IMPACTS OF COMMERCIAL INSECTICIDE APPLICATIONS ON NATURAL ENEMIES

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Abstract

Cotton fields were sampled prior to and after commercial, whole-field applications of insecticides to monitor the effects of insecticides on the densities of beneficial arthropods. The effects of single product conventional chemistry treatments varied somewhat with species of beneficial arthropod, but in general, showed short-lived adverse effects on species impacted. Tracer showed the least adverse effects of all of the products tested. Regent appeared to have rather broad spectrum effects, with longer residual activity than the single product conventional chemistry treatments. The combination of Karate plus Guthion also appeared to have more severe effects, with a longer residual than the single product applications, but this may have been a result of multiple applications rather than the chemistry.

Introduction

Research conducted in 1997 and 1998 (partially funded by Cotton Inc.) indicated that common insecticides used against boll weevils generally had short lived adverse effects against beneficial arthropods, particularly when applied only once. In both years, large experimental plots (8 to 10 acres each) were used. The objective of the work conducted in 1999 was to evaluate the effects of commercial, whole-field applications of insecticides on beneficial arthropods to provide insight as to whether the large plot experimental results are indicative of results expected with whole-field applications.

Materials and Methods

Contacts were made with several commercial cotton producers in the Lower Rio Grande Valley (LRGV) to identify fields which were scheduled for insecticide treatment. Fields for sampling were selected based on field size, location, insecticide to be applied, and recent treatment history. Small fields were generally avoided. Fields were selected from areas throughout most of the cotton growing region of the LRGV. Each field sampled either had not been previously treated with insecticide, or had not received a treatment within two weeks. Insecticide treatments evaluated included a range of products representing most of the currently registered insecticide classes and one experimental product (the experimental product was evaluated on a large plot on the Texas A&M Research and Extension Center's farm). Three fields were sampled during two sequential applications of insecticides.

Treatments evaluated included: organophosphates (azinphos-methyl,Guthion 2L, Bayer AG, Kansas City, MO; ULV malathion, Fyfanon, Cheminova Agro, Lemvig, Denmark and Atrapa, Griffin L.L.C., Valdosta, GA), carbamates (oxamyl, Vydate C-LV, E. I. Du Pont de Nemours and Company, Wilmington, DE; and [Vydate+] carbofuran, Furadan 4F, FMC Corporation, Philadelphia, PA), pyrethroids (cypermethrin, Ammo 2.5EC, FMC Corporation, Philadelphia, PA; lambda-cyhalothrin, Karate Z and 1EC, Zeneca Ag Products, Wilmington, DE), a fermentation product (spinosad, Tracer 4SC, Dow AgroSciences, Indianapolis, IN), and a phenyl pyrazole (fipronil, Regent 4F, Aventis, Research Triangle Park, NC). Three fields sampled during mid-season were monitored before and after the first application (Vydate, Guthion and Karate) and monitored again before and after a second application (Karate+Guthion in all three fields).

Reprinted from the *Proceedings of the Beltwide Cotton Conference*
Volume 2:1133-1138 (2001)
National Cotton Council, Memphis TN

Information on field size, insecticides and rates applied are presented in Table 1. Use rates reflect the producers choice and represent common use rates for the LRGV.

In each field, beneficial arthropods were sampled before and after insecticide applications. Pre-application samples were generally taken the day before treatment, but ranged from the day of treatment (prior to treatment) to three days before treatment. Three post-application samples were targeted at 2 to 3 days after application, 4 to 5 days after application, and 6 to 7 days after application.

Sampling was conducted with a modified leaf blower/vacuum (Sparks and Norman, 1998). Each field was sampled at 6 to 8 locations (generally 8), with 100 feet-of-row sampled at each location. Samples were tagged, transported to the laboratory in an ice chest, and placed in a freezer to kill the arthropods and for storage. Each sample was examined under magnification and beneficial arthropods were counted. Beneficial arthropods and stages sampled were: [names within ( ) indicate the designations used for tabular data]

Lady beetles:
- Non-*Scymnus* adults (LB adults)
- Non-*Scymnus* larvae (LB larvae)
- *Scymnus* adults (Sc adults)
- *Scymnus* larvae (Sc larvae)

Green lacewing adults (GLW adults)
Green lacewing larvae (GLW larvae)
Big-eyed bug adults (BB adults)
Big-eyed bug nymphs (BB nymphs)
Pirate bug adults (PB adults)
Pirate bug nymphs (PB nymphs)
Nabids (Nabids)
Assassin bugs (Abugs)
Spiders (Spiders)
Parasitic wasps (Wasps)

Data from each field were analyzed with the PROC GLM procedure of PC-SAS to estimate effects over sample dates. Where significant differences were indicated ($P<0.05$), means were separated with Duncan's Multiple Range Test (DMRT; $P=0.05$). Samples within a date were used as replications. This is NOT a statistically valid evaluation, but does provide some indication of the effects of sample variability - where significant differences are indicated, the numerical differences are 'real' (differences between the dates did occur and are not simply a result of sampling variability) but does not provide proof of the cause of the difference (population changes, sampling efficiency change due to weather, etc.). Thus, interpretation of the differences seen in the data should be compared to expectations based on experience, experimental data, and 'replication' across multiple sites.

Results and Discussion

Results for each field are presented in Tables 2-18. Species not detected, or at densities less than 1.0 per sample, in a particular field are not listed for that field.

ULV Malathion (Tables 2 and 3)
A general decline in lady beetles and spiders occurred following application. By 6 days after treatment, lady beetles, spiders, and parasitic wasps were increasing rapidly. Survival of lady beetles may have been enhanced through pupation as seen in the high proportion of larvae prior to treatment, a high proportion of adults at 6 days after treatment, and observation of high densities of pupae on plants after treatment. Overall, malathion appeared to have a short-lived adverse effect on the beneficial arthropods present.

Guthion(Tables 4 and 5)
General trends for Guthion were similar to those for malathion. Most beneficial arthropod densities decreased shortly after treatment (or were at low levels prior to treatment), but increased by the last sample. This trend was seen with lady beetles, green lacewings, spiders and parasitic wasps. Similar trends were seen with big-eyed bugs and pirate bugs in one field each; however, both also showed a trend for increase shortly after treatment, followed by a decrease in the last sample in one field each. Overall, Guthion showed a trend for short-lived adverse effects on beneficial arthropods.

Vydate (Tables 6, 7 and 8)
Vydate appeared to have rather minor effects on most species present (lady beetles, spiders, wasps, green lacewings), with responses ranging from slight to no reductions in density after treatment followed by increasing densities, to generally increasing densities throughout. These results may also represent random variation with no significant differences over time for these species. The possible exception to these trends is for big-eyed bug nymphs, which showed an obvious decline in density, without recovery, in one field. Overall, with the possible exception of big-eyed bug nymphs, Vydate appeared to have minor effects on the beneficial arthropods present.

Furadan + Vydate (Table 9)
Trends in this field were very similar to those for Vydate alone, with the exception that parasitic wasps densities decreased by the last sample. This may have resulted from changes in host densities (from both biological and chemical control). The high survival rate for lady beetles may have been influenced by pupation of larvae at the time of treatment as evidenced by the high larval populations before treatment and increased adult populations after treatment (as well as general observations in the field).

Pyrethroids (Ammo and Karate; Tables 10, 11, 12 and 13)
In the three fields at the Busse farm treated with pyrethroids, lady beetles consistently decreased in density shortly after treatment, but rebounded within a week. Spiders and pirate bugs showed trends similar to the lady beetles but were generally less adversely effected. Parasitic wasp densities varied over time, but did not show consistent trends in response to the pyrethroids. Two fields showed decreased wasp densities on the last sample date, one field showed densities roughly equal to the pre-treatment sample on the last sample date, and one field showed increased densities over time. The one field with green lacewings present showed increased densities of both adults and larvae throughout the test. Overall, the pyrethroids appeared to have short-lived adverse effects on lady beetles and pirate bugs and to a lesser extent on spiders. Effects on wasps were probably also minimal and short-lived. Green lacewings appear to have not been adversely effected by the pyrethroids.

Tracer (Tables 14, 15 and 16)
The generally low beneficial densities detected on the final sample at San Perlita West may have resulted from adverse weather conditions (rain) which prevented a final sample at San Perlita East. Tracer had minimal adverse effects on most of the beneficial arthropod species present. Lady beetle densities appeared to be slightly reduced over time, but these differences were not significant. Big-eyed bugs, pirate bugs and spiders generally showed increases immediately after treatment, with slight reductions thereafter. Parasitic wasp densities consistently showed trends for decreased densities by the last sample date, but these differences also were not significant. Overall, Tracer appeared to have minimal adverse effect on the species of beneficial arthropods present.

Regent (Tables 17 and 18)
Following the first application of Regent, most beneficial species present showed no effect or increases in density at 2 days after treatment, but generally declined in density thereafter. Following the mid-season application, a general decline in beneficial arthropods was noted throughout the test period. In general, Regent appeared to have broad spectrum adverse impact on the beneficial arthropods present, with the impact increasing over the length of the test, as compared with most other products having an immediate impact after application and dissipating over time.

Multiple Applications (Tables 5, 8 and 13)
Three of the test fields received a second application of insecticide shortly after termination of sampling for the first application. The first application varied, but all three fields were treated with a tank mix of Karate and Guthion for the second application. These three applications appeared to generally have more severe effects on beneficial arthropod densities than any of the single applications. The exception to this was green lacewing larvae, which showed little effect or an increase in density following applications. These treatments did not eliminate beneficial arthropods from the fields, but the beneficial densities did not appear to rebound as rapidly has they had from earlier treatments. Whether these effects are a result of the chemical combinations or the repeated applications (all with a little over 2 weeks between applications) will require additional study.

Summary

The effects of single product conventional chemistry treatments varied somewhat with species of beneficial arthropod, but in general, showed short-lived adverse effects on species impacted. Tracer showed the least adverse effects of all of the products tested. Regent appeared to have rather broad spectrum effects, with longer residual activity than the single product conventional chemistry treatments. The combination of Karate plus Guthion also appeared to have more severe effects, with a longer residual than the single product applications, but this may have been a result of multiple applications rather than the chemistry.

Acknowledgments

The authors thank Mr. Cesar Medelez and and Mr. Frank Olvera, Jr. for their valuable assistance in completing the field work associated with this project. We also express our gratitude to the many producers who provided fields for these studies. This work was funded in part by Cotton Incorporated.

Reference

Sparks, A.N., Jr. and J.W. Norman, Jr. 1998. Modification of a leaf blower/vac for sampling of arthropods. Proceedings Beltwide Cotton Conferences. 1302-1304.

Table 1. Data on fields monitored for effects of insecticide application on beneficial arthropods, Lower Rio Grande Valley, Texas, 1999.

Field name	Treatment	Rate (lb AI/ac)	Estimated acreage
Chappell ULV	Malathion ULV (Fyfanon and Atrapa)	12 oz./acre	8 not treated Fyfanon - 36 Atrapa - 17
Highline	Guthion	0.25	15
Hoelscher #6 *	Guthion *	0.25 (in oil)	40
Fuller	Vydate	0.236	20
Meaney South	Vydate	0.25	20
Meaney North *	Vydate *	0.25	40
Jacob	Furadan + Vydate	0.125+ 0.25	80
Busse AM	Ammo	0.1	80
Busse OK	Karate 1EC	0.033	40
Busse NK	Karate Z	0.035	60
Hoelscher C&D *	Karate *	0.03	40
Chappell	Tracer	0.047	280
San Perlita West	Tracer	0.047	197
San Perlita East	Tracer	0.047	285
Hiler	Regent 4F	0.05	7.5

* - indicated fields were also sampled after a second application of Karate + Guthion (in oil) at 0.03 and 0.25 lb AI/ac, respectively.

Table 2. Effects of Fyfanon on beneficial arthropods. Field: Chappell ULV - treated on 20 April, 2000.

Beneficial Arthropod	Number collected per 100-foot blower/vac sample			
	4/19	4/22	4/23	4/26
LB adults	1.00 b	2.50 b	2.25 b	20.00 a
LB larvae	30.50 a	0.00 b	0.50 b	0.50 b
Sc adults	1.25 a	0.50 a	0.25 a	3.00 a
Spiders	2.25 a	0.75 a	0.25 a	2.00 a
Wasps	2.50 a	2.50 a	2.25 a	26.5 a

Numbers within rows followed by the same letter are not statistically different (DMRT; P=0.05).

Table 3. Effects of Atrapa on beneficial arthropods. Field: Chappell ULV - treated on 20 April, 2000.

Beneficial Arthropod	Number collected per 100-foot blower/vac sample			
	4/19	4/22	4/23	4/26
LB adults	2.25 a	0.75 a	2.00 a	18.50 a
LB larvae	34.75 a	0.50 b	0.25 b	2.00 b
Sc adults	3.00 ab	0.25 c	0.50 bc	5.00 a
Sc larvae	0.50 a	0.00 a	0.00 a	2.75 a
BB adults	2.50 a	0.25 b	0.00 b	0.75 b
Spiders	4.00 a	0.00 b	0.25 b	3.00 a
Wasps	2.50 b	1.50 b	12.25 b	81.50 a

Numbers within rows followed by the same letter are not statistically different (DMRT; P=0.05).

Table 4. Effects of Guthion on beneficial arthropods. Field: Highline - treated on 2 June, 2000.

Beneficial Arthropod	Number collected per 100-foot blower/vac sample			
	6/1	6/4	6/7	6/9
LB adults	0.00 b	0.00 b	0.25 b	7.88 a
LB larvae	3.38 a	1.75 a	0.00 a	0.38 a
Sc adults	0.88 b	2.63 a	2.50 a	3.25 a
Sc larvae	1.50 b	0.38 b	0.00 b	5.88 a
GLW adults	0.50 b	2.63 b	1.13 b	18.50 a
GLW larvae	3.00 a	3.00 a	1.50 a	3.13 a
BB adults	0.00 b	4.00 a	3.38 a	0.38 b
PB adults	5.75 b	1.38 b	1.25 b	52.13 a
PB nymphs	0.13 b	0.00 b	0.00 b	9.75 a
Spiders	0.38 a	0.75 a	1.50 a	0.88 a
Wasps	55.38 a	25.38 b	20.13 b	53.00 a

Numbers within rows followed by the same letter are not statistically different (DMRT; P=0.05).

Table 5. Effects of Guthion and Guthion plus Karate on beneficial arthropods. Field: Hoelscher - treated with Guthion on 25 May, 2000; treated with Guthion plus Karate on 8 June, 2000.

Beneficial Arthropod	Number collected per 100-foot blower/vac sample			
	5/25	5/27	5/29	6/1
LB adults	6.13 a	0.38 bc	0.50 bc	1.50 b
LB larvae	8.88 a	0.13 b	1.38 b	0.25 b
Sc adults	4.38 a	0.75 b	5.88 a	6.25 a
GLW adults	1.13 a	0.63 a	0.75 a	3.25 a
GLW larvae	0.75 b	0.63 b	0.75 b	0.38 b
BB adults	7.88 a	0.25 d	3.75 bc	2.50 bcd
PB adults	0.75 bc	1.38 bc	3.50 a	0.13 c
Spiders	4.25 a	0.88 b	0.50 b	1.00 b
Wasps	7.75 cd	3.38 e	6.75 ed	32.13 a
	6/8	**6/10**	**6/14**	
LB adults	0.75 bc	0.00 c	0.25 bc	
LB larvae	1.88 b	0.00 b	0.00 b	
Sc adults	4.75 a	0.38 b	1.63 b	
GLW adults	6.50 a	2.13 a	0.38 a	
GLW larvae	2.88 a	1.13 b	0.38 b	
BB adults	4.38 b	0.75 cd	1.13 bcd	
PB adults	1.75 b	1.13 bc	0.63 bc	
Spiders	2.00 b	1.25 b	0.75 b	
Wasps	22.75 b	11.50 c	9.50 cd	

Numbers within rows followed by the same letter are not statistically different (DMRT; P=0.05).

Table 6. Effects of Vydate on beneficial arthropods. Field: Fuller - treated on 30 April, 2000.

Beneficial Arthropod	Number collected per 100-foot blower/vac sample			
	4/27	5/1	5/3	5/6
LB adults	1.50 b	0.38 b	0.13 b	5.50 a
Sc adults	1.13 b	0.38 b	0.50 b	5.88 a
BB nymphs	6.38 a	0.38 b	0.13 b	0.00 b
Spiders	1.38 b	1.63 b	0.50 b	3.63 a
Wasps	3.50 b	3.25 b	3.25 b	6.00 a

Numbers within rows followed by the same letter are not statistically different (DMRT; P=0.05).

Table 7. Effects of Vydate on beneficial arthropods. Field: Meaney South - treated 22 May, 2000.

Beneficial Arthropod	Number collected per 100-foot blower/vac sample			
	5/21	5/24	5/26	5/28
LB adults	4.63 a	4.88 a	2.71 a	4.63 a
Sc adults	2.88 a	2.38 a	1.86 a	3.63 a
GLW adults	1.00 a	0.75 a	1.00 a	1.75 a
BB adults	5.00 a	1.88 b	1.57 b	5.13 a
Spiders	1.38 a	1.00 a	0.71 a	1.25 a
Wasps	6.38 ab	2.13 c	4.71 b	7.25 a

Numbers within rows followed by the same letter are not statistically different (DMRT; P=0.05).

Table 8. Effects of Vydate and Karate plus Guthion on beneficial arthropods. Field Meaney North - treated with Vydate on 22 May, 2000; treated with Karate plus Guthion on 8 June, 2000.

Beneficial	Number collected per 100-foot blower/vac sample			
Arthropod	5/21	5/24	5/26	5/28
LB adults	2.38 b	5.38 a	4.00 ab	4.88 a
Sc adults	0.88 cd	0.88 cd	1.88 c	6.38 a
GLW adults	0.00 b	0.25 b	0.25 b	1.38 b
GLW larvae	0.00 c	0.00 c	0.13 c	0.38 c
BB adults	3.88 b	5.25 b	3.88 b	4.13 b
PB adults	0.00 b	0.13 b	0.75 b	1.00 b
Spiders	1.13 b	3.25 a	0.63 b	1.00 b
Wasps	0.88 d	5.50 bc	2.50 cd	6.63 b
	6/8	6/10	6/14	
LB adults	2.50 b	0.00 c	0.00 c	
Sc adults	4.00 b	0.38 cd	0.00 d	
GLW adults	7.50 a	0.13 b	2.25 b	
GLW larvae	2.13 c	5.38 b	10.13 a	
BB adults	10.75 a	0.25 c	0.38 c	
PB adults	2.75 a	0.00 b	0.13 b	
Spiders	1.63 b	1.00 b	0.50 b	
Wasps	17.75 a	0.63 d	2.38 cd	

Numbers within rows followed by the same letter are not statistically different (DMRT; P=0.05).

Table 9. Effects of Furadan plus Vydate on beneficial arthropods. Field: Jacob - treated on 21 April, 2000.

Beneficial	Number collected per 100-foot blower/vac sample			
Arthropod	4/20	4/23	4/26	4/28
LB adults	11.38 c	12.38 c	40.25 b	52.25 a
LB larvae	57.75 a	7.25 b	3.75 b	2.75 b
Sc adults	4.38 b	1.88 b	4.13 b	8.75 a
BB adults	5.63 a	3.13 a	5.25 a	6.88 a
PB adults	0.88 a	0.00 a	1.75 a	0.88 a
Spiders	1.63 a	0.50 a	1.38 a	1.25 a
Wasps	10.75 a	15.38 a	11.75 a	3.63 b

Numbers within rows followed by the same letter are not statistically different (DMRT; P=0.05).

Table 10. Effects of Ammo on beneficial arthropods. Field: Busse AM - treated 12 May, 2000.

Beneficial	Number collected per 100-foot blower/vac sample			
Arthropod	5/12	5/14	5/17	5/20
LB adults	4.50 b	0.13 c	1.25 c	13.88 a
LB larvae	12.25 a	1.13 b	0.63 b	0.25 b
Sc adults	4.38 a	0.75 b	0.63 b	3.00 a
GLW adults	0.50 a	0.00 a	0.00 a	1.25 a
GLW larvae	0.13 a	0.13 a	0.25 a	0.75 a
BB adults	1.38 a	0.00 b	0.13 b	0.63 ab
PB adults	3.75 a	0.75 b	1.63 b	3.63 a
Spiders	3.38 a	2.75 a	1.63 a	2.38 a
Wasps	18.50 ab	12.13 bc	21.38 a	5.63 c

Numbers within rows followed by the same letter are not statistically different (DMRT; P=0.05).

Table 11. Effects of Karate 1EC on beneficial arthropods. Field: Busse OK - treated 12 May, 2000.

Beneficial	Number collected per 100-foot blower/vac sample			
Arthropod	5/12	5/14	5/17	5/20
LB adults	3.00 b	0.50 b	3.50 b	13.38 a
LB larvae	10.88 a	2.75 b	2.75 b	0.13 b
Sc adults	4.00 a	0.50 b	0.25 b	1.13 b
PB adults	0.00 a	0.00 a	2.00 a	0.13 a
Spiders	1.88 a	0.25 a	0.75 a	0.38 a
Wasps	10.00 a	5.25 b	9.75 a	0.25 c

Numbers within rows followed by the same letter are not statistically different (DMRT; P=0.05).

Table 12. Effects of Karate Z on beneficial arthropods. Field: Busse NK - treated 12 May, 2000.

Beneficial	Number collected per 100-foot blower/vac sample			
Arthropod	5/12	5/14	5/17	5/20
LB adults	4.13 b	0.25 c	1.63 c	8.38 a
LB larvae	5.13 a	0.75 b	0.38 b	0.00 b
Sc adults	5.50 a	0.38 b	0.13 b	1.13 b
PB adults	1.00 a	0.13 a	0.00 a	0.75 a
Spiders	2.25 a	0.38 a	0.50 a	1.13 a
Wasps	2.88 a	4.88 a	3.88 a	4.00 a

Numbers within rows followed by the same letter are not statistically different (DMRT; P=0.05).

Table 13. Effects of Karate and Karate plus Guthion on beneficial arthropods. Field: Hoelscher C&D - treated with Karate on 26 May, 2000; treated with Karate plus Guthion on 8 June, 2000.

Beneficial	Number collected per 100-foot blower/vac sample			
Arthropod	5/25	5/28	5/31	6/2
LB adults	0.13 b	0.13 b	0.50 b	0.43 b
LB larvae	0.00 b	0.13 b	0.25 b	0.00 b
Sc adults	0.00 b	0.25 b	0.88 b	0.29 b
GLW adults	0.88 b	2.63 b	3.38 b	5.00 b
GLW larvae	0.38 d	3.50 cd	5.50 bc	2.43 cd
BB adults	0.00 b	0.13 b	1.00 b	0.29 b
BB nymphs	0.00 b	0.38 b	0.25 b	1.14 b
PB adults	0.50 b	0.13 b	0.38 b	0.57 b
Spiders	0.50 b	0.13 b	0.75 b	0.00 b
Wasps	5.75 cde	11.88 c	3.13 de	29.86 a
	6/8	6/10	6/14	
LB adults	1.75 a	0.00 b	0.00 b	
LB larvae	4.63 a	0.00 b	0.00 b	
Sc adults	7.25 a	0.13 b	0.13 b	
GLW adults	18.88 a	3.00 b	4.25 b	
GLW larvae	9.88 a	7.75 ab	9.75 a	
BB adults	9.75 a	0.00 b	0.00 b	
BB nymphs	4.38 a	0.00 b	0.00 b	
PB adults	29.13 a	2.25 b	0.75 b	
Spiders	1.88 a	0.13 b	0.13 b	
Wasps	21.13 b	0.25 e	7.75 cd	

Numbers within rows followed by the same letter are not statistically different (DMRT; P=0.05).

Table 14. Effects of Tracer on beneficial arthropods. Field: Chappell - treated on 13 April, 2000.

Beneficial Arthropod	Number collected per 100-foot blower/vac sample			
	4/11	4/15	4/16	4/20
LB adults	2.43 a	1.00 a	1.63 a	1.13 a
LB larvae	6.29 a	8.13 a	6.13 a	6.50 a
Sc adults	5.29 a	2.00 a	2.25 a	1.13 a
Sc larvae	0.43 a	0.38 a	1.50 a	0.00 a
BB adults	2.14 a	0.75 a	1.25 a	1.13 a
Spiders	4.57 a	2.50 a	3.75 a	3.88 a
Wasps	7.57 a	2.75 a	2.38 a	1.63 a

Numbers within rows followed by the same letter are not statistically different (DMRT; P=0.05).

Table 15. Effects of Tracer on beneficial arthropods. Field: San Perlita West - treated on 4 and 5 May, 2000 (2 days to complete treatment).

Beneficial Arthropod	Number collected per 100-foot blower/vac sample			
	5/4	5/7	5/10	5/12
LB adults	23.25 a	12.13 b	4.38 c	2.50 c
Sc adults	6.38 a	6.38 a	2.50 b	0.13 c
BB adults	1.88 a	3.13 a	1.88 a	0.38 a
BB nymphs	0.50 a	2.88 a	2.25 a	0.75 a
PB adults	0.88 b	3.38 a	2.88 a	0.13 b
Spiders	1.38 c	4.75 a	3.25 b	1.25 c
Wasps	6.63 a	6.00 a	7.88 a	1.00 b

Numbers within rows followed by the same letter are not statistically different (DMRT; P=0.05).

Table 16. Effects of Tracer on beneficial arthropods. Field: San Perlita East - treated on 4 and 5 May, 2000 (2 days to complete treatement).

Beneficial Arthropod	Number collected per 100-foot blower/vac sample		
	5/4	5/7	5/10
LB adults	0.75 b	7.25 a	2.38 b
LB larvae	7.13 a	26.0 a	4.75 a
Sc adults	0.50 b	2.75 a	0.75 b
Sc larvae	1.00 a	2.88 a	0.00 a
BB adults	0.63 b	2.50 a	0.88 b
PB adults	0.25 b	2.88 a	4.25 a
A bugs	0.13 a	1.13 a	0.50 a
Spiders	1.13 a	2.75 a	1.00 a
Wasps	86.13 a	95.75 a	62.00 a

Numbers within rows followed by the same letter are not statistically different (DMRT; P=0.05).

Table 17. Effects of Regent on beneficial arthropods. Field: Hiler - treated on 5 May, 2000.

Beneficial Arthropod	Number collected per 100-foot blower/vac sample			
	5/4	5/7	5/10	5/12
LB adults	2.00 c	6.75 b	10.25 a	6.88 b
LB larvae	11.67 b	23.63 a	12.00 b	3.75 b
Sc adults	1.67 a	6.88 a	6.88 a	4.13 a
Sc larvae	1.50 b	9.88 a	2.00 b	0.25 b
BB adults	1.17 a	1.38 a	0.00 b	0.13 b
PB adults	3.67 bc	12.00 a	7.63 b	3.13 c
PB nymphs	0.00 b	4.25 a	0.25 b	0.00 b
Spiders	1.83 a	2.50 a	1.00 a	0.50 a
Wasps	14.17 b	19.13 a	4.63 c	1.63 c

Numbers within rows followed by the same letter are not statistically different (DMRT; P=0.05).

Table 18. Effects of Regent on beneficial arthropods. Field: Hiler - treated on 1 June, 2000.

Beneficial Arthropod	Number collected per 100-foot blower/vac sample			
	5/31	6/3	6/5	6/7
LB adults	4.88 a	0.75 b	0.13 b	0.50 b
Sc adults	6.88 a	6.13 a	3.75 a	4.38 a
GLW adults	4.25 a	0.38 b	0.50 b	1.00 b
GLW larvae	9.88 a	4.00 b	2.75 b	1.13 b
BB adults	1.38 a	0.00 a	0.25 a	0.88 a
PB adults	38.88 a	9.38 b	8.88 b	7.13 b
PB nymphs	22.50 a	21.38 a	7.63 b	0.50 c
Spiders	4.38 a	1.63 b	1.63 b	0.75 b
Wasps	21.63 b	30.75 a	18.63 b	6.63 c

Numbers within rows followed by the same letter are not statistically different (DMRT; P=0.05).