CRITICAL CONSIDERATIONS FOR ACCURATELY DETERMINING THE EFFECTIVENESS OF INSECTICIDES AGAINST LYGUS BUGS IN COTTON

Larry Antilla and Mike Whitlow
Arizona Cotton Research and Protection Council
Tempe, AZ
T. J. Dennehy and June Russell
University of Arizona
Tucson, AZ

Abstract

The Arizona Cotton Research and Protection Council conducted field trials utilizing standardized ground spray equipment for lygus control at ten sites throughout the cotton growing area of Arizona in 1997. Fifteen insecticides registered for lygus control were tested singly and in combinations. Sweep samples taken one day pre- and 3, 7 and 14 days post treatment provided data for evaluation of material efficacy.

Nine of the 15 insecticides tested produced consistent declines in both adult and nymphal populations. Variations in percentages of control over untreated checks were widely divergent. The adjusted values ranged from 19 to 60 percent control three days post treatment and far lower by days 7 and 14. This raises questions as to the residual effectiveness of currently available lygus materials. Unexplained population declines in 70% of the untreated control plots complicated analyses. Because of the complexity of field trial activities, reliable efficacy data mandates multiple tests including untreated control plots plus the utilization of standardized equipment and methodology to reduce variability. Regional differences in lygus susceptibility to various insecticides offers hope for reducing control costs and the implementation of sound chemical rotational strategies.

Introduction

Lygus bugs (primarily *Lygus hesperus* Knight) are key pests of cotton in Arizona, and present year round on a wide variety of native and commercial crop hosts, including alfalfa and safflower. As early as 1918, Morrill reported that *Lygus hesperus* and *L. lineolaris* were the "most destructive pests of cotton in Arizona". Lygus may enter cotton in significant numbers from May through September. Serious invasions cause square shed and excessive vegetative growth, producing tall spindly plants, thereby reducing yield (Seva cherian and Stern 1974). Bioassays conducted by Mauney documented feeding damage rates ranging as high as eight squares/insect/day (Mauney and Henneberry 1979).

Reprinted from the *Proceedings of the Beltwide Cotton Conference*
Volume 2:1206-1209 (1998)
National Cotton Council, Memphis TN

In recent years, a common opinion shared by growers and pest control advisors has been that lygus are increasingly difficult to control. Widespread variability in chemical control efficacy was elucidated in lab studies initiated by Dennehy in 1994 (Dennehy and Russell 1996).

That research documented broad differences in susceptibility to selected insecticides on the part of numerous local populations of lygus collected statewide. During the 1997 cotton season Arizona Cotton Research and Protection Council personnel attempted to compare some of these lab-conducted studies to replicated field trials utilizing standardized commercial ground application equipment. In addition to documenting local levels of lygus population susceptibility/resistance the primary focus of the trials was to establish rates and/or insecticides combinations most suited to provide effective site specific control.

Methods and Materials

Single applications of a variety of insecticides for lygus control were made on fields at ten diverse locations throughout the Arizona cotton growing area. Where possible these coincided with collection sites where lab tests were being run on local lygus populations by the Extension Arthropod Resistance Management Laboratory, University of Arizona, Tucson, AZ. Individual plots were 18 rows wide (on 38-40 inch centers) running the length of each field being treated and replicated three to four times in a randomized complete block design. All treatments were made with a high clearance ground sprayer (John Deere 6500 Hi Cycle), equipped with a three module chemical injector system (Raven SCS 750). Treatments were over the top sprays approximately 12 inches above canopy height through flat fan nozzle(s) delivering 15 gal/acre at 40 lbs/square inch. Sampling was carried out using a standard 15 inch sweep net. The sampling procedure consisted of 50 sweeps of a single row of cotton, replicated three times for each of the three to four replications of each chemical evaluated. Within each plot, one set of 50 sweeps was taken starting at the field edge and the other two samples at least 100 feet from the edge and separated by at least 100 feet. Sweep samples were taken one day pretreatment and three, seven and 14 days post treatment. Counts of both adults and nymphs were recorded from each 50 sweep sample. Tests were initiated when lygus numbers reached a level sufficient to demonstrate variations in control regimes or when numbers reached the threshold normally acted on by the cooperating grower.

Results and Discussion

During the 1997 cotton season a total of fifteen insecticides used singly and in combinations were tested on full fields in ten separate sites dispersed throughout eight counties in Arizona.

Results of the tests clearly demonstrated the complexity of both implementation and analysis of lygus field trial data. Attempts to limit variability involved utilizing standardized ground spray equipment as well as a single four person team to conduct all pre- and post treatment sampling in accordance with specific guidelines.

Nine of the fifteen insecticides tested alone or in combinations produced consistent declines in both adult and nymphal lygus population numbers in test plots. These included methamidophos (Monitor), acephate (Orthene), zetamethrin (Mustang), methomyl (Lannate), oxamyl (Vydate), endosulfan (Phaser), lamda-cyhalothrin (Karate), methidathion (Supracide) and methyl parathion (PennecapM).

Variations in percentages of control, however, were widely diverse. Table 1 summarizes insecticide efficacy in descending order of control. Percentages displayed compare decreases (or in three cases increases) in adult lygus populations over three post treatment sampling intervals as adjusted to concurrent declines in untreated control plot populations. These adjusted values range from 60 to 19 percent three days post treatment and far lower at days 7 and 14. Most growers would consider these levels of control to be unacceptable and are of the opinion that many of the insecticides listed in Table 1 provide a much greater degree of lygus mortality.

Contained in this data, however, are two significant principles that should be carefully considered in future lygus insecticide efficacy trials:

1. Lygus populations in cotton often decline over time naturally during sequential sampling periods. This is no doubt partially due to the fact that the adult insect is highly mobile and does not normally seek out cotton as a preferred host.

Figures 1 and 2 demonstrate how such natural declines in adult population levels can often hamper attempts to establish true insecticide efficacy values. Further this phenomenon does not appear to be an unusual event. Data gathered from the ten field trials reported in this paper confirms the fact that 70% of the untreated control plots had declining adult and 60% had declining nymphal populations.

2. Given the elements contained in number 1 above, the establishment of untreated control plots is absolutely essential to the success of any comparative field tests for lygus control. This unfortunately is not normally done in the commercial arena. The usual scenario begins with a grower or his field entomologist sweep sampling a field. Assuming that an economic threshold for lygus control is met, the field is treated with an insecticide. Past history of product or current knowledge of success on neighboring farms generally provides the basis for insecticide choice. Post treatment samples are taken up to seven days later and compared with pretreatment counts.

The problem with this approach is illustrated in Table 2, which lists the four most effective insecticide combinations tested for lygus control by the Arizona Cotton Research and Protection Council in 1997. In every instance the percent reduction over precount was markedly higher than the percent reduction over the untreated control. This has potential for being particularly misleading from days 7 through 14 post treatment. The same phenomenon was also evident in most of the tests involving materials which provided poor lygus control, further confusing the issue.

Throughout the tests declining numbers of both adults and nymphs in the untreated controls raised questions and complicated analyses. One hypothesis was that the 18 row checks were too small with resultant reductions of adults due to movement in and out of adjacent treatment plots.

To test this hypothesis, fields in the Coolidge area were set up as blocks containing four replicates of 18, 36 and 72 row untreated controls adjacent to 18 row plots treated with an insecticide combination of endosulfan/methomyl. Figure 3 summarizes the percent change in adult population over precounts for treatment plots and all three untreated control replicates. While reductions in the treatment block occurred at least through day three post treatment, no significant differences were observed in control plots regardless of size on any of the three sampling dates. From this it was concluded that 18 row control plots are of sufficient size to accurately portray lygus population dynamics without being adversely effected by adjoining treatment blocks.

One critical objective of the trials was not adequately addressed; namely comparison of field test data with lab assays conducted at the Extension Arthropod Resistance Management Laboratory, University of Arizona in Tucson. Limited evidence of variation in regional susceptibility to insecticides was however observed from tests run in Marana and Bowie (South-central and Eastern Arizona respectively). Both areas have reduced pesticide use in comparison with cotton grown in Central and Western Arizona. Tests run in Marana resulted in the singly applied materials endosulfan (32 oz), acephate (1 lb) and oxamyl (32 oz) achieving lygus control equivalent to combinations of insecticides such as methomyl (32 oz) / oxamyl (32 oz) and endosulfan (32 oz) / methomyl (24 oz). Tests conducted in Bowie, including half rates of acephate (.5 lb) produced control that was not significantly different from acephate applied at the one pound rate. Clearly more comparative studies are needed to provide bridging data between field trials and laboratory assays.

Summary

The Arizona Cotton Research and Protection Councils' inaugural year of field testing for lygus control provided a much needed foundation for data base development. Published rankings of the insecticides tested provided growers with real time efficacy data to assist in decision making in addition to establishing the basis for future comparative testing. The trials also clearly documented the complexity of lygus field work. This underscores the importance of untreated controls in any experimental design, the value of multiple tests and the need for standardized equipment and methodology. The relatively low levels of control, even for some highly toxic insecticide combinations, raised questions as to the residual effectiveness of currently available lygus materials. Regional differences in population susceptibility to various pesticides offers hope for reducing control costs and implementation of sound chemical rotational strategies. Further comparisons between field tests and laboratory assays are needed..

Acknowledgements

We wish to thank the cotton growers of Arizona for the financial support that made this study possible.

We thank Richard Craft, Arizona Cotton Research and Protection Council, for outstanding service in all aspects of the treatment phase of the project.

For technical and logistical support we thank the field and administrative staff of the Arizona Cotton Research and Projection Council.

References

Dennehy, T. J. and Russell, J. E. 1996. Susceptability of lygus bug populations in Arizona to acephate (Orthene) and bifenthrin (Capture) with related contrasts of other insecticides. Proc Beltwide Conferences, pp 771-777.

Mauney, J. R. and Henneberry, T. J. 1978. Plant bug damage and shed of immature cotton squares in Arizona. pp 41-42. Proc 32nd Cotton Physilogy Conference. National Cotton Council, Memphis, TN.

Sevacherian, V. and Stern, V. M. 1974. Host plant preference of lygus bugs in alfalfa interplanted cotton fields. Environ. Entomol. 3:761-766.

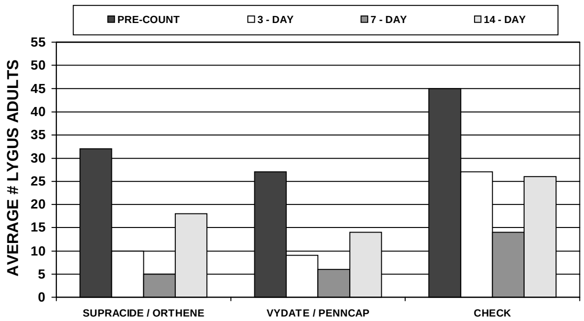
Table 1. Lygus insecticide efficacy summary for cotton field tests in Arizona, 1997.

	% Post treatment reduction or <increase> in adult lygus population over controls		
Insecticide(s)	3 days	7 days	14 days
methamidophos / acephate (Monitor 32 oz / Orthene 1 lb)	60	47	9
zetamethrin / acephate (Mustang 4.26 oz / Orthene 1 lb)	47	27	4
methomyl / oxamyl (Lannate 32 oz / Vydate 32 oz)	39	65	12
endosulfan / methomyl (Phaser 32 oz / Lannate 24 oz)	37	23	<3>
lamda-cyhalo thrin / acephate (Karate 4.5 oz / Orthene 1 lb)	33	37	25
methidathion / acephate (Supracide 2 lb / Orthene l lb)	29	15	2
oxamyl / methyl parathion (Vydate 32 oz / PenncapM 48 oz)	26	9	6
acephate (Orthene 1 lb)	26	3	<1>
oxamyl (Vydate 32 oz)	22	10	<6>
endosulfan (32 oz)	19	4	1

Table 2. Lygus insecticide efficacy comparison of percent reduction of adults in untreated controls versus percent adult reduction in precounts in the same test block in Arizona, 1997.

	Days post treatment		
Insecticide(s)	3	7	14
Monitor / Orthene			
% reduction over control	60	47	9
% reduction over precount	82	85	89
Mustang / Orthene			
% reduction over control	47	27	4
% reduction over precount	76	88	71
Lannate / Vydate			
% reduction over control	39	65	12
% reduction over precount	71	78	92
Phaser / Lannate			
% reduction over control	37	23	<3>
% reduction over precount	65	55	81

North



South

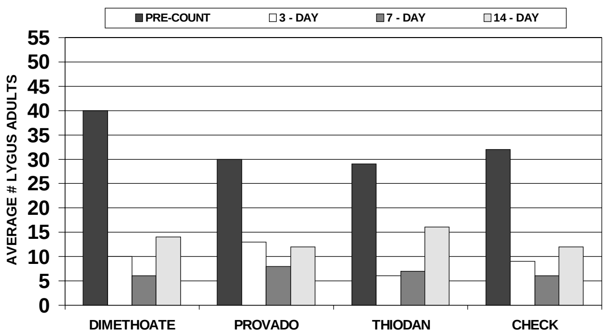


Figure 1 and 2. Declining adult numbers in both treated and untreated control plots within the same test fields in Buckeye, Arizona, 1997.

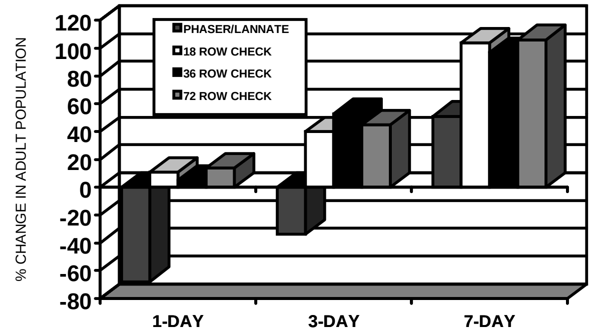


Figure 3. Percent change in adult lygus population in replicated treatment versus 18, 36 and 72 row untreated control plots over 1, 3 and 7 days post treatments in Arizona, 1997.