ADULT CORN ROOTWORM SUPPRESSION TO PREVENT OVIPOSITION

Jon Tollefson
Professor, Entomology
Iowa State University

A chemical-control strategy that might eliminate the need for a grower to apply a granular insecticide at planting or cultivation time is the application of a foliar spray by a commercial aerial applicator. Iowa began experimenting with the application of foliar broadcast sprays to control adult corn rootworms in 1974. In theory, if female beetle numbers can be sufficiently reduced during the egg-laying period, a damaging population of corn rootworm larvae should not develop the following season. The technology that stimulated interest in the concept was the development of a persistent formulation of carbaryl insecticide (Sevin® 4-Oil). Experiments conducted during 1974-1976 demonstrated that the formulation had sufficient persistence to warrant full-scale field testing.

During 1977 six rootworm infested Iowa cornfields were chosen to field test the concept. An ultra-low volume application of Sevin 4-Oil at the rate of approximately one quart/acre, containing one pound of carbaryl was aerially applied to half of each field and the remainder left untreated. The adulticide sprays were applied to a field when beetle counts reached one beetle per plant and 10% of the females contained eggs (were gravid).

The adulticide treatments reduced the subsequent year's root damage in all six fields (Table 1). In only one field, i.e., Mead Farm, was the 1978 root damage economic. The previous year's adulticide treatment did, however, provide good larval-damage suppression in this field.

Table 1. Average root-damage ratings in Iowa cornfields following treatment with Sevin 4-Oil insecticide the preceding year (1977) to suppress adult corn rootworm populations

Location	Root Damage Rating[1]	
(Application Date)	Adulticide	No Adulticide
Ranshau Farm (July 24)	1.5	1.8
Grevengoed Farm (July 24)	1.7	2.0
Goode Farm (July 29)	2.2	2.4
Mead Farm (July 30)	2.3	4.4
Hahn Farm (Aug. 1)	2.2	2.3
Perkins Farm (Aug. 10)	2.4	2.7

[1] Iowa damage-rating scale with 1 = no to minor damage and 6 = severe damage (Hills and Peters 1971).

During 1978 the design was modified. The objectives were to evaluate the timing of adulticides to determine if a longer beetle-free period would improve subsequent root protection, and to compare adult suppression with the preventative use of soil insecticides applied at planting the subsequent year. Two timings and multiple applications of the adulticide (Sevin 4-Oil) were achieved by dividing four Iowa cornfields in half and treating one side with a broadcast aerial application. Treatments were applied when beetle numbers reached one beetle per plant and 10% of the females were gravid.

When beetle numbers recovered to 1/2 beetle per plant, the field was divided again perpendicular to the first division and one half was treated. The two divisions and perpendicular applications resulted in the fields being divided into quadrants with: one quadrant receiving an early spray, one a late treatment, the third both an early and late application, and the final quarter received no adulticide treatment.

The following season (1979), the farmers applied their soil insecticide of choice to the fields at planting. They were asked to leave two strips across the field, one in each half, untreated with the soil insecticide. Each strip bisected two quadrants, providing soil insecticide treated and untreated areas in all four adult-suppression treatments.

In the 1978 and 1979 experiments (Table 2), the root damage rating corresponding to "no adulticide" and "No Soil Insecticide" represents the root damage when no insecticides were used. The rating corresponding to "no adulticide" and "Soil Insecticide" provides a reference as to the root protection provided by the standard soil insecticide applied in a band at planting.

During 1978 two of the four fields sprayed, i.e., Paysen and Harksen farms, had economic root damage the year following the adulticide applications. All but one of the adulticide treatments provided sufficient suppression of egg laying to avoid economic root damage the following year. In the Paysen field, the July 28 application of an adulticide reduced the subsequent larval damage, but not to the acceptable level of 3.0. While the subsequent root damage in the rest of the adulticide treatments was slightly greater than a soil insecticide alone, it was below the economic level. In fact, control was sufficiently good that the addition of a planting-time soil insecticide the following year only improved root protection slightly.

Table 2. Comparison of adulticide (Sevin 4-Oil) applied the preceding year for adult suppression with soil insecticides applied at planting time for the protection from corn rootworm larval damage in Iowa

Adulticide Treatment	Root Damage Rating[1]	
	No Soil Insecticide	Soil Insecticide
1978		
Seesor Farm		
July 14 treatment	2.5	2.0
July 28 treatment	2.6	2.0
early + late treatments	2.0	1.5
no adulticide	2.7	1.9
Paysen Farm		
July 16 treatment	2.4	2.4
July 28 treatment	3.8	1.9
early + late treatments	2.4	1.8
no adulticide	4.3	2.1
Barr Farm		
July 14 treatment	2.6	
Aug. 2 treatment	2.4	
early + late treatments	1.7	
no adulticide		1.8
Harksen Farm		
July 19 treatment	2.2	1.9
Aug. 10 treatment	2.0	1.7
early + late treatments	2.0	1.7
no adulticide	3.4	1.7
1979		
Oster Farm		
July 28 treatment	2.2	1.9
no adulticide	2.1	2.6
Harksen Farm		
July 28 treatment	2.2	1.8
no adulticide	2.7	2.3
Shaffer Farm		
July 30 treatment	1.9	1.8
Aug. 21 treatment		
early + late treatments	1.6	1.4
no adulticide	2.2	1.7

[1] Iowa damage-rating scale with 1=no to minor damage and 6=severe damage.

The final assessment of suppressing adult populations with conventional insecticidal formulations to avoid reliance on soil applied insecticides was conducted in three Iowa cornfields during 1979. Two fields were divided in half and received a single, early application of the adulticide. The third was divided into quarters and half treated at each of two times in perpendicular directions in a similar manner as 1978. Again all three farmers were asked to withhold soil insecticides from two strips across the fields, one in each half, to provide a contrast of adulticide and larvicide treatments for the protection of corn roots from rootworm larval damage.

Efficacy of the adulticide and larvicide treatments was evaluated by digging 10 roots at each of five sites in all treatments. The roots were transported to Ames and the soil removed using an air-pressurized water spray. The damage was rated using the Iowa 1 to 6 damage rating scale, where 1 = no or only minor damage and 6 = three nodes of roots destroyed.

The subsequent year's root damage in all three fields was below economic levels (Table 2). Under the light infestations of 1979, the prevention of larval damage by the adulticide sprays equalled the planting-time application of soil insecticides.

While the foliar application of adulticides was demonstrated to provide protection from corn rootworm larval damage that was comparable to application of granular formulations to the soil, there was not an incentive, in cost, nor effectiveness, to switch to adulticides. At the same time, late 1970s and early 1980s, research was being conducted that might change this perspective. Midwest scientists had been studying semiochemicals that affect adult corn rootworms. Semiochemicals are chemicals produced by one individual that affect the behavior of another. The two semiochemicals being sought were the sex pheromone that the female beetle uses to attract the male and volatiles in host plants that aid the beetle in finding a host. At about the same time, early 1980, both semiochemicals were identified and synthetic mimics made available.

It was postulated that the chemicals could be combined with a toxicant and, by attracting the insects to the formulation and enticing them to feed on it, the rate of application of the insecticide could be drastically reduced. In 1983 Purdue University demonstrated that the beetles could be killed using doses of insecticide as low as 1/10 to 1/50 the normal one pound per acre rate when combined with the semiochemicals. To examine the practicality of the concept, the midwest states coordinated an effort to test the concept across the midwest during 1984. The experimental formulation killed beetles but the application equipment required was not the most commercially suitable, so the sufficiency of the residual activity was sufficient was in question.

Since 1985 sporadic attempts by various manufacturers have been made to develop a formulation that can be applied through existing equipment and will still provide adequate persistence to cover the corn rootworm ovipositional period. During 1990, we tested a formulation that could be applied with existing equipment, but it did not provide adequate residual. This year, 1991, we applied a formulation that required only a single treatment to

reduce beetle numbers below the economic threshold for prevention of larval damage, but we were back to using specialized equipment. Because of societal concerns over perceived avian wildlife hazards posed by granular formulations applied to the soil, the interest in developing a liquid adulticide remains prevalent. We intend to continue to cooperate with manufacturers in their attempt to identify a commercially suitable adulticide formulation for the prevention of oviposition that has the desirable attribute of a very low toxicant concentration.