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POTATO SPRAYING EXPERIMENTS AT RUSH IN 1913.

F. C. STEWART.



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# POTATO SPRAYING EXPERIMENTS AT RUSH IN 1913.

F. C. STEWART.

## SUMMARY.

During the summer of 1913 an extensive series of potato-spraying experiments was conducted in the vicinity of Rush, N. Y. In each of 66 fields a portion of one row (one-fiftieth acre) was very thoroughly sprayed by hand every two weeks. At digging time the yield of this row was compared with that of an adjacent row which had not received the special spraying. In 47 of the fields no spraying was done by the owner. In these fields the test was a comparison between very thorough spraying and no spraying. In the other 19 fields more or less spraying was done by the owner. In these, the test was a comparison between very thorough spraying and the kind of spraying done by the owner.

In the 47 unsprayed fields the spraying done by the Station increased the average yield by 17.76 bushels per acre, or 16.4 per ct.; and in the 19 sprayed fields, by 15.04 bushels per acre, or 11.2 per ct.

It is believed that the increase obtained was due to the partial control of tip-burn which was quite plentiful in some fields, the better control of Colorado potato beetles (not well controlled by the owner in a few cases), and stimulation of the plants. Late blight was entirely absent and early blight and flea beetles scarce. Probably, the gain from spraying would have been considerably larger had not the plants been killed prematurely by an early frost.

## PRESENT PROBLEMS IN POTATO SPRAYING.

It pays to spray potatoes in New York. That has been conclusively proven by the numerous experiments made by this Station. Further experimentation along that line is unnecessary. Nevertheless, there is still something to be learned from potato spraying experiments. There is reason to believe that the present methods of spraying may be considerably improved. For one thing, it is probable that potato-growers would find it profitable to spray more thoroughly than they are now doing. Probably, lack of thoroughness is the chief fault of the present methods. Although some are spraying quite thoroughly, many New York potato-growers are

doing a very poor job with the spray outfit; and, worse yet, the majority, probably, are not spraying at all.

In the ten-year experiment on the Station grounds at Geneva five to seven very thorough sprayings increased the yield at the rate of 97.5 bushels per acre on the average. In the series of farmers' business experiments conducted during the last nine years of the same period the average increase in yield due to spraying was only 36.1 bushels per acre.\* It appears that the better results obtained in the Station experiment were due, chiefly, to the thoroughness of the spraying. If so, it behooves farmers to spray more thoroughly. However, some hold that such spraying as was done in the Station experiments would not have increased the yield so much in farmers' fields. We think there may be some truth in this. Undoubtedly, the largest returns from spraying are to be obtained in fields in which the cultural conditions are favorable to large yields.

By means of the experiments reported in the present bulletin it was sought to obtain information on some of the points above mentioned. An attempt was made to find out what thorough spraying will accomplish in farmers' fields. To be more explicit, the objects of the experiments were three:

- (1) To determine how much the yield in farmers' fields may be increased by very thorough spraying;
- (2) To determine how efficient are the spraying methods now employed by farmers;
- (3) To furnish object lessons for farmers in their own fields.

### THE EXPERIMENTS.

Rush was selected as the location of the experiments chiefly for two reasons: (1) Because potatoes are grown extensively there; and (2) because we were able to secure there a suitable man to do the spraying, viz., Mr. H. F. Keyes, a student in the New York State College of Agriculture, who performed the work during his summer vacation. In June, Mr. Keyes visited potato-growers in the vicinity and secured permission to spray a portion of one row (290.4 feet long) in each of 66 fields. After the potatoes came up a careful selection of rows was made and the portion to be sprayed marked at both ends by means of stakes driven in the ground. In the selection of these rows care was taken to avoid dead-furrows, back-

\* Bulletin No. 349 of this Station.

furrows and soil inequalities. Spraying was commenced when the plants were six to eight inches high and repeated at intervals of two weeks until frost, which occurred on September 14. At this time the rows in the early-planted fields had received six sprayings and those in the later-planted fields five sprayings. All spraying was done very thoroughly by means of a knapsack sprayer. The first two applications were made with bordeaux mixture containing four pounds of copper sulphate (and sufficient lime to neutralize it, as shown by the potassium ferrocyanide test) to each fifty gallons. Paris green was added at the rate of one pound to fifty gallons. Subsequent applications were made with bordeaux mixture, alone, in which the quantity of copper sulphate was six pounds to fifty gallons. The supply of bordeaux for each day's work was carried in a barrel fastened on the rear of a one-horse buggy which was driven from field to field as needed. In 47 of the fields containing experiments the owner used no bordeaux, but applied only such treatment as he considered necessary for the control of bugs. In the remaining 19 fields more or less bordeaux was applied by the owner, the number of applications in different cases varying from one to eight (see Table II) and there were no unsprayed rows; that is to say, in these fields the spraying done by the Station was in addition to that done by the owner. If the owner sprayed three times and the Station six times the plants on the Station row received a total of nine sprayings.

The season was a very dry one and there was no late blight (*Phytophthora infestans*) in any of the fields, not even on unsprayed plants. Neither was there early blight (*Alternaria solani*) of any consequence, nor serious damage done by flea beetles. But in nearly all fields there was more or less tip-burn which, in some cases, was quite severe. "Bugs" were moderately plentiful. In a few fields they were not fully controlled by the treatment employed by the owner.

A killing frost occurred on the night of September 14. At this time the plants in most of the fields were in nearly full foliage. As 51 of the fields had been planted after June 1, and many of them between June 10 and 17, this untimely frost cut off from two to four weeks of growth and thereby lowered the yield considerably.

At digging time the row sprayed by the Station and an adjacent row of equal length were dug by hand and the product sorted and weighed. This work was all done by Mr. Keyes. The yields are shown in Tables I and II.

TABLE I.—RESULTS OF THOROUGH SPRAYING OF SINGLE ROWS IN FORTY-SEVEN UNSPRAYED POTATO FIELDS.

OWNER'S NAME.	UNSPRAYED.			Times sprayed	SPRAYED BY THE STATION.			Increase per acre due to spray- ing
	YIELD PER ROW.		Yield per acre; market- able tubers.*		YIELD PER ROW.		Yield per acre; market- able tubers	
	Market- able tubers.	Culls.			Market- able tubers.	Culls.		
	Lbs.	Lbs.	Bu.		Lbs.	Lbs.	Bu.	Bu.
M. Perry	98	10	81.7	5	172	3	143.3	61.6
F. O. Todd	152	0	126.7	5	205	0	170.8	44.1
Wm. Fagan	30	12	25	5	80	8	66.7	41.7
F. Hinderland	151	4	125.8	5	201	3	167.3	41.5
Roy Dunn	134	4	111.7	5	180	3	150	38.3
Mrs. F. Lonthair	92	0	76.7	5	136	0	113.3	36.6
John Remelt	154	4	128.3	6	194	4	161.7	33.4
R. Fielder	150	0	125	5	189	0	157.5	32.5
Jas. McNall	114	3	95	5	153	5	127.5	32.5
R. Laidlan	177	0	147.5	6	215	0	179.2	31.7
J. Burmeister	90	4	75	5	126	5	105	30
L. Loss	100	3	83.3	5	135	3	112.5	29.2
J. Fagan	124	7	103.3	6	158	18	131.7	28.4
H. E. Benedict (1)	218	0	181.7	5	250	0	208.3	26.6
Geo. Bean	151	0	125.8	5	181	0	150.8	25
F. Howlett	130	5	108.3	5	160	5	133.3	25
Frank Stanton	132	0	110	5	162	0	135	25
R. A. Keyes	118	3	98.3	6	146	3	121.7	23.4
L. H. Bemis	192	0	160	5	216	0	180	20
Jay Green	186	0	155	5	210	0	175	20
E. G. Darrohn	115	0	95.8	5	138	0	115	19.2
W. J. Kirkpatrick	70	3	58.3	5	92	5	76.7	18.4
T. Maloney	99	4	82.5	6	120	4	100	17.5
J. E. Christ	180	0	150	5	199	0	165.8	15.8
Mrs. F. Gardner	78	3	65	5	95	3	79.2	14.2
J. Gutschau	160	0	133.3	5	176	0	146.7	13.4
M. Moran	74	3	61.7	5	90	5	75	13.3
L. Wagner	111	0	92.5	5	127	0	105.8	13.3
A. Cummins	164	7	137	6	180	3	150	13
John Heech	198	0	165	5	212	0	176.7	11.7
J. Darrohn (1)	141	0	117.5	5	154	0	128.3	10.8
E. Green	109	7	90.8	5	121	5	100.8	10
F. C. Long	95	0	79.2	5	107	0	89.2	10
J. Leyden	99	3	82.5	5	111	3	92.5	10
D. Maher	77	2	64.2	5	89	2	74.2	10
Geo. Allen	90	0	75	5	100	0	83.3	8.3
F. A. Sheldon	110	3	91.7	5	120	5	100	8.3
Wm. Spatsker	168	3	140	5	174	3	145	5
R. Shoemaker	105	3	87.5	5	108	3	90	2.5
A. Keafer	162	4	135	5	163	3	136	1
H. M. Van Voorhis	231	0	192.5	6	232	0	193.3	0.8
Chas. Post	72	3	60	5	72	3	60	0
J. Darrohn (2)	108	10	90	5	105	14	87.5	†-2.5
W. Rotherick	100	3	83.3	5	96	3	80	-3.3
Chas. O'Brien	126	0	105	5	120	0	100	-5
Paul Martin	129	7	107.5	5	120	6	100	-7.5
W. Markham	240	0	200	5	216	0	180	-20

\* A row 290.4 x 3 ft. = one-fiftieth acre. In some fields the rows were less than 3 feet apart. Nevertheless, in the computation of the acre yields given in Tables I and II the area of a row is assumed to be one-fiftieth acre in all cases. † A minus sign indicates reduced yield.

*Average yield of unsprayed rows, 108.23 bu. per acre.*

*Average yield of the rows sprayed by the Station, 126 bu. per acre.*

*Average increase in yield per acre, 17.76 bu., or 16.4 per ct.*

TABLE II.—RESULTS OF THOROUGH SPRAYING OF SINGLE ROWS IN NINETEEN SPRAYED POTATO FIELDS.

OWNER'S NAME.	SPRAYED ONLY BY OWNER.				SPRAYED ALSO BY STATION.				Increase per acre due to extra spraying by Station.
	Times sprayed.	YIELD PER ROW.			Times sprayed by Station.	YIELD PER ROW.			
		Market-able tubers.	Culls.	Yield per acre; marketable tubers.		Market-able tubers.	Culls.	Yield per acre; marketable tubers.	
		Lbs.	Lbs.	Bu.		Lbs.	Lbs.	Bu.	Bu.
F. L. Martin.....	3	136	2	113.3	5	193	3	160.8	47.5
W. Perry.....	3	138	0	115	6	179	0	149.2	34.2
David Dell.....	8	140	0	116.7	5	180	0	150	33.3
W. A. Keyes (1)...	7	126	3	105	6	162	4	135	30
G. J. McNall.....	1	121	0	100.8	5	152	0	126.7	25.9
C. Schwartz.....	2	90	5	75	5	120	7	100	25
C. A. Search.....	2	186	0	155	5	215	0	179.2	24.2
D. Harrington....	1	191	0	159.2	5	211	0	175.8	16.6
Norris Bros.....	7	248	0	206.7	6	266	0	221.7	15
A. White.....	4	139	11	115.8	5	157	11	130.8	15
F. Rath.....	5	101	7	84.2	5	116	7	96.7	12.5
C. Diver.....	1	180	0	150	5	191	0	159.2	9.2
B. H. Diver.....	1	190	3	158.3	5	200	3	166.7	8.4
Frank Chase.....	5	217	0	180.8	5	224	0	186.7	5.9
D. S. McNall.....	4	146	3	121.7	5	149	3	124.2	2.5
H. E. Benedict (2)...	1	240	0	200	5	240	0	200	0
M. Harrigan.....	1	141	3	117.5	5	139	3	115.8	-1.7
W. A. Keyes (2)...	6	141	7	117.5	5	133	7	110.8	-6.7
P. F. Martin.....	6	200	0	166.7	5	187	0	155.8	-10.9

*Average yield of rows sprayed only by owner, 134.7 bu. per acre.*

*Average yield of rows sprayed also by the Station, 149.74 bu. per acre.*

*Average increase in yield per acre, 15.04 bu., or 11.2 per ct.*

#### COMMENTS ON THE RESULTS.

The increase in yield due to spraying was small compared with that usually obtained by very thorough spraying. However, it is as large as could be reasonably expected when it is considered that the conditions were extremely unfavorable. In dry seasons when there is little or no blight the increase in yield from spraying is largely dependent upon the fact that sprayed plants live considerably

longer than unsprayed ones. In the present case this advantage of prolonged growth was lost through the killing of the plants by an early frost. It appears that the increase obtained was due to the partial control of tip-burn, the better control of "bugs" (in a few cases) and the imperfectly-understood stimulation effect of the bordeaux.

In experimental work of this kind the experimental error is certainly large for individual experiments, though for an average of forty-seven experiments it is probably small. That is to say, we believe that the average increase from thorough spraying was, actually, between 17 and 18 bushels per acre as shown by the results of the experiments, notwithstanding the fact that in certain of the experiments there was an unaccountable reduction in yield. In five of the experiments the row very thoroughly sprayed by the Station yielded less than the unsprayed check row adjacent and in three other experiments (in sprayed fields) the extra spraying done by the Station apparently decreased the yield.

There is no reason, whatever, for believing that spraying was harmful in these eight experiments. Undoubtedly, the true explanation is that the check row possessed some advantage over the Station row and would have outyielded it still more if neither row had been sprayed. In one case (J. Darrohn's experiment) an explanation was found in the fact that the check row contained 21 more hills than the Station row; but what was the cause of the erratic results in the other seven experiments is unknown.

If the reduction in yield in these eight experiments is ascribed to original inequalities between the test rows it must be admitted that similar inequalities existed in some of the experiments showing increased yield from spraying. It is doubtless true that, in some of the experiments, the increase in yield apparently due to spraying was, in reality, partly due to other causes. However, by averaging the results of a large number of experiments the probability of error is greatly diminished.

The average gain from the spraying done by the Station was nearly as large in sprayed fields as in unsprayed ones, being 15.04 bushels per acre in the former and 17.76 bushels per acre in the latter. If these figures are reliable, they indicate that the spraying done by the owners was of small value; but it should be considered that the number of experiments in sprayed fields was rather small — only



nineteen. In the experiment of David Dell (the only one in which an unsprayed row was left in a sprayed field) the Station row out-yielded the owner's row by 33.3 bushels per acre, while the unsprayed row yielded 16.7 bushels per acre less than the owner's row. Mr. Dell sprayed eight times.

Of the sixty-six fields in which these experiments were conducted, only nineteen, or less than one-third, were sprayed by the owner; and of the nineteen sprayed fields certainly not more than nine were properly sprayed. Probably, this represents fairly well the present status of potato spraying at Rush. It is very evident that potato-growers here are still unconvinced that it pays to spray potatoes. If all the summers were like that of 1913 such a view might be justified, but they are not. Another season's experiments may show spraying in a very different light. It is expected that the experiments will be repeated during the coming season.