New insecticides. What is their effect on bees when applied to flowering alfalfa?

George F. Knowlton
*Utah State University*

William P. Nye
*Utah State University*

F. V. Lieberman

F. E. Todd

George E. Bohart
*Utah State University*

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NEW INSECTICIDES

What is Their Effect on Bees When Applied to Flowering Alfalfa?

Scientists Find Insecticide That Will Control Harmful Insects With Minimum Loss of Pollinators

By G. F. KNOWLTON, W. P. NYE, F. V. LIEBERMAN, F. E. TODD, and G. E. BOHART

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DISCOVERY of the remarkable insect-killing powers of DDT immediately created an “insecticide age.” Soon other new and powerful insecticides were developed and marketed. The use of DDT and these newer chemicals was widely encouraged before there had been sufficient opportunity for research workers to learn much about their limitations. Entomologists were particularly alarmed that these spectacular insecticides in commercial use might destroy excessive numbers of beneficial insects. Insofar as bees are concerned this alarm was clearly warranted.

To many crops of fruit and seed, bees are the most important beneficial insects. Alfalfa seed is one of these crops. It is completely dependent upon either honey bees or certain native bees for the cross-pollination essential to profitable seed setting. Growers of alfalfa seed should therefore be vitally concerned in protecting the bees which visit the alfalfa flowers.

All insecticides can kill bees. They must therefore be used wisely at all times, and special effort must be made to avoid the application of dusts or sprays during either day or night to plants in bloom. Research has shown that usually harmful insects can be adequately controlled by applying insecticides before the alfalfa blooms. This fact must be accepted as the first rule for chemically controlling insects in seed alfalfa. Control measures that have been recommended to Utah seed growers conform to this principle.

Occasionally, however, an insecticide application may be necessary after the field has come into flower. High re-infestation by lygus may occur, this condition usually being associated with growing of seed on first crop alfalfa. Unanticipated grasshopper infestation may develop. Armyworms may appear. Therefore, there is demand for insecticides that will give adequate control of harmful insects after plants have reached the bloom stage but, at the same time, will not cause economic damage to bees. During the past three years a series of experiments has been conducted in Utah in a search for such insecticides. One has been found that promises to fulfill many of the needs for insect control in flowering alfalfa.

Tests on New Insecticides

Results of numerous tests that have been made against honey bees are summarized in the accompanying table. Included in the experiments were DDT, toxaphene, chlordane, methoxychlor, parathion, lindane, benzene hexachloride, aldrin, and dieldrin. The latter two insecticides have been developed only recently, and they are not yet on the commercial market. All of the others are already familiar items of the insecticide industry, and each now serves useful purposes in the control of certain insects. A study of the table will indicate that some killing of bees may be expected when any of these insecticides is applied to alfalfa that is in flower. Furthermore, all but two of the insecticides tested appear to be too destructive to bees for use on plants in bloom. The two exceptions are methoxychlor and...
toxaphene. However, it must be clearly understood that the favorable results with these two insecticides were obtained by applying the chemicals during the period when few or no bees were visiting the flowers. In Utah, this means between the hours of 7 p.m. and 7 a.m. Applications in broad daylight must always be avoided. The mortality caused by the applications listed in the table would be much higher in every case if they had been made when the bees were visiting blossoms in the field.

Many growers have tried to observe the effects of these new insecticides on bees. Some have reported that bees were killed. Others haven’t been able to find dead bees. Perhaps, then, it would be helpful to explain how the mortalities reported in the table were measured.

In most cases, fields selected for the experiments were out of flight range of bees from commercial apiaries. This fact assured us that most of the bees visiting the experimental field were from our own hives. The test colonies were placed at the edge of the experimental field a few days before the first application. Locating the test hives close to the alfalfa to be treated made it possible for most of the affected bees that did not die in the field to reach the hives before being overcome. Theoretically, then, most of the bees killed by the insecticide would either die in the field or at the hives. A reasonable estimate of the number killed could therefore be made by counting the number that died at these two places. The complete kill could never be determined since some of the affected bees would fly astray and die. Also, there is no way of learning how many dead bees might be removed by rodents or scavenger insects before our counts were made.

Estimating Numbers of Bees Killed

It is fairly simple to estimate the number of insecticide-killed bees that die at the hives. For at least two days before an application the dead bees found within a fixed area in front of each hive were picked up at 7 a.m. and counted. The average of these figures is the normal daily death rate at the hives. Following an application, dead bees were picked up each morning as long as the number counted was clearly above normal. The difference between the normal figure and the actual number picked up is the number that died as a result of the application of insecticides.

Estimating the number of bees that are killed in the field is difficult. In fact, we now know that in future experiments of this kind we must improve our methods of determining whether or not a bee has died on the day found. This will probably involve carefully determining just how long a bee will remain “fresh” in the field when killed by each different insecticide tested. However, mortality occurring in the field itself, as we have determined it in tests to date, is probably underestimated. The kills reported in the table are perhaps lower.
than they should be for this reason as well as those given previously. To estimate the number of bees that died in the field we carefully examined before and after each application at least 18 separate two-square-yard areas distributed at random throughout the field. All dead bees found were picked up and closely examined. Those found were classified as "fresh" or "old." The number of fresh dead bees found after an application minus the average number of fresh dead bees found in our pretreatment counts gave us an estimate of the number killed by the insecticide. After an application, counts in the field were made at the end of each day as long as the death rate at the hives remained above normal.

Bee mortality was related to the number of bees directly exposed. By direct exposure we mean contact with the insecticide while actually visiting flowers. These counts were averaged. Mortalities given in the table are based on this field visitation.

Mortality of bees produced by the various insecticides was largely confined to the two days immediately following an application. Use of dieldrin provided an exception to this rule; bees continued to die in large numbers for 5 days.

In these tests it appeared that only bees actually visiting the flowers (the field force) were affected and killed. However, both dieldrin and parathion might have killed other adult bees in the hive through their contact with the returning field force. The brood was apparently unaffected.
concerning toxaphene and honey bees will also apply to wild bees.

Methoxychlor in the single test made did not kill a detectable number of bees. Unfortunately, this insecticide appears to have no useful purpose for control of insects in blooming alfalfa.

In one test as a spray and at a low dosage DDT gave a favorable result, killing only 3.5 percent of the bees. Further studies may show that DDT can be safely used as a low-dosage spray. However, a factor such as increase of spider mite populations when DDT is used more than once on a given crop may prohibit even low-dosage sprays of this insecticide during bloom. Incidentally, DDT usually repels bees for several days, and kills by this material would probably be much higher without this repellency.

Chlordane has shown great variability in our tests. If this variability can be explained by differences in the material, it might also have a place in controlling insects in blooming alfalfa. High kills by chlordane were obtained in 1947 and 1948 but not in 1949. Further studies of this material are justified.

At present, lindane, benzene hexachloride, parathion, aldrin, and dieldrin appear to be too toxic to bees to warrant additional testing for use on seed alfalfa in bloom. Dieldrin is particularly toxic. Note that in this instance the estimate of dead bees exceeded the estimate of bees visiting the field by 7 percent. It is known that a few other experimental hives were within flight range of this field. Some of the dead bees found in the treated acreage undoubtedly came from these other colonies.

### Table 1. Mortality of honey bees produced by various insecticides when applied to fields of alfalfa in bloom, Logan, Utah, 1947-49

<table>
<thead>
<tr>
<th>Insecticide applied as a spray</th>
<th>Insecticide applied as a dust</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Name</strong></td>
<td><strong>Dosage of active ingredient</strong></td>
</tr>
<tr>
<td></td>
<td>lbs. per acre</td>
</tr>
<tr>
<td>Toxaphene</td>
<td>2.3</td>
</tr>
<tr>
<td></td>
<td>2.8</td>
</tr>
<tr>
<td>Methoxychlor</td>
<td>1.5</td>
</tr>
<tr>
<td>DDT</td>
<td>0.44</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Chlordane</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>1.25</td>
</tr>
<tr>
<td>Lindane</td>
<td>0.43</td>
</tr>
<tr>
<td>Aldrin</td>
<td>0.53</td>
</tr>
<tr>
<td>Dieldrin</td>
<td>0.56</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Applications were made during hours when bees were not in the fields.
† This dust contained 0.32 lbs. of gamma isomer per acre; lindane is 99 percent gamma isomer.