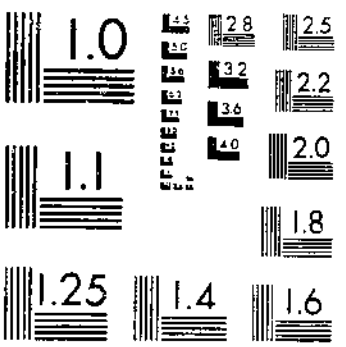
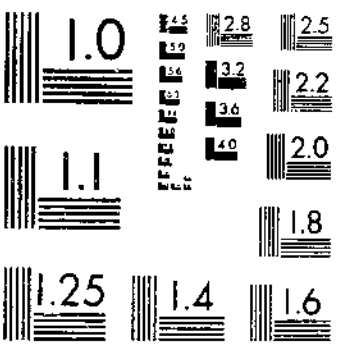
START



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

TECHNICAL BULLETIN No. 5 DECEMBER, 1927

UNITED STATES DEPARTMENT OF AGRICULTURE
WASHINGTON, D. C.

SOURCE, CHARACTER, AND TREATMENT OF POTATO SETS

By WILLIAM STUART, *Horticulturist;* W. C. EDMUNDSON, *Associate Horticulturist;* P. M. LOMBARD, *Assistant Horticulturist;* and G. W. DEWEY, formerly *Assistant Horticulturist, Office of Horticulture, Bureau of Plant Industry*

CONTENTS

SOURCE OF POTATO SETS [1]

In the ensuing study of the literature pertaining to comparisons that have been made by various investigators who have considered the relative merits of apical and basal sets of potatoes for seed and the advisability of using overgrown tubers for this purpose, it is the aim of the writers to state briefly their more important findings. No attempt is made to present an exhaustive study of all published data, but rather to indicate some of the outstanding results that have been obtained.

COMPARISON OF APICAL AND BASAL SETS

The relative value of the apical and basal portions (seed and stem ends) of potato tubers for seed purposes has served as a basis for numerous studies, both in this and in foreign countries to determine which portion of the tuber will ordinarily produce the larger yield. Some growers are so firmly convinced that the seed or apical end of the tuber is undesirable for seed purposes that they clip it off and discard it. Another group of growers are equally convinced that

[1] By William Stuart and P. M. Lombard.

38950°—27——1

the seed end is superior to the stem end for planting. These different viewpoints have been responsible for repeated efforts to demonstrate the superiority of one over the other.

PREVIOUS EXPERIMENTAL EVIDENCE

One of the earliest statements regarding the relative value for seed purposes of apical and basal sets which has come to the attention of the writers is found in Wilson's book on farm crops (*41, p. 41*)[2] in which he says:

> A difference has also been observed in the germinating powers of sets cut from different parts of the tuber; that those taken from the rose end or upper part [apical] produce more vigorous plants and ripen earlier than those taken from the center or from the opposite extremity or heel [basal], as it is commonly termed.

Experimental evidence does not always sustain this statement, as may be noted from the following examples cited:

Taft (*37, p. 190–193*) obtained larger yields from sets taken from the middle portion of the tuber than from either apical or basal sets. The basal sets slightly outyielded apical sets. In the following year his report (*38, p. 180*) again shows larger yields from sets taken from the middle portion of the tuber, but there is a slight increase from apical over basal sets.

From a preliminary study of this question Alwood (*3, p. 17*) concludes that "the stem end, middle, and seed end eyes show about equal vitality under equal conditions." This statement is well supported by that of Speer (*32*), who says:

> Although I have conducted hundreds of potato experiments I have never noticed anything that would indicate that one end of a thoroughly ripe tuber is better for seed than the other end.

Rather extensive studies with seed pieces from four parts of the tuber, embracing the apex, near apex, near base, and base, by Arthur (*7*) showed that, theoretically at least, the vigor of the eyes decreases in a definite series from the apical to the basal portion of the tuber.

Troop (*39*) found that the apical sets gave a much larger proportion of large tubers than basal sets. The results of a study of apical and basal sets for seven years reported by Sanborn (*31*) showed an average acre yield of 168 bushels from the apical sets and 148 bushels from the basal sets, a difference of 20 bushels in favor of the former.

In a later report from Utah, Richman (*29, p. 4*) reports a yield of 358 pounds of primes and 120 pounds of culls from apical sets and 388 pounds of primes and 142 pounds of culls from basal sets. This represents an increase of more than 8 per cent of primes and of more than 18 per cent of culls, a total gain of 14.5 per cent, in favor of basal sets.

Experimental studies by Halsted (*17*) with the Early Rose, American Giant, and Rural New Yorker No. 2 varieties gave the results shown in Table 1.

---

[2] Reference is made by number in italics to "Literature cited," p. 33.

TABLE 1.—*Yields of potatoes from apical, middle, and basal sets, as reported by Halsted*

Variety	Comparative yield (pounds)		
	Apical sets	Middle sets	Basal sets
Early Rose	66	80.5	55.5
American Giant	37.5	55	31
Rural New Yorker No. 2	94	123.5	100.5
Average yield	197.5	259	187

In a subsequent report Halsted (*18*) presents a somewhat more detailed account of further studies on the behavior of apical, central, and basal sets planted in alternate rows. Each set was cut squarely across the tuber and the totals of the sets in each group were of equal weight. During the first four weeks there was a noticeable difference in the size of the plants, those from the basal sets being decidedly smaller than those from apical or central sets. This difference, however, disappeared as the season advanced, and in August all were alike. The yield from the apical sets was 85.2 pounds, from the central sets 110.1 pounds, and from the basal sets 92.8 pounds. These data again show a larger yield from the middle portion of the tuber than from either the apical or the basal sets, but are not in accord with those previously reported in respect to yield from apical and basal sets in that their positions are reversed, the basal sets in this case outyielding the apical sets.

Close and White (*10, p. 162–163*) tested the relative merits of apical and basal sets of two varieties and obtained larger yields from the apical sets, the differences in acre yields being respectively 22 and 19 bushels when Maine-grown seed was used and 44 and 24 bushels from home-grown seed.

Appleman (*5*), on the other hand, obtained diametrically opposite results from Close and White, but with less marked differences in yield. His data show a better stand from apical sets, 85.4 as against 82 per cent from basal sets. The yield, however, is greater from the basal sets, 216 as against 208 bushels. When calculated to a perfect stand the figures are 263 to 243 bushels per acre, a difference of 20 bushels in favor of basal sets.

A 5-year study of the relative behavior of apical and basal sets from 21 varieties by Myers (*22*) indicates a greater yield from apical sets. Myers states that the tubers used were all from pedigreed cultures and that the sets were cut horizontally and trimmed to approximately the same size, in order, as he states, to eliminate any differences that might result from different-sized seed pieces. The 5-year average yield from apical sets was 159.4 bushels and that from the basal sets was 132.4 bushels, a difference of 27 bushels in favor of the apical sets. It is further stated that in not a single variety did the basal sets outyield the apical sets.

DEPARTMENT INVESTIGATIONS

Although a preliminary study of the relative value of apical and basal sets was made by the Office of Horticulture of the United States

Department of Agriculture in 1913, it was not until 1915 that serious attention was given to the subject. The experimental data which follow are based on studies of the relative merits of apical and basal sets at the Virginia Truck Experiment Station, Norfolk, Va., in 1915, 1916, and 1917, and at Presque Isle, Me., in 1917 and 1918. The Irish Cobbler variety was used at Norfolk and the Irish Cobbler and Green Mountain at Presque Isle. The seed stock used in all of the experiments, with the exception of 1916 and 1917 at Norfolk, consisted of 3-ounce and 4-ounce tubers. In the 1916 experiment at Norfolk tubers weighing 2, 3, 4, and 5 ounces were used, and in 1917 only 3-ounce stock was employed. In cutting the tubers care was exercised to divide them horizontally into as nearly equal weights as possible, the two halves of each tuber being planted in adjoining rows.

EXPERIMENTS AT NORFOLK, VA.

The data presented in Table 2 include the results from 1½, 2, and 2½ ounce sets; that is, from tubers weighing, respectively, 3, 4, and 5 ounces. The data given represent the number of sets planted, the percentage harvested, the average number and weight of tubers per set, the average number and weight of primes (market-sized tubers) per set, and the computed acre yields of primes and total yield. It will be noted that comparison of sets of different sizes is possible only for the years 1915 and 1916, in both of which 1½ and 2 ounce sets were planted.

TABLE 2.—*Behavior of apical and basal sets of Irish Cobbler potatoes at Norfolk, Va., in 1915, 1916, and 1917*

Season and kind of sets	Sets		Tubers produced per set				Average acre yield	
			Primes		Total			
	Planted	Harvested	Average number	Average weight	Average number	Average weight	Primes	Total
	Number	*Per cent*		*Pounds*		*Pounds*	*Bushels*	*Bushels*
Season of 1915:								
1½-ounce sets, apical	565	98.9	4.55	1.32	7.89	1.59	245.1	293.3
1½-ounce sets, basal	565	99.6	4.47	1.28	8.24	1.52	241.6	285.3
2-ounce sets, apical	330	99.6	4.07	1.35	8.04	1.60	251.7	308.3
2-ounce sets, basal	330	98.8	4.00	1.33	8.85	1.64	247.8	306.1
Season of 1916:								
1½-ounce sets, apical	200	99.5	4.78	1.85	9.70	2.20	300.0	365.1
1½-ounce sets, basal	200	99.0	5.20	1.83	10.50	2.20	302.3	377.1
2-ounce sets, apical	200	99.0	5.10	2.08	10.40	2.44	343.5	410.5
2-ounce sets, basal	200	99.5	5.68	2.08	10.90	2.52	344.7	418.7
2½-ounce sets, apical	200	99.5	5.60	2.05	12.14	2.53	342.1	419.5
2½-ounce sets, basal	200	100.0	5.60	1.90	12.08	2.55	331.6	242.2
Season of 1917:								
1½-ounce sets, apical	400	100.0	2.59	.75	8.27	1.20	125.0	100.9
1½-ounce sets, basal	400	100.0	3.21	.99	8.57	1.46	165.0	243.3
Average 1½-ounce sets, 1915–1917:								
Apical	388.3	99.5	3.07	1.31	8.62	1.66	225.4	286.1
Basal	388.3	99.5	4.20	1.35	9.10	1.76	232.8	301.9
Average 1½-ounce sets,[1] 1915 and 1916:								
Apical	382.5	99.2	4.67	1.59	8.70	1.89	275.5	329.2
Basal	382.5	99.3	4.83	1.53	9.37	1.95	266.7	331.2
Average 2-ounce sets, 1915 and 1916:								
Apical	269.5	98.9	5.05	1.77	9.67	2.05	297.0	359.4
Basal	269.5	99.2	5.34	1.72	9.88	2.08	290.3	362.4

[1] The 2-year average is given for comparison with 2-ounce sets of same years.

Notwithstanding slight seasonal differences in the behavior of apical and basal sets, the average production of the 1½-ounce basal sets slightly exceeds that of the corresponding apical sets both in number and weight of tubers per set. This statement holds good as to primes and total yield. The total average acre yield from apical and basal sets was 286.1 and 301.9 bushels, respectively.

A comparison of the 2-ounce set data for 1915 and 1916 shows a similar behavior of the apical and basal sets with the exception that the average weight of the primes per set was approximately the same. The total average acre yield was 359.4 and 362.4 bushels, respectively, from apical and basal sets.

In the 1-year comparison of 2½-ounce apical and basal sets the data show a slight advantage in number of tubers per set in favor of the apical sets with an equally small difference in average weight of the tubers in favor of the basal sets. Although the average production of primes per set was identical, there was a slight difference in weight in favor of the apical sets. This difference is reflected in the average yield of primes per acre, the apical sets yielding at the rate of 342.1 bushels as against 331.6 bushels by the basal sets.

A comparison of the average performance of 1½-ounce and 2-ounce apical and basal sets for 1915 and 1916 shows that the larger sized sets produced the larger crop. In these two seasons apical sets produced a larger yield of primes and a slightly smaller total yield.

EXPERIMENTS AT PRESQUE ISLE, ME.

The data from Presque Isle represent a comparison of apical and basal sets of the Irish Cobbler and Green Mountain varieties for the years 1917 and 1918 in which 3-ounce and 4-ounce tubers were used. The data given in Table 3 are similar to those in Table 2 except for the additional set of data on the average number of stems per set. Aside from the fact that a smaller number of sets were used than in the Norfolk experiment, the data in all other essentials represent similar observations. Although the percentage harvested is not quite as high as in the Norfolk studies, it in no case fell below 96.3 and in 7 out of 14 cases was perfect.

In 1917 the 1½-ounce Irish Cobbler basal sets produced a larger average number of stems per set than did the corresponding apical sets, whereas the 2-ounce apical sets produced a larger number than the 2-ounce basal ones. In 1918 both the 1½-ounce and 2-ounce basal sets produced a larger average number of stems than the apical sets.

In 1917 1½-ounce apical and basal sets of the Irish Cobbler averaged about the same number of tubers per set, but there was a difference of 2.32 tubers per set in favor of 2-ounce apical sets. In 1918 the 1½-ounce apical and basal sets averaged 7.56 and 8.13 tubers per set, respectively, a difference of more than half a tuber per set in favor of basal sets. In the case of the 2-ounce sets the average number of tubers per set was 9.89 and 8.82, respectively, a difference of 1.07 tubers in favor of apical sets.

Comparison of the average weight of tubers produced by the 1½-ounce apical and basal sets in 1917 and 1918 indicates a slight advantage in favor of the basal sets, whereas the reverse was true in regard to 2-ounce sets.

TABLE 3.—*Behavior of apical and basal sets of Irish Cobbler and Green Mountain potatoes at Presque Isle, Me., in 1917 and 1918*

Variety, season, and kind of sets	Sets			Tubers produced per set				Average acre yield	
				Primes		Total			
	Planted	Harvested	Average number of stems	Average number	Average weight	Average number	Average weight	Primes	Total
IRISH COBBLER									
Season of 1917:	*Number*	*P. ct.*			*Lbs.*		*Lbs.*	*Bus.*	*Bus.*
1½-ounce sets—apical	300	96.3	3.55	4.21	1.17	8.57	1.62	194.6	262.1
1½-ounce sets—basal	300	97.7	3.82	4.38	1.20	8.58	1.72	200.8	270
2-ounce sets—apical	300	98	4.60	4.83	1.31	10.68	1.88	218.4	300.8
2-ounce sets—basal	300	98	3.75	4.45	1.26	8.36	1.68	209.7	274.9
Season of 1918:									
1½-ounce sets—apical	100	100	2.54	3.53	1.03	7.56	1.47	171.2	250.5
1½-ounce sets—basal	100	100	2.77	3.88	1.17	8.13	1.60	195.1	267.1
2-ounce sets—apical	100	99	3.01	3.73	1.05	9.89	1.58	174.8	264
2-ounce sets—basal	100	99	3.09	3.63	1.03	8.82	1.52	171.6	245.1
Two-year average:									
1½-ounce sets—apical	200	98.2	3.05	3.87	1.10	8.07	1.55	182.9	256.3
1½-ounce sets—basal	200	98.9	3.29	4.13	1.19	8.36	1.66	197.9	268.5
2-ounce sets—apical	200	98.5	3.80	4.28	1.18	10.30	1.73	196.6	285.4
2-ounce sets—basal	200	98.5	3.42	4.04	1.15	8.59	1.60	190.6	260
GREEN MOUNTAIN									
Season of 1917:									
1½-ounce sets—apical	100	100	2.91	3.57	.99	8.21	1.48	165.9	246.3
1½-ounce sets—basal	100	100	2.38	3.36	.91	7.22	1.32	152.4	219.2
Season of 1918:									
1½-ounce sets—apical	300	99.3	2.35	3.14	.93	7.63	1.44	154.3	239.6
1½-ounce sets—basal	300	100	2.08	3.09	.94	6.16	1.37	156.2	228.3
2-ounce sets—apical	300	100	3.05	3.31	.99	8.20	1.56	164.4	250.1
2-ounce sets—basal	300	100	2.25	3.34	.98	7.58	1.48	163.3	247.1
Two-year average:									
1½-ounce sets—apical	200	99.7	2.36	3.36	.96	7.92	1.96	160.1	242.9
1½-ounce sets—basal	200	100	2.23	3.23	.93	6.69	1.35	154.3	223.8

The average number of primes from 1½-ounce sets in 1917 and 1918 was greater from the apical than from the basal sets.

A clearer idea of the relative merits of the two classes of sets is obtained from the average acre yield than from the analysis of the preceding data.

In the production of primes per acre the 1½-ounce basal sets outyielded the apical sets in both 1917 and 1918 by 6.2 and 23.9 bushels, respectively. The 2-ounce apical sets, on the other hand, outyielded the corresponding basal sets by 8.7 and 3.2 bushels, respectively. In total yield per acre the 1½-ounce basal sets showed increased yields of 7.9 and 16.6 bushels, respectively, over the apical sets.

The average production of primes for the two seasons 1917 and 1918 from the 1½-ounce apical and basal sets shows a gain in favor of the basal sets of 15 bushels per acre. A similar comparison of the 2-ounce apical and basal sets shows a gain of 6 bushels per acre in favor of the apical sets. In total yield the 1½-ounce basal sets produced 12.2 bushels per acre more than the apical sets, whereas the 2-ounce apical sets yielded 25.4 bushels more than the basal sets. The significant feature of these data is the consistently larger yields from the 1½-ounce basal sets and from the 2-ounce apical sets.

In trials with the Green Mountain variety, 3-ounce tubers were used in 1917 and 3-ounce and 4-ounce tubers in 1918. The data

indicate responses from apical and basal sets different from those in the case of the Irish Cobbler variety. Comparison of the average number of stems and tubers per set shows a larger average number from the apical sets. Taking the 2-year average, the apical sets gave 2.63 stems and 7.92 tubers per set, and the basal sets averaged 2.23 and 6.69. The average weight of primes from 1½-ounce apical and basal sets for the two seasons 1917 and 1918 was 0.96 and 0.925 pounds, respectively. A comparison of the average total acre yield also favors apical sets, the figures being 242.95 bushels as against 223.75 bushels. These results would seem to indicate a different varietal response from apical and basal sets. It would also appear that apical and basal sets from 4-ounce tubers responded differently from those of 3-ounce tubers.

SUMMARY OF RESULTS FROM APICAL AND BASAL SETS

A study of the literature cited indicates many disagreements in yields from apical and basal sets. It is therefore doubtful whether there is any real difference in their value for seed purposes. The results obtained by Myers (*22*), however, are worthy of careful consideration on account of the evident care exercised in cutting the sets to an even weight.

In the Norfolk experiment the 3-year average yield of primes from 1½-ounce apical sets was less than from basal sets. This statement also holds good with respect to total yield. Comparison of the 2-ounce apical and basal sets shows a slight increase in yield of primes from the apical sets, but with the advantage in favor of the basal sets in total yield.

Somewhat larger differences in yield from 1½-ounce apical and basal Irish Cobbler sets were obtained at Presque Isle. The basal sets outyielded apical sets by 15 bushels per acre in the case of primes and by 12.2 bushels in total yield. Apical 2-ounce sets gave a somewhat larger yield of primes than basal sets and a considerable gain in total yield.

Both 1½-ounce and 2-ounce apical Green Mountain sets outyielded basal sets.

The data as a whole seem to indicate that as the weight of the set increases there is a greater response from the apical than from the basal set.

COMPARISON OF SETS FROM NORMAL AND OVERSIZED TUBERS

UTILIZATION OF LARGE TUBERS

Owing to the almost universal prejudice of seed-potato buyers against oversized tubers, there is little demand for this class of stock other than for table or starch purposes. In fact when there is an oversupply of potatoes the outlet for overgrown tubers is largely confined to hotel, restaurant, or dining-car demands for the "big baked potato." It is a matter of some economic importance, therefore, to find out whether the grower's prejudice against large tubers for seed purposes is based on sufficient evidence to justify it. In other words, are oversized tubers likely to produce a crop inferior to that grown from normal-sized tubers? Is there sufficient justifi-

cation to warrant a discriminatory ruling by most State seed certification inspection services whereby only a relatively small percentage of tubers exceeding 12 ounces in weight are tolerated in properly graded seed stock? It is not the purpose of the writers to determine whether such a ruling is desirable or undesirable, but rather to present the results of a comparative study of the relative merits of equal-weight sets taken from normal and oversized seed stock.

DEPARTMENT INVESTIGATIONS

In 1922 the Office of Horticulture undertook a study of the relative merits of normal and oversized tubers of the Irish Cobbler and Green Mountain varieties. The method followed was first to remove all the overgrown tubers from a given lot of stock and then to use the remaining tubers for the normal-sized tuber source. It was assumed that the stock from which the overgrown tubers were removed would very closely approximate the average commercial

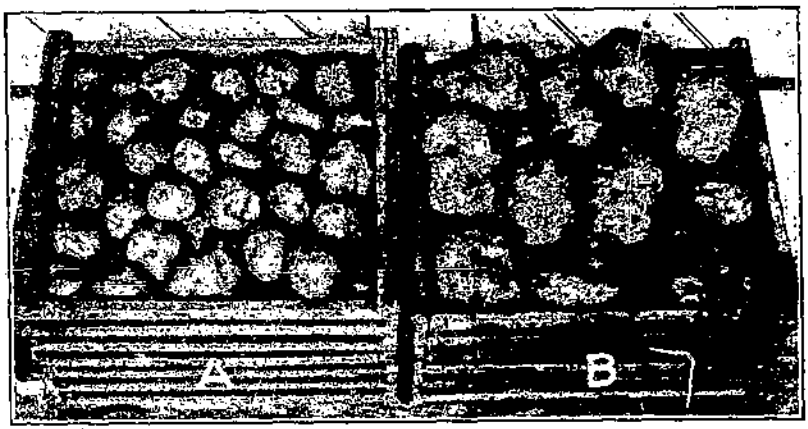


FIG. 1.—Irish Cobbler potatoes: Tubers of normal size in crate A, oversized tubers in crate B

lot of seed potatoes. The tubers selected from each lot thus separated were weighed in grams in order to furnish data for estimating the variation in the quantity of seed required to plant a given acreage. As might naturally be expected, the average weight of the tubers varied from year to year during the 3-year period of the test.

A fair idea of the general run of both sizes of seed stock may be obtained from Figures 1 and 2. All sets were cut to 2 ounces. In 1924 all eyes but one were removed from each set in order to assure a greater degree of uniformity in the number of stems per set. The data relative to the average weight of the tubers selected, the percentage of germination, and the average number of stems per set, as given in Table 4, show that the average weights of the oversized Irish Cobbler tubers in 1922, 1923, and 1924 were 14.72, 16.73, and 12.2 ounces, respectively, the average for the three years being 14.6 ounces. The corresponding weights of the normal-sized tubers were 5.5, 4.58, and 3.9 ounces, an average of 4.6 ounces for the three years. In the case of the Green Mountain variety the oversized tubers averaged 15.2, 13.12, and 15.97 ounces, an average of 14.8 ounces, and the

normal-sized tubers averaged 7.6, 5.85, and 5.8, an average of 6.4 ounces.

Sets from normal-sized tubers gave a slightly higher percentage of germination than those from oversized tubers.

Comparison of the average number of stems per set discloses striking differences in the 1922 and 1923 Irish Cobbler data in favor of sets from normal-sized tubers, with considerably less variation in the case of the Green Mountain. The 3-year averages for the former variety show a gain of more than 18 per cent in favor of sets from normal-sized tubers.

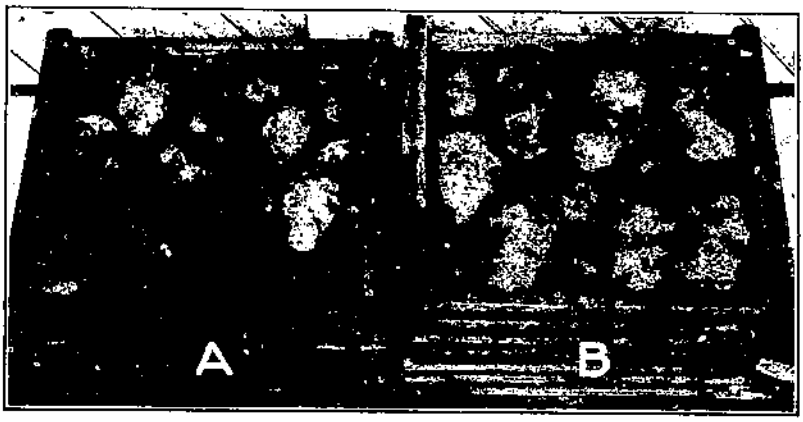


FIG. 2.—Green Mountain potatoes: Tubers of normal size in crate A, oversized tubers in crate B

TABLE 4.—*Weight of potato tubers from which seed pieces were taken, percentage of germination, and average number of stems at Presque Isle, Me., in a 3-year test*

Variety and size	Average weight of tubers (ounces)				Germination (per cent)				Average number of stems per set			
	1922	1923	1924	3 years	1922	1923	1924	3 years	1922	1923	1924	3 years
Irish Cobbler:												
Oversized	14.72	16.73	12.21	14.6	92.5	100	100	97.5	2.77	3.26	2.56	2.86
Normal size	5.5	4.58	3.9	4.6	99.6	100	100	99.8	3.09	4.36	2.58	3.34
Green Mountain:												
Oversized	15.2	13.12	15.97	14.8	93.4	100	100	97.8	------	2.62	2.57	2.6
Normal size	7.6	5.85	5.8	6.4	95.3	100	100	98.4	------	2.74	2.38	2.56

The yearly variation in primes (Table 5) showed the following differences in the yield from sets from Irish Cobbler oversized tubers as compared with the yield from sets from normal-sized tubers: In 1922, 31.25 bushels more; in 1923, 17.92 bushels more; in 1924, 18.5 bushels less. In the case of the Green Mountain the average yield of primes for the three seasons shows the insignificant difference of 2.5 bushels in favor of sets from oversized tubers, the difference in total yield being less than 1 bushel.

Sets from oversized tubers are evidently as productive as those from normal-sized tubers, and in seasons when a considerable proportion of the seed stock grows too large to satisfy commercial de-

mands it may be recommended for seed purposes. The chief objections that have always been raised in regard to oversized tubers are that there is more wastage in cutting, involving a larger quantity by weight to plant an acre, and in addition that they are slightly more difficult to handle and cut.

TABLE 5.—*Comparative yields from sets taken from oversized and normal-sized potato tubers at Presque Isle, Me., in a 3-year test*

Variety and size	Acre yields (bushels)											
	1922			1923			1924			3-year average		
	Primes	Culls	Total	Primes	Culls	Total	Primes	Culls	Total	Primes	Culls	Total
Irish Cobbler:												
Oversized	203.33	40.83	244.16	288.75	23.33	312.08	200.00	12.91	212.91	230.69	25.69	256.38
Normal size	172.08	62.08	234.16	270.83	32.28	303.11	218.50	15.00	233.50	220.47	36.45	250.92
Green Mountain:												
Oversized	238.53	82.50	321.03	185.83	50.83	236.66	261.33	14.33	275.66	228.56	49.22	277.78
Normal size	241.87	91.25	333.12	175.41	50.41	225.82	260.83	10.56	271.49	226.04	50.77	276.80

CHARACTER AND TREATMENT OF POTATO SETS

The questions in regard to the relative merits of immature seed potatoes as compared with mature seed and of greened (light-sprouted) potatoes as compared with ungreened seed have long engaged the attention of potato specialists the world over. It is generally accepted that immature seed is superior to mature seed in vigor of plant and productiveness, and among foreign potato growers there is a more or less general acceptance of the superiority of greened over ungreened sets.

COMPARISON OF MATURE AND IMMATURE SEED

A study of some of the experimental data obtained from comparative tests of the behavior of mature and immature seed stock indicates for the most part a more or less marked increase in yield from the immature sets.

PREVIOUS EXPERIMENTAL EVIDENCE

In 1906 Stewart (*34, p. 14–16*) reported results from a study of the relative merits of immature and mature seed planted in 1905. Five varieties were harvested in an immature and in a mature condition in 1904 to provide seed for the 1905 trials. The vines of those harvested for immature seed were still green and the skin of the tuber was yet tender. In the case of mature seed the vines had died down and the skin of the tuber was tough, indicating full maturity. The average increase in yield from immature over mature whole seed of the five varieties in 1905 was less than 6 per cent. In a later publication (*35*) the statement is made that Wonder was the only variety that had shown any marked advantage from the use of immature seed, and the suggestion is made that it is questionable whether a grower would be justified in attempting to restore vigor to his potatoes by growing immature seed.

The foregoing results are quite different from those obtained by Sutton & Sons in 1906 (*36*), in which the average increase in yield of marketable potatoes from the immature sets over the mature was more than 100 per cent and the gain in total yield was nearly 61 per cent. Eight varieties were used in the experiment, but the number of plants of each variety grown was relatively small.

Some interesting experiments with immature and mature seed are reported by Ramsay (*25–28*). In his 1914–15 experiment he compared whole and cut sets of both immature and mature tubers. Immature whole sets yielded at the rate of 207 bushels per acre and the mature sets only 150 bushels. In the case of the cut sets there was a much greater difference in favor of the immature sets—178.5 to 65.6 bushels. Expressed in percentages, the whole immature sets showed an increase of 38 per cent and the cut sets more than 172 per cent. In the 1921–22 tests a difference of more than 41 per cent in favor of immature seed was obtained. The following year the increase amounted to nearly 65 per cent and in 1925 to nearly 26 per cent. As will be noted, all these differences in favor of immature seed are sufficiently large to be significant.

In 1916 Vilmorin (*40*) reported the results of seven years of study of immature and mature seed stock, 1909 to 1915, inclusive. According to this writer the data obtained during this period were more or less conflicting, because a number of varieties gave better yields from mature seed. In general the immature seed from the early varieties showed more consistent larger yields than that from the late varieties. In explanation of this result Vilmorin states that in his opinion it was due to the fact that well-ripened seed of the late-maturing varieties was not obtained.

In a test recorded by Dunlop (*13*) in which immature and mature seed of the Factor variety were compared, the immature seed stock yielded at the rate of 486.7 bushels per acre and the ripe seed produced 456.7 bushels. In the following year, 1915 (*14*), a similar comparison was made between immature and mature seed of the King Edward variety. The immature seed was dug September 9, 1914, and the ripe seed October 15, 1914. The tubers from these two lots were sized in 1915 between a 1½-inch and a 2-inch riddle. The unripe seed yielded at the rate of 484.2 bushels per acre and the ripe seed produced only 232.5 bushels, a difference of more than 108 per cent in favor of immature seed.

Noll (*23*) in 1917, 1918, and 1919 from seed harvested at weekly intervals obtained the maximum yield from tubers harvested three to four weeks before maturity. Seven harvestings were made from the 1916 crop for the 1917 plantings. The first harvesting was made August 22. In 1917 the first of the six harvestings occurred August 17, and in 1918 the first of the seven lots of seed was dug August 31. Noll states that the actual dates of digging are not so important as the stage of maturity. The best time seems to be when the lower leaves are turning yellow.

The experience of Helmer (*19*) with immature and mature seed was distinctly in favor of mature seed.

Davidson (*12, p. 380*) suggests that experiments have proved that there is nothing to the idea that immature seed is superior to

mature stock except that plants dug early are not so likely to become infected from neighboring diseased plants.

In their reports of field-crop work in New Jersey, App (*4*) and Cox (*11, p. 208*) state that immature seed potatoes dug in late July or early August while the vines were green and allowed to dry for a few weeks before placing in a cool cellar or cold storage until spring were compared with northern-grown seed and late-crop or American Giant seed from Virginia and southern New Jersey. The germination and vine growth of the immature seed throughout the season were generally better than from the northern-grown seed. The immature seed set more tubers per plant, but they averaged smaller, and more rot was present.

Many important additional studies upon the relative value of mature and immature seed might be mentioned, but as no attempt is being made to present an exhaustive review of the literature on this subject, it is not thought desirable to give further consideration to this phase of the question.

In a recent study of maturity in potatoes by Appleman and Miller (*6*) an attempt was made to determine the character of the chemical and physiological changes in potatoes while they are ripening and maturing on the vines. The chief information sought according to the authors was to determine the extent to which the maturing processes in the tuber may continue in storage. Tubers were taken from plants in full bloom, June 17; after the blossoms were gone, June 24; when tips of leaves were beginning to die, July 8; 80 per cent of leaves dead, July 15; leaves all dead, July 22; vines brown and dry, August 27.

In summarizing their results Appleman and Miller state that the ripening and maturing processes may continue during storage. No chemical or physiological basis was revealed for the superiority of immature potatoes for seed. The authors express their belief that in the cases reported of immature seed giving better results than mature seed it may have been due to its greater freedom from degeneration diseases.

DEPARTMENT INVESTIGATIONS

The question as to the actual superiority of immature over mature seed potatoes first seriously engaged the attention of the Office of Horticulture of the United States Department of Agriculture in 1913, when steps were taken to provide immature and mature seed of the Irish Cobbler variety for comparative study in 1914. This was accomplished by harvesting a few rows in a commercial field near Houlton, Me., on August 20, when the plants were still green. The mature stock was harvested a month later when the plants were practically ripe. The early-harvested tubers were held in an ordinary storage house until the mature stock was harvested. Both lots were then shipped to Washington and held in the cold-storage room of the Arlington Experiment Farm until required for planting at Norfolk, Va., and Caribou, Me., at which points they were grown for comparative study in 1914. The seed for the 1915 studies was obtained in a manner similar to that for 1914, but in 1916 and 1917 the mature and immature seed for the work of the ensuing year was obtained from three plantings made at approximately 20-day inter-

vals. In the later studies, which were continued on Aroostook Farm, Presque Isle, Me., from 1919 to 1921, immaturity of seed stock was obtained by harvesting early-planted stock at three intervals of time. As will be noted later, this method proved to be the most satisfactory.

Further studies on mature and immature seed were made at the Colorado Potato Experiment Station, Greeley, Colo., during the seasons of 1921 to 1925, inclusive. Immature seed was obtained by harvesting a portion of the seed plot when the vines were still green, and the mature was obtained by harvesting the remainder of the plot about a month later, at the close of the growing season. The variety used in the Greeley experiments was the Rural New Yorker No. 2.

Studies on mature and immature seed were also conducted at the potato experiment station, Jerome, Idaho, during the years 1916 to 1918, inclusive. The Charles Downing variety was used throughout the 3-year period, the Russet Burbank for two seasons, and the Peoples variety one season. Immaturity was obtained by early and late plantings.

EXPERIMENTS AT NORFOLK, VA.

Comparison of the relative value of mature and immature Irish Cobbler seed potatoes from the production standpoint was first undertaken by the Office of Horticulture at the Virginia Truck Experiment Station, Norfolk, Va., in the spring of 1914. The data on yield which follow are based on 1,555 plants from the mature seed and 1,675 from the immature. With the exception of the last mature seed plot these plants were grown in eight alternating four-row plots, each row of which represented one one-hundredth of an acre. The last mature seed plot consisted of three rows. A study of the data in Table 6 indicates an increase of 11 per cent in the average yield of primes or marketable tubers [3] from the immature stock and a slight difference in total production in favor of the mature seed. Notwithstanding the same size of seed used, the mature sets averaged one more tuber per set than the immature. The greater number of tubers was offset, however, by their smaller average size, less than 29 per cent of them being classed as primes, as against 34.5 per cent from the immature sets.

In 1915 comparative studies were made on 19 rows each of mature and immature seed stock, and the resultant data, as shown in Table 6, indicate the reverse of the results of the previous season, showing that instead of the immature seed producing a larger yield of primes there was a slight difference in favor of the mature, though not sufficient to justify any conclusions. The total yield is in favor of immature seed, but here again it is not sufficiently marked to indicate a superiority over mature seed. The average number of tubers per set in 1915 was nearly one greater from the immature stock, whereas in the case of primes the number was practically identical. Thus, the increase in total yield consisted in a larger percentage of small tubers.

[3] All tubers weighing 3 ounces or over were considered as primes and all below that weight were rated as culls. This statement applies to all of the experimental data presented.

In 1916 comparison was made between 37 rows each of mature and immature seed stock, representing, as in 1915, tubers varying from 2 to 6 ounces in weight, which, with the exception of the 2-ounce size, were planted whole and halved and quartered. As in 1914, the 1916 data showed a larger number of tubers per set from the mature seed, averaging about one and one-third tubers more per set. This increase was about equally divided between primes and culls. It will be noted that not only was the set of tubers greater in 1916 than in the two preceding years but that the yield also was correspondingly greater. The increase in yield of primes from the mature seed was more than 14 per cent and that in total yield was nearly 14 per cent.

TABLE 6.—*Behavior of sets from mature, medium-mature, and immature Irish Cobbler seed potatoes at Norfolk, Va., 1914 to 1918, inclusive*

Kind of seed and year planted	Sets harvested (number)	Tubers produced								Average acre yield [1]				
		Number		Primes			Culls			Bushels			Gain (per cent)	
		Total	Average per set	Weight (pounds)	Number		Weight (pounds)	Number		Primes	Culls	Total	Primes	Total
					Total	Average per set		Total	Average per set					
Mature:														
1914	1,555	13,969	8.98	878.0	4,027	2.59	657.8	9,042	6.39	97.5	73.1	170.6	----	0.65
1915	2,125	17,159	8.07	2,697.5	9,716	4.57	587.5	7,443	3.50	236.7	51.5	288.2	0.42	----
1916	3,881	43,433	11.80	7,190.5	15,994	5.43	1,906.2	23,439	6.37	323.8	85.8	409.6	14.30	13.78
1917	498	3,307	6.64	371.5	1,229	2.49	173.3	2,068	4.15	123.8	57.7	181.5	2.57	6.89
1918	599	4,594	7.67	783.3	2,283	3.81	196.9	2,311	3.86	217.6	54.7	272.3	----	----
Average [2]	1,691.6	16,492.4	9.75	2,384.2	7,451.8	4.41	704.3	9,040.6	5.34	199.9	64.6	264.4	2.83	3.89
Immature:														
1914	1,675	13,356	7.97	1,040.0	4,618	2.76	586.0	8,738	5.21	108.3	61.2	169.5	11.08	----
1915	2,085	18,718	8.98	2,687.0	9,575	4.59	687.0	9,143	4.39	235.7	60.3	296.0	----	2.71
1916	3,665	38,311	10.45	6,290.5	17,349	4.73	1,705.5	20,962	5.72	283.3	76.7	360.0	----	----
1917	498	2,894	5.81	361.8	1,078	2.16	147.8	1,816	3.65	120.7	49.1	169.8	----	----
1918	600	4,723	7.87	806.7	2,479	4.13	200.7	2,244	3.74	224.1	55.8	279.9	2.99	2.79
Average	1,704.6	15,600.4	9.15	2,237.2	7,019.8	4.12	665.4	8,580.6	5.03	194.4	60.0	255.0	----	----
Medium mature:														
1917	496	3,541	7.14	432.0	1,354	2.73	185.5	2,187	4.39	144.0	61.8	205.8	[3]19.3	[3]21.2

[1] Comparisons made are between yields from mature and immature seed and medium-mature and immature seed.
[2] Average number of tubers per set was obtained by dividing the total tubers by the total number of sets harvested.

The 1917 data are based on 5 rows each of mature, medium mature, and immature seed produced from plantings made May 11, May 31, and June 20. All the seed stock from these three plantings was harvested on the same date. A study of these data in Table 6 shows a larger average per set from the medium-mature seed than from the mature or the immature, the actual figures being 7.14, 6.64, and 5.81 tubers per set, respectively. The percentage of gain in yield was based on the data from the immature seed. On this basis of comparison the percentage of increase in yield of primes from the mature seed was 2.57 and in total yield 6.89, and the corresponding figures for the medium-mature seed were 19.3 and 21.2 per cent.

In 1918 comparative studies were made between seed produced from plantings made May 17 and June 7. Six rows of each lot of seed

were planted, and the resultant data in Table 6 indicate a slight advantage in favor of the immature seed in average number of tubers per set as well as in the yield. The gain, however, is not sufficient to warrant any deductions, as the differences may as justly be attributed to soil or fertility variations as to actual seed differences.

A summary of the data for five years furnishes a bird's-eye view, so to speak, of the comparative behavior of each class of seed stock during the five seasons. The 1916 data are especially interesting on account of the striking increase in tubers per set and in actual yield in bushels per acre. In this table are found the total and average performance of the mature and the immature seed. A study of these data shows that the mature sets averaged 0.6 of a tuber more than the immature and produced 0.29 of a tuber more primes per set. The average acre yield of primes was 199.9 and 194.4 bushels, respectively, from the mature and the immature stocks, a difference of 2.83 per cent in favor of the former. The total yields showed a difference of 3.68 per cent in favor of the mature seed. Thus it is apparent that although the average result during the five seasons at Norfolk was in favor of the mature seed, the difference was too small to be regarded as significant.

EXPERIMENTS AT CARIBOU AND PRESQUE ISLE, ME.

Preliminary studies to determine the relative merits of mature and immature seed were undertaken at Caribou, Me., in 1914. The seed used in these studies was a portion of the same stock as that used in the 1914 trials at Norfolk, Va. In the following year the work was transferred to Aroostook farm, Presque Isle, Me. At that time a course of procedure was adopted for procuring seed of different degrees of maturity for the further conduct of these studies. The seed used in the 1916, 1917, and 1918 studies was obtained from plantings made on different dates in the preceding year and all harvested on the same date. For example, the 1916 seed used was harvested from 1915 plantings made May 17, June 10, and June 25. The same system was followed in the 1916 and 1917 seed-stock plantings. Immaturity, therefore, for the 1916, 1917, and 1918 seed stock was obtained from late plantings. For the following three seasons immaturity was obtained by harvesting the seed on different dates, that is, having only one planting date and three harvesting dates.

In the 1914 experiment at Caribou, the seed stock was planted with a two-man planter, and as a result the spacing between the sets in the row was not uniform. It is assumed, however, that such variation as may have occurred would average about the same for both the mature and the immature stock. The data taken, which are given in Table 7, do not permit of the same statistical presentation as those of the Norfolk experiments, but as the yield factor of primes and culls represent the practical and commercial values of the two classes of seed stock the same comparison may be made.

The seed of both the mature and the immature stock which was used in planting the 1914 experimental plot was divided on the basis of size into two lots, each designated as large and small tubers. This separation was made for the purpose of noting whether small tubers from mature stock were comparable with those from imma-

ture stock. The data obtained were somewhat conflicting; that is, the small tubers from the mature stock behaved differently from those of the immature stock, the acre yield from the former being 337.3 bushels of primes from the small mature stock as against 295 bushels from the latter, a difference of 42.3 bushels. If, however, comparison is made between the yield from the large and small tubers of the mature and immature stock it will be noted that the yield of primes is greater from the small than from the large tubers in the first case and smaller in the latter instance. In both classes of seed the yield of culls was greater from the small tubers than from the large. The total yields of primes from both large and small tubers of the two classes of stock are almost identical, and therefore do not indicate any superiority of one stock over the other. Rather significant differences are found when the yield of primes from the large tubers of the two stocks are compared with each other. The large mature tubers yielded at the rate of 276.2 bushels per acre, whereas the large immature tubers yielded 313.2 bushels, a difference of 37 bushels per acre in favor of the immature stock.

TABLE 7.—*Comparison of yields of large and small tubers of mature and immature Irish Cobbler potato seed at Caribou, Me., in 1914*

Character of seed used	Sets harvested			Average yield per set	Average acre yield			Gain	
	Number	Percentage by weight			Primes	Culls	Total	Primes	Primes and culls
		Primes	Culls						
Mature:				*Pounds*	*Bushels*	*Bushels*	*Bushels*	*P. ct.*	*P. ct.*
Large	4,191	78.35	21.65	1.21	276.2	76.3	352.5	0.87	1.9
Small	1,060	78.54	21.46	1.48	337.3	92.2	429.5		
Immature:									
Large	2,449	81.70	18.30	1.32	313.2	70.2	383.4		
Small	1,489	76.79	23.21	1.32	295.0	89.2	384.2		

As has been previously mentioned, the seed used in 1916 was produced from plantings made on May 17, June 10, and June 25, 1915. All lots in 1915 were harvested on the same date, so that maturity or immaturity of the seed stock was the result of early or late planting. The data obtained from the 1916 experimental plot as presented in Table 8 indicate a decided increase in yield from the medium-mature and immature seed above that from the mature seed. This increase consisted entirely of primes, the medium-mature seed showing a yield greater by 57 bushels and the immature by more than 54 bushels.

The mature seed obtained by early planting contained less disease than was found in the stock from either the medium or late plantings, indicating that disease infection is ordinarily greater in the latter part of the growing season. These observations, as will be noted later, are borne out by the second series of experiments.

The 1917 experiment was a repetition of that of 1916, but the data obtained, presented in Table 8, are not corroborative of those of the preceding season. The yield from the medium-mature seed was markedly less than from either the mature or the immature

stock. The nearly identical yields from the mature and the immature stocks are rather unusual and would seem to indicate that in 1916 the seasonal conditions were such as to leave little impress on the seed stock, at least so far as maturity was concerned. Although the disease present in all three stocks was less than in 1916, the percentage was much larger in the immature stock.

TABLE 8.—*Comparative yields from mature, medium-mature, and immature Irish Cobbler seed potatoes at Aroostook farm, Presque Isle, Me., in 1916, 1917, and 1918*

Season and character of seed stock	Acre yield (bushels)					Percentage of disease
	Primes	Culls	Total	Increase [1]		
				Primes	Total	
Season of 1916:						
Mature	212.5	23.1	235.6			5.4
Medium mature	269.6	21.9	291.5	57.1	55.9	12.5
Immature	266.9	23.1	290.0	54.4	54.4	12.3
Season of 1917:						
Mature	260.0	42.7	302.7	36.2	62.0	1.7
Medium mature	223.8	16.9	240.7			2.6
Immature	259.2	42.8	302.0	35.4	61.3	8.1
Season of 1918:						
Mature	224.1	31.7	255.8			5.0
Medium mature	273.4	32.4	305.8	49.3	50.0	4.9
Immature	228.0	35.2	264.1	4.8	8.3	7.0
Three-year average:						
Mature	232.2	32.5	264.7			3.9
Medium mature	255.6	23.7	279.3	23.4	14.6	6.6
Immature	251.7	33.7	285.4	19.5	20.7	9.1

[1] In each case the lowest yield is used as the basis of comparison.

The data obtained in 1918, although more in keeping with those of 1916, do not substantially corroborate them, because the yield from the medium mature seed, especially of primes, is distinctly superior to either the mature or the immature stock. This is a direct reversal of the 1917 performance and from the commercial standpoint at least strikingly emphasizes the necessity for refraining from hasty conclusions regarding the merits of mature and immature seed.

These data show that the yield of primes from the medium-mature stock was greater than from the mature and immature by 49.3 and 44.5 bushels, respectively. The slight increase in yield from the immature stock over the mature is not sufficient to justify the assumption that it was actually due to a more vigorous seed stock. The percentage of disease was again greater in the immature stock, but there was practically no difference between the mature and the medium-mature stock.

A summary of the data given for three seasons reveals the fact that the average production of primes of the three classes of maturity of seed stock was greatest from the medium-mature seed and least from the mature, the actual difference being 23.4 bushels per acre in favor of the medium mature and 19.5 bushels in favor of the immature. In total production, however, the immature seed showed the largest yield, the increase over the mature seed being at the rate of 20.7 bushels per acre as compared with 14.6 bushels from the medium

mature. A significant feature of the data is found in the column giving the percentages of disease, which increase in a progressive ratio from the mature to the immature stock, being 3.9, 6.6, and 9.1, respectively.

The data of the three years are graphically shown in Figures 3 and 4. The solid black bars in Figure 3 represent the yield of primes

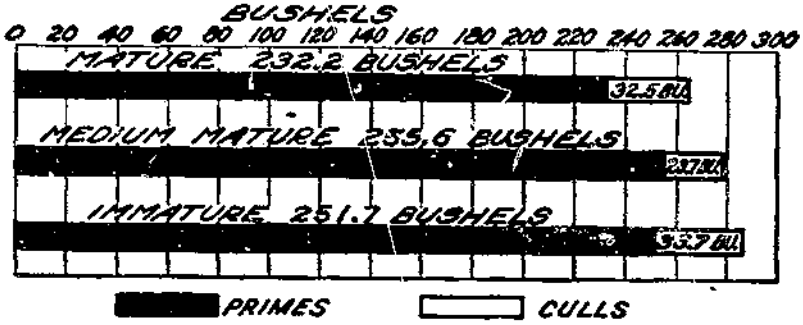


FIG. 3.—Average acre yields from mature, medium-mature, and immature seed potatoes at Presque Isle, Me., in 1916, 1917, and 1918

and the light portion that of the culls. Figure 4 shows the average percentage of disease noted in the three classes of stocks.

As previously indicated, a different procedure was adopted in 1918 for procuring mature and immature stocks for the 1919, 1920, and 1921 experiments. This procedure was the direct reverse of that followed for procuring seed stocks for the 1916, 1917, and 1918 experiments. Instead of planting on different dates it was decided to plant a sufficient area of the stock at the normal planting period and then harvest one portion of the area about a month before normal maturity, approximately August 10 to 15. The second harvest was made about the time the lower leaves began to show signs of maturity, usually about 20 days after the first harvesting. The remainder of the plot was harvested when the plants were mature, about 20 days after the second. This method of procuring immature stock was found to be much more satisfactory than by planting on different dates.

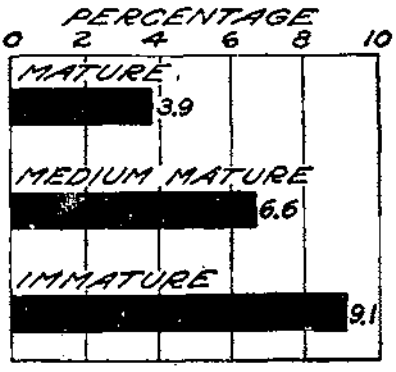


FIG. 4.—Average percentage of disease in mature, medium-mature, and immature seed potatoes at Presque Isle, Me., in 1916, 1917, and 1918

The data from the 1919, 1920, and 1921 comparative studies of the three classes of seed stock, presented in Table 9, show a fairly appreciable increase in yield from the immature over the mature seed in all three seasons and over the medium mature in 1919 and 1920.

The medium-mature stock outyielded the mature stock in 1919 and 1921, but was somewhat inferior to it in 1920. For the three years

the gain in yield of primes from the immature over the mature stock was, respectively, 28.5, 22.7, and 26.5 bushels per acre. The relative uniformity of these larger yields is rather striking and would seem to justify the assumption that they were not accidental. In the case of the medium-mature seed the increase over the mature seed was 15.9 bushels per acre in 1919 and 25.1 bushels in 1921, whereas in 1920 the acre yield was 7.9 bushels less.

TABLE 9.—*Comparative yields from mature, medium-mature, and immature Irish Cobbler seed potatoes at Aroostook farm, Presque Isle, Me., in 1919, 1920, and 1921.*

Season and character of seed stock	Acre yield (bushels)					Percentage of disease
	Primes	Culls	Total	Increase [1]		
				Primes	Total	
Season of 1919:						
Mature	207.0	18.4	225.4			8.29
Medium mature	222.9	19.8	242.7	15.9	17.3	2.45
Immature	235.5	18.9	254.4	28.5	29.0	5.89
Season of 1920:						
Mature	388.3	17.4	405.7	7.9	3.8	3.14
Medium mature	380.4	21.5	401.9			.90
Immature	411.0	20.1	431.1	30.6	29.2	1.30
Season of 1921:						
Mature	190.2	16.1	215.3			29.71
Medium mature	224.3	15.8	240.1	25.1	24.8	10.27
Immature	225.7	18.4	244.1	26.5	28.8	6.96
Three-year average:						
Mature	264.8	17.3	282.1			13.71
Medium mature	275.9	19.0	294.9	11.1	12.8	4.54
Immature	290.7	19.1	309.8	25.9	27.7	4.72

[1] In each case the lowest yield is used as the basis of comparison.

The occurrence of disease in the second series of experiments is the exact reverse of that found in the first series; that is, the later harvested stock was exposed to a later period of infection than that dug earlier. The percentages of disease occurring were 8.29, 3.14, and 29.71, respectively, in the mature stock; 2.45, 0.9, and 10.27 in the medium-mature stock; and 5.89, 1.30, and 6.96 in the immature stock.

In the summary of 3-year averages it is possible to obtain a little clearer idea of the relative merits of mature, medium-mature, and immature seed stock as obtained from different harvesting dates. These data show an increase in yield of the medium mature over the mature and of the immature over the medium mature. The increase per acre of primes in the former case is 11.1 bushels and in the latter 14.8 bushels. The increase of primes from the immature over the mature stock was 25.9 bushels. In total acre yield the differences in favor of the medium-mature and immature over the mature stock were 12.8 and 27.7 bushels, respectively.

In comparing the average percentage of disease for the three seasons little difference is found between the medium-mature and the immature stock, but there is approximately three times as much disease in the mature stock.

The relative average production from mature, medium-mature, and immature stocks, as graphically shown in Figure 5, makes it possible

to visualize the average performance of each class of seed stock. In a similar manner Figure 6 well illustrates the average variation in the percentage of disease occurring in the three lots of seed.

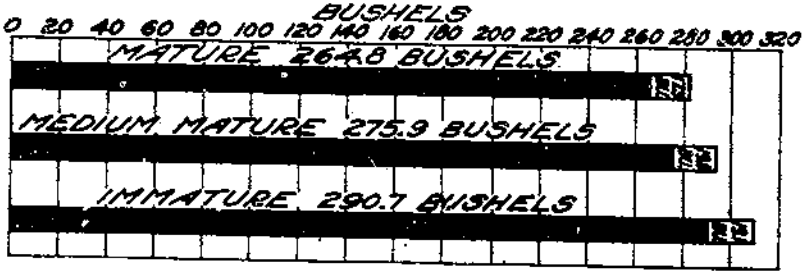


FIG. 5.—Average acre yields from mature, medium-mature, and immature seed potatoes at Presque Isle, Me., in 1919, 1920, and 1921

A summary of the data from the work of six seasons at Presque Isle, Me., presented in Table 10, corroborates that given in Table 9. Larger yields from both the medium-mature and the immature seed stocks as compared with the mature seed are shown, the differences being, respectively, 18.4 and 22.7 bushels per acre for primes and 14.9 and 24.2 bushels per acre in total yields. Although these data are not very significant, they nevertheless indicate that immature seed on the average is somewhat more productive than mature seed.

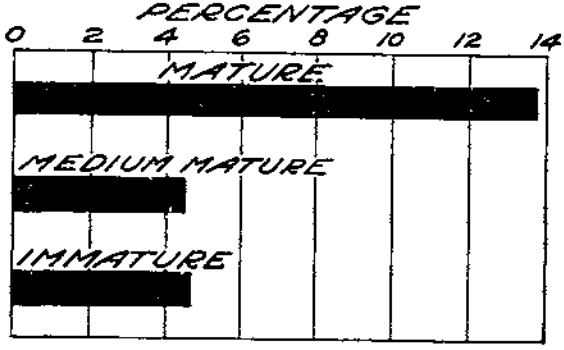


FIG. 6.—Average percentage of disease in mature, medium-mature, and immature seed potatoes at Presque Isle, Me., in 1919, 1920, and 1921

TABLE 10.—*Comparative yields from mature, medium-mature, and immature Irish Cobbler potato stocks, Presque Isle, Me., 1916 to 1921, inclusive*

Character of seed stock	Acre yield (bushels)				
	Primes	Culls	Total	Increase over mature sets	
				Primes	Total
Mature	248.5	24.9	273.4		
Medium mature	266.9	21.4	288.3	18.4	14.9
Immature	271.2	26.4	297.6	22.7	24.2

EXPERIMENTS AT GREELEY, COLO.

The relative merits of mature and immature Rural New Yorker No. 2 seed potatoes were studied at the Colorado Potato Experiment

Station, Greeley, Colo., during the years 1921 to 1925, inclusive. The data reported for the first four years of these experiments were obtained on land operated as an experiment station from 1915 to 1924, inclusive, but the study for 1925 was made on the new experiment farm and represents the results of only one year. Owing to the lower fertility of the land on which the 1925 crop was grown, very much lower yields were obtained.

The plots devoted to this study were grown under irrigation. The number of irrigations given the potato crop varied from year to year, depending upon seasonal conditions. In all cases the quantity of irrigation water applied to each plot was as nearly alike as possible, the aim being to supply just enough water to provide optimum growing conditions for the plants. This was accomplished by giving light frequent irrigations when conditions seemed to warrant.

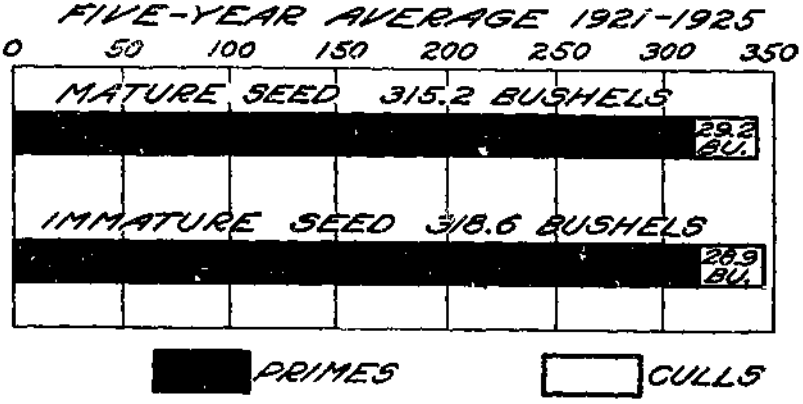


FIG. 7.—Average acre yields from mature and immature seed potatoes at Greeley, Colo., 1921 to 1925

The seed for each year's trial were grown the preceding year on the station grounds. It was usually planted the first week in June, the only exception being in 1923, when the planting date was May 26. Immature seed was obtained by harvesting a portion of the seed plot while the vines were still green.

The earliest harvesting date was September 16, 1924, and the latest September 20, 1920. The mature seed was harvested about a month later than the immature, the earliest harvesting date being October 12, 1924, and the latest October 20, 1923. The vines were generally killed by frost during the last week in September. In 1921, however, a frost occurred on September 20. In 1922 the first frost occurred October 7. A comparison of the data as presented in Table 11 shows that the average percentage of stand from the mature and immature seed for the five seasons was practically identical, being 93 per cent for the former and 93.16 per cent for the latter. In three out of the five seasons the immature slightly outyielded the mature stock. The average increase of primes from immature seed during the 5-year period was 3.4 bushels per acre with a total increase of 3.1 bushels. Figure 7 represents the average yield of primes and culls from the mature and the immature seed stock.

TABLE 11.—*Comparative yields from mature and immature Rural New Yorker No. 2 seed potatoes at Greeley, Colo., 1921 to 1925, inclusive*

Season and character of seed stock	Percentage of stand	Acre yield (bushels)			Increase	
		Primes	Culls	Total	Primes	Total
Season of 1921:						
Mature	97.3	317.2	46.3	363.5		
Immature	97.3	327.5	43.5	371.0	10.3	7.5
Season of 1922:						
Mature	90.6	353.9	28.7	382.6	1.3	1.2
Immature	94.8	352.6	28.8	381.4		
Season of 1923:						
Mature	94.1	282.6	33.2	315.8	5.7	3.8
Immature	95.8	278.9	35.1	312.0		
Season of 1924:						
Mature	99.1	349.3	22.7	372.0		
Immature	98.9	356.3	24.2	380.5	7.0	8.5
Season of 1925:						
Mature	77.9	273.1	15.1	288.2		
Immature	79.0	279.9	12.8	292.7	6.8	4.5
Average, 1921 to 1925:						
Mature		315.2	29.2	344.4		
Immature		318.8	28.9	347.5	3.4	3.1

EXPERIMENTS AT JEROME, IDAHO

Comparison was made of the relative behavior of mature and immature seed stock of the Charles Downing (*Idaho Rural*) and Peoples varieties of potatoes in 1916 and of the Charles Downing and Russet Burbank in 1917 and 1918. Immaturity was obtained by different dates of planting as in the Virginia and Maine tests for those years. The crop was grown each year under irrigation.

The results from the 1916 test were distinctly in favor of the immature seed. The acre yield of primes from the immature seed of the Charles Downing variety exceeded that from the mature stock by 52.1 bushels and in total yield by 38 bushels. The immature seed of the Peoples variety outyielded that of the mature seed by 77.3 bushels of primes per acre. (Table 12.)

TABLE 12.—*Comparative yields from mature and immature seed stock of potato varieties at Jerome, Idaho, in 1916, 1917, and 1918*

Variety and year	Acre yield (bushels)					
	Mature seed			Immature seed		
	Primes	Culls	Total	Primes	Culls	Total
Charles Downing 1916	312.0	25.2	337.2	364.1	11.2	375.3
Charles Downing 1917	194.0	41.3	235.3	353.8	41.2	395.0
Charles Downing 1918	237.4	14.2	251.6	371.4	16.6	388.0
Average	247.8	26.9	274.7	363.1	23.0	386.1
Gain		3.9		115.3		111.4
Russet Burbank 1917	165.0	26.0	191.0	314.1	18.8	332.9
Russet Burbank 1918	166.4	7.8	174.2	380.2	11.6	391.8
Average	165.7	16.9	182.6	347.2	15.2	362.4
Gain		1.7		181.5		179.8
Peoples, 1916	220.2	8.1	237.3	306.5	8.1	314.6
Gain				77.3		77.3

In 1917 immature seed of the Charles Downing yielded 159.8 bushels more primes than did the mature seed, and in the case of the Russet Burbank the immature seed outyielded the mature seed by 149 bushels of primes.

In 1918 the increase in yield of primes from immature Charles Downing seed stock was 134 bushels. Under similar conditions the immature Russet Burbank seed stock produced 213.8 bushels more primes per acre than the mature seed.

A summary of the data for the three seasons shows an average gain from the immature Charles Downing seed over that of the mature of 115.3 bushels of primes and in total yield of 111.4 bushels.

The average gain in primes from the immature Russet Burbank stock in 1917 and 1918 was 181.5 bushels and the total increase 179.8 bushels per acre.

These very positive results in favor of immature seed at the Jerome station are in striking contrast to those obtained at Greeley, Norfolk, and Presque Isle. No plausible explanation can be offered for this seeming inconsistency except to suggest that conditions at Jerome favored late planting and that the seed stock produced seemingly possessed greater vigor than the stock from early planting.

SUMMARY OF RESULTS FROM MATURE AND IMMATURE SETS

A review of the experimental data cited discloses the fact that while previous investigations have not been uniformly in favor of immature seed there is sufficient evidence to support the claim that as a rule it is superior to mature seed.

The experimental results obtained from the Norfolk, Va., studies show that in the tests of only two seasons of the five were larger yields of primes obtained from immature seed. The average yield of primes for the 5-year period from mature seed was 199.9 bushels, as against 194.4 bushels from the immature seed, a difference of 2.83 per cent in favor of mature seed. A similar comparison of the average total for the same period indicates 3.69 per cent increase in the same direction.

The Caribou, Me., data show a slight gain in primes from mature seed and a trifle larger increase in total yield.

In the first of the two 3-year tests of mature and immature seed stock at Presque Isle, Me., medium-mature seed gave increases of primes of 23.4 bushels and in total yield of 14.6 bushels as compared with mature seed, and the corresponding differences in favor of immature over mature seed were respectively 19.5 and 20.7 bushels per acre. The second 3-year period, in which immaturity was obtained by harvesting the seed on different dates, showed a larger increase of primes from the immature than from the medium-mature seed over the mature seed, the medium mature showing a gain of 11.1 bushels, as against 25.9 bushels from the immature. Based on 3-year averages, both medium-mature and immature seed stock gave larger yields than mature stock at Presque Isle, Me.

The percentage of disease was larger in immature seed when immaturity was obtained from late plantings, and the reverse was found to be true when immaturity was the result of early harvesting.

In the Greeley, Colo., experiments, where immaturity was the result of early harvesting, larger yields were obtained in three out

of the five seasons from immature seed. The differences, however, were not sufficiently great to be convincing, as the average increase for the 5-year period for primes was only 3.4 bushels and for total yield only 3.1 bushels.

At Jerome, Idaho, the average gains in acre yields of primes from immature Charles Downing, Russet Burbank, and Peoples seed were so strikingly large as to preclude the possibility of its being due to accidental variations.

COMPARISON OF GREENED AND UNGREENED SEED

Sprouting seed potatoes in the light before planting them, a process known as "greening," has long been practiced by growers of early potatoes in most European countries, more particularly by commercial potato raisers in England, Scotland, Ireland, and on the island of Jersey. This practice is the result of an effort to hasten the development of tubers of marketable size in order to command the high prices which generally prevail early in the season. Just when this method of hastening the maturity of the crop was first attempted it is impossible to say, but it is safe to infer that the practice is relatively old. For the purpose of this presentation it is not important whether it had its inception a century or only half a century ago. The important thing is to determine the relative value of sprouted (greened) seed as compared with unsprouted seed in so far as it influences early maturity of yield, or both. It is important to know that the practice is almost universal among English and Jersey Island growers, particularly the latter.

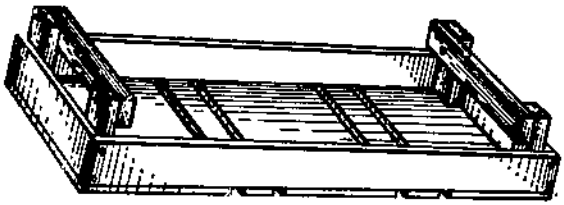


FIG. 8.—Type of germinating tray commonly used by Ayrshire (Scotland) potato growers. After Speir (33)

In all probability the method first employed was to spread the seed potatoes in a thin layer on the floor or ground beneath a shed or outbuilding where they were exposed to the light and could be furnished protection against light frosts. Later, some grower conceived the idea of placing the seed tubers in a shallow box with corner posts projecting some 4 to 5 inches above the sides. These posts make it possible to stack the boxes one above another to any height desired and still admit air and light to each lot of tubers. By connecting these corner posts across the end with a 2-inch strip of board, handles were provided for moving or carrying the trays. (Fig. 8.) Another type of germinating box has a strip lengthwise of the tray connecting with the end strips, making it possible to handle the tray or box with one hand. (Fig. 9.) These several developments are without doubt the direct result of efforts to facilitate the handling of large quantities of green-sprouted seed. Some idea of the extent of the labor involved in greening seed potatoes may be had from the statement that growers on the island of Jersey frequently sprout in this way 1,500 or more tons (61,000 bushels) of seed stock for the season's planting.

In considering the proper time at which to put the seed tubers in the boxes, Speir (*33, p. 155*) makes the following suggestions:

> If the variety is an early one which it is desired to dig as soon as the tubers are a moderate size, the potatoes may be put in the boxes any time after the middle of July. Late varieties may be put in the boxes any time after digging till the end of January. As the boxes are usually only from 3 to 4 inches deep the potatoes are seldom over two deep in them, and are emptied in without any care as to whether or not the bud end is up.

A perusal of the literature on the subject of green sprouting seed potatoes would seem to indicate that a proper degree of sprouting is desirable if best results are to be obtained.

Among English growers the greening of potatoes may be practiced from an entirely different motive from that of sprouting or germinating the tubers in the light. In some localities greening is practiced to prevent undue loss of moisture or excessive germination after the termination of the dormant period. When this practice is followed the seed tubers are placed in the germinating boxes when dug and are stored in a lighted building. When so handled, the tubers get green and the skins become tough and leathery, thus lessening transpiration losses. Experiments have indicated that when two identical lots of potatoes are held under the same storage conditions with the exception that light is excluded from one lot by means of opaque black paper, the tubers not exposed to light lose approximately six times more moisture than those fully exposed to light. It is further asserted that seed greened in this manner will give a better stand and produce plants stronger than those from ungreened seed.

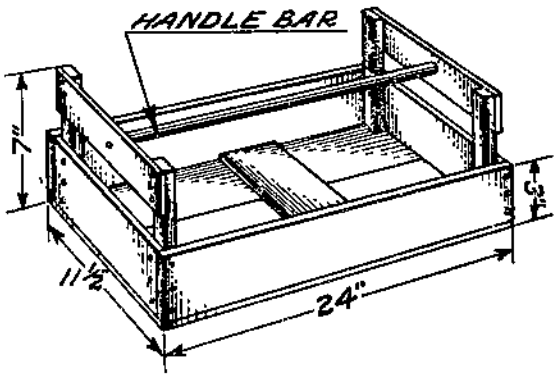


FIG. 9.—Type of germinating tray commonly used by potato growers on the Island of Jersey. After Speir (*33*)

PREVIOUS EXPERIMENTAL EVIDENCE

A review of some of the experimental results obtained from comparative studies of greened and ungreened seed potatoes shows that although the data are not always in accord, the evidence on the whole is in favor of the greened and sprouted seed tubers.

In 1902 Speir (*33*) reported the results from a comparative study of the relative yielding capacity of germinated and ungerminated tubers. The gain in yield per acre from the germinated tubers in 4 tests averaged 9 hundredweight (16.8 bushels). In 2 tests with Up-to-Date the excess was 10½ hundredweight (19.6 bushels), and in still another experiment involving 4 varieties and 8 tests the average gain from germinated over ungerminated seed was 10¾ hundredweight (20.1 bushels).

Studies by Greig (*16*) embracing 7 varieties and conducted on 9 different farms showed larger acre yields from germinated than from ungerminated seed, the excess ranging from 18¼ hundredweight to 3 tons 1¼ hundredweight (approximately 34.1 to 114.3 bushels).

In studying the effect on yield of tubers from seed that was badly sprouted and wilted, as compared with firm ungerminated seed tubers, Emerson (*15*) found that there was a pronounced reduction in yield from the badly sprouted and wilted seed. The total yield from the firm and ungerminated tubers was 870 pounds, as against 556 pounds from the sprouted and wilted stock. This experiment, however, is not a fair test of green-sprouted seed, as the sprouted potatoes used did not sprout in the light, and according to the description given had sprouted to the extent of becoming seriously wilted.

Some interesting data are presented by Wright (*42*) in which substantial differences in favor of germinated seed are noted. Four varieties were used in his experiment, viz, British Queen, Up-to-Date, Langworthy, and Scottish Triumph. The results obtained from each variety indicate varietal differences in response to green sprouting the seed. The yields per acre from germinated over ungerminated seed, stated in pounds for convenience, are as follows for the respective varieties: 2,042, 5,436, 4,760, 7,616.

According to Ballou (*3*), the sun sprouting of seed potatoes, if sufficiently prolonged, will obviate the necessity of treating them in a formaldehyde or corrosive-sublimate solution, as "bright hot sunshine is in itself an effective fungicide." It is also asserted that the crop can be hastened approximately two weeks by this means.

In a comparative study of sprouted and unsprouted seed Karel (*20*) obtained larger yields from unsprouted seed, but in this case the sprouts were removed, indicating that germination had taken place in the dark.

In a series of experiments conducted in every county in Ireland (*1*) during the 10 years from 1903 to 1912 it was shown that sprouted seed yielded 12 tons 5 hundredweight and unsprouted seed 10 tons 6 hundredweight, which is the equivalent of 457.3 and 384.5 bushels, respectively, per acre.

Yields varying from 12 to 14 per cent larger from sprouted than from unsprouted seed were obtained by Lunden (*21*). Late-maturing varieties gave the largest increase. More large tubers were obtained from sprouted seed. In the interior highland of southern Norway seed sprouted for 4 weeks gave a yield averaging 22 per cent higher, and from seed sprouted 6 weeks the increase was 33 per cent. Sprouting early and medium varieties for 4 weeks gave as large an average gain as the late sorts, but with sprouting for 6 weeks the late varieties gave the larger yields.

In experiments conducted by the British Ministry of Agriculture (*2*) the average increase in yield in favor of sprouted seed in 12 centers was 1 ton 16 hundredweight per acre, or 67.2 bushels.

A test of the relative behavior of light-sprouted with dark-sprouted tubers was made by Pitt (*24*). The tubers were subjected for three weeks to germinating conditions before planting. Light-sprouted tubers yielded at the rate of 504.2 bushels per acre, and

the dark-sprouted seed produced 487.7 bushels, a difference of 16.5 bushels in favor of green sprouting.

The conclusions of Rosa (*30*) regarding the value of green sprouting potatoes were to the effect that this practice generally reduced the yield and was not profitable. When cut seed pieces were used, the greening and sprouting treatment did not markedly affect the number of stalks per hill, but resulted in a slight decrease; also in a decided decrease in the average weight of tubers. With small whole tubers the number of both stalks and tubers per hill was greater in the sprouted lots, but the average weight of tubers was less.

DEPARTMENT INVESTIGATIONS

A preliminary study of the relative value of green sprouting seed potatoes was undertaken in a very limited way at the Virginia Truck Experiment Station, Norfolk, Va., as early as 1913, but it was not until three years later that it was made the subject of a more definite and careful study. In 1916 studies were undertaken at the potato experiment stations at Jerome, Idaho, and Greeley, Colo., the Virginia Truck Experiment Station, and Aroostook farm, Presque Isle, Me.

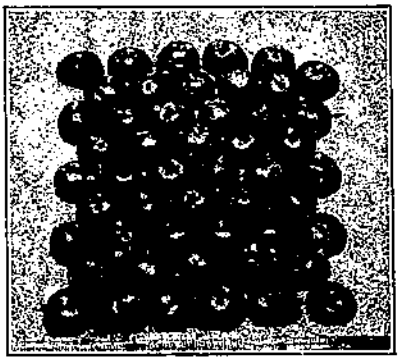


FIG. 10.—Potato tubers at proper stage of germination to plant safely with horse-drawn planter

The results obtained at Greeley for the years 1916 to 1918 were published by Clark (*9*) in 1921, and therefore will not be considered in this connection except to state that in only one season (1916) was any significant advantage obtained from green sprouted seed. In this year the increase averaged 28 bushels per acre.

EXPERIMENTS AT NORFOLK, VA

In the study of the relative merits of green-sprouted and unsprouted tubers for seed purposes at Norfolk, Va., the tubers were sprouted in flats in the greenhouse potting house at the Arlington Experiment Farm, Rosslyn, Va., where they were subjected to good light but not to direct sunlight. They were usually exposed to light and heat for three to four weeks before shipment to Norfolk, and as a rule the sprouts varied from one-fourth to one-third of an inch in length (figs. 10, 11). The ungreened or ungerminated tubers remained in the storage house at a temperature of 40° F. until the day of their shipment.

The 1916 experiment consisted of 24 rows of one one-hundredth of an acre each. These rows were planted alternately with greened and ungreened seed, thus reducing as far as possible the influence of any soil differences that might obtain in the field. In harvesting the plants each row was dug separately and the primes and culls were counted and weighed, thus giving a row record as well as an average record for the 12 rows. The data in Table 13 represent

averages of the 12 rows rather than individual rows. There was a fairly substantial increase in the number of tubers per row and of bushels per acre of both primes and culls from the greened seed. For example, there is a gain of 18.7 bushels of primes and a total increase in yield of 43.5 bushels per acre.

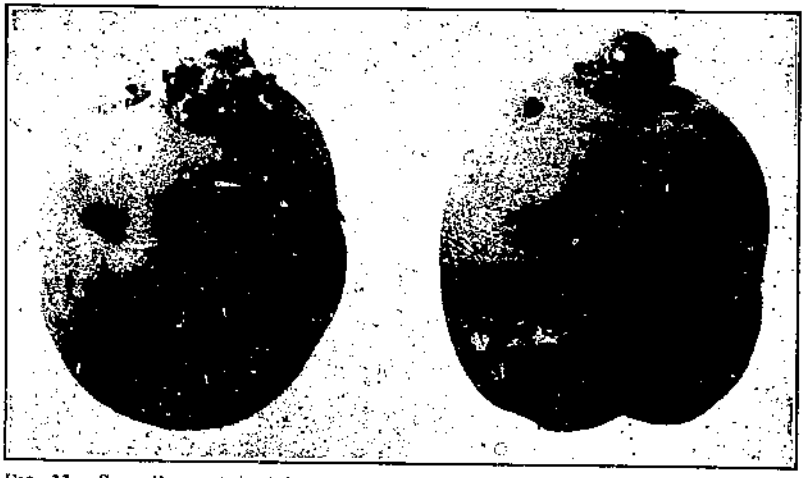


FIG. 11.—Sprouting potato tubers, showing stage of germination in which some of the terminal sprouts would be broken off if used in machine planting

TABLE 13.—*Average comparative yields from greened and ungreened Irish Cobbler seed potatoes at Norfolk, Va., in 1916, 1917, and 1918*

Treatment of seed	Primes			Culls			Primes and culls		
	Tubers		Acre yield	Tubers		Acre yield	Tubers		Acre yield
	Number	Weight		Number	Weight		Number	Weight	
		Pounds	*Bushels*		*Pounds*	*Bushels*		*Pounds*	*Bushels*
Season of 1916:									
Greened	436	147.4	245.7	525.6	40.1	66.8	961.6	187.5	312.5
Ungreened	378.2	136.2	227.0	308.9	25.2	42.0	687.1	161.4	269.0
Difference in favor of greened seed	57.8	11.2	18.7	216.7	14.9	24.8	274.5	26.1	43.5
Season of 1917:									
Greened	191.2	54.1	90.2	819.0	58.6	97.7	1,010.2	112.7	187.9
Ungreened	244.6	70.3	117.2	660.3	54.9	91.5	904.9	125.2	208.7
Difference in favor of greened (+) or ungreened (−) seed	−53.4	−16.2	−27.0	+158.7	+3.7	+6.2	+95.3	−12.5	−20.8
Season of 1918:									
Greened	329.2	105.2	175.3	550.3	46.4	77.2	879.5	151.6	252.5
Ungreened	342.5	114.8	191.3	449.9	41.9	69.8	792.4	156.7	261.1
Difference in favor of greened (+) or ungreened (−) seed	−13.3	−9.6	−16.0	+100.4	+4.5	+7.4	+87.1	−5.1	−8.6
Three-year average: 1916 to 1918—									
Greened	318.8	102.2	170.4	631.6	48.4	80.6	950.4	150.6	251.0
Ungreened	321.8	107.1	178.5	473.0	40.7	67.8	794.8	147.8	246.3
Difference in favor of greened (+) or ungreened (−) seed	−3.0	−4.9	−8.1	+158.6	+7.7	+12.8	+155.6	+2.8	+4.7

In 1917 the experiment included 9 rows of greened seed and 12 of ungreened tubers. The yield of primes in both number and weight was greater from the ungreened seed. The average production per acre of primes from the greened seed was 90.2 bushels and that of the ungreened was 117.2 bushels, an increase of 27 bushels in favor of ungreened seed. The production of culls is heavy in both cases, being 97.7 bushels from the greened and 91.5 bushels from the ungreened, a difference of 6.2 bushels. In total yield the ungreened seed excelled the green-sprouted seed by 20.8 bushels.

In 1918, 12 rows each of greened and ungreened seed were planted. The same plus and minus data appear in 1918 as in 1917, but the increased yield of primes from the ungreened seed is not quite so large as in 1917. In other respects, however, the data are very much the same.

A summary of the three seasons indicates a slight gain in primes from the ungreened seed and a somewhat greater difference in the yield of culls in favor of the greened seed. The total shows a slight advantage in favor of the greened seed. The differences are too small, however, to support the claim of superiority for green-sprouted seed.

EXPERIMENTS AT PRESQUE ISLE, ME.

Although some preliminary study had been made at Presque Isle with greened and ungreened seed prior to 1916, the data are not regarded of sufficient importance for inclusion in this report.

TABLE 14.—*Comparative yields from spring and fall greened and ungreened Irish Cobbler seed potatoes at Presque Isle, Me., in 1916, 1917, and 1918*

Kind of seed and date planted	Date seed harvested in 1917 for 1918 crop	Tubers produced									Difference in acre yield above (+) or below (−) ungreened (bushels)		
		Primes			Culls			Total					
		Number	Weight (pounds)	Acre yields (bushels)	Number	Weight (pounds)	Acre yields (bushels)	Number	Weight (pounds)	Acre yields (bushels)	Primes	Culls	Total
Spring greened:													
1916		424.8	132.5	220.8	345.6	37.0	61.7	770.2	169.5	282.5	+15.3	+5.4	+20.7
1917		356	96.9	101.5	510	43.5	72.5	866	140.4	234.0	+15.5	−9.2	+24.7
1917				170.6			97.6			268.2	−17.9	+6.5	−11.4
1918	Sept. 20			264.8			61.9			326.7	−27.7	−6.7	−34.4
Fall greened:													
1917		368	91.8	153.0	469	47.5	79.1	837	139.3	232.1	+7.0	+15.8	+22.8
1917				204.4			122.3			326.7	+15.9	+31.2	+47.1
1918	Aug. 11			293.6			64.7			358.3	+3.6	+6.8	+10.4
1918	Aug. 27			267.9			64.9			332.8	+27.0	+.2	+27.2
Ungreened:													
1916		423.5	123.2	205.5	330.5	33.8	56.3	754.0	157.1	261.8			
1917		340	87.6	146.0	346	38.0	63.3	686	125.6	209.3			
1917				188.5			91.1			279.6			
1918	Aug. 11			290.0			57.9			347.9			
1918	Aug. 27			240.9			64.7			305.6			
1918	Sept. 20			262.5			68.6			331.1			
Average:													
Spring greened				[1]190.0			[1]77.3			[1]282.1	+7.2	+10.1	+17.3
Fall greened, 1917				[2]208.4			[2]88.8			[2]297.2	+16.6	+15.8	+32.4
Ungreened, 1918				[2]191.8			[2]73.0			[2]264.8			

[1] Includes two 1917 harvestings and that of 1918.
[2] Includes two 1917 harvestings and that of Aug. 27, crop of 1918.

In Table 14 will be found the results in 1916 from 16 rows of approximately one one-hundredth of an acre each. Eight of these rows were planted with green-sprouted tubers and the remainder with ungreened tubers. The former gave a slightly larger yield.

In 1917 the experiment was slightly modified to include fall-greened seed. The fall greening of potatoes is not practiced in this country so far as known. In 1917 data are based on two rows of each class of seed harvested August 27, prior to full maturity. Harvesting was made on this date in order to note the effect of greening on early maturity of the crop. A study of these data shows larger yields from both fall-greened and spring-greened than from ungreened stock. These differences are not large, the increase of primes from spring-greened and fall-greened over ungreened seed being 15.5 bushels and 7 bushels, respectively. The gain in total yield was respectively 24.7 and 22.8 bushels in favor of spring and fall greened seed. A later harvesting made September 19, when the plants had reached full maturity, gave somewhat different results.

EXPERIMENTS AT JEROME, IDAHO

Comparative yield test studies were made with green-sprouted and unsprouted seed during the seasons of 1916, 1917, and 1918 at Jerome, Idaho. Fall-greened seed were included in 1917. Two varieties were used in these studies, the Charles Downing and the Russet Burbank, throughout the experiment. The 1916 and 1918 trials did not include fall-greened seed.

TABLE 15.—*Comparative yields of primes and culls from greened and ungreened Charles Downing and Russet Burbank seed potatoes at Jerome, Idaho, 1916, 1917, and 1918*

Variety	Treatment of seed	Acre yield (bushels)					
		Primes	Culls	Total	Difference above (+) or below (−) ungreened seed		
					Primes	Culls	Total
Season of 1916:							
Charles Downing	Greened	254.1	24.0	278.1	+35.8	+6.3	+42.1
	Ungreened	218.3	17.7	236.0			
Russet Burbank	Greened	190.0	10.0	200.0	+17.8	+1.4	+19.2
	Ungreened	172.2	8.6	180.8			
Season of 1917:							
Charles Downing	Fall greened	202.1	42.2	244.3	−1.8	+2.2	+.4
	Spring greened	226.5	39.7	266.2	+22.6	−.3	+22.3
	Ungreened	203.9	40.0	243.9			
Russet Burbank	Fall greened	158.6	30.1	188.7	+14.5	+7.8	+22.3
	Spring greened	210.4	36.3	246.7	+66.3	+14.0	+80.3
	Ungreened	144.1	22.3	166.4			
Season of 1918:							
Charles Downing	Greened	445.4	11.9	457.3	+9.9	−12.0	−2.1
	Ungreened	435.5	23.9	459.4			
Russet Burbank	Greened	540.3	18.4	558.7	−.7	−.9	−1.6
	Ungreened	541.0	19.3	560.3			
Three-year average (fall greened omitted):							
Charles Downing	Greened	308.7	25.2	333.9	+22.8	−2.0	+20.8
	Ungreened	286.9	27.2	313.1			
Russet Burbank	Greened	313.6	21.6	335.2	+27.8	+4.9	+32.7
	Ungreened	285.8	16.7	302.5			

The results obtained from the 1916 test are presented in Table 15. The green-sprouted seed in both instances outyielded the ungreened seed. The greatest increase in yield was obtained from the Charles Downing seed, a difference of 35.8 bushels of primes being recorded.

In 1917 the experiment was enlarged by the addition of fall-greened stock. The data from the 1917 test show an appreciable difference in favor of spring-greened and sprouted tubers of both the Charles Downing and the Russet Burbank. A moderate advantage was obtained from fall-greened seed of the Russet Burbank. The largest increase (66.3 bushels of primes) was obtained from spring-sprouted seed of the Russet Burbank.

The 1918 test included only green-sprouted and unsprouted seed. The results (Table 15) show only a slight gain, 9.9 bushels per acre of primes, from greened seed of Charles Downing; all other data show lower yields from the greened seed.

Summarizing these data by omitting the fall-greened seed, it is found that the average production for the three seasons indicates a moderate increase in primes from the green-sprouted seed. The increase in yield was at the rate of 22.8 bushels in the case of the Charles Downing variety, and 27.8 bushels per acre in that of the Russet Burbank. On the average, green-sprouted seed gave somewhat larger yields than ungreened or ungerminated seed under conditions obtaining at Jerome, Idaho.

EXPERIMENTS AT GREELEY, COLO.

Greened and ungreened seed studies were conducted at Greeley, Colo., from 1919 to 1925, inclusive. For the first six years the studies were conducted on the farm operated as an experiment station from 1915 to 1924, inclusive, but the 1925 data were obtained at the new station. The seed was disinfected in a corrosive-sublimate solution and placed in trays for green sprouting. For about a month before planting, these trays were kept in the light but not in direct sunlight. Each tray held about 60 pounds of tubers. The tubers intended for planting in a dormant condition were held in the dark in the potato-storage house until the date of planting. Four-row plots 242 feet in length were planted in triplicate, the greened and ungreened seed being planted in alternate plots. The crop, as at Jerome, Idaho, was grown under irrigation, and every effort was made to irrigate all plots as uniformly as possible, the number of irrigations necessarily varying with seasonal conditions. All plots were planted with a 2-man planter in order to place the experiment on a practical basis.

In 1919 the greened and ungreened seed plots were planted with the Charles Downing variety. The following year and thereafter throughout the experiment the Rural New Yorker No. 2 variety was used. (Table 16.)

There was very little difference in yield from the greened and ungreened seed in six out of the seven years in which the experiment was conducted. The greatest difference occurred in 1919, when the greened seed produced at the rate of 130.1 bushels and the ungreened 179.1 bushels per acre, a difference of 49 bushels in favor of the ungreened seed. The Charles Downing is a medium early-maturing variety and one that does not yield exceptionally well in the

Greeley district. This may account in part for the spread in yield between the two lots of seed.

The average acre yields from greened and ungreened seed for the 7-year period show that the yield from the greened seed was smaller by 11.4 bushels of primes and 11.9 bushels of total yield. Although these differences are not large enough to be significant, they clearly indicate that under Greeley conditions and with the varieties used the green sprouting of seed potatoes is not to be recommended.

TABLE 16.—*Comparative yields from greened and ungreened seed potatoes at Greeley, Colo., 1919 to 1925, inclusive*

Variety and year	Greened seed				Ungreened seed				
	Stand (per cent)	Acre yield (bushels)			Stand (per cent)	Acre yield (bushels)			
		Primes	Culls	Total		Primes	Culls	Total	Difference in primes of greened above (+) or below (−) ungreened
Charles Downing:									
1919	89.95	130.1	51.9	182.0	91.17	179.1	58.7	237.8	−49.0
Rural New Yorker No. 2:									
1920	93.44	220.7	21.1	247.8	96.70	255.0	22.5	277.5	−28.3
1921	98.44	306.1	35.6	341.7	98.60	305.5	32.6	338.1	+.6
1922	95.17	361.9	30.1	392.0	93.15	357.4	27.5	384.9	+4.5
1923	97.00	262.3	28.2	290.5	97.00	277.8	32.0	309.8	−15.5
1924	97.04	336.8	21.7	358.5	98.02	338.6	22.6	361.2	−1.8
1925	76.71	248.4	21.3	269.7	77.04	238.4	17.7	256.1	+10.0
Average	92.5	267.5	30.0	297.5	93.1	278.9	30.5	309.4	
Difference in favor of ungreened						11.4	.5	11.9	

SUMMARY OF RESULTS FROM GREENED AND UNGREENED SETS

The green sprouting of potatoes extensively practiced by the growers of potatoes for the early market in Great Britain and the island of Jersey is not as yet a commercial practice in the United States.

Green-sprouted potatoes ordinarily reach market maturity from 10 days to 2 weeks in advance of potatoes from unsprouted seed.

The use of shallow trays or baskets for the green sprouting of the seed is almost universally practiced by foreign potato growers.

The bulk of the experimental data presented seem to substantiate fully the claim regarding the advantages accruing from the green sprouting of the seed. There are exceptions to the rule, however.

Department studies covering a period of years in four different localities show rather conflicting data when yearly comparisons are made or when the average yields for the period covered are considered.

The 3-year average yield from green-sprouted and unsprouted Irish Cobbler seed potatoes at Norfolk, Va., showed an increase of 8.1 bushels of primes from the unsprouted seed. In total acre yield,

however, the green-sprouted seed showed a gain of 4.7 bushels. These differences are too slight to have any significance.

At Presque Isle, Me., for the same seasons (1916–1918) and with the same variety, the unsprouted seed showed a gain in primes per acre of 3.7 bushels, with practically no increase in total yield. The difference in yield in this case is too slight to justify any assumption as to the value of green sprouting seed potatoes, at least so far as northern Maine is concerned.

Green-sprouted Charles Downing and Russet Burbank seed potatoes outyielded unsprouted seed at Jerome, Idaho, by 22.8 and 27.8 bushels of primes and in total yield by 20.8 and 32.7 bushels per acre, respectively.

Tests of green-sprouted and unsprouted seed at Greeley, Colo., for seven years showed a difference in favor of unsprouted seed of 11.4 bushels of primes and 11.9 bushels of primes and culls per acre. These differences are hardly sufficient to be significant.

With the exception of the Jerome, Idaho, data, the department studies presented do not support the contention that the green sprouting of seed potatoes necessarily increases their yielding capacity or that it is a profitable practice.

LITERATURE CITED

(1) ANONYMOUS.
1913. CULTIVATION OF MAINCROP POTATOES. Ireland Dept. Agr. and Tech. Instr. Jour. 13: 764–774.

(2) ———
1922. THE MINISTRY'S TRIALS OF VARIETIES OF POTATOES, 1921. Jour. Min. Agr. [Gt. Brit.] 29: 163–170.

(3) ALWOOD, W. B.
1891. POTATO TESTS. Va. Agr. Exp. Sta. Bul. 8, 23 p., illus.

(4) APP, F.
1921. REPORT OF THE DEPARTMENT OF AGRONOMY AND FARM MANAGEMENT. N. J. Agr. Exp. Sta. Ann. Rpt. (1920) 41: 251–258.

(5) APPLEMAN, C. O.
1918. PHYSIOLOGICAL BASIS FOR THE PREPARATION OF POTATOES FOR SEED. Md. Agr. Exp. Sta. Bul. 212: 79–102, illus.

(6) ——— and MILLER, E. V.
1926. A CHEMICAL AND PHYSIOLOGICAL STUDY OF MATURITY IN POTATOES. Jour. Agr. Res. 33: 569–577.

(7) ARTHUR, J. C.
1892. A PHYSIOLOGICAL BASIS FOR THE COMPARISON OF POTATO PRODUCTION. Agr. Sci. 6: 201–216.

(8) BALLOU, F. H.
1910. THE STATUS OF THE POTATO-GROWING INDUSTRY IN OHIO. Ohio Agr. Exp. Sta. Bul. 218: 561–603, illus.

(9) CLARK, C. F.
1921. REPORT OF POTATO INVESTIGATIONS. Colo. Agr. Exp. Sta. Bul. 261, 34 p., illus.

(10) CLOSE, C. P., and WHITE, T. H.
1909. IRISH POTATO INVESTIGATIONS. Md. Agr. Exp. Sta. Bul. 132: 151–173, illus.

(11) COX, H. R.
1921. REPORT OF THE SPECIALIST IN SOIL FERTILITY AND FARM CROPS. N. J. Agr. Exp. Sta. Ann. Rpt. (1920) 41: 207–210.

(12) DAVIDSON, W. D.
1925. POTATO GROWING FOR SEED PURPOSES. Jour. Dept. Lands and Agr. Ireland 24: 374–423.

(13) DUNLOP, J.
1914. REPORT ON THE FIELD TRIALS OF THE COLLEGE FARMS IN 1914 WITH RIPE AND UNRIPE SEED POTATOES. Midland Agr. and Dairy Col. Rpt. 1914: 21–22.

(14) ———
1915. REPORT ON THE FIELD TRIALS ON THE COLLEGE FARMS IN 1915, OF RIPE VERSUS UNRIPE SEED POTATOES. Midland Agr. and Dairy Col. Rpt. 1915: 42.

(15) EMERSON, R. A.
1907. POTATO EXPERIMENTS. Nebr. Agr. Exp. Sta. Bul. 97, 26 p.

(16) GREIG, R. B.
1906. REPORT ON SPROUTING SEED POTATOES, 1905. Aberdeen and North of Scot. Col. Agr. Bul. 3, 9 p.

(17) HALSTED, B. D.
1897. FURTHER EXPERIMENTS WITH POTATOES. N. J. Agr. Exp. Sta. Ann. Rpt. (1896) 17: 315–318.

(18) ———
1899. POTATO EXPERIMENTS AFTER TURNIPS. N. J. Agr. Exp. Sta. Ann. Rpt. (1898) 19: 307–309.

(19) HELMER, R. H.
1923. POTATOES. COMPARISON OF YIELDS FROM MATURE AND IMMATURE SEED. Canada Exp. Farm Sta., Summerland, B. C. Rpt. Supt. 1922: 60–61.

(20) KAREL, M.
1912. VERSUCHE MIT ANGEKEIMTEN UND ENTKEIMTEN KARTOFFELKNOLLEN. Fühlings Landw. Ztg. 61: 777–779.

(21) LUNDEN, A. P.
1923. EXPERIMENTS WITH SPROUTING OF POTATOES BEFORE PLANTING. Aarsberet. Norges Landbr. Høiskoles Akervekstforsøk (1920–21) 32: 9–40. In Swedish. English summary, p. 37–40.

(22) MYERS, C. H.
1924. IMPROVING THE POTATO CROP BY SELECTION. N. Y. State Col. Agr. Cornell Reading Courses 3: 229–248. (Plant Breeding Ser. No. 3.)

(23) NOLL, C. F.
1920. THE USE OF IMMATURE POTATOES FOR SEED. Penn State Farmer 14: 74, 87.

(24) PITT, J. M.
1921. POTATO TRIALS, 1920–21. Agr. Gaz. N. S. Wales 32: 473–479.

(25) RAMSAY, J. T.
1915. EXPERIMENTS IN THE CULTIVATION OF POTATOES, 1914–15. Jour. Dept. Agr. Victoria 13: 340–348, illus.

(26) ———
1922. POTATO EXPERIMENTS, 1921–22. Jour. Dept. Agr. Victoria 20: 415–417.

(27) ———
1923. POTATO EXPERIMENTS, WERRIBEE. Jour. Dept. Agr. Victoria 21: 110–114, illus.

(28) ———
1925. POTATO EXPERIMENTS, 1924–25. Jour. Dept. Agr. Victoria 23: 467–471.

(29) RICHMAN, E. S.
[n. d.] HORTICULTURE. Utah Agr. Exp. Sta. Bul. 14, 7 p.

(30) ROSA, J. T. Jr.
1922. SEED STUDIES WITH IRISH POTATOES. Mo. Agr. Exp. Sta. Bul. 101, 32 p., illus.

(31) SANBORN, J. W.
[n. d.] POTATO TRIALS. Utah Agr. Exp. Sta. Bul. 5, 22 p.

(32) SPEER, R. P.
1891. EXPERIMENTS WITH POTATOES, ETC. Iowa Agr. Exp. Sta. Bul. 12: 507–552.

(33) SPEIR, J.
1902. BOXING SEED POTATOES. Highland and Agr. Soc. Scot. Trans. (V) 14: 147–166, illus.

(34) STEWART, J. G.
1906. A REPORT ON EXPERIMENTS WITH POTATOES, 1905. Univ. Leeds and Yorkshire Council Agr. Ed. [Pamphlet] 55, 30 p., illus.

(35) ———
1907. A REPORT ON EXPERIMENTS WITH POTATOES, 1906. Univ. Leeds and Yorkshire Council Agr. Ed. [Pamphlet] 63, 24 p., illus.

(36) SUTTON & SONS.
1906. POTATO DEMONSTRATION.. 48 p., illus. Reading, England.

(37) TAFT, L. R.
1890. VEGETABLES. COMPARATIVE TESTS, METHODS OF CULTURE. Mich. Agr. Exp. Sta. Bul. 57: 179–218.

(38) ———
1891. VEGETABLES. VARIETIES AND METHODS. Mich. Agr. Exp. Sta. Bul. 70: 160–198.

(39) TROOP, J.
1892. EXPERIMENTS IN METHODS OF CUTTING AND CULTIVATION OF POTATOES. Ind. Agr. Exp. Sta. Bul. 38: 25–29.

(40) VILMORIN, P. DE
1916. SUR L'EMPLOI DE SEMENCES DE POMMES DE TERRE IMPARFAITEMENT MURES. Compt. Acad. Agr. France 2: 1085–1099.

(41) WILSON, J.
1859. OUR FARM CROPS. v. 2, illus. London.

(42) WRIGHT, R. P.
1907. REPORT ON AN EXPERIMENT IN 1906 ON THE EFFECTS OF PLANTING SPROUTED SEED ON THE YIELD OF THE POTATO CROP. West of Scot. Agr. Col. Bul. 43: 101–105.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

December 1, 1927

Secretary of Agriculture	W. M. JARDINE.
Assistant Secretary	R. W. DUNLAP.
Director of Scientific Work	A. F. WOODS.
Director of Regulatory Work	WALTER G. CAMPBELL.
Director of Extension	C. W. WARBURTON.
Director of Personnel and Business Administration	W. W. STOCKBERGER.
Director of Information	NELSON ANTRIM CRAWFORD.
Solicitor	R. W. WILLIAMS.
Weather Bureau	CHARLES F. MARVIN, *Chief.*
Bureau of Animal Industry	JOHN R. MOHLER, *Chief.*
Bureau of Dairy Industry	C. W. LARSON, *Chief.*
Bureau of Plant Industry	WILLIAM A. TAYLOR, *Chief.*
Forest Service	W. B. GREELEY, *Chief.*
Bureau of Chemistry and Soils	H. G. KNIGHT, *Chief.*
Bureau of Entomology	C. L. MARLATT, *Chief.*
Bureau of Biological Survey	PAUL G. REDINGTON, *Chief.*
Bureau of Public Roads	THOMAS H. MACDONALD, *Chief.*
Bureau of Agricultural Economics	LLOYD S. TENNY, *Chief.*
Bureau of Home Economics	LOUISE STANLEY, *Chief.*
Federal Horticultural Board	C. L. MARLATT, *Chairman.*
Grain Futures Administration	J. W. T. DUVEL, *Chief.*
Food, Drug, and Insecticide Administration	WALTER G. CAMPBELL, *Director of Regulatory Work, in Charge.*
Office of Experiment Stations	E. W. ALLEN, *Chief.*
Office of Cooperative Extension Work	C. B. SMITH, *Chief.*
Library	CLARIBEL R. BARNETT, *Librarian.*

This bulletin is a contribution from

Bureau of Plant Industry	WILLIAM A. TAYLOR, *Chief.*
Office of Horticulture	L. C. CORBETT, *Senior Horticulturist, in Charge.*

36

ADDITIONAL COPIES
OF THIS PUBLICATION MAY BE PROCURED FROM
THE SUPERINTENDENT OF DOCUMENTS
U. S. GOVERNMENT PRINTING OFFICE
WASHINGTON, D. C.
AT
10 CENTS PER COPY

▽

END