IMPACT OF NEW BOLLWORM INSECTICIDES ON NATURAL ENEMIES IN THE SOUTHERN ROLLING PLAINS OF TEXAS

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Abstract

Conservation of natural enemies is an important part of a comprehensive cotton integrated pest management program. Currently, cotton insecticide development focuses not only on the efficacy of the products on the pest but also the selectivity of the products on natural enemies. The objective of this study was to evaluate three new lepidopteran materials for their impact on natural enemies under different rate and spray frequency regimes.

Each of the newer products had less impact on natural enemies than the pyrethroid standard. Natural enemy populations declined with the first application and the reduction was significant with spiders and *Scymnus* spp. The second application six days later prevented all the treated plots from recovering to the same level as in the untreated plots. Tracer® had less impact than Steward® and Steward® had less impact than Denim® when natural enemies were considered as a group. Not all the natural enemies evaluated in this study responded the same to the different compounds. Consultants and producers must be aware of the natural enemy complex in cotton fields to assess the impact of these newer products and consider the insecticides selectivity when determining product choice.

Introduction

With the removal of the boll weevil (*Anthonomus grandis grandis* Bohemon) as a significant pest in the Southern Rolling Plains (SRP), biologically intensive integrated pest management (IPM) programs can be developed to manage cotton pests in the region (Sansone et al. 1999). Costs due to losses by lepidopteran pests play a significant role in management in cotton (Williams 1999). In addition, the cotton aphid (*Aphis gossypii* Glover) can be a significant pest in the SRP. The cotton aphid problem can be caused not only by weather but also by insecticides that disrupt the natural enemy complex (Slosser et al. 1989).

Many studies have shown that the natural enemy complex in cotton has a significant impact on pests (Ewing and Ivy 1943, Fletcher and Thomas 1943, Ehler et al. 1973). A key component of an IPM program in cotton is conservation biological control. Cotton provides an ideal habitat for natural enemies (Whitcomb and Bell 1964). If new products are developed that can selectively control pests and reduce the impact on natural enemies, pest managers would be able to manage key pest outbreaks and minimize the chance of a secondary pest outbreak.

Three new chemistries were available to producers to control lepidopteran pests in 1999. Spinosad (Tracer®, Dow AgroSciences) has been used in cotton since 1995. Indoxacarb (Steward®, DuPont) had a limited EUP in 1999 and emamectin benzoate (Denim®, Novartis) had a section 18 in Texas for beet armyworm (*Spodoptera exigua* (Hhbner)). Steward® and Tracer® have been shown to be selective to natural enemies under limited field trials and laboratory conditions (Pietrantonio and Benedict 1997, Tillman et al. 1998). The objective of this study was to determine the impact of these products on natural enemies compared to a pyrethroid standard and to determine if differences of toxicity to different natural enemies could be determined under field conditions.

Materials and Methods

The trial was established in a commercial cotton field north of Ballinger, TX on August 12, 1999. The treatments are shown in Table 1. The treatments were based on rates and also on multiple applications. The first application occurred on August 12 and the second on August 17, five days after the first which would be consistent with bollworm (*Helicoverpa zea* (Boddie)) and tobacco budworm (*Heliothis virescens* (F.)) applications (Kharboutli et al. 1999). The plots were sprayed with a Lee Spider Spray Trac small plot sprayer with nozzles spaced every 19 inches. Drop nozzles were used between the rows such that each row had three nozzles directed toward the cotton. The nozzles on the drops were Teejet® VS-6 conejet and the nozzles over the row were Teejet® 8002 VS. The total volume sprayed was 12 gallons per acre using 30 psi. Plots were 4 rows (38 inch) x 50 feet (0.01 A). Each treatment was replicated four times in a randomized complete block design. Only one rate of each product was evaluated for two applications.

Natural enemy counts were made by sampling ten plants in each plot with a beat bucket (Knutson 1999). Natural enemies sampled included spiders, *Geocoris* spp., *Orius* spp., assassin bugs (*Zelus* spp. and *Sinea* spp.), *Chrysoperla* spp., *Hippodamia* spp., *Nabis* spp. and *Scymnus* spp. and included both the nymphs or larvae and adults. Sample dates included August 12, August 13, August 18 and August 23. Numbers were converted to ln x+1 values and analyzed by analysis of variance. Means were separated using Fisher's LSD at P=0.05 (Jandel Scientific 1995).

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Results and Discussion

The data are variable and in many cases no significant differences occur. However, trends for declining numbers, especially after the second application are apparent. Steward® and Asana® both significantly reduced spider populations after the first application ($F=2.47$, $DF=11, 36$, $P=0.022$) (Tables 3). The spider data show the difficulty in assessing insecticides in a field situation because of plot variability. Only one of the Steward® treatments at 0.09 lbs ai/ac and one of the Asana® treatments had significantly lower numbers. The low rate (0.055 lbs ai/ac) of Steward® seemed to have less of an impact. All treated plots had lower numbers than the untreated plots after the second application.

The big-eyed bug data show no significant differences between any of the products. None of the treated plots recovered to levels in the untreated plots.

Orius spp. seems to be more tolerant to insecticide applications (Tables 6 and 7). Numbers did not decline in the Asana® plots until after the second application (Table 7).

Assassin bugs again showed the same similar pattern of variability among treatments. The untreated plots showed a rapid decline after the first application but quickly recovered (Tables 8 and 9). Tracer® and Denim® reduced numbers more than Steward® but none of the treatments were significantly different for any of the dates.

Asana® and Denim® significantly reduced *Scymnus* spp. numbers after the first application ($F=2.067$, $DF=11, 36$, $P=0.05$) (Tables 10 and 11). However, populations rebounded quickly at 6 days and numbers were not reduced significantly with the second application. Steward® had the least impact with one application and Denim® and Steward® having lower numbers than Tracer® after the second application. The *Scymnus* spp. population consisted primarily of adults.

All the treatments reduced the total natural enemies sampled when compared to the untreated plots (Tables 12 and 13). As expected, the second application prevented numbers from rebounding to the level of the untreated plots.

Conclusions

Conservation of natural enemies will be an important component of future cotton IPM programs. New insecticides being developed should have a degree of selectivity between the targeted pest and natural enemies.

All the products in this trial had less of an impact on natural enemies than the pyrethroid standard. However, all the products reduced numbers below the untreated plot numbers although the difference was not significant. The reduction usually occurred with the first application, but the second application prevented natural enemies from recovering to levels seen in the untreated plots. Tracer® had less of an impact than Steward® and Steward® had less of an impact than Denim® when natural enemies are considered as a group.

The newer products showed differences in selectivity between the different natural enemies in the trial. *Orius* spp. was the most tolerant to all of the insecticides. Even the first pyrethroid application did not reduce numbers below the untreated plots. Spiders and *Scymnus* spp. showed them most sensitivity to the new products. Spiders showed a significant reduction with the first application of the 0.09 lbs ai/ac rate of Steward® and spider numbers decreased in the Denim® plots after the second application. *Scymnus* spp. adults were reduced with the first Tracer® application but numbers rebounded quickly. Steward® and Denim® further reduced *Scymnus* spp. adults after the second application.

Similar to other studies (Tillman et al. 1998), Steward® has a reduced impact on *Geocoris* spp. Denim® reduced numbers after the second application and Tracer® is similar to the Steward®. None of the products affect assassin bugs although Tracer® and Denim® caused an initial reduction but numbers recovered quickly.

This study shows the difficulty in evaluating products for their impact on natural enemies. In addition to toxicity, factors such as the age of the plant, alternate food sources and repellency of the insecticide can all affect evaluations. Nevertheless, the study does indicate some differences between the newer products and does show that the newer chemistries do have the potential to conserve natural enemies especially when compared to the pyrethroid standards.

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Table 1. Treatments evaluated in comparison of new bollworm insecticides and their impact on natural enemies. Runnels Co., TX. 1999.

Treatment	Rate (oz/ac)	Rate (lbs ai/ac)	Number of Applications
Tracer® 4 EC	2.08	0.065	1
Tracer® 4 EC	2.08	0.065	2
Steward® 1,25 EC	5.63	0.055	1
Steward® 1.25 EC	6.65	0.065	1
Steward® 1,25 EC	9.21	0.09	1
Steward® 1.25 EC	9.21	0.09	2
Steward® 1.25 EC	11.26	0.11	1
Denim® 0.16 EC	8.0	0.01	1
Denim® 0.16 EC	8.0	0.01	2
Asana® 0.66 EC	5.81	0.03	1
Asana® 0.66 EC	5.81	0.03	2
Untreated			

Table 2. Average number of spiders in 10 beat bucket samples in plots treated once with a selected insecticide. Runnels Co., TX. 1999.

Treatment[1]	Rate (lbs ai/ac)	Pre	1 DAT[2, 3]	6 DAT	11 DAT
Tracer®	0.065	6.75a	4.50a	3.75a	5.50a
Steward®	0.055	8.25a	7.00a	4.75a	4.50a
Steward®	0.065	8.00a	5.50a	5.00a	4.50a
Steward®	0.09	9.50a	5.75a	3.00a	3.00a
Steward®	0.11	7.00a	5.25a	3.75a	5.75a
Denim®	0.01	7.50a	5.50a	3.00a	3.50a
Asana®	0.03	8.00a	5.75a	3.25a	3.00a
Untreated		9.00a	7.00a	4.75a	5.75a

1. Treatments were applied August 12, 1999
2. Data were transformed using ln x + 1 for analysis
3. Means followed by the same letter do not significantly differ (P=0.05, Fisher's LSD)

Table 3. Average number of spiders in 10 beat bucket samples in plots treated twice with a selected insecticide. Runnels Co., TX. 1999.

Treatment[1]	Rate (lbs ai/ac)	Pre	1 DAT[2, 3, 4]	1 DAT[5]	6 DAT[6]
Tracer®	0.065	7.25a	6.25a	3.75a	2.25a
Steward®	0.09	8.00a	3.00b	3.00a	4.25a
Denim®	0.01	8.75a	7.00a	2.00a	4.50a
Asana®	0.03	7.00a	1.00b	2.00a	2.25a
Untreated		9.00a	7.00a	4.75a	5.75a

1. Treatments were applied August 12 and August 17, 1999.
2. Plots evaluated one day after August 12 application
3. Data were transformed using ln x + 1 for analysis
4. Means followed by the same letter do not significantly differ (P=0.05, Fisher's LSD)
5. Plots evaluated one day after August 17 application
6. Plots evaluated six days after August 17 application

Table 4. Average number of big-eyed bug nymphs and adults in 10 beat bucket samples in plots treated once with a selected insecticide. Runnels Co., TX. 1999.

Treatment[1]	Rate (lbs ai/ac)	Pre	1 DAT[2, 3]	6 DAT	11 DAT
Tracer®	0.065	2.25a	1.75a	0.75a	1.00a
Steward®	0.055	2.00a	0.25a	0.75a	0.50a
Steward®	0.065	1.75a	1.75a	0.00a	0.25a
Steward®	0.09	2.75a	0.50a	1.25a	0.25a
Steward®	0.11	1.75a	0.25a	0.50a	1.25a
Denim®	0.01	2.00a	0.50a	0.25a	1.00a
Asana®	0.03	1.50a	0.75a	0.75a	0.25a
Untreated		1.50a	1.50a	2.00a	1.75a

1. Treatments were applied August 12, 1999
2. Data were transformed using ln x + 1 for analysis
3. Means followed by the same letter do not significantly differ (P=0.05, Fisher's LSD)

Table 5. Average number of big-eyed bug nymphs and adults in 10 beat bucket samples in plots treated twice with a selected insecticide. Runnels Co., TX. 1999.

Treatment[1]	Rate (lbs ai/ac)	Pre	1 DAT[2, 3, 4]	1 DAT[5]	6 DAT[6]
Tracer®	0.065	1.25a	1.25a	1.25a	0.75a
Steward®	0.09	1.75a	1.50a	2.00a	0.50a
Denim®	0.01	1.75a	1.00a	0.50a	0.00a
Asana®	0.03	2.25a	2.00a	0.25a	0.00a
Untreated		1.50a	1.50a	2.00a	1.75a

1. Treatments were applied August 12 and August 17, 1999.
2. Plots evaluated one day after August 12 application
3. Data were transformed using ln x + 1 for analysis
4. Means followed by the same letter do not significantly differ (P=0.05, Fisher's LSD)
5. Plots evaluated one day after August 17 application
6. Plots evaluated six days after August 17 application

Table 6. Average number of *Orius* spp. nymphs and adults in 10 beat bucket samples in plots treated once with a selected insecticide. Runnels Co., TX. 1999.

Treatment[1]	Rate (lbs ai/ac)	Pre	1 DAT[2, 3]	6 DAT	11 DAT
Tracer®	0.065	2.75a	2.50a	2.00a	1.50a
Steward®	0.055	2.00a	3.25a	2.25a	1.00a
Steward®	0.065	2.75a	2.25a	2.50a	1.00a
Steward®	0.09	2.50a	1.50a	3.00a	0.50a
Steward®	0.11	3.00a	3.75a	5.00a	2.25a
Denim®	0.01	2.50a	1.50a	1.00a	1.00a
Asana®	0.03	3.25a	2.50a	3.00a	1.75a
Untreated		2.00a	2.00a	3.75a	1.75a

1. Treatments were applied August 12, 1999
2. Data were transformed using ln x + 1 for analysis
3. Means followed by the same letter do not significantly differ (P=0.05, Fisher's LSD)

Table 7. Average number of *Orius* spp. nymphs and adults in 10 beat bucket samples in plots treated twice with a selected insecticide. Runnels Co., TX. 1999.

Treatment[1]	Rate (lbs ai/ac)	Pre	1 DAT[2, 3, 4]	1 DAT[5]	6 DAT[6]
Tracer®	0.065	2.25a	1.50a	3.00a	1.00a
Steward®	0.09	2.50a	2.25a	2.00a	0.25a
Denim®	0.01	2.50a	1.75a	1.00a	0.75a
Asana®	0.03	2.75a	3.00a	1.50a	1.25a
Untreated		2.00a	2.00a	3.75a	1.75a

1. Treatments were applied August 12 and August 17, 1999.
2. Plots evaluated one day after August 12 application
3. Data were transformed using ln x + 1 for analysis
4. Means followed by the same letter do not significantly differ (P=0.05, Fisher's LSD)
5. Plots evaluated one day after August 17 application
6. Plots evaluated six days after August 17 application

Table 8. Average number of Assassin bug nymphs and adults in 10 beat bucket samples in plots treated once with a selected insecticide. Runnels Co., TX. 1999.

Treatment[1]	Rate (lbs ai/ac)	Pre	1 DAT[2, 3]	6 DAT	11 DAT
Tracer®	0.065	1.00a	0.25a	1.00a	0.75a
Steward®	0.055	1.25a	2.25a	3.50a	1.00a
Steward®	0.065	2.00a	0.50a	1.75a	1.75a
Steward®	0.09	1.50a	0.25a	2.00a	2.25a
Steward®	0.11	1.50a	1.00a	1.75a	1.00a
Denim®	0.01	0.75a	0.25a	1.75a	2.00a
Asana®	0.03	1.25a	2.50a	1.75a	0.75a
Untreated		0.75a	0.50a	3.50a	0.50a

1. Treatments were applied August 12, 1999
2. Data were transformed using ln x + 1 for analysis
3. Means followed by the same letter do not significantly differ (P=0.05, Fisher's LSD)

Table 9. Average number of Assassin bug nymphs and adults in 10 beat bucket samples in plots treated twice with a selected insecticide. Runnels Co., TX. 1999.

Treatment[1]	Rate (lbs ai/ac)	Pre	1 DAT[2, 3, 4]	1 DAT[5]	6 DAT[6]
Tracer®	0.065	1.25a	0.25a	1.25a	1.25a
Steward®	0.09	2.00a	2.50a	2.25a	1.25a
Denim®	0.01	1.25a	0.75a	2.25a	1.50a
Asana®	0.03	1.00a	1.25a	2.50a	0.50a
Untreated		0.75a	0.50a	3.50a	0.50a

1. Treatments were applied August 12 and August 17, 1999.
2. Plots evaluated one day after August 12 application
3. Data were transformed using ln x + 1 for analysis
4. Means followed by the same letter do not significantly differ (P=0.05, Fisher's LSD)
5. Plots evaluated one day after August 17 application
6. Plots evaluated six days after August 17 application

Table 10. Average number of *Scymnus* spp. larvae and adults in 10 beat bucket samples in plots treated once with a selected insecticide. Runnels Co., TX. 1999.

Treatment[1]	Rate (lbs ai/ac)	Pre	1 DAT[2, 3]	6 DAT	11 DAT
Tracer®	0.065	1.75a	1.50ab	2.75a	2.00a
Steward®	0.055	2.00a	1.25ab	2.50a	1.25a
Steward®	0.065	1.50a	1.25ab	2.50a	2.25a
Steward®	0.09	2.00a	2.75a	2.25a	2.50a
Steward®	0.11	2.25a	2.25a	2.50a	1.00a
Denim®	0.01	2.00a	0.50bc	1.50a	1.25a
Asana®	0.03	1.75a	0.25c	2.25a	0.25a
Untreated		2.50a	1.50ab	2.25a	0.50a

1. Treatments were applied August 12, 1999
2. Data were transformed using ln x + 1 for analysis
3. Means followed by the same letter do not significantly differ (P=0.05, Fisher's LSD)

Table 11. Average number of *Scymnus* spp. larvae and adults in 10 beat bucket samples in plots treated twice with a selected insecticide. Runnels Co., TX. 1999.

Treatment[1]	Rate (lbs ai/ac)	Pre	1 DAT[2, 3, 4]	1 DAT[5]	6 DAT[6]
Tracer®	0.065	2.00a	0.50bc	2.25a	2.00a
Steward®	0.09	1.50a	2.25a	1.25a	2.00a
Denim®	0.01	1.50a	1.75ab	1.75a	0.75a
Asana®	0.03	2.25a	0.25c	0.75a	0.50a
Untreated		2.50a	1.50ab	2.25a	0.50a

1. Treatments were applied August 12 and August 17, 1999.
2. Plots evaluated one day after August 12 application
3. Data were transformed using ln x + 1 for analysis
4. Means followed by the same letter do not significantly differ (P=0.05, Fisher's LSD)
5. Plots evaluated one day after August 17 application
6. Plots evaluated six days after August 17 application

Table 12. Average number of natural enemies in 10 beat bucket samples in plots treated once with a selected insecticide. Runnels Co., TX. 1999.

Treatment[1]	Rate (lbs ai/ac)	Pre	1 DAT[2, 3]	6 DAT	11 DAT
Tracer®	0.065	16.25a	13.50a	12.00a	11.25a
Steward®	0.055	19.00a	15.75a	14.75a	10.75a
Steward®	0.065	18.75a	12.50a	13.50a	12.25a
Steward®	0.09	15.00a	11.25a	12.75a	9.50a
Steward®	0.11	17.75a	13.50a	14.25a	12.50a
Denim®	0.01	20.00a	9.75a	9.25a	9.25a
Asana®	0.03	15.75a	13.25a	12.00a	6.25a
Untreated		16.50a	14.00a	16.75a	11.75a

1. Treatments were applied August 12, 1999
2. Data were transformed using ln x + 1 for analysis
3. Means followed by the same letter do not significantly differ (P=0.05, Fisher's LSD)

Table 13. Average number of natural enemies in 10 beat bucket samples in plots treated twice with a selected insecticide. Runnels Co., TX. 1999.

Treatment[1]	Rate (lbs ai/ac)	Pre	1 DAT[2, 3, 4]	1 DAT[5]	6 DAT[6]
Tracer®	0.065	19.50a	11.00a	12.75a	8.50a
Steward®	0.09	17.00a	12.00a	11.00a	8.50a
Denim®	0.01	18.00a	14.25a	8.25a	8.75a
Asana®	0.03	19.25a	8.75a	7.00a	5.25a
Untreated		16.50a	14.00a	16.75a	11.75a

1. Treatments were applied August 12 and August 17, 1999.
2. Plots evaluated one day after August 12 application
3. Data were transformed using ln x + 1 for analysis
4. Means followed by the same letter do not significantly differ (P=0.05, Fisher's LSD)
5. Plots evaluated one day after August 17 application
6. Plots evaluated six days after August 17 application