RESIDUAL ACTIVITY OF SELECTED INSECTICIDES ON LYGUS HESPERUS IN COTTON

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Abstract

The pest status of *Lygus* bugs as a Texas High Plain cotton pest has increased in recent years. Insecticides are commonly used for *Lygus* population management in this region. Six commonly used insecticides, Vydate, Brigade, Orthene, Endosulfan, Carbine and Ammo, at high and low concentrations (H and L), were tested for their field weathered activity on adults of *Lygus hesperus*. In the laboratory, *L. hesperus* adults caged in petri dishes containing excised cotton leaves. The cotton field was sprayed and leaves collected at 0, 3, 7, and 14 days after treatment (DAT), and were tested for any residual insecticide activity on adult *Lygus*. Check plots were untreated. Observations on the mortality of the insects were taken until the fifth day of exposure in petri dishes. However, for comparison purposes, mortality data at 48 hours after exposure (HAE) were utilized for all insecticides except Carbine for which 96 HAE readings were utilized. Results indicated that the insecticide residues remained on the plant for 7 days. Ammo (H and L), Vydate (H) and Orthene (H) recorded significantly higher mortality than all other treatments. Carbine was the least toxic compound tested at the 48 HAE observations, but at 96 HAE, its higher rate provided 88.4 and 73.4% mortality at 3 DAT and 7 DAT, respectively. The effectiveness of Endosulfan, Orthene and Brigade lasted less than a week after which these compounds, even at their higher dose, failed to provide >50% mortality. Rainfall (1.07 inches) recorded between 7 DAT and 14 DAT may have contributed to the drop in the mortality for the 14 DAT samples.

Introduction

Lygus hesperus Knight is a polyphagous pest reported to feed on more than 100 non-crops and more than 25 cultivated plants (Schwartz and Foottit 1998). *Lygus* cause significant damage to cotton every year and are ranked second to the bollworm/budworm complex in reducing yields by about 0.67% (Williams 2007). Feeding by *Lygus* on cotton causes tissue necrosis, abscission of fruiting forms, deformation of fruit and seeds, altered vegetative growth, and tissue malformations (Tinguey and Pillemer 1977). Due to its high mobility, broad host range and cryptic damage, management of *L. hesperus* is problematic (Ruberson and Williams 2000). In 2007, *Lygus* in the Texas High Plains infested an estimated 497,046 acres, over one-half of which required at least one insecticide application. The current management strategy for this pest includes use of chemical insecticides (Siders et al. 2007).

Ammo (cypermethrin), Brigade (bifenthrin), Orthene (acephate) and Vydate (oxamyl) are insecticides recommended for *Lygus* control in Texas (Siders et al. 2007). Although effective, because these are broad-spectrum insecticides, they may result in unwanted destruction of natural enemies and outbreaks of secondary pests. Insecticides that are more target specific and/or less harsh on insect natural enemies might be more suitable to a sustainable IPM system. In Arizona, Endosulfan, which is less detrimental to many insect natural enemies, is sometimes used for *Lygus* management. Recently, Carbine (flonicamid), which is primarily effective against plant sucking pests, was registered for *Lygus* control in cotton. Carbine is thought to be safer to insect natural enemies than many of the currently recommended insecticides.

Acephate, an organophosphate insecticide recommended for use in cotton for *Lygus* bugs, provides effective suppression of the pest (Robbins et al. 1998). Capture 2EC (bifenthrin) was another broad spectrum insecticide used widely in cotton for managing plant bugs and the bollworm/ budworm complex. Tillman et al. (2003) reported that the level of control with organophosphate, carbamate and pyrethroid insecticides has decreased over the past several years in some cotton production areas where resistance to all these insecticides has been reported. Cook et al. (2005) reported that Vydate and Orthene suppressed both adults and nymphs of *Lygus*.

In a pest management program it is essential to know about the residual fate of insecticide applications. Some insecticides are more persistent than others and have a longer residual action. When the effective residues are present in the plant system, either externally or internally, the plant may be spared significant damage from constant pest migration. Studying the field weathered residues can be a good method to evaluate the toxic nature of the persisting chemical on the plant.

The objective of this laboratory study was to investigate the toxicity of field weathered residue of six insecticides at recommended high and low doses in cotton on adults of *Lygus hesperus*.

Materials and Methods

This study was conducted on irrigated cotton (cultivar ST 4554 B2RF) planted on 6 June 2007 on 40-inch rows at the Texas AgriLife Research Farm near Lubbock, TX. The test was initiated on 10 August 2007 when the cotton was in its squaring stage. Insecticides were applied to 4-row X 30 ft plots with a CO_2 pressurized hand-boom sprayer calibrated to deliver 10 gpa through TeeJet XR8003VS extended range flat spray tip nozzles (2 per row) at 30 psi. The insecticides tested were Ammo, Brigade, Orthene, Endosulfan, Vydate and Carbine in high and low recommended rates (Table 1). The control plot was left untreated. At the time of application the air movement was minimal and drift was not a concern. The spray appeared uniformly deposited on the leaf surface. At two hours after treatment, after insuring that the spray was dry, five whole leaves were picked from plants selected randomly from the middle two rows of each plot. These fully expanded whole leaves which were totally exposed and at about the fifth node position were sampled. Similarly, leaves were collected at 3, 7 and 14 days after treatment (DAT). Selection of these leaves was made carefully to ensure that the leaf sampled had been exposed to insecticide treatment and was not new growth. This was achieved by picking the leaves one node lower each sampling period. After sampling, leaves were immediately transported to the laboratory and transferred to petri dishes (9-cm dia) that contained moistened filter paper. The leaves were positioned in the petri dishes with the top side of the leaf facing upwards. The *Lygus hesperus* adults were obtained from a lab culture maintained in the Cotton Entomology Program Texas AgriLife Research lab, Lubbock. Three to six day old adults which were well fed were utilized for the bioassay. The experiment had a split plot design with five replications. Four individuals were released into each petri dish (replication) using an aspirator and immediately closed with the cover plate and kept at room temperature maintained at 75°F. Observations on mortality were recorded daily through the fifth day of exposure, and individuals which lacked movement upon prodding or which were moribund were considered dead. The mortality data for Carbine was calculated at 96 HAE and rest of the treatments at 48 HAE. Mortality data was corrected using the Schneider-Orelli (1947) formula and subjected to SAS Proc Mixed analysis of variance ($P \leq 0.05$).

Table 1. Treatments and their rates of application

Treatment/ formulation	Product rate /acre	
	Low	High
Ammo 2.5EC	3.0 fl-oz	5.0 fl-oz
Brigade 2EC	3.84 fl-oz	6.4 fl-oz
Orthene 90SP	0.5 lb/ac	1.0 lb/ac
Vydate C-LV 3.77	17.0 fl-oz	34.0 fl-oz
Endosulfan 3EC	1.3 qt/ac	2.0 qt/ac
Carbine 50WG	1.7 oz	2.8 oz
Untreated	-	-

Results and Discussion

The results of the mortality data analyzed for insecticides at high (H) and low (L) rates showed that Vydate (H), Ammo (H and L) and Orthene (H) demonstrated significantly higher residual toxicity at 48 HAE with mean overall corrected percent mortalities of 78, 64 and 60 and 64 respectively (Fig 1). The mortality values showed differences among all the treatments except at 14 DAT which may have been influenced by precipitation. Precipitation occurred between the 7 and 14 DAT evaluations and totaled 1.07 inches.

Mortality data for the pyrethroids, Ammo (cypermethrin) and Brigade (bifenthrin), showed a similar trend (Fig. 2). Ammo recorded a mortality of 80% for the L and H rates at 0 DAT, whereas at 3 DAT mortality was 100% for both rates. Mortality declined to 60 and 75% at 7 DAT for the L and H rates, respectively (Table 2). At 14 DAT no mortality was recorded indicating that there was no residual toxicity present. Brigade recorded mortality of 0 and 50% for L and H rates at 0 DAT, respectively, but mortality values increased to 80 and 95% at 3 DAT, and subsequently decreased to 5 and 25% at 7 DAT. These results are similar to that reported by Long et al. (2000), where bifenthrin was reported to have greater stability to ultra violet rays and subsequently showed residual toxicity to tobacco budworm larvae at 5 DAT by exhibiting a 73% mortality rate. Ammo appears to have greater residual stability on the cotton leaves than Brigade according to our results, but quantification of total residues on the leaf might be required to confirm this. The results agree with a report by Cardwell et al. (2000) that in spite of resistance development, growers continued to use pyrethroids for *Lygus* control, due to its longer residual action.

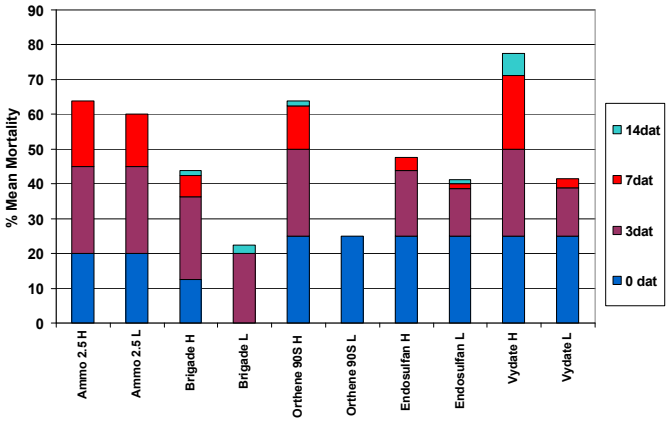

Figure 1. Mean percent mortality of *Lygus* exposed to field weathered insecticides.

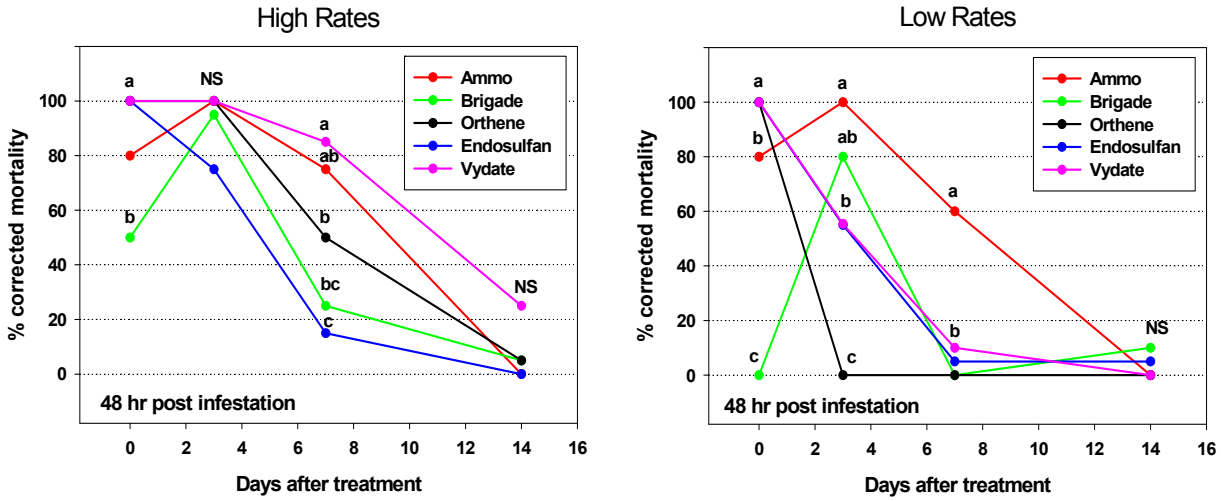

Figure 2. Percent mortality of *Lygus* exposed to high and low rates of field weathered insecticides at 0, 3, 7 and 14 days after treatment (DAT) following 48 hours of exposure.

Mortality values for the pyrethroids in our test increased from 0 DAT to 3 DAT and decreased thereafter (Fig 2). This may have occurred because at 0 DAT both the insecticides may have had a repulsive effect on the *Lygus* which

forced it to have limited direct contact with treated leaf. This might explain the reason for low mortality in Brigade at 0 DAT where mortality recorded was zero.

Orthene (acephate) proved highly toxic to *Lygus* adults at 0 DAT resulting in 100 % mortality at the L and H rates, whereas at 3 DAT the lower rate of Orthene provided only 5% mortality as compared to 95% mortality at its high rate (Table 2). This indicates that the lower dose of Orthene lost its residual toxicity in three days of field weathering. The high rate of Orthene was more persistent than the low rate, providing 50% mortality at 7 DAT (Fig. 2).

Table 2. Mean percent corrected mortality of *Lygus* at 48 hours after exposure (HAE)

Treatment/ formulation	Dose	Days after treatment (DAT) 0	3	7	14
Ammo 2.5EC	L	80 a	100 a	60 ab	0 a
Ammo 2.5EC	H	80 a	100 a	75 ab	0 a
Brigade 2EC	L	0 b	80 ab	5 c	10a
Brigade 2EC	H	50 b	95 a	25 bc	5 a
Orthene 90SP	L	100 a	5 c	0 c	0 a
Orthene 90SP	H	100 a	95 a	50 b	5 a
Vydate C-LV 3.77	L	100 a	55 b	10 c	0 a
Vydate C-LV 3.77	H	100 a	100 a	85 a	25 a
Endosulfan 3EC	L	100 a	55 b	5 c	5 a
Endosulfan 3EC	H	100 a	75 a	15 c	0 a

Within an insecticide, means in a column followed by the same letter are not significantly different based on a PROC MIXED analysis ($P > 0.05$) (SAS Institute 2007).

Vydate (oxamyl) at its high rate showed the highest residual toxicity providing 100% mortality at 0 and 3 DAT, 85% at 7 DAT and 25% at 14 DAT (Table 2). At its lower rate, Vydate was effective only until 3 DAT after which the mortality values declined drastically (Fig 2).

Dennehy et al. (1998) reported that Orthene and Vydate demonstrated the greatest suppression of *Lygus* in field tests. They also reported that field weathered residues of Vydate were similar to Orthene but exhibited low mortality at 1 DAT. Our results suggest that high rates of both Orthene and Vydate retained its residual toxicity for a much longer period. Possibly, the cotton plants in the Arizona test may have been taller with denser vegetation than in our test and thus adequate coverage may have been more of a problem in the Arizona study.

Endosulfan was very effective at 0 DAT wherein 100% mortality resulted for both L and H rates, but with time it readily lost its residual toxicity providing 55 (L rate) and 75% (H rate) at 3 DAT, and 5 (L rate) and 15% (H rate) at 7 DAT (Table 2).

Carbine (flonicamid) is thought to act primarily as a feeding blocker and demonstrated its earliest effective mortality at the 96 HAE evaluations. Essentially, sufficient time (4 days) was required for the *Lygus* to starve to death. Percent mortality values at 0 DAT were 16 and 35% for the L and H rates, respectively which increased to 50 and 88.4% at 3 DAT (Fig 3). At 7 DAT Carbine at the higher rate resulted in a mortality of 73%. Mortality values at 3 and 7 DAT at 96 HAE for the high rate were significantly higher than the low rate.

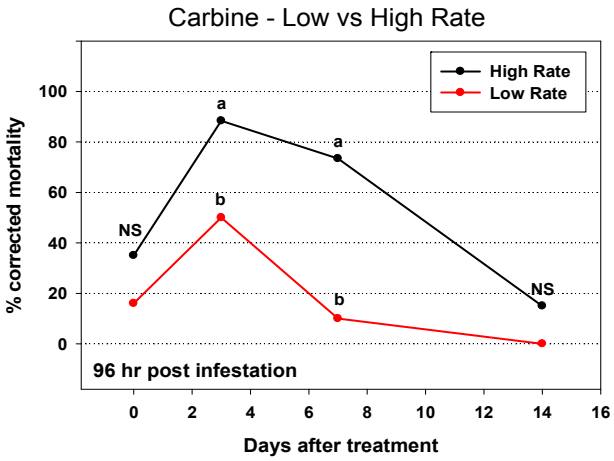

Figure 3. Percent mortality of *Lygus* exposed to high and low rates of field weathered Carbine at 0, 3, 7 and 14 days after treatment following 96 hours of exposure.

Lygus management is becoming a major cost input to the cotton growers throughout much of the U.S. cotton belt. Although large quantities of insecticide are utilized for its management, the effectiveness in terms of residual activity of many insecticides under various environmental conditions is not known. Among the six insecticides tested at low and high rates for the field weathered residual activity on *Lygus*, Vydate (H), Ammo (L and H) and Orthene (H) gave the longest residual activity at 48 HAE with mortality >50% at 7 DAT. The reason that Ammo had longer residual activity than the other pyrethroid, Brigade, is not certain and requires more research. The reduced mortality in pyrethroids (especially Brigade) at 0 DAT is an anomaly and may have been due to repellency that is exhibited by many pyrethroids. Carbine, regarded as a feeding blocker, proved to be the least effective as a quick acting insecticide but still provided 88% mortality at 3 DAT (96 HAE). Endosulfan (H and L), Orthene (L) and Brigade (H and L) were all effective until 3 DAT, after which their activity dropped precipitously. Rainfall received between 7 DAT and 14 DAT samples may have contributed to the drop in residual activity at 14 DAT.

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