EFFECTIVENESS OF DIFLUBENZURON ON BOLL WEEVILS IN THE TEXAS ROLLING PLAINS[1/][2/]

Don R. Rummel

Texas Agricultural Experiment Station
Lubbock, TX 79401

ABSTRACT

Under conditions of heavy boll weevil infestation 8 applications of diflubenzuron at rates of 35, 70 and 140 g AI/ha resulted in a seasonal average adult boll weevil, Anthonomus grandis Boheman, emergence of 44.4, 40.0, and 27.0%, respectively. Adult boll weevil emergence from untreated cotton plots averaged 73.5%. Lint yield data indicated the 70 and 140 g AI/ha rates to be equal in effectiveness to 8 applications of azinphosmethyl at a rate of 336 g AI/ha. Four applications of diflubenzuron at rates of 52.5, 70, and 140 g AI/ha directed against a light overwintered boll weevil population resulted in adult emergence of 24.5, 13.4, and 9.7%, respectively. All rates of diflubenzuron were less detrimental to selected beneficial arthropods than azinphosmethyl.

INTRODUCTION

The boll weevil, Anthonomus grandis Boheman, is a key pest in many cotton producing areas of the Texas Rolling Plains extending to the eastern border of the High Plains. Because of the harsh winter climate, the most severe seasonal infestations are distributed in areas with the most favorable overwintering habitat (Rummel and Adkisson 1970).

The use of insecticides to control boll weevils during the growing season sometimes results in outbreaks of the bollworm, Heliothis zea (Boddie), and the tobacco budworm, H. virescens (F.), due to the destruction of beneficial arthropods. Therefore, alternative methods such as the suppression of diapausing boll weevils in the fall or controlling overwintered weevils during the early squaring period are preferred.

The insect growth regulator (IGR) diflubenzuron (N-[[(4-chlorophenyl) amino]carbonyl]-2,6-difluorobenzamide, Dimilin®, TH-6040) has been reported effective against boll weevils by several authors (Taft and Hopkins 1975, Ganyard et al. 1977, Lloyd et al. 1977, Ganyard et al. 1978). In addition to its suppressive effect on boll weevil populations, some studies have indicated that diflubenzuron is less detrimental to most beneficial arthropods than conventional insecticides used for boll weevil control (Ables et al. 1980, Keever et al. 1977). The potential for suppressing boll weevil populations with a less severe impact on beneficial arthropods made diflubenzuron a desirable material for testing in the West Texas area.

1/ Coleoptera: Curculionidae.
2/ Technical Contribution No. TA-16083, Texas Agricultural Experiment Station.

MATERIALS AND METHODS

1976 Tests. During 1976, tests were conducted in a 49-ha field of TAMCOT SP-37 cotton in Stonewall County, TX. The field was surrounded by very favorable boll weevil overwintering habitat and had a history of heavy infestations. Leaf litter samples taken from groves of sand shinnery oak, *Quercus havardii* Rydb., indicated that a large overwintering boll weevil population was present in the vicinity of the field.

The test field was divided into 1.5-ha plots separated by 2 rows of forage sorghum to restrict spray drift between plots. Five treatments, each replicated 3 times, were scheduled for the experiment: (1) untreated check; (2) azinphosmethyl (Guthion®), 336 g AI/ha (0.3 lbs/A); (3) diflubenzuron, 35 g AI/ha (0.5 oz/A); (4) diflubenzuron, 70 g AI/ha (1.0 oz/A); (5) diflubenzuron, 140 g AI/ha (2.0 oz/A). Diflubenzuron (W-25, 25% AI) was applied in combination with a nonphytotoxic petroleum oil (Sun Oil 7N) and water at a total volume of 16.8 L/ha with a ULV Clark Spray Coupe Speed Sprayer®. An EC formulation of azinphosmethyl was applied in water at a volume of 37.4 L/ha with a tractor-mounted sprayer. Treatments of diflubenzuron and azinphosmethyl were scheduled for 8 applications at 5- to 7-day intervals.

Inspection of all plots just prior to the initiation of the experiment indicated that extremely large numbers of boll weevils were entering the field from overwintering habitat. Therefore, all plots were oversprayed with ULV malathion at the rate of 1.1 kg AI/ha. Following the overspray, the experiment was started on July 1 when the majority of the plants were in the "pinhead square" stage of development. Field inspections conducted on July 6 revealed that the overwintered boll weevil population in the test plots had increased to an average of 8354 adults/ha. Because such great numbers of overwintered boll weevils would have prevented a fair evaluation of the effectiveness of diflubenzuron, all plots were oversprayed with azinphosmethyl to reduce the adult population. The 2nd application of diflubenzuron was applied the following day, while the azinphosmethyl overspray was designated as the 2nd application in the azinphosmethyl plots.

The adult boll weevil population was determined by making whole plant inspections on 4 m lengths of row at each of 10 locations in each plot. After the initiation of fruiting, squares at least 1/3 grown with obvious boll weevil oviposition punctures (100/sample) were collected from each plot and held in emergence cages in the laboratory to determine the percentage of adult emergence from the various treatments. The percentage of squares with oviposition punctures was determined by randomly sampling 100 squares from each plot within each treatment. All samples were taken on a weekly basis.

Weekly samples of selected beneficial arthropods were made to determine the comparative effects of the test materials on nontarget arthropods. These samples were taken by operating a D-VAC® sampling machine over a 61 m length of row in each plot.

1977 Tests. During the 1977 season diflubenzuron (W-25, 25% AI) was applied to a 40-ha commercial cotton field in a test designed to determine the effects of various rates of the material on overwintering boll weevils. The field was divided into 4 sections of approximately equal size in order to have field plots large enough to avoid excessive spray drift between plots.

Diflubenzuron was applied by aircraft at the rates of 52.5, 70, and 140 g AI/ha in a 1:3 mixture of crop oil (Savol®) and water at a total volume of 28 L/ha. The 1st applications of diflubenzuron were scheduled to start at the "pinhead square" stage. However, due to a delay in shipment of the diflubenzuron, 1/3-grown squares and boll weevil oviposition punctures were already present when the 1st application was made. Plots were treated 4 times at 5- to 7-day intervals.

The large field plots including the untreated check plot were subdivided into 4 sections for sampling. Sampling procedures were the same as those described in the 1976 tests with the exception that there were no samples of beneficial arthropods. In addition to the untreated check plot within the treatment field, a nearby commercial cotton field was used as an outside check.

RESULTS

1976 Tests. The boll weevil infestation was relatively uniform and quite heavy throughout the test field. Fig. 1 shows the seasonal average percentage of squares with oviposition punctures in the various test plots. These percentages were calculated for the period July 6, when oviposition punctures were 1st detected, through September 7, 1 wk following the last applications.

Seasonal square damage (oviposition punctures) averaged 60% in all treated plots and was slightly less (50%) in untreated check plots. However, as a result of the expected adult mortality, the percentage of oviposition damaged squares in the azinphosmethyl-treated plots was considerably less, with a seasonal average of 33%.

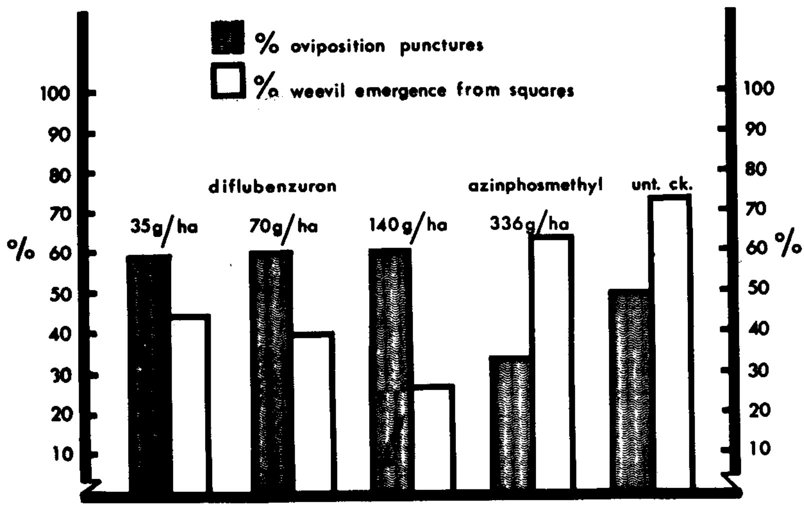

FIG. 1 Seasonal averages of squares bearing boll weevil oviposition punctures and adult weevil emergence from field plots treated with 8 applications of azinphosmethyl and plots receiving 8 applications of diflubenzuron at various rates.

Because of the unique mode of action of diflubenzuron, the percentage of adult boll weevils emerging from infested squares is the best measure of the effectiveness of this material. All the diflubenzuron treatments reduced adult emergence when compared to azinphosmethyl treatment and the untreated check. There was little difference (44.4% and 40.0%, respectively) in the average percentage seasonal emergence of adults from squares collected in plots receiving diflubenzuron treatments at the 35 and 70 g AI/ha rates. The greatest reduction in boll weevil emergence from infested squares was found in plots receiving the 140 g AI/ha diflubenzuron treatment where seasonal emergence averaged only 27%.

Numbers of adult boll weevils in the different plots fluctuated during the season, but differences in numbers among the treatments were relatively small. Calculated as seasonal averages, the numbers of adult boll weevils in the plots treated with 35, 70, and 140 g AI/ha diflubenzuron were 3462, 3459 and 3707/ha, respectively. Numbers of adult weevils averaged 3128/ha in the azinphosmethyl plots and 4959 in the untreated check plots.

There were no significant differences in yields of cotton lint between the 3 diflubenzuron treatments and the azinphosmethyl treatment. However, all treatments except the 35 g AI/ha rate of diflubenzuron resulted in a significant increase in yield over the untreated check (Table 1).

TABLE 1. Yields of Lint from Cotton Plots Treated with Diflubenzuron or Azinphosmethyl for Boll Weevil Control.

Treatment	Lint yield (kg/ha)[a]
Diflubenzuron 140 g AI/ha	263 a
Azinphosmethyl 336 g AI/ha	258 a
Diflubenzuron 70 g AI/ha	224 a
Diflubenzuron 35 g AI/ha	155 ab
Untreated check	64 b

[a] Means followed by the same letter are not significantly different at the 0.05 probability level based on Duncan's new multiple range test.

The seasonal averages of selected beneficial arthropods/ha are shown in Fig. 2. The greatest numbers were found in the plots treated with 140 g AI/ha of diflubenzuron, closely followed by the untreated check plots. Beneficial arthropod populations were somewhat smaller in the 35 and 70 g AI/ha plots than in the 140 g AI/ha and untreated plots. However, beneficial arthropod populations in all diflubenzuron-treated plots greatly exceeded those in plots treated with azinphosmethyl.

1977 Tests. Results of the 1977 test in which diflubenzuron was applied by air are shown in Table 2. These data show the average numbers of adult boll weevils, oviposition-damaged squares, and the average percentage of boll weevils emerging from squares during the period June 20 to July 18. This period covered the time from the 1st application of diflubenzuron until 10 days after the last application.

The numbers of adult boll weevils and damaged squares varied among the plots although the differences in most instances were not great. A

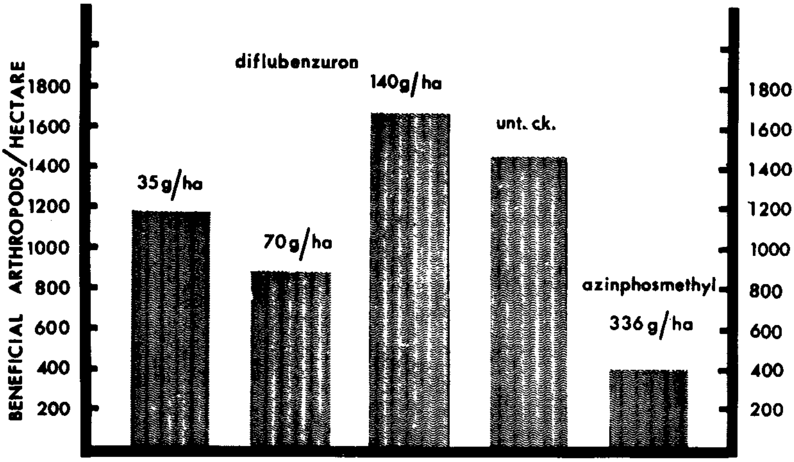

FIG. 2 Mean seasonal populations of selected beneficial arthropods in field plots treated with azinphosmethyl and diflubenzuron. Arthropods sampled were: Coccinellidae (adults and larvae), Collops sp. (adults), Scymnus sp. (adults), Nabis sp. (adults), Geocoris sp. (adults), Oris sp. (adults), Chrysopa sp. (adults and larvae) and all spiders.

considerable difference in the percentage emergence of adult boll weevils in the treated and untreated plots was noted.

Adult boll weevil emergence from infested squares collected from the 2 untreated checks averaged over 65%. Emergence from the plots receiving the 140 g, 70 g, and 52.5 g AI/ha treatments of diflubenzuron averaged 9.7, 13.4, and 24.5%, respectively.

The 1978 season was extremely hot and dry, and boll weevil infestations developed very slowly following the overwintered infestation. Therefore, no differences in yield were noted among the various treatment and check plots.

TABLE 2. Boll Weevil Infestation Levels and % Adult Emergence from Squares in Field Plots Treated with Various Rates of Diflubenzuron During the Period 20 June to 18 July, 1977[a].

Treatment	$\overline{X}$ no. adult boll weevils/ha	$\overline{X}$ % oviposition damaged squares	$\overline{X}$ % weevil emergence from squares
Diflubenzuron 52.5 g/ha	608	8.0	24.5
Diflubenzuron 70 g/ha	209	12.0	13.4
Diflubenzuron 140 g/ha	166	20.0	9.7
Untreated Check No. 1	349	12.0	69.2
Untreated Check No. 2	583	19.0	64.7

[a] Applications made on 20 & 25 June, 1 & 8 July. Inspections made and infested squares collected for adult emergence data on 28 June and 6, 12, 18 July, 1977.

CONCLUSIONS

The 1976 study was conducted in an area supporting an extremely large overwintered boll weevil population. All test plots within the field were heavily infested with boll weevils throughout the season. The relatively small degree of isolation from other cotton fields was not great enough to prevent the immigration of large numbers of weevils from untreated fields. Under these conditions the average percentage of adult emergence from treated plots was greater than that reported from some earlier studies. However, yield data showed that 8 applications of diflubenzuron at the 70 and 140 g AI/ha rate were equal in effectiveness to 8 applications of azinphosmethyl at 336 g AI/ha.

Even though there were no differences in the percentages of oviposition damaged squares in the diflubenzuron plots and the untreated checks, the treated plots produced considerably more cotton. This indicates that many of the squares that received oviposition punctures developed normally when the boll weevil eggs failed to hatch, or mortality occurred during the newly eclosed larval stage.

The unfavorable weather conditions for boll weevil development prevented a more thorough evaluation of the 1978 test because the population developed very slowly in all fields following the initial infestation by overwintered boll weevils. However, the study showed that diflubenzuron treatments greatly reduced reproduction by overwintered boll weevils during the treatment period and for several days following the last application. The percentage of adults emerging from diflubenzuron-treated plots had increased considerably after 10 days, and no difference in emergence from treated and untreated plots was evident after 14 days. It was apparent, however, that diflubenzuron treatments resulted in a much higher level of reproduction suppression in 1977 than in 1976 when the overwintered boll weevil population was much greater.

The relatively minor effect of diflubenzuron on beneficial arthropods, as compared with the effect of azinphosmethyl, is an important consideration in its use in controlling the boll weevil. Even though the present study evaluated population levels of only a few beneficial species, the results seem to support the findings of Ables et al. (1977) and Keever et al. (1977) concerning the minimal adverse effects of diflubenzuron on beneficial arthropods.

Conclusions derived from studies with diflubenzuron in West Texas are in general agreement with those of Ables et al. (1980). The most effective method for using diflubenzuron appears to be a program designed to suppress reproduction by overwintered boll weevils with the 1st application made at the "pinhead square" stage before reproduction begins. Due to the apparent quick recovery of adult boll weevils from the effects of diflubenzuron (Bull 1980), treatment intervals should not exceed 5 to 7 days.

Under heavy overwintered boll weevil pressure like that experienced in the 1976 tests, effectiveness is reduced. Under these conditions diflubenzuron applications should be supplemented with at least 1 application of a conventional insecticide.

ACKNOWLEDGMENT

This study was conducted under TAES Project H-6035 as cooperative agreement no. 12-14-7001-819, with USDA, SEA, AR. The assistance of Drs. D. L. Bull and J. R. Ables is greatly appreciated.

LITERATURE CITED

Ables, J. R., V. S. House, S. L. Jones, and D. L. Bull. 1980. Effectiveness of diflubenzuron on boll weevils in the Central Texas river bottoms area. Southwest. Entomol. Suppl. No. 1, p. 15-21.

Ables, J. R., S. L. Jones, and M. J. Bee. 1977. Effect of diflubenzuron on beneficial arthropods associated with cotton. Southwest. Entomol. 2:66-72.

Bull, D. L. 1980. Fate of diflubenzuron after application to cotton and the boll weevil. Southwest. Entomol. Suppl. No. 1, p. 2-7.

Ganyard, M. C., J. R. Bradley, Jr., F. J. Boyd, and J. R. Brazzel. 1977. Field evaluation of diflubenzuron (Dimilin) for control of boll weevil reproduction. J. Econ. Entomol. 70:347-50.

Ganyard, M. C., J. R. Bradley, Jr., and J. R. Brazzel. 1978. Wide-area field test of diflubenzuron for control of an indigenous boll weevil population. J. Econ. Entomol. 71:785-8.

Keever, D. W., J. R. Bradley, Jr., and M. C. Ganyard. 1977. Effects of diflubenzuron (Dimilin) on selected beneficial arthropods in cotton fields. Environ. Entomol. 6:732-6.

Lloyd, E. P., R. H. Wood, and E. B. Mitchell. 1977. Boll weevil: Suppression with TH-6040 applied in cottonseed oil as a foliar spray. J. Econ. Entomol. 70:442-4.

Rummel, D. R., and P. L. Adkisson. 1970. Distribution of boll weevil-infested cotton fields in relation to overwintering habitats in the High and Rolling Plains of Texas. J. Econ. Entomol. 63:1906-9.

Taft, H. M., and A. R. Hopkins. 1975. Boll weevils: Field populations controlled by sterilizing emerging overwintered females with a TH-6040 sprayable bait. J. Econ. Entomol. 68:551-4.