I. THE STATUS OF THE POTATO GROWING INDUSTRY IN OHIO
II. SEASONAL NOTES ON POTATOES

OHIO
Agricultural Experiment Station

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BULLETIN 218

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1In cooperation with the College of Agriculture, Ohio State University, Columbus.
2In cooperation with the U. S. Department of Agriculture.
Potato culture, in Ohio, is rapidly developing into a vast industry. The crop of 1907—the last year for which statistics are available—reached the enormous aggregate of 10,825,659 bushels. Among the staple products of Ohio soil, potatoes, therefore, rank fourth in the number of bushels produced—corn being first, oats second and wheat third.

Roughly dividing the state into four parts by drawing an imaginary line from Sandusky on the north to Ironton on the south; and from Bellaire, in Belmont county, on the east to Greenville, Darke county on the west, we find that, in the northeastern quarter were grown in 1907, approximately 5,800,000 bushels, or more than one-half of the total production of the entire state.

The ten heaviest potato producing counties of Ohio are Portage, Wayne, Medina, Cuyahoga, Hamilton, Stark, Lucas, Summit, Erie and Mahoning, named in the order of their yields for 1907, beginning with the highest. The same counties have maintained their precedence as the banner producers for the past ten years, although the order of individual yields may have been transposed occasionally—especially those noted for close competition. Seven of the ten heaviest producing counties, in 1907, were embraced wholly within the northeastern quarter; also the greater part of another—Erie. Lucas county, the seventh in point of production, and a small part of Erie, are in the northwestern quarter. Hamilton county, the fifth in point of production, in 1907, contributes this distinction to the southwestern quarter.

While these figures and data are interesting, they should by no means be construed to suggest that outside of the sections and counties named this industry is not followed with success and profit,
nor that potatoes of equally as fine quality cannot be grown. The valleys of the Great Miami, Little Miami, Scioto, Licking, Hocking, Muskingum and other rivers and their hundreds of tributaries, as well as many fertile, upland soils in various other parts of the state, yield fully as high an average per acre in bushels, and equally as good potatoes as relates to table quality.

The ten lightest potato producing counties of the state, during the period of the last ten years, are Fayette, Union, Highland, Madison, Harrison, Preble, Warren, Adams, Jackson and Gallia. Of these counties, during the period of the last ten years, Fayette stands notable as the least devoted to potato culture, therefore producing the least number of bushels, of any county in Ohio. Its average for the ten years is about 7,200 bushels per year. Only 580 bushels were grown in Fayette county in 1907. This county will illustrate the fact that the status of the potato growing industry in different counties is determined not by the degree of fertility or productivity of the soils of these counties, but by the branch or branches of agriculture or horticulture which are specialized by the land owners thereof.

In addition to the regular lines of potato work at the Experiment Station there has been considerable material of a miscellaneous nature gradually accumulating through special experiments and careful observations both at the Station grounds and throughout the state, which should be of much practical value to the potato grower, especially the beginner. The more important features of this accumulated fund of practical information are now assembled in this bulletin, inasmuch as it was considered that such a publication would clearly and fully answer many oft-recurring questions from correspondents, which cannot be fully and satisfactorily answered within the limited scope of personal letters to each one.

**ROTATIONS FOR POTATOES**

An excellent rotation for the potato farmer is a three-year cycle of potatoes, wheat and clover. Barnyard manure, unless it be well rotted, in this rotation is preferably used as a winter top-dressing on the wheat or clover. It is not advisable to plow under fresh stable manure in preparation for potatoes, as such manure favors conditions under which the tubers are likely to be more or less attacked by the scab fungus, thereby blemishing a portion of the crop. The aim should be to induce a strong growth of clover, and to this end lime may often be used to advantage on the wheat preceding the clover crop.
Another good rotation for the potato grower who is also engaged in strawberry growing, is clover, potatoes and strawberries. In detail, the strawberry bed is plowed under at the close of the first or second season's fruiting, the soil finely and firmly worked down and medium red clover immediately sown at the rate of 15 or 20 pounds per acre. This plan of mid-July clover seeding has rarely met with failure under the writer's observation or practice. If the season be at all favorable the clover will make a good growth the same season of sowing. A crop of hay may be taken the following season, the second growth being allowed to remain on the ground to be turned under the following spring. Potatoes follow the clover, and after these are harvested rye is sown as a winter cover crop to be turned under the succeeding spring in preparation for strawberries. This plan provides for a four-year rotation if a single crop of strawberries be gathered, or a five-year rotation if two crops be harvested. Other garden crops may be substituted for the strawberries if the grower desire. A late crop of potatoes, using sprouted seed, may also be grown after strawberries. This plan is usually very satisfactory if properly carried out, often giving a yield of potatoes equal to or greater than the early planted crop. The strawberry bed should first be thoroughly disked and then plowed and carefully harrowed, then rolled and harrowed again. Wheat and then clover follow the potatoes.

PREPARATION OF THE SOIL AND METHOD OF APPLICATION OF FERTILIZERS

The question is often submitted: "Is it a commendable plan to plow ground, intended for potatoes, in the autumn or during open periods in the winter?" Fall or winter plowing might be advisable under certain conditions. These conditions would depend principally upon the character of the soil and the amount of work to be done with a given force of help. If the soil be tenacious clay or heavy clay loam, plowing too far in advance of the planting season would certainly result in the soil becoming so compacted by late winter and early spring rains that preparation of a deep, mellow seed-bed would be a difficult proposition. Lighter clay loams abounding in humus, or soils of a sandy nature, might safely be plowed in autumn or winter, providing they are so situated that there is no great danger of loss of soil and fertility by washing, as would be the case on steep hill-slopes. In any case where fall plowing is practiced it is well to work the ground as deeply as possible in the spring with a disk harrow or two-horse cultivator. Those who farm level or comparatively level land do not realize the importance of great care in this respect in the hilly sections.
In a general way it may be stated that the better plan is to plow potato ground as early in the spring as the ground becomes in good condition to work. In sections of the state where early planting is practiced it is the custom to plow, prepare and plant at once. In other sections, as in certain parts of northern Ohio, where June planting is the rule, the ground may well be plowed as soon in the spring as it will work well and harrowed every week or ten days until the chosen time of planting arrives. This will result in the germination of millions of weed seeds and the prompt finish of the tiny plants. In any case the ground should be worked down until the soil is fine and the surface level and smooth.

After experimenting with different methods of application, the Experiment Station now favors and practices drilling in commercial fertilizer by the use of a common grain drill with fertilizer attachment. This is done after the ground has been harrowed once or twice and just previous to planting, where early planting is the rule. In case of late planting on early prepared ground a greater number of harrowings would, of course, precede the fertilizer application, which would be delayed until planting time. By this means of application the fertilizer is distributed evenly over (or rather in) the entire area where the feeding roots of the potatoes will readily find it as they freely extend through the upper soil. By this uniform distribution of the fertilizer the potato plants not only more fully profit by the application, but the surplus food, left in the soil after the maturity of the potatoes, will be evenly distributed for the wheat, rye or other crop which may follow. The modern horse potato planters are almost invariably provided with fertilizer attachments, planned only for distributing the fertilizer in the bottom of the furrow in a comparatively narrow line. While the crop, of course, benefits from this application, it does not by any means do so to the extent that would be possible were the plant food spread throughout the soil. Only a comparatively small percentage of the potato roots are found within the restricted limits of the three or four inch wide strips extending beneath the rows of plants. True the feeding roots of plants, according to one of the laws of nature, to some extent are attracted toward, concentrate and multiply about these rich sources of available plant food; but such concentration clearly means a greater or lesser degree of congestion or crowding and a corresponding and unusual drain upon the soil moisture of these restricted areas. This, especially in seasons of severe drought, is a condition of the feeding root systems of our plants not especially desirable and preferably not invited.

It is, of course, impracticable in planting by hand, small or garden areas for home use, to use a grain drill for applying the fertilizer. In these small patches it is a most excellent plan to open the
furrows with a large, broad-bladed, single shovel plow, leaving furrows approximately six inches deep and twelve inches broad at the top. The fertilizer is then applied by hand, scattering it not only in the bottom of the large furrow, but covering the sides or slopes as well. When the potatoes are planted in this furrow, covered, and the ground levelled down with a fine tooth harrow or cultivator, there will be spaces fully a foot wide along and beneath the rows, in which the fertilizer will be well distributed and mixed with the soil.

NORTHERN VERSUS HOME GROWN SEED POTATOES.

STORAGE

The widely prevailing belief that there is some special quality of superiority in northern grown potato seed stock, not possessed by our home grown seed, is responsible for many thousands of dollars being annually expended by Ohio potato growers for "northern grown stock." The Experiment Station is frequently called upon (especially by beginners in potato culture) to state whether there is just cause for entertaining such a belief and adhering to such practice.

It must be admitted that there is more or less abuse of the phrase "northern grown;" it is wonderfully elastic as commonly employed in the trade, and may signify much, considerable, little, or nothing at all. Maine, Vermont, Michigan or Wisconsin grown potatoes are truly "northern grown" stock as received and used by Ohio planters. Ohio grown stock is truly "northern grown" when used by planters in the southern states. Seed tubers produced in the Lake Erie district might, with some justification, be sold as "northern grown" to southern Ohio growers. But frankness prompts the suggestion that an indiscriminate selling, by dealers and seedsmen, of Ohio grown stock to Ohio planters, as "northern grown," approaches a travesty on the seedsmen's trade; it borders closely on deception and the getting of money under false pretence; it is, to say the least, making use of a "magic phrase" that has come to mean too much to the buying public and too little in reality. Happily, when the Ohio purchaser seeks northern grown potatoes and is supplied with Ohio grown stock that is plump, sound, bright and dormant; and if the conscience of the dealer become not a source of annoyance at these bits of deception, no one is materially injured—least of all the buyer; for, if the seed be as I described—well preserved and dormant—he will have secured as good stock for planting as the continent produces. But let us insist that this commodity be placed on the market for what it is; and let us judge its value as seed stock by its apparent purity as to variety and by its condition rather than by its source.
Excellence or inferiority of potato seed stock, therefore, depends vastly more upon its condition at the time of planting than upon the latitude or locality in which it was grown. The reason that northern grown stock has come to be noted for its superiority for a more southern latitude is because the seed is wintered in a lower degree of temperature in the more northern sections; it is kept sound and hard, crisp, fresh and dormant, and comes down to us at or just previous to planting time in this most desirable condition. It has lost none of its vitality through sprouting in storage. But, if seed tubers of our own growing be given similar storage conditions and is plump and dormant when spring comes, these are equal to the best stock in the market, no matter how far north it may have been produced. However, too often, our seed stock is wintered in too warm a storage, where it exhausts its vitality and becomes withered and shrunken through excessive sprouting. Especially is this true of stock wintered in cellars under dwellings.

The problem of storage, therefore, becomes the chief consideration and the determining factor of success as against failure for the professional potato seed grower, the dealer and the home or market grower who desires to produce his own seed stock. It is an especially important matter with the grower who is interested in the improvement of his favorite variety or varieties by careful selection from year to year. He must preserve his stock from season to season and preserve it in good condition if he maintain a continuity of the fascinating work and marked progress he is achieving in his chosen line of potato breeding. Those who make a practice of annually buying seed from another latitude or section as a rule do not realize or recognize the possibilities of, nor attach great importance to seed selection; and even if they do, it is not possible for them to take part in the maintenance of the high standard of a variety or its improvement by the potent means of selection of superior strains of that variety.

Not only extended observation, but carefully conducted tests at the Ohio Station, have shown that far northern grown potato seed stock is not superior to Ohio grown seed, if our home grown seed is well preserved. Bovee, Happy Medium, Gold Coin and Carman No. 3, seed from Maine, Michigan and Wisconsin was, in 1905, planted alongside seed taken from the cool, barn-basement storage on the Station grounds. The growing and yielding qualities of the home-grown stock was in every point fully equal to the northern grown seed. No more uniform plots could have been grown had the different plots of the same varieties been planted from the same seed-lots. But it must be admitted that our Station grown seed was in equally
as good condition at the time of planting as that from the more northern and colder latitudes. Had the seed of our own growing been robbed of its vitality by becoming excessively sprouted in a too warm storage, and withered and shrunken as too often home grown seed stock becomes, the results would doubtless have been in favor of the northern grown seed stock, as has often been proved in comparative tests.

A cellar or basement under the barn or some similar farm building can usually be converted into a suitable storage for seed potatoes. Storage cellars under outbuildings are much cooler than those under dwellings. The temperature of such a potato storage may quite readily be held at from 34 to 40 degrees, by reasonably careful attention. When a dangerously low degree of cold is threatening, a lantern, or small, oil stove may be kept burning in the storage room. To guard against possible danger from explosion, or overturning of the lantern or stove, and spreading of oil, the heating device should be set in a large metal pan, or a metal tub. If the temperature of the storage ascends to 40 degrees or above, through the influence of unusually high, daytime temperature, the outside doors or the ventilators should be thrown open during the colder temperature prevailing through the night time. This will usually lower the temperature of the storage and its contents to the desired degree. All outside openings should be provided with fine-meshed wire screens to exclude vermin when the outside doors are open.

Underground storage rooms or "caves," built in a hillside or on well-drained level situations, may be made to do excellent service for potato seed storage. The same means of controlling the temperature of these, as used in cellars of outbuildings, may be employed.

Potatoes may also be buried in out-door pits and kept in fine condition until planting time. A well drained location should be chosen for the pit—one from which the surface water will readily run away. The tubers are piled in conical, pyramidal or long, sharp-ridged heaps, and covered over with six or eight inches of clean straw. Over the straw is covered about six inches of soil. Straw is also spread on the ground in a circle a little distance back from the base of the pit; this is to prevent the ground thus covered from freezing, so that more soil may be readily available when desired. As soon as the first covering of the soil over the pit has become solidly frozen a second covering of straw is added, and over the straw another six inches of soil. The second stratum of soil is then allowed to freeze solid, after which a layer of bundles of corn stover or a heavy covering of straw is placed around or over the pit, to shade and maintain the low degree of temperature prevailing within. Potatoes wintered in this way come out clean, plump, fresh and unsprouted at planting time.
It is evident that as the preservation of seed potatoes in good condition for planting becomes more and more difficult as the southern limit of Ohio is reached, the advisability of procuring seed from more northern sections becomes a more important consideration unless some plan of cold storage is available. But in the northern two-thirds of our state, no great difficulty need be experienced in keeping home grown stock in good condition in carefully constructed outbuildings or barn storage rooms. Growers in the southern states resort to growing a second crop of potatoes from the seed of the first crop, in a single season. The second crop seed keeps in good condition for the next season's planting. This plan is not practicable for our latitude; but late planting of "sun-sprouted" seed tubers may be substituted, and an excellent quality of long-keeping seed stock produced for the following year's planting. Such seed stock is fully equal to second crop southern seed, and is better than much of the so-called northern grown seed found in the market.

"SUN-SPROUTING" SEED POTATOES AS A MEANS OF PRESERVATION AND PREPARATION FOR PLANTING

While it is impossible to preserve seed potatoes in good condition in a storage which combines a too high degree of temperature with darkness, semi-darkness or even slightly subdued light, it is quite possible to keep them for several weeks, in late spring or early summer, when they are spread thinly on the floor of a bright sunny room. After danger of freezing weather's past they are even better placed out of doors in the direct sunshine. A series of shelves arranged one above another on the southern exposure of the dwelling or a farm building provides an excellent place for sun sprouting. The tubers are spread in single layers on the shelves and allowed to remain until wanted for planting. Exposed to the full force of the sun's rays the tubers, instead of sending out long, white, tender, succulent sprouts as in poorly lighted storage, become hardened in

Fig. 1. Tuber exposed to direct sunlight for four weeks.
flesh and green in color, and very short, stubby, firm, green sprouts are developed by the eyes. Withering of the tubers is but slight as compared with that under conditions found in a warm, dark storage, and they will remain in the sunlight many weeks in good condition for planting. Photographs are herewith presented showing one tuber that was exposed to the sunlight four weeks and another that was exposed ten weeks. Such tubers, when cut one sprout to a piece and planted, send up strong plants in a surprisingly short time.

It is hardly profitable to sun sprout large tubers for planting, as not all of the eyes will develop sprouts and considerable waste will result. However, the plan is excellent when smaller tubers are used and planted without cutting. So firm and tough become the hard short, sturdy sprouts developed in the sun, that planting may be done with certain horse-power machines without injury to the seed tubers if not too many are placed in the planter at a time. Planting of sun-sprouted seed is often delayed as late as the early part of July with excellent results in the production of a fine quality of seed stock for the following year.
Seed stock subjected to the prolonged “sun bath” does not require treatment for tuber infesting fungi, with formalin or corrosive sublimate. Bright, hot sunshine is, in itself, an effective fungicide. However, the usual recommended treatment with formalin seems not to produce any injury to the firm, green sprouts, as determined by a test in the season of 1908.

By the plan of sprouting the tubers of first early varieties in a sunny room early in the spring, the season of new potatoes for table use can be hastened nearly or quite two weeks, as was also demonstrated in 1908 in a comparison of sun-sprouted seed with ordinary cellar stored stock.

EXPERIMENTS WITH DIFFERENT QUANTITIES OF SEED POTATOES PER ACRE

The principle test work with potatoes in the season of 1906-1907, aside from the regular fertilizer and variety experiments, was the comparison of different quantities of seed per acre (determined by the different sized seed pieces used) planted in adjoining uniform plots of soil. The work was taken up in response to numerous inquiries from correspondents, and conducted with the utmost care and interest.

In this experiment were used, the first year, 10, 15, 25 and 40 bushels per acre, planting two standard varieties, Bovee and Carman No. 3, and duplicating the work in full so that dependable average results might be obtained. The second year’s work was a duplication of that of the first year with the exception of one additional plot, representing a different rate of seeding with a different class of seed tubers not used the first season. This will be explained in its proper place.

The seed pieces were very carefully cut and accurately weighed in each and every rate of planting. In the 10 bushels per acre rows one-eye seed-pieces were used; in the 15 bushels per acre, two eyes; in the 25 bushels per acre, half tubers, and in the 40 bushels per acre whole tubers. The tubers throughout were smooth, of fine form and as nearly uniform in size as it was possible to have them in order to secure the desired weights from the different sized seed pieces. In order to overcome the now generally recognized tendency of plants to perpetuate, in the new generation, individual characteristics whether these be desirable or objectionable, not more than one seed piece from a divided tuber was permitted to be planted in a single test row. As an illustration: In the selection of seed tubers it is quite likely that we shall unwittingly choose an occasional tuber that was grown from a seed piece that produced in the hill a very small number of tubers. Perchance the
tuber we have chosen for planting was the only one of acceptable size produced by its parent plant; we do not and cannot know, unless we had selected the seed tubers from individual plants or hills the preceding season. Assuming that the unproductiveness of that particular hill was inherited from the parent seed stock, it is evident that we should make a grave mistake in dividing possibly the only good tuber from that hill and using it for planting a consecutive number of hills in a single test row. What is true of a tuber of inherent unproductiveness is also true of a tuber of inherent prolificacy.

Therefore, in order to render our test of more value and dependence, we first cut a tuber in halves. One half was used to plant one hill in the 25 bushels per acre section. One eye out of the remaining half went to form a hill in the 10 bushels per acre section. A two-eye piece from the same half-tuber found its way to a hill in the 15 bushels per acre section. If there were any eyes left from that particular half-tuber, they were discarded. Each hill of the 40 bushels per acre section of course required a whole or individual tuber, hence there was no division and no great danger of duplication of seed tubers from the same parent plant.
It was interesting to note the difference between the young plants of the different sections, as they pushed up through the soil in due time after planting. The difference in vigor of plants, for the first week or two, was decidedly in favor of the whole tubers. The plants from the one-eye pieces were at first much more slender than those from the two-eye pieces, half-tubers or whole tubers. These more delicate plants required greater care in the first cultivation, but the difference was not so apparent later on as the plants gained in size and vigor, and by the height of the growing season the individual stalks from the single-eye pieces were as large and strong as the stalks from the larger seed pieces.

As the rate of seeding per acre was increased, depending on the size of seed pieces used, in like proportion was the average number of plants or stalks per hill increased. Increasing the size of potato seed pieces, therefore, (with a corresponding addition to or multiplication of the number of eyes contained) is equivalent to increasing the number of grains per hill in seeding corn; and from extended observation in the past as well as from experiments conducted to obtain data for this bulletin, the results in either case may reasonably be expected to prove similar. By increasing the number of stalks per hill (up to a certain limit) the total yield may be somewhat enlarged, but this gain in yield is often at the expense of the size, development and quality of the product—whether this product be potato tubers or ears of corn. The following table shows the average number of potato stalks per hill from the different sized seed pieces used. One row of 45 hills was counted in each section:

<table>
<thead>
<tr>
<th>Size of seed pieces</th>
<th>Rate of seeding</th>
<th>Total number of stalks in one row of 45 hills</th>
<th>Average number stalks per hill</th>
</tr>
</thead>
<tbody>
<tr>
<td>One eye</td>
<td>10 bus. per acre</td>
<td>94</td>
<td>2+</td>
</tr>
<tr>
<td>Two eyes</td>
<td>25 &quot;</td>
<td>262</td>
<td>6+</td>
</tr>
<tr>
<td>Half-tubers</td>
<td>40 &quot;</td>
<td>485</td>
<td>11</td>
</tr>
<tr>
<td>Whole tubers</td>
<td>22.6 &quot;</td>
<td>356</td>
<td>7+</td>
</tr>
<tr>
<td>Small tubers (2 oz.)</td>
<td>10 bus. per acre</td>
<td>92</td>
<td>2+</td>
</tr>
<tr>
<td>Two eyes</td>
<td>25 &quot;</td>
<td>181</td>
<td>4+</td>
</tr>
<tr>
<td>Half-tubers</td>
<td>40 &quot;</td>
<td>282</td>
<td>5+</td>
</tr>
<tr>
<td>Whole tubers</td>
<td>22.6 &quot;</td>
<td>153</td>
<td>4+</td>
</tr>
</tbody>
</table>

It will be noted that in the above table that the large seed pieces of Bovee produced a correspondingly increased number of stalks to the hill, while the Carman No. 3 does not exhibit this tendency in
nearly so marked a degree. Indeed the Carman, as a representative of a distinct type of potatoes to which many varieties belong, is widely different from the Bovee, which is likewise representative of another type or family. It is almost impossible to cause the Carman to crowd in the hill, from the planting of a single seed piece, no matter how large. A whole tuber of good size may produce but two or three strong stalks, while had that same tuber been divided into one- or two-eye pieces each piece would likely have produced an equal number of strong shoots. It can hardly be said that the buds or eyes of the Carman lack vigor, but it is true that there is a tendency for a good percentage of the eyes to remain dormant in a whole or half tuber when planted, while further cutting of the same tuber—the isolation of each single eye—would have resulted in a full percentage of growth. On the other hand the Bovee represents a class of varieties which may be said to be free and profuse in their habit of sprouting or germination, as has already been demonstrated in the accompanying table.

As to the time of maturity, in the different sections of the same varieties, there seemed not to be a noticeable difference, although it has been observed by some experimenters that while plants from whole tubers do not mature earlier in the season, there may be obtained from hills grown from whole tubers new potatoes of usable or marketable size earlier in the season than from piece planting.

The following table presents, in a form convenient for comparison, the average results of two years' experiments (1906-1907) with different quantities of seed potatoes per acre. The test of small tubers, as noted in the table, was included only in the test of the second season (1907). The addition of this test of small tubers was and is considered a feature of but minor importance. The figures are given only as a matter of interest.

It will at once be noticed that with the Bovee the yield of small or "unmarketable" tubers (tubers less than two ounces in weight) increases quite uniformly as the size of the seed pieces and quantity of seed per acre are increased. This is not apparent with the Carman, clearly for reasons already given with reference to the Carman's peculiar nature or habit of restricted sprouting or "germination."
TABLE SHOWING RESULTS OF USING DIFFERENT QUANTITIES OF SEED POTATOES PER ACRE. AVERAGE FOR TWO YEARS

<table>
<thead>
<tr>
<th>Variety</th>
<th>Yield per acre, bus.</th>
<th>50</th>
<th>100</th>
<th>150</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bovee (one eye)</td>
<td>10 bushels per acre</td>
<td>146.6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>marketable</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>unmarketable</td>
<td>32.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bovee (two eyes)</td>
<td>15 bushels per acre</td>
<td>159.1</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>marketable</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>unmarketable</td>
<td>45.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bovee (half tubers)</td>
<td>25 bushels per acre</td>
<td>131.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>marketable</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>unmarketable</td>
<td>73.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bovee (whole tubers)</td>
<td>40 bushels per acre</td>
<td>168.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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</tr>
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<td></td>
<td>unmarketable</td>
<td>99.4</td>
<td></td>
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<tr>
<td>Bovee (small or 2 oz. tubers)</td>
<td>22.6 bushels per acre</td>
<td>150.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>marketable</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>unmarketable</td>
<td>73.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carman No. 3 (one eye)</td>
<td>10 bushels per acre</td>
<td>164.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>marketable</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>unmarketable</td>
<td>25.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carman No. 3 (two eyes)</td>
<td>15 bushels per acre</td>
<td>204.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>marketable</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>unmarketable</td>
<td>31.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carman No. 3 (half tubers)</td>
<td>25 bushels per acre</td>
<td>217.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>marketable</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>unmarketable</td>
<td>35.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carman No. 3 (whole tubers)</td>
<td>40 bushels per acre</td>
<td>223.0</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>marketable</td>
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<td></td>
<td>unmarketable</td>
<td>51.8</td>
<td></td>
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<tr>
<td>Carman No. 3 (small or 2 oz. tubers)</td>
<td>22.6 bushels per acre</td>
<td>145.2</td>
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<td></td>
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<tr>
<td></td>
<td>unmarketable</td>
<td>48.2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Upon a basis of dollars and cents, we find that the Bovee, at the fair, average price of 50 cents per bushel both for the seed used and the product grown:
15 bushels of seed per acre gave a gain of $3.75 over the 10 bushels.
15 bushels of seed per acre gave a gain of 18.70 over the 25 bushels.
15 bushels of seed per acre gave a gain of 7.70 over the 40 bushels.

With the Carman No. 3, at the same price per bushel:
15 bushels of seed per acre gave a gain of $17.55 over the 10 bushels.
25 bushels of seed per acre gave a gain of 1.40 over the 15 bushels.
15 bushels of seed per acre gave a gain of 3.15 over the 40 bushels.
In these calculations the value of the excess of seed, where the larger quantities were used, was of course taken into consideration. There yet remains a very important feature to be explained which the foregoing table does not exhibit. This matter pertains to the size, uniformity and beauty of the tubers; these qualities figure largely when the product goes upon the market—especially a discriminating, retail market. In every case the tubers grown from the one- and two-eye seed pieces, while somewhat less in number, average far above those grown from the heavier rates of seeding. For the cause of this we have only to refer to the table showing the proportionate increase of the number of stalks or plants per hill as the quantity of seed per acre is increased by using larger seed pieces. It becomes clear that a surplus potato stalk in a hill of potatoes is just as a surplus stalk of corn in a hill of corn; it is a "weed plant;" and while its presence may or may not lower the total yield, in weight or bulk, of the hill in which it occurs, its presence will detract from size, the fullest development and sightliness of the individual tubers produced in that hill. The photographs which follow show conclusively that the
quality or the product declines as the rate of seeding per acre increases, even though the scales and the bushel measure may indicate a greater or lesser increase in the total weight or bulk.

Inasmuch as whole, small or two ounce tubers were used in 1907 in comparison with the one- and two-eye seed pieces and the half-tubers and whole tubers (all from select stock) it will, perhaps, be well to include a brief statement relative to results. For reasons which will be made clear in the chapter on potato seed selection and improvement, the writer does not care to spend much time with small tubers as a basis of experimental work with potatoes, nor valuable space in discussing them. However, it has been urged by some growers (and it is true) that small potatoes used for seed materially cuts down the expense of crop production, because of such stock not being marketable—because it would otherwise represent a by-product, a waste, a loss in the business of the market grower. Certainly economy in every industry is to be commended and encouraged so long as such economy does not foster a menace for the future. So long as the grower produces stock for a market
that caters solely to the country’s food supply and chooses to use the culls, the screenings, the chaff of his successive crops for seed we can hardly object; but when he repeatedly uses such seed stock and disposes of his product to seed dealers who distribute it far and wide as pure, well-bred, high-class seed stock, the thread of truth, honor, discretion and safety is strained wellnigh to, if not beyond the breaking point.

Small seed potatoes, planted whole, often produce as great a bulk of tubers that can be passed into the marketable grade, as piece-planting of good sized tubers; but, taken as a whole, the character of the marketable stock grown from small tubers is far below that produced from one- or two-eye pieces of larger and uniform seed stock.

These results have been observed again and again; it needed no field test to prove what has been seen year after year in various sections. Therefore, as was anticipated, just such results were found very marked in the test plots of 1907. The marketable quantities from the small seed tubers compared well with the marketable quantities from the different rates of seeding from large tubers, but the aver-
age size of the tubers that composed the marketable product from the small seed was very noticeably inferior to the product of one- and two-eye pieces of the same varieties grown in adjoining plots, while

the proportion of small or unmarketable tubers was greater in both Bovee and Carman No. 3 than from any of the rates of seeding save that of 40 bushels per acre where the large, whole tubers were used. The crowding of the plants in the hill where small, whole seed was used, was but little less than where the whole, large tubers were planted—as might well be expected from the fact that a small tuber contains as many eyes as that same tuber would have contained had it grown to much greater size.

POTATO SEED SELECTION AND IMPROVEMENT. TUBER ROW AND HILL-ROW TESTS

By far the greater number of new varieties of potatoes originate as seedlings; this is true also of most varieties of vegetables, fruits and cereals. Many potato growers insist that a variety possesses a fixed character; that its attributes—excellent, mediocre or inferior—are determined for all time at its origin, its birth; that it remains absolutely unchangeable so long as it is, through the exercise of proper care, propagated and perpetuated in purity. Certain others
maintain that even though a variety possess all the qualifications of an ideal potato at and immediately subsequent to its origination it will, as time passes, gradually decline in vitality, prolificacy and quality until it is no longer of value; that it will, to use a common phrase, "run out." Still others, and in this class are included our practical and scientific plant breeders, recognize the fact that there are no duplications in nature; that no two plants of the same variety, divisions of the same plant, or buds of the same division are absolutely identical either in physical construction or power to reproduce. Each plant, division, branch and bud possesses an individuality which renders it more or less different from others of its kind. This is termed natural plant variation. Such variations, it is true, are usually so slight, so generally unnoticeable, as rarely to attract attention from the casual observer; but there are no set boundaries, no marks of limitation, within which the individuality of a plant may safely be declared to assert itself. Nine hundred and ninety-nine plants of a certain variety may be stamped each with its own peculiar though perhaps well nigh inscrutable personality, while the one-thousandth individual may manifest so little regard for family precedent, example or influence as to bound so high above or descend so far below the average of its companions in performance or appearance, or both, as to establish a new record for excellence or utter worthlessness never before approached by an individual plant of that variety. It has, indeed, sprung so far without the usual limits of performance of its parent type as to warrant its being declared a new variety. This greater variation of plants is technically known as mutation, though the terms "bud sporting" and "freaking" are commonly applied. To mutation was due the origin of the White Seneca Beauty or Livingston potato, which was discovered as a white skinned tuber in a hill of red Senecas—an excellent example of "sporting." Other examples of varieties of fruits and vegetables originating in this manner might be given. If this remarkable breaking away from varietal boundaries has been in the direction of improvement, the new variety will be accorded an appreciative reception at the hands of the culturists; it will become widely known and profitably grown. If, on the other hand, the extreme variation brings with it only inferiority as compared with the original, average or parent type (which is more often true) it may well be lost to cultivation, as it surely will be.

Therefore, through extreme bud variation or mutation may a new variety be born as truly as from seed. Likewise, through the lesser, though still clearly marked mutations, may a variety improve or degenerate without losing its identity with the parent variety; and it
is upon this natural variation of plants—even the lesser variations—that the plant breeder bases his reasonable hope of success in the betterment of already standard and favorite varieties, by selection of such strains as give promise of retaining the desirable and eliminating the undesirable characteristics of the original type. Such improvements are already accredited to not a few of our thoughtful careful, potato breeders.

We have, then, in view of the fact of universal plant variation, to unlearn the old adage that "like begets like." Instead, at the very outset of our effort to improve varieties by selection, let us assure ourselves that, as a rule and at best, similarity begets similarity; that a variety is composed of a great number of strains; that the older a variety may be the greater will be this multiplication of strains, that these multitudinous strains will represent all gradations of value from the superior to the inferior, yet possibly all be sufficiently similar to the original type to justify us in maintaining that the variety is pure.

What would be the result, therefore, of separating the superior strains of a variety of potato, as represented by perfectly formed tubers from high-yielding hills, from the commonplace and inferior and planting these separately? The yielding power, uniformity and appearance of that variety would at once show marked improvement. On the other hand if the inferior strains, as represented by the small, imperfectly formed tubers from low-yielding hills, be separated from the superior strains and used for seed, the yielding power will be reduced and the uniformity and appearance will exhibit marked deterioration.

It is for the purpose of separating the superior from the commonplace and inferior that the several plans for selection of seed stock have been devised. Let us carefully note at least two of these schemes:

It often happens that the interest of the potato grower in potato seed improvement is awakened only at or near the time of planting. His only recourse at such a time is to choose his seed from the bulk or "bin" of the storage. This plan is open to well founded objections as compared with choosing seed stock from individual hills in the field at the time of digging, but it is vastly more to be commended than failure to choose at all. Let us see wherein lies the weakness of selecting even the choicest appearing tubers from the bin or bulk. It is evident that the planter will accept only those specimens which appeal to him as representative or typical of the variety with which he is concerned; they must be smooth, uniform and bear indications of vitality as evidenced by soundness and well-developed eyes. But
he has no means of determining whether a tuber answering these requirements in appearance was one of several similar ones in a high-yielding hill, or the only one of its size in a low-yielding hill. It would really be to his future interest and profit to separate these strains, retaining the prolific and discarding the unproductive. The tuber-row-test will prove this point and he will proceed as follows:

Cut each of the selected tubers to uniform, one-eye pieces. It is not difficult to find tubers of almost any variety that will each afford ten such seed-pieces; but let the number of seed-pieces from each selected tuber be such that the test rows planted from each will be uniform in length and number of hills. Plant these tuber-test-rows with one seed-piece to a hill, the hills 16 inches apart and marked with a numbered stake driven securely in the ground, on as nearly uniform soil as can be chosen. Give the same care in the way of fertilization, cultivation and spraying to all the rows composing the tuber tests. There is no limit to the number of tuber rows which may thus be included in the trial plot; but it is a significant fact that the greater the number of tubers thus planted the greater will be the number of striking variations sure to be exhibited both in habit of growth of the plants and in yields; and also the more extended will be the opportunity of obtaining a number of superior strains of the variety being studied. At digging time the product of each test-row should be weighed and the weight as well as the general characteristics of the product carefully compared with those of its companion rows. The more excellent lots may be distinctly labelled by numbers and kept in separate crates for a second trial upon a more extended scale; or, if but one season’s trial be all that it be desired to make, the superior yielding strains may be thrown together, thus forming a composite seed lot to be planted the following season in comparison with ordinary or unselected stock. This is not recommended, however, in careful potato selection; the isolation of separate strains should be maintained until the one superior strain is determined by repeated tests. The second season’s test should be in duplicate—that is, one-half the seed of a certain tuber-product should be planted in Row No. 1 in Section A, and the other half in Row No. 1 in Section B in another part of the field or area. Average results in yield under different conditions are thus obtained from each strain.

The ideal method of inaugurating an experiment in potato seed selection is to make the original selection in the field at the time of digging the crop. Several hundred hills should be dug in a representative portion of the field, each hill being thrown by itself. After the separate hill products are thus exposed a careful selection of individual hills should be made, choosing only such hills as contain
a satisfactory yield of uniform, marketable tubers which are typical of the variety to which they belong. It is well to keep in mind that a hill of potatoes may be good because it is inherently good, or it may be good because of certain conditions of the soil or of other environment which have affected that hill alone. A few small tubers in a hill should be no objection to the choosing of that hill, providing that hill contains a liberal yield of good, representative, marketable tubers. Each hill chosen should be bagged separately and numbered consecutively. Muslin bags are preferable, though strong, paper bags may be made to answer. The muslin bags are superior because the hill selections contained therein can not only be readily and safely stored in covered, mouse-proof barrels, but at planting time the seed can be treated in the bags with formalin or corrosive sublimate, by throwing the bags of seed into the solution. With paper bags this cannot be done without their breaking and causing mixture of the potatoes.

At planting time from each hill of tubers is cut a certain number of uniform, one-eye seed-pieces. It is quite easy to obtain from an average hill 20 of these seed-pieces. Duplicate test rows, each containing 10 seed-pieces planted one eye to a hill and the hills 16 inches apart, are planted from each parent hill, on uniform soil. As an illustration from parent hill No. 1 are cut 20 one-eye seed-pieces; ten of these single-eye pieces are planted in hill-row No. 1 in Section A; the remaining 10 similar pieces are likewise planted in hill-row No. 1, Section B (the duplicate). Parent hill No. 2 likewise goes to plant hill-row No. 2 in Section A and hill-row No. 2 in Section B. Every fifth or sixth row in both Section A and Section B is planted with good tubers taken at random from bin or bulk, cut to one-eye pieces and so distributed in the various check rows that but one seed-piece from each tuber will be planted in the same check row. Twenty such tubers, each cut to 10 single eye pieces, will suffice to plant 20 check rows of 10 hills each with no two hills in the same check row planted from the same tuber. In detail, “check tuber” No. 1 cut to 10 one-eye pieces may be used to plant hills No. 1 in ten different check rows; “check tuber” No. 2 cut in the same way will go to plant hills No. 2 in the ten different check rows, etc. The object of the check rows is to afford a standard or average made up of composite seed stock, with which to compare the yields from the different rows planted from selected parent hills. The following diagram, the writer trusts, will assist in rendering the plan of a duplicated hill row test plot readily interpreted.
Well marked results in potato seed selection, as determined by the hill-row test plots, have been secured at the Ohio Station, both in selection for high yields of tubers and for disease resistance of plants. The work was begun under the supervision of Mr. C. W. Waid, in 1903, by selecting:

(1) A series of heavy producing hills of Carman No. 3, regardless of the character of the plants producing such yields.

(2) A corresponding series of hills of the low yielding or common stock of Carman No. 3 for comparison, regardless of the character of the plants producing the same.

(3) A series of hills of Whiton's White Mammoth, the plants of which exhibited marked resistance or immunity against blight, which was prevalent in the field in 1903.

(4) A corresponding series of hills of Whiton's White Mammoth the plants of which were destroyed by late blight in the season of 1903.

Records of yields from individual hills and their progeny, of these various lots, were secured by Mr. Waid during the seasons of 1904-5-6, all individual hill products being kept separate during that time. In the spring of 1907 the writer was given charge of the work and the now great number of selected seed lots for the purpose of determining, under field conditions, what had really been gained by the original hill selection and the great amount of painstaking work of the succeeding three years. The first move in the enlargement of the scope of the work was to take from the hundreds of separately preserved hill-lots of seed:

(1) Seventy representative hills of the high yielding strains of Carman No. 3, which weighed in total, 94 pounds.
(2) Seventy representative hills of the lower yielding or common strains of Carman No. 3, which weighed, in total, 36 pounds.

Composite seed lots were made by mixing together the 70 hills of high-yielding strains; also by mixing together the 70 hills of low yielding strains or common stock. Sufficient seed was taken from these two separate lots to plant four rows of the high-yielding strains and two rows of the common strains for comparison. Care was exercised to have the tubers of the respective lots as uniform in size, form and appearance as could be selected. This accounts for the unequal number of rows planted, as from the 70 hills of the common strains there could not be found a sufficient number of tubers that would grade up to the required standard of size to plant four rows, or the number planted from the high-yielding strains. This fact in itself is a significant one and quite suggestive of the trend of results of the years 1904-5-6.

The following table exhibits the results of the field test of the selected and unselected Carman No. 3 for the year 1907. The rate of yield in bushels per acre was calculated upon a corrected or uniform stand of plants (or hills) per row:

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<thead>
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<td>5</td>
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<td>172</td>
<td>76½</td>
<td>14½</td>
<td>91</td>
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</table>

Average per acre in total yield, selected strains, 181.9 bushels.
Average per acre in total yield, unselected strains, 116.15 bushels.

A similar though still more extensive field test was conducted in 1907, comparing the blight resistant strains of Whiton's White Mammoth with the non-resistant strains of the same variety. Comparisons of these resistant and non-resistant strains had been carefully carried on during the seasons of 1904-5-6, by Mr. Waid, just as had been done with the high yielding and common stock of Carman No. 3, all individual hill products being kept separate during this period. In 1907 composite seed lots were made up by throwing together and mixing the hill-product of the resistant strains; likewise the non-resistant strains. A plot of 12 rows was planted, embracing 8 rows of the resistant and 4 rows of the non-resistant stock. The following table shows the result of the field test, The rate of yield per acre is based on a corrected stand of plants or hills per row:
THE POTATO GROWING INDUSTRY IN OHIO

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<td>158.9</td>
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<td>12</td>
<td>170</td>
<td>157</td>
<td>16</td>
<td>154</td>
<td>158.9</td>
</tr>
</tbody>
</table>

Average yield per acre, disease resistant strain, 206.9 bushels.
Average yield per acre, disease non-resistant strain, 153.5 bushels.

The foregoing tables are sufficient to prove, quite within themselves, the value of potato seed selection. However, in addition, the writer is constrained to add that the 1907 field test plots of both Carman No. 3 and Whiton's White Mammoth were object lessons in demonstration of the effects of seed selection the whole season through. The high yielding Carmans, because of their superior vigor, could be distinguished from the common strains, even by a disinterested visitor, as far away as the plot could be seen. Likewise there was a remarkable difference between the rows of resistant and non-resistant W. W. Mammoth. This difference was more and more marked as the close of the growing season approached. The non-resistant rows of plants were quite dead in early September, while the resistant rows continued green, vigorous and growing until cut down by the frost some three weeks later. No spraying for blight was done on this plot as it was strictly a test of disease resistant versus non-resistant plants.

It may well be stated, furthermore, that experiments coupled with many observations suggest that little is to be gained by selection of parent hills of potatoes on the basis of disease resistance of the plants, over selection of parent hills because of the superior, individual yields. It is the actual work done within the hill that should most interest the potato breeder; the more promptly these desired results are accomplished by the plant the more desirable that strain. While, as the latter table shows, good results are obtained by selection of hills because of disease resistance—because of long standing and late growing in the field—it has not been apparent that this cause for selection is to be commended above the plan of selecting for prolificacy in the hill regardless of the character of the plants of
such hills. Indeed selection of long standing, late growing hills or plants should not be done unless blight or other disease is surely known to be present in the field and responsible for the premature breaking down of the majority of the plants; for, through natural variation of plants in which season of maturity as well as other characteristics are affected, there is grave danger of so lengthening the season of growth and development of that variety by choosing these late growing strains, that danger of non-maturity of crops may be thus invited for future years.

Many isolated, late growing hills of Carman No. 3 were dug from a 3-acre field on the Station grounds in the autumn of 1907 and compared with adjacent hills which ripened many days previously. In not a single case was the product of a late growing individual hill found to be greater or better in any way than equally vigorous hills which had more promptly closed their season of growth. Blight was not present in the field, however, and the later growing hills simply demonstrated that there develop, through natural plant variation, these tardy, deliberate, slow-maturing strains which we should not mistake for strains of special disease resistance.

**SHALL WE USE THE SMALL POTATOES FOR SEED PURPOSES?**

The question is often asked by potato growers, "What about using the small potatoes for seed?" This subject has already been touched upon in a preceding chapter. It is one of importance not only to the individual potato grower, but to the potato growing industry of our state and country at large. As a regular practice there is no hesitation on the part of the writer in declaring that the use of the small or cull stock for seed is not to be considered for a moment by the grower who would improve or maintain the quality of his stock. In a word, while the small tubers of a crop may include a small percentage of the standard strains composing a variety, it also includes all the worthless trash, all the "chaff" of an unselected variety, developed through years, perhaps decades of plant variation. Let us consider the matter from a simple illustration:

From a block of 1000 hills of common, unselected stock including high, moderate and low yielding strains of a given variety, seed for the succeeding year's planting is to be taken. Let us estimate that 800 of these hills fairly represent the average or moderate yielding strains of the variety; that 150 hills are below the average type—are low yielding strains; that 50 hills are above the average type—are superior high-yielding strains. It is reasonable to figure on this basis, for experiments have repeatedly shown that there is a greater
tendency, through natural plant variation, toward a falling below
the average type of a variety than of rising above the same. Now,
what would be the character of the seed stock chosen from the 1000
hills by the grower who insists upon careful selection of his seed and
would accept only good sized uniform, representative, marketable
tubers from the bin or bulk? His choice would include:

(a) A *very heavy*, perhaps almost *total percentage* of the *high
yielding strains*.

(b) A *heavy percentage* of the *average or moderate yielding
strains*.

(c) A *very small percentage* of the *inferior or low yielding
strains* limited to the occasional tuber that would grade up to the
required size and form.

Upon the other hand what would be the character of the seed
stock used by the grower who insists upon selling the marketable
tubers and retaining the small ones for planting? His choice would
include:

(a) A *very insignificant percentage* of the *superior or high yield-
ing strains*.

(b) A *small percentage* of the *moderate yielding strains*.

(c) A *very heavy, almost total percentage* of the *low yielding or
inferior strains*.

The persistent use of small seed year after year can have but
one result, the rapid deterioration of the variety thus perpetuated
by the steady, certain process of elimination of all the good and
superior strains of that variety. Growers who practice this plan of
"seed saving" and dollar saving(?) are persistent in their theory
that varieties of potatoes "run out;" and they offer their personal
experience and their crops in support of their theory and as evidence
that they are right in their conclusions.

There are, however, certain conditions under which, for a time
at least, the smaller tubers (not culls) may be used with good re-
results. It is subsequent to a thorough course of selection in which
there has been a "weeding out" of the inferior strains. A tuber may
be small because of crowding in the hill with larger tubers; or it
may be small because of some unfavorable condition under which it
was forced to exist; these, if they be of selected strains, ought to
give satisfactory results when used for seed. It is the small tuber
that is small because of *inherent inferiority* to which objection may be
justly urged. However, at the same time of using these smaller
tubers for seed there should be in progress a continuity of seed
selection with the purpose in view of gradual, constant improvement
of the variety or varieties which have been accepted as the most
profitable for local or special requirements. The land owner who insists upon placing the cream of his farm crops upon the market and using the “skim-milk” product for the basis of succeeding crops is progressing only toward well merited defeat which will be met sooner or later. The choicest of the crop is none too good for seed purposes.

PLANTING AND CULTURE

In a preceding chapter have been discussed approved methods of preparation and fertilization of the soil for potatoes. Thorough preparation renders planting a comparatively easy and agreeable task—especially where the land is level, or nearly so, and a modern horse-power planter is used. For the general crop the rows should be spaced three feet apart and the seed pieces dropped from 14 to 16 inches in the rows. The more dwarf growing plants of some of the first early sorts may allow of spacing the rows at 30 inches and dropping the seed pieces 12 inches apart, though this close planting is not recommended for the stronger growing varieties. The machine should be adjusted to deposit the seed pieces at least four inches below the level of the surface of the ground. Most planters cover the seed in such a way as to leave a little ridge over the rows, beneath which the seed pieces are probably covered something near six inches in depth. After the seed has sprouted well and the young shoots are approaching the surface of the ground, the field may be gone over with a weeder or a fine smoothing harrow in which the teeth slant backward, levelling the ridges and leaving the surface smooth, even and mellow. A second and even third cultivation may be given with weeder or harrow by the time the little plants are beginning to show well in the rows. These early cultivations save much work later on, as millions of weed seeds are germinated and the tiny plants are killed before they have become established.

On rough, steep ground or on small areas where a horse planter is not practicable, the ground may be furrowed with a large-bladed, single-shovel plow, as described in a foregoing chapter. The furrows should be deep and broad even if it should require two or three passages with the shovel plow to complete them. The rows should always be across the slope of the hill—never up and down the slopes where it is possible to avoid it. By holding the plow firmly the loose soil will be thrown out on either side—a part of it rolling back into the forrow as the shovel of the plow passes, leaving three or four inches of loose soil in the bottom of the furrow upon which to drop the seed pieces. The fertilizer, as before stated, should be applied over the bottom and sides of the broad furrow before dropping the seed, where hand work is done. The rows are spaced and the seed pieces dropped the same distances apart as when planting with a machine.
The seed may be covered either with a hand hoe or shovel plow. If the ground be not too full of stones or sods or roots, the plow will do very good work when run on either side of the open furrow at the proper distance to fill it with mellow soil. The plot should be run over with a weeder or fine tooth harrow when weed seeds begin to germinate, as described for a machine planted field.

The after cultivation is done with a narrow-hoed or "spike-toothed" cultivator, keeping the surface of the ground as level as possible, mellow and free from weeds throughout the growing season. The crust of the soil, after rains, should be broken up as soon as the ground is dry enough to work, and a fine "soil-mulch" maintained on the surface as long as it is possible to drive between the rows with the cultivator without pulling out or breaking the tops of the plants. The maintenance of the "dust mulch" is a sort of insurance against the effects of dry weather; and fine crops of potatoes have been grown by this careful, persistent cultural work even in seasons of serious drought.

The old plan of "hilling up" the rows of potatoes, leaving a high, sharp ridge, is quite unnecessary, and, in fact, is detrimental to the success of the crop should the latter part of the season be deficient in rainfall. Sufficient soil should be worked toward the rows with the cultivator, to insure that the new tubers may not be exposed to the sun; but the surface of the soil should be kept practically level the season through so that the entire area may uniformly receive, absorb and retain the rainfall.

SPRAYING FOR INSECTS AND FUNGOUS DISEASES

The spraying outfit is coming to be regarded as an important factor in the equipment of the potato grower. There are many excellent sprayers made; in fact so many firms are engaged in making spraying machines—there is so much competition—that a sprayer necessarily must come up to a reasonable standard of efficiency in order to be recognized on the market. For small plots of potatoes for family use, as well for general use about small grounds and the kitchen garden, there is no form of sprayer more convenient, effective and satisfactory than the small, compressed-air outfit. This consists of a strong, air-tight tank, preferably constructed of heavy, sheet brass, fitted with an air-pump for compressing the air. These tanks are about four gallons in capacity. In use three gallons of spray mixture are filled in the tank and the remaining space of one gallon pumped full of air to a high pressure. The compressed air forces the liquid out through the nozzle in a fine mist. As the pressure becomes too low for effective work through continued spraying, a few strokes of the air-pump again fills the vacant space in the tank.
with compressed air. Two or three short pumpings will suffice to force out the contents of the tank. Such outfits are easily carried about with a strap over the shoulder, while the addition of a few feet of light, brass extension pipe, connected to the hose, enables the operator to spray a limited number of young fruit or ornamental trees of considerable height.

For field use in potato spraying, a horse power outfit will be necessary. These, of various styles, are constructed to spray from four to six rows at a single passage, making rapid work in combating the insect and fungus enemies of the potato plant. The traction geared potato sprayers are preferable to those fitted merely with hand pumps, as one man to drive the team is all that is required in the field. However, excellent four-row sprayers can be made by any one who has a good, barrel spray pump and is handy with plumbers' tools. Such a barrel outfit may be placed in a wagon or cart and carried through the field, employing one man to drive and another to pump.

The nozzles on potato sprayers should be adjustable to different widths of rows, and only such nozzles should be used as will apply the liquid with considerable force directly downward upon the plant and in a fine mist or fog-like spray. Mere sprinkling will not suffice where fungus disease is to be effectually combated.

Spraying should begin on the early varieties as soon as the plants are from 6 to 8 inches in height, using a combined mixture that is both a fungicide and an insecticide. Early blight and Colorado beetles are thereby combated at the same time. Spraying should be repeated every ten days or two weeks.

The later varieties or "general crop" may likewise be protected, special care being given to spraying with Bordeaux mixture for the late blight during the month of July. The insecticides may readily be combined with the Bordeaux mixture (fungicide) when the presence of the larvae of the Colorado beetles render an insecticide necessary. The black or "blist'er beetles," so destructive in certain sections and so difficult to effectually combat with poisons, become sadly discouraged where Bordeaux mixture is freely used and leave the potato field if there be other vegetation in the vicinity upon which they may subsist. The formula for making Bordeaux mixture is given below:

**BORDEAUX MIXTURE**

- Copper sulfate (blue vitriol) 4 pounds
- Fresh lime 5 pounds
- Water 50 gallons
Where Bordeaux mixture is needed for different sprayings during the season much time and inconvenience may be saved by making up a “stock solution” of copper sulphate; this stock solution will keep indefinitely without deterioration. To make the stock solution use a good barrel (a kerosene, vinegar or whiskey barrel serves well). After removing one of the heads fill the barrel to within 6 or 8 inches of the top with water, measuring the water by gallons. Weigh out in a burlap bag, as many pounds of copper sulphate as the number of gallons of water contained in the barrel. Tie the bag with a strong twine close down to the contents, leaving a loop through which a stick may be thrust. Suspend the bag of copper sulphate in the water by resting the stick across the top of the barrel, in such a way that the bag will be but partially submerged in the water. The material will dissolve much more quickly when held near the surface of the water than when poured loosely into the barrel or suspended near its bottom, as the copper charged water is heavier than the clear water and sinks to the bottom in the form of a saturated solution which no longer has the power to dissolve the substance with which it is laden. When the content of the bag is dissolved each gallon of the water in the barrel will contain one pound of copper sulphate. It is well to slightly stir or agitate the solution previous to measuring out a portion for use.

Bordeaux mixture: Pour four gallons of the stock solution (4 pounds copper sulphate) into the spray barrel and add water to this until the barrel is half filled. The copper solution must be weakened thus before adding the lime or a curdled mixture will result. Weigh out, in a bucket, 5 pounds of fresh hydrated lime (known also as “builders’ lime,” “flour lime,” “sack lime,” etc.). Add water to the lime, stirring vigorously and pouring off the “milk of lime” or thin white-wash into a second vessel until all the lime is dissolved. Strain the milk of lime, diluted still further with water, through a fine meshed brass wire strainer into the dilute copper solution in the spray barrel, churning vigorously as the lime is being added. A clear bright blue mixture should result. Add to this mixture whatever poison it be desired to use for the destruction of insects and finish by filling the barrel with water.

INSECTICIDES

Arsenate of lead: This is a commercial preparation, as generally used, and one of the most lasting and effective known at the present time, as it is very adhesive. It comes to the buyer in paste form in different sized cans, buckets, kegs or barrels. For one barrel or 50 gallons of spray mixture weigh out, in a bucket, 3 pounds of
arsenate of lead. Add a little water and stir and beat vigorously until a quantity of “milk of lead” is formed. Pour this off into a second vessel or through the strainer into the spray barrel as the paste is dissolved. The lead is slow to dissolve, but by repeatedly adding water, stirring and pouring off it will soon be reduced to milk of lead. Arsenate of lead will not injure foliage, even if used without lime.

**ARSENITE OF SODA**

Commercial white arsenic 2 pounds  
Carbonate of soda 4 pounds

Boil the arsenic and carbonate of soda together in one gallon of water until a clear liquid is formed (15 minutes of brisk boiling will usually suffice). Dilute this solution to 2 gallons by adding water. Pour into a two gallon jug or other vessel that may be securely covered and label “Poison.” Use one quart of this stock solution to 50 gallons of spray mixture. If not used in Bordeaux mixture add 5 pounds of lime to insure against burning of foliage.

**PARIS GREEN**

Paris green 8 ounces  
Water 50 gallons

Paris green may be used in the Bordeaux mixture without danger of injury to foliage. If used without combining with Bordeaux add 5 pounds of lime to the barrel of solution.

Lime for spraying purposes: A word should be added regarding the kinds of lime recommended for spray mixtures, as much confusion and misunderstanding exist among beginners in spraying. Fresh burned, lump lime or “stone lime” cannot be excelled for spraying purposes, but many times and in many places cannot be obtained in the desired state of freshness; hence the hydrated or sack lime has come into quite general use. Stone lime, too, requires slaking, and unless a considerable quantity be slaked at a time and this held in reserve as a “stock supply,” several purchases as well as several slakings will need to be made during the spraying season. It is always best to buy a quantity at the first of the season, slake it all at once and preserve it in paste form for use. In order to prepare for spraying in this way, weigh out say 50 pounds of good, sound lumps. Slake these in a shallow box by adding water and stirring well to prevent burning. Continue to add water and stir until a smooth paste is formed. Level this paste down in the box and when it is well settled mark the surface off into ten squares of uniform size. Each square will contain what was formerly 5 pounds of lump lime. Cut out and use one square for each 50 gallon barrel of spray mixture. Keep the paste at all times covered with water to prevent drying out.
Hydrated or builders' lime can usually be purchased of most dealers in lumber or building materials. It is put up in air-tight sacks and will keep in good condition a long lime if kept in a dry place. This is a very convenient form of lime for the sprayer, as no slaking is necessary. However, it is well to use a little excess in weight over that recommended for the stone lime, therefore 6 pounds of hydrated lime is used for each barrel of 50 gallons of Bordeaux mixture. The writer has used only the hydrated for the past six years with quite satisfactory results.

A PRACTICAL CLASSIFICATION OR GROUPING OF VARIETIES OF POTATOES

The Ohio Experiment Station has tested hundreds of varieties of potatoes and is yet continuing this work. Reports of these tests may be obtained by application, free of cost. Many new varieties are constantly being offered by originators, introducers or dealers, in different parts of the country. A few of these prove of value; an occasional one is excellent; many are quite inferior to our already well known and standard kinds. It is not the purpose of the writer to embody a descriptive list of varieties in this cultural treatise.

Such a chapter would need revision many times over before the chapters dealing with cultural methods should lose their value through evolution or modification of approved and dependable methods of the present day. The question of varieties, too, is one that cannot be treated in a general way with equal benefit to all potato growers. Each grower must determine for himself those varieties which do best under his particular conditions of soil and climate, and use his own judgment in retaining the choicest of these for home use or
market, or both. It is advisable, however, for each grower to test
the more promising of the newer kinds grown and reported upon by
the experiment station of his state. He may thus find one or more
varieties which would prove to be more profitable or excellent in
quality than the kinds he has been growing for market or table use.
The writer has visited certain sections of Ohio in which the same
variety has been grown for perhaps ten, fifteen or twenty years, and
this without any particular care in selection and improvement of
seed stock. The newer varieties of superior value are unknown—
perhaps unheard of.

It has been remarked by certain growers, too, that it is well
nigh useless to buy new varieties; for, in many cases, they declare,
the alleged new variety proves to be only an old sort renamed and
sold at a fancy price. This position tends to confusion and mis-
understanding and often unjust criticism of originator, introducers
and dealers in pure seed stock. True there are cases in which old
varieties may have been reintroduced under new names—we are
aware of a limited number of such cases—but such deception is more
rare than general. Usually the confusion of growers is occasioned
by the fact that there are several distinct types, families or groups
of potatoes and that the hundreds of varieties of different origin may
be classified in these several groups. Indeed there are many varie-
ties of separate and distinct origin which follow a single type so
closely as not to be readily distinguished from each other either by
habit of growth of plant or character of tubers, even by an expert
potato specialist.

To present in completeness and with absolute accuracy the lists
of varieties belonging to the various groups would tax the most care-
ful student of botany. Such exact classification is neither necessary
nor advisable in a purely practical treatise of this kind. In the follow-
ing classification the writer has not only reduced the groups to the
least possible number, but mentions only a few of the many varieties
which might easily be included in each one. The classification is
based principally upon similarity of the character of the tubers of
the different varieties, without special consideration of the similarity
of the plants of each. In many cases, however, there is a similarity
of plants as well as of tubers.

The Triumph Group: round, white, red or mottled; first early.
Bliss Red Triumph (known also as Stray Beauty, Strawberry and
Bermuda red.
Bliss White Triumph Noroton Beauty Nott's Early Peachblow
Woods' Earliest
The Early Market Group: Round or oval, flattened; white or slightly tinted; very early; good quality—much superior to the Triumph group.

Early Market  Early Standard  Early Petosky  Irish Cobbler

Early Ohio Group: very similar to Early Ohio in various ways.

Early Ohio  Early White Ohio  Early Six Weeks
Baker's Extra Early  Peck's Early  Acme  Ohio Junior

Early Rose Group: long or oblong, cylindrical or flattened; pink or white or mottled.

Early Rose  Early Roser  Mountrose  Northern Star  Early Fortune  Early Bovee  Early Sensation  Early Norther  Algoma  Miller-Brooke  Early Breakfast (white)  Early Michigan (white)

Green Mountain Group: oblong to long; somewhat irregular in form; usually white or straw color.

Green Mountain  Whiton's White Mammoth  Gold Coin  Ionia  Uncle Sam  Washington  Happy Medium  American Giant  State of Maine

Seneca Beauty Group: long or oblong, smooth; small, very shallow eyes; red, pink, or white with pink eyes; quality excellent.

Seneca Beauty  Livingston (White Seneca Beauty)  Piqua Chief  Pat's Choice

Rural New Yorker Group: round or oval, much flattened; few shallow eyes; color usually white; quality variable.

Rural New Yorker  Rural Russet  Banner  Carman No. 3  President Roosevelt  Prosperity  Sir Walter Raleigh  Ohio Wonder  Green's No. 21  White Giant  World Wonder
An interesting and instructive feature of the season's work for 1909 was a further study of the results of sprouting potatoes in sunlight before planting.

The results given in the table below show that it is better to take extra pains to drop the pieces in the furrow sprout end up. The first row was dropped with the sprouts up in each case, the second row with the sprouts down, and the third at random, irrespective of the position of the sprouts. The second series is a duplication of the first.

<table>
<thead>
<tr>
<th></th>
<th>Sprouts Up</th>
<th>Sprouts Down</th>
<th>At Random</th>
</tr>
</thead>
<tbody>
<tr>
<td>First series</td>
<td>98%</td>
<td>66%</td>
<td>68%</td>
</tr>
<tr>
<td>Second series</td>
<td>89%</td>
<td>76%</td>
<td>89%</td>
</tr>
<tr>
<td>Average</td>
<td>93%</td>
<td>71%</td>
<td>78%</td>
</tr>
</tbody>
</table>

These results indicate that considerable care is necessary in planting sun-sprouted potatoes, and that if dropped by a planter the work is not likely to be done satisfactorily.

**LATE GROWN VS. COMMON SEED POTATOES**

Stock which had been raised from sun-sprouted seed, planted in July, 1908, was planted in the fertilizer plots the past year (1909) by the side of common stock, or seed which had been grown in the ordinary way. There are 34 tenth-acre plots in each series of the 3-year rotation, potatoes-wheat-clover. The plots are 272 feet long and 16 feet wide, which permits five rows of potatoes in each plot. The first three rows in each plot were planted with seed tubers from the July planted stock and the other two with the ordinary seed. This method precluded the possibility of any unequal effect upon the various plots by using two lots of seed.
THE LATE GROWN VS. COMMON POTATO SEED

Rows 272 feet long, hills 15 inches apart, 216 hills per row.

<table>
<thead>
<tr>
<th>Plot No.</th>
<th>Late grown</th>
<th>Common</th>
<th>Percent of germination</th>
<th>Average yield per row—lbs.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rows 1, 2, 3</td>
<td>Rows 4, 5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>199</td>
<td>148.5</td>
<td>73</td>
<td>74.1</td>
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<tr>
<td>2</td>
<td>157</td>
<td>168.5</td>
<td>72</td>
<td>46</td>
</tr>
<tr>
<td>3</td>
<td>172.7</td>
<td>180.5</td>
<td>72</td>
<td>46</td>
</tr>
<tr>
<td>4</td>
<td>155</td>
<td>168</td>
<td>73</td>
<td>46</td>
</tr>
<tr>
<td>5</td>
<td>201.3</td>
<td>171.5</td>
<td>79</td>
<td>74</td>
</tr>
<tr>
<td>6</td>
<td>190.6</td>
<td>169</td>
<td>73</td>
<td>73</td>
</tr>
<tr>
<td>7</td>
<td>204</td>
<td>178</td>
<td>74</td>
<td>79</td>
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<tr>
<td>8</td>
<td>205</td>
<td>175</td>
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<td>11</td>
<td>215</td>
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<td>14</td>
<td>195.3</td>
<td>197.5</td>
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<td>130.1</td>
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<td>192.5</td>
<td>94</td>
<td>115.1</td>
</tr>
<tr>
<td>30</td>
<td>206.6</td>
<td>170</td>
<td>94</td>
<td>115.1</td>
</tr>
<tr>
<td>31</td>
<td>196.6</td>
<td>179</td>
<td>94</td>
<td>115.1</td>
</tr>
<tr>
<td>32</td>
<td>203.5</td>
<td>192.5</td>
<td>94</td>
<td>115.1</td>
</tr>
<tr>
<td>33</td>
<td>206.6</td>
<td>170</td>
<td>94</td>
<td>115.1</td>
</tr>
<tr>
<td>34</td>
<td>196.6</td>
<td>179</td>
<td>94</td>
<td>115.1</td>
</tr>
<tr>
<td>Avg.</td>
<td>200.3</td>
<td>172.3</td>
<td>90</td>
<td>78.3</td>
</tr>
</tbody>
</table>

The potatoes were all the same variety (Carman No. 3) and were all planted the same day. The plants grown from July sun-sprouted seed appeared nearly two weeks in advance of the others and maintained quite a noticeable difference until they were of large size. In fact so noticeable was the difference in the vigor and increased size of the plants that the casual observer would stop and remark and the more interested one would inquire into the details of the method. Many thought that the two parts of the plots were planted at different dates or possibly were of different varieties. Let it be understood that this particular seed was not sprouted but that it was the crop raised from sprouted seed, which had been planted the first of July the year previous. The serious inroads made by the dry rot fungus or fusarium wilt seriously impaired the results, but an examination of the figures given in the table show that the increased yield and higher percent of germination were constant throughout the plots.

A half bushel of potatoes raised from sprouted seed were placed in a closed box in the storage room beside a half bushel raised by the ordinary method placed in a similar closed box. A half bushel
of the same were placed in closed boxes and set in the greenhouse under a raised bed, over winter. In both cases the July planted potatoes kept much firmer and were much slower to sprout than the others.

TREATING POTATOES FOR SCAB

There are several methods of treating potatoes for scab, such as with flowers of sulphur, soaking in formalin solution or corrosive sublimate, and fumigating with formalin gas. The later method is not used as extensively as it should be, probably because the average grower is not acquainted with it. A comparative test was made between soaking in formalin and the formalin gas treatment.

Johnson No. 1 was used in the test, for the reason that it was the most infected variety available. The tubers were nearly covered with scab and as a consequence the treated plots showed far more scab than would be the case if fairly clean seed were used.

The two methods consist essentially in the following details:

Soaking in Formalin: One pint formalin to 15 gallons of water, soak 2 hours. The seed is thrown into a tub containing this solution or placed in wire baskets and suspended in barrels containing the solution. They are then dried and are ready to plant.

Fumigating with Formalin Gas: Three pints of formalin is poured over 23 ounces of potassium permanganate (for each 1000 cubic feet of space) and the potatoes are exposed to the fumes for 24 to 48 hours.

An air-tight room or enclosure is necessary, with all cracks carefully filled in with paper or other material, as the gas is quite penetrating. A large pan or earthen vessel should be used as there is large increase in volume through the chemical action when the formalin comes in contact with the permanganate. The person should leave the room immediately, as the gas is very poisonous.*

The following results were obtained by the two methods:

<table>
<thead>
<tr>
<th>Treatment of Seed</th>
<th>Percent Scabby Potatoes in Crop</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Row 1</td>
<td>Row 2</td>
<td>Average</td>
<td></td>
</tr>
<tr>
<td>Untreated</td>
<td>50.3</td>
<td>66.3</td>
<td>58.5</td>
<td></td>
</tr>
<tr>
<td>Soaked in formalin</td>
<td>10.8</td>
<td>22.6</td>
<td>16.7</td>
<td></td>
</tr>
<tr>
<td>Fumigated</td>
<td>21.0</td>
<td>15.9</td>
<td>18.4</td>
<td></td>
</tr>
</tbody>
</table>

When there is a quantity of potatoes to be treated it would be advisable to use the fumigation method as the figures show practically no difference in the two methods and fumigation requires no

*Formalin can be purchased for 65 cents per pound. Potassium permanganate at 85 to 90 cents per pound.
time or labor on the part of the operator aside from preparing the room or cellar for the work. On the other hand, if there are but few potatoes to be planted the soaking method will probably be more feasible and satisfactory.

**EFFECT OF TREATMENT ON VITALITY OF THE SEED**

Unfavorable results are sometimes reported from treating seed potatoes for the scab fungus. Recognizing that injury may sometimes result from this practice, but believing it to be the fault of the operator in most cases, the following observations were made during the past season. The rows were 40 rods long and 3 feet apart. Planted April 28th. All treatment refers to soaking in formalin.

Effect of treatment on vitality of the seed:

- 3 rows Early Toledo Market
  - Treated
- 4 rows " "
  - Untreated
- 3 rows Early Bird
  - Treated
- 3 rows " "
  - Untreated
- 1 row Miller-Brooke
  - Treated
- 1 row " "
  - Untreated
- 3 rows W. W. Mammoth
  - Treated
- 3 rows " "
  - Untreated
- 4 rows Pres. Roosevelt
  - Treated
- 3 rows " "
  - Untreated
- 2 rows Gold Coin
  - Treated
- 3 rows " "
  - Untreated

Careful observations were made from the time of germination throughout the season to maturity and in no case was there any appreciable difference in date of germination, percentage of germination or vigor of plants, between the treated and untreated seed throughout the test.

Cases are reported where germination was poor or slow or an apparent lack of vigor in the plants because of treatment but in all cases which we have been able to trace the treatment was longer or the solution stronger than recommended, or there was improper handling of the seed after treatment.

**RESULTS FROM THE USE OF FERTILIZERS ON POTATOES**

In this experiment potatoes, wheat and clover are grown in a 3-year rotation, each crop being grown every season. The fertilizers are applied to both potatoes and wheat. The table gives the results as computed on the potato crop alone, but the wheat and clover show a further increase, which adds to the total and net profits from the treatment.
INCREASE PER ACRE SECURED FROM THE USE OF FERTILIZERS ON POTATOES, 15 YEAR AVERAGES. YIELD OF UNFERTILIZED PLOTS, 154 BUSHELS PER ACRE

<table>
<thead>
<tr>
<th>Fertilizing materials and quantities used per acre</th>
<th>Increase per acre bus.</th>
<th>Cost of fertilizers per acre</th>
<th>Value of increase per acre at 50c. per bushel</th>
<th>Net profit per acre</th>
<th>Cost of increase per bushel</th>
</tr>
</thead>
<tbody>
<tr>
<td>160 lbs. acid phosphate</td>
<td>14.99</td>
<td>$1.20</td>
<td>$5.89</td>
<td>$4.79</td>
<td>$.08</td>
</tr>
<tr>
<td>100 lbs. muriate potash</td>
<td>9.02</td>
<td>2.50</td>
<td>3.80</td>
<td>1.30</td>
<td>.26</td>
</tr>
<tr>
<td>80 lbs. nitrate of soda</td>
<td>9.06</td>
<td>2.00</td>
<td>3.63</td>
<td>1.03</td>
<td>.22</td>
</tr>
<tr>
<td>150 lbs. acid phosphate</td>
<td>20.79</td>
<td>3.20</td>
<td>8.31</td>
<td>5.11</td>
<td>.15</td>
</tr>
<tr>
<td>80 lbs. nitrate of soda</td>
<td>30.66</td>
<td>3.70</td>
<td>12.26</td>
<td>8.56</td>
<td>.12</td>
</tr>
<tr>
<td>160 lbs. muriate potash</td>
<td>12.36</td>
<td>4.50</td>
<td>4.94</td>
<td>.44</td>
<td>.36</td>
</tr>
<tr>
<td>100 lbs. muriate potash</td>
<td>24.18</td>
<td>5.70</td>
<td>9.67</td>
<td>3.97</td>
<td>.23</td>
</tr>
<tr>
<td>160 lbs. acid phosphate</td>
<td>31.71</td>
<td>7.70</td>
<td>12.68</td>
<td>4.98</td>
<td>.24</td>
</tr>
<tr>
<td>100 lbs. muriate potash</td>
<td>35.91</td>
<td>11.40</td>
<td>14.36</td>
<td>2.96</td>
<td>.31</td>
</tr>
<tr>
<td>160 lbs. nitrate of soda</td>
<td>35.63</td>
<td>19.10</td>
<td>8.56</td>
<td>.53</td>
<td></td>
</tr>
<tr>
<td>80 lbs. nitrate of soda</td>
<td>42.26</td>
<td>5.70</td>
<td>16.90</td>
<td>11.20</td>
<td>.13</td>
</tr>
<tr>
<td>8 tons yard manure</td>
<td>39.31</td>
<td>15.72</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

It will be seen that the lowest cost of the increase has been in the use of acid phosphate alone, but this should not obscure the fact that the greatest profit per acre has been secured with a complete fertilizer, and this, notwithstanding the fact that this land is of higher than average fertility—the unfertilized yield of wheat having averaged 26 bushels per acre for the fifteen years—and that clover has been grown every third season.

AN OUTBREAK OF FUSARIUM WILT

Early in the season a pronounced condition of tip burn was noticed both throughout the Carmans in the fertilizer work and in the variety test grounds. Soon correspondence began to show that it was prevalent throughout the state, causing serious loss. There was some early blight accompanying the tip burn but no late blight developed at the Station. The condition grew much worse as the season advanced; the foliage assumed a pronounced yellowing, and the disease was identified by the Botanical department of the Station as *Fusarium oxysporum* Schlecht. or dry rot fungus. Many varieties died in July and August and nearly all varieties died prematurely
The general manifestations of the disease are a check in growth, usually a curling and folding of the leaves, most noticeable at the growing point of the haulm, a decided condition of tipburn on practically all the leaves of the plant, a premature dying of the plant and finally a darkening of the tissue of the tuber at the stem end. It begins by yellowing the woody vessels at the stem of the tuber but finally may work through the whole tissue.

The premature dying of the plant greatly affects the yield and size of tubers. In some places where the disease had an early development the crop was scarcely worth digging.

There is some variation in the susceptibility of varieties but nearly all the standard early and late varieties were attacked to a greater or less degree in the Station test grounds.

This disease is very slightly controlled by spraying except as it promotes a healthier condition of the plant.

In the fertilizer plots the one receiving the largest amount of fertilizers remained green the longest, while the "No fertilizer" plots were very noticeably the first to go down. They were all sprayed and cultivated alike.

The selection of disease resistant varieties and the special selection of resistant plants, combined with an intelligent rotation of crops and proper handling of seed will be factors largely instrumental in fighting the disease. The Station has made numerous tests for resistance to this disease.

The comparative effect of the Fusarium trouble on different varieties on August 6th is shown below. Later practically all varieties succumbed to the disease.

CONDITION OF VINES AUGUST 6, 1909

DEAD

<table>
<thead>
<tr>
<th>Early Petosky*</th>
<th>Early Standard*</th>
<th>Epicure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early Russet*</td>
<td>Noroton Beauty</td>
<td></td>
</tr>
</tbody>
</table>

BADLY AFFECTED

<table>
<thead>
<tr>
<th>Cal. Russet*</th>
<th>Early Thoroughbred*</th>
<th>Merrill*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clyde*</td>
<td>Frayer O. K.*</td>
<td>Millerbrooke*</td>
</tr>
<tr>
<td>Early Fortune</td>
<td>Happy Medium*</td>
<td>White Albion*</td>
</tr>
<tr>
<td>Early Johnson*</td>
<td>Knowles' Big Crop*</td>
<td>Plucky Baltimore*</td>
</tr>
<tr>
<td>Early Ohio*</td>
<td>Lily White*</td>
<td>White Rose</td>
</tr>
<tr>
<td></td>
<td>May's Late*</td>
<td></td>
</tr>
</tbody>
</table>
### FAIRLY GREEN

<table>
<thead>
<tr>
<th>Variety</th>
<th>Variety</th>
<th>Variety</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bovee*</td>
<td>Late Hebron</td>
<td>Red Pearle*</td>
</tr>
<tr>
<td>Early Bird*</td>
<td>Market Prize*</td>
<td>Noxall</td>
</tr>
<tr>
<td>Early Breakfast*</td>
<td>Early Monarch</td>
<td>Norcross*</td>
</tr>
<tr>
<td>Early Michigan*</td>
<td>Early Fortune</td>
<td>Kellers Green Mt.</td>
</tr>
<tr>
<td>Green Mt.*</td>
<td>White Rose*</td>
<td>New Snow</td>
</tr>
<tr>
<td>Ionia Seedling*</td>
<td>Washington*</td>
<td>Pioneer</td>
</tr>
<tr>
<td>Johnson's No. 2*</td>
<td>Seedling No. 4</td>
<td>Seedling No. 4</td>
</tr>
</tbody>
</table>

### GREEN

<table>
<thead>
<tr>
<th>Variety</th>
<th>Variety</th>
<th>Variety</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carman*</td>
<td>D. J. Miller*</td>
<td>Prosperity*</td>
</tr>
<tr>
<td>S. Com. Violet*</td>
<td>N. Late Nebraska*</td>
<td>Pres. Roosevelt*</td>
</tr>
<tr>
<td>Mortgage Lifter*</td>
<td>New Queen*</td>
<td>Planet*</td>
</tr>
<tr>
<td>Green's 21*</td>
<td>Banner*</td>
<td>Pioneer</td>
</tr>
<tr>
<td>Harrolds’ Choice*</td>
<td>White Elephant*</td>
<td>Ohio Wonder*</td>
</tr>
<tr>
<td>Johnson’s No. 1*</td>
<td>Snow*</td>
<td>New Snow</td>
</tr>
<tr>
<td>Late Petosky*</td>
<td>Seneca Beauty*</td>
<td>Late Hebron</td>
</tr>
<tr>
<td>Lepas*</td>
<td>Seedling No. 5*</td>
<td>Noxall</td>
</tr>
<tr>
<td>Livingston*</td>
<td>Seedling No. 4*</td>
<td>Snowflake</td>
</tr>
<tr>
<td>Early Manistee*</td>
<td>Rural Russet*</td>
<td>W. W. Mammoth</td>
</tr>
</tbody>
</table>

* Means that duplicate row was the same.