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POTATO SEED EXPERIMENTS: WHOLE SMALL TUBERS VS. PIECES OF LARGE TUBERS OF THE SAME PLANT

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POTATO SEED EXPERIMENTS: WHOLE SMALL TUBERS VS. PIECES OF LARGE TUBERS OF THE SAME PLANT

F. C. STEWART

SUMMARY

This bulletin gives an account of experiments made for the purpose of determining the comparative value, for seed purposes, of whole small tubers and pieces of the same average weight cut from large tubers of the same plant.

In the first experiment, conducted in 1906, the four rows planted with whole small tubers outyielded the alternating four rows planted with pieces of large tubers at the rate of 21.4 bushels of marketable tubers and 8.6 bushels of small tubers per acre.

In the second experiment, conducted in 1920, there were 20 rows of 100 plants each. The ten odd-numbered rows were planted with pieces of large tubers, while the ten even-numbered rows were planted with whole small tubers. The rows planted with whole small tubers made the better showing in every respect — the stand was better, the early growth of the plants was more rapid, fewer of the plants were affected with leafroll, and the yield of both large and small tubers was greater. However, all of these differences were too small to establish definitely the superiority of whole small tubers.

In the second experiment the average number of stalks per plant was 1.91 for plants from whole small tubers and 2.14 for plants from pieces of large tubers. This result is opposed to the theory that the use of uncut tubers for seed results in a large number of stalks per plant. For both groups of plants it can be shown that the yield increased as the number of stalks increased, and, also, as the height of the plants increased. The average number of tubers produced per plant was 6.57 for plants

from whole small tubers and 6.39 for plants from pieces of large tubers. The rows planted with whole small tubers outyielded those planted with pieces of large tubers at the rate of about 17 bushels per acre. The percentage of small tubers was but slightly greater in the crop from whole small tubers than in the crop from pieces of large tubers, being 1.73 per cent in the former and 1.58 per cent in the latter.

The principal conclusion to be drawn from the experiments is that, for seed purposes, uncut tubers between 1 and 2 ounces in weight are at least as good as, and, probably, a little better than, pieces of equal weight cut from large tubers of the same plant.

INTRODUCTION

At one time or another, almost every thinking potato grower has asked himself, or somebody else, the question, "Is it profitable to use whole small tubers for seed?" And notwithstanding much has been said and written upon the subject, many growers do not yet have a clear understanding of it. The question is not so simple as it appears. It cannot be answered simply by "yes" or "no." The answer must be qualified in several respects because it depends upon circumstances.

EARLY EXPERIMENTS

In order to answer the small potato question satisfactorily it is necessary, first of all, to know how the yield of plants from whole small tubers compares with that of plants from pieces of large tubers under similar conditions. To the uninitiated, it may appear easy to obtain this information by planting a quantity of small whole tubers and a similar quantity of pieces of large tubers and measuring or weighing the crop produced by each of the two kinds of seed. As a matter of fact, many such experiments have already been made, but the results are conflicting. The literature of such experiments is so voluminous that a thoro-going review of it is a larger task than the writer is willing to undertake. It is unnecessary for our present purpose. However, it may be said that many of the early experiments were unimportant. Some were poorly planned and carelessly conducted. In most cases too small a number of plants was used and too little attention given to the elimination of soil inequalities. Moreover, early experimenters failed to recognize the important rôle played by the size of the seed piece.

This Station has made its contribution to the literature of the small-potato question in three short articles by Goff (13, p. 149; 14, p. 86; 15, p. 162)[1] and one by Emery (11, p. 236). Goff's experiments, conducted in 1886, 1887, and 1888, were designed to answer the question, "Is cutting the tuber, in itself, detrimental?" He planted half tubers and pieces bearing one, two, and three eyes each in comparison with whole tubers of the same average weight. His conclusion is stated as follows (15, p. 165): "It is possible that the number and magnitude of the experiments are not sufficiently large to justify a final conclusion, but so far as their teachings go, we may infer that, under conditions like those of the Station, little or nothing is gained by using cut potatoes for seed, while the labor of cutting and the greater market value of the larger tubers may constitute a positive loss." Emery's experiment, conducted in 1889, was a continuation of Goff's work and the results were similar to those obtained by Goff.

From 1890 to 1892, Arthur (2, 3) made some important seed potato investigations at the Indiana Experiment Station. While these touched the small-potato problem only indirectly, they advanced knowledge of it greatly by clearing up certain closely related matters and placing such investigations on a more scientific basis. Among other things it was proved, "that the number of eyes per piece is immaterial, but that the weight of the piece is a very important factor."

In 1896 Duggar (10) summed up the matter as follows: "Although the evidence seems fairly conclusive that small uncut seed potatoes may sometimes be used with profit, we can not advise that small seed tubers be selected year after year from a crop which has been grown from small potatoes."

In 1897 Bolley (4) published an important paper in which he reported the results of some carefully conducted experiments the purpose of which was "a comparison of the growth from large and from small tubers selected from the same vine." After making brief quotations from the publications of several writers and pointing out that experiments conducted by able investigators are apt

[1] The figures in parenthesis refer to Literature Cited, page 29.

to result in contradictory or conflicting conclusions, he proceeds to a discussion of the variability of potato plants and their tendency to gradually run into strains. He then says (p. 216): "Now, it is to be observed that few, if any, of the experimenters upon the question of the comparative value of different tubers for seed purposes have attempted to eliminate this element of strain variation from their field tests. * * * It is quite evident that much of the variation observed in many enumerated experiments may more properly be assigned to stock variations as a first cause than to the specified conditions of the experiments." Subsequently, he states that what is usually known as " degeneration " or " running out " is simply variation of the crop into certain strains. In the light of present knowledge of spindling-sprout, mosaic, and leaf-roll it is clear that Bolley was in error as to the cause of potatoes running out, but this does not invalidate his criticism of the methods employed in some of the early experiments. The conclusion which he drew from the results of his experiments was as follows (p. 243): "In planting equal weight pieces from small and large tubers of the same vine, there will not be a sufficient difference in favor of one or the other size of potatoes to be noticeable under farm methods, provided all are normally mature."

The paper by Bolley above mentioned was called a "preliminary report." Altho further experiments along the same line were conducted at the North Dakota Station in 1898, 1899, and 1901, it appears that no detailed account of them has been published. All that has been given out concerning these later experiments is found in brief statements in the ninth, tenth, and twelfth annual reports of the Station to the effect that the results confirm the conclusions drawn from the earlier experiments (5, 6, 7).

Soon after the publication of Bolley's work the writer conceived the idea of attacking the problem in a different way. While Bolley's experiments were made with much care, the number of plants employed was too small to insure the elimination of the chance effects of environmental factors. From an examination of the data in the fifth column of his Table 1 (4, pp. 227–229) it will be seen that the yield of adjacent plants (*a* and *b*) of the same parentage was very variable. In some pairs the plant from the small tuber (*a*) gave the larger yield, while in other pairs the plant from the large tuber (*b*) was the more productive. With the idea of overcoming this difficulty and obtaining a more accurate determination of the relative productivity of large and small tubers of the same plant the following experiment was made.

THE 1906 EXPERIMENT

METHODS

At digging time in the autumn of 1905 the product of each of about 1,500 potato plants (variety, Carman No. 3) was laid out by itself. Selection was then made of 928 small tubers of the size of a small hen's egg, and of an equal number of the largest tubers of the same plants. If two small tubers were taken from a plant two large tubers, also, were taken from that plant. During the following winter the two lots of tubers were stored in the same cellar under parallel conditions.

In the spring of 1906, after treatment with formaldehyde solution for scab, the tubers were prepared for planting in the following manner: The total weight of the 928 small tubers was taken and found to be 1,642 ounces, or 1.77 ounces each on the average. None of them were cut, it being the intention to plant them whole. From each of the large tubers a single piece was taken. In the great majority of cases the piece was cut from the stem end and included two eyes; but a few pieces were taken from other parts of the tuber, and a few bore three eyes each. The aim was to make the pieces of the same average weight as the small tubers. This was accomplished by first cutting the pieces a little large and afterwards trimming some of the larger ones until the total weight was reduced to 1,642 ounces.

At the time of making the formaldehyde treatment, on May 22, the tubers were slightly wilted and had sprouts ¼ to ½ inch long, but in the handling incident to disinfection and cutting most of the longer sprouts were broken off. The cutting was done on May 23 and the planting on May 28.

In the field, the experiment occupied eight rows, each 290.4 feet long. The four odd-numbered rows were planted with pieces of large tubers and the four even-numbered rows with whole small tubers. There was, also, a buffer row on either side of the experimental plat. The rows being 3 feet apart and the seed pieces

15 inches apart in the row, each row contained 232 seed pieces and had an area of 1/50 acre.

In the process of planting, shallow furrows were opened with a double moldboard plow, 10 pounds of commercial fertilizer scattered in each furrow by hand as evenly as possible, the seed pieces accurately spaced with the aid of a ruled rod, and the covering done by means of hoes. The soil at planting time was in excellent condition, being fine, mellow, and moist.

By thoro spraying with bordeaux mixture and paris green, the plants were protected from injury by blight and insects.

RESULTS

As no record was made of the early growth of the plants, it is not now known whether there was any difference between the two lots of plants in the time of emergence or in rapidity of growth. Neither is anything known concerning the number of stalks. Altho it is known that there was nearly a full stand of plants, the exact percentage is unknown.

The digging was done by hand. The product of each row was sorted by hand into two grades, large and small, and the tubers of each grade weighed but not counted. Tubers weighing over 2 ounces were classed as "large;" and those less than 2 ounces in weight, as "small." None of the tubers were affected with rot. The yields are shown in Table 1.

In each of the four pairs of rows the row planted with whole small tubers outyielded the row planted with pieces of large tubers. On the average, the difference in yield of large tubers amounted to 25.6 pounds per row, or 21.4 bushels per acre; while the difference in the yield of small tubers amounted to 10.4 pounds per row, or 8.6 bushels per acre. Expressed in terms of percentage, the yield of the rows from whole small tubers was the greater by 8.1 per cent for large tubers and 6.2 per cent for small tubers. Concerning the statistical significance of these results, it may be said that when tested by the method recommended by Student (20) it was found that the odds were 28.2 to 1 that the difference in yield of large tubers is positive, and 71.7 to 1 that the difference in yield of small tubers is positive. Thus it appears highly probable that, under such conditions as obtained in this experiment, whole small tubers are actually more productive than pieces of large tubers from the same plants.

TABLE 1.— YIELDS IN EXPERIMENT OF 1906 ON THE RELATIVE PRODUCTIVITY OF POTATO PLANTS FROM LARGE AND SMALL TUBERS OF THE SAME PLANT.

Row	Character of Seed	Actual yield per row		Calculated yield per acre		
		Large tubers	Small tubers	Large tubers	Small tubers	Total
		Pounds	*Pounds*	*Bushels*	*Bushels*	*Bushels*
1	Pieces of large tubers........	303.5	21.5	252.9	17.9	270.8
2	Whole small tubers.........	330.0	33.0	275.0	27.5	302.5
3	Pieces of large tubers........	321.0	15.0	267.5	12.5	280.0
4	Whole small tubers.........	341.0	20.0	284.2	16.7	300.9
5	Pieces of large tubers........	310.0	15.0	258.3	12.5	270.8
6	Whole small tubers.........	360.0	32.0	300.0	26.7	326.7
7	Pieces of large tubers........	330.0	16.0	275.0	13.3	288.3
8	Whole small tubers.........	336.0	24.0	280.0	20.0	300.0
Average for pieces of large tubers....		316.1	16.9	263.4	14.1	277.5
Average for whole small tubers......		341.7	27.3	284.8	22.7	307.5
Difference in favor of whole small tubers.........................		25.6	10.4	21.4	8.6	30.0

RECENT VIEWS

A suitable opportunity for repeating the experiment of 1906 did not occur for 14 years. In the meantime, the view that, weight for weight, the several tubers of a plant are of approximately equal value for seed purposes, appears to have made considerable advance toward general acceptance. It is pointed out that the method of propagating potatoes is essentially propagation by means of cuttings and that plants grown from cuttings are quite similar to the parent plant. However, it is admitted that exceptions to the rule occur occasionally among the tubers of plants affected with spindling-sprout, leafroll, or mosaic (17, 18). An objection sometimes made to the use of small potatoes for seed is that uncut tubers produce a large number of stalks and this results in an increase in the percentage of small tubers in the crop (1, 16, 19, 22). On the other hand, when the soil or weather conditions are unfavorable at planting time, better stands are obtained from whole small tubers than from cuttings (8, 9, 21). Also, small tubers are popularly believed to be less mature than large tubers of the same plant and this is considered by many to be to the advantage of the small tubers (19, 21).[2]

THE 1920 EXPERIMENT

METHODS

The variety used was Enormous No. 9, a member of the Rural group. In the autumn of 1919 a portion of the Station seed plat was dug by hand, the tubers of each plant being laid out together by themselves. Wherever there could be found a small tuber weighing between 1 and 2 ounces it was saved for seed and a large tuber between 6 and 10 ounces in weight was taken from the same plant. Some plants furnished two small tubers and two large ones. This method of selection was continued until 1000 small tubers and 1000 large tubers of the same plants had been obtained. During the winter the two lots of tubers were stored in the same cellar under parallel conditions.

The following spring the 1000 small tubers were weighed and found to have a total weight of 74 pounds, or an average weight of 1.184 ounces. On May 20 the large tubers were divided into three lots, a single piece cut from each tuber, and the remainder discarded. Lot 1 consisted of 333 pieces cut from the stem end of the tuber. A large majority of the pieces of this lot bore a single eye, but some had more. They were somewhat variable in size. Their total weight was 25 pounds. Lot 2 consisted of 333 pieces cut from the middle portion of the tuber. Each piece bore a single eye. The pieces were very uniform in size and shape and had a total weight of 25 pounds. Lot 3 consisted of 334 pieces cut from the bud end of the tuber. Each piece bore several eyes. The pieces were fairly uniform in size and shape and had a total weight of 24 pounds.

The plat of land used for the experiment sloped gently toward the south. In the season of 1919 it produced a crop of mangel

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[2] Clark, in United States Dept. Agr. Bul. No. 958, attributes the differences in the size of tubers in the individual hill to unequal rate of growth rather than to differences in the age of the tubers.

The popular opinion that immature tubers are superior to mature tubers for seed purposes is widespread, but reliable experimental evidence to support it seems to be lacking.

wurzel beets. The soil was clay loam of medium fertility, and apparently of uniform quality thruout. It was plowed in the fall and again in the spring, both times in the same direction — east and west. Previous to planting it was very thoroly fitted.

The experiment proper included 20 rows each 125 feet long by 3 feet wide. In addition, there were two outside or buffer rows. The rows ran north and south. Planting was done on May 24 under exceptionally favorable conditions. The seed pieces were just beginning to show their first sprouts. Immediately before planting shallow furrows were opened with a double moldboard plow. While the soil was dry enough to prevent undue packing, the damp air and clouded sky prevented the soil exposed in the open furrows from becoming excessively dry. In each furrow 4.5 pounds of commercial fertilizer were scattered by hand as uniformly as possible. The soil being fine it was possible with the aid of a ruled rod to place the seed pieces quite accurately 15 inches apart in the furrow. Covering was done by means of hoes. Each row contained 100 seed pieces. The pieces of large tubers were planted in the odd-numbered rows. The stem-end pieces were planted in Rows 1, 3, 5, and the north third of Row 7. The middle pieces were planted in the south two-thirds of Row 7 and in Rows 9, 11, and the north two-thirds of Row 13. The bud-end pieces were planted in the south third of Row 13 and in Rows 15, 17, and 19. The 1000 small whole tubers were planted in the even-numbered rows.

When, upon the emergence of the sprouts, it was found that ten seed pieces had failed to produce plants their places were filled with transplants from the outside rows. In this way, the difficulty of making proper allowance for the effect of missing hills was avoided.

A part of the cultivation in the early stages of growth was done with a horse cultivator, but all of the later cultivation was done with a hoe in order to avoid the risk of injury to the plants.

The plants were protected from blight by five very thoro sprayings with bordeaux mixture. In the application of August 30, made after the plants had become large, some injury was caused by the long hose used; but in the last application, made on September 15, such injury was avoided by separating and turning back the vines of plants in rows between which the spray hose was to be drawn. Colorado beetles were almost entirely absent and no damage of any consequence was done by flea beetles, leafhoppers, or other insects.

At harvest time, most of the digging and all of the sorting, counting, and weighing, were done by the writer, much care being taken to correct errors. A record was made of the number of tubers and total weight of tubers produced by each plant. The methods employed were essentially the same as those described on page 9 of Bulletin No. 489 of this Station.

In about 20 hills one or more of the tubers were gnawed by field mice. Since portions of the injured tubers were invariably left behind, it was always possible to determine the number of tubers, but their weight could only be estimated.

RESULTS

Stand.— Both lots of plants came up slowly and somewhat unevenly. Upon making an investigation of the cause, the conclusion was reached that the dry weather which followed planting was chiefly responsible. Rhizoctonia was not a factor of any consequence. On the whole, the plants from whole small tubers came up a bit earlier than those from pieces of large tubers. The stand obtained was 99.8 per cent for whole tubers and 99.2 per cent for pieces.

Stature of the plants.— Arthur (2) states that " whatever increases the rate of growth at the beginning increases the yield." For the purpose of securing evidence on this point each of the 2000 plants in the experiment was measured twice during the early stages of growth — first, on July 2 and 3, when a majority of the plants were 5 to 7 inches high; and also on July 15 and 16, when they were 14 to 16 inches high. The plants were measured from the surface of the soil to the growing point of the tallest stalk. Since both of these points are somewhat indefinite, the measurements can be only approximately correct. Moreover, it was impossible to make all of the measurements on the same day and as the plants were growing very rapidly measurements made on successive days do not admit of close comparison. Accordingly, the measurements of plants in Rows 1 to 10, made on July 2 and 15, will be considered separately from those of plants in Rows 11 to 20, made on July 3 and 16. The average height and yield of the plants by rows is given in Tables 2 and 3.

TABLE 2.— COMPARATIVE HEIGHT AND YIELD OF POTATO PLANTS FROM WHOLE SMALL TUBERS AND FROM PIECES OF LARGE TUBERS IN EXPERIMENT OF 1920 (ROWS 1 to 10).

Row	Character of seed	Average height of plants		Total yield per plant
		July 2	July 15	
		Inches	*Inches*	*Ounces*
1	Pieces from stem end of large tubers	5.24	15.12	47.224
2	Whole small tubers	5.83	16.11	50.305
3	Pieces from stem end of large tubers	4.90	14.88	43.366
4	Whole small tubers	5.63	15.54	43.900
5	Pieces from stem end of large tubers	4.72	14.15	43.755
6	Whole small tubers	5.59	14.95	44.409
7	Pieces of large tubers; 33 from stem end, 67 from middle	4.77	13.72	39.150
8	Whole small tubers	5.76	15.73	44.060
9	Pieces from middle of large tubers	5.09	13.39	39.145
10	Whole small tubers	5.97	15.51	40.403
Average for plants from pieces of large tubers		4.95	14.25	42.528
Average for plants from whole small tubers		5.76	15.57	44.615

TABLE 3.— COMPARATIVE HEIGHT AND YIELD OF POTATO PLANTS FROM WHOLE SMALL TUBERS AND FROM PIECES OF LARGE TUBERS IN EXPERIMENT OF 1920 (ROWS 11 to 20).

Row	Character of seed	Average height of plants		Total yield per plant
		July 3	July 16	
		Inches	*Inches*	*Ounces*
11	Pieces from middle of large tubers	6.32	13.98	39.750
12	Whole small tubers	7.29	16.18	44.100
13	Pieces of large tubers; 66 from middle, 34 from bud end	6.29	14.35	42.835
14	Whole small tubers	6.88	15.88	46.970
15	Pieces from bud end of large tubers	6.88	15.07	42.778
16	Whole small tubers	6.98	15.70	39.185
17	Pieces from bud end of large tubers	8.11	16.07	43.005
18	Whole small tubers	6.42	15.55	40.475
19	Pieces from bud end of large tubers	7.22	15.66	42.170
20	Whole small tubers	6.95	15.80	39.845
Average for plants from pieces of large tubers		6.97	15.03	42.106
Average for plants from whole small tubers		6.91	15.83	42.118

The figures in Table 2 show plainly that the early growth of plants from whole small tubers was more rapid than that of plants from pieces of large tubers; also, that this more rapid growth was correlated with larger yield. But the figures in Table 3 are somewhat contradictory. While Rows 11 to 14 gave results which harmonize with those shown by Rows 1 to 10, Rows 15 to 20 are discordant. Altho the average height of the plants in Row 15 (planted with pieces) was less than that of plants in Row 16 (planted with whole tubers), the yield of the former was the greater. Also, plants in Rows 17 and 19 (from pieces of large tubers) made more rapid growth than those in Rows 18 and 20 (from whole small tubers). In this respect the behavior of Rows 17 to 20 was directly opposite to that of the remainder of the experiment. The writer suspects that Row 17 possessed some unknown advantage; also, there is the possibility that the irregular results obtained in this part of the experiment were partly due to the fact that the seed pieces used were bud-end pieces. However, it should be noted that in nine of the ten pairs of rows in the experiment the row having the taller plants gave the larger yield.

The relation which the rapidity of early growth bears to the yield is brought out still more clearly by grouping the plants according to their height and comparing the mean yields of the plants in the several groups as shown in Tables 4 and 5.

Because of the necessity of considering the plants from whole small tubers separately from the plants from pieces of large tubers, and plants measured the first day separately from plants measured the second day, it is necessary to divide the 2,000 plants in the experiment into four great groups of about 500 plants each. In Tables 4 and 5 the further grouping within each of the four great groups is based on differences of 1 inch in height. In order to include all of the plants it is necessary to make 15 groups for the first measurement (Table 4) and 19 groups for the second measurement (Table 5). Under this method of grouping several of the groups contain fewer than ten plants each and the mean yield of so small a number of plants is not dependable. Probably, this accounts for the irregularities appearing near the top and bottom of both tables.

TABLE 4.— RELATION OF THE RAPIDITY OF EARLY GROWTH OF POTATO PLANTS TO THEIR YIELD IN EXPERIMENT OF 1920 (FIRST MEASUREMENT).

HEIGHT OF PLANTS*	Rows 1, 3, 5, 7, AND 9		Rows 2, 4, 6, 8, AND 10		Rows 11, 13, 15, 17, AND 19		Rows 12, 14, 16, 18, AND 20	
	Number of Plants	Average Yield	Number of Plants	Average Yield	Number of Plants	Average Yield	Number of Plants	Average Yield
Inches		*Ounces*		*Ounces*		*Ounces*		*Ounces*
0 to 1	5	24.30	3	24.00	1	0.00	2	18.75
1 to 2	3	15.83	3	26.33	4	21.00	2	31.00
2 to 3	28	28.75	10	36.65	4	20.12	0	......
3 to 4	88	35.06	48	37.03	13	30.57	6	25.58
4 to 5	142	38.78	92	41.91	33	31.77	39	30.21
5 to 6	91	45.68	92	43.16	77	36.31	73	35.29
6 to 7	56	51.19	112	47.25	118	40.48	101	41.50
7 to 8	27	52.04	66	49.11	92	43.41	121	44.43
8 to 9	30	53.33	38	51.37	60	46.39	85	45.51
9 to 10	11	56.45	21	55.40	47	48.61	39	47.77
10 to 11	11	60.31	10	66.95	21	54.88	20	51.60
11 to 12	1	72.00	3	47.17	16	53.38	6	50.33
12 to 13	0	......	1	44.00	9	57.88	4	77.50
13 to 14	0	......	0	......	3	57.83	1	66.50
14 to 15	0	......	0	......	1	64.50	0	......

* Rows 1 to 10 were measured on July 2; Rows 11 to 20, on July 3.

Disregarding groups which contain fewer than ten plants the mean yield increases quite rapidly as the height of the plants increases, with three exceptions, the most notable of which appears at about the middle of the last column of Table 5. Here, the mean yield of the 30 plants in the 13-to-14-inch group is given as 37.18 ounces, while the mean yield of the 65 plants of the 14-to-15-inch group was only 36.77 ounces. The writer is unable to account for this irregularity.

The results of this experiment strongly support Arthur's claim that rapid early growth is an indication of large yield. Apparently, it is possible to separate the high-yielding plants from the low-yielding ones while the plants are yet quite small. For example, if the 493 plants in Rows 1, 3, 5, 7, and 9 be divided into two groups one of which contains the 266 plants which were less than 5 inches high on July 2, and the other the remaining 227 plants which were 5 or more inches in height on the same date, the mean yield of the former group is 35.96 ounces, while the mean yield of the latter group is 50.16 ounces.

TABLE 5.— RELATION OF THE RAPIDITY OF EARLY GROWTH OF POTATO PLANTS TO THEIR YIELD IN EXPERIMENT OF 1920 (SECOND MEASUREMENT).

HEIGHT OF PLANTS*	Rows 1, 3, 5, 7, AND 9		Rows 2, 4, 6, 8, AND 10		Rows 11, 13, 15, 17, AND 19		Rows 12, 14, 16, 18, AND 20	
	Number of Plants	Average Yield	Number of Plants	Average Yield	Number of Plants	Average Yield	Number of Plants	Average Yield
Inches		*Ounces*		*Ounces*		*Ounces*		*Ounces*
4 to 5	2	8.25	0	......	1	0.00	0	......
5 to 6	2	5.50	0	......	0	......	0	......
6 to 7	1	3.50	1	16.00	0	......	0	......
7 to 8	2	19.50	0	......	3	18.00	0	......
8 to 9	10	22.05	0	......	4	10.50	1	21.50
9 to 10	16	21.72	3	29.67	8	12.94	3	17.83
10 to 11	18	23.42	4	18.25	10	29.30	1	33.00
11 to 12	25	31.30	9	25.44	17	31.09	8	18.62
12 to 13	44	36.72	14	30.75	29	31.88	18	27.17
13 to 14	78	39.06	42	36.58	54	37.33	30	37.18
14 to 15	89	41.90	77	41.81	75	42.39	65	36.77
15 to 16	62	47.73	127	44.49	104	42.24	102	40.99
16 to 17	56	51.21	88	47.86	68	46.00	111	43.93
17 to 18	36	52.58	73	50.21	64	47.84	83	46.66
18 to 19	25	56.54	26	55.69	33	49.59	39	47.36
19 to 20	15	58.50	28	59.01	16	51.03	22	50.00
20 to 21	9	57.67	5	60.30	10	59.80	13	50.31
21 to 22	1	62.50	2	52.00	2	62.75	3	78.17
22 to 23	2	63.25	0	......	1	53.00	0	......

* Rows 1 to 10 measured on July 15; Rows 11 to 20, on July 16.

Or, if the 499 plants in Rows 2, 4, 6, 8, and 10 be divided into two groups, one of which contains the 248 plants which were less than 6 inches high on July 2, and the other the 251 plants which were 6 or more inches in height on the same date, the mean yield of the former is 40.81 ounces, while the mean yield of the latter is 49.82 ounces.

Likewise, if the 499 plants in Rows 11, 13, 15, 17, and 19 be divided into two groups, one of which contains the 250 plants which were less than 7 inches high on July 3, and the other the remaining 249 plants which were 7 or more inches in height on the same date, the mean yield of the former is 36.73 ounces, while the mean yield of the latter is 47.50 ounces.

Finally, if the 499 plants in Rows 12, 14, 16, 18, and 20 be divided into two groups, one of which contains the 223 plants which were less than 7 inches high on July 3, and the other the remaining 276 plants which were 7 or more inches in height on the same date, the mean yield of the former is 36.76 ounces, while the mean yield of the latter is 46.44 ounces.

A generalization based on the results of a single experiment of this kind is unwarranted, but were such a conclusion to be drawn it might be stated thus: If a lot of potato plants, a majority of which are 5 to 7 inches high, be divided according to their height into two equal groups, it may be expected that the taller group will outyield the shorter group by about 29 per cent.

Altho the data here presented show a close relation between yield and the rapidity of early growth, it does not follow that plants making a rapid early growth will always give a larger yield than plants which grow more slowly at first. For example, potatoes on the Station grounds reached an average height of 6 inches more quickly in 1919 than in 1920, yet the yield in 1920 was more than twice that obtained in 1919. The potatoes were of the same strain, planted on adjoining plats, and treated in the same way in the two seasons. The greater yield in 1920 was due, chiefly, to a difference in rainfall, the season of 1919 being dry, while in 1920 there was an abundance of rain except during the period of early growth. From such observations as this it appears to the writer that Arthur's statement that " whatever increases the rate of growth at the beginning increases the yield " requires qualification. A better form of statement would be that, subsequent conditions being equal, whatever increases the rate of growth at the beginning increases the yield.

Leafroll.— Altho the seed used in the experiment was grown in a seed plat in which less than 0.5 per cent of the plants were affected with leafroll, and these removed early in the season, about 5.7 per cent of the plants in the experiment became affected with leafroll.

The first inspection for leafroll was made on July 17 when the average height of the plants was 15 to 16 inches. At this time there were found 97 plants clearly affected with leafroll and 7 others which were probably affected.

Ten days later a second inspection was made. By this time the plants had branched, settled down, spread out, and mingled their branches to a considerable extent making it less easy to detect the leafroll plants. Some of the plants suspected of having leafroll at the time of the first inspection now appeared nearly or quite normal. On the other hand, a few new cases of leafroll were found. The record for this inspection was 98 plants definitely affected with leafroll and 10 suspected.

It is interesting to note the distribution of the leafroll plants with respect to the use of whole and cut seed. In the ten rows planted with whole small tubers there were 41 plants definitely affected with leafroll and 7 suspected of having it. In the ten rows planted with pieces of large tubers there were 57 definitely affected and 3 suspected. This indicates that no more leafroll is to be expected from small tubers than from large tubers of the same plant. Also, that leafroll plants and normal plants may come from different tubers of the same plant. Possibly, the disease was masked in some cases, as sometimes happens, but the weather conditions seemed to be favorable for the development and detection of leafroll.

Since the seed used in the experiment came from a seed plat from which all leafroll plants were supposed to have been removed, most, if not all, of the leafroll plants in the experiment must have come from tubers of plants which were apparently normal the previous season. In other words, the leafroll in this experiment is the first visible result of infection. Such being the case it is of interest to know how it affected the yield. The mean yield of the 98 plants definitely affected with leafroll was 17.5 ounces; while the mean yield of 174 normal plants immediately adjoining the leafroll plants on either side was 50.4 ounces; and the mean yield of all plants in the experiment, exclusive of those definitely affected with leafroll, was 44.34 ounces. Stated in terms of percentage, the mean yield of the leafroll plants was 34.7 per cent of that of the normal plants next to them, or 39.5 per cent of the mean yield of all plants in the experiment not definitely affected with leafroll.

Folsom (12, p. 45) says: "Tests have shown that when the leafroll hills of a stock are grown separately, the leafroll part will yield only from 15 to 40 per cent as much as the healthy part. * * * * When the diseased hills are scattered among the healthy hills their poor yield may, as shown by experiments, be balanced somewhat by better yields of the healthy plants growing next to the dwarfed leafroll hills, but even then there is some reduction which is greater as the percentage of leafroll hills is greater."

It has already been shown that the yield increased as the height of the plants increased; and on a subsequent page it will be shown, also, that the yield increased as the number of stalks increased. Since about 5 per cent of the plants in the experiment were definitely affected with leafroll it is pertinent to inquire how the leafroll plants compared with the normal plants in height and number of stalks.

The 57 leafroll plants in the rows planted with pieces of large tubers had, on the average, 1.56 stalks each, while the remaining 935 plants had 2.19 stalks each. The 41 leafroll plants in the rows planted with whole small tubers had 1.73 stalks each, while the remaining 957 plants in these rows had 1.92 stalks each. These figures seem to show that leafroll plants have fewer stalks than normal plants, but in drawing conclusions from them it should be borne in mind that the number of leafroll plants is rather small.

The comparative height of leafroll and normal plants is shown in Tables 6 and 7. The normal plants were considerably the taller, but the difference in height was not as great as the difference in yield.

Number of stalks.— The average number of stalks per plant was greater for plants from pieces of large tubers than for plants from whole small tubers, amounting to 2.14 for the former and 1.91 for the latter. It is interesting to note that among the plants from pieces of large tubers those coming from stem-end seed pieces had, on the average, 2.40 stalks each; while those coming

TABLE 6.— COMPARATIVE HEIGHT OF NORMAL AND LEAFROLL PLANTS FROM PIECES OF LARGE TUBERS.

Rows 1, 3, 5, 7, and 9				Rows 11, 13, 15, 17, and 19			
Kind of plants	Number of plants	Mean height		Kind of plants	Number of plants	Mean height	
		July 2	July 15			July 3	July 16
		Inches	*Inches*			*Inches*	*Inches*
Normal.....	458	5.02	14.51	Normal....	477	7.05	15.19
Leafroll.....	35	4.00	10.96	Leafroll....	22	5.16	11.41

TABLE 7.— COMPARATIVE HEIGHT OF NORMAL AND LEAFROLL PLANTS FROM WHOLE SMALL TUBERS.

Rows 2, 4, 6, 8, and 10				Rows 12, 14, 16, 18, and 20			
Kind of plants	Number of plants	Mean height		Kind of plants	Number of plants	Mean height	
		July 2	July 15			July 3	July 16
		Inches	*Inches*			*Inches*	*Inches*
Normal.....	480	5.79	15.69	Normal....	477	6.97	15.97
Leafroll.....	19	4.87	12.18	Leafroll....	22	5.59	12.64

from one-eye seed pieces taken from the middle of the tuber had only 1.95 stalks each, and plants from bud-end seed pieces only 2.09 stalks each. This result with seed pieces from different portions of the tuber is at variance with that obtained by Arthur (2, p. 213) in a similar experiment. Arthur found that bud-end seed pieces produce more stalks than stem-end seed pieces of equal weight. Perhaps varieties differ in this respect. Dr. Arthur has not given the name of the variety used in his experiment.

Table 8 shows the number of plants having one stalk, two stalks, three stalks, etc., for each of the two kinds of seed.

TABLE 8.— WHOLE VS. CUT SEED: A COMPARISON OF THE NUMBER OF STALKS PRODUCED.

Pieces of large tubers planted in Rows 1, 3, 5, 7, 9, 11, 13, 15, 17, and 19		Whole small tubers planted in rows 2, 4, 6, 8, 10, 12, 14, 16, 18, and 20	
Total number of plants..........	992	Total number of plants...........	998
Number having 1 stalk...........	214	Number having 1 stalk...........	314
Number having 2 stalks..........	499	Number having 2 stalks..........	502
Number having 3 stalks..........	210	Number having 3 stalks..........	146
Number having 4 stalks..........	62	Number having 4 stalks..........	34
Number having 5 stalks..........	6	Number having 5 stalks..........	1
Number having 6 stalks..........	1	Number having 6 stalks..........	0
Average number of stalks per plant.	2.14	Number having 7 stalks..........	0
		Number having 8 stalks..........	1
		Average number of stalks per plant.	1.91

In Bulletin No. 489 of this Station the writer has shown how, in an experiment conducted in 1919, the yield of potato plants increased as the number of stalks increased. The present experiment furnishes additional evidence of the same kind. In each of the two groups of plants the mean yield of plants having two stalks each was considerably larger than the mean yield of plants having one stalk each. Also, the mean yield of plants having three stalks was somewhat larger than that of plants having two stalks. For plants having four or more stalks the correlation of number of stalks with yield was less clear. Perhaps, the number of plants in the higher classes was too small for an accurate determination.

The relation of the number of stalks to the yield is shown in Table 9. In the calculation of the mean yields shown in Columns 3 and 6, the yields of plants at the ends of the rows have been excluded, because end plants, having no competition on one side, are likely to give abnormally large yields.

TABLE 9.— RELATION OF THE NUMBER OF THE STALKS TO THE YIELD.

Pieces of large tubers planted in rows 1, 3, 5, 7, 9, 11, 13, 15, 17, and 19			Whole small tubers planted in rows 2, 4, 6, 8, 10, 12, 14, 16, 18, and 20		
Number of stalks	Number of plants *	Mean yield per plant	Number of stalks	Number of plants *	Mean yield per plant
		Ounces			*Ounces*
1	210	34.73	1	309	37.86
2	488	43.14	2	493	45.11
3	209	45.45	3	141	49.01
4	58	46.10	4	33	45.09
5	6	43.92	5	1	63.00
6	1	18.50	6	0	.....
			7	0	.....
			8	1	16.00

* Plants at the ends of the rows have been excluded.

Number of tubers.— The average total number of tubers produced per plant was 6.57 for plants from whole small tubers and 6.39 for plants from pieces of large tubers. Of the former, 92.2 per cent, and of the latter, 93.1 per cent, were of marketable size, i. e., over 2 ounces in weight.

Table 10 shows the total number of tubers produced by each row and the average number of tubers per plant for each row.

Weight of tubers.— In order to compare the performance of whole and cut seed with respect to the average total weight of tubers produced per plant, per row, and per acre, Table 11 has been constructed. In this table the actual total yield of each row is shown in the fourth column and the total yield of each row calculated for full stand in the fifth column. The method used

TABLE 10.— WHOLE VS. CUT SEED: COMPARISON OF THE NUMBER OF TUBERS PRODUCED.

Pieces of large tubers used as seed				Whole small tubers used as seed			
Row	Number of plants	Total number of tubers	Average number of tubers per plant	Row	Number of plants	Total number of tubers	Average number of tubers per plant
1........	98	725	7.40	2.......	100	693	6.93
3........	97	688	7.09	4.......	100	642	6.42
5........	98	694	7.08	6.......	99	655	6.61
7........	100	621	6.21	8.......	100	687	6.87
9........	100	573	5.73	10.......	100	653	6.53
11........	100	568	5.68	12.......	100	659	6.59
13........	100	606	6.06	14.......	100	646	6.46
15........	99	641	6.47	16.......	100	669	6.69
17........	100	599	5.99	18.......	99	633	6.39
19........	100	625	6.25	20.......	100	624	6.24
Totals....	992	6,340	....	Totals....	998	6,561	....
Average number of tubers per plant....................			6.39	Average number of tubers per plant....................			6.57

for calculating the yield for full stand consisted in dividing the actual total yield of the row by the number of plants in the row and multiplying the quotient thus obtained by 100 (the number of plants required to make a full stand). This method of calculation is permissible because vacancies created by failure of seed were filled early in the season with transplants. (See page 11.)

It will be observed that the average total weight of tubers produced per plant may be calculated either from the figures in the fourth column or from those in the fifth column. If we use the figures in the fourth column and add together the actual row yields of the ten rows planted with pieces of large tubers (Rows 1, 3, 5, 7, 9, 11, 13, 15, 17, and 19) the total yield obtained is 41,963 ounces. Dividing by 992, the total number of plants producing this yield, we obtain 42.30+ ounces as the average total yield per plant. By the same method of calculation, the average total yield per plant for plants from whole small tubers (Rows 2, 4, 6, 8, 10, 12, 14, 16, 18, and 20) is found to be 43.73+ ounces.

Now, if we apply the same method of calculation to the figures in the fifth column, we obtain a slightly different result, viz., 42.31 + ounces as the average total yield for plants from pieces of large tubers and 43.73 — ounces as the average total yield for plants from whole small tubers.

TABLE 11— WHOLE VS. CUT SEED: A COMPARISON OF THE TOTAL WEIGHT OF TUBERS PRODUCED IN EXPERIMENT OF 1920.

Row	Character of seed	Number of plants	Total yield		
			Actual	Calculated for full stand	Difference in yield of adjoining rows*
			Ounces	*Ounces*	*Ounces*
1	Pieces of large tubers..........	98	4628.0	4722.4	
2	Whole small tubers............	100	5030.5	5030.5	+308.1
3	Pieces of large tubers..........	97	4206.5	4336.6	
4	Whole small tubers............	100	4390.0	4390.0	+53.4
5	Pieces of large tubers..........	98	4288.0	4375.5	
6	Whole small tubers............	99	4396.5	4440.9	+65.4
7	Pieces of large tubers..........	100	3915.0	3915.0	
8	Whole small tubers............	100	4406.0	4406.0	+491.0
9	Pieces of large tubers..........	100	3914.5	3914.5	
10	Whole small tubers............	100	4403.0	4403.0	+488.5
11	Pieces of large tubers..........	100	3975.0	3975.0	
12	Whole small tubers............	100	4410.0	4410.0	+435.0
13	Pieces of large tubers..........	100	4283.5	4283.5	
14	Whole small tubers............	100	4697.0	4697.0	+413.5
15	Pieces of large tubers..........	99	4235.0	4277.8	
16	Whole small tubers............	100	3918.5	3918.5	—359.3
17	Pieces of large tubers..........	100	4300.5	4300.5	
18	Whole small tubers............	99	4007.0	4047.5	—253.0
19	Pieces of large tubers..........	100	4217.0	4217.0	
20	Whole small tubers............	100	3984.5	3984.5	—232.5

Mean yield per plant from cut seed, 42.30 + ounces.
Mean yield per plant from whole seed, 43.73 + ounces.
Mean difference in yield per row, 141.01 ± 70.75 ounces in favor of whole seed.
Mean difference in yield per acre, 17.06 bushels in favor of whole seed.

* A plus sign (+) indicates that the difference is in favor of the row planted with whole seed, a minus sign (—) that it is in favor of row planted with cut seed.

In the belief that these discordant results must be due to errors in calculation, all calculations were carefully checked without the discovery of any error. Finally, it was realized by the writer that mean yields obtained from the two columns of figures cannot agree exactly. The reason is that some rows are represented by a larger number of plants in the row yields of Column 5 than in the row yields of Column 4, while for other rows the representation remains unchanged. Since, in the experiment under consideration, the difference is so small as to be neglible it is unnecessary to enter into a discussion of the relative merits of the two methods of calculation. It is sufficient to point out that they cannot be expected to yield identical results.

If the total yield per acre is calculated by multiplying the mean yield per plant by 11,616, the number of plants on an acre, it is found to be 529.13 bushels for whole small tubers and 511.83 bushels for pieces of large tubers. Hence, the difference in total yield was 17.3 bushels per acre in favor of whole small tubers. Another method of calculation giving a slightly smaller difference in total yield is described on page 26.

It having been sometimes stated that the use of uncut tubers for seed results in a crop containing a high percentage of small tubers, it is worthy of note that such a result was not obtained in this experiment. The percentage of the crop consisting of tubers under 2 ounces in weight was 1.73+ per cent for whole small tubers and 1.58— per cent for pieces of large tubers. Expressed in bushels per acre, the yield of small tubers was at the rate of 9.18 bushels for whole small tubers and 8.07 bushels for pieces of large tubers. The difference in yield of marketable tubers was 16.19 bushels per acre in favor of whole small tubers.

The figures in the sixth column of Table 11 are of considerable interest. They show how the yield of each odd-numbered row, planted with pieces of large tubers, compares with the yield of the adjoining even-numbered row, planted with whole small tubers. When the difference in yield is in favor of the row planted with whole small tubers it is given a plus sign, and when it is in favor of the row planted with pieces of large tubers it is given a minus sign. It will be observed that for each of the first seven pairs of rows the difference is in favor of whole small tubers, while in the last three pairs of rows it is in favor of pieces of large tubers. Also, that the differences given for the first three pairs of rows, altho in favor of whole small tubers, are not nearly so large as those given for the next four pairs of rows. How are these variations to be explained? Doubtless a large part is due to differences in soil and other environmental factors entirely apart from the kind of seed used. This view is supported by the fact that different rows planted with the same kind of seed vary widely in yield, the extremes being 5,030.5 ounces on Row 2 and 3,918.5 ounces on Row 16. The difference of 1,112 ounces between the yields of these two rows planted with the same kind of seed is more than twice the size of the greatest difference in Column 6. But when it is recalled that the first three odd-numbered rows were planted with stem-end pieces, the next four odd-numbered rows chiefly with pieces from the middle of the seed tuber, and the last three with bud-end pieces (page 11), one wonders if that does not account for the different results obtained from different parts of the experiment. Apparently, the stem-end pieces and the middle pieces gave a smaller yield than whole small tubers while the bud-end pieces outyielded whole tubers. If these results are trustworthy they tend to support the view that the apical portion of the tuber is more productive than the stem-end portion. However, it should be noted that, in the present experiment, the stem-end pieces produced more stalks than the bud-end pieces (page 19) and it has been proved that the yield increases as the number of stalks increases. (See page 21.) In short, our data are contradictory as regards the relative productivity of the stem end and the bud end of the tuber. Without entering into a discussion of the subject other than to call attention to the fact that widely different results have been obtained by different experimenters, the writer ventures to express the opinion that the superiority of the bud end of the tuber for seed purposes has not yet been proved conclusively. He is unwilling to accept the view that the peculiar result shown by the figures in the sixth column of Table 11 is due to the seed pieces being taken from different portions of the seed tuber.

In some respects it is unfortunate that the seed pieces cut from large tubers were not thoroly mixed before planting so as to secure uniformity in the character of the seed used on the odd-numbered rows in the experiment. Because of the difference in seed used and the difference in soil conditions in different portions of the experimental plat, it may be that a more accurate determination of the difference in total yield per acre would be obtained by using the figures in the sixth column of Table 11. The algebraic sum of the differences in Column 6 is +1,410.1 ounces. This means that for ten pairs of rows the total difference in total yield is 1,410.1 ounces in favor of whole small tubers. The mean difference per row is 141.01 ± 70.75 ounces,[3] which multiplied by 116.16, the number of rows required to make an acre, gives 16,380 ounces, or 17.06+ bushels, as the difference in total yield per acre in favor of whole small tubers. Since this mean difference is only twice the magnitude of its probable error the odds against its occurrence by chance are only 4.6 to 1. Accordingly, it cannot be regarded as statistically significant.

SUMMARY OF RESULTS IN 1920 EXPERIMENT

A brief statistical summary of the principal results obtained in the experiment of 1920 is presented in Table 12.

TABLE 12.— SUMMARY OF RESULTS OBTAINED IN 1920 EXPERIMENT: PERFORMANCE OF PLANTS FROM WHOLE SMALL TUBERS COMPARED WITH THAT OF PLANTS FROM PIECES OF LARGE TUBERS OF THE SAME PLANTS.

ITEMS COMPARED	PLANTS FROM WHOLE SMALL TUBERS	PLANTS FROM PIECES OF LARGE TUBERS
Stand	99.8 per cent	99.2 per cent
Average height of plants on July 2; Rows 1 to 10	5.76 inches	4.95 inches
Average height of plants on July 3; Rows 11 to 20	6.91 inches	6.97 inches
Average height of plants on July 15; Rows 1 to 10	15.57 inches	14.25 inches
Average height of plants on July 16; Rows 11 to 20	15.83 inches	15.03 inches
Average number of stalks per plant	1.91	2.14
Total number of plants affected with leafroll	48	60
Average number of tubers per plant	6.57	6.39
Percentage of total number weighing over 2 ounces	92.2 per cent	93.1 per cent
Average total weight of tubers per plant	43.73 ounces	42.30 ounces
Total yield per acre	529.13 bushels	511.83 bushels
Yield of marketable tubers (over 2 oz.) per acre	519.95 bushels	503.76 bushels
Yield of small tubers (under 2 oz.) per acre	9.18 bushels	8.07 bushels
Percentage of total crop consisting of small tubers	1.73 per cent	1.58 per cent

[3] Probable error calculated by the formula, $P.\ E. = \pm\ 0.6745 \sqrt{\frac{\Sigma d^2}{n\ (n-1)}}$.

CONCLUSIONS

In the experiment of 1920 the showing made by whole small tubers was slightly better in all respects than that made by pieces of large tubers. They gave a better stand, the early growth of the plants was more rapid, fewer of the plants were affected with leafroll, and the yield of both merchantable and small tubers was greater. However, these differences were too small to establish definitely the superiority of the whole small tubers. In the experiment of 1906 the greater productivity of whole small tubers was more clearly demonstrated.

The principal conclusion drawn by the writer may be stated as follows: For seed purposes, uncut tubers between 1 and 2 ounces in weight are at least as good as, and, probably, a little better than, pieces of equal weight cut from large tubers of the same plant. While this principle is likely to have general application, it can, of course, be affirmed only for the combination of varieties and conditions had in these experiments. It may not hold for all varieties or for all conditions of weather, soil, and culture.

Other conclusions which may be drawn from the results of the second experiment are:

(1) The yield of potato plants increases as the number of stalks increases.

(2) Subsequent conditions being equal, plants making rapid growth early in the season will outyield plants which grow more slowly.

(3) The use of uncut tubers for seed does not always result in a large number of stalks or in a large proportion of small tubers in the crop.

PRACTICAL APPLICATION OF RESULTS

The conclusion above stated, that the small tubers are as good as the large tubers of the same plant for seed purposes, is in line with the teachings of potato experts in recent years and should not materially alter the present practice of our best potato growers with respect to the use of whole small potatoes for seed. However, it seems advisable to make a restatement of the case at this time.

Every farmer who grows potatoes commercially and uses home-grown seed should maintain a special seed plat of sufficient size to produce the amount of seed required for planting his entire potato acreage. This plat should be located at considerable distance from other potatoes; it should be planted with hill-selected seed; it should be thoroly rogued for mosaic, leafroll, wilt, and weak plants; and it should be thoroly sprayed. At digging time, some of the best hills, which have been carefully selected, should be dug separately and preserved for planting next year's seed plat. The remainder of the crop from the seed plat may then be bulked and used for planting the main acreage. When a seed plat is managed in this way it is unnecessary to reject the small tubers. All tubers over 1 ounce in weight may be used for seed.

On the other hand, it is not advisable, as a rule, to plant small tubers from a crop which has not been carefully rogued, and the practice of planting only small tubers without any selection or change of seed invariably leads to disaster. Occasionally, when seed potatoes are dear, it may be profitable to plant, for a single season, whole small tubers, provided they can be obtained from a field which, tho unrogued, has given a satisfactory yield and is known to have been reasonably free from weak and degenerate plants.

In general, the buyer of seed potatoes should accept only tubers of good size. But if the potatoes have been properly inspected and certified and shown by the inspector's report to have yielded well and to have been nearly or quite free from mosaic, leafroll, wilt, and weak plants, the buyer need not be particular about the size of the tubers. The seconds from such fields are likely to be more valuable than the firsts from fields containing even a moderately high percentage of weak, diseased, or degenerate plants.

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