INSECTICIDE RESISTANCE TRENDS
IN SAN JOAQUIN VALLEY LYGUS BUG

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ABSTRACT

Insecticide resistance in lygus bugs infesting alfalfa that was planted next to cotton was studied for five years using a treated-plastic bag bioassay method. Resistance to the pyrethroid Capture is of concern because it appears to be intensifying in both hay and seed alfalfa. Resistances to the organophosphates, carbamates, and chloronicotinyl tested are more likely to be manageable if use of these insecticides is limited because resistance is low and/or is less stable than pyrethroid resistance. New, more selective insecticides are clearly needed for lygus bug control.

Keywords: Lygus bug, insecticide, resistance, pyrethroid, organophosphate, carbamate, chloronicotinyl, alfalfa, cotton.

Introduction

The picture of lygus bug (*Lygus hesperus*) resistance in San Joaquin Valley cotton is complicated by the fact that lygus bugs infest a number of crops. In addition, the insecticides applied for other pests, such as cotton aphid and alfalfa weevil, also select for resistance in lygus bugs. Lygus bug is a key pest in cotton fields as foothill vegetation dries and as neighboring alfalfa fields are harvested (Goodell 1998). San Joaquin Valley populations of lygus bugs have had a long history of organochlorine, organophosphate, and carbamate insecticide exposure (more than 30 years). More recently (since the early 1990s) they have also been treated with the pyrethroid, Capture.

Between 1985 and 1995, pesticide use increased from 1.5 applications to as many as 6 applications per season for combined cotton pests and yields were very low in 1995. At first, insecticide resistance in cotton aphids was blamed for the escalation of pesticide use. However, insecticide resistance wasn't the only reason that cotton aphids became a problem. In the early 1990s, San Joaquin Valley growers began to plant higher yielding varieties of cotton. Increasing amounts of nitrogen and irrigation helped create an environment that caused aphids to grow and reproduce faster (Godfrey et al. 1999). Cotton aphids, which had previously been an early season or late season pest problem became a serious mid-season pest, thus escalating pesticide use.

Another factor escalating pesticide use was the introduction of early season applications of the pyrethroid Capture for both cotton aphid and lygus bug control. Cotton aphid

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developed resistance to Capture rapidly, and by 1995, it was no longer effective for controlling aphids (Grafton-Cardwell and Goodell 1996). Resistance to Capture in lygus was also detected in 1996, however, it was not as severe (Grafton-Cardwell et al. 1997) or as stable (Knabke and Staetz 1997) as Capture resistance in cotton aphids. Because the pyrethroids gave longer residual control than other insecticides, growers continued to use pyrethroids for lygus control in spite of resistance. When pyrethroids are used for early season lygus control, insecticide use for secondary pests such as cotton aphids, spider mites, and various Lepidoptera escalates (Godfrey et al. 1998). This is because pyrethroids are toxic to the natural enemies that control these pests and because they cause Capture-resistant aphids to reproduce faster.

In response to the extremely heavy broad-spectrum pesticide use and low yields experienced in 1995, University of California Extension personnel held a cotton industry workshop to review the pest situation. One outcome of this review was a series of insecticide resistance management guidelines that emphasized the preservation of natural enemies by avoiding early season broad-spectrum insecticides and the careful rotation of insecticide chemistries (Goodell et al. 1999).

In this article, we report on the pesticide use patterns and pest resistance of lygus bugs during 1993-2000, the period just prior to and following implementation of the resistance management guidelines.

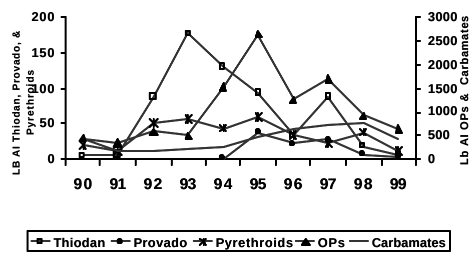
PROCEDURES

We were not able to test all of the insecticides registered for lygus bug control, and so we chose insecticides from major chemical classes. Insecticide resistance bioassays for lygus bugs were prepared by treating plastic ziploc bags with 5 µl technical grade insecticide in acetone. We tested the pyrethroid Capture, the organophosphate Metasystox-R, the carbamate Lannate, and the chloronicotinyl Provado. The bags were kept frozen till used. Lygus bug mortality was assessed after 8 hours. We expected to observe greater than 80% mean mortality of individuals placed in these dishes if the population was susceptible to the pesticide. We collected the lygus bugs using a sweep net from cotton fields and alfalfa neighboring cotton in order to obtain enough individuals for bioassays. Collections were made in the early season (June) and the fields were resampled in July/August if lygus bugs were available. Pesticide use data was obtained from the California Department of Pesticide Regulation for 1990-1999 and summarized for Merced, Madera, Fresno, Kings, Tulare and Kern counties. Estimates of pest densities were obtained from the Cotton Insect Losses summary for the National Cotton Council (Williams 1991-2000).

RESULTS

Insecticide use for lygus, cotton aphid, and other miscellaneous pests between 1990-1999 in the San Joaquin Valley is illustrated in Figure 1. Thiodan/Phaser use reached a peak in 1993, organophosphate and pyrethroid use peaked in 1995, carbamate use peaked in 1998 (primarily Temik), and Provado use was initiated in 1995. In 1995, when organophosphate and pyrethroid use was at it's highest, pesticides were not very effective in controlling cotton aphid or spider mites. The resistance monitoring program was initiated the following year (1996) in response to concerns that resistance was the cause of the aphid and mite problems.

Figure 1.
San Joaquin Valley Insecticide Use (x1,000 lbs)



In 1997, lygus bugs were found to be fairly susceptible to Capture (61 to 100% mortality) at the beginning of the season before insecticides were applied in either hay or seed alfalfa (Fig. 2 & 3). Resistance was observed to increase after Capture was applied to seed alfalfa in June-July. At that time, pyrethroids were not registered for hay alfalfa and it was thought that resistance could be managed by limiting Capture to a single application in seed alfalfa and cotton per year. However, resistance to Capture in lygus bugs, averaged over the entire season, increased from 40-60% of sites in 1996-97 to ≥80% of populations tested in 1998-2000 (Fig. 4).

Fig. 2 Yr 1997

Response of Lygus to 200 micrograms Capture (bifenthrin) in hay alfalfa

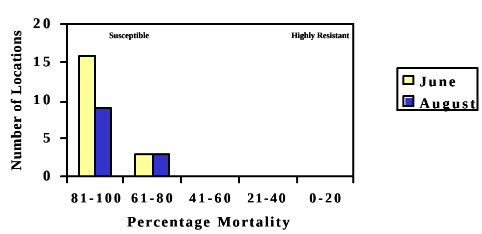
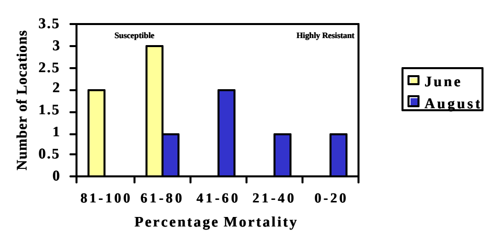


Fig. 3 Yr 1997

Response of Lygus to 200 micrograms Capture (bifenthrin) in seed alfalfa



Although pyrethroid use declined in cotton after 1995, use in alfalfa has dramatically increased (Fig. 5). Recent registration of pyrethroids for alfalfa weevil control and other pests of hay alfalfa greatly escalated pyrethroid use. Thus, hay alfalfa is no longer a source of pyrethroid-susceptible lygus bugs for interbreeding with lygus from seed alfalfa and cotton

Lygus Bugs
Capture (bifenthrin) 200 micrograms

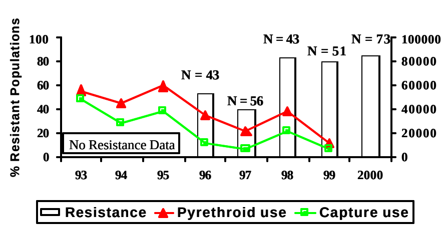
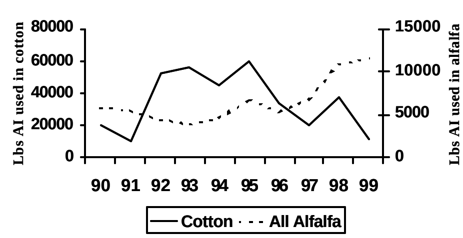
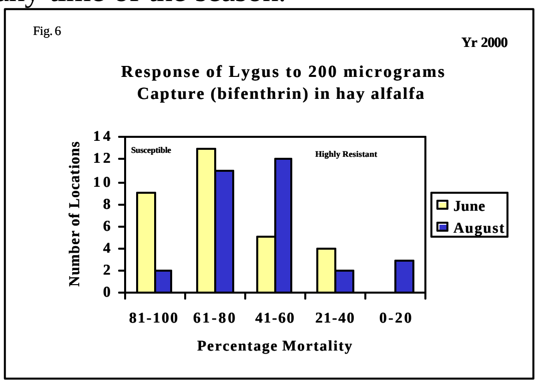


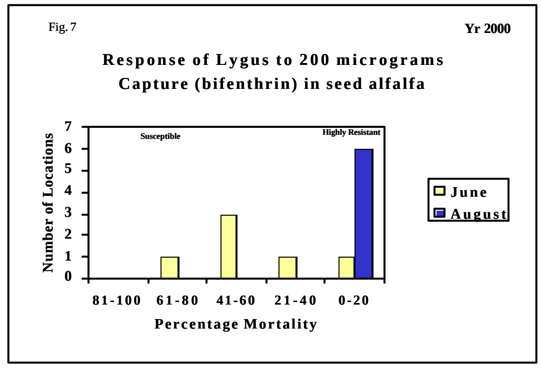
Figure 4. Capture and pyrethroid use (lb AI) during 1995-99 and the percentage of Capture-resistant Lygus populations of total (N) tested during 1996-2000.

Figure 5. San Joaquin Valley Pyrethroid Use



We found that lygus bugs collected from hay alfalfa in 2000 (Fig. 6) were less susceptible in both the early season (21-100% mortality) and the late season (0-100% mortality) compared to 1997 (Fig. 2). The situation was even more extreme for seed alfalfa (Fig. 7) where pyrethroid exposure has occurred over a greater number of years. In seed alfalfa, all late season populations exhibited <20% mortality of Capture in the bioassay. If pyrethroid use in alfalfa continues at its current rate, we are likely to see Capture resistance in lygus continue to intensify until it will no longer effectively control lygus at any time of the season.





Resistance of lygus bugs to the organophosphate Metasystox-R seemed to fluctuate as use fluctuated, but recently is on the increase (Fig. 8). Cotton growers find that Capture has greater efficacy and residuality than the organophosphates for lygus bug control, in spite of the greater frequency of resistance to Capture that we are able to detect in the bioassays. Resistance of lygus bugs to the carbamate Lannate has only been documented for three years, but seems to fluctuate from year to year (Fig. 9).

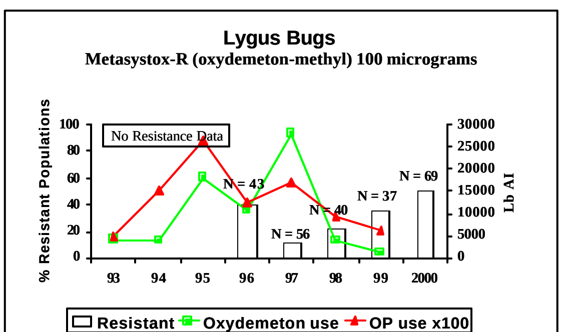


Figure 8. Oxydemeton-methyl and organophosphate use (lb AI) during 1995-99 and the percentage of oxydemeton-methyl-resistant Lygus populations of total (N) tested during 1996-2000.

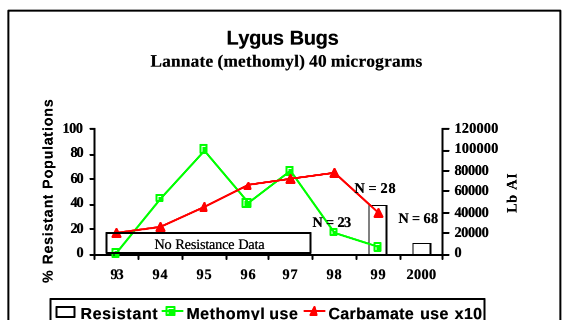


Figure 9. Methomyl and carbamate use (lb AI) during 1995-99 and the percentage of methomyl-resistant Lygus populations of total (N) tested during 1998-2000.

Provado resistance in lygus bugs was tested for the first time in 2000 and a low percentage of populations with resistance (16%) were found.

CONCLUSIONS

Pesticide bioassays were useful for detecting trends in lygus bug resistance to major groups of insecticides. The data indicate that pyrethroid resistance in lygus is quite high and intensifying, suggesting that pyrethroid usefulness may be approaching an end. In contrast, resistances to organophosphates and carbamates occur, yet the level or frequency of resistance fluctuates from year to year. There is greater potential for maintaining susceptibility to these pesticides if their use is limited. There is a great need for new insecticides for lygus control to provide different chemistries to rotate with and so manage insecticide resistance. In addition, greater selectivity of new lygus insecticides is needed to allow the natural enemies of other pests to survive so that growers are less dependent on insecticides..

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