SHOULD POTATO GROWERS SPRAY? II.

F. H. HALL, F. C. STEWART, H. J. EUSTACE AND F. A. SIRRINE.

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SHOULD POTATO GROWERS SPRAY? II.

F. H. HALL.

Throughout most of the potato-growing districts of New York State, late blight was very prevalent in 1903 during the late summer and early fall. A conservative estimate places the loss during this season, from preventable diseases, at 50 bushels per acre; for in many districts the crop was hardly worth digging and, so far as known, there were no considerable areas where diseases did not do more or less injury. These figures indicate a loss to the State, largely unnecessary, of nearly $10,000,000; for the area devoted to potatoes in recent years has been about 400,000 acres, and the average value of late potatoes at harvesting time this season was about 50 cents a bushel.

Experiments made last year at the Station and at Most of loss Riverhead, Long Island, confirmed the belief preventable. held by all students of potato diseases that spraying with bordeaux mixture will prevent most of this loss; and tests made during the past season at the same places and at six other localities in the State lend most emphatic support to the belief. The potato grower who sprays thoroughly every year insures his crop against serious damage from blight.

*This is a brief review of Bulletin No. 241 of this Station, on Potato Spraying Experiments in 1903, by F. C. Stewart, H. J. Eustace and F. A. Sirrine. Anyone specially interested in the detailed account of the investigations will be furnished, on application, with a copy of the complete bulletin. The names of those who so request will be placed on the mailing list to receive bulletins regularly, either popular edition or complete edition as desired. Bulletins are issued at irregular intervals as investigations are completed, not monthly.
and rot; and in a season when disease is epidemic will make enough profit to repay the cost of treatment for many years. For example, the gain from spraying at Geneva in 1902 was 123 bushels per acre and in 1903, 118 bushels, a gain for the two seasons, at the lowest allowable figure, $1 a barrel for potatoes, of $80. Allowing each application of the spray mixture to cost $1 an acre, a very liberal estimate, this profit would allow the Station to spray potatoes for 13 years, making 6 applications each year, and come out even, if no further damage from blight should occur. Is there any potato grower who believes that 13 years will elapse before blight again strikes the potato crop of the State? However, the tests at Geneva and Riverhead are to be continued for eight years more, at the end of which time it is believed that sufficient data will have been collected to answer conclusively the question whether it pays, on the average, to spray potatoes.

In the ten-year tests at Geneva and Riverhead, rows of potatoes are grouped in series, the first row sprayed three times during the season, the next sprayed every two weeks and the third left unsprayed. The series are repeated so that each method of treatment is applied to one-tenth of an acre. The soil is well fitted, the plants given good culture, rather heavy applications of chemical fertilizers are used, and great care is taken to make the spraying thorough. Some arsenical poison is used to kill the "bugs," which is combined with the bordeaux mixture on the sprayed rows at as many of the applications as needed. On the unsprayed rows the poison is applied in lime water to prevent burning the foliage, or dusted on with a powder gun.

The results are summarized below:
# Results of Ten-Year Potato Spraying Tests

## At Geneva

<table>
<thead>
<tr>
<th>No. of Sprayings</th>
<th>Yield per acre</th>
<th>Gain</th>
<th>No. of Sprayings</th>
<th>Yield per acre</th>
<th>Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>* Bu.</td>
<td>0</td>
<td>0</td>
<td>* Bu.</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>219</td>
<td>317½</td>
<td>3</td>
<td>174</td>
<td>262</td>
</tr>
<tr>
<td>7</td>
<td>342½</td>
<td>123½</td>
<td>5</td>
<td>292</td>
<td>118</td>
</tr>
</tbody>
</table>

## At Riverhead

<table>
<thead>
<tr>
<th>No. of Sprayings</th>
<th>Yield per acre</th>
<th>Gain</th>
<th>No. of Sprayings</th>
<th>Yield per acre</th>
<th>Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>267½</td>
<td>27½</td>
<td>0</td>
<td>207</td>
<td>39½</td>
</tr>
<tr>
<td>3</td>
<td>295½</td>
<td>45</td>
<td>3</td>
<td>246½</td>
<td>56</td>
</tr>
<tr>
<td>7</td>
<td>312½</td>
<td>48</td>
<td>5</td>
<td>263</td>
<td>56</td>
</tr>
</tbody>
</table>

That is: At Geneva, in 1902, the gain from spraying three times during the season was 45 per ct. and from spraying every two weeks 56½ per ct.; in 1903 the gains were 50½ and 68 per ct. respectively, for similar treatments. At Riverhead the gains in 1902 were 10½ and 16½ per ct. respectively; in 1903, 19 and 27 per ct., respectively.

The percentage of increase on Long Island has been less than at Geneva in both years of the test; in 1902, because late blight was not at all destructive in the section of the Island where the tests were located, so that the benefits from spraying were due to better protection from "bugs" and flea beetles, to prevention of foliage burning from arsenical poisons, and to the stimulative effect of the bordeaux mixture upon the sprayed plants. In 1903, the blight did not appear until the potatoes were approaching maturity, so that the damage on unsprayed areas was not so great as at Geneva; but when it did appear it soon destroyed the foliage of fields not sprayed and thus drove the innumerable flea-beetles, through hunger, to the green, sprayed plants, so that the latter suffered more than usual from these insects and did not produce as heavily as they should.

Both at Geneva and at Riverhead the protection against blight by spraying was very good; but not complete, since the disease
was especially virulent and worked almost too rapidly for efficient control with sprayings made only once in two weeks. The sprayed rows remained green and growing from 15 to 18 days longer than those not sprayed. There was little damage from rot at either place. The potato beetles were easily controlled by poisons used in the bordeaux mixture.

Criticism was made of the Station tests of 1902, on the grounds that they were on too small a scale, that the conditions and culture were better than the commercial grower could give, and that the spraying was more thorough than it could be made in field practice. To meet these objections, arrangements were made by the Station with farmers in different parts of the State who intended to spray in 1903, to conduct "practical" or business tests.

Each grower was to give the crop only such conditions, culture and care as he would ordinarily; to spray as often as he thought best, using his own mixtures, apparatus and methods, and to keep an itemized account of the expense of spraying. The Station merely required that a portion of the field fairly representative of the whole, be left unsprayed and the product weighed for comparison with the yield on an equal, adjacent area of sprayed rows.

Six farmers coöperated with the Station in these tests, three near Phelps, from six to eight miles from Geneva, one at Southampton, on Long Island, one at West Rush in the Genesee Valley, south of Rochester, and one at Charlotte, north of Rochester.

On the total area of 61½ acres sprayed in the six experiments in different parts of the State there was a total increase in yield of 3746 bushels, or an average of 61.24+ bushels per acre. At 50 cents per bushel the increase was worth $1873. Subtracting from this amount the total expense of the spraying, $296.49, there is a remainder of $1576.51 which is the total net profit. This is at the rate of $25.77+ per acre. In very condensed form the results of these tests are shown in the following table:
FARMERS’ POTATO SPRAYING TESTS.

<table>
<thead>
<tr>
<th>Locality</th>
<th>Area sprayed</th>
<th>No. of Applications</th>
<th>Acre cost of each spraying</th>
<th>Acre yield sprayed</th>
<th>Total gain</th>
<th>Total cost</th>
<th>Total cost</th>
<th>Profit per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charlotte</td>
<td>5 Acre</td>
<td>3</td>
<td>$2.67</td>
<td>292½ Bu.</td>
<td>35</td>
<td>$40.00</td>
<td>$-4.50</td>
<td></td>
</tr>
<tr>
<td>Southampton</td>
<td>13 Acre</td>
<td>4</td>
<td>.98</td>
<td>328 Bu.</td>
<td>702</td>
<td>50.91</td>
<td>23.08</td>
<td></td>
</tr>
<tr>
<td>Phelps</td>
<td>10 Acre</td>
<td>5</td>
<td>.80</td>
<td>155 Bu.</td>
<td>625</td>
<td>40.07</td>
<td>27.24</td>
<td></td>
</tr>
<tr>
<td>Phelps</td>
<td>13 Acre</td>
<td>5</td>
<td>.80</td>
<td>147 Bu.</td>
<td>896</td>
<td>55.76</td>
<td>28.01</td>
<td></td>
</tr>
<tr>
<td>W. Rush</td>
<td>15½ Acre</td>
<td>16</td>
<td>.39</td>
<td>260 Bu.</td>
<td>1222</td>
<td>96.32</td>
<td>32.85</td>
<td></td>
</tr>
<tr>
<td>Phelps</td>
<td>3½ Acre</td>
<td>5</td>
<td>.77</td>
<td>194½ Bu.</td>
<td>266</td>
<td>13.43</td>
<td>34.16</td>
<td></td>
</tr>
</tbody>
</table>

1 Potatoes at 50 cents a bushel.
2 Loss due to absence of blight until late in the season and to great cost of spraying.

To illustrate the method of keeping account of the cost of treatment, the detailed statement for the Southampton experiment is here given:

COST OF SPRAYING 13 ACRES FOUR TIMES.

- 294 lbs. copper sulphate at 6 cts .................................. $17.64
- 80 " paris green at 18 cts ............................................. 14.43
- 1 barrel lime ............................................................. 1.35
- Repairs on spraying outfit .............................................. 1.50
- 45 hrs. labor for man at 20 cts ....................................... 9.00
- 45 " " " horse at 10 cts .................................................. 4.50
- Interest on investment (sprayer, etc., $12) at 6% at 6% ............. 2.52

Total ................................................................. $50.91

The spraying outfits used were of varied types: Purchased horse-power sprayer covering six rows in two experiments at Phelps; second-hand outfit of same nature in other Phelps experiment, hand-power pump attached to 100-gallon tank and treating five rows at a time, at Southampton; home-made horse-power sprayer covering six rows at West Rush; and hand pump on 50-gallon tank hauled by one horse, supplying two leads of hose each handled by a man walking, at Charlotte. One of the machines,—that used at Southampton—was fitted with two nozzles to a row, the others with but one nozzle.

The West Rush experiment is peculiar in the large number of sprayings, the owner believing in frequent light applications. The cost for each application is small, but the total expense per acre for the season does not differ much from that of less frequent, more thorough sprayings. The results, in this case at least, were excellent.
Too much man labor was used in the work at Charlotte, thus raising the cost. Thorough spraying was done, which would undoubtedly have yielded a nice profit had blight been prevalent in the vicinity.

In the last Phelps test no poison was used against the "bugs," consequently the cost of spraying was reduced. In other tests paris green or arsenite of lime was used.

A supplementary test was also made on Long Island to ascertain the cost of applying poison to control the potato beetles, using the material in dry form and applying it with a "powder gun." Eighteen acres of potatoes were treated in this manner, using "Green Arsenoid" as the poison, at the rate of two pounds to the acre, undiluted. Two applications were required on early potatoes and three applications on the late crop. The "bugs" were fairly well controlled, but not all were killed at any application; while in the other experiments the poison applied once or twice in the spray mixture was very effective, a third treatment being required but rarely.

The expense of the powder poisoning was 49 cents an acre for each application. This expense would hold about the same for paris green as for "Green Arsenoid," since the two are nearly alike in both price and effectiveness. It is probable that the poison applied in this way injured the foliage to some extent since no agent was used to neutralize the free acid; while in spraying, the lime used in making the bordeaux mixture combines with acid in the poison to form an insoluble compound harmless to the foliage.

In reckoning the cost of spraying in the "practical" experiments the cost of the poisons used by spraying has been included. If this expense be left out, or (what is fairer, since "bugs" must be fought anyway), if the cost of applying the poison in dry form be deducted from the expense of spraying it will make an even better showing of the financial benefit from the use of bordeaux mixture. Making this deduction from the expense, it would appear that, from the profits of the season of 1903, the owners of the sprayed areas, except that at Charlotte, could repeat the spray-
ing against blight for from six to nine years without loss, even if they did not suffer from blight in that time.

Influenced by the great damage caused by blight in 1902, many farmers sprayed potatoes for the first time in 1903. Some report failure and are inclined to condemn the practice; while the disappointment is largely due to two preventable sources of failure. First, it is necessary to spray at the right time. Spraying is a preventive of plant diseases, not a cure; and if treatment be delayed until signs of damage begin to appear, but little good will be likely to result. When the leaves begin to turn brown at the edges and curl up, the little plants which grow within the potato leaves and stalks cause the disease have already become thoroughly established inside the tissues and are out of reach of any spray mixture. Though the foliage be thoroughly drenched with spray each day after this time, the infected plants are certain to die quickly if weather conditions be right. Spraying to be effective must be done before any signs of disease appear.

Second, it is necessary to spray thoroughly, for unless the entire surface of the foliage be protected by a film of bordeaux mixture, some of the tiny germs (or seeds) of the disease may find a spot on which to germinate and from which to send their little tubes down into the tissues of the host plant. In time of moist, warm weather the potato is growing rapidly and new surface is constantly being exposed. At this time, also, the fungus plants also grow best so the danger from an attack of blight is great. At such times, especially if heavy rains accompany the warm weather and wash off the spray mixture, repeated applications may be necessary to secure good protection.

Ordinarily, however, it will be sufficient to start Directions when the plants are six or seven inches high and spray regularly every two weeks during the growing season. Three applications, applied judiciously, have given excellent results in the ten-year tests. Some may prefer to make lighter applications more frequently. If this is done the spraying at successive applications should be from different directions to insure as perfect a coating as possible.
Make the bordeaux with good stone lime slaked gradually by adding just enough water to keep it moist, not to flood it. When slaked, dilute with one-third or one-half the water required by the formula, and add the dissolved copper sulphate diluted with the rest of the water. The common formula for bordeaux for potato spraying is 6 lbs. copper sulphate, 4 lbs. fresh stone lime and 50 gallons of water.

For poisoning the bugs add to the amount of the mixture you will use in covering one acre, one pound of paris green or its equivalent in white arsenic in the form of arsenite of lime.

This latter material is cheaper and better than paris green. It costs about one-third as much per pound and is equal in poisoning properties to twice as much paris green. It requires some time and thought to prepare, however. It is made and used as follows:—Dissolve one pound of white arsenic and four pounds of salsoda (washing soda) in one gallon of water by boiling 15 or 20 minutes. This makes the stock solution which can be bottled and kept until desired for use. For spraying potatoes add two quarts of the stock solution (one-half pound white arsenic) to the quantity of bordeaux required to cover an acre. This is equivalent to an application of one pound of paris green per acre.

In using the white arsenic stock solution with bordeaux mixture prepared by the potassium ferrocyanide test it is always advisable to add lime a little in excess of the amount required to satisfy the test in order to prevent the possibility of injuring the foliage. In our experience it has not injured the foliage in the least when used with bordeaux. If used in lime water there must be plenty of lime or the foliage will be injured. White arsenic was used with entire satisfaction in both of the Salisbury experiments at Phelps and in the Station experiments at Geneva and Riverhead.