. If planted deeper than this both the planting and digging cost is increased. Also the temperature of the soil at greater depths is lower and germination and growth will be retarded. If planted too shallow, subsequent cultivation with the harrow will move and even pull up some of the seed and plants. There is also a tendency for some of the crop to be exposed, resulting in sunburned potatoes, which are valueless. Those which may not be injured in this way may be frosted if too near the surface.

CULTIVATION.

After the crop is planted it should be cultivated as frequently as weeds and the maintenance of the soil mulch require.

The harrow is an excellent tool for the early cultivation. It may be used with good results until the plants are four to six inches above ground. It is not meant that this can be done on all soils and under all conditions. When a loose sandy soil prevails the entire crop might be ruined by the use of a heavy, straight-toothed harrow. Good judgment needs to be exercised and when it is seen that the plants are being injured the cultivator should be substituted.

Level culture should be practiced. For this there is nothing better than the six or eight-shovel two-horse cultivator. Do not use the old type four-shovel machine as too much ridging is done and they must be run too deep in order to move all the surface. For this reason the small shovel types are recommended. With these the surface can be stirred two or three inches without needless ridging. After the vines become too large a five-shovel or the harrow-tooth one-horse cultivator may be used.

The number of cultivations necessary will depend upon the season and the amount of weeds present. If the soil is clean, there is nothing to be gained by excessive cultivation. After each rain of sufficient amount to form a crust the surface should be stirred. Other than this it is only necessary to keep all weeds out. This latter is very essential. Two crops cannot be grown on the same land at the same time and if a crop of weeds is present a full crop of potatoes cannot be expected.

HARVESTING AND SORTING.

Where small areas are grown the digging may be done with the ordinary plow or lister. Several harrowings are necessary to uncover those which roll under the furrow slice. At best there will be a considerable amount that is lost. The elevator digger is to be recommended always where any appreciable acreage is grown. If one farmer cannot afford a machine, then two or more neighbors should arrange to purchase one jointly. In the end the machine is the most economical.

It is advisable to sort as the crop is dug. The cost of handling so bulky a crop as potatoes is very great and if the sorting can be done in the field at the time of digging it should always be practiced. Sorters mounted on skids and drawn by a horse keep pace with the pickers. The potatoes are brought to the sorters by the pickers and are delivered from the sorter into sacks in the grades at the lower end. The one most commonly used in this state contains two screens. Those passing over the upper are marketable, those going through are unmarketable. The lower screen takes out all dirt and those less than three-quarters of an inch in diameter. Any size of screen may be used for the marketable ones. The North Pacific Fruit Distributors

demand that the round or oval types pass over 1⅞ inches and the long or Burbank type pass over a 1¾ inches screen. This, no doubt, will be raised to 2 inches and 1⅞ inches respectively, as the eastern market becomes more particular.

The sorting in the field as described requires one extra man to operate. His duties are to put on and remove the sacks and manipulate the sorter. He also picks out any cut, badly bruised or diseased tubers, puts them in the unmarketable sack. If he attends to the work properly and does not permit the screens to become overloaded, excellent work can be done. After sorting the crop is ready for the market or for the storage cellar.

TIME TO MARKET.

Whether or not the farmer sells at digging or holds for higher prices is governed very largely by the individual. Some potato growers make it a practice to sell at digging time regardless of prices. Others hold the crop until after the first rush of marketing and still others will sell as their judgment directs. No set rule can be laid down. It is a fact that generally the price advances as the season progresses. When the crop is stored several things must be taken into consideration.

First: There is the storage charge, or if the farmer builds a cellar on his farm the interest and depreciation on the investment.

Second: The shrinkage.

Third: The possible increased cost of hauling due to bad roads

Fourth: The cost of the extra handling of the bulky crop.

Fifth: Interest on the capital tied up from the time of digging until the crop is sold.

Sixth: The possible loss through freezing.

STORAGE.

For the farmer in North Idaho where roads are as a rule heavy in the spring, the most economical storage for his marketable crop is central storage plants located on the siding so that the crop can be moved direct to the car. Where the crop is stored on the farm, especially if the distance to railroad is great, advantage of a rise in market cannot always be had due to bad roads or freezing weather.

Where located on a good road not too far from the railroad no doubt the farm cellar would be advantageous. Storing facilities for seed at least should be provided. The cellar for Idaho climatic conditions is not of necessity very expensive. In a dry well-drained location a pit four feet deep and any width and length to accommodate the needs should be dug. A knoll is preferable to a side hill. It may be stated that a cubic foot will store approximately forty pounds. The studding for side walls may be posts set firmly in the ground and should rise a foot above the surface of the ground. The roof need not have greater than a one-fourth pitch. It may be built of round poles or four by four timbers for rafters and covered with stock lumber. The sides of the cellar should be covered on the inside with the same lumber. Ventilators 10x10 inches are necessary every 16 feet in the ridge. The whole structure is now ready for the final covering, and it may be started with 18 inches of straw and then 6 to 8 inches of the soil which was removed from the pit.

Where large amounts are to be stored the cellar should be wide enough to permit of a driveway. There need not be a door at each end, altho that is better. Where the crop is stored in sacks a floor is necessary as sacks will rot if put in contact with the soil. This floor may be slatted as this will facilitate ventilation.

The temperature for best results should be but two or three degrees above freezing, thirty-four degrees F. being ideal. This temperature should be maintained as nearly as possible. With some attention this is simple. Where the nights of spring and fall are cool, as in almost all parts of the state, the opening of doors in the evening and closing early in the morning after the crop is put in will soon reduce the temperature to the standard. It can be maintained quite closely by the judicious use of the doors throughout the storage season.

CONCLUSIONS.

Potatoes can be grown profitably in most of North Idaho.

The acreage should be increased and substituted for the wasteful summer fallow in this section.

Climate and soil are well adapted to the crop.

Too much work cannot be put upon the preparation of the seed bed.

The crop should be improved by the adoption of the hill selection method of saving seed.

Excessive cultivation will not necessarily increase the yield proportionately.

Too thin planting is preferable to too thick, provided a perfect stand is secured.

Not more than two types should be grown in any one locality and present indications are that these should be the Rural New Yorker or Gold Coin for the round or oval, and the Netted Gem for the long type.

POTATO CULTURE UNDER IRRIGATION.

BY J. S. WELCH.

Within the past few years the production of potatoes on the irrigated lands of southern Idaho has grown to be an important industry. Farming conditions generally are well enough adapted to the potato crop to warrant its becoming of even greater importance.

It is the purpose of this part of this bulletin to review the various phases of potato culture under irrigation and to call attention to those facts and practices upon which the successful growing of the crop depends.

SOILS AND SOIL MANAGEMENT.

As in the production of any intensively cultivated crop, the question of soils is of the greatest importance. The practice in all the great potato sections of the world and numerous experiments have clearly demonstrated that the best results are obtained with the loose, friable, easily worked, sandy, and medium loams which are well drained and allow good aeration. It has been noted that the smoothness, uniformity, and quality of the crop depend almost entirely upon these physical requirements of the soil, while the quantity depends to a greater extent upon the available plant food, the cultivation, etc. The heavier clays are not as well adapted to potatoes because they are harder to work, harder to displace by the growing tuber and do not allow as good aeration and drainage.

Most of the soils of southern Idaho are fairly well supplied with the inorganic elements of plant food. In nearly all cases, however, they show a deficiency in nitrogen and humus. These necessary constituents of a fertile soil come from the growth and decay of plant and animal matter. After clearing and leveling the first step in the preparation of sage brush lands for potatoes is the addition of these elements of fertility. This can be done by growing leguminous crops, such as alfalfa and clovers and plow-

ing under some of the growth for green manure or by the use of barnyard manure.

It must not be supposed that one treatment of this kind will be sufficient for all time. The constant use of barnyard manures and a good system of crop rotation are absolutely necessary for the continual and successful production of high grade potatoes. On the average irrigated farm, alfalfa, potatoes and small grains can be arranged nicely in a paying system of crop rotation.

Conservation of natural moisture is of almost as great importance to the irrigation farmer as to the man on the dry land. For this reason good fall plowing is preferable. Land that is fall plowed and left rough over winter not only catches and retains a good deal of moisture, but is improved by the weathering action of the winter frosts.

As soon as the land can be worked in the spring it should be disced and harrowed to pack the seed bed and to place a mulch on the surface that will prevent the escape of the winter moisture. Occasional harrowing from then until planting time will keep this surface mulch in good condition, will assist in the preparation of a fine firm seed bed and will be very effectual in destroying young weeds.

In case the potatoes follow alfalfa that has been fall-crowned, or, if for any other reason, spring plowing is necessary, care should be taken to work the land down as soon as possible after planting to prevent the loss of moisture.

At seeding time the seed bed should be fine and firm and should contain sufficient moisture to bring the crop up.

PLANTING.

The most desirable time for planting will vary with different localities. In any case the soil and weather should be warm enough to start the sprouts at once, since the seed is sure to lose vitality if it lies in the wet, cold soil for any length of time. The best plan will be to do this seeding so that the danger of hard frosts will be past when the plants are out of the ground. These conditions will exist late in the season but the planting should be done early enough to allow plenty of time for the crop to mature before the hard frosts of the fall.

It is safe to say that nearly all of our planting is done in

May and for conditions similar to those at Gooding from the 5th to the 20th of May is preferable.

Where only small acreages are grown good results are often secured by plowing the land shallow and dropping the seed in every third furrow. Where large tracts are being grown this is not practical and the machine planters are used. There are a number of types of these on the market, but those requiring two men for operation are to be preferred. The automatic pickers used on the one man machine bruise the seed, aid in distributing disease and are not usually accurate enough to secure a perfect stand.

The seed can be planted from three to five inches deep, varying with different kinds of soil, using the greater depths on the lighter soils. Rows are usually three or three and one-half feet apart and the hills twelve to eighteen inches apart. The more fertile soils will stand closer planting.

SEED.

There is considerable difference of opinion among potato farmers concerning the size of tubers that should be used for seed. Many prefer using small potatoes and cutting them in two or more pieces. Some plant the small potatoes whole. The practice of the most successful growers and considerable experimental data go to prove that the best results are obtained with medium sized seed. The most important considerations in the selection of seed potatoes from the cellar are trueness to type and freedom from disease.

Hill selection of seed is being practiced with excellent results in many cases. This consists of going over the field at digging time and choosing tubers of good type and medium size from the most vigorous, uniform and productive hills.

The question of whole versus cut seed is also one upon which there is considerable difference of opinion. Experiments conducted at the Gooding Station have so far failed to throw any light on this subject. The most successful growers of Europe and many in this country use whole seed and there are good arguments in its favor. If cut seed is used the pieces should have

two eyes each and should be large so as to insure a good vigorous start.

The rate of seeding depends upon the size of the seed and the distances of planting. Medium sized, cut seed planted in rows three and a half feet apart and hills fifteen inches apart will run about one thousand pounds per acre. Smaller seed may run as low as six hundred pounds and larger seed planted whole sometimes reaches three thousand pounds per acre.

VARIETIES.

The Gooding Experiment Station has conducted a potato variety test during the past four years. In this experiment we have attempted to get together all of the well-known types and varieties and grow them under exactly the same conditions in order to ascertain their relative value for our locality. In all, twelve varieties have been grown. Since this work was begun when the farm was first established the first two crops were grown on comparatively raw soil so that the yields are somewhat lower than is common on the best irrigated lands.

The following table gives the average results of the four years' work, showing yield of marketable potatoes, yield of culls and the percentage of the total crop that was marketable. Those classed as culls were the tubers that passed through a two-inch screen and those that were very irregular in shape.

In 1910-11 Red Peachblows were grown and in 1912-13 Idaho Rurals.

Name	Yield Marketable Potatoes, per acre	Yield Culls per Acre	Per cent of Total Yield Marketable
	Lbs.	Lbs.	
Carmen	13,349	3,169	80.81
Peerless	13,070	2,564	83.60
Netted Gem	12,702	2,820	81.83
Early Ohio	12,526	1,765	87.64
Dalmeny Challenge	12,376	5,010	71.18
Pearl	12,255	3,109	79.76
Idaho Rural	11,722	3,603	76.49
Red Peachb'w	11,545	3,830	75.02
Early Rose	10,801	2,587	80.06
Burbank	8,862	3,395	72.30
W. Peachb'w	8,455	2,475	77.35
Moseley's Pedigree	6,171	5,299	53.80

Since the above varieties represent various types and characteristics the yield is not the only thing that must be taken into consideration.

The Carmen is a white potato, usually of medium size and good quality. It has a roundish and somewhat flat shape and as a rule is fairly uniform and regular.

The Peerless is a white potato somewhat elongated in shape. It has a tendency to grow too large and is often quite irregular, so that even though it is a high yielder it does not give the best satisfaction on irrigated lands.

The Netted Gem is a well-known variety, sometimes called Russet Burbank. It is an excellent keeper and because of its comparatively thick skin is disease resistant to a greater extent than the smoother, thinner-skinned varieties. It has a long, slightly flattened shape and is usually very uniform. It is excellent for home use and has recently been recognized as a commercial type on the market. Long shaped potatoes are partial to the light soils and cannot be grown successfully on as heavy soils as can the round varieties.

The Early Ohio has a pink color, is somewhat elongated and inclined to be cylindrical in shape. It is a good early potato although when left to mature fully it tends to become somewhat irregular. It has a very thin skin and is quite susceptible to disease. As a rule southern Idaho farmers will not find it practicable to raise early potatoes on a scale greater than is sufficient to supply the local demand.

The early immature potatoes will not stand the long shipping that is necessary to reach the big markets and because of earlier seasons and shorter distances other localities can sell sooner and cheaper than we possibly can.

The Dalmeny Challenge, Pearl and Idaho Rural are somewhat alike, and are very well adapted to our irrigated lands. These with the Carmen furnish that white skinned, medium sized, regular shaped, uniform type that is in greatest demand in our best markets.

The last five varieties in the table have not given satisfaction, and do not fall under recognized commercial types.

The United States Department of Agriculture is now conducting some very extensive variety tests with potatoes at its Jerome,

Idaho station. These tests are designed to discover especially disease resistant types as well as to determine the relative yields of a great number of varieties.

There can be no question about the advisability of agreeing upon one or not more than two, standard types and growing them to the exclusion of all others.

CULTIVATION.

For a number of reasons cultivation is a very important phase of potato culture. Properly done it stirs the soil, allowing good aeration, it conserves moisture and eradicates weeds. Where machine planters are used so that the rows are discernible the best practice is to give a deep, thorough cultivation soon after planting. This does not start the hilling but works the soil deeper than will be possible after the roots have begun to grow. On small patches where the planters have not been used the only cultivation that can be given before the plants appear is good harrowing. After the plants are up the cultivation should be continued but should not be so deep. Shovels should be used that will move the soil toward the plants gradually, making deep furrows and high ridges that are necessary for proper irrigation. The early irrigation should be followed by cultivation to keep the furrows deep, to prevent the soil from crusting, and to kill small weeds that may have sprouted.

Cultivation is impracticable after the middle of the season when the vines and root systems are large enough to be injured.

IRRIGATING.

There is considerable difference of opinion among the farmers of the state concerning the stage of plant growth at which the first irrigation should be applied to potatoes. In order to furnish accurate information along this line the following experiment was planned at the Gooding Experiment Station and has been conducted for two years. We do not wish to be too positive in our conclusions until the work has been carried over a longer period, but we believe that the results so far obtained are interesting and valuable.

PLAN OF TIME OF IRRIGATION EXPERIMENT.

Plat No. 1. First irrigation when plants are four or five inches high. From then as often as is necessary to keep sufficient soil moisture to furnish good growing condition until the tubers are the size of an egg. Then no more irrigation.

Plat No. 2. First irrigation when plants are four or five inches high and as often as is necessary during the remainder of the season.

Plat No. 3. First irrigation when the tubers begin to form and as often as is necessary during the remainder of the season.

Plat No. 4. First irrigation when the tubers are the size of an egg and as often as is necessary during the remainder of the season.

Plat No. 5. No irrigation.

This plan has been carefully followed during 1912-1913. Idaho Rurals have been used in both seasons.

TIME OF IRRIGATING POTATOES.

Plat No.	Average Precipitation	No. of Irrigations	Length of Irrigation Season	Total Water,	Yield Marketable Potatoes,	Yield Culls,	Percentage of Total Yield Marketable	Marketable Potatoes per Acre Foot of Water.
			Days	A. Ft.	Lbs.	Lbs.		Lbs.
1	.234	2	23	1.387	9,281	3,838	70.54	6,691.42
2	.234	4	48	2.449	14,454	3,618	76.65	5,902.00
3	.234	4	32	1.759	14,847	3,482	80.70	8,440.51
4	.234	2	17	1.897	12,912	4,165	75.60	6,806.54
5	.234			.00	5,649	3,465	61.21	

In all cases the last irrigations were applied about the middle of August. This is the usual time of ceasing irrigation in all of our work with potatoes. By this time the tubers have attained their growth and the soil should be dried to allow them to ripen.

These plats were cultivated after irrigation from the be-

ginning of the season until further cultivation was made impracticable because of large vines and extensive root systems. In all cases the plats were given the same cultivation.

One of the first things that will be noted in a study of the above table is that when the irrigation of a crop of potatoes has been started, it should be continued throughout the rest of the season. Plat 3, which received its first irrigation at the formation of the tubers, produced a greater yield and a higher percentage of marketable potatoes with less water than did either Plats 2 or 4. It is believed that the difference in yield and uniformity between Plats 1 and 4 is due far more to the time of application than to the amount applied. This work so far indicates that potatoes should be irrigated first when the tubers begin to form and from then should be given frequent light applications until time to allow them to dry and ripen. If the work of the next two or three years substantiates these results we shall be able to outline a plan for time of irrigating potatoes that will increase the duty of water, and the quantity and quality of the crop.

It must be remembered that this work is based upon climatic and soil conditions that are normal, or nearly so, for Southern Idaho. It is possible under extreme drouth that irrigation may be required as soon as the plants are up, or even before that.

Potatoes should never be flooded. Neither should they be irrigated with furrows that are so shallow that the water is allowed to come in direct contact with the tubers. An examination of the potato plant will show that the roots which supply the plant with moisture and food are below the potatoes. These feeder roots are the only parts of the plant that need to reach the moisture supply. If the soil around the tubers is once saturated with water it will become hard and more compact, the uniform growth of the potato will be checked and as a result it will be irregular and ill shaped. A wet tuber bed will allow such diseases as scab and rhizoctonia to have a much greater effect. If the top soil is only moist, due to the water that has risen from below by capillary attraction, it will remain loose and easily displaced and the tuber will make a uniform, healthy growth.

In order to produce this desirable condition, potato rows should be well hilled up and the furrows between them compara-

tively deep. A small stream should be allowed to run in these furrows until the lower soil is well soaked, although it need not run until the top of the row is wet. In some cases the first irrigations are applied in every other row. This practice may be satisfactory in the lighter soils, but the medium soils should have water in every row.

The experiments on the duty of water for potatoes have extended over the four years of Station work. In 1910-11 Red Peachblows were grown and in 1912 and 1913 Idaho Rurals. In 1910-11 this work was conducted on new sagebrush soil, in 1912 on land that had been heavily manured and in 1913 on alfalfa land, so that the results represent average conditions.

The potatoes were planted about sixteen inches apart in the row and the distance between rows was 42 inches. In 1910 the potatoes were irrigated at planting time, but in all other cases the first irrigations were given when the tubers began to form, to avoid any variation that would be caused by a difference in time of application. The water was applied in deep furrows and the plats were cultivated as suggested above. In harvesting, the potatoes which passed through a two-inch screen and those which were knotty and ill-shaped were classed as culls.

The following table gives the average results of four years and two varieties.

DUTY OF WATER FOR POTATOES.

Plat No.	Precipitation	No. of Irrigations	Length of Irr. Season	Total Water.	Yield Marketable Potatoes.	Yield Culls,	Percentage Total Yield Marketable	Marketable Potatoes per Acre Ft. of Water
			Days	A. Ft.	Lbs.	Lbs.		Lbs.
1	.229	2	*20	.687	6,310	2,772	65.25	9,184.86
2	.229	4	51	1.724	13,499	2,925	81.61	7,830.04
3	.229	6	60	2,831	13,385	4,078	76.98	4,728.01

*Note—The average length of irrigation season is increased because of the fact that in 1910 the first irrigation was given at the time of planting.

It will be noted that one and three-quarters feet of water

produced the highest percentage of marketable potatoes. The maximum plat with about two and three-quarters feet produced much the same yield, but a considerably smaller percentage of marketable potatoes. Since culls are almost valueless, we are safe in saying that the time and expense of applying the last foot of water to the maximum plat was practically a dead loss.

In the fall of 1911 six average-sized potatoes from each plat were baked to determine the effect of varying amounts of water on the quality of the tuber. The potatoes from the minimum plat were more mealy and whiter than any others. The ones grown with medium irrigation were nearly as good as the ones receiving the least water. The tubers from the maximum plat were soggy and inferior in quality to either of the others.

These results indicate conclusively that about one and three-quarters feet of water given in four applications is the proper and economic amount to be used in the irrigation of potatoes on soils like ours.

HARVESTING.

Where potatoes must be shipped as far as it is necessary to ship Idaho potatoes, it is essential that they be well matured before digging. The maturity can easily be ascertained by causing the skin to slip or peel when rubbed with the hand.

A number of good types of diggers and sorters are on the market. Care should be taken to dig and grade the potatoes with as little cutting and bruising as possible. In too many cases growers are too careless in handling the tubers and as a result they do not stand storage or long shipment.

If our growers are to reach the best markets and secure the greatest profits it is absolutely necessary that they agree upon a uniform grade and adhere to it strictly. In many cases the temptation to increase the amount of a shipment by including some slightly inferior potatoes is great, but such procedure will always mean a loss to the individual and to his community.

As we suggested on one of the preceding pages, digging time is the proper time to make some careful hill selections of seed. It may not be practicable to select seed for the entire crop this way but at least enough can be chosen for a seed plat which will

be large enough to plant the main crop the second year. Careful use of hill selection and the seed plat will do as much for the potato crop as careful seed selection for the corn crop or careful breeding for the dairy herd.

SUMMARY.

The soil and climatic conditions of the irrigated lands in Idaho are well adapted to potato growing.

The best results are secured from the loose, friable, sandy and medium loams which are well drained and easily worked.

The addition of nitrogen and humus by the use of barnyard manures and by crop rotation is essential.

Fall plowing of potato lands is preferable to spring plowing.

The seed bed should be worked down early in the spring.

Planting can be done to advantage between the 5th and 20th of May.

Two men planters give the best results.

Seed should be planted three to five inches deep, in rows three to three and one-half feet apart and hills twelve to eighteen inches apart in the row.

The best seed comes from the most productive hills and is true to type, medium sized and uniform.

If seed is cut the pieces should have at least two eyes and should be large.

The white skinned, medium sized varieties, such as Carmen and Idaho Rural are well adapted to our conditions and are in greatest demand.

Of the other types the Netted Gem is the most satisfactory.

The farmers of the state should not grow more than two types and should put these on the market in a uniform grade.

Thorough cultivation is absolutely necessary.

The irrigation of potatoes should commence about the time the tubers begin to form. During the next five or six weeks about four irrigations should be given, applying about one and three-quarters acre feet per acre (on medium soils similar to those at Gooding), The water should be applied in deep furrows.

Potatoes should be fully matured before digging and care should be used in handling them.

DRY LAND POTATO CULTURE FOR SOUTHERN IDAHO.

BY L. C. AICHER.

Introduction.

Dry-land potato production is a comparatively new industry in the southern part of Idaho. The possible proportions the industry will take cannot even be estimated until more information as to the value of dry-land seed on irrigated land is determined.

Practically all the dry-farmers in the Aberdeen district grow all their own potatoes used for home consumption and many of them sell considerable quantities for table use.

It is hardly probable however, that the dry farmer in the southern part of the state will be able to compete to any extent with the irrigated farmer in producing table stock for the markets, but he can produce a very excellent quality of seed potatoes in sufficient quantities to make the crop profitable if the present prices for seed stock are maintained.

The future status of the irrigated potato industry will decide to a considerable degree the extent to which the dry-land potato industry will develop. Unless means are found to check the many diseases now affecting the potato industry on the irrigated lands of the west, it may be impossible for the irrigated farmer to produce his own seed potatoes. However, if the irrigated farmer is still able to grow a good crop, if good seed is provided, the dry farmer may find a very ready market for his excellent potato seed.

Present information indicates that dry land seed is almost free from all but two of the potato diseases, these two being scab and the storage disease known as dry-rot. This is especially true if the seed has been grown on dry land for a few seasons.

With reasonable care in the planting and harvesting of the crop, the damage from these diseases can be very greatly reduced, if not eliminated.

Moisture supply and markets are two important limiting factors which enter into the dry-land potato industry. The former bears very directly upon the latter. In favorable seasons where an ample moisture supply is furnished, the tubers become large enough to sell on the market as table stock. In dry seasons, however, the tubers do not grow so large and hence only a few may be sold on this market.

The seed market, on the other hand, can utilize a smaller potato, and is therefore the dry farmer's best outlet. The dry farmer is able to vary the size of the tubers to a considerable degree by increasing or decreasing the width of row and the spacing in the row, but it must be remembered that in any case the dry farm tubers do not reach the size of those produced under irrigation. The irrigated farmer can use a smaller dry land seed potato for planting, under the same conditions, than he would select from the irrigated potatoes. Seed from 2 to 4 ounces in size are planted throughout the area and excellent results are obtained. This does not necessarily mean, however, that planting a little larger potato would not produce a larger crop. This experiment is being tried on the station and one year's results seem to indicate that the practice in use is fairly satisfactory.

Dry land potato work has just been started on the Aberdeen station, hence only one season's results are available. The information regarding dry land potato production, herein embodied, has been secured by observation and through consultation with a great many dry farmers in the Aberdeen district. While at the present time only small quantities for home production are produced on the dry farms in this district, it has been clearly demonstrated by several dry farmers that excellent seed can be grown.

In the spring of 1912 the Extension Department of the Idaho State University undertook to furnish the Greeley, Colorado, district with dry land seed potatoes. A carload of small seed of only fair quality was shipped to Aberdeen and the writer was asked to take charge of the distribution and advise the

dry farmers in the district as to method of planting and care. Fifty-eight farmers received quantities of the seed, a few general instructions were given at the time of distribution and the only further instruction extended was given when the writer visited the various farms during the growing season. The potatoes were shipped to Greeley in the fall. While they were not received at Greeley in very good condition, due to poor storage facilities just before shipping, it was clearly demonstrated that seed could be readly grown on the dry-lands. A recent report from the Greeley potato growers stated that the seed potatoes shipped them produced very well and compared very favorably with Wisconsin and other northern grown seed, and that they would be glad to receive more seed. This work will be carried on further in order that more information regarding the value of dry land seed for planting on irrigated land may be secured.

If any results from the work on the station are referred to in this circular, it must be taken into consideration that only one year's results are quoted, hence the information is only suggestive and should not be taken as final.

CLIMATIC FACTORS.

In order that comparisons with other sections of the state might be made, the rainfall, the amount of evaporation, and length of growing season for the Aberdeen station are reported. Records have been taken for only two years.

	Precipitation	*Evaporation*	*Length of Growing Season*
1912	11.83 in.	.307 in.	130 days
1913	10.10 in.	.22 in.	128 days

Moisture supply, evaporation, length of growing season and frequency of summer frosts enter very largely into the success or failure of the dry land crop. An available supply of moisture, to some extent under the control of the farmer, must be maintained in order to grow a marketable dry land potato. Cultivation at the right time, good plowing, and timely additions of

humus are the three essentials in assisting nature in the storing and conservation of moisture.

LAND PREPARATION.

It is very impotrant that land be properly prepared for potato planting. Potatoes require a good, deep, mellow seed bed, which can only be obtained by good, deep plowing, say from 7 to 10 inches, and proper surface mulching to conserve moisture.

Wherever possible under dry land conditions it is advisable to plow previously summer-fallowed land as early as possible in the spring. Follow this immediately with double disking and harrowing, thus working a mulch to conserve moisture. This makes a fairly compact seed-bed which has time to settle a little before planting. Caution must be exercised in preparing the mulch, as fining the soil too much will permit of ready blowing. A clod mulch is to be preferred in the southeastern dry-farming areas of the State in order to prevent blowing. Deep fall plowing with deep spring plowing following as previously outlined is another good practice, but one not extensively used; this is a more expensive system than the one above.

Many dry farmers plow in the seed, thus economizing time and labor. This is done by opening a couple of furrows and then dropping the tubers behind the plow. Three furrows are then plowed and the dropping of tubers is repeated. Where the crop is plowed in, the plowing is seldom over five inches in depth. This does not permit of a deep, mellow seed bed unless well plowed in the fall previous, hence the necessity for good deep plowing in the fall. There is another vital objection to plowing in potatoes, the land is not settled, hence the seed piece, while covered, does not come in close contact with the soil particles to cause quick growth. A poor stand can in many cases be traced to plowing in the seed.

Many dry farmers now double-disk grain stubble before plowing. This practice is commendable in that it aids very materially in moisture conservation and decay of vegetable matter by thoroughly mixing the top soil with the grain stubble. When this is turned under a quicker union between the turned furrow-slice and the hard bottom is made. Thus the moisture supply

is held almost normal by capillary action, rather than decreased, by a straw barrier which often checks this action.

If the land is plowed a few weeks before planting, it is important that a clod mulch be established to prevent loss of moisture. The potato needs a deep and mellow, yet a fairly compact seed bed. A poor stand in many cases can be traced to a loose seed bed, for the soil moisture that should be available for the tuber is lost through evaporation.

SEED SELECTION AND TREATMENT.

The quality of seed potatoes has a great deal to do with the success or failure of the crop. The only kind of seed to plant is good healthy tubers taken from a vigorous growing crop the year previous. Do not plant the culls. Like tends to beget like. Therefore, if you want a good, vigorous, high-yielding crop, select seed from plants or fields of that sort. Avoid all plants which show disease. Dry land tubers are remarkably free from disease and the dry-farmer should do his utmost to keep them so.

The hill selection of tubers for seed has been found a very profitable practice. This is done by going through the field just before harvest and digging out the most vigorous hills, saving those which are true to type and yield more than a certain number of marketable tubers. These are planted and harvested separately from the main crop the following season and similar selections made. For best reuslts these selections should be continued from year to year. This work takes a little time, but the results secured pay very good interest on the investment.

At present there is considerable difference of opinion among dry-farmers as to the advisability of planting whole or cut seed. Those who plant whole tubers invariably secure a more vigorous vine growth and a slightly larger yield of tubers. On the other hand, those who plant the cut seed obtain a considerably higher percentage of marketable tubers. The whole potatoes set more tubers, but they do not grow as large as the fewer tubers produced from the cut potatoes. Results on the Aberdeen station this year, using Pearl and Idaho Rural varieties, indicate that cut seed will cost less to plant an acre and yield a greater percentage of marketable tubers. This is partially accounted for by

the fact that the cut seed-pieces carry only one or two eyes, whereas the whole tuber of Pearl and Idaho Rurals may carry as high as six or more. The whole tubers produce more stalks and they are given a better start, due to the larger supply of moisture and plant food in the seed-piece. The cut seed-pieces produce one or two stalks and the vine growth is not as vigorous as the growth from whole tubers.

Observations on the station indicate that the best producing hills of marketable tubers are the ones with the fewer number of stalks in the hill, but on the other hand, that it is not profitable to plant a small sized cut seed-piece. The dry land usually does not contain any more moisture than is necessary to start the growth of the seed potato, while sometimes it is too dry to carry the plant along after the seed-piece has sprouted. For this reason it is essential that at least a 2 ounce cut piece be planted in order that the young plant may receive a good start before it must depend upon the soil to carry it along. However, 2-ounce whole seed can be planted with much more assurance of a good stand.

Seed treatment for scab has been found very effective. The formalin treatment will prevent scab if the disease is not present in the soil. Most other diseases should be avoided in the selection of the seed. If good clean seed is planted on clean ground, with machinery not infected with disease, a good start has been made toward disease prevention. Prevention is thus far the only cure for most of our potato diseases. The prevention of dry-rot lies to a great extent in avoiding all injuries to the tuber at harvest time and in storing. This is further aided by keeping the stored potatoes at a temperature a very few degrees above freezing.

PLANTING.

As previously stated, a very common practice in planting potatoes on the dry-lands is to plow them in. When this is done the usual width of furrow is about 12 inches and the depth of plowing varies from 4 to 6 inches, depending on whether the potatoes are planted in the bottom of the furrow or part way upon the furrow slice. It is best to plant the tuber so that some loose soil is between the seed piece and the furrow-bottom. It is

doubtful if the practice of plowing in potatoes is advisable.

The method of planting which is recommended for dry-farming sections and the one practiced on the Aberdeen station, because it has given very excellent results, consists of early spring plowing of previously summer-fallowed land. This is immediately followed by double-disking and harrowing to prepare a good mulch. At planting time furrows are opened up by means of a small mold-board plow or shovel plow and the tubers are dropped by hand. Covering is usually done by means of harrow, chain, cultivator, plow or some special covering device. It is aimed to cover the tubers about four inches deep.

Where planting is done on a large scale it is advisable to use a regular potato planter. The land in this case must also be well prepared beforehand. Picker and cup planters are in use. With a good operator the cup planter will give better results than the picker planter, as a more uniform stand can be secured. The cup planter has another advantage which should be carefully considered. In case disease is to be found among the tubers or cut pieces, the picker planter by piercing the diseased tuber as well as all subsequent healthy or diseased seed pieces is no doubt a great medium in spreading disease. The cup planter on the other hand does not injure the seed piece.

Seed spacing in the row averages from 16 to 36 inches, with rows 36 to 40 inches apart. The average distance in the row is about 24 inches, using 36 inch rows. The tubers are usually planted about 4 inches deep, this depending to some extent upon the moisture supply and how close it is to the surface.

The quantity of seed to plant to the acre varies according to the size of the seed piece, the distance planted in the row and the width the rows are apart. Planting 2 ounce seed 24 inches apart in 36 inch rows will require about 825 pounds of potatoes. If it is desired to plant whole seed or to plant closer, more seed of course will be required. The spacing will depend to some extent upon the market in which the crop is to be sold. Closer planting will ordinarily yield smaller tubers and wider plantings larger tubers. Beyond 30 inch planting, however, it is doubtful if any increase in size is obtained and it is known that under ordinary conditions the yields are considerably less.

CULTIVATION.

The amount of cultivation given potatoes on the dry lands varies greatly and very little is known as to how much should be given. The controlling factors, however, are conservation of moisture and eradication of weeds. Most of the cultivation is given with a harrow before the potatoes break through or just after they have come up, or both, this depending upon the necessity for weed eradication and moisture conservation. A little cultivation is given the potatoes during the growing season. Shovel and harrow-tooth cultivators are used for this work. Dry farm potatoes as a rule should not be hilled up, as considerable moisture is lost through this operation. Shallow cultivation should be the practice. Deep cultivation cuts off many rootlets and often injures the tubers. If deep cultivation is to be practiced, it should by all means be given at the first cultivation, or better, just after the tubers are planted, using the bull-tongue cultivator for the purpose. Too much cultivation is as harmful as not enough. Unless a crust is to be broken or weeds are to be killed, there is very little to gain by cultivating on the dry land. Too much cultivation causes loss of moisture and plant food.

HARVESTING AND SORTING.

In harvesting the crop, the dry-farmer usually plows it out with a walking plow or lister plow. Sometimes a potato digger is used, this depending upon the acreage to be harvested. Many farmers sort in the field, though a greater number store the potatoes in pits until all have been taken out of the ground, in order to avoid freezing. If the weather permits, the potatoes are then sorted and either sold to buyers or re-pitted and held for better prices. The potatoes are sorted over a 1½ inch screen when they are to be sold for seed and over a 2 inch screen when sold for table use. The seed crop as a rule will bring better prices, as a larger percentage of the crop can be sold and a higher price, usually 15 cents per cwt. over the market price can be obtained. Careful handling in harvesting, sorting and storing to avoid bruising aids in preventing dry rot in storage.

YIELD AND PERCENTAGE OF MARKETABLE TUBERS.

Total yields of different varieties of potatoes ranging from 50 to 250 bushels per acre have been recorded on the dry lands in the Aberdeen district. Of these yields it is usually estimated that from 65 to 76 per cent are sorted out and sold for seed. If sold for table use, a smaller percentage of marketable tubers, in many cases less than 50 per cent is obtained. The seed market is by far the best for the dry land farmer. He should do all in his power to encourage the industry and assist in building it up. Probably the greatest assistance he can render would be to grade up his potatoes, sell an honest product, and keep the variety pure.

POSSIBILITIES OF THE INDUSTRY.

The possibilities of the dry-farm potato industry hinge a great deal upon the future of the industry on the irrigated land. It is barely possible that with improved methods the dry-farmer might possibly produce potatoes for table market. The great drawbacks to this part of the industry, however, are the great distance to markets, and the high percentage of waste if the grade of stock shipped is to compare favorably with that produced by the irrigated farmer. If the seed industry turns out successfully, the dry farmer has his market right at home and his tubers will command a higher price than the average price of table stock. In addition, his percentage of marketable seed stock is from 15 to 25 per cent higher. Until more definite information regarding the value of dry farm seed on irrigated land is available, the status of the seed industry on dry land is unknown. The fact that excellent tubers in considerable quantity, free from disease, can be grown, presents great possibilities which future experimental evidence may fully substantiate.

Should the potato seed industry become established it will assist the dry farmer in adopting a practicable rotation. Alfalfa for seed, potatoes, and either barley or wheat would work in very well together. It would obviate the present practice of summer-fallowing half the farm every year and it would diversify farming so that the dry-farmer would not be dependent upon one

crop for sustenance, as heretofore. In case of a crop shortage it would not affect him to such an extent as single cropping would.

STANDARDIZATION AND COMMUNITY PRODUCTION OF SEED CROP.

The potato seed industry differs from the table stock industry in that the consumer dictates entirely which variety shall be grown for him. This is no doublt a great help to the industry. If the dry-farmer desires to produce seed, he must produce the kind of seed which the market demands. However, if he has a home market to supply which only demands a few sacks, and not car-lots, the individual whims of some farmers who have not reached the stage where the advantages of community standardization appeal to them, cause them to grow other varieties than the standard crop grown in the community.

It is very important that communities shipping potatoes in car-lots to markets hundreds of miles away, should co-operate in standardizing their crop so that but one variety and quality of potato is grown. Standardization insures a higher price for uniform stock, facilitates handling and shipping and makes the best advertising medium the community can secure. Uniformity of type and quality of seed are absolutely essential to continued success.

VARIETIES.

There are many varieties of potatoes grown on the dry land, but of these very few seem to be worth while. The Early Rose and Early Ohio groups seem to be the most in demand of the early varieties, with the Pearl and Idaho Rural the leading late varieties. The Pearl yields remarkably well considering it is a late potato. The Early Rose is at present the heaviest yielding early variety. Unless other varieties have been given a very thorough trial it is urged that the dry-farmer confine his choice of seed to the above-mentioned groups. If the farmer is growing potatoes for seed he should by all means endeavor to furnish the variety which the irrigated farmer demands.

SUMMARY.

Dry-land potato production for market is a comparatively new industry in the southern part of Idaho and one which holds considerable promise.

The future of the industry depends to a great extent upon the effect the various potato diseases will have upon the potatoes grown on irrigated land.

Dry land potatoes are practically free from all potato diseases.

Moisture and markets are the two limiting factors affecting the dry land potato industry.

Dry land potatoes should be planted on well summer-fallowed land, plowed 7 to 10 inches deep, and well mulched just before planting.

Tubers are usually planted by hand, either immediately following the plow or following a furrowing machine after the land has been plowed. Covering is done by means of chains, harrow or other covering device. A few farmers use potato planters to put in the crop.

Clean disease-free seed should be planted in clean soil. Hill selection of seed is a profitable practice.

At present more whole seed than cut seed is planted on the dry land. Results thus far seem to indicate that cut seed yields a little larger percentage of marketable tubers, and costs less to plant than whole seed.

It is advisable to plant at least a two-ounce seed piece either whole or cut. Distance of planting in the row should be about 20 inches in rows 36 inches apart. Seed should be planted about four inches deep.

Seed treatment for scab is effective on dry land. Other diseases should be avoided by selecting clean seed.

Too much cultivation is as harmful as not enough. Unless a surface crust is to be broken or weeds destroyed, there is very little to gain by cultivating on dry land.

Plowing out is the usual method of harvesting the crop. The digger is sometimes used. Dry land tubers are sorted over a 1½-inch screen when sold for seed and over a 2-inch screen when sold for table stock.

Yields vary from 50 to 250 bushels per acre, sorting out from 65 to 75 per cent marketable seed stock and about 50 per cent table stock.

The potato crop, if successful, will be a valuable crop to use in dry-land rotations.

Standarization of the potato crop insures a higher price for uniform stock, facilitates handling and shipping and makes a good advertising medium. Uniformity and quality are paramount.

The varieties that should be grown are Early Rose, Early Ohio, Pearl and Idaho Rural.

DISEASES AND INSECT PESTS OF THE POTATO.

BY C. E. TEMPLE.

Introduction.

Importance of the Potato Crop.—One of the most important crops in our state is that of the potato. The fertile, virgin soils, coupled with sufficient moisture and almost ideal climatic conditions produce potatoes of large yield and of good quality. The increasing demand for these potatoes has been met by an increased acreage. With increased acreage there has come greater competition for potatoes of the fancy grade, and along with this has come a decrease in the demand for the poorer grades. It requires but little more labor, no more seed, and not as much land to grow a ton of fancy potatoes as it does to grow the same amount of low grade potatoes; and the net profit in favor of the former is many times that of the latter, if, indeed, there can be a profit in growing low grade potatoes. What we need most at this time, then, is *quality and continued good yield* in this one of the world's great food crops. The road to quality and good yield has been fairly well worked by practical growers and trained scientists. In view of this fact, the potato is becoming more and more important as a field crop.

Losses Due to Disease. The relative increase in the amount of the poorer grades in proportion to the fancy grade has been caused mainly by potato diseases. During the past few years these diseases have been accumulating in the seed stock and in the soil, wherever no effort has been made to control them. In some of these places great loss to the grower has resulted. In certain sections there have been losses estimated as high as 50 per cent of the stand, and a still further loss in storage as high as 20 per cent of the stored stock. In other cases, where the most modern methods of controlling the diseases were practiced, there has been an increase in yield and an increase in the relative amount of the fancy grade.

Purpose. It is not the intention of the writer to give here the results of original investigations but rather to give mainly those results that have been tried out by scientific workers and practical potato growers in this and foreign countries. This bulletin is intended expressly for those who are growing or otherwise handling potatoes in Idaho. On the other hand, it is not intended for advanced students or technically trained men; they should go to the sources or to more technical papers for their information. An attempt has been made, therefore, to make the language as simple as possible, so that it can be read and understood by the farmer and his children. It is hoped that they will get, at least, some suggestions from the following pages whereby they can improve the quality and yield of their potatoes. In other words, it is with the hope that the excessive losses from low grade potatoes and poor yields may be reduced in the future, and that the potato crop may be continued and improved as one of the big assets of the State, that this part of the Potato Bulletin is offered.

Acknowledgments. Grateful acknowledgment is here made to Mr. W. A. Orton, of the U. S. Department of Agriculture for the use of material and for the illustrations as credited in the legends; to Professor W. J. Morse, of the Maine Agricultural Experiment Station for helpful suggestions; and, to Professor Lawrence Bruner, of the University of Nebraska for the loan of the cut of the Colorado Potato Beetle.

I.—FUNGOUS DISEASES.

The diseases that belong to this group are caused by small parasitic plants. In size these little organisms vary from mold-like growths barely visible to the unaided eye to minute germs visible only with the aid of a compound microscope. They inhabit the potato plant and its tubers in large numbers and draw their food therefrom. Certain ones infest mainly the stems and leaves of the plant and either kill them or dwarf their growth, in which case the tubers may not set, or if they do, they too are

dwarfed. Others infest mainly the tubers and either confine themselves to the skin making the tuber unsightly or enter the tuber causing decay immediately or later. The organisms, here considered, are capable of rapid reproduction. Their reproductive bodies, being much smaller than the organisms, are never visible to the unaided eye, except where they are produced in such large numbers as to constitute a powdery mass or covering with a distinctive color. Being so small they are easily distributed; they are carried long distances by the wind, and too, they cling to everything that touches them, as sacks, tools, insects, one's hands, etc. Some of these little reproductive bodies find their way to other potato plants where they germinate and grow into the plant or tuber. On the other hand, millions fail to again come in contact with the potato and are therefore lost.

Even though only a few hills may be diseased the first time potatoes are grown on a piece of land, the fungous reproductive bodies of these few diseased hills are easily distributed over the entire field by machinery, wind, etc. Then, too, they may retain their vitality in many cases for a number of years. These facts make it necessary where disease is at all prevalent, to rotate the crop, growing only one potato crop on a given piece of land in every four or five years. If this rotation is not practiced, these fungous reproductive bodies accumulate in the soil from year to year and may finally cause an entire crop failure.

FUNGOUS DISEASES OF THE POTATO PREVALENT IN IDAHO.

COMMON SCAB.

This disease, caused by *Oospora scabies is* probably the most common potato disease. It is prevalent wherever potatoes are grown and is one of our worst diseases. It may be identified by more or less circular, shallow-pitted spots in the surface of the tubers. (See Fig. 1).

These spots in the surface of the tubers are sometimes confused with those made by some insects which eat into the tubers as in the case of the white grub; however, the scab spots are more superficial than the spots made by the grub. The scab spots may be widely scattered over the tuber or they may almost

completely cover its surface. Even the scabby potatoes are edible, they are not salable unless the attack is light, and then only at a reduced price. The loss in the market value due to common scab has been placed by some investigators in special cases as high as 75 per cent. of the potato crop. At any rate, whatever the loss, if any, on every grower's farm, it is sure to increase unless special attention is given to the best methods for combatting the disease.

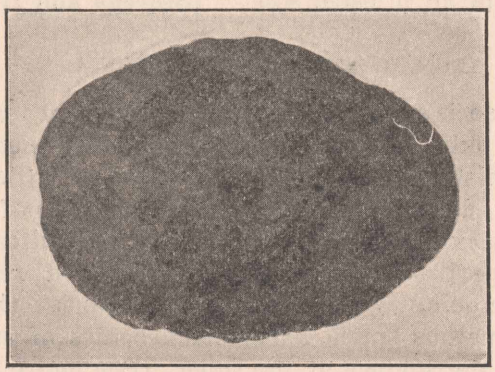

Fig. 1.—A potato affected with Common Scab. (After Orton).

These methods may be directed along two lines: seed treatment and soil treatment. It is known for certain that the organisms can be killed by either the formalin or the corrosive sublimate dip recommended in this bulletin. Thus scabby potatoes, if not too badly infested, may be used for planting if properly treated. At the same time it is not intended to infer that scabby potatoes, tho treated, are as good as healthy ones for planting. It is also known that an alkaline or neutral soil favors the growth of the scab organisms, whereas an acid soil tends to check their growth. Fresh stable manure, lime, and wood ashes make the soil more alkaline. These, therefore, should not be applied to land immediately before potatoes are to be planted. On the other hand, the plowing under of green vegetation tends to make the soil slightly acid in reaction and consequently less favorable to the growth of the scab organisms, but this cannot be depended upon to control the disease. Wherever the organism is already in the soil a four or five year rotation should be made

with crops that are not attacked by this organism. Those crops to be avoided in this rotation are turnips, beets and mangels, as the fleshy roots of these plants are rather susceptible to the scab disease. "In general, it may be said that scabby seed potatoes in any soil will produce a scabby crop, but the amount of scab is determined somewhat by the soil conditions. Seed potatoes free from scab, in a soil free from scab, will raise a crop free from scab. Seed potatoes free from scab will not produce a healthy crop if grown in an infested soil." (*Stevens* and *Hall.*)

RUSSET SCAB AND RHIZOCTONIA.

This disease is characterized by brownish or russet colored areas on the skin of the tuber accompanied usually by irregular, brownish colored, shallow cracks. (See Fig. 2). Slight attacks do not interfere with the use of the tuber, but severe attacks make them useless. The disease is prevalent in the northwest, especially in irrigated regions. The fungus Rhizoctonia, which seems to cause this trouble, forms also numerous small, hard, black bodies of sterile tissue, which cling to the surface of the tuber. (See figure 3.) At first

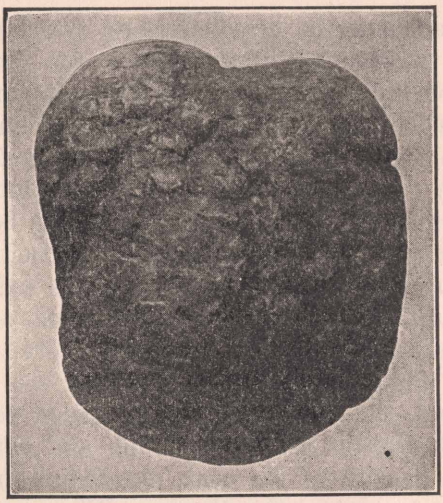

Fig. 2.—A potato affected with Russet Scab, showing the russeting and cracking, associated with the fungus Rhizoctonia, of the western potato. (After Orton).

sight they resemble patches of dirt but they do not wash off; they can, therefore, be readily recognized. This stage of the organism is much more common than the russet stage but it does not injure the tubers greatly except for seed. When diseased tubers are planted the organism attacks the sprouts and stems below the ground. Sometimes the young tubers are cut off from the main stem in which case the plants make a heavy growth of vines with very little yield. In other cases the main stem is destroyed at or beneath the surface of the ground. Plants thus

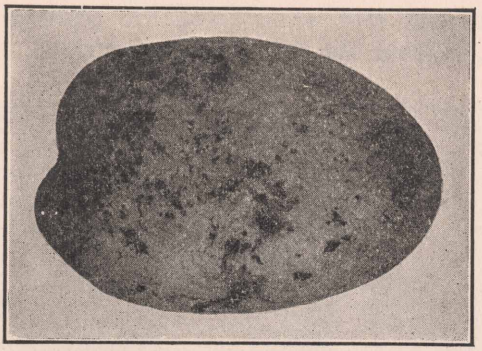

Fig. 3.—Black resting bodies, or sclerotia, of Rhizoctonia on a potato. (After Orton).

affected turn pale green or yellowish and are very conspicuous in the field about two months after planting. In other cases the stem below ground is only partially destroyed, in which case the stem above ground may produce small tubers. The disease is common and serious. It is known as Rhizoctonia or Rosette.

Recent investigations by Stewart and Gloyer of the New York Agricultural Experiment Station show that the corrosive sublimate dip is effective for treatment of Rhizoctonia, but both the formalin dip and the formalin gas treatment are ineffective for treating tubers affected with Rhizoctonia.

FUSARIUM WILT.

Fusarium Wilt (*F. oxysporum* (*Schlecht*) *Sm.* and *Sw.*) is characterized by a wilting of the foliage and a brown discoloration of the interior of the tubers at the stem end. (See figure 4.)

"The lower leaves droop and die first, the upper ones wither or wilt, and the entire plant dies prematurely. The leaf-roll that accompanies wilt differs from the true leaf-roll in that the former lacks turgidity or crispness and the leaves die within a few days." (*Orton,* 1914). This rapid dying is due to the fact that the organism is confined mainly in the vascular tissue, where it plugs up the vessels that carry water up. Even in the tuber it is confined to the vascular tissue, where it causes a brown discoloration, but it is not the cause of powdery dry-rot as formerly supposed. (*Wollenweber,* 1913). The fungus is carried over winter in infected tubers, and when these are planted, it attacks the young plants, causing the wilt already described.

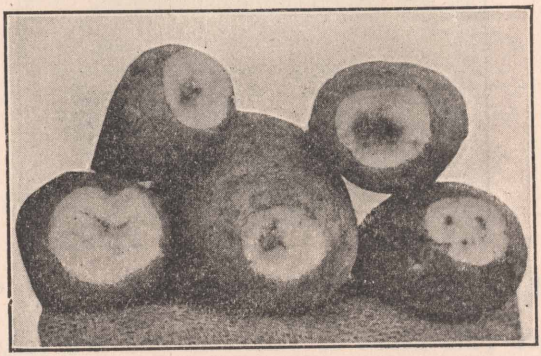

Fig. 4.—Potatoes affected with Fusarium Wilt, showing stem-end discoloration of the vacsular ring. (After Orton).

As to the distribution of this disease, Mr. Orton, who has made a thoro investigation of it says (1914) : "the wilt has been long present in Colorado and cases much injury, especially when attempts were made to grow two or three successive crops of potatoes. In Utah it is much the same, and the newly opened districts in Idaho are rapidly introducing the fungus in seed potatoes brought from older localities. Nor is the wilt confined to the irrigated parts of the West. It also occurs on the "dry farms," and is not the least of the problems which the settlers in these areas have to solve."

The disease will be largely eliminated by hill selection of seed and rotation of crops.

POWDERY DRY ROT.

This disease is known also as Fustrium Dry Rot (*F. trichothecioides Wr.*). The decayed portion is typically wrinkled, whitish, dry and powdery (See Fig. 5). On the other hand, it

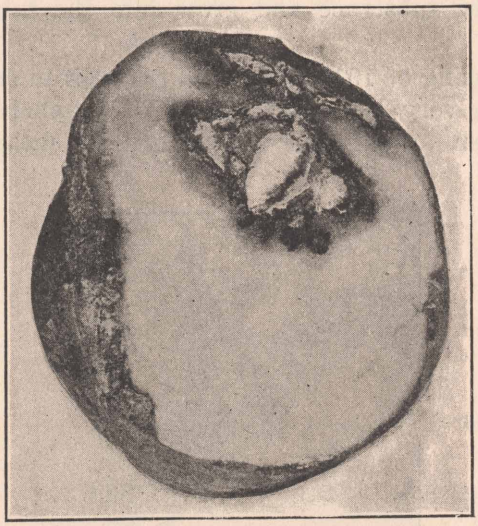

Fig. 5.—A potato affected with powdery dry-rot. Section through a diseased tuber. (After Orton).

may be brown or black and watery under certain conditions. In cold storage the decay proceeds rather slowly, but when stored potatoes are kept too warm, the organism becomes very active, in which case all the potatoes of a pit, root cellar, or car in transit have been known to decay in a few weeks. It constitutes, therefore, our worst storage rot, as it has been found in every part of the state which has been examined for it.

It should be understood that under normal storage conditions the organism causing the dry rot is unable to enter the tuber except where the skin has been broken. It is, therefore, a wound parasite. In controlling it, three things are important: Careful handling of the potatoes so as not to wound them, cold storage, and careful selection of seed free from the organism, so as not to carry the organism into the field, where it will live through

the summer and infest the new crop the following year. The worst cases observed by the writer were those where the tubers were frosted just a little at digging time or during storage. In these cases the frost was not severe enough to break down much of the tuber tissue—just enough to cause a little water to ooze out. The reproductive bodies of the organism germinate readily in this watery substance and grow into the tuber, causing its decay.

In the spring of 1913 the stored potatoes in certain irrigated sections were very badly infested. The financial loss was not great, however, as potatoes were unusually cheap at that time.

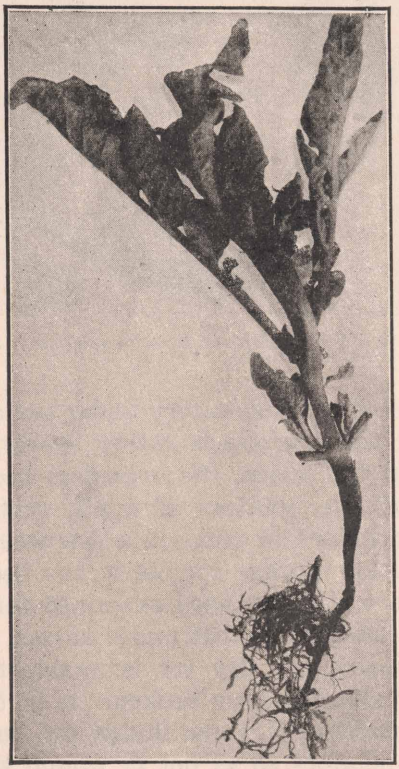

Fig. 6.—A potato plant affected with Black-leg in the summer stage, the result of planting diseased tubers. The lower part of the stem is shriveled and black; the leaves are yellow and rolled upward. (After Orton)

At the same tme, the trouble may be expected to reappear from year to year unless special methods are practiced for eliminating the disease. If the fungus becomes abundant in the root cellar, fumigation of the cellar might help to prevent another outbreak of the disease. All decayed or partially decayed tubers should be destroyed.

There are a number of other organisms that cause a dry-rot but this is the most serious with us. It should be noted too that a tuber may be attacked by a dry-rot organism and this may be followed by another organism that causes a wet-rot. A foul odor usually indicates the presence of bacteria in the decayed tissue.

BLACKLEG.

This is a serious and common disease of the potato in the northwest. It is caused by a bacterium (*Bacillus phytopthorus Appel*), which attacks the lower end of the young potato stem, causing that part under ground to decay more or less and turn black. The diseased part may extend along the stem upward for a few inches above ground. The leaves and branches of the diseased plants turn upward and have a tendency to form a more

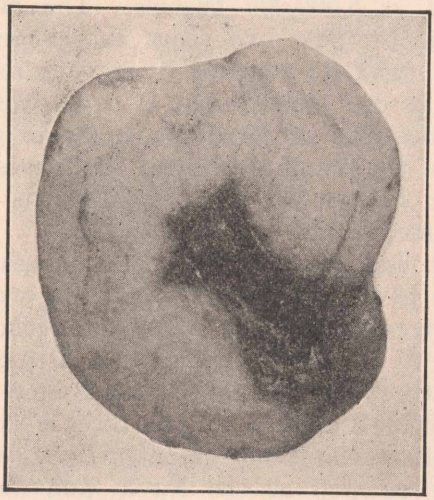

Fig. 7.—A potato affected with Black-leg, showing decay starting from the stem end. (After Orton).

compact top than the normal plants. As the disease progresses the top of the plant becomes pale green, then yellow, and finally it dies. A very good illustration of Blackleg is given in Fig. 6. The organisms causing the disease are able to pass from the stem to the new tubers, if any are formed, causing at first, browning of the vessels at the stem end of the tuber. This is followed usually by the total decay of the tuber. See Fig. 7.

The disease does not spread noticeably except by the seed tubers. It can, therefore, be controlled by hill selection of seed and seed treatment by the formalin dip.

POTATO BLIGHT.

Early Blight. This is a characteristic leaf blight; it is caused by the fungus *Macrosporium solani E. and M.* The disease can be identified by the brownish, more or less circular, diseased spots with concentric rings, which appear upon the leaves. The spots, although small, are often very numerous, in which case the leaves are killed, resembling somewhat tip-burn. This premature dying of the leaves greatly reduces the yield. So great is the loss that it has been estimated as high as 50 per cent in some cases, and the loss in Wisconsin in 1906 due to this disease was placed at 5,000,000 bushels. The disease has been common in Idaho the past two years but no great losses seem to have resulted from it; however, it spreads most rapidly and is most serious in dry seasons and in dry localities. Spraying with three applications of Bordeaux mixture, giving the first application when the plants are about six inches high, and following this with one or two more applications about ten days apart, has been found to control the disease.

Late Blight and Rot. Of all potato diseases this is the worst. It exists in all potato countries of the world but is most serious in certain regions where the climatic conditions are most favorable. Mr. W. A. Orton of the U. S. Department of Agriculture has placed the loss in the United States due to the Late Blight at $36,000,000 annually. The disease is caused by the fungus *Phytophthora infestans* (Mont.) *DeB.*, which is able to enter the tuber as well as the leaves and stems. The first indication of the disease usually appears at the margin of the

leaves, then on the stems, and finally on the tubers. The diseased leaves and stems quickly die, turn black, and give off an offensive odor. "On the tuber the surface shows slightly depressed, dark-colored areas, while internally the normal white color changes to dirty brown. If the soil is dry, dry-rot results; if wet, the tubers decay as wet, slimy, ill-smelling masses. In storage the disease continues, and the loss sustained in the field may be greatly augmented."—(*Stevens and Hall*). On account of our dry summers and cool nights this disease will never become as serious in Idaho as it has been in the northeastern states and in foreign countries. However, the disease is quite generally distributed over the state, as it is carried in the seed tubers. Seed selection by the hill method and rotation will possibly be sufficient to keep the disease down under our climatic conditions. It is controlled fairly well by spraying as for Early Blight.

DISEASES OF THE POTATO THAT MAY BECOME PREVALENT IN IDAHO.

LEAF-ROLL.

The cause of leaf-roll is not known, although considerable investigation has been carried on to determine the cause. It is one of the newer diseases in this country, but it bids fair to become a serious trouble. In 1911 it caused an epidemic in the Greeley district and in western Nebraska. In this connection Mr. Orton (1914) says: "The shipment from the Greeley district fell from an expected 7,000 to 200 cars. The average yield of the 3,190 acres in the Mitchell (Neb.) district was only 14 bushels per acre that year, as compared with 103 in 1909, 39 in 1910, and 102 in 1912. The cause of this extraordinary falling off in yield was the leaf-roll disease, though at first it was locally thought to be Fusarium and Rhizoctonia combined with the effect of the very dry and unfavorable weather of spring and early summer."

From the above it is easy to see that this disease may easily become a serious trouble in our state without careful hill selection of the seed stock. However, so far as the writer knows, the disease has not been reported from Idaho. Fig. 8 illustrates the visible characters of leaf-roll. The occurrence of any suspected cases should be reported, that its spread may be checked.

POWDERY SCAB.

"This differs from the common scab in the character of the spots on the tubers, which are at first covered and later break out into brown, powdery masses.—(*W. A. Orton*). See Fig. 9. This scab disease, caused by *Spongospora subterranea*, has been reported in the United States, and it occurs in Europe and Canada. It will probably be found in the west in the near future, although our government has placed a quarantine upon the potatoes of those districts where this disease is known to exist.

Fig. 8.—Typical potato leaf-roll. Observe that the leaves roll without wilting. (After Orton).

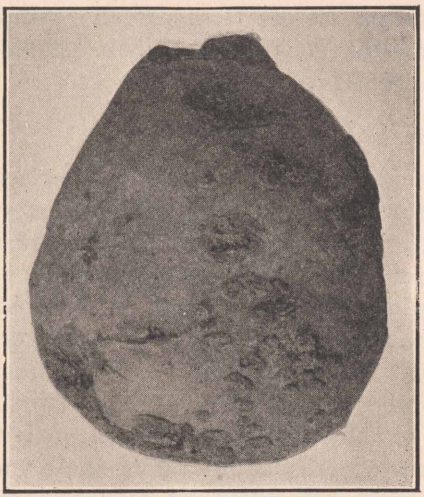

Fig. 9.—A potato affected with powdery scab. (After Orton).

Strict inspection is also made of foreign potatoes entering this country. It is hoped that this disease and the wart disease described later may be kept out. These diseases are given here so that the growers may keep on the watch for them. Any tubers that look suspicious should be sen tfor identification to the Experiment Station, Moscow, or to the Bureau of Plant Industry, Washington, D. C.

POTATO WART.

Potato wart is another disease that has not been reported from the United States; however, it has existed in Europe for eighteen years. During that time it has spread rapidly from Hungary, where it was first discovered, to almost all of the European countries, and recently to Canada. By means of quarantines against the disease in those districts where it is known to exist and strict inspection of all potatoes coming from foreign countries, it is hoped that this disease will be kept out of the United States. On the other hand, the importation of potatoes the last few years has been great, so the disease may have been carried in before strict government inspection was established. It is, therefore, important that every grower and every other one handling potatoes, should keep on the watch for the disease and report, at once, any suspected cases. The disease is due to a fungus (*Synchitrium endobioticum Perc.*) which causes irregular warty outgrowths on the tubers or destroys them entirely. Both conditions are shown in Fig. 10.

SILVER SCURF.

This disease has recently come into the eastern states from Europe and is spreading rapidly. It has not yet been reported from the West; however, it may be established as some potatoes are introduced from the East every year for seed. Mr. W. A. Orton (1913) says: "This disease is marked by dark areas on the skin of the tuber, which on close examination may be seen to be spotted with fine black points. This fungus does not produce a decay of the potato, but after the skin is killed there is a rapid loss of moisture and the tubers shrivel and take on a silvery appearance, greatly depreciating their market value. This fungus is apparently not killed by seed disinfection; therefore, all infected potatoes must be rejected.

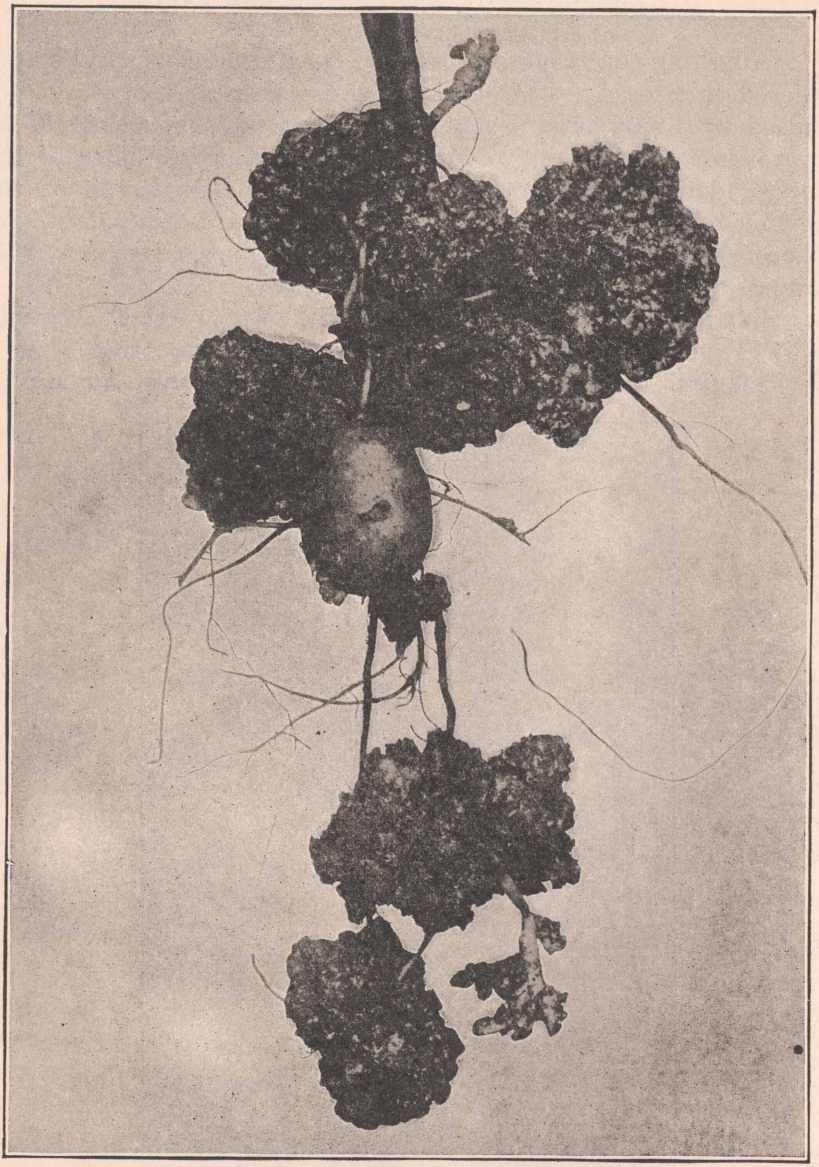

Fig. 10.—Shows the underground part of a potato plant destroyed by the Wart Disease. All of the tubers are destroyed except one and it has a wart on it. (After H. T. Gussow).

II.—PHYSIOLOGICAL DISEASES OF THE POTATO.

Anything that causes a plant to function abnormally is considered a disease. There are then diseases of the potato not caused by living organisms. Such disorders are spoken of as "physiological diseases." Familiar examples are tip-burn of the potato, due to excessive heat; stunting of the growth of the plant, due to unfavorable soil fertility, moisture, heat, light, etc. There are some other disorders which may be given here that are not so familiar as the above. These are:

Curly Dwarf. The cause of curly dwarf is not certainly known, but recent investigations seem to indicate that it is a physiological disease. The disease is characterized by a pro-

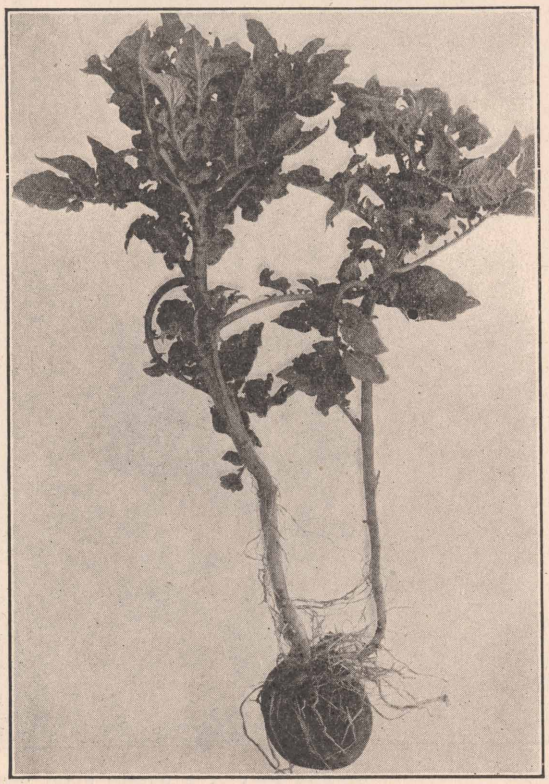

Fig. 11.—Potato Curly-Dwarf, showing dwarfing, reduction of foliage, and absence of tubers. Houlton, Me., August 12, 1912. (After Orton).

nounced curling and wrinkling of the foliage, and by the decided dwarfed appearance of stem and leaves which tend to form denser tops than those of normal plants. See Fig. 11. Diseased plants produce very poor yields. Mr. Orton reports the prevalence of the disease in fields examined from Maine to California at usually less than two per cent of the stand, but he found fields in which "even half or more of the plants showed curly dwarf." The disease seems to be inherited, and since the diseased plants are conspicuous in the field, hill selection will eliminate the disease.

Black Heart. This trouble arises when potatoes become too warm. It often occurs during transportation when stoves are placed in the cars, and in pits and root cellars when potatoes heat. The trouble may be identified by the black center of the tuber. In extreme cases there is a cavity found in the center of the tuber with a black border. The remedy consists in proper ventilation, keeping the tubers from becoming too hot.

Hollow Tuber. The exact cause of the cavity in potatoes does not seem to be known; however, some investigations are under way by the writer to determine the cause and methods of prevention. At the same time, some observations which have been made as to the conditions which tend to produce hollow potatoes may be instructive. In those parts of the state not under irrigation where almost all of the moisture falls in the winter and spring, hollow potatoes are seldom found. This is also true in those valleys where the water that makes the potato crop subs up gradually during the growth of the tubers. Under these conditions exceedingly large, yet perfectly sound tubers are produced. In the irrigated sections where the water is applied uniformly, as in the conditions mentioned above, there are practically no hollow tubers. On the other hand, if the growth of the tubers before they reach maturity is checked by the lack of sufficient moisture, and then an abundance of moisture becomes available, large numbers of hollow tubers result. The cavities are not confined to the larger tubers but are produced in the smaller ones as well. Conditions similar to those here described have been observed in the middle west when a soaking rain followed a drouth at a time when the plants of the late potatoes were still green. In this case, of course, these

conditions were unavoidable; however, in the irrigated regions they are usually avoidable. This is then another argument in favor of making the water supply for irrigated potatoes as nearly uniform as possible so that the development of the tubers may not be checked.

Second Growth and Knotty Tubers. The conditions which cause hollow potatoes have been observed to produce second growth and knotty potatoes. However, there seems to be also certain inherited tendencies toward second growth in potato tubers. The trouble can be controlled by hill selection of seed tubers and by applying the moisture uniformly so as not to check the development of the tubers until the end of the growing season.

III.—INSECT PESTS.

There are many insects which attack the potato but only a few of the most important are here given. Every grower should feel it his duty to report to the proper authorities any new insect trouble or fungous disease that may come under his observation, whether in his own crop or in the crop of others.

Colorado Potato Beetle. This is one of the most destructive incest pests of the potato; but at the same time it is one of the most easily held in check. The beetles come out of the ground in the spring and fly about on warm days and each female lays about 500 yellow eggs in small clusters on the under side of potato leaves. These eggs hatch in about a week and an army of small larvæ begins to devour the foliage of the potato. About three weeks later these reach maturity, enter the soil and form what is known as the pupæ. In about two weeks the adult beetles emerge from the pupa stage, and after feeding about two weeks longer, lay eggs for a second brood. The number of broods per year varies from one to three, according to the length of the growing season. In Idaho probably only one brood per year is the rule, as excessive loss from this insect has not been reported in the state. However, the insect has been present in relatively small numbers for several years in certain parts of the state;

but there are yet sections where it has not been seen. In view of the fact that it has destroyed the entire crop in certain parts of other states, it should not be allowed to become more prevalent than it now is. Spraying with either of the following solutions will control the pest. It is best to apply the spray just before each brood hatches. Both solutions are poisonous, so care must be taken not to leave them exposed to children or live-stock.

Slake 3 to 5 pounds of fresh lime in a small amount of water and strain; dissolve one-half pound of Paris green in about the same amount of water; mix the two solutions thoroughly and add enough water to make 50 gallons of the mixture. The lime is added to prevent injury to the foliage.

Or, dissolve thoroughly 2 pounds of lead arsenate in a little water and add enough water to make 50 gallons. For the identification of the insect see Fig. 12.

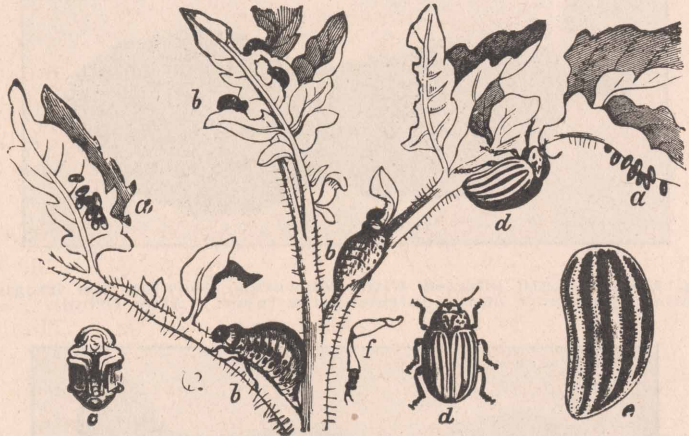

Fig. 12.—Colorado Potato Beetle. (aa), eggs; (bb), larvae; (c), pupa; (dd), beetles—all enlarged about one-fourth; (e), wing-cover—much enlarged. (After Riley).

Potato Tuber Moth. This pest of the potato causes more loss in California than in any other part of the United States. The loss from this source alone in the Salinas Valley has been placed at times as high as 40,000 sacks in a single year. At present our state has a quarantine against California potatoes on account of the tuber moth. If these moths were introduced into Idaho, they would undoubtedly spread over the state and cause untold

losses to our potato industry. The greatest injury comes from the larvæ while the tubers are in storage. Although the plants and tubers in the field are attacked, the larvæ, which are very small, burrow beneath the skin of the tubers. The injury to the skin is followed by the entrance of bacteria and fungi which soon decay the tubers. Suspected cases should be reported to the experiment station.

White Grubs. The common white grubs with which every grower is familiar may cause total loss to the growing potato crop. These grubs feed naturally upon the roots of grasses so that when potatoes are planted in the sod of an old meadow they turn upon the roots and tubers of the potatoes. The writer has observed a case in the northern part of the state, where three acres of potatoes were destroyed and several more acres were

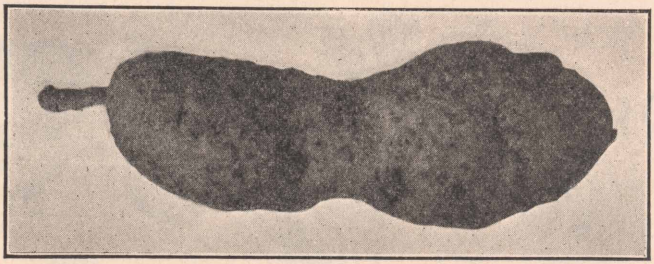

Fig. 13.—A potato affected with Eel-worms, showing the irregular, knotted appearance of the outside of the tuber. (After Orton).

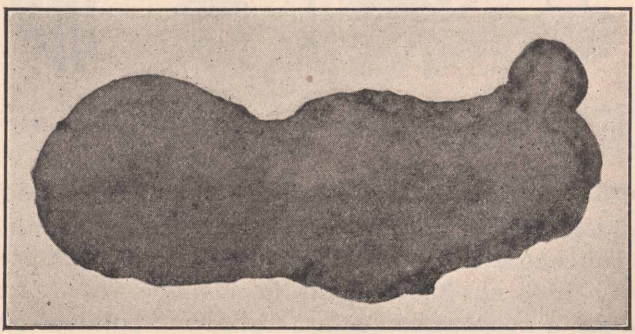

Fig. 14.—Longitudinal section of a potato affected with Eel-worms. (After Orton).

greatly injured by these grubs. When such cases occur it is well to let hogs root out the tubers, they will eat the grubs also. Late plowing will also help to destroy them.

Nematodes. These are not insects, but they should be mentioned here as they are minute eel-like worms. They enter the potato tubers and form small, hard, glistening white bits of tissue just beneath the skin and also a rough external appearance as shown in the Figures 13 and 14. An outbreak of *nematodes* occurred last year in southern California and southwestern Arizona; and the same without doubt will occur wherever infected seed is planted. Report at once to the experiment station any suspected cases for the pest must not be allowed to spread.

IV.—RECOMMENDATIONS.

1.—*Organization.* In order to grow a normal crop of potatoes, seed tubers free from disease must be planted in soil that is also free from the disease-causing organisms. These two points are of prime importance, and, if the grower is not willing to put forth an honest effort to make these a part of his practice, he had better stop growing potatoes as a field crop. It is well known that whenever any crop is grown continuously in any locality for a long time, the diseases of that crop tend to become more numerous and their attacks more severe from year to year. It is known also that plant diseases new to science are usually first discovered under just such conditions. It is further known that, unless the ravages of the worst diseases are held in check, there will come a time when the conditions are especially favorable for fungous growth and distribution. When that time comes, an epidemic with total loss of crop may follow. This has happened many times with other crops and a few times already with potatoes. The most noted of the latter was due to late blight which caused the potato famine in Ireland in 1845. In view of these facts, then, we may expect the potato crop in Idaho to become more infested from time to time with the diseases to which the crop is subject; and if nothing is done to hold these diseases in check, the crop will become eventually inferior and

unprofitable. On the other hand, the crop is too important to neglect longer. It is true that in almost every locality where potatoes constitute a field crop, some few enterprising growers have practiced methods of controlling the diseases; but it is not sufficient for a select few to practice these methods—*every grower must practice them every year.* This includes also the grower who realizes the value of practicing methods of control but who is often negligent in putting these methods into operation, as well as the grower who is not yet convinced that it pays financially to practice such methods. In this connection it is important to realize that the potato fields of indifferent and negligent growers may become centers of distribution to adjacent fields, for fungous diseases and insect pests are no respecters of farm fences. Therefore, as long as there are these various classes of men growing the same crop under similar conditions in the same community, some sort of organization is necessary for enforcing those practices and regulations that are for the general good of that community. It is as important to have unity and co-operation in the methods of producing a crop as it is for disposing of the harvest.

2.—*Seed Plat and Hill Selection.* Every potato grower should have a seed plat. It is important to start with seed tubers as nearly free from disease as it is possilbe to secure and to treat these with the corrosive sublimate or formalin dip. The size of the plat will depend upon the acreage to be grown the following year. The plat should never be located on ground that has been freshly manured or that has been in potatoes within the preceding four years. New land that has never grown potatoes but has grown a leguminous crop, as alfalfa, clover or peas, is preferable for the seed plat. The seed plat is given the usual care and cultivation during the growing season. If any diseased hills appear they should be removed, roots and all, and burned or buried. Just before frost, even though the plants are green, the plat should be dug, a hill at a time, with a fork, placing the tubers from each hill on the ground separate from those of all other hills. The seed tubers for the next year's seed plat are first selected with special attention given to freedom from disease, to yield, to shape, and to whatever other characters one might care to select for. Then the seed tubers for the main crop are selected, leaving on the ground only those

hills with one or more diseased tubers, together with those that made a poor yield, and those with knotty or small tubers. The selected tubers in both cases will be all the better if they are allowed to lie in the sun a few days to ripen the skin; however, this is not necessary. In potatoes, as in other crops, there are many strains in each variety; for example, there are low yielding strains and high yielding strains; strains with knotty tubers and subject to second growth and strains in which these characters almost never appear; there are strains that are susceptible to disease and strains more resistant to disease. By the hill method of selection all of these undesirable characters are gradually eliminated, although they may never entirely disappear. On the other hand by the bin method of selecting seed these undesirable characters will never be eliminated. Perfectly smooth, normal sized tubers which might appear to be very desirable for seed may have come from a hill that had all of the undesirable strains mentioned above. The bin method, therefore, cannot be depended upon to materially improve the potato crop. The hill method of securing seed requires extra labor but it will repay well any one for his trouble, if he will practice the method for a number of years. He will grow not only a better quality of potatoes but he will grow greater yields, thus profiting doubly by the practice.

In this connection, Prof. W. H. Olin. in his American Irrigation Farming, says: "On many irrigated farms this is now being practiced. In the heart of the Rockies at an altitude of 5,500 feet from seed plots on sagebrush land two potato farmers have harvested from twelve to thirty-one potatoes per hill of excellent quality and just right size for seed. On fields of twenty-five and thirty or more acres these farmers by using this seed plot have had field averages of 30,000 pounds per acre. We have known instances where a careful test gave one sack of culls to 200 sacks of commercial potatoes with hill selected seed and one sack of culls to twenty sacks of commercial potatoes using field run or average bin seed."

3—*Rotation.* Plant potatoes in soil that is free from organisms that cause diseases. As the disease-causing organisms are able to live a number of years in the soil, it is important to grow potatoes only once or at most twice in every four or five years on a given piece of ground. The rotation should not include

turnips, beets or mangels, but it should include at least one crop of legumes, as alfalfa, clover, beans or peas.

4—*Treat Seed Potatoes.* Treat all seed potatoes by one of the following methods. It is best to treat them before they begin to sprout, but they may be treated later without serious injury. For common scab only, use formalin dip; for scab and Rhizoctonia, use corrosive sublimate dip; for root cellars and storage houses, fumigate with formalin gas. After treating potatoes do not put them into untreated containers, lest they may become reinfected.

(*A*)—*Formalin Dip.* The uncut seed tubers should be immersed for two hours in a solution of one pint of forty per cent formalin to twenty-five gallons of water. Allow the potatoes to dry, after which they are ready to plant. When treating a large quantity of potatoes it is advisable to fix up the solution in six to ten barrels about one-half full so that one man can give his undivided time to the work. Each barrel should have a card attached for tabulating the time when each lot of potatoes is immersed and removed. If any lot should happen to be left in the solution four or five hours, they should not be planted, but they may be used for food after they have dried. This treatment is probably the best that can be recommended for common scab. The solution can be used repeatedly, if kept covered, but should not be allowed to stand exposed to the air for several days as it loses strength.

(*B*)—*Corrosive Sublimate Dip.* The uncut tubers are immersed for one and one-half hours in a solution of four ounces of corrosive sublimate in crystaline form to thirty gallons of water. This solution loses strength rapidly with each application and is not safe to use more than three or four times. It will corrode metal containers, consequently it is best to keep it in wooden or earthen containers. It has the distinct advantage over the formalin dip in that it will kill Rhizoctonia as well as all of the scab organisms; on the other hand, *it is a deadly poison, so that potatoes must not be eaten or fed to live stock after they are dipped.*

(*C*)—*Formalin Gas.* When treating potatoes by this method considerable attention must be given to details and for that reason it is not recommended for the use of the ordinary farmer;

and further, it is not recommended to anyone for cases where the formalin dip or the corrosive sublimate dip can be used. It does not kill all Rhizoctonia, as does the corrosive sublimate dip. It is, therefore, no more effective for treating seed tubers than the formalin dip; on the other hand, it is much more liable to injure the tubers than either of the dips. It does have the advantage, however, of saving time and expense when large quantities of potatoes are to be treated. It may also be used for fumigating root cellars, storage houses, dwellings, etc. When using this method for treating potatoes either for seed or for storage, the following details must be followed:

First. Secure a room that is practically air-tight and by measurement figure the number of cubic feet of space in it.

Second. Place the potatoes to be treated in slatted crates six to eight inches deep and arrange these so that the gas can circulate freely around all of the potatoes.

Third. The amount of potatoes to be used is 100 sacks for every 1,000 cubic feet of space in the room, or approximately ten pounds per cubic foot. According to recent investigations by Stewart and Gloyer this is one of the most important points to be observed in the whole process, although it might seem to be the most unimportant of all. For a discussion on this point see Bulletins 369 and 370, N. Y. Agr. Exp. Station, Geneva, N. Y.

Fourth. For each 1,000 cubic feet of space in the fumigating room use 23 ounces of potassium permanganate and three pints of 40 per cent formalin. Place the potassium permanganate in a large vessel and place this vessel in another larger container; for example, a large pail for the first and a wash tub for the second will suffice. The smaller container is placed 2½ feet from the nearest potatoes to avoid injury from heat which is generated by the chemicals. The proper amount of formalin is now poured from a pail (not from a bottle) upon the potassium permanganate. The smaller container is given a turn or two in order to distribute the formalin evenly over the crystals. Close the door quickly and tightly and do not open for 24 hours. Potatoes thus treated are not injured for food.

5—*Plant Whole Potatoes.* There are good reasons for planting whole potatoes from the standpoint of disease as well as from the standpoint of increased yield. Everyone has noticed that

cut potatoes in storage decay before uncut ones. It has been observed that when whole potatoes are planted they are often found at digging time still undecayed, even though watery; on the other hand, when freshly cut tubers are planted they usually decay in a few weeks. The reason for this difference lies in the fact that the skin of the potato keeps the decaying organisms of the soil from entering, whereas the freshly cut surface of the tuber makes a good culture medium for these same organisms. So they grow into the set and devour the food which rightly belongs to the new potato plant. If this is done before the new plant has developed roots and leaves, its growth will stop. No doubt this often happens and is, therefore, an important factor in causing poor stands. If you have had trouble in getting a good stand, try planting whole potatoes.

6. *Prevent as far as possible all injury to the skin of the tubers.* This is especially important when digging, storing and sorting. Considerable injury to the skins will be averted when sorting, if the potatoes are poured upon a sack at the upper end of the sorter and allowed to roll from this onto the bars. Handling potatoes with a potato shovel is without reason. However, the fact that the skin is slipped on a certain lot of potatoes does not mean that those potatoes are going to rot; various conditions may prevent rotting. The important point is that every time the skin is broken a new door is opened to organisms that cause decay.

7—*Keep the Cellar Cold.* The organisms that cause decay of potatoes are living beings and like ordinary beings their life processes become more sluggish the colder they become. The secret of successful storage is therefore to keep such organisms as that which causes dry rot so cold that it is compelled to lie dormant during the whole storage period. With proper ventilation it is possible to hold the temperature of the storage cellar between 32° and 35° F. for several months. A good thermometer in the cellar is necessary. If the temperature goes up to the 40°-45° F. mark the potatoes will begin to sprout and rotting will be manifested.

8. *Do not Plant Potatoes in Freshly Manured Land.* Certain organisms that cause potato diseases are able to live in fresh barnyard manure. The exact relationship existing between these organisms and the manure is not known. However, the follow-

ing observation illustrates well what may be expected when potatoes are planted on freshly manured ground. In this particular case the seed was treated by the formalin gas method here given. It was planted in ground which had been in timothy meadow for the preceding ten years, the ground being plowed the fall before planting. At one side of this field there was a barn and hay lot and manure had accumulated from cattle and horses for a few rods out into the meadow. So far as known no potatoes had been fed to this stock in previous years. However, the potatoes were badly diseased with scab where there was most manure but farther away from the barn on the same rows, where there was no manure, there was no scab. This is only one of many convincing cases that potato scab occurs, when potatoes are planted in freshly manured land.

9. *Do not Feed Diseased Potatoes to Live Stock* unless the potatoes have been cooked. The reproductive bodies of some disease-causing organisms retain their vitality after they pass through the animal. They may, therefore, be carried out with the manure to infest new fields.

10. *Destroy Decayed Tubers.* Bury, burn or cook them; never throw them into gullies or irrigation ditches.

11. *Destroy the Insects.*

12. *Report New Diseases.* Keep on the watch for them and report them to the experiment station. Franking tags may be secured from the experiment station, Moscow, Idaho. These tags will carry as much as 20 pounds of diseased plants without postage. They are free; make use of them.