EFFECT OF DIFLUBENZURON ON ENTOMOPHAGOUS ARTHROPODS ASSOCIATED WITH COTTON[1/,2/]

J. R. Ables, S. L. Jones, V. S. House, and D. L. Bull

Cotton Insects Research Laboratory,
AR, SEA, USDA, College Station, TX 77841

ABSTRACT

In laboratory studies, the insect growth regulator (IGR) diflubenzuron has been tested for harmful effects against several species of entomophages. While the IGR had no adverse effects on Geocoris punctipes (Say), Apanteles marginiventris (Cresson), and Trichogramma pretiosum (Riley), mortality of immature stages occurred in Hippodamia convergens Guéren-Méneville and Chrysopa carnea Stephens. However, the deleterious effects tended to subside if treatments were discontinued. Further laboratory and field studies showed that Savol®, the parafinic crop oil with which the IGR is formulated, was toxic to some predators and reduced parasitism of Heliothis virescens (F.) eggs by T. pretiosum. Field studies have also demonstrated reduced populations of Geocoris and Nabis spp. in soybeans and Geocoris spp. in cotton. However, when applied to cotton at the recommended rate for field use, 70 g AI/ha, diflubenzuron is much less harmful to populations of entomophagous arthropods than are most conventional insecticides.

INTRODUCTION

Available evidence suggests that diflubenzuron (N-[[(4-chlorophenyl)amino] carbonyl]-2,6-difluorobenzamide; Dimilin®, TH-6040) may be useful in the control of the boll weevil, Anthonomus grandis Boheman. However, this insect growth regulator (IGR) appears to have little or no effect on the Heliothis populations that often occur concurrently with the boll weevil. Thus, the successful use of diflubenzuron in cotton will often require that alternative controls are available for suppression of Heliothis.

Numerous species of entomophagous arthropods prey on Heliothis spp. eggs and larvae, and these frequently retain these pests below economic injury levels (Whitcomb and Bell 1964, Ridgway and Lingren 1972, McDaniel and Sterling 1979). Conservation of entomophagous arthropods is a practical and economical method of dealing with Heliothis in cotton and a relatively selective chemical such as diflubenzuron might be compatible with the conservation approach. Herein, we review the effects of this IGR on various entomophagous arthropods as determined in several laboratory and field studies.

DISCUSSION

Laboratory Studies. Ables et al. (1977) and Wilkinson et al. (1978) have tested diflubenzuron in the laboratory for harmful effects on several species of entomophagous arthropods; their results are summarized in Table 1. For

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2/ This paper reports the results of research only. Mention of a pesticide in this paper does not constitute a recommendation for use by the USDA nor does it imply registration under FIFRA as amended.

TABLE 1. Summary of Laboratory Tests of Diflubenzuron Toxicity to Entomophagous Arthropods Associated With Cotton.

Species tested	Life stage treated	Diflubenzuron concentration (ppm)[a]	Effect(s)	Reference
Hippodamia convergens	Adults	7.7	Reduced egg hatch; larval mortality	Ables et al., 1977
		10,000	No adult mortality	Wilkinson et al., 1978
Chrysopa carnea	Larvae fed treated prey	5	Larval & pupal mortality	Ables et al., 1977
		100	No mortality	Wilkinson et al., 1978
		10,000	Pupal mortality	
Geocoris punctipes	Nymphs & adults	10,000	No mortality	Wilkinson et al., 1978
	Adults	2,100	Normal fecundity, egg hatch, and predation	
Trichogramma pretiosum	In host eggs & adult substrate	8	None	Ables et al., 1977
Apanteles marginiventris	Adult	10,000	None Normal parasitization	Wilkinson et al., 1978

[a] 2,100 ppm is approximately equivalent to the recommended rate for field use (70 g AI/ha).

example, topical applications of 7 ppm diflubenzuron (W-25, 25% AI) to adult pairs of convergent lady beetles, Hippodamia convergens Guérin-Méneville, resulted in reduced egg hatch and larval development, but the harmful effects gradually subsided after treatments were terminated (Ables et al. 1977). Similar results were obtained when H. convergens adults from diflubenzuron-treated (140 g AI/ha) cotton fields were held in the laboratory (Keever et al. 1977). Also, topical treatments (concentrations of $\leq$ 10,000 ppm) produced no adult mortality (Wilkinson et al. 1978). Similar studies with green lacewings, Chrysopa carnea Stephens, revealed lower egg viability when adults were topically treated (5 ppm) and increased larval and pupal mortality when larvae were fed topically treated (5 ppm) prey (Ables et al. 1977). Furthermore, topical applications of a high diflubenzuron concentration (10,000 ppm) to C. carnea larvae significantly increased mortality of pupae developing from these larvae (Wilkinson et al. 1978). The IGR had no apparent effect on the following species: Geocoris punctipes (Say), Apanteles marginiventris (Cresson), and Trichogramma pretiosum (Riley) (Wilkinson et al. 1978, Ables et al. 1977).

The cited tests were made with suspensions of diflubenzuron (W-25) in water. Wilkinson et al. (1978) demonstrated that the paraffinic crop oils with which the IGR is usually formulated for boll weevil control are extremely toxic to some entomophagous species. We have since (unpublished data) supported these findings by determining that diflubenzuron-oil formulations applied to cotton apparently reduce emergence of Trichogramma adults from parasitized eggs and that similarly treated host eggs in the laboratory were significantly less susceptible to parasitism. Thus, additional research on the effects of diflubenzuron-oil formulations on entomophagous species may be warranted.

It is difficult to relate the results of these various laboratory studies to actual field conditions because topical applications probably produce greater direct exposure to the chemical. Also, many of the tested concentrations are much higher than those applied to cotton in the field. Thus, field studies may more accurately reflect the net effects of the IGR on entomophagous arthropods.

Field Studies. Field studies to determine the effects of diflubenzuron spray programs on predacious arthropods have been conducted in North Carolina (Keever et al. 1977) and in central and west Texas (Ables et al. 1977, Rummel et al. 1979). Results from the central Texas study (Table 2) indicated that the IGR had little or no impact on predacious arthropods when applied at 5-day intervals at rates of 35, 70, or 140 g AI in 4.5 L of crop oil (Savol®) and 13.6 L of water/ha. Predator populations were slightly higher in the untreated plots, but the plots receiving the highest rate of diflubenzuron had greater predator abundance than any of the other plots. Thus the observed differences were probably due to factors other than the IGR, for example, plant phenology and prey abundance. The standard treatment (methyl parathion + toxaphene + chlordimeform) severely reduced the number of predators (Ables et al. 1977).

Studies in west Texas (Rummel et al. 1979) involving the same rates of diflubenzuron produced results similar to those obtained in central Texas. Moreover, mean seasonal predator populations were again higher in the plots receiving 140 g AI/ha than at the lower rates and the untreated control. The standard treatment with azinphosmethyl (336 g AI/ha) produced a major reduction in predators.

Field studies in North Carolina showed that diflubenzuron (140 g AI/ha) apparently caused a significant reduction in populations of G. punctipes as well as a reduction in egg hatch of H. convergens (Keever et al. 1977); other predacious species were unaffected. Turnipseed et al. (1974) stated that populations of Geocoris spp. and Nabis spp. were reduced when the IGR (281 or 562 g AI/ha) was applied to soybean foliage; however, they could not determine whether the reduction was due to the IGR, to a shortage of prey, or to a combination of these factors.

TABLE 2. Seasonal Mean No./ha for Various Predators in Insecticide-Treated and Untreated Cotton Fields: College Station, TX, June 11-August 5, 1976.[a]

Treatment	X no./ha								
	Scymnus	Other Coccinellidae	Other Coleoptera	Orius	Geocoris	Other Hemiptera	Chrysopa	Spiders	Total
Diflubenzuron[b]									
35 g AI/ha	782	4,404	276	4,426	644	830	69	6,409	16,114
70 g AI/ha	899	5,486	622	6,086	1,153	1,568	185	4,841	20,933
140 g AI/ha	506	8,689	1,198	8,714	1,314	1,729	368	6,108	27,698
Methyl parathion (1682 g) + toxaphene (841 g) + chlordimeform (140 g)[c]	0	0	59	0	59	138	59	770	956
Untreated	714	12,564	622	8,968	1,084	2,304	346	5,348	32,090

[a] Figures represent means for a total of 71.3 m row/plot samples 2-3 times/wk. Each treatment and the control were represented by 3 plots of various sizes (0.8-39.5 ha each).
[b] Treatments initiated on June 19 and applied at 5-day intervals until August 5.
[c] Treatments initiated on July 7 and applied at 3- to 5-day intervals until August 4.

CONCLUSIONS

Laboratory and field studies thus far have demonstrated that diflubenzuron and particularly the crop oils with which the IGR is formulated, may have a detrimental impact on several of the entomophagous species associated with cotton. However, these deleterious effects are somewhat minimal and may often ameliorate after diflubenzuron treatments are terminated. Generally, the IGR is much more selective than most conventional insecticides and when applied at the currently recommended rate (70 g AI/ha) should allow the conservation of most entomophagous arthropod species. Diflubenzuron thus has considerable potential for the selective control of the boll weevil, which should reduce the frequency and severity of Heliothis outbreaks in cotton due to destruction of the entomophagous species.

LITERATURE CITED

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.

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.

McDaniel, S. G., and W. L. Sterling. 1979. Predator determination and efficiency on Heliothis virescens eggs in cotton using ^{32}P. Environ. Entomol. 8:1083-7.

Ridgway, R. L., and P. D. Lingren. 1972. Predacious and parasitic arthropods as regulators of Heliothis populations. P. 48-56 in Distribution, Abundance, and Control of Heliothis Species in Cotton and Other Host Plants. South. Coop. Ser. Bull. No. 169.

Rummel, D. R., G. R. Pruitt, J. R. White, and L. J. Wade. 1979. Comparative effectiveness of diflubenzuron and azinphosmethyl for control of boll weevils. Southwest. Entomol. 4:315-20.

Turnipseed, S. G., E. A. Heinrichs, R. F. P. da Silva, and J. W. Todd. 1974. Response of soybean insects to foliar applications of a chitin synthesis inhibitor TH6040. J. Econ. Entomol. 67:760-2.

Whitcomb, W. H., and K. Bell. 1964. Predacious insects, spiders, and mites of Arkansas cotton fields. Ark. Agric. Exp. Stn., Bull. 690. 83 pp.

Wilkinson, J. D., K. D. Biever, C. M. Ignoffo, W. J. Pons, R. K. Morrison, and R. S. Seay. 1978. Evaluation of diflubenzuron formulations on selected parasitoids and predators. J. Ga. Entomol. Soc. 13:227-36.