INSECTICIDE EFFICACY AGAINST LOUISIANA POPULATIONS OF BOLLWORM AND TOBACCO BUDWORM DURING 2000

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Abstract

Bollworm (BW) and tobacco budworm (TBW) control with Tracer 4SC (0.067 lb AI/acre) or Steward 1.25SC (0.11 lb AI/acre) was compared between ground (6 GPA) and aerial (3 GPA) application methods. Four applications were applied during late Jul to early Aug on Phytogen 355 cotton. Both Tracer and Steward reduced the number of BW/TBW injured and larval infested fruiting forms and increased seedcotton yield compared to the non-treated plots. Treatments applied by ground were more effective in controlling BW and TBW compared to those applied aerially. In a second experiment, the ovi-larvicidal efficacy of selected insecticides was evaluated against native BW and TBW infestations. Ovi-larvicidal toxicity ranged from 12.5% (Provado 1.6SC, 0.0375 lb AI/acre) to 77.5% (Steward 1.25SC, 0.11 lb AI/acre). The highest levels of mortality to eggs and larvae were measured for Tracer 4SC (70%) (0.067 lb AI/acre), Denim 0.16 EC (75%) (0.01 lb AI/acre), and Steward 1.25SC (77.5%) (0.11 lb AI/acre).

Introduction

The bollworm (BW), *Helicoverpa zea* (Boddie), and tobacco budworm (TBW), *Heliothis virescens* (F.), are annual pests in Louisiana cotton fields. Control measures are usually required on >85% of the crop's acreage to reduce economic losses from this pest complex. The commercialization of the Bollgard technology by Monsanto in 1996 provided cotton producers with a risk management strategy to manage BW and TBW. Bollgard cotton cultivars that effectively manage TBW have increased their share of total cotton acreage from 21% (1996) to 81% (2000) in Louisiana.

Bollgard has proven to be highly efficacious against TBW, but supplemental control of BW with foliar insecticides is still necessary to maximize yields. In Louisiana, cotton producers treat Bollgard acreage with ca. one to three applications of foliar insecticides to manage BW. Non-Bollgard acreage receives ca. four to eight insecticide applications per year for this pest.

In spite of the high adoption of Bollgard cultivars, insecticides remain an important pest management tool to control BW and TBW in Louisiana. Several insecticides are being developed as potential products that can be used against these pests. The performance of new compounds should be evaluated to determine the most logical and cost-effective use patterns.

This report summarizes the results of two studies completed in 2000. The effects of application method (ground vs. aerial) on the efficacy of Tracer and Steward against native infestations of BW and TBW were determined in large field plots. In a second experiment, the ovi-larvicidal efficacy of eight insecticides was evaluated against a native field infestation of TBW.

Materials and Methods

Application Methods

Phytogen 355 cottonseed was planted on 9 June at the Macon Ridge location of the Northeast Research Station (MR-NERS) near Winnsboro, LA, into a Gigger-Gilbert silt loam soil. Plots consisted of ca. 3.5 acres (84 rows x 1200 ft). The treatments included indoxacarb (Steward 1.25SC [0.11 lb AI/acre), E. I. DuPont de Nemours Co., Wilmington, DE), spinosad (Tracer 4SC [0.067 lb AI/acre], Dow Agrosciences, Indianapolis, IN), and a non-treated control. Insecticides were applied during the morning hours on 28 Jul and 4, 11, 18 Aug with a fixed wing aircraft or ground sprayer. Aerial applications were done by Winn Air services near Winnsboro, LA, (Pete Wollerson, pilot) with a Turbo-Air Tractor equipped with CP-nozzles (30^{o} deflectors) flying at ca. 140 mph calibrated to deliver two GPA. Ground applications were done with a John Deere 6700 high clearance sprayer calibrated to deliver six GPA through Teejet TX-8 hollow cone nozzles (2/row) at 52 psi. Treatment efficacy against BW and TBW was determined by examining 100 fruiting forms (squares or bolls) at ten randomly chosen sites within each plot. Plots were sampled four to five days after treatment (DAT) for evidence of fruiting form damage from Heliothines and forms infested with larvae. Eight rows of each plot were mechanically harvested on 13 Oct to estimate cotton yields. These plots were not replicated, but the ten sub-samples within each plot on a sample date and repeated measures following four applications were used to develop mean treatment effects with an estimate of variation (sample standard deviation).

Ovi-Larvicidal Test

The toxicity of selected insecticides to Heliothine eggs and neonate larvae was determined in a field experiment at the MR-NERS during 2000. This test was done in plots of cotton (Phytogen 355) planted 23 May. Plots in these trials consisted of four treated rows on row centers of 40 inches and 50 ft in length. The insecticides included imidacloprid (Provado 1.6SC [0.047 lb AI/acre], Bayer Corp., Kansas City, MO.), cyfluthrin (Baythroid 3EC [0.025 lb AI/acre], Bayer Corp., Kansas City, MO.), imidacloprid + cyfluthrin pre-mix (Leverage 2.7EC [0.0634 lb Ai/acre], Bayer Corp., Kansas City, MO.), spinosad (Tracer 4SC [0.067 lb AI/acre], Dow Agrosciences, Indianapolis, IN), indoxacarb (Steward 1.25SC [0.11 lb AI/acre], E. I. DuPont de Nemours Co. Wilmington, DE), emamectin benzoate (Denim 0.16EC [0.01 lb AI/acre], Novartis Corp., Greensboro, NC), thiamethoxam (Centric 40WG [0.0375 lb AI/acre], Novartis Corp., Greensboro, N.C.), and thiodicarb (Larvin 3.2 F[0.25 lb AI/acre], Aventis, Research Triangle Park, NC). Treatments were arranged in a randomized complete block design with four replications. Insecticides were applied on 1 Aug with a Hi-Clearance Sprayer equipped with a CO_2 charged delivery system and two TX-8 hollow cone nozzles per row calibrated to deliver a total volume of 6 gpa at 52 psi. There was no rainfall recorded and relative humidity was high.

Cotton plants across the test area were naturally infested with BW and TBW eggs. Eggs (ten/plot) were randomly collected from the upper one-third of the plant canopy on the two center rows of each plot within 4 h after treatment (HAT). Only those eggs less than 24 h old with a milky white color and no obvious embryonic development (darkening of the egg contents or formation of a red band around the chorion circumference) were collected from the plots. During oviposition, BW and TBW eggs are glued to the plant foliage, therefore the eggs and the attached cotton foliage were placed in the plastic bags and transported to the laboratory. Each egg and a small piece of adjoining plant tissue was placed in a 1 oz plastic cup partially filled with a meridic diet for rearing BW and TBW. The cups were capped and inverted so the egg was not in direct contact with the rearing medium. The cups were placed outside the laboratory in a covered open-air insectary. Mortality of eggs and larvae were measured at 96 and 128 HAT, respectively. Egg mortality was based on incomplete larval eclosion from the chorion. Larval mortality was recorded if the larva had completely emerged from the chorion and was unable to translocate. Survivors of the egg cohort in the non-treated control were identified to determine BW and TBW species composition.

Data were analyzed and the results were corrected for mortality in each respective control treatment with Abbott's (1925) formula. These data were

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subjected to analysis of variance procedures and means compared with DMRT (SAS Institute 1998).

Results and Discussion

Application Methods

The Heliothine populations during this test were represented mostly by tobacco budworm (> 85%). Ground and aerial applications of Tracer reduced the number of BW and TBW damaged fruiting forms and fruiting forms infested with larvae in all post-treatment samples and for the test mean compared to that in the non-treated plots (Fig. 1). The plots treated with Tracer using ground applications generally had fewer damaged fruiting forms and fruiting forms infested with larvae than plots treated with aerial applications of Tracer. Tracer applied by ground and air increased seedcotton yields above that in the non-treated plots by 1745 lb/acre and 1155 lb/acre, respectively (Fig. 2).

Steward reduced the number of BW and TBW damaged fruiting forms and fruiting forms infested with larvae in all post treatment samples and the test mean compared with that in the non-treated plots (Fig. 3). The plots treated with ground applications of Steward generally had fewer damaged fruiting forms and fruiting forms infested with larvae compared to that in the plots treated with aerial applications of Steward. The ground and aerial applications of Steward increased seedcotton yields above that in the non-treated plots by 794 lb/acre and 693 lb/acre, respectively (Fig. 4).

Previous studies have shown Tracer and Steward at the rates evaluated in the current study to be effective in controlling Heliothine pests in cotton (Leonard et al. 1999, Allen et al. 2000). Applications of either insecticide by ground consistently provided better control of these pests than those treatments in aerial applications. The ground applications of six GPA probably resulted in better coverage than two GPA in aerial treatments. Rester et al. (1994) demonstrated more consistent control of Heliothines in cotton with aerially applied finished sprays of five GPA compared to two GPA. Although BW and TBW control in that study was considered acceptable with the two GPA applications, there was considerable less variation in control with the five GPA applications. The use of foliar sprays to successfully manage high Heliothine populations in Louisiana requires the applications to be timely and efficient. In Louisiana cotton fields, the plant canopy becomes closed during the mid-to-late season and makes successful insect control in the lower two-thirds of the plants difficult to achieve. In a previous study, the efficacy of Tracer against Heliothines was highest in aerial applications of five gpa (200 um droplets) compared to aerial applications of two gpa (200 um droplets) (Esquivel and Kirk 1998, Kirk and Esquivel 1998). Furthermore, Tracer at five and two GPA was less efficacious against Heliothines in closed plant canopy treatments compared to that in open plant canopy treatments. Spray deposition and plant coverage are important factors that can affect the efficacy of insecticides. The standard insecticide application volume used for cotton insect control by many Louisiana aerial applicators ranges from two to three GPA. During the late-season, with high densities of Heliothines and closed canopy fields, aerial application volumes within this range may not be sufficient to provide the necessary plant coverage and can result in unsatisfactory control. The data in the present study suggest that more consistent BW and TBW control might be expected for ground applications of Tracer and Steward compared to aerial applications.

Ovi-Larvicidal Test

Based on surviving larvae from eggs collected in the non-treated plots, > 75% were identified as TBW. Natural mortality of eggs and larvae in the non-treated control was ca. 22.0% and 5.0%, respectively. BW and TBW mortality from the ovicidal, larvicidal and ovi-larvicidal toxicity of these insecticides ranged from 5.0 to 27.5%, 7.5 to 70.0%, and 12.5 to 77.5%, respectively (Table 1). Although egg mortality was generally low, the highest ovicidal activity was observed in plots treated with Leverage, Tracer, and Larvin. Residual toxicity to larvae hatching from treated eggs was significantly higher in plots treated with Tracer, Denim and Steward compared to that in plots treated Provado, Baythroid, Leverage, Centric and Larvin. All insecticides demonstrated higher levels of ovi-larvicidal efficacy than that for Provado. The results of this test are generally within the range of those values previously reported for many of these insecticides (Leonard et al. 1990, Peterson et al. 1998, Ngo et al. 1999). Tracer, Denim, and Steward demonstrated generally low toxicity to eggs, but efficacy of these products against larvae hatching from treated eggs or eggs hatching on treated leaf surfaces were significantly higher than for the other treatments.

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Table 1. Ovi-larvicidal activity of selected insecticides against bollworm and tobacco budworm in Louisiana, 2000.

	Percent Mortality[2]			
Treatment[1]	**Rate/Acre Lb (AI)**	**Ovicidal (96HAI)**	**Larvicidal (168HAI)**	**Ovi-larvicidal (168 HAI)**
Provado 1.6SC	0.0375	5.0a	7.5c	12.5d
Baythroid 2EC	0.025	20.0a	17.5c	37.5bc
Leverage 2.7E	0.0634	22.5a	10.0c	32.5c
Tracer 4SC	0.067	25.0a	45.0b	70.0a
Denim 0.16EC	0.01	5.0a	70.0a	75.0a
Steward 1.25SC	0.11	7.5a	70.0a	77.5a
Centric 40WG	0.0375	12.5a	20.0c	32.5c
Larvin 3.2SC	0.25	27.5a	22.5c	50.0b
(P>F)		0.09	<0.01	<0.01

Means followed by the same letter do not significantly differ (P=0.05, DMRT).

[1] Control mortality of eggs (22%) and larvae (5%) corrected with Abbott's formula.

[2] Tobacco budworm represented >75% of the Heliothine population.

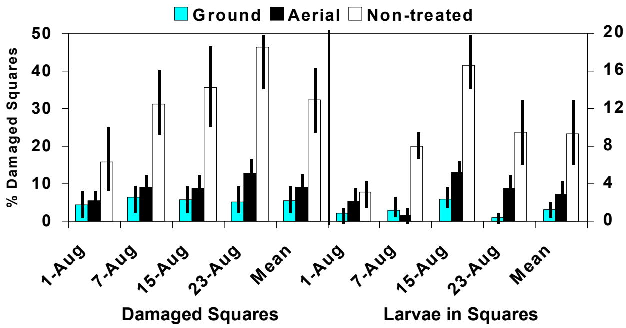

Figure 1. Efficacy of Tracer 4SC (0.067 lb. AI/acre) against Heliothines in aerial and ground applications.

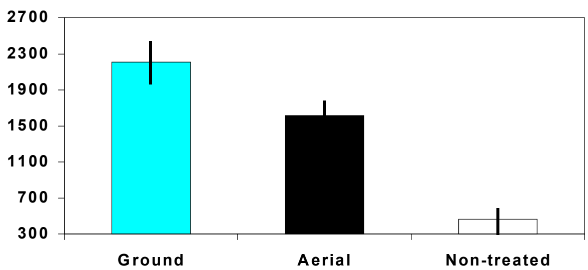

Figure 2. Seedcotton yields of Tracer 4SC (0.067 lb. AI/acre) treated plots, ground vs. aerial.

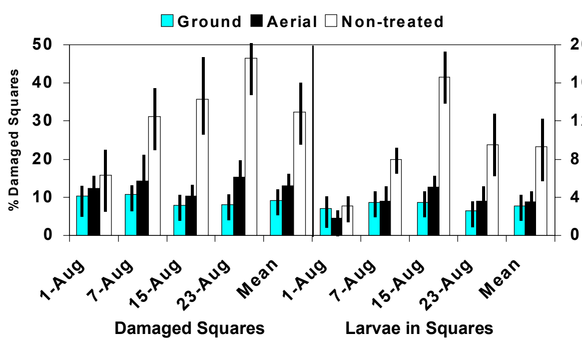

Figure 3. Efficacy of Steward 1.25SC (0.11 lb AI/acre) against Heliothines in aerial and ground applications.

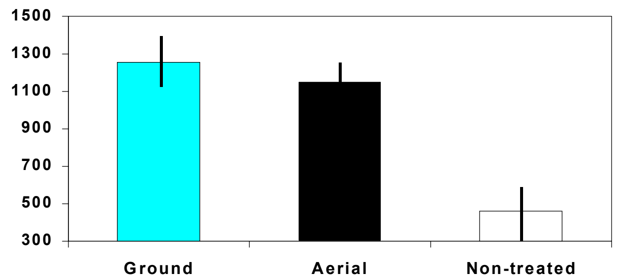

Figure 4. Seedcotton yields of Steward 1.25SC (0.11 lb. AI/acre) treated plots, ground vs. aerial.