MORTALITY OF TARNISHED PLANT BUG AND BOLL WEEVILS TO PROVADO AND DIFFERENT FORMULATIONS OF FIPRONIL

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Abstract

The efficacy of four formulations of Fipronil (80 WG, 2.5 EC, 0.73 EC, and 2.5 Gel) at three rates (0.018, 0.025, and 0.038 lb AI/acre) and Vydate (3.77 L at 0.25 lb AI/acre) for tarnished plant bugs, *Lygus lineolaris* (Palisot de Beauvois) and boll weevils, *Anthonomus grandis* Boheman, was determined by caging adults of the two species on cotton terminals treated in a spray chamber with the insecticides. All formulations and rates of Fipronil and Vydate were effective against boll weevils producing mortalities of 90% or greater. Fipronil 80 WG and 2.5 EC were the best formulations for plant bug control producing mortalities at rates of 0.025 and 0.038 lb AI/acre that were not significantly different from mortality obtained with Vydate. Two or three applications of Fipronil 80 WG (0.05 lb AI/acre), Fipronil 2.5 EC (0.05 lb AI/acre), Provado 1.6 F (0.047 lb AI/acre) and Curacron 8 E (0.5 lb AI/acre) were needed to control a large insecticide resistant population of plant bugs found in cotton in August. The effectiveness of Fipronil and Provado on plant bugs, along with the fact that each represents a new class of insecticide, will be very useful in early season insect control and in reducing insecticide resistance.

Introduction

Provado (imidacloprid, Bayer Ag Company) recently received federal registration (Almand 1995) for foliar and seed treatment on cotton. Prior to 1995, imidacloprid was evaluated as a foliar application under the trade name, Admire 2F. Earlier reports in the Beltwide Cotton Conference Proceedings have described the potential for imidacloprid as a foliar treatment in cotton (Almand and Mullins 1991; Mullins and Engle 1993; McNally et al., 1994; Engle et al., 1994). Mullins and Christie (1995) reported that Admire 2F was highly effective on populations of the tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois). Fipronil (phenylpyrazole) 80 WG applied at 0.05 lb AI/acre has been in world wide development as an insecticide on major crops that include cotton since 1989. Rhone Poulenc expects to have an experi-mental use permit for Fipronil 80 WG applied at 0.038 to 0.05 lb AI/acre for evaluation on cotton under commercial conditions in the U.S. for 1996 (Shaw 1995). Fipronil has received extensive evaluation on cotton since 1989 in the Mid-South by University and USDA researchers. Burris et al. (1994) reported that Fipronil had excellent activity on insect pests of cotton such as thrips, *Frankliniella* sp., tarnished plant bug, and boll weevils, *Anthonomus grandis* Boheman. Burris et al. (1995) reported the effectiveness of Fipronil and imidacloprid on the control of thrips in cotton. Imidacloprid and phenylpyrazole chemistries represent novel classes of insecticides that offer potential control of several insect pest species in cotton that are capable of causing economic losses.

In 1995, imidacloprid was marketed under the trade name of Provado 1.6 F as a foliar treatment on cotton. Rhone Poulenc presently has several formulations of phenylpyrazole chemistry that are under evaluation. In the studies reported herein, the primary objective was to determine the efficacy of different formulations and rates of Fipronil on tarnished plant bugs and boll weevils using cotton treated in a spray chamber. A small plot field test was conducted to compare the efficacy of both Fipronil and Provado to a standard insecticide for the tarnished plant bug.

Materials and Methods

Spray Chamber Tests. In these tests, adults were placed in cages with cotton terminals after the terminals were treated using a spray chamber as described in Elzen et al. (1992). The spray chamber was calibrated to deliver a total volume of six gallons of spray per acre using one hollow cone nozzle (TX6, spraying systems, Hammond, LA). Four formulations of Fipronil (80 WG, 2.5 EC, and 0.73 EC) were each applied at three rates (0.038, 0.025, and 0.018 lb AI/acre), and compared to Vydate (0.25 lb AI/acre) as a standard. Each treatment had three replications with ten cages per replication. Cages were ventilated paper cups (10 oz.), and controls were adults caged on cotton terminals treated with water. Susceptible tarnished plant bugs were collected from wild hosts as late instar nymphs and held on green beans in the labora-tory until they were 2-3 day old adults. Boll weevils were obtained as young adults from the Gast Rearing Facility, Mississippi State, MS. After plant terminals were treated and allowed to dry, two plant bugs or boll weevils were placed in each cage (60 insects per treatment). Insects were held in a holding room with a constant temperature of 78-80°F, relative humidity of 70%, and 12 h light. Mortality readings were taken at 24 h post-treatment. Treatment means were corrected for check mortality using Abbott's (1925) Formula. Data were analyzed using analysis of variance (SAS Institute 1987) and means were separated using least significant difference (LSD).

Reprinted from the *Proceedings of the Beltwide Cotton Conference*
Volume 2:987-990 (1996)
National Cotton Council, Memphis TN

Small Plot Field Test. Provado 1.6 F (0.047 lb AI/acre + 0.125 % vv Kinetic), Fipronil 80 WG (0.05 lb AI/acre), Fipronil 2.5 EC (0.05 lb AI/acre), Curacron 8E (0.50 lb AI/acre), and an untreated check were evaluated in small plots (16 rows x 80 feet) replicated three times for tarnished plant bug control. Each treatment was applied on 8, 11, and 15 August using a high clearance sprayer. Treatments were applied in water at 6 gal/acre with two TX6 nozzles/row at 5 mph. All treatments were sampled two to three days post-treatment with a drop cloth. Data were analyzed using analysis of variance (SAS Institute 1987) and means were separated by least significant difference (LSD).

Results and Discussion

The highest tarnished plant bug mortality found in the spray chamber bioassay was in the Vydate treatment (Table 1). It had significantly higher ($F = 6.40$; $df = 12, 24$; $P = 0.0001$) mortality than was found with all three rates of Fipronil 2.5 Gel and all but the highest (0.038 lb AI/acre) rate of Fipronil 0.73 EC. Fipronil 80 WG and Fipronil 2.5 EC were the best two of the four formulations of Fipronil tested for plant bug control, and plant bug mortality in the high and medium (0.038 and 0.025 lb AI/acre) rates of these two formulations was not significantly different from mortality in the Vydate treatment. Plant bug mortality in the three rates of the best two formulations of Fipronil differed significantly only with the low (0.018 lb AI/acre) rate of Fipronil 2.5 EC which produced only 66.7% mortality. Prior to their use in the test, 100 of the adult plant bugs were tested for pyrethroid resistance using permethrin in a discriminating dose glass vial bioassay as described in Snodgrass and Scott (1996). The adults were found to be susceptible with a mortality of 91% in the bioassay.

No significant differences ($F = 0.68$; $df = 9, 18$; $P = 0.72$) in boll weevil mortality were found among the treatments used in the second spray chamber bioassay. All Fipronil treatments produced mortalities of 90% or greater as compared to 96% in the Vydate treatment (Table 2).

In the field test, tarnished plant bug populations averaged approximately 30,000 per acre in all treatment plots prior to the first treatment application. One-hundred adults were collected from the field two days prior to the first treatment application and tested for pyrethroid resistance using permethrin in a discriminating dose glass vial bioassay as described in Snodgrass and Scott (1996). The adults were found to have a high level of pyrethroid resistance since mortality in the bioassay was only 30%.

The first application of the treatments (8 August) did not significantly reduce the nymphal population found in the cotton (Table 3), although reductions in numbers of nymphs ranged from 32 to 54% (as compared to the check). Adults were significantly reduced in number as compared to the check only in the Fipronil 2.5 EC treatment. Following the second treatment application (11 August) significant reductions in numbers of adults and nymphs as compared to the check occurred. Nymphs were significantly reduced in all treatments, while numbers of adults in both Fipronil treatments were significantly lower. Reductions in numbers of nymphs ranged from 66 (in the Fipronil 2.5 EC) to 85% (in the Fipronil 80 WG) as compared to the check. After the final treatment application (15 August), numbers of nymphs were again significantly lower in all treatments as compared to the check, with reductions ranging from 91 to 95% (as compared to the check). Numbers of adults were significantly lower in both Fipronil and the Provado treatments as compared to the check.

In the field test, nymphal counts were probably more accurate than the adult counts because of the mobility of the adult insects and the small plot size. The nymphal data from the test showed that the plant bugs in the field were difficult to control in the large cotton found in August even with two insecticides, Fipronil and Provado, that represented new classes of insecticides. It took two applications to reduce numbers of nymphs by 66 to 85%, and three applications to produce reductions in all treatments greater than 90%. Difficulty in controlling pyrethroid resistant plant bugs in mid-season (July) in cotton with insecticides other than pyrethroids was reported by Snodgrass and Elzen (1995). They made two applications of organophosphate (Bidrin, Guthion, methyl parathion, and Orthene), carbamate (Furadan and Vydate), and cyclodiene (Thiodan) insecticides, and the greatest reduction in numbers of nymphs was only 45.2% with Orthene. They found the control problem in the field to be partly due to insecticide resistance, while other factors not measured in the test (such as spray cover-age) also contributed to the control failure. Results of the present study show that Fipronil, Provado, and Curacron will not control insecticide resistant plant bugs in large cotton with a single application. However, control was achieved with two to three applications.

In summary, the spray chamber tests showed that Fipronil 80 WG or 2.5 EC were effective in controlling tarnished plant bugs at the highest two rates tested. All formulations and rates tested for Fipronil were effective against boll weevils, producing mortalities of 90% or greater. The field test showed that Fipronil 80 WG, Fipronil 2.5 EC, Provado 1.6 F, and Curacron 8E, used at rates of 0.05, 0.05. 0.047, and 0.5 lbs AI/acre, respectively, could control insecticide resistant plant bugs in late-season cotton. However, two to three applications were needed. It would be better to not use pyrethroids in early season for boll weevil and plant bug control to avoid increasing insecticide resistance in plant bugs and the tobacco budworm. The present availability of Provado for use in cotton will provide a new class of insecticide for use in early season plant bug control. It would be even better if Fipronil, another new class of

insecticide, was also available for early season plant bug and boll weevil control.

Acknowledgement

The authors wish to thank Mr. Richard Shaw (Rhone Poulenc Ag Company), Mr. Fred Donaldson (Bayer Ag Company), and Mr. Dale Brown (Ciba-Geigy) for their continuous support of this research.

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Table 1. Mortality of tarnished plant bugs caged for 24 h on cotton terminals treated in a spray chamber with Fipronil or Vydate.

Treatment	Formulation	Rate (lb AI/acre)	% Mortality[a]
Fipronil	60720A 80WG	0.038	93.0ab
Fipronil	60720A 80WG	0.025	89.5ab
Fipronil	60720A 80WG	0.018	82.5bc
Fipronil	61017A 2.5EC	0.038	93.0ab
Fipronil	61017A 2.5EC	0.025	91.2ab
Fipronil	61017A 2.5EC	0.018	66.7d
Fipronil	60342A 0.73EC	0.038	89.5ab
Fipronil	60342A 0.73EC	0.025	75.4cd
Fipronil	60342A 0.73EC	0.018	68.4d
Fipronil	60942A 2.5Gel	0.038	71.9cd
Fipronil	60942A 2.5Gel	0.025	71.9cd
Fipronil	60942A 2.5Gel	0.018	63.2d
Vydate	3.77 L	0.25	98.3a
LSD			13.80

Means in a column not followed by a common letter are significantly different (LSD, $P \leq 0.05$).
[a]Corrected for check mortality using Abbott's (1925) formula.

Table 2. Mortality of boll weevils caged for 24 h on cotton terminals treated in a spray chamber with Fipronil or Vydate.

Treatment	Formulation	Rate (lb AI/acre)	% Mortality[a]
Fipronil	60720A 80WG	0.038	100.0a
Fipronil	60720A 80WG	0.025	98.0a
Fipronil	60720A 80WG	0.018	100.0a
Fipronil	61017A 2.5EC	0.038	98.0a
Fipronil	61017A 2.5EC	0.025	100.0a
Fipronil	61017A 2.5EC	0.018	90.0a
Fipronil	60342A	0.038	100.0a
Fipronil	0.73EC	0.025	95.0a
Fipronil	60342A	0.018	97.0a
Vydate	0.73EC	0.25	96.0a
LSD	60342A		11.36
	0.73EC		
	3.77 L		

Means in a column not followed by a common letter are significantly different (LSD, P≤0.05).
[a]Corrected for check mortality using Abbott's (1925) formula.

Table 3. Mean numbers of tarnished plant bug adults and nymphs per acre collected with a drop cloth in cotton near Stoneville, MS, after treatment with various insecticides.

Treatment[a]	Rate (lb AI/acre)	10 August	
		Adults	Nymphs
Fipronil 80WG	0.05	11616b	7260NS
Fipronil 2.5EC	0.05	2178a	8712
Provado 1.6F	0.047	10890b	10890
Curacron 8E	0.5	13068b	10164
Check		15246b	15972
LSD		8058	8232
F value		4.08	1.72
P > F		0.04	0.24
df		4, 8	4, 8

Means in a column not followed by a common letter are significantly different (LSD, P≤0.05). NS = no significant differences.
[a] Treatments were applied on 8, 11, and 15 August.

Table 3. cont'd.

Treatment[a]	Rate (lb AI/acre)	14 August	
		Adults	Nymphs
Fipronil 80WG	0.05	6171b	2541b
Fipronil 2.5EC	0.05	1452c	5808b
Provado 1.6F	0.047	8712ab	5082b
Curacron 8E	0.5	6897ab	3630b
Check		10890a	17424a
LSD		4464	8417
F value		6.60	5.43
P > F		0.01	0.02
df		4, 8	4, 8

Means in a column not followed by a common letter are significantly different (LSD, P≤0.05). NS = no significant differences.
[a] Treatments were applied on 8, 11, and 15 August.

Table 3. cont'd.

Treatment[a]	Rate (lb AI/acre)	18 August	
		Adults	Nymphs
Fipronil 80WG	0.05	1089b	1452b
Fipronil 2.5EC	0.05	1089b	726b
Provado 1.6F	0.047	726b	1089b
Curacron 8E	0.5	3630a	1452b
Check		3993a	15972a
LSD		1497	5078
F value		11.69	18.09
P > F		0.00	0.00
df		2	5
		4, 8	4, 8

Means in a column not followed by a common letter are significantly different (LSD, P≤0.05). NS = no significant differences.
[a] Treatments were applied on 8, 11, and 15 August.