LYGUS RESISTANCE MONITORING

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Lygus (*Lygus hesperus*) is the major insect pest limiting alfalfa seed production in California and other Western seed-producing states. It is also a troublesome pest in a number of crops grown in the Central San Joaquin Valley, such as cotton, beans, and safflower. It will be many years before varieties resistant to Lygus are available, so at this point growers must rely primarily on the few chemicals currently registered for use which effectively control this damaging pest.

Lygus populations cycle between crops due to harvest or desiccation, and as they move to a new area, they carry with them their previous chemical exposure. Many of the chemicals registered for lygus control in seed alfalfa, are also registered and used on a number of other crops, so the potential for rapid development of resistance is high. Since seed alfalfa is a minor crop, chemical companies are unwilling or unable to justify the expense of registering new materials, so as an industry, we must preserve the materials currently available to us while pursuing the development of information to improve alternate control measures and/or resistant varieties.

Bioassay techniques can be used to evaluate resistance mechanisms and predict resistance development which gives growers the opportunity to adjust practices to retard its progress. We need to monitor insect populations to detect resistance in the early stages and manage it before it becomes widespread and common. Given resistance information, growers may have the option to switch to a pesticide with a different mode of action, and delay the development of resistance to any one pesticide.

MATERIALS AND METHODS

A successful bioassay technique was developed by Bill Brindley at Utah State University to determine dose response regressions and LC_{50} values. The bioassay technique is very simple. Small plastic ziplock bags are pretreated with solvent containing concentrations of insecticide bracketing expected residues for effective bioassays. Five to six treatment brackets, including the check, were included in all of the bioassays conducted. Each treatment was replicated 4 times. Treatment bags were stored in a freezer until taken to the field to conduct the bioassays. In the field, a small cork or dry bean and an alfalfa trifoliolate were placed in each bag. Adult lygus were collected by sweep net and 5 insects were placed in each bag. Bioassay bags were held at about 30°C (68-70°F) in a portable incubator. After 8 hours in the incubator, the lygus bugs in each bag were observed and mortality levels recorded. Regression analysis on each bioassay data set derived LC_{50}, slope, and r^2 values. Dose response screening of 100-120 adult lygus occurred with each bioassay. In 1997, 116 bioassays were conducted between June 10 and August 12. In 1998, 90 bioassays were conducted between June 11 and September 15.

BIOASSAY MATERIALS								
1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
Capture	Capture	Capture	Capture	Capture	Capture	Capture	Capture	Capture
MSR	MSR	MSR	MSR	MSR	MSR	MSR	MSR	MSR
Bathyroid					Monitor	Monitor	Monitor	Monitor
					Carzol	Carzol	Carzol	Carzol
					Lannate	Lannate	Lannate	Lannate
					Lorsban	Lorsban	Lorsban	Orthene
					Thiodan	Thiodan	Thiodan	Thiodan
							Malathion	Malathion
								Dibrom

RESULTS

Metasystox-R

LC50 values for MSR did not change significantly between 1990 and 1994 since the material was not used extensively in this area. Late season LC50 values were not much different from those observed early in the season. Values ranged from 15.7 to 82.7 ug/bag which are comparable to values from ID, OR, NV, WA and UT where the material still performs well. Although MSR use increased in 1995, LC50 values were not different from those recorded in 1994.

In 1996, however, early season values were somewhat higher than those recorded between 1992 and 1995, and there was a substantial increase in LC50 late in the season, indicating the possibility of resistance development. Early season populations are still susceptible, but based upon bioassay results, a second application of MSR in a single season is not recommended. In 1997, LC50 values for MSR were very low early in the season, ranging from 25 to 40 ug/bag. Bioassays conducted in late June, July, and August indicated that there was little development of resistance in 1997. Values ranged from 30 to 110 ug/bag, with an average of 51.3 ug/bag - lower than the pre-season values for 1996!

In 1998, early season bioassays failed due to high control mortality. The first successful bioassay was conducted on 6/26/98. The LC50 value recorded was 24.2 ug/bag. Values remained low until late July and August when they averaged almost 100 ug/bag, still well within a range where acceptable performance would be expected. A late start to the production season and low pest pressure until mid-July may have limited the use of MSR in 1998. Results from these bioassays are consistent with results from the Northwestern seed producing states - lygus populations do not appear to develop resistance as quickly to MSR as compared to Capture.

Capture

We did expect to see an increase in Capture LC50 values through the years since there is tremendous selection pressure for resistance. 1990 should be considered as a baseline level since the material was not registered in California when the bioassays were conducted. Use increased dramatically once the product was registered in 1991. This material could be used twice per season until 1996 on seed alfalfa and three times per season on cotton, which is grown in the same production area. In 1992, 1993, and 1994, the early sampling took place prior to Capture application. The late sampling would follow at least one, and in many cases two, applications of Capture. LC50 values were two to four times higher at the end of the season compared to pre-bloom values.

In 1995, pretreatment LC50 values for Capture were consistent with values from 1993 and 1994, and rose as expected with subsequent applications during the season. Late 1995 LC50 values represent bioassays from fields which had received two Capture applications. There was a significant increase in the average LC50 values indicating the development of resistance. A bioassay was conducted in a field that received three Capture applications. Results are not included in the averages, but the LC50 level from that one field was 955 ug/bag! As we observed in previous years, lygus populations returned to a susceptible condition by the beginning of the following season, but populations in 1996 appeared to exhibit resistance much more quickly than in the previous years. LC50 values were just over 110 ug/bag prior to Capture use, but rose to over 500 ug/bag following a single application of Capture. In previous years, two applications of Capture resulted in values around 400 ug/bag.

In 1997, LC50 values for Capture were similar to early season values from previous years when testing began in the second week of June. Although Capture had not been used in one field bioassayed on 6/11, the LC50 value was 275 ug/bag. I believe Capture was used earlier in the season in 1997 as compared to previous years, and we saw some resistant populations from the beginning of the production season. There was a difference in 1997 in the development of resistance as the season progressed. Late season bioassays ranged from 37 to 275 ug/bag (averaging 161.7 ug/bag). These were the lowest late season LC50 values we've seen since the research began. In 1998, June bioassays had an average LC50 of 205 ug/bag, up slightly from previous early season results. However, due to late and lighter than normal pest pressure in 1998, late season values averaged only 290 ug/bag.

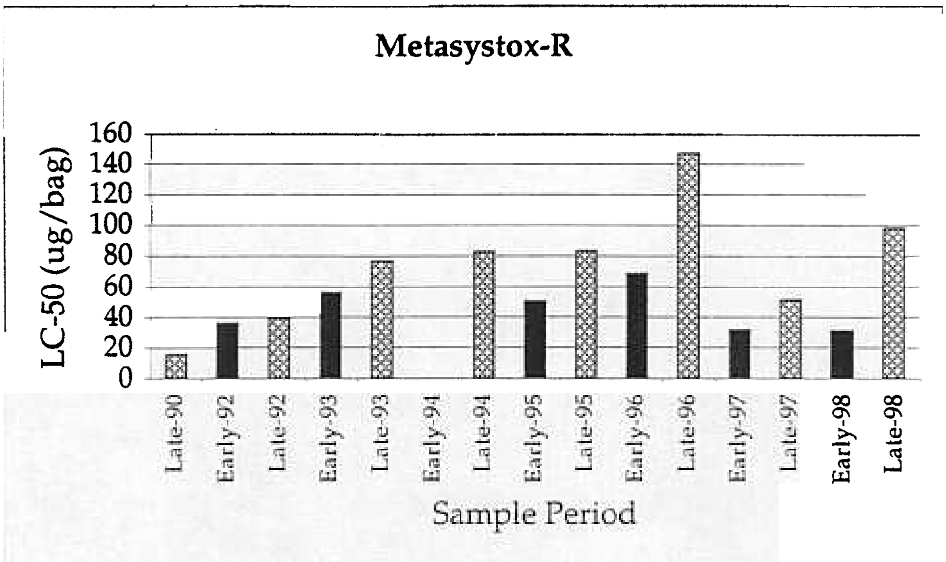
Monitor, Carzol, Lannate, Lorsban, Thiodan, Malathion, Dibrom, and Orthene

In addition to evaluating Capture and MSR, technical grade materials were obtained in 1995 to begin to evaluate resistance levels for Monitor, Carzol, Lannate, Lorsban, and Thiodan. In 1997, Malathion was added to the list, and in 1998, Dibrom and Orthene were evaluated. It took several bioassays to establish the range of concentrations for each material. Bioassays have not worked well for Thiodan, Lorsban, and Malathion.

LC-50 Values (ug/bag)

	Monitor	Carzol	Lannate	Dibrom	Orthene
1995	5.3	4.6	18.5		
1996	37.4	16.8	17.6		
1997	22.1	8.6	13.0		
1998	20.4	13.9	27.8	142.9	19.0

In 1995, levels for Carzol, Lannate, and Monitor were all low. Not much change was observed in bioassays conducted in 1996 for Carzol and Lannate, but the average LC50 value for Monitor did increase. This was not surprising considering the changes in its use pattern. Many growers, when faced with a lack of effective alternatives, used Monitor during bloom in addition to using it as a clean up material. In 1997, LC50 values for Carzol and Lannate were lower than in 1996. LC50 values for Monitor were lower than 1996 values, but still reflected the higher use pattern as a result of the loss of other materials. In 1998, bioassay results were similar to previous years indicating that with the current limited use (≤1 application per season) there is no evidence of development of resistance.


Metasystox-R
LC-50 (ug/bag)
160
140
120
100
80
60
40
20
0
Late-90
Early-92
Late-92
Early-93
Late-93
Early-94
Late-94
Early-95
Late-95
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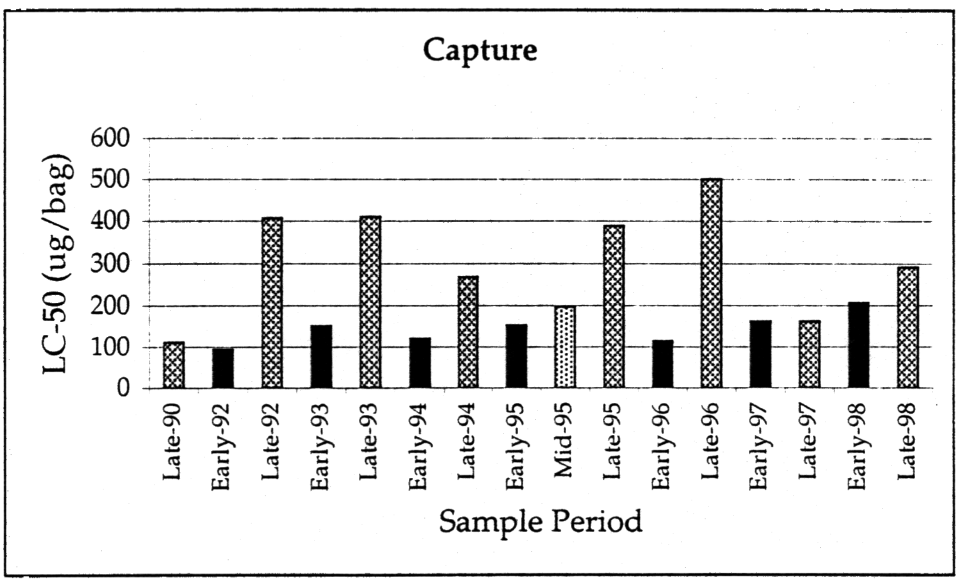
Late-96
Early-97
Late-97
Early-98
Late-98
Sample Period


Capture
LC-50 (ug/bag)
600
500
400
300
200
100
0
Late-90
Early-92
Late-92
Early-93
Late-93
Early-94
Late-94
Early-95
Mid-95
Late-95
Early-96
Late-96
Early-97
Late-97
Early-98
Late-98
Sample Period

SUMMARY

Bioassay results agree in general with reports of field efficacy, but the LC50 value at which the insecticide would fail in field applications is not known at this point. We recommend that growers:

- monitor pest populations, predators, and natural enemies,
- use materials only once per season and delay pyrethroid use as long as possible,
- keep good records of pest population levels and pesticides used and their performance.

When a decline in efficacy is observed, it is far better to switch to a different chemistry rather than increasing the rate, or reducing the interval between applications. Both practices increase the development of resistance.

Growers should also adopt rotation of insecticides whenever possible as a routine part of their pest management programs in both cotton and seed alfalfa to delay the onset of resistance and maintain the efficacy of currently available products. Whenever possible, coordinating the use of materials over a wide area will help insure that a susceptible population is being treated.

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