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Six-row tractor-mounted duster in a field of dry-land potatoes.

DUSTING FOR POTATO
PSYLLID CONTROL

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DUSTING FOR POTATO PSYLLID CONTROL

WILLIAM A. RIEDEL

INTRODUCTION

The potato psyllid (Paratrioza cockerelli Sulc) causes the disease, psyllid yellows of potatoes, or what is frequently called "purple top." This insect causes heavier losses of potatoes in the Rocky Mountain area than any other insect pest or plant disease. Where no control measures are practiced, losses usually range from 20 to 60 per cent, with total losses frequently occurring in cases of severe infestations. It is estimated that psyllid yellows caused an average annual loss of approximately 28 per cent of the potato crop in Wyoming during the past four years.

Spraying with lime-sulphur solution has been the common method of control since 1934. Many growers do not spray their potatoes, however, because of the high cost of spray equipment, the large amount of labor required and the impracticability of spraying small fields and garden plots.

Because of lower equipment and labor costs and greater ease of application, dusts have frequently been substituted for sprays in disease and insect control. Unfortunately, at the time the present studies were begun, no information was available on the effectiveness of dusts in potato psyllid control under Wyoming conditions. In order to obtain such information, the writer conducted trials using various dust treatments in comparison with lime-sulphur and wettable sulphur sprays during the years 1939 to 1942, inclusive. These trials were conducted under irrigated conditions at the Agronomy Experiment Farm near Laramie, Wyoming. Because of the high altitude, 7,200 feet above sea level, the growing season here is cool and a high potato psyllid population occurs nearly every year.

Results of the trials in 1939 and 1940 and a review of literature were published in Wyoming Agricultural Experiment Station Bulletin Number 245. Results of the trials in 1941 and 1942 are given in the present publication.
EXPERIMENTAL RESULTS, 1941

Comparisons of seven different treatments were made on Bliss Triumph potatoes in 1941. The treatments and rates per acre per application were as follows:

1. Two gallons lime-sulphur, 80 gallons water.
2. One gallon lime-sulphur, 4 pounds 325-mesh wettable sulphur, 80 gallons water.
3. Thirty pounds conditioned dusting sulphur, 98 per cent through 325-mesh.
4. Thirty pounds tri-basic copper sulphate.
5. Thirty pounds sulphur-copper dust mixture containing 6 per cent red copper oxide.
6. Thirty pounds conditioned dusting sulphur, 93 per cent through 325-mesh.
7. Untreated check.

The 93 per cent and 98 per cent 325-mesh dusting sulphurs differed only as to particle size, the 98 per cent 325-mesh product being the finer. Both of these materials contained 2½ per cent inert conditioning agent to overcome the tendency of finely ground sulphur to lump.

The treatments were applied to four-row plots 135 feet long, replicated four times and randomized. Three applications of each treatment were made on the following dates: July 21, August 12 and August 27.

The lime-sulphur and wettable sulphur were applied with a four-row sprayer having three nozzles per row, one nozzle on each side of the row spraying upward at a 45 degree angle and one on top of the row spraying down. The spray was applied at a pressure of 300 to 400 pounds per square inch. The dusts were applied with a two-row duster which applied the dust to both sides of the row. The duster was equipped with a hood, (Figure 1), which helped to confine the dust about the plants.

Readings on the psyllid populations were made by R. L. Wallis, Assistant Entomologist of the U. S. Department of Agriculture, stationed at Scottsbluff, Nebraska. Readings on the adult, egg
and nymph populations were made on two replications of the treated plots and on four replications of the untreated or check plots. Seven readings were made at weekly intervals during the growing seasons. The results are shown in Table I.

**TABLE I**

POPULATION OF THE POTATO PSYLLID (*Paratriozia cockerelli* Sulc) ON CONTROL PLOTS, LARAMIE, WYOMING, 1941

<table>
<thead>
<tr>
<th>No.</th>
<th>Treatments</th>
<th>Adults</th>
<th>Rank</th>
<th>Eggs</th>
<th>Rank</th>
<th>Nymphs</th>
<th>Rank</th>
<th>Total</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Lime-sulphur spray</td>
<td>10.8</td>
<td>3</td>
<td>8.7</td>
<td>3</td>
<td>6.1</td>
<td>4</td>
<td>25.6</td>
<td>4</td>
</tr>
<tr>
<td>2.</td>
<td>Wettable sulphur- lime-sulphur spray</td>
<td>12.6</td>
<td>5</td>
<td>7.8</td>
<td>2</td>
<td>7.1</td>
<td>5</td>
<td>27.5</td>
<td>5</td>
</tr>
<tr>
<td>3.</td>
<td>Dusting sulphur (98% 325-mesh)</td>
<td>10.1</td>
<td>1</td>
<td>9.0</td>
<td>4</td>
<td>4.2</td>
<td>3</td>
<td>23.3</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>Tri-basic copper sulphate</td>
<td>15.4</td>
<td>6</td>
<td>9.8</td>
<td>6</td>
<td>14.0</td>
<td>6</td>
<td>39.2</td>
<td>6</td>
</tr>
<tr>
<td>5.</td>
<td>Dusting sulphur plus red copper oxide</td>
<td>11.1</td>
<td>4</td>
<td>6.0</td>
<td>1</td>
<td>3.4</td>
<td>2</td>
<td>20.5</td>
<td>1</td>
</tr>
<tr>
<td>6.</td>
<td>Dusting sulphur (93% 325-mesh)</td>
<td>10.2</td>
<td>2</td>
<td>9.2</td>
<td>5</td>
<td>3.2</td>
<td>1</td>
<td>22.6</td>
<td>2</td>
</tr>
<tr>
<td>7.</td>
<td>Check (untreated)</td>
<td>18.0</td>
<td>7</td>
<td>11.5</td>
<td>7</td>
<td>18.7</td>
<td>7</td>
<td>48.2</td>
<td>7</td>
</tr>
</tbody>
</table>
All of the spray and dust treatments reduced the adult, egg and nymph populations. The sulphur dusts, with and without red copper oxide, gave as good as or better control than the sprays; tri-basic copper sulphate used alone gave the poorest control. There was probably no significant difference in the control obtained with the two grades of dusting sulphur.

The yields shown in Table II are based on the potatoes harvested from the two center rows of each four-row plot. The U. S. No. 1 potatoes were graded U. S. No. 1 except for scab. The differences required for significance were calculated at the 5 per cent point by the analysis of variance method.*

### TABLE II

THE EFFECT OF SPRAY AND DUST TREATMENTS FOR THE CONTROL OF PSYLLID YELLOWS ON THE YIELD OF POTATOES, AGRONOMY FARM, LARAMIE, WYOMING, 1941

<table>
<thead>
<tr>
<th>No.</th>
<th>Treatments</th>
<th>Total Bushels per Acre</th>
<th>Rank</th>
<th>Bushels of U. S. No. 1 per Acre</th>
<th>Rank</th>
<th>Per Cent of U. S. No. 1</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Lime-sulphur spray</td>
<td>294.1</td>
<td>4</td>
<td>27.6</td>
<td>5</td>
<td>76.2</td>
<td>5</td>
</tr>
<tr>
<td>2.</td>
<td>Wettable sulphur-lime-sulphur spray</td>
<td>304.7</td>
<td>3</td>
<td>236.3</td>
<td>3</td>
<td>77.6</td>
<td>4</td>
</tr>
<tr>
<td>3.</td>
<td>Dusting sulphur (98% 325-mesh)</td>
<td>310.9</td>
<td>2</td>
<td>248.0</td>
<td>2</td>
<td>79.8</td>
<td>1</td>
</tr>
<tr>
<td>4.</td>
<td>Tri-basic copper sulphate</td>
<td>260.3</td>
<td>7</td>
<td>173.6</td>
<td>7</td>
<td>66.7</td>
<td>6</td>
</tr>
<tr>
<td>5.</td>
<td>Dusting sulphur plus red copper oxide</td>
<td>294.1</td>
<td>4</td>
<td>233.8</td>
<td>4</td>
<td>79.5</td>
<td>2</td>
</tr>
<tr>
<td>6.</td>
<td>Dusting sulphur (93% 325-mesh)</td>
<td>320.6</td>
<td>1</td>
<td>232.8</td>
<td>1</td>
<td>78.9</td>
<td>3</td>
</tr>
<tr>
<td>7.</td>
<td>Check (untreated)</td>
<td>270.5</td>
<td>6</td>
<td>179.3</td>
<td>6</td>
<td>66.3</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Difference required for significance</td>
<td>28.2</td>
<td>6</td>
<td>23.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

All of the spray and dust treatments except tri-basic copper sulphate gave significant or nearly significant increases in yield over the untreated check. The sulphur dusts gave the highest yields. These were followed by wettable sulphur plus lime-sulphur.

*The difference required for significance, shown in the various tables is two times the standard error of the difference as computed by the variance method of R. A. Fisher. The assumption is that the odds are 19 to 1 that a difference between any two treatments as great as, or greater than, the value shown is due to a real difference between treatments and not to experimental error.
sulphur dust plus red copper oxide, lime-sulphur spray and untreated check, in the order given.

The increases in total yield for the sulphur dusts over lime-sulphur spray do not reach the difference required for significance, however, the increases in yield of U. S. No. 1 potatoes for sulphur dusts over lime-sulphur spray are significant.

The sulphur dust treatments and sulphur dust plus red copper oxide gave the highest per cent of U. S. No. 1 potatoes.

EXPERIMENTAL RESULTS, 1942
Comparisons of nine treatments were made on Bliss Triumph potatoes in 1942. The treatments and rates* per acre per application, were as follows:

(1) Two gallons lime-sulphur, 80 gallons water.
(2) Thirty-seven pounds dusting sulphur, 98 per cent through 325-mesh, containing 2 1/2 per cent inert conditioning agent.
(3) Thirty pounds dusting sulphur, 93 per cent through 325-mesh, containing 7 per cent inert conditioning agent.
(4) Twenty pounds dusting sulphur, 93 per cent through 325-mesh, containing no conditioning agent.
(5) Twenty-seven pounds sulphur-calcium arsenate dust mixture, containing 2 parts dusting sulphur to 1 part calcium arsenate.
(6) Twenty-eight pounds sulphur-cryolite dust mixture containing 2 parts dusting sulphur and 1 part cryolite.
(7) Thirty-seven pounds sulphur-copper dust mixture containing 9 parts dusting sulphur and 1 part basic-copper-sulphate compound (3.4 per cent metallic copper).
(8) Thirty pounds microfine dusting sulphur.
(9) Untreated check.

*Since it is practically impossible to adjust the opening of the hopper of a duster to apply exactly the same amount of the various dusts per acre, the opening was adjusted to apply 30 pounds per acre of the 93 per cent 325-mesh dusting sulphur, containing 7 per cent conditioning agent. This same opening was used for all of the dust treatments applied. Later a test was conducted to determine the amount of each dust applied per acre. The results of this test are shown by the rates of application given above.
The dusting sulphur used in treatments 5 and 6 was the same grade as that used in treatment 3; the sulphur used in treatment 7 was the same grade as that used in treatment 4. The microfine dusting sulphur contained 5 per cent inert conditioning agent and was ground substantially finer than the 325-mesh grades.

The spray and dust treatments were applied in the same manner as in the previous year except that a four-row power duster (Figures 1 and 2) was used instead of a two-row duster. The treatments were applied to four-row plots, 120 feet long and replicated four times.

Since it was felt that the first application of the treatments was not made early enough the previous year to obtain the best control, the first application was made earlier this year. Four applications of the treatments were made on the following dates: July 9, July 30, August 12 and August 25.

Readings on the adult psyllid population were again made by R. L. Wallis, Assistant Entomologist of the U. S. Department of Agriculture. The readings were made on the four replications of each treatment at weekly intervals, beginning July 21 and continuing to September 9. A total of nine readings were made during the season. The results are shown in Table III.
TABLE III
ADULT PSYLLID (Paratrioza cockerelli Sulc) POPULATIONS ON CONTROL PLOTS AT LARAMIE, WYOMING IN 1942
AVERAGE PER 100 SWEEPS OF FOUR REPLICATIONS

<table>
<thead>
<tr>
<th>Date</th>
<th>Un treated Check</th>
<th>Lime-Sulphur</th>
<th>Sulphur Dust 20% 225-mesh</th>
<th>Sulphur Dust 90% 225-mesh</th>
<th>Unconditioned Sulphur Dust</th>
<th>Sulphur Dust plus Calcium Arsenate</th>
<th>Sulphur Dust plus Copper</th>
<th>Micro line Sulphur Dust</th>
</tr>
</thead>
<tbody>
<tr>
<td>July</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>2.13</td>
<td>.88</td>
<td>.50</td>
<td>.88</td>
<td>.63</td>
<td>.59</td>
<td>1.38</td>
<td>.50</td>
</tr>
<tr>
<td>29</td>
<td>1.33</td>
<td>1.00</td>
<td>.75</td>
<td>.75</td>
<td>.25</td>
<td>.75</td>
<td>1.00</td>
<td>.63</td>
</tr>
<tr>
<td>August</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>2.38</td>
<td>1.00</td>
<td>.75</td>
<td>.75</td>
<td>.50</td>
<td>.75</td>
<td>.88</td>
<td>.50</td>
</tr>
<tr>
<td>12</td>
<td>5.63</td>
<td>3.50</td>
<td>1.00</td>
<td>1.13</td>
<td>1.00</td>
<td>1.50</td>
<td>1.63</td>
<td>1.13</td>
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<tr>
<td>19</td>
<td>15.25</td>
<td>8.13</td>
<td>4.38</td>
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<td>5.38</td>
<td>6.38</td>
<td>4.25</td>
</tr>
<tr>
<td>26</td>
<td>12.75</td>
<td>6.13</td>
<td>4.13</td>
<td>3.25</td>
<td>3.13</td>
<td>5.25</td>
<td>5.50</td>
<td>4.25</td>
</tr>
<tr>
<td>September</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>14.88</td>
<td>8.25</td>
<td>3.13</td>
<td>4.13</td>
<td>4.00</td>
<td>4.38</td>
<td>5.38</td>
<td>3.63</td>
</tr>
<tr>
<td>9</td>
<td>11.00</td>
<td>4.88</td>
<td>2.75</td>
<td>3.00</td>
<td>2.38</td>
<td>4.13</td>
<td>4.75</td>
<td>2.50</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>65.35</td>
<td>33.77</td>
<td>17.39</td>
<td>18.39</td>
<td>15.89</td>
<td>22.64</td>
<td>26.90</td>
<td>16.39</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>8.17</td>
<td>4.22</td>
<td>2.17</td>
<td>2.30</td>
<td>1.99</td>
<td>2.83</td>
<td>3.36</td>
<td>2.05</td>
</tr>
<tr>
<td>Rank</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>8</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td>5</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>Per cent of control*</td>
<td></td>
<td>48.38</td>
<td>73.43</td>
<td>71.85</td>
<td>75.64</td>
<td>65.36</td>
<td>58.87</td>
<td>74.01</td>
</tr>
</tbody>
</table>

*Per cent of reduction of population under check.
All of the treatments reduced the adult psyllid population. All of the dust treatments gave better control of adult psyllids than lime-sulphur spray. Unconditioned dusting sulphur gave the best control; however, this material is difficult to handle in a row-crop duster and for this reason it cannot be recommended for general use in all machines.

The yields shown in Table IV are based on the potatoes harvested from the two center rows of the four-row plots. The U. S. No. 1 potatoes were graded U. S. No. 1 except for scab and mechanical injury.

All spray and dust treatments gave significant increases in yield over the untreated check. The only other differences which reached the level of significance were between plots treated with unconditioned dusting sulphur and the sulphur-copper dust mixture. Since no early blight was present in the field it is difficult to explain why sulphur dust plus copper gave the highest yield. It may be that the copper had a stimulating effect on the plants.

Calcium arsenate and cryolite were used with sulphur in these tests to determine their effectiveness in the control of flea beetle and other leaf-chewing insects, but, since none of these pests were present in damaging numbers, no measure of the effectiveness of these insecticides was obtained.

Microfine dusting sulphur gave the highest yield of U. S. No. 1 potatoes, followed by sulphur dust plus copper, sulphur dust plus cryolite, sulphur dust plus calcium arsenate, 93 per cent 325-mesh conditioned dusting sulphur, lime-sulphur spray, 98 per cent 325-mesh conditioned dusting sulphur, unconditioned dusting sulphur and check, in the order given.

All of the treated plots gave significant increases in yield of U. S. No. 1 potatoes over the check; however, none of the differences between the treated plots are significant.

All of the dust treatments gave higher percentages of U. S. No. 1 potatoes than lime-sulphur spray and the untreated check.
TABLE IV
THE EFFECT OF SPRAY AND DUST TREATMENTS ON THE ADULT PSYLLID POPULATION AND YIELD OF POTATOES
AGRONOMY FARM, LARAMIE, WYOMING, 1942

<table>
<thead>
<tr>
<th>No.</th>
<th>TREATMENTS</th>
<th>Adult Psyllids Per 100 Sweeps</th>
<th>Total Yield Per Acre</th>
<th>Yield U. S. No. 1 Per Acre</th>
<th>Per Cent U. S. No. 1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Average No.</td>
<td>Rank</td>
<td>Bushels</td>
<td>Rank</td>
</tr>
<tr>
<td>1.</td>
<td>Lime-sulphur spray</td>
<td>4.22</td>
<td>8</td>
<td>265</td>
<td>4</td>
</tr>
<tr>
<td>2.</td>
<td>Conditioned dusting sulphur (98% 325-mesh)</td>
<td>2.17</td>
<td>3</td>
<td>256</td>
<td>7</td>
</tr>
<tr>
<td>3.</td>
<td>Conditioned dusting sulphur (93% 325-mesh)</td>
<td>2.30</td>
<td>4</td>
<td>260</td>
<td>6</td>
</tr>
<tr>
<td>4.</td>
<td>Unconditioned dusting sulphur (93% 325-mesh)</td>
<td>1.99</td>
<td>1</td>
<td>244</td>
<td>8</td>
</tr>
<tr>
<td>5.</td>
<td>Dusting sulphur plus calcium arsenate</td>
<td>2.83</td>
<td>5</td>
<td>263</td>
<td>5</td>
</tr>
<tr>
<td>6.</td>
<td>Dusting sulphur plus cryolite</td>
<td>3.36</td>
<td>7</td>
<td>271</td>
<td>3</td>
</tr>
<tr>
<td>7.</td>
<td>Dusting sulphur plus copper</td>
<td>2.05</td>
<td>2</td>
<td>277</td>
<td>1</td>
</tr>
<tr>
<td>8.</td>
<td>Microfine dusting sulphur</td>
<td>3.10</td>
<td>6</td>
<td>274</td>
<td>2</td>
</tr>
<tr>
<td>9.</td>
<td>Check (untreated)</td>
<td>8.17</td>
<td>9</td>
<td>209</td>
<td>9</td>
</tr>
</tbody>
</table>

Difference required for significance.
RATE OF APPLICATION

Dusting sulphur, 93 per cent 325-mesh, containing 7 per cent conditioning agent, was tested at the rate of 20 and 30 pounds per acre. These rates were applied to four-row plots replicated three times. Four applications of the dust were made on the same dates as shown for the previous experiment. The results are shown in Table V.

<table>
<thead>
<tr>
<th>Rate Per Acre</th>
<th>Total Bushels Per Acre</th>
<th>Bushels of U. S. No. 1 Per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 pounds</td>
<td>253</td>
<td>223</td>
</tr>
<tr>
<td>30 pounds</td>
<td>257</td>
<td>226</td>
</tr>
<tr>
<td>Difference required for significance</td>
<td>21</td>
<td>21</td>
</tr>
</tbody>
</table>

While the 30-pound rate per acre gave slightly higher yields of both field run and U. S. No. 1 potatoes than the 20-pound rate, the increases are not significant.
TABLE VI

SUMMARY OF THE ADULT PSYLLID POPULATION,
TOTAL YIELD AND YIELD OF U. S. NO. 1 POTATOES IN PER
CENT OF THE UNTREATED CHECK
FOR 1941 AND 1942

<table>
<thead>
<tr>
<th>TREATMENTS</th>
<th>No. of Years Tested</th>
<th>Adult Psyllid</th>
<th>Total Yield</th>
<th>Yield of U. S. No. 1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Per cent Rank</td>
<td>Per cent Rank</td>
<td>Per cent Rank</td>
</tr>
<tr>
<td>Lime-sulphur...........................................</td>
<td>2</td>
<td>56 8</td>
<td>118 8</td>
<td>130 10</td>
</tr>
<tr>
<td>Wettable sulphur plus lime-sulphur.....................</td>
<td>1</td>
<td>70 11</td>
<td>113 10</td>
<td>132 8</td>
</tr>
<tr>
<td>Dusting sulphur (98% 325-mesh containing 2% conditioning agent)</td>
<td>2</td>
<td>41 6</td>
<td>119 6</td>
<td>138 7</td>
</tr>
<tr>
<td>Tri-basic copper sulphate................................</td>
<td>1</td>
<td>86 12</td>
<td>96 12</td>
<td>97 12</td>
</tr>
<tr>
<td>Dusting sulphur plus red copper oxide..................</td>
<td>1</td>
<td>62 10</td>
<td>109 11</td>
<td>130 10</td>
</tr>
<tr>
<td>Dusting sulphur (93% 325-mesh containing 2% conditioning agent)</td>
<td>1</td>
<td>57 9</td>
<td>119 6</td>
<td>141 5</td>
</tr>
<tr>
<td>Dusting sulphur (93% 325-mesh containing 7% conditioning agent)</td>
<td>1</td>
<td>29 3</td>
<td>124 5</td>
<td>140 6</td>
</tr>
<tr>
<td>Dusting sulphur (93% 325-mesh containing no conditioning agent)</td>
<td>1</td>
<td>24 1</td>
<td>117 9</td>
<td>131 9</td>
</tr>
<tr>
<td>Dusting sulphur plus calcium arsenate..................</td>
<td>1</td>
<td>35 4</td>
<td>126 4</td>
<td>142 4</td>
</tr>
<tr>
<td>Dusting sulphur plus cryolite..........................</td>
<td>1</td>
<td>41 6</td>
<td>130 2</td>
<td>145 3</td>
</tr>
<tr>
<td>Dusting sulphur plus copper (9-1 mixture)...............</td>
<td>1</td>
<td>25 2</td>
<td>133 1</td>
<td>150 1</td>
</tr>
<tr>
<td>Microfine dusting sulphur................................</td>
<td>1</td>
<td>38 5</td>
<td>131 3</td>
<td>150 1</td>
</tr>
</tbody>
</table>
Table VI gives a summary of the adult psyllid populations, the total yields, and yields of U. S. No. 1 potatoes in per cent of the untreated checks for the years 1941 and 1942.

Most of the sulphur dust treatments gave better control of the adult psyllids than lime-sulphur. Tri-basic copper sulphate gave the poorest control. For total yield, all of the sulphur dust treatments ranked above lime-sulphur except unconditioned sulphur dust and sulphur dust plus red copper oxide. All of the plots treated with sulphur dust yielded more U. S. No. 1 potatoes than those treated with lime-sulphur spray. Tri-basic copper sulphate used alone as a dust gave a lower yield of both field run and U. S. No. 1 potatoes than the untreated check.

In Table VII are shown the psyllid adult, egg and nymph populations, the total yields, and yields of U. S. No. 1 potatoes in per cent of the untreated checks for all experiments conducted in 1939 to 1942, inclusive.

**TABLE VII**

<table>
<thead>
<tr>
<th>Psyllid</th>
<th>Adults</th>
<th>Eggs</th>
<th>Nymphs</th>
<th>Total Yield</th>
<th>U. S. No. 1 Potatoes</th>
</tr>
</thead>
<tbody>
<tr>
<td>All sulphur dusts</td>
<td>39.5</td>
<td>66.1</td>
<td>27.4</td>
<td>126.6</td>
<td>145.1</td>
</tr>
<tr>
<td>Lime-sulphur spray</td>
<td>54.2</td>
<td>68.7</td>
<td>36.7</td>
<td>123.0</td>
<td>142.0</td>
</tr>
<tr>
<td>Wettable sulphur spray*</td>
<td>69.2</td>
<td>79.6</td>
<td>54.1</td>
<td>121.6</td>
<td>139.4</td>
</tr>
<tr>
<td>Tri-basic copper sulphate†</td>
<td>85.6</td>
<td>85.2</td>
<td>74.9</td>
<td>96.2</td>
<td>96.8</td>
</tr>
</tbody>
</table>

*These results are a three-year average including one year in which 325-mesh wettable sulphur was used alone and two years in which it was used in admixture with liquid lime-sulphur.
†One year's results.

It will be noted from this table that the average of all sulphur dust treated plots shows better control of the psyllid adults, eggs and nymphs and higher yields of field run and U. S. No. 1 potatoes than lime-sulphur spray, wettable sulphur spray and tri-basic copper sulphate.

Tri-basic copper sulphate used alone as a dust gave the poorest control of psyllids and even had a depressing effect on yield.
A survey was made to determine the comparative cost of spraying and dusting. Cost records were obtained from 12 growers by means of a questionnaire. The results of this survey are shown in Table VIII.

### Table VIII

#### Comparative Cost of Spraying and Dusting

**Spraying**
- Cost of sprayer: $600.00
- Cost of lime-sulphur per 55 gallon barrel: $11.27
- Gallons of lime-sulphur per acre: 2.21
- Acres sprayed per 10-hour day: 26.75
- Man hours per 10-hour day: 24.37
- Tractor cost per 10-hour day: $10.00
- Truck cost per day: $4.50

**Dusting**
- Cost of duster: $168.00
- Cost of dust per 100 lbs: $3.68
- Pounds of dust per acre: 23.00
- Acres dusted per 10-hour day: 48.50
- Man hours per 10-hour day: 10.00
- Tractor cost per 10-hour day: $10.00
- Truck cost per day: $0.75

#### Comparative Cost per Acre per Application

**Spraying**
- Equipment: $0.76
- Materials: $0.44
- Tractor: $0.37
- Truck: $0.17
- Man labor @ 50c per hour: $0.46
- Total: $2.20

**Dusting**
- Equipment: $0.21
- Materials: $0.85
- Tractor: $0.21
- Truck: $0.02
- Man labor @ 50c per hour: $0.10
- Total: $1.39

Since the average acreage of potatoes produced by growers who have a sprayer or duster is approximately 50 acres, the cost of equipment was calculated on the basis of 50 acres receiving three applications of control treatments per year.

While it is known that the depreciation for a duster is not as great as for a sprayer, and that a duster is capable of handling a larger acreage than a sprayer, depreciation costs were calculated on the same basis for both the sprayer and duster. The depreciation on spraying and dusting equipment was calculated at the rate of 10 per cent per year, repairs at the rate of 5 per cent of the...
cost of equipment, and interest at the rate of 8 per cent on one-half of the cost of equipment.

The tractor costs were figured at $1.00 per hour for both spraying and dusting. The cost given by the growers was considerably below this, especially for dusting, but it was felt that the growers did not include depreciation and interest on investment.

From Table VIII, it will be noted that the cost of materials is considerably more for dusting than for spraying but the cost of equipment, tractor, truck and man labor is considerably more for spraying than for dusting. The total cost per acre per application for spraying was $2.20 and for dusting it was $1.39. This shows a saving for dusting over spraying of 81 cents per acre per application, or a total of $121.50 per year on the basis of 50 acres.
SUMMARY AND CONCLUSIONS

Four years' results show that the potato psyllid can be effectively and more economically controlled with the 325-mesh dusting sulphur than with lime-sulphur or wettable sulphur sprays.

Sulphur dust has given better control of the psyllid adult, egg and nymph populations, and has given a higher total yield and a higher yield of U. S. No. 1 potatoes than lime-sulphur or wettable sulphur sprays. The increases in yield were not statistically significant in most cases.

Microfine dusting sulphur has given good yields, but, because of the higher cost of this material, it should be tested further to determine if lower rates of application will give satisfactory control.

Sulphur-copper dust mixtures have given higher yields than sulphur dust alone, even though no blight was present. Copper may have a stimulating effect on potato plants.

Sulphur-calcium arsenate and sulphur-cryolite dust mixtures have controlled psyllids very well, but these mixtures should be tested further to determine their effectiveness in the control of flea beetle and other leaf-chewing insects.

The 30-pound rate of sulphur dust per acre has given slightly higher yields than the 20-pound per acre rate, but the difference was not statistically significant.

Dusting for the control of the potato psyllid is cheaper, faster and easier than spraying. More timely applications can be made, and less damage is done to the vines and the fields.
GENERAL RECOMMENDATIONS FOR DUSTING

Effective control of the potato psyllid depends upon three factors: proper dusting materials, thorough and uniform coverage and timely applications.

Sulphur dust of such fineness that at least 93 per cent of it will pass through a 325-mesh screen and containing not more than 7 per cent inert conditioning agent should be used.

Thorough and uniform coverage depends upon the type of duster, nozzle arrangement and the amount of dust applied per acre. For large acreages a power duster having either a tractor power-take-off or a separate gasoline motor will give good coverage. Such dusters will handle four to twelve rows at one time.

The nozzles should be set to direct the dust into the vine in such manner as to insure good coverage of all leaf and stem surfaces (Figure 4). It is recommended that a hood be attached over the boom of the duster to confine the dust around the plants (Figures 1 and 3). The hood may be made of canvas, heavy muslin or bed ticking material.

For small garden plots, satisfactory control can be obtained when the dust is applied with a hand dust gun, a wheelbarrow duster, or by shaking it over the plants through a muslin bag.

When a power duster is used, apply approximately 20 pounds of dusting sulphur per acre per application when the plants are small, and increase the rate up to about 30 pounds per acre as appears necessary to give adequate coverage for later applications.

The psyllid population is the best criterion to follow in determining when to dust. It is advisable to dust when an average of two to three adult psyllids are found per 100 sweeps with an insect net having an opening \( \frac{7}{8} \) inches in diameter. In general, the first application of dust should be made when the plants are four to eight inches in height.

Early applications are important as the treatments are for prevention rather than for cure.

At least two applications should be made when potatoes are grown under dry land conditions, and three when potatoes are grown under irrigated conditions. The applications should be
made at two to three week intervals, or at shorter intervals, depending upon the psyllid population.

Light, frequent applications give better control than heavy applications applied less frequently.

Apply dust in the early morning or at night when there is little or no wind.

For the control of leaf-chewing insects, materials such as cryolite, barium fluosilicate, basic copper arsenate and calcium arsenate may be added to the sulphur dust. Calcium arsenate, when used alone as a dust, is usually applied at the rate of 4 to 8 pounds per acre per application, the heavier rate being the more effective. A mixture containing three parts of sulphur dust and one part of calcium arsenate, applied at the rate of 30 pounds per acre, should give good control of both psyllid and most leaf-chewing insects. Other insecticides should be mixed with sulphur dust and applied in accordance with the manufacturers’ directions. However, more work is needed to determine best mixtures and rates of application.

When early blight develops, one of the insoluble copper compounds should be added to the sulphur dust. Various brands
are on the market and they should be applied in accordance with the manufacturers' directions for blight control.

When dust mixtures are used, the materials should be thoroughly mixed before being poured into the hopper of the duster. This may be accomplished with a dust mixer especially designed for mixing insecticide and fungicide dusts. When poisonous materials are used in the mixture it is advisable for the operator to wear a respirator.

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