EXPERIMENTS WITH POTATOES

IN 1889-1890

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It is more difficult to improve the potato, (Solanum tuberosum) by the production of new varieties from seeds, than any other common field or garden vegetable. Although hundreds of promising kinds are produced every year, yet none of the new varieties is better than the old Mercer, Pink Eye, Snow Flake, Early Goodrich or Jersey Peach-blow. No other experiments have been tried oftener, than the planting of big potatoes against little ones or pieces with several eyes or single eyes, yet nothing has been gained by such experiments. Sometimes the little potatoes or the single eyes come out ahead ; but generally, about the time that the results appear to be satisfactory, somebody else gets very different results. I have conducted such experiments and many others, without being able to discover why potatoes are inclined to degenerate, or why the single eye pieces come out ahead one year and fall behind the next. In 1888, we planted about 80 varieties of potatoes on our experiment grounds. All of the seed potatoes had been carefully assorted, and they were cut into two and three-eyed pieces as nearly alike in size as possible. The planting of all of the varieties was done on the 21st day of May in the same manner, and they received the same cultivation during the following summer. About the time the early varieties were flowering, I observed that all of the stalks or vines of certain kinds were of the same size and equally vigorous, and that there were great differences between the vines of other varieties. In some of the rows I found the vines of one-third of the hills very vigorous ; another third was much less thrifty, and the remaining third were small and appeared to be unhealthy. When we dug the potatoes in the fall, I found as great differences between the products of the hills of the different varieties, as I had found between the vines while they were growing. I was convinced that the discovery of the causes of such differences would show that all of the faults were in the pieces of seed potatoes, and I determined to give the matter special attention during the following summer. About the 1st of May, '89, I examined our seed potatoes which had been stored in bushel boxes in an out-door cellar, and found that the early varieties had produced sprouts from their seed ends from two to three inches long; but all of the eyes or buds on their stem ends were dormant. I had observed the early sprouting of the seed ends of potatoes often before, and I knew that the terminal buds of trees always started first, and that their stems grew upwards and their roots downwards; but I did not inquire for causes, as I supposed it was their nature to do so. Before leaving the cellar, the question occurred to me: If I should plant the vigorous buds from the seed ends of the potatoes, would they produce a better or a worse crop, than weak and dormant buds from their stem ends? I knew that both ends of the potatoes were well supplied with starch; but I thought that the difference between the starting of the eyes might be caused by a scarcity of albuminoids in their stem ends. To settle the matter, I selected medium sized Blue Victor and O. K. Mammoth potatoes, which were in a dormant condition. Then I cut out 266 eyes from the seed ends and 266 eyes from the stem ends of tubers of each of the varieties and kept the four lots separate. The pieces of potatoes which were attached to the eyes, were of equal size and each of them was as large as a medium-sized gooseberry. The four lots of eyes were analyzed by Prof. G. E. Patrick, and the results of the analyses were as follows:

EYES OF SEED ENDS OF BLUE VICTOR POTATOES.

Crude protein, (N. x 6.25) Dry Substance....................17.14 per cent.
True albuminoids, (N. x 6. 25)........................... 9.83 " "

EYES OF STEM ENDS OF BLUE VICTOR POTATOES.

Crude protein, (N. x 6.25) Dry Substance....................12.53 per cent.
True albuminoids, (N. x 6.25)........................... 7.62 " "

EYES OF SEED ENDS OF O. K. MAMMOTH POTATOES.

Crude protein, (N. x 6.25) Dry Substance....................16.34 per cent.
True albuminoids, (N. x 6.25)...........................11.84 " "

EYES OF STEM ENDS OF O. K. MAMMOTH POTATOES.

Crude protein, (N. x 6.25) Dry Substance....................12.38 per cent.
True albuminoids, (N. x 6.25)........................... 8.81 " "

On the 20th of May, 1889, I selected lots of large, medium-sived and small (1 oz.) smooth Livingston and State of Maine potatoes, which had from five to eight sprouts on each of their seed ends, that were from 3 to 3½ inches long. Ten of each class of both varieties of the selected tubers, were planted, after removing all of the sprouts from each potato, except three. Then all of the sprouts were removed from ten tubers of each class of both kinds, and they were planted in a row, 3½ feet distant from the first described lots of potatoes and all were labeled properly. The distance between hills in all of our planting was 20 inches.

The potatoes in the first row came up six to seven days before the potatoes from which all of the sprouts had been removed, and their stalks and leaves showed that they were ripe ten days before the latter. When we dug them, only slight differences were found between the yields of the hills of the large and medium sized potatoes of the State of Maine in both of the rows. The products of the hills of the large and medium-sized Livingston potatoes in both rows, ran as even as the State of Maine potatoes; but they averaged one-fifth smaller than the latter. The products of the hills of the small potatoes in both rows averaged even; but they did not yield more than two-thirds as many good table potatoes as the same number of hills of the large or medium-sized potatoes.

On the 20th of May, 1889, I planted 33 nubs of State of Maine potatoes, 20 inches apart in the row. None of them came up in less than 13 days and the last one of them appeared above the ground in 19 days. Their stalks were always very slim and feeble. When they were dug and carefully assorted, the product of the 33 hills was as follows: 20 potatoes were like small hens' eggs; 35 were not larger than hulled walnuts, and 128 potatoes were like average-sized gooseberries.

I also planted on the 20th of May, 1889, State of Maine and Livingston potatoes which were described in my note book as follows: Seed ends, stem ends, seed half potatoes, stem half potatoes, large potatoes, small potatoes, half and quarter potatoes cut lengthwise, and nubs and sprouts taken from seed ends of large potatoes. Only one potato, or one piece of a potato was planted in each hill. For descriptions of experiments with seed ends, stem ends, sprouts, etc., and results, see table on the following page.

Nos. 1 to 18 grown in 1889. Nos. 19 to 25 grown in 1890.	KINDS OF POTATOES, AND DESCRIPTIONS OF THE PIECES OF POTATOES WHICH WERE PLANTED.	No. of hills.	No. of eyes in each piece.	Good and fair sized table potatoes.	No. of table potatoes.	No. of little potatoes unfit for table use.
No. 1.	Large, State of Maine, seed ends..........	8	2	Fair	17	11
No. 2.	Large, State of Maine, stem ends..........	8	2	Good	32	12
No. 3.	Medium sized, State of Maine, seed ends...	8	1	Fair	15	13
No. 4.	Medium sized, State of Maine, stem ends...	8	1	Good	23	14
No. 5.	Duplicate of No. 3, State of Maine, seed ends..................................	8	1	Fair	16	11
No. 6.	Large, State of Maine, seed end half of potato..................................	1	All	Fair	5	6
No. 7.	Large, State of Maine, stem end half of potato..................................	1	All	Good	8	4
No. 8.	Large, State of Maine, whole potatoes.....	8	All	Fair	39	51
No. 9.	Small (1 oz.), State of Maine, whole potatoes	8	All	Inferior	28	42
No. 10.	Large, State of Maine, half tubers cut lengthwise...........................	8	All	Good	45	38
No 11,	Large, State of Maine, quarters cut lengthwise..................................	8	All	Fair	39	31
No. 12,	Large, State of Maine, from middle, seed and stem ends........................	8	1	Fair	31	28
No. 13.	Medium sized, State of Maine, from middle, seed and stem ends..................	8	1	Fair	27	19
No. 14.	Large, Livingston potatoes, seed ends......	6	1	Fair	19	17
No. 15.	Large, Livingston potatoes, stem ends.....	6	1	Good	24	15
No. 16.	Livingston potatoes, seed end of large nub.	1	All	Inferior	1	33
No. 17.	Large, Livingston potatoes, seed ends.....	6	2	Inferior	12	16
No. 18.	Large, Livingston potatoes, stem ends....	6	2	Good	20	12

Nos. 1 to 18 grown in 1889. Nos. 19 to 25 grown in 1890.	KINDS OF POTATOES, AND DESCRIPTIONS OF THE PIECES OF POTATOES WHICH WERE PLANTED.	No. of hills.	No. of eyes in each piece.	Good and fair sized table potatoes.	No. of table potatoes.	No. of little potatoes unfit for table use.
No. 19.	Large, Livingston potatoes, sprouts 4 inches long, seed ends	85	....	Fair	186	23
No. 20.	Large, Dictator, sprouts 4 inches long, seed ends	12	....	6 lbs.	24	1
No. 21.	Large, Dictator, middle, seed and stem ends	12	2	6⅜ lbs.	37	77
No. 22.	Medium size, Dictator, halves cut lengthwise	12	All	10¼ lbs.	32	98
No. 23.	Large, Blue Victor, 4 inch sprouts, seed ends	20	....	8¾ lbs.	29	2
No. 24.	Large, Blue Victor, middle, seed and stem ends	20	2	13¼ lbs.	51	40
No. 25.	Large, Blue Victor, stem ends	20	2	14½ lbs.	45	2

While looking over my potato notes on Sept. 30, 1890, I came to the conclusion that there must have been a great scarcity of albuminoids in the thirty-three unripe nubs which I planted in 1889. For the purpose of getting more definite information in regard to the matter, I cut thirteen pieces as large as hickory nuts from the seed ends of Dictator nubs and thirteen similar pieces from the seed ends of Connecticut nubs, which were mixed and put in a basket by themselves. Then I selected three other samples as follows: One consisted of forty-five small Early Ohio potatoes about the size of quail's eggs, which had ripened prematurely on account of drouth. The second consisted of pieces from the seed ends of thirteen good, medium sized Early Ohio, and pieces from the seed ends of thirteen medium sized Six Weeks potatoes. The third sample consisted of one piece from the seed end of each of forty-five large Early Ohio potatoes, which had ripened naturally. All of the pieces of the last two samples were also as large as quail's eggs. The four samples were analyzed by Prof. G. E. Patrick, and the results of the analyses are as follows:

TWENTY-SIX NUBS OF DICTATOR AND CONNECTICUT.

Crude protein, (N. x 6.25) Dry Substance	14.14 per cent.
True albuminoids (N. x 6.25)	8.04 per cent.

FORTY-FIVE SMALL EARLY OHIO POTATOES RIPENED PREMATURELY.

Crude protein, (N. x 6.25) Dry Substance	13.06 per cent.
True albuminoids, (N. x 6.25)	7.73 per cent.

TWENTY-SIX PIECES FROM SEED ENDS OF MEDIUM SIZED EARLY OHIO AND SIX WEEKS.

Crude protein, (N. x 6.25) Dry Substance	17.77 per cent.
True albuminoids, (N. x 6.25)	14.45 per cent.

SEED ENDS OF FORTY-FIVE LARGE RIPE EARLY OHIO POTATOES.

Crude protein, (N. x 6.25) Dry Substance	13.01 per cent.
True albuminoids, (N. x 6.25)	10.82 per cent.

By comparing the results of the analyses with each other, we find that the nubs and unripe little potatoes are far behind the medium sized and large ripe potatoes in albuminoids.

By comparing the albuminoids with the crude protein, we find that a very large share of the nitrogenous matter in the unripe potatoes consisted of amides, which were not in proper condition to be stored and held through a long winter for future use. Although the evidence appeared to be sufficient to establish the facts, that unripe potatoes and unripe seed ends of potatoes are unfit for seed, and that unripeness of seed potatoes is the cause of their degenerating; nevertheless, I concluded that I would obtain additional evidence, and I cut each one of 12 long Everitt potatoes into three pieces of equal lengths and planted them in our green house on April 9th, 1890, after removing a part of the eyes from them, so that only three or four eyes were left on each piece. Their seed ends showed that they were not entirely ripe. I took them up and examined them carefully on May 4th, and the results of the experiment were as follows:

Seed Ends.

Ten pieces had sprouts which averaged 1⅞ inches, and two were dormant.

Middle Pieces.

All of them had sprouted and the average length of the sprouts was 3¼ inches.

Stem Ends.

Six pieces had made twelve sprouts, and the average length of the sprouts was two inches. Six of them had just started sprouts.

On the 10th of November, 1890, I planted ten Dictator nubs and four unripe small potatoes in the green-house, and on January 6th all of them were dormant. On the 10th of November, 1890, I planted ten small Beauty of Hebron potatoes in the green-house, which had ripened naturally. On January 6th, nine of them had sprouts on their seed ends, which varied in length from 1½ to 2½ inches, and one of them was dormant. Four O. K. Mammoth potatoes, which had very green seed ends and apparently ripe stem ends, were cut crosswise into three equal parts and planted in the greenhouse on Nov. 10th, 1890. On Jan. 6th, all of the seed ends were dormant. Two of the middle pieces had one sprout each two inches long, and the other two were dormant. Each of the stem pieces had one sprout, and the sprouts measured as follows: Three, three and a half, four, and five inches. In one of my old note books, a potato experiment is reported, and the results are given as follows: On March 20, 1883, I cut two medium sized Parson's Prolific potatoes lengthwise into four pieces, and planted them with cut sides down in my green-house. Eight days afterwards they had produced well rooted sprouts, which were separated from the pieces of tubers and planted in boxes of rich soil. Sprouts were taken from the pieces of tubers three times afterwards, which were planted in other boxes. As often as the transplanted sprouts would bear cutting without injuring them seriously, cuttings were taken from them and rooted like geraninm slips. On the 5th of May I cut the four half potatoes into single-eyed pieces, and planted them and the sprouts and rooted cuttings in rich ground out-of-doors. I dug them on the 5th of October, when the product of the two potatoes proved to be seven bushels and six pounds. I found many potatoes in each of the hills where the single eye pieces were planted, but half of them were too small for table use, and a majority of the other half were very nubby. There were only from three to eight potatoes in each of the hills where the sprouts and rooted cuttings were planted, but nearly all of them were large and smooth. From the results of the experiments which I have reported, it is evident that unripe potatoes are unfit for seed and that they are less nutritious than ripe potatoes; but I will try to make it clearer why the one is better than the other. There is but little difference between the ripening of trees and potatoes. Without reserve food materials, neither of them could make any growth in the spring. When a tree is ripe, its reserve starch is stored in its pith and medullary rays in granular form, and its reserve proteids or albuminous compounds are found in and near its buds and in its cambium layer. When potatoes ripen naturally, their stalks die after storing the necessary reserve materials in their tubers. During the winter of 1888–9, Dr. Halstead made the difference between ripe and unripe fruit trees very plain, by microscopic examinations of their twigs at the Iowa Experiment Station. The experiments were continued through two months for the purpose of determining whether there were structural differences, or differences between the quantities of reserve food materials in the various kinds of fruit trees, sufficient to account for well known differences of hardiness. The principal point that he made clear was, that when the leaves of trees and other perennial plants are killed by fall frosts, perfect ripeness counts more for hardiness than anything else. He found that in well matured twigs, there was a marked concentration of granulated starch in well defined cones of lignified pith about a quarter of an inch below their terminal buds; that there was a concentration of starch also below their lateral buds, and that considerable quantities of granulated starch was stored also in the pith, which was farther away from the buds and in the medullary rays. These are the only parts of ripe twigs in which starch is found. In unripe twigs the starch is scattered through all parts of the buds, wood and green bark, but it is not granulated. In ripe twigs there is also a marked concentration of albuminoids or proteids in the buds; in the soft tissue between the buds and cones of lignified pith below them, and in their cambium layers. Much larger quantities of reserve materials are found in and near ripe terminal buds than in latteral buds, and the former always start first in the spring and grow most vigorously; while the lowest of the latter remain dormant frequently. In the buds of unripe twigs and in the soft tissue below them, the albuminoids are found in very limited quantities. When the leaves of immature trees and other perennial plants are killed by fall frosts, there can be no farther storage of reserve food materials, and fatal injuries result frequently on account of such conditions, when the winters are very cold or very changeable. Generally, when such injuries do not prove fatal, nothing more than a sickly growth can be expected the following year.

There is a concentration of albuminoids near the buds of ripe potatoes, as well as in the buds of ripe trees. In potatoes there are ducts or channels leading from the lower stem end buds to all of the buds above them, and when growth begins at the seed ends of potatoes, the albuminoids are drawn away gradually from the lower buds and they remain dormant.

In 1890, we planted about fifty varieties of potatoes on two acres of ground which had no faults, except that it had a subsoil of impervious blue clay. A considerable number of the potatoes which we planted were not ripe, and the folly of planting such potatoes was evident from the time that the potatoes came up until they were dug in the fall. Where potatoes were planted which had green seed ends, there were vigorous hills and little feeble hills from one end of a row to the other; but where ripe seed was used, nearly all of the stalks showed equal vigor. The summer drouth was more injurious to potatoes and other crops than that of the previous year.

After the first fall shower, the late potatoes recovered their color and made a little growth; but before the next shower came they were as yellow as before. We had two other showers before the potato tops were killed by frosts, and each of them produced the same effect upon the late varieties as that which was noticed after the first. When I dug the late potatoes, I found them in a very unripe condition, and many of them had not only nubs, but nubs on nubs. Many of the potatoes had stopped growing before the first fall shower, and when they began to grow again after the rain, their skins were so thick and tough, that some of them were compelled to prolong new growths of tubers from their seed ends. In some instances, such prolongations were repeated a second time after the second shower, and frequently the youngest extension of the potato was three times greater than the oldest part of the tuber. I have pointed out before, that when trees and herbaceous plants are exposed to unfavorable conditions such as severe droughts, there is less assimilation of plant food than is needed for present use; consequently there can be no storage of reserve food materials at such times for future use. I think that I have made it clear also, that the difference between a ripe and unripe tree or potato is, that in the first instance, the tree or potato has completed its growth naturally, and stored up albuminoids, starch, sugar, etc., in concentrated form and in sufficient quantities to start growth the following spring; while an unripe tree or potato has not completed its growth; is using assimilated matter for the production of growth, and has stored but little or no food materials in proper form for future use. When the tops of unripe potatoes are killed by frosts or other causes, they will always remain unripe, unfit for seed and of low quality for culinary use. It is well known that all of the best varieties of American potatoes have been discarded within a quarter of a century after the time of their coming into general use, on account of their degenerating, and the results of our experiments show plainly why they ceased to be profitable. The Wilson strawberry which was reproduced by runners, and many noted verbenas and other green house plants which were reproduced in large numbers from green cuttings only a few years ago, are good examples of loss of vitality on account of improper treatment. How can the degeneracy of potatoes be prevented? is easily answered. Plant only healthy, well ripened tubers, and see that they are not exposed to unfavorable conditions while they are growing. That this statement has more than guess-work to support it, I will refer only to the remarkable vigor and productiveness of the Wilson Strawberry, (which has been propogated by runners) on the grounds of J. M. Smith, of Green Bay, Wis., where none but strong, healthy plants have been used for the starting of new beds. On Mr. Smith's grounds, the old Wilson is not planted on a few square rods for family use, but on a large scale for city markets. For him, it has yielded at the rate of 400 bushels per acre and produces well every year. Potatoes like the Jersey Peach Blow, which have large stalks and leaves to shade the ground during drouths, will not degenerate as rapidly as potatoes like the Snow-flake and Pink-eye which have slender stalks and smaller leaves. Andrieux Vilmorin reported a few years ago, that the best potatoes degenerated usually so much in from 15 to 20 years in France, that it was not profitable to grow them ; but that the Shaw and Segonzac had maintained their original vitality for 60 years. Many of the late potatoes which we used for seed in 1889 and 1890, were unripe when we dug them, and summer drouths had prevented many of the early varieties from ripening naturally. By comparing the results of the 25 experiments which I have reported in the table on a preceding page, we find that the stem ends of the potatoes which were riper than their seed ends, produced the largest and best potatoes invariably. By referring to the reports of the chemical analysis of seed ends, stem ends and green nubs of potatoes by Prof. Patrick, we find also that there is much more nitrogenous matter in the seed ends than in the stem ends of potatoes. By comparing the true albuminoids with the crude protein of the seed ends and nubs of unripe potatoes, we see that from 5 to 7 per cent. of the crude protein consists of amides ; while in the ripe seed ends of the Early Ohio, only from 2 to 3 per cent. of amides were found in the crude protein. As our Early Ohio potatoes were grown when the surrounding conditions were not favorable for plant growth, I have no doubt that a smaller difference would be found between the true albuminoids and crude protein of the seed ends of thoroughly ripe potatoes. A comparison of the remarkably small products of the 33 green nubs which were planted in 1889, with the yields or products of riper seed ends and riper stem ends of potatoes, show conclusively that good crops cannot be produced when unripe potatoes are used for seed. The results of our experiments with the seed and stem ends and ripe and unripe potatoes which we planted in the green-house, points also in the same direction. Although I have conducted hundreds of potato experiments, I have never noticed anything that would indicate that one end of a thoroughly ripe medium-sized potato is better for seed than the other ; but our potatoes are injured so often by drouths, weeds and other unfavorable conditions, that it is unsafe generally to plant little potatoes or the seed ends of potatoes. As there is a concentration of albuminoids near the eyes of ripe potatoes, and as they are much more nutritious than starch ; therefore potatoes should be cooked with the skins on. For Iowa, I would prefer the Early Ohio, Rural New Yorker No. 2, New Champion, O. K. Mammoth and Blue Victor potatoes, before other varieties.