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Herbicidal Tests on Sweet Potatoes and Several Wild Host Plants of the Sweet Potato Weevil

C. E. Smith, K. L. Cockerham, and O. T. Deen

WARNING!

USE 2,4-D COMPOUNDS WITH CARE

The herbicide 2,4-D was found to be very effective in killing sweet potatoes and morning-glories. It should prove valuable in destroying volunteer sweet potato plants, discarded plant beds, mother rows and wild morning-glories provided it is used with extreme care. Such crops as cotton, okra, tomatoes, legume crops and ornamentals are sensitive to 2,4-D poisoning and may be severely damaged by drift from sprays and dusts applied some distance away. Sprayers and dusters that have been used to apply 2,4-D should never be used to apply fungicides and insecticides on susceptible crops or plants.
HERBICIDAL TESTS ON SWEET POTATOES AND SEVERAL WILD HOST PLANTS OF THE SWEET POTATO WEEVIL

By

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The sweet potato weevil, Cylas formicarius elegantulus (Sum.), breeds in several species of morning-glories which belong to the same genus as the sweet potato, Ipomoea. Morning-glories are not killed below the surface of the ground during the mild winters which usually prevail in the area inhabited by this insect, namely the southern one-third to two-fifths of Louisiana. Therefore, these wild plants, together with volunteer plants and crop remnants of sweet potatoes, provide excellent overwintering host materials in the field. This is one of the most important factors involved in the control and eradication of the sweet potato weevil. The need for a chemical that could be used in destroying these field hosts has been recognized for a long time.

In 1918-20 the senior author studied the use of different chemical preparations as herbicides against morning-glories, and the results were reported in Louisiana Bulletin No. 188. In 1944 the field laboratory of the Bureau of Entomology and Plant Quarantine at Opelousas inaugurated similar studies which included sweet potato plants and discarded seedbeds or "mother" rows. In 1945, after the Federal laboratory was moved to Baton Rouge, the Department of Entomology of the Louisiana Agricultural Experiment Station collaborated in the study, devoting its efforts largely toward testing chemicals for destroying sweet potato vines just prior to digging time. The objective was twofold, namely (1) to evaluate chemicals as herbicides for killing the vines, thus eliminating them as an overwintering medium; and (2) to study the penetrating effects of the chemicals into the roots of the plants, thus determining their possible value for use in field and wild host-plant eradication. The purpose of this paper is to report the results obtained in these studies.

* T. C. Barber and P. T. Dutsch of the Louisiana Agricultural Experiment Station assisted in the field work of experiments conducted by the Experiment Station.
Studies Conducted at Opelousas, Louisiana, during 1944

These studies consisted of testing sodium fluoride and calcium fluosilicate as herbicides against sweet potato and morning-glory plants. The chemicals were used as dusts and, with one exception, on plants moist with dew or sprinkled with water. The dusts were applied with small plunger-type hand dusters in the laboratory and with rotary-type shoulder dusters in the field. Observations on effects were made periodically over periods ranging from five days to several months.

The tests consisted of (1) potted sweet potato plants at the laboratory under outdoor conditions; (2) "mother" rows of sweet potatoes grown from cut and uncut potatoes, some of which were infested with the sweet potato weevil; (3) volunteer plants from roots and scrap potatoes left in the ground after the old seed potatoes in the "mother" rows were dug and removed; (4) sweet potato plants growing in the field under normal conditions; (5) plants of the perennial morning-glory, Ipomoea pandurata (L.) G. F. W. Mey; and (6) uncultivated land on which a fairly thick stand of I. trichocarpa Ell. and I. hederacea Jacq. was growing.

The results showed that both sodium fluoride and calcium fluosilicate were toxic to the vines of sweet potatoes and morning-glories. Each chemical killed nearly 100 per cent of the vines down to soil level. Observations indicated that sodium fluoride was slightly more toxic than calcium fluosilicate, especially to the roots of the young plants, as calcium fluosilicate killed comparatively few roots. Neither of these chemicals appeared to have any effect upon the tuberous roots of I. pandurata and the underground parts of old "mother" potatoes.

Tests on Destruction of Discarded Sweet Potato "Mother" Rows and Morning-glories

Two tests were conducted at Baton Rouge during 1946 in which 2,4-D (2,4-dichlorophenoxyacetic acid) spray was used, one on old "mother" row plants and the other on morning-glories. The treatments consisted of one application of a solution of 2,4-D, 1 ounce to 4 gallons of water. The applications were made July 25, and the observations on the effects of the treatments were for periods of one and three months, respectively.

Six days after the application on the sweet potato "mother" row, the vines showed a high degree of 2,4-D poisoning, the leaves were droopy, yellow, and dying. The "mother" potatoes also were showing the effect of the spray and were beginning to decay. In four weeks after the application, practically 100 per cent of the vines were dead and nearly 100 per cent of the old potatoes were decayed.

Approximately two weeks after the 2,4-D was applied in the test on the morning-glories, all the vines of I. pandurata had been killed down to the tuberous roots, and all the vines and roots of I. trichocarpa and I. hederacea Var. integrigiculsa Gray were completely dead. No new growth developed from the roots of I. pandurata during a period of about three months following the treatment, after which the roots of the treated plants were dug for examination.
These roots ranged in diameter from about $\frac{1}{2}$ to $3\frac{1}{2}$ inches and extended into the soil from 6 to 30 inches. The entire root systems of eight of the plants were decayed; the upper 1 to 4 inches of the remaining six were affected, but the remaining lower portions appeared normal.

**Tests on Sweet Potatoes**

Two experiments were conducted on sweet potatoes under field conditions, one in 1945 and one in 1946. The Porto Rico variety was used as the test crop, and was planted and cultivated similarly to commercial plantings.

**1945 Experiment** — The experiment consisted of 40 plots arranged in four randomized blocks — one plot for each of the nine herbicidal treatments and one untreated check. The plots were 50 feet long by 16 feet wide, consisting of four rows.

The treatments consisted of a single application of the chemicals, on October 19 - 20, except the superphosphate, which was applied at the time of digging. The dusts were applied with rotary-type shoulder dusters in early morning while the plants were moist with dew, and the liquid sprays with a small power sprayer during the day after the dew had dried from the plants.

Records were made on the progressive effects the chemicals had on the leaves, vines, and roots. The observations on the leaves and vines were made during the period between the application of the chemicals and the digging of the roots, and again about 60 days after the vines had been been covered in digging. The latter observation consisted of examination of the pieces of vines still alive, which had been uncovered with a plow in the center of the plots. The observations on the potatoes were started at digging time and continued in storage, being concluded on May 14, 1946, or about six months after the roots were dug. The samples were taken from the two middle rows of the plots and consisted of two bushels of sound roots per plot, or the amount produced when the total yield was less than two bushels. Replications A and D were dug on October 30, and replications B and C on November 6 — 11 and 12 days and 17 and 18 days, respectively, after the application.

The treatments, with the data obtained, are listed according to their effectiveness in killing the vines as determined by visual observations (Table 1).

**Discussion** — As indicated by the data in column 4 of Table 1, there was a relatively high correlation between the effectiveness of the treatments determined by visual observations, and the number of vines remaining alive after being turned under, with the exception of the 2,4-D treatments. The lack of correlation in the latter was doubtless due to the slow and long period of action of 2,4-D. The data in columns 5, 6, and 7 are self-evident: the 2,4-D treatments were very effective in destroying both the vines and roots. The data indicate also that none of the other treatments had any effect on the roots, since the check sustained a greater loss from decay than did any of the chemical treatments.
1946 Experiment — This experiment consisted of 48 plots arranged in four randomized blocks — one plot for each of 12 treatments, including the check. The plots were 50 feet long by 16 feet wide, consisting of four rows.

The treatments consisted of a single application of the chemicals, which was made November 1. The dusts were applied with rotary-type shoulder dusters early in the morning while the plants were dripping with dew, and the liquid sprays were applied during the day after the dew had dried from the plants. The 2,4-D solution was applied with a hand-pump wheelbarrow sprayer, and treatments 2, 3, and 4 with a 3½-gallon compressed-air sprayer. The vines or crowns in treatments 11, 10, 9, and 6 were cut with weeding hoes at the surface or slightly below, just before, within 2 hours after, one day after, and three days after the application.

Records were made on the progressive effects of the herbicides on the leaves, vines, and roots. The observations on the vines were started when the applications were made and continued for a period of about one month. The observations on the roots were started at digging time and were concluded March 19, 1947. The samples consisted of two bushels, or the amount of sound potatoes produced when the yield was less than two bushels, taken from the two inside rows of the plots, and were dug November 14 and 15 (Table 2).

Discussion — The ammonium sulfamate and oil (treatments 2 and 4) acted very quickly upon the foliage, and appeared to obtain their maximum effective-
<table>
<thead>
<tr>
<th>Chemical</th>
<th>Applications</th>
<th>Rate per acre</th>
<th>Pieces of vines alive about 60 days after harvest</th>
<th>Roots showing breakdown at time of harvest</th>
<th>Roots placed in storage</th>
<th>Roots decayed in storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Dinitro-O-sec-butyl phenol</td>
<td>3½ gals. to 100 gals.</td>
<td>100 gals.</td>
<td>11</td>
<td>7.0</td>
<td>242</td>
<td>3.7</td>
</tr>
<tr>
<td>2. Ammonium sulfamate</td>
<td>1 lb. to 1 gal.</td>
<td>100 gals.</td>
<td>9</td>
<td>0.0</td>
<td>340</td>
<td>3.7</td>
</tr>
<tr>
<td>3. Calcium fluosilicate</td>
<td>undiluted</td>
<td>90 lbs.</td>
<td>7</td>
<td>1.0</td>
<td>279</td>
<td>2.5</td>
</tr>
<tr>
<td>4. Sodium pentachlorophenate</td>
<td>8½ lbs. to 100 gals.</td>
<td>100 gals.</td>
<td>36</td>
<td>0.0</td>
<td>295</td>
<td>4.0</td>
</tr>
<tr>
<td>5. Sodium fluoride</td>
<td>undiluted</td>
<td>65 lbs.</td>
<td>3</td>
<td>0.0</td>
<td>293</td>
<td>3.4</td>
</tr>
<tr>
<td>6. 2,4-D spray¹</td>
<td>1¼ lbs. to 100 gals.</td>
<td>100 gals.</td>
<td>1</td>
<td>32.0</td>
<td>256</td>
<td>90.2</td>
</tr>
<tr>
<td>7. 2,4-D spray²</td>
<td>1¼ gal. to 100 gals.</td>
<td>100 gals.</td>
<td>2</td>
<td>25.0</td>
<td>319</td>
<td>75.5</td>
</tr>
<tr>
<td>8. Ammonium salt of dinitro-O-sec-butyl phenol</td>
<td>½ gal. to 100 gals.</td>
<td>100 gals.</td>
<td>89</td>
<td>0.0</td>
<td>279</td>
<td>2.9</td>
</tr>
<tr>
<td>9. Superphosphate</td>
<td>undiluted</td>
<td>1000 lbs.</td>
<td>124</td>
<td>0.0</td>
<td>320</td>
<td>3.4</td>
</tr>
<tr>
<td>10. Check</td>
<td></td>
<td></td>
<td>148</td>
<td>0.0</td>
<td>293</td>
<td>6.1</td>
</tr>
</tbody>
</table>

¹Commercial preparation said to contain 75 per cent of 2,4-dichlorophenoxyacetic acid.
²Commercial preparation said to contain 80 per cent of sodium 2,4-dichlorophenoxyacetate.
ness within three days after the application. Vines not killed in these treatments, except those of ammonium sulfamate, started putting out new growth in a week or ten days. Although some of the vines on the ammonium sulfamate plots appeared to be alive, very little new growth had started within 33 days after the application. During the first few days after the application, there appeared to be little or no difference between the effectiveness of the dust and the spray of 2,4-D. However, in 11 days the sprayed plants showed considerably more breakdown than did plants that were dusted (Figure 2). At this time there was no visible difference between the cut and uncut sprayed vines, but as time passed those cut appeared to disintegrate a little faster. A few of the uncut vines, especially on the dusted plots, showed a little sign of recovering after about a month.

On December 4, it was also noted that there were more and larger sprouts and new growth on the vines on the border rows in some of the 2,4-D plots than in others. An examination showed that the order of the treatments based on the number and size of the sprouts was treatments 11, 10, 9, and 6, respectively. This seems to indicate that the difference in effect resulted from the timing of the cutting of the vines.

To check further on the effects of the 2,4-D under the various ways it was used, 150 crowns on the border rows per treatment were examined and their condition recorded December 4. The results showed that in treatment 11, 2 per cent of the crowns were dead; in treatment 8, 26 per cent were dead; in treatment 10, 4.7 per cent were dead; in treatment 9, 18.7 per cent were dead; in treatment 6, 25 per cent were dead; and in treatment 7, 20.7 per cent were dead.
<table>
<thead>
<tr>
<th>Chemical</th>
<th>Applications</th>
<th>Rate per acre</th>
<th>Roots showing breakdown at time of harvest</th>
<th>Roots placed in storage</th>
<th>Roots showing breakdown in storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Calcium fluosilicate</td>
<td>undiluted</td>
<td>71 lbs.</td>
<td>0.0</td>
<td>637</td>
<td>3.2</td>
</tr>
<tr>
<td>2. Ammonium sulfamate</td>
<td>1 lb. to one gal.</td>
<td>78 gals.</td>
<td>0.0</td>
<td>628</td>
<td>3.2</td>
</tr>
<tr>
<td>3. Dinitro-O-sec-butyl phenol</td>
<td>3½ lbs. to 100 gals.</td>
<td>82 gals.</td>
<td>0.0</td>
<td>570</td>
<td>12.1</td>
</tr>
<tr>
<td>4. Oil, 50% aromatic hydrocarbons</td>
<td>undiluted</td>
<td>41 gals.</td>
<td>0.0</td>
<td>597</td>
<td>4.0</td>
</tr>
<tr>
<td>5. Sodium fluoride-clay</td>
<td>1 lb. to 1 lb.</td>
<td>56 lbs.</td>
<td>0.0</td>
<td>568</td>
<td>4.2</td>
</tr>
<tr>
<td>6. 2,4-D spray&lt;sup&gt;1&lt;/sup&gt; vines cut 3 days after spraying</td>
<td>1½ lbs. to 125 gallons</td>
<td>95 gals.</td>
<td>12.9</td>
<td>579</td>
<td>16.8</td>
</tr>
<tr>
<td>7. 2,4-D dust&lt;sup&gt;2&lt;/sup&gt;</td>
<td>15 per cent</td>
<td>25 lbs.</td>
<td>10.8</td>
<td>599</td>
<td>36.1</td>
</tr>
<tr>
<td>8. 2,4-D spray&lt;sup&gt;1&lt;/sup&gt; vines uncut</td>
<td>1½ lbs. to 125 gals.</td>
<td>95 gals.</td>
<td>10.1</td>
<td>630</td>
<td>20.0</td>
</tr>
<tr>
<td>9. 2,4-D spray&lt;sup&gt;1&lt;/sup&gt; vines cut 1 day after spraying</td>
<td>1½ lbs. to 125 gallons</td>
<td>95 gals.</td>
<td>4.8</td>
<td>564</td>
<td>7.8</td>
</tr>
<tr>
<td>10. 2,4-D spray&lt;sup&gt;1&lt;/sup&gt; vines cut within 2 hrs. after spraying</td>
<td>1½ lbs. to 125 gallons</td>
<td>95 gals.</td>
<td>0.2</td>
<td>620</td>
<td>10.8</td>
</tr>
<tr>
<td>11. 2,4-D spray&lt;sup&gt;1&lt;/sup&gt; vines cut previous to spraying</td>
<td>1½ lbs. to 125 gallons</td>
<td>95 gals.</td>
<td>0.0</td>
<td>586</td>
<td>6.1</td>
</tr>
<tr>
<td>12. Check</td>
<td></td>
<td>0.0</td>
<td>533</td>
<td>3.2</td>
<td>8.1</td>
</tr>
</tbody>
</table>

<sup>1</sup> A commercial product said to contain 70 per cent of sodium 2,4-dichlorophenoxyacetate.

<sup>2</sup> A dust containing 15 per cent of methyl 2,4-dichlorophenoxyacetate.
These data indicate that relatively little of the 2,4-D was taken up by the stumps of the plants cut previous to, or soon after, the applications (treatments 11 and 10); but that enough had passed into the subterranean parts within 24 hours (treatment 9) to give almost maximum effect and within three days (treatment 6) total effect upon the roots.

The data presented in column 4 support the above observations regarding the rapidity of 2,4-D in penetrating the crowns. It was noted also that the potatoes in storage tended to sprout in the same order.

Workers in experiment stations over the country have found that traces of 2,4-D in the soil are highly injurious to young seedlings of practically all vegetables. The period required after treatment for planting with safety has not been determined, but 2,4-D may be expected to remain in the soil for at least four week. There were no ill effects apparent on weeds which grew on the soil following the 2,4-D treatments of the 1945 experiment, on sweet potatoes on the same soil in 1946, or on Austrian Winter peas following the 1946 experiment.

Two other materials, which were received too late to be included in the 1946 experiment, were tested on small areas of the same planting. These were lithium fluosilicate, which was applied both as a spray and as a dust, and a sodium arsenite solution (55 per cent As₂O₃) that was applied at dilutions of 1 to 100 and 1 to 200.
The lithium fluosilicate was about the same as calcium fluosilicate in effectiveness in killing the vines, the dust being a little superior to the spray. The sodium arsenite spray, 1 to 100 dilution, was extremely effective. It killed all vines and crowns to the surface of the ground. The 1 to 200 dilution was slightly less effective, but it gave what would be considered a satisfactory kill. A few potatoes, which were evidently exposed through cracks in the soil, appeared to be "burned" by the arsenical treatments.

Summary

Several chemicals were tested as herbicides against wild morning-glories and sweet potatoes, hosts of the sweet potato weevil, *Cylas formicarius elegans-tulus* (Sum.), in several series of experiments conducted at Opelousas, Louisiana, during 1944 and at Baton Rouge, Louisiana, during 1945 and 1946.

Sodium fluoride and calcium fluosilicate applied as dusts killed the vines of sweet potatoes and morning-glories to about the ground level. Sodium fluoride killed a considerable number of the crowns and roots of young plants of sweet potatoes and the morning-glories *Ipomoea hederacea* and *I. trichocarpa*, whereas calcium fluosilicate killed relatively few. Neither of these chemicals appeared to have any effect on the tuberous roots of *I. pandurata*. 2,4-D killed all the tops and roots of the morning-glories on which it was tested, except the large, tuberous roots of *I. pandurata*, which were largely, but not completely, destroyed; and all of the plants and nearly all of the old seed potatoes in "mother" rows.

In the experiments on sweet potatoes, dinitro-o-sec-butyl phenol, ammonium sulfamate, calcium fluosilicate, sodium pentachlorophenate, and sodium fluoride killed a high percentage of the vines down to the crowns, whereas the ammonium salt of dinitro-o-sec-butyl phenol was less effective; and superphosphate, applied at harvesttime, had no apparent effect on the decaying of the vines after they were plowed under. None of these chemicals appeared to have much, if any, effect on the potatoes.

In killing the vines and roots of sweet potatoes, 2,4-D was highly effective. It was relatively ineffective on the roots, however, when the crowns of the plants were cut before or within two hours after the application; maximum pentration appeared to occur within three days. The acid form, 2,4-dichlorophenoxyacetic acid, appeared to be slightly more effective than the sodium and methyl ester salts.

In limited tests lithium fluosilicate appeared comparable to calcium fluosilicate, and sodium arsenite solutions were highly effective in killing sweet potato vines.