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ENTOMOLOGY DURING 1995: WASN’T IT EXCITING

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Wasn’t this past year an exciting year for insects? It was great to be an entomologist as well! The hackberry lace bugs were worse this year then I have seen them in my quarter century in Iowa. How bad were they? Let me tell you. My neighbor has a small, white dog whose color attracts the insect. The bugs were so bad on his four hackberries that the dog would only go outside when absolutely necessary. The European corn borer moth flights were so heavy in August that my daughter had to stop at Kwik Trip to wash off the windshield before returning my truck (she didn’t fill the tank). And the corn rootworms, weren’t the rootworms exciting in 1995. Let me tell you how exciting.

Soil Insecticide Performance

We had tremendous infestations in our corn rootworm insecticide-evaluation plots during 1995. At our Ames location, every root from the untreated plots rated 6 (three nodes of roots completely destroyed), the maximum rating that we assign. The severe infestations generated numerous complaints of corn rootworm insecticide failures this past season. The failures required that Dr. Marlin Rice, ISU Extension Entomologist, respond with an article in the Integrated Crop Management September 15 newsletter. With Marlin’s permission, I am reproducing his article here.

“Many continuous cornfields throughout Iowa experienced significant corn rootworm damage and lodging problems this year. Fields treated with either a granular insecticide at planting or a liquid insecticide post planting showed damage ratings of 5 (two complete nodes of roots removed to within 1½ inch of the stalk) or 6 (three complete nodes of roots removed). Determining the exact cause of the insecticide failure in any field can be very difficult because many factors that contributed to the problem cannot be specifically identified. However, several probable causes could provide an explanation. These are listed separately below, but many of them are strongly interrelated.

Large Rootworm Populations. This was a banner year for corn rootworm populations. In Mitchell and Worth counties where insecticide failures occurred, several cornfields had beetle populations exceeding 10 beetles per plant. In one field, three plants selected randomly had 24, 27, and 33 beetles. To put this in perspective, the economic threshold for determining whether an insecticide would be needed the following year is only 0.75 beetle per plant.

High Larval Survival. An abundance of rootworm larvae is necessary to injure roots significantly. The large beetle populations in many fields indicates that the larva
population was even larger. If an insecticide normally kills 50 percent of the larvae in an average-sized population, not too many survive to cause root damage. But if a very large population exists and 50 percent survive the insecticide, proportionally more larvae per plant remain to do damage.

**Late Larval Hatch.** Did the larvae actually hatch later than normal this year? Maybe. The first western corn rootworm beetles were found in central Iowa on July 10 and 4 or 5 days later in northeastern Iowa. During the past seven years, the first beetle has been found from June 27 (1994) to July 20 (1993), with the average date being July 5. If it takes about four weeks for larvae to develop to adults in the field, the collection of the first beetle on July 10 suggests that larvae began hatching near June 12, about a week later than average.

**Late-Maturing 1994 Corn.** Late maturing or late silking fields can attract female rootworm beetles from neighboring fields. The beetles leave brown-silk fields and fly to fields with green silks. The eggs they lay in the green-silk field are added to those laid by the beetles originally there, resulting in a larger number of rootworm larvae the following year. This may explain in part why rootworm populations were so large in some fields.

**Early-Planted Corn.** Shortly after an insecticide is placed in the soil, it starts to breakdown. If corn was planted in mid April, and it was two months before the larvae hatched, there may not have been enough insecticide to sufficiently reduce the large rootworm population below damaging levels.

**Late-Planted Corn.** Wet weather prevented some fields from being planted until late May or early June. When plants finally emerged, the young root systems were very small and more vulnerable to significant pruning by the larvae.

**Dry Soils.** Insecticide performance is inhibited by dry soil. Insecticide in low soil-moisture conditions is neither readily moved off the granule nor evenly distributed throughout the soil, or it may be bound to organic matter. Many counties where lodging problems occurred had dry soils the last two to three weeks of June -- the critical time when larvae were initiating feeding and insecticide was most needed. Also larvae survive better after hatching if the soil is dry rather that saturated with moisture. When soils are extremely wet, many larvae drown before tunneling into roots.

**Rootworm Size.** During the dry period of June, many larvae fed uninhibited on the roots. When the rains finally came, the larvae were larger and many of them may have been feeding safely inside the roots, away from insecticide in the surrounding soil. To compound the problem, it takes 2 to 4 times more insecticide to kill third instar larvae than to kill newly-hatched first instar larvae.

**Root Regrowth.** Dry soils also can hinder a corn plant’s ability to regrow roots that have been damaged. Small root systems heavily pruned by rootworms are more likely to lodge as the plants get taller and heavier.
Insecticide Chemistry. Some of you have asked if the chemistry of the insecticides is blame. If a failure were noted with only one insecticide, chemical nonperformance might have been a legitimate concern. But failures were reported for all products: Counter, Dyfonate, Force, Furadan, Lorsban, and Thimet. Because failures were reported with all products, this indicates that the problems were environmentally related.

Large populations of larvae, high insect survival, later than average rootworm hatch, dry soils, small root systems, unavailability of the insecticide, planting time, and poor root regrowth all could have contributed to the corn lodging problems seen in 1995. Some factors discussed above may help explain problems you observed this year. The next question, though, is should we do anything different with our soil insecticides in 1996? I don’t think so. Remember that:

- Crop rotation is a viable option to control rootworms,
- Some insecticides protect corn roots quite well during most years, and
- Rootworm problems rarely occur on a major scale.”

A new development in the soil insecticide market for 1996 is the registration of two new soil insecticides for protecting corn from corn rootworm larval injury. The new products are Aztec and Fortress. We have been testing the products for many years, and the actual formulations that received registration for the past four years. Mr. James Oleson, the Agricultural Specialist that coordinates the corn rootworm insecticide trials, has summarized the last four years’ performance of the insecticides labeled for corn rootworm larval control. His summary is presented in Table 1. You will be interested in the “Root Rating” that compares the chemicals’ ability to protect corn roots and the “Percentage Consistency” which ranks the products across all locations that had an economic infestation. The root ratings range from 1= little or no damage to 6= three nodes of roots completely destroyed. When deciding which product to purchase you should also consider, however, their cost and the Oral LD50. The larger the LD50, the safer the product is to mammals.

Damage to Rotated Corn

A second exciting corn rootworm event occurred in east central Illinois and west central Indiana. In this area, the western corn rootworm severely damage corn grown in an annual rotation with soybeans. Corn rootworm researchers have been aware of localized, light infestations for several years, but in 1995 the “brush” fire turned into a “forest” fire. Some growers were reporting that they thought they would completely loss some fields to corn rootworm larval feeding.

The preliminary research from the last several years has led the researchers to believe that an extended-diapause western corn rootworm has not developed. They are suggesting that changes in corn-production practices may be responsible. The series of events that the researchers are proposing as possibly being responsible is: farmers are planting corn earlier, the insecticides that are being applied at planting are not lasting long enough to control the larvae that hatch later in June, the earlier planted corn is more mature when these later hatching survivors emerge, because the corn is less attractive, the beetles are leaving cornfields in search of pollen sources, the beetles find pollen in soybean fields, and are willing to lay their eggs in the bean fields.
because the corn stalks left by reduced tillage are sufficient to fool the beetles into "thinking" they are in a cornfield. Behavioral research is currently underway to confirm this theory or to develop a more plausible one.

Iowa has not had the opportunity to experience the magnitude of western corn rootworm damage to rotated corn that Illinois and Indiana have. What then is my forecast concerning the likelihood that Iowa will share the experience?

When the western corn rootworm spread from the Rocky Mountains across the Corn Belt, it moved eastward at the rate of about 50 miles per year. I am hoping that the prevailing winds will assist us by causing long-range dispersal of the pest to continue to be to the east. That is, those western corn rootworms that seem to have different ovipositional preferences will move, if they spread, away from Iowa. That is not to say I am not expecting the "problem" to develop in Iowa. If we use similar production practices, which we probably do, we will generate the problem ourselves without the assistance of our easterly neighbors.

I will lean on my experience with the "extended-diapause" northern corn rootworm to offer suggestions on how to prepare for the "new western variety." As the northerns adapted to rotated corn, growers initially experienced lodged corn in spots in some of their fields. These initial infestations developed into extensive, severe infestations over several years. The western corn rootworm problem in rotated corn seems to have developed in a similar fashion. Illinois and Indiana researchers have been investigating limited, localized infestations for several years. Now they have exploded. Their experience leads me to recommend that crop consultants and growers watch for initial infestations, lodged rotated corn and western beetles in soybeans. As the infestations develop, they can be treated therapeutically, that is, soil insecticides applied to the infested fields or even parts of fields to protect the root systems. This is a short-term approach that does not prevent or cure the problem of western corn rootworm infestation of rotated corn.

How we stop western corn rootworm from infesting rotated corn will become clearer when we understand the biological changes that have occurred in the pest population. We are looking to Illinois and Indiana growers and researchers to explain those changes, but of course we are cooperating and will continue to cooperate.

Insecticide Resistance

The third corn rootworm development during 1995 is insecticide resistance. Corn rootworm resistance to the cycloodiene insecticides began in central Nebraska irrigated corn in the late 1950s, and by early 1960 had spread into South Dakota and Kansas. This resistance made the cycloodiene insecticides useless and they were replaced with the organophosphates and later, 1970, the carbamates. The situation appears to be developing again in central Nebraska.

There is an area in central Nebraska where growers have routinely relied upon controlling adult corn rootworms with broadcast, foliar sprays to prevent egg laying. During the last three decades farmers in the area have coordinated the annual, area-wide application of insecticides, primarily a single organophosphate material, to control beetles. Last season it took 17 times more of the
organophosphate insecticide to kill beetles from the management area than those collected from an area in northeast Nebraska where beetle spraying is not commonly practiced (L. Meinke, personal communication).

The demise of the cyclodiene insecticides is most probably due to the routine use of broadcast treatments over extensive areas. The problem was compounded by broadcasting 3% DDT to control corn rootworm adults, thereby preventing egg laying and subsequent larval damage. Corn rootworm larval and adult populations both were exposed to broadcast applications of the cyclodiene class of insecticides. The applications produced a severe selection pressure on the rootworms, killing most of the susceptible individuals, and selecting for those that tolerated the cyclodienes.

Corn rootworms have not been reported to be resistant to soil applications of the organophosphate and carbamate insecticides. But then these classes, because of cost constraints, have been applied as band treatments over or into the seed furrow. The consequence is that only 1/6 to 1/4 of a field of corn is treated. Many corn rootworms survive outside of the treated area and are not exposed to the insecticides. Do these untreated areas provide refugia for susceptible insects that mate with those that survive chemical treatment and delay the development of resistance? I believe they do!

The lesson to be learned, at least from the last two 1995 “developments,” is that if we rely on a single management tactic that causes heavy mortality over an extensive area, the rootworms will become tolerant to it and it will lose its effectiveness. Consider the extended-diapause northern corn rootworm in northwest Iowa. This cultural practice that effectively controls corn rootworms has been heavily practiced in this area, as much as 90% of the corn is rotated annually with soybeans. We should strive to maintain an environment that is “full of uncertainty” for the rootworm. This means mixing management tactics as appropriate to prevent the pest from adapting to a single strategy.
Table 1. Performance Consistency of Labeled Rates of Soil Insecticides Applied for Corn Rootworm Control. 1992-1995

<table>
<thead>
<tr>
<th>Insecticide</th>
<th>Placement</th>
<th>Percentage Consistency¹</th>
<th>Root Rating</th>
<th>Oral LD₅₀ (rat)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>Counter 20CR</td>
<td>band</td>
<td>100 a²</td>
<td>1.87</td>
<td>29</td>
</tr>
<tr>
<td>Counter 15G</td>
<td>band</td>
<td>100 a</td>
<td>1.89</td>
<td>11.7</td>
</tr>
<tr>
<td>Counter 15G</td>
<td>furrow</td>
<td>100 a</td>
<td>1.97</td>
<td>11.7</td>
</tr>
<tr>
<td>Counter 20CR</td>
<td>furrow</td>
<td>100 a</td>
<td>2.26</td>
<td>29</td>
</tr>
<tr>
<td>Fortress 2.5G³</td>
<td>furrow</td>
<td>97 ab</td>
<td>2.19</td>
<td>229</td>
</tr>
<tr>
<td>Force 1.5G</td>
<td>furrow</td>
<td>97 ab</td>
<td>2.44</td>
<td>3015</td>
</tr>
<tr>
<td>Aztec 2.1G</td>
<td>furrow</td>
<td>94 ab</td>
<td>2.37</td>
<td>190</td>
</tr>
<tr>
<td>Aztec 2.1G</td>
<td>band</td>
<td>92 ab</td>
<td>2.29</td>
<td>190</td>
</tr>
<tr>
<td>Force 1.5G</td>
<td>band</td>
<td>92 ab</td>
<td>2.29</td>
<td>3015</td>
</tr>
<tr>
<td>Lorsban 15G</td>
<td>band</td>
<td>89 abc</td>
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<td>&gt;2000</td>
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<tr>
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<td>band</td>
<td>81 bc</td>
<td>2.59</td>
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<tr>
<td>Thimet 20G</td>
<td>band</td>
<td>81 bc</td>
<td>2.76</td>
<td>13.5</td>
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<tr>
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<td>72 c</td>
<td>2.78</td>
<td>229</td>
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<tr>
<td>Untreated</td>
<td>band</td>
<td>0 d</td>
<td>4.80</td>
<td></td>
</tr>
</tbody>
</table>

¹ Consistency equals the percentage of times an insecticide treatment (labeled rate) kept the root rating equal to 3.00 or less when the untreated rating was greater than 3.00. Thirty-six replications were analyzed over four years.

² Means within a column followed by the same letter are not significantly different (P ≤ 0.05, Ryan’s Q test).
