# *Lygus* Chemical Control: Are Combination Sprays Worth It?

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### *Abstract*

*We need efficient sampling methods, appropriate thresholds based on a well-defined* Lygus *density – yield relationship, and knowledge of the most effective chemical controls available. Insecticides were evaluated for control of* Lygus *at 5 'at-risk' grower locations, as well as at 4 other experimental sites. Application methods were different at each site according to grower practice or experimental protocol (5–20 GPA; by ground, air, or electrostatically-assisted ground sprayers). Evaluations were made based on the number of* Lygus *per 100 sweeps. Orthene®, Vydate® or, to a lesser degree, Monitor® used alone and at high rates appeared to perform adequately at all sites. Both rates of Regent™, a new chemistry under development by Rhône-Poulenc, provided excellent levels of control comparable to Orthene in a high density test. In this same test, none of the experimental and registered pyrethroids provided adequate control when used alone. Thiodan®, when mixed with Mustang®, provided some level of control. Over all tests measured for yield, a positive net return was possible with no more than 2 sprays of solo materials which yielded between 0.3 and 0.5 bales / A more than untreated comparisons or between $51–130 / A net return. Also, at one site where yields were in excess of 4.2 bales / A, optimum planting and fruit-set prior to heavy* Lygus *pressures and monsoon-associated heat stress was an important cultural tactic for avoiding losses to* Lygus *— the check yielded over 3.7 bales / A! As seen at grower sites and confirmed in experimental studies, **solo compounds, at appropriate rates, performed as well or better than any combination tested. And, mixtures at this time do not appear to provide any additive, synergistic or economic benefits in the control of** **Lygus.** Combinations, unless indicated by another pest problem (e.g., whiteflies), are not "worth it," and needlessly expose the grower to larger input costs, "empty" applications, and higher risks of resistance, pest resurgence, secondary pest outbreaks, and phytotoxic effects by insecticides.*

## Introduction

When other measures fail to control or prevent damaging levels of an insect population, chemical controls become necessary. The vast majority of insecticides deployed for insect pests in Arizona cotton is directed at pink bollworms, whiteflies, and *Lygus* bugs. Recent advances in insecticidal technologies have provided growers with highly effective options for pink bollworm (transgenic, 'Bt' cotton) and whiteflies (insect growth regulators). Because of the selectivity and effectiveness of these technologies against their targets, *Lygus* bugs have been spared collateral control by broad-spectrum compounds which were formerly used against pink bollworm and whiteflies (Ellsworth et al. 1998). As a result, industry awareness of this pest has increased in the last two years. With this new found prominence within our system, many practitioners have actively searched for effective control measures for *Lygus* (e.g., Antilla et al. 1998; Pacheco, 1998).

Our research program in integrated *Lygus* management has been focused on the development of new sampling strategies for *Lygus*, the definition of the *Lygus* density-yield relationship for the development of action thresholds, and the optimization of chemical controls (Ellsworth, 1998). Coupled with new understanding of how *Lygus* controls interact with other pest dynamics, we are preparing the industry for a new era in pest management—a **knowledge-intensive** system built on the strategic use of selective insecticidal technologies and the active management of **natural** enemies (see Ellsworth et al. 1998; Naranjo et al. 1998a,b).

The focus of this paper is identification of the best chemical control options available to growers now as well as in the future. With the success of synergized pyrethroids and other insecticidal combinations for whitefly control, the industry as a whole has adopted a "standard practice" of mixing chemistries to achieve optimal pest control. Our studies reported here were structured to examine the viability of these practices. In other words, are combinations of insecticides worth the investment?

## Methods

A total of nine experiments were conducted in 1997. Insecticide efficacy of registered compounds was studied on five commercial fields with grower cooperators and their own application equipment. Only 'at risk' sites were selected for study as defined by historical inputs for *Lygus* and/or proximity to hay alfalfa. Two experiments were conducted on small plots at the Maricopa Agricultural Center (MAC). One was dedicated to registered insecticides; the other was divided into pyrethroid and novel chemistries. In addition, a threshold study was conducted on medium-sized experimental plots at MAC, where Orthene® (1 lb ai/A) was applied at 17 GPA according to 3 *Lygus* bug densities. The final study was part of an integrated whitefly management trial where half of the plots received a single treatment for *Lygus* with Vydate C-LV® (1 lb ai/A) under quasi-commercial conditions (Ellsworth et al. 1998). Unless stated otherwise, all studies were conducted on Bt varieties, and the highest labelled rate of the materials were used, even when used in combinations. Thus when used, combinations were always comprised of double the potential active ingredient of their solo comparisons. Orthene (1 lb. ai/A) was the standard in all comparative tests. An untreated check was included wherever possible, but only partially replicated at some commercial sites. Additional site-specific details are provided in the Results section.

## Results

### *Integrated Whitefly Management Trial*

In this trial, we examined whitefly dynamics under quasi-commercial conditions. When *Lygus* reached high levels (ca. 35 / 100 sweeps), we split all plots in half and treated once on 25 July with Vydate (1 lb ai / A) at 17 GPA. *Lygus* numbers dropped below threshold (< 15 total *Lygus* / 100 sweeps) and were never re-treated. The production cycle was mature enough to justify foregoing any additional applications for *Lygus*. As a result of the split-plot design, we were able to examine yield response in a series of contrasted whitefly control regimes (Fig. 1). In all five contrasts (20 subplots), the *Lygus* treated portion of the whole plot significantly out-yielded the untreated portion (ca. 0.3–0.5 bales / A). The untreated portions averaged 2.54 bales / A, while the treated portions yielded 2.94 bales / A. The '95IRM' was not split into subplots, because many of the materials used to control whiteflies were also active against *Lygus*.

### Lygus *Threshold Study*

Orthene was applied at 7.5, 15 and 30 total *Lygus* / 100 sweeps for a total of 4, 2, and 1 application(s), respectively. *Lygus* numbers responded to each application and levels never exceeded 35 total *Lygus* / 100 sweeps, even in the untreated check. The crop was planted very early for this location, and early fruiting was very heavy. Threshold levels of *Lygus* began well after initiation of fruiting. The 15 total *Lygus* / 100 sweeps resulted in yields (3.29 bales / A) significantly higher than in the 7.5 (3.10 bales/A) ($P = 0.04$), and the 30 total *Lygus* thresholds (3.08 bales / A) ($P = 0.02$) and the untreated check (3.06 bales / A) ($P = 0.004$) (Fig. 2). The latter three treatments were not significantly different from each other ($P > 0.41$). The high level of production in the untreated check is a reflection of the early fruiting, prior to threshold levels of *Lygus*, and the moderate to low season-long *Lygus* pressure in this experiment.

### *Scottsdale Commercial Site*

*Lygus* numbers were monitored for six weeks prior to spraying. During that time, *Lygus* adults and nymphs built-up steadily and proportionally until the first spray by electrostatic, ground-sprayer at 5 GPA on 24 July. At the time of spraying nymphs represented ca. 50% of the total count. Supracide® at 0.5 lb ai/A was too viscous to be delivered at this low volume through the electrostatic system. The second spray was made using the emulsifiable formulation of Supracide which is no longer marketed. Also, on the first spray only, Vydate was mixed with Baythroid® at the half rate (0.5 lb ai/A). Each treatment included an anti-foaming agent (Defoamer® at 1 oz/40 gal.). The untreated check was only partially replicated (2/4 replicates). Plot sizes were 18 rows by 1250 ft.

*Lygus* numbers, especially nymphs, declined after the first spray. There were no significant differences 6 DAT, except that nymph numbers were lower in treated vs. untreated plots. At 11 DAT all treated plots remained below threshold and had significantly fewer nymphs than the untreated. At 20 DAT, some treatments were below, some at, and the check above threshold. Baythroid + Vydate (the only pyrethroid combination) had significantly fewer total *Lygus* than Vydate alone or the rest of the treatments. This difference did not persist at 27 DAT, when nymphal numbers began to increase significantly throughout (Fig. 3: dark portions of bars). Re-treatment was called for at 28 DAT, in part, because nymphal numbers were so high relative to adults (ca. 70%). Seven and 14 days after the second treatment, all counts went to zero for all treatments including the untreated! A large, very localized storm was likely partly responsible for the dramatic, late-season, decline in numbers.

## *Marana Commercial Site*

Four weeks of precounts were taken during which numbers fluctuated at sub-threshold levels until 28 July. On this date, over half of the sample was nymphs, and an aerial spray at 5 GPA was made on 1 August. There were only three of four replicates with an untreated check. Plots were 13 rows (1 swath width) by 1700 ft. The variety used was DP 20b, except for 2 plots in one replicate which were planted to DP 20 (not included in yield analyses). No other sprays were made prior to, during, or after the test. All sprays included cottonseed oil (FertiOil® at 4 oz/A) and a foliar feed (Fertigro® at 1 qrt/A).

Nymph numbers declined from 50% to less than 10% of total *Lygus* numbers by 5 DAT with no significant treatment differences in *Lygus* numbers (Fig. 4). Yet, adult numbers remained high, above threshold, at 5 and 10 DAT. At 10 DAT, there were no significant differences in adult or total numbers among treatments; however, there were very slight (range: 0–3.3 nymphs / 100 sweeps), but significant differences in nymph numbers as determined by orthogonal contrasts. The Orthene solo and combination treatments had fewer nymphs than the check ($P = 0.001$). Vydate + Orthene had fewer nymphs than Vydate alone ($P = 0.002$), but the same as Orthene alone. Nymph numbers in combination treatments were not significantly lower than solo treatments ($P = 0.09$).

On 13 August (12 DAT), the field was re-sprayed mainly because adult numbers failed to respond to any of the treatments. By 5 DAT2, all treatments were significantly lower than the check (UTC) and below threshold. Numbers continued to decline by 9 DAT2, and all had fewer nymphs than the check which remained above threshold. A large rainstorm occurred that could have reduced residual before the next evaluation. At 14 DAT2, numbers increased, but were still below threshold and lower than the check (adults, nymphs, and total). While nymphs were much higher relative to adults (ca. 50%) at this time, additional treatments were not warranted due to the advanced stage of growth by this date (27 Aug). By 27 DAT2 (not shown), all numbers declined slightly, while nymph numbers declined greatly. At no time did a combination perform better than a solo material.

Harvests were made with commercial equipment and weighed in trailers for each plot. All treated plots had significantly higher lint yields than the untreated check ($P = 0.0003$) (Fig. 5). There were no other significant differences. Combination treatments had no significant yield advantage over the solo materials. Orthene yields did not significantly different from any Orthene combination ($P > 0.467$). The Orthene + Vydate combination did not yield significantly more than the Vydate ($P = 0.106$) or Orthene solo treatments ($P = 0.901$). In contrast, the solo materials were less expensive to use and therefore resulted in a larger net revenue than the combination treatments.

## *Roll Commercial Site*

The crop at this site was at a very advanced stage of development before any significant *Lygus* numbers developed. Three weeks of precounts were taken, and *Lygus* levels were low even before the first spray especially considering the small numbers of nymphs (<15%). The only spray was made on 11 July at 15 GPA by ground. There were 18 row by 1250 ft plots and four replicates. All cotton was DP 50b, and there was only one small untreated area in the design (ca. 8 rows by 1250 ft.).

All treatments reduced the *Lygus* numbers below the starting level 8 DAT with no differences among treatments (Fig. 6). At 13 DAT, numbers declined more, and there was no further need for additional *Lygus* control measures. There were no differences among the materials used.

## *Casa Grande Commercial Site*

Three precount and 6 post-count evaluations of *Lygus* densities were made at this site. Plot sizes were ca. 18 rows X 1600 ft with four replicates including an untreated check. Numbers increased to threshold with a significant proportion of nymphs (ca. 30%) and were sprayed on 30 July by ground at 9 GPA. All treatments included a crop oil (FertiOil at 1 pt/A). Metasystox-R® was used at 0.5 lb ai / A. The crop was under stress several times through the season due to the lack of availability of water. Weed competition was high in some areas of the field.

*Lygus* numbers declined sharply after the first spray and remained below threshold for over 3 weeks (Fig. 7). Nymph numbers, especially, declined to near zero 6 DAT. At 26 DAT, all treatments were at or above threshold, and all treatments were re-sprayed. At 8 and 15 DAT2 (not shown), numbers declined to virtually zero (0.6 total *Lygus* / 100 sweeps). At no time were there any significant differences among treatments. There were no differences from the check on all sample dates. Water stress may have served to make this crop less attractive to *Lygus*, and levels throughout the season were relatively low in this field. Yields were low for this site (ca. 2 bales/A) and not significantly different among any of the treatments including the untreated check. The lack of treatment separation suggests that *Lygus* were not at economically damaging levels for this field which is supported by the *Lygus* density data.

## *Buckeye Commercial Site*

At this site, only one precount was taken just prior to spraying as well as two post-count evaluations. There were four replicates with plot sizes of 22 rows by 1250 ft to accommodate aerial spraying. There was a 44 row buffer on either side of the field. An anti-foaming agent was included in each treatment applied at 5 GPA. Supracide was used at 0.95 lb ai / A.

*Lygus* numbers were well above threshold by the first spray (29/100) with a significant gradient across the field. Nymphs constituted about one third of the total precount, but declined to less than 9% at 6 DAT with no treatment differences (Fig. 8). Adult numbers remained high, and the field was oversprayed 10 DAT by the grower. By 15 days after the first spray, overall numbers were down, but nymphs increased to around 50% of the total count. Orthene + Monitor had fewer total *Lygus* than Monitor alone, but not fewer than Orthene alone. No other differences existed at this site. Sampling was discontinued due to the overspray.

## *Registered Chemistry*

All treatments were applied 2 times (using high label rates) except for Provado® and Provado + Ovasyn® which were sprayed 3 times. Each plot was 12 rows by 33 ft with 6 ft between plots. All applications were made by ground at 20 GPA without additives. Sprays were made on 26 June, 3 July (Provado treatments only), and 23 July. *Lygus* levels were low throughout this test never exceeding 25 / 100 sweeps (in the untreated). Thus, there were few consistent differences among treatments, except at 18 DAT (Fig. 9). On this date, all Orthene or Vydate treatments performed better than Provado treatments, Supracide, Penncap-M®, and the untreated control (UTC). Penncap-M or Supracide resulted in *Lygus* levels even higher than in the UTC, perhaps as a result of natural enemy disruption. Natural enemies were sampled from all tests and will be analyzed in the future.

Yields were extraordinarily high (> 4 bales / A), in part, due to the early planting and avoidance of monsoon-related heat stress and damaging levels of *Lygus* during early bloom. Yields also reflected relative efficacy of insecticides for *Lygus* control (Fig. 10). While lint yields were excellent throughout (even in the check), they were significantly higher than the check for all Orthene, Vydate, or their combination treatments except MSR + Vydate (Fig. 10). Orthogonal contrasts showed that Vydate alone was not significantly different from MSR + Vydate ($P = 0.36$) or Orthene + Vydate ($P = 0.66$); Orthene alone was not significantly different from Orthene + Supracide ($P = 0.36$) or Orthene + Vydate (0.99). No combination material out-yielded comparative solo materials, except Supracide alone was not as effective as Orthene + Supracide ($P = 0.079$) suggesting that Orthene is all that is necessary from this combination for controlling *Lygus*. Provado with or without Ovasyn yielded the same ($P = 0.98$).

*Experimental and Pyrethroid Chemistries*

This trial included both experimental and pyrethroid chemistries. Each plot of the four replicate test was 12 rows by 38 ft with 6 ft skips between plots. Three applications were made on 18 July, 29 July, and 5 August at 20 GPA by ground.

*Lygus* numbers were extremely high in this test, peaking at 125 total *Lygus* / 100 sweeps (only 68 / 100 in the untreated) (Fig. 11). At the 6 DAT evaluation, only Orthene, Mustang + Thiodan, and the Regent™ treatments were below threshold. At 10 DAT, these same treatments remained relatively low. After the second spray (6 DAT2) and during the period of highest pressure, Mustang® + Thiodan® was also low relative to the rest of the treatments. By the third spray (6 DAT3), *Lygus* levels were moderating, and by the final evaluation, the crop was less attractive to *Lygus*. Nymph levels were lowest for Orthene throughout this test.

Yields were very good for the planting date and location. *Lygus* levels were very high and sustained for several weeks, maximizing the chance to observe *Lygus* efficacy in yield results. Only the 3+ bale treatments were significantly different from the check ($P < 0.05$) (Fig. 12): Mustang + Thiodan (the only registered pyrethroid combination tested in this study), both rates of Regent (under development by Rhône-Poulenc), and the standard, Orthene. Both rates of Regent were similar in yields ($P = 0.70$). The pyrethroids used alone (the next four highest yields) were not significantly different from the untreated check ($P > 0.05$), nor did they suppress *Lygus* significantly. The Mustang + Thiodan did out-yield Mustang alone ($P = 0.009$) as well as the other pyrethroids ($P = 0.007$). The remaining three treatments are experimental whitefly materials and have no apparent *Lygus* activity. Whiteflies in these plots, however, were noticeably lower than in any other treatment. The surfactant did not significantly enhance the Pyridaben treatment ($P = 0.46$).

## Discussion

As the use of Bt cotton technology increases and growers have access to selective anti-whitefly agents (i.e., IGRs), *Lygus* become increasingly more important due to their destabilizing nature on the system, either directly or as a result of their disruptive controls (Ellsworth et al. 1998). Yield loss is widely evident due to this pest, but poorly quantified or related to pest densities. Further, crop development in relation to dynamic pest density affects yield relationships dramatically. *Lygus* management in Arizona cotton depends on an IPM strategy built upon tactics for avoiding damaging populations, appropriate sampling methods, adherence to threshold guidelines, and use of effective insecticides (Ellsworth, 1998). The series of studies reported here, as part of a larger program in *Lygus* IPM, details the chemical control options available and how best to optimize their use. Specifically, these studies identify the best materials for controlling *Lygus* and evaluate the utility of mixing compounds for *Lygus* control.

Timely chemical control based on periodic sampling and adherence to thresholds consistently returned from 0.3–0.5 bales / A in the majority of test locations and conditions with only 1 or 2 applications. The integrated whitefly management, threshold, registered chemistry, and Marana commercial trials achieved profitable chemical control of *Lygus* with 1 or 2 sprays of either Orthene or Vydate used alone at high rates. Even at 60¢/lb for cotton, a 0.3 bale increase returns $90 / A on an investment no higher than $39 / A. Additional sprays have not demonstrated as consistent or as large a return. In the threshold study, spraying on a lower threshold two additional times actually cost twice as much and yielded almost 0.2 bales / A less (a total net loss of ca. $115 / A). This emphasizes the importance of understanding all aspects of chemical control, including the direct effects of insecticides (efficacy) and their indirect or unintended consequences [natural enemy destruction (see Naranjo et al. 1998a,b), resistance (Dennehy, 1998; Dennehy et al. 1997), phytotoxicity of insecticides, and secondary pest outbreaks].

Insecticides were evaluated for control of *Lygus* at 5 'at-risk' grower locations in AZ, 2 comparative experimental sites at Maricopa, and 2 other quasi-commercial sites at Maricopa. Application methods were different in each test according to grower practice or experimental protocol. Delivery methods were by ground, by air, or by electrostatically-charged sprays from ground equipment. Volumes ranged from 5 to 20 GPA, and crop growth stages ranged from peak flower to cut-out. In the majority of cases, Bt cotton was used and no other sprays interfered with the interpretation of results. Among all of the sites, some 17 combinations and 9 solo materials were tested. There were several common conclusions to be drawn from these studies. At all sites tested, solo materials performed as well as or better than any of the higher priced dual combination materials. Relatively speaking our top performing insecticides in one location were in fact top performers at all locations. Namely, Orthene (1 lb ai / A) and Vydate C-LV (1 lb ai / A) [and to a lesser degree Monitor (1 lb ai / A)] all met or surpassed levels of suppression of any other solo or combination material tested. In the registered chemistry trial, yields were exceptional topping out at over 4.2 bales / A. The better yields were found in the Orthene, Orthene combination, and Vydate treatments. Optimum planting and fruit-set prior to heavy *Lygus* pressures and monsoon-associated heat stress is an important cultural method for avoiding losses to *Lygus* — the untreated check yielded over 3.7 bales / A!

The experimental chemistry under study was, in general, developed for other target pest species; however, each new compound needs to be examined for spectrum of activity (i.e., for *Lygus* in AZ). (Several compounds are under development for whitefly, mite, worm, or weevil control.) Faced with extremely high densities, most compounds failed to provide significant control of *Lygus* with one exception. Both rates of Regent provided levels of control comparable to Orthene. In this test, experimental and registered pyrethroids were also studied. None provided adequate control when used alone. Thiodan, when mixed with Mustang, provided some level of control.

In general, *Lygus* control was accomplished with 1–2 sprays and resulted in significant reductions in the nymphal population (note dark portions of bars). Adult numbers were less responsive to the treatments and may have been related to adult movement to and from local sources. At no location was more than two applications required to address the season-long potential of this pest. In addition, we can conclude, in spite of potential for resistance (Dennehy, 1998; Dennehy et al. 1997), *Lygus* are controllable with the available, registered materials, and, when properly applied and timed, these compounds can contribute to outstanding yields. Conclusions from these studies reinforce the results from previous years' trials (e.g., see Pacheco, 1998).

As seen at grower sites and measured at experimental sites, ***solo compounds, at appropriate rates, performed as well or better than any combination tested.*** And, ***mixtures at this time do not appear to provide any additive, synergistic or economic benefits to the control of*** **Lygus.**

## Acknowledgments

The authors wish to thank the agrochemical industry for their support and cooperation in these studies, including AgrEvo, Bayer, BASF, Dow, DuPont, Elf Atochem, FMC, Gowan, Monsanto, Novartis, Rhône-Poulenc, Valent, and Zeneca. Partial support for these and related studies was provided for 1 year by the Arizona Cotton Research & Protection Council and in part by the Arizona Cotton Growers Association, State Support Committee. We also thank Donna Meade and Jon Diehl and the rest of the technical staff at MAC, especially Kelly Lyda and Mark Lowe, and the grower cooperators (C. Sharpe, B. Heiden, D. Prechel, S. Gladden, K. Rodgers) and their advisors (B. Heiden, C. Boyd, B. Griffin, B. Hoyler, M. Pettigrew, D. Osborne) and applicators (Tom Glover, Hal Heiden) for their assistance in this work. Thank you to Terry Mikel for his ready assistance and Prof. Jeff Silvertooth and Theo Watson for their advice & assistance and the assistance of their staff.

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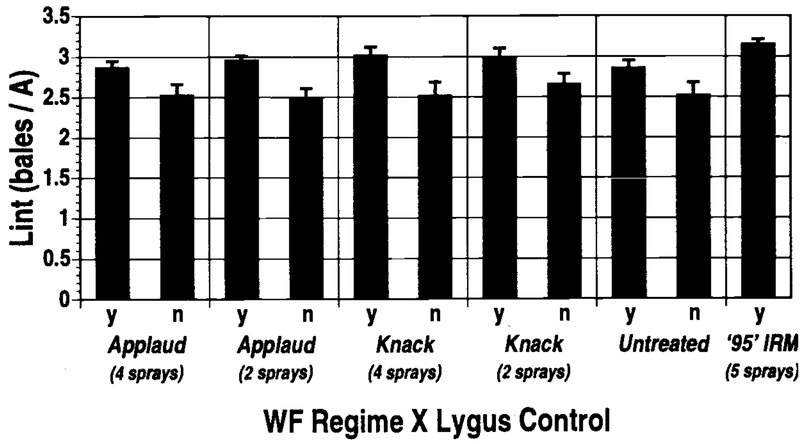


Figure 1. Yield Response to *Lygus* Control, Integrated Whitefly Management Trial. Each whitefly regime (number of sprays for whitefly control) was divided into replicated split-plots with and without 1 application of Vydate C-LV for *Lygus* control on 25 July (y=yes, n=no spray). In each case, one spray for *Lygus* out-yielded significantly the unsprayed comparison treatment ($P < 0.05$). Yields were 0.3–0.5 bales higher in the sprayed sub-plots. Additional sprays did not appear necessary. Note the conventional regime (95IRM) was sprayed 5 additional times with *Lygus* active insecticides without a statistically significant improvement over the IGR-treated regimes.

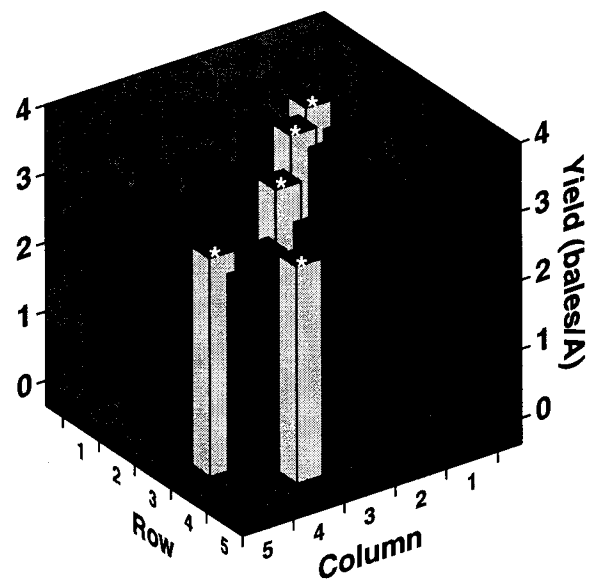


Figure 2. Spatial Arrangement of Yield Responses, *Lygus* Threshold Study. This study was a latin square design, which places each threshold in a unique row and column of the grid design. Densities were variable across the field with significant row and column effects on some dates as well as in yields. Nonetheless, the 15 total *Lygus* / 100 sweeps threshold (highlighted) out-yielded all other thresholds (ca. 3.29 vs. 3.07 bales / A). Plots from this treatment were ranked highest or second highest yielding in every row and column combination. The '15' treatment (2 sprays) even out-yielded the more input intensive 7.5 total *Lygus* / 100 sweeps treatment which required 4 sprays.

# Scottsdale
## 5 GPA, Ground, Electrostatic

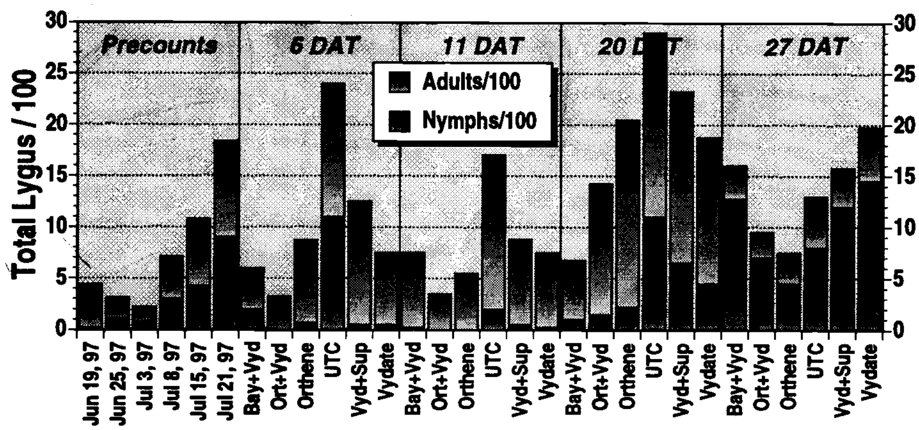


Figure 3. *Lygus* Densities in Response to Chemical Control, Scottsdale. Evaluations of *Lygus* (total / 100 sweeps) are shown as adults (light portions of bars) & nymphs (dark portions of bars) per 100 sweeps. Two additional post-count evaluations, 7 & 14 days after the second spray, declined to 0 (not shown). The check had significantly more nymph, adult &/or total numbers 6, 11, & 20 DAT. No insecticide treatment was different from each other, except Baythroid + Vydate which had slightly fewer total *Lygus* (but not nymphs or adults) than Vydate or the remaining treatments at 20 DAT. Abbreviations: Bay=Baythroid, Vyd=Vydate, Ort=Orthene, Sup=Supracide, DAT=days after treatment.

# Marana
## 5 GPA, Air

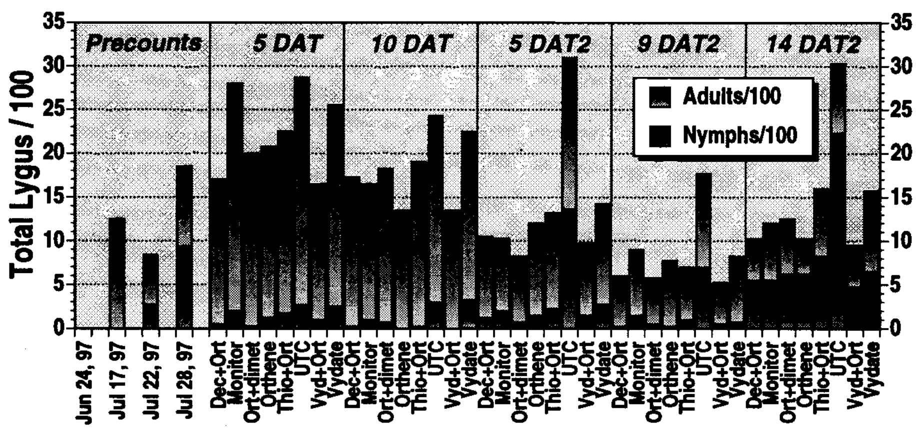


Figure 4. *Lygus* Densities in Response to Chemical Control, Marana. Precount and 5 post-count evaluations of *Lygus* densities (total *Lygus* / 100 sweeps) are shown as adults (light portions of bars) and nymphs (dark portions of bars) per 100 sweeps. One additional post-count evaluation, 27 days after the second spray, is not shown, but numbers declined. Combination treatments did not suppress *Lygus* significantly more than solo treatments for all stages and dates, except at 10 DAT when Vydate + Orthene had marginally fewer nymphs (0/100) than Vydate alone (3.3/100) but not Orthene alone (0.3/100). Abbreviations: Dec=Decis, Ort=Orthene, dim=dimethoate, Thio=Thiodan, Vyd=Vydate, DAT=days after treatment.

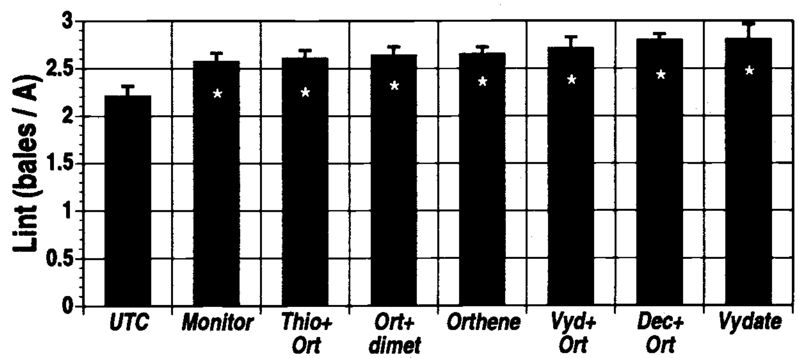


Figure 5. Yield Response to *Lygus* Control, Marana. All treated plots had significantly higher yields than the untreated check, but were not different from each other. Combination treatments did not significantly differ from solo treatments. In terms of economics, the solo treatments, Orthene or Vydate, returned greater net revenues than any other treatment. Abbreviations: Dec=Decis, Ort=Orthene, dimet=dimethoate, Thio=Thiodan, Vyd=Vydate, * = significantly different from check (Dunnett's Test, $P < 0.05$).

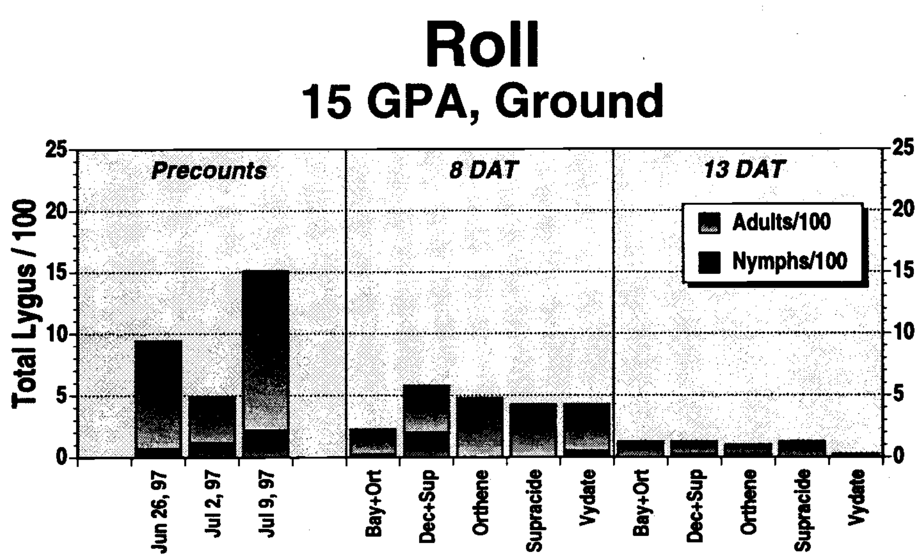


Figure 6. *Lygus* Densities in Response to Chemical Control, Roll. Precount and 2 post-count evaluations of *Lygus* densities (total *Lygus* / 100 sweeps) are shown as adults (light portions of bars) and nymphs (dark portions of bars) per 100 sweeps. Combination treatments did not suppress *Lygus* significantly more than solo treatments for all stages and dates. Abbreviations: Bay=Baythroid, Ort=Orthene, Dec=Decis, Sup=Supracide, DAT=days after treatment.

# Casa Grande
## 9 GPA, Ground

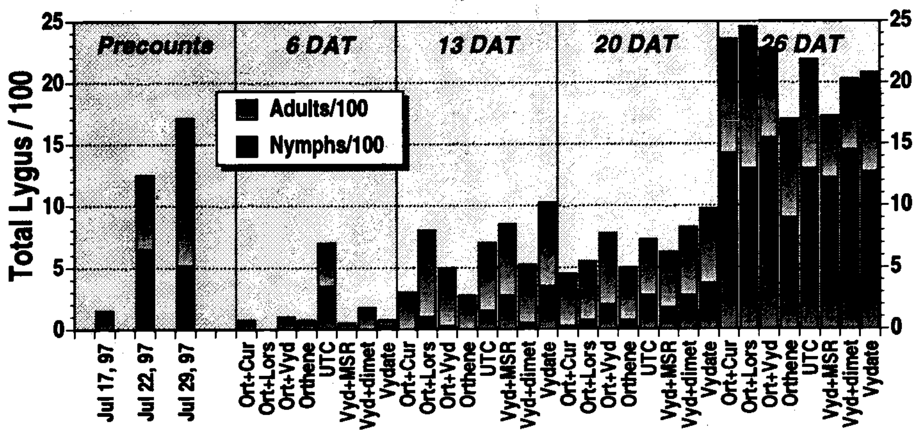


Figure 7. *Lygus* Densities in Response to Chemical Control, Casa Grande. Precount and 4 post-count evaluations of *Lygus* densities (total *Lygus* / 100 sweeps) are shown as adults (light portions of bars) and nymphs (dark portions of bars) per 100 sweeps. Two additional post-count evaluations, 7 and 14 days after the second spray, are not shown, but numbers declined to zero. Combination treatments did not suppress *Lygus* significantly more than solo treatments for all stages and dates. There were no significant treatment effects season-long. There were no significant differences in yields. Abbreviations: Ort=Orthene, Cur=Curacron, Lors=Lorsban, Vyd=Vydate, MSR=Metasystox-R, dim=dimethoate, DAT=days after treatment.

# Buckeye
## 5 GPA, Air

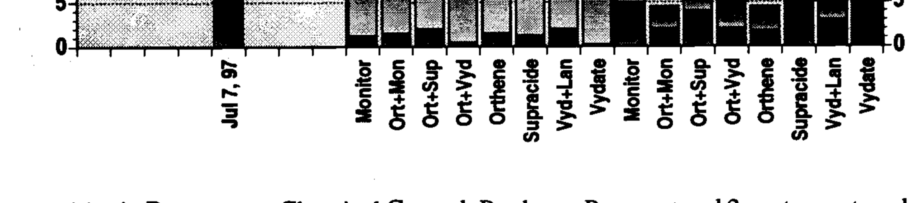


Figure 8. *Lygus* Densities in Response to Chemical Control, Buckeye. Precount and 2 post-count evaluations of *Lygus* densities (total *Lygus* / 100 sweeps) are shown as adults (light portions of bars) and nymphs (dark portions of bars) per 100 sweeps. Combination treatments did not suppress *Lygus* significantly more than solo treatments for all stages and dates, except at 15 DAT when Orthene + Monitor had marginally fewer total *Lygus* (4.5/100) than Monitor alone (10.3/100) but not Orthene alone (4.5/100). Abbreviations: Mon=Monitor, Ort=Orthene, Sup=Supracide, Vyd=Vydate, Lan=Lannate, DAT=days after treatment.

# Registered Chemistry
## 20 GPA, Ground (F-110)

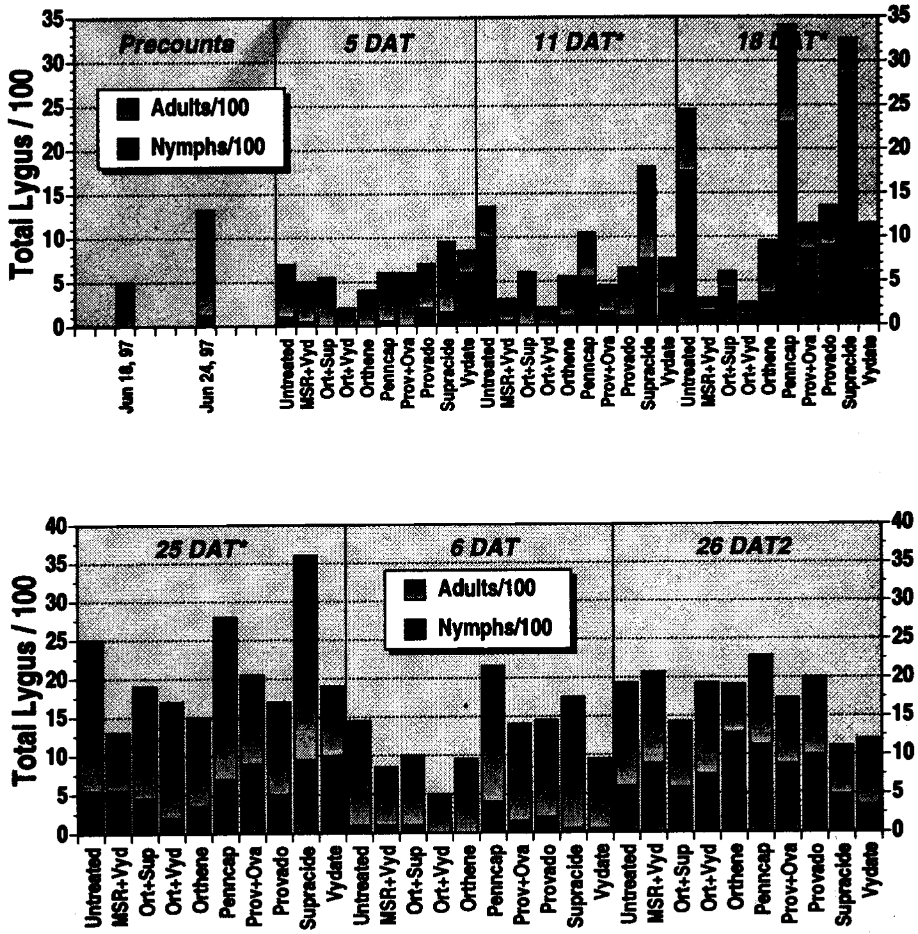


Figure 9. *Lygus* Densities in Response to Chemical Control, MAC. Evaluations of *Lygus* (total / 100 sweeps) are shown as adults (light portions of bars) & nymphs (dark portions of bars) per 100 sweeps. At 18 DAT (top graph), all Orthene or Vydate treatments performed better than Provado treatments, Supracide, Penncap-M, and the untreated check (UTC). Abbreviations: MSR=Metasystox-R, Vyd=Vydate, Ort=Orthene, Sup=Supracide, Prov=Provado, Ova=Ovasyn, DAT=days after treatment.

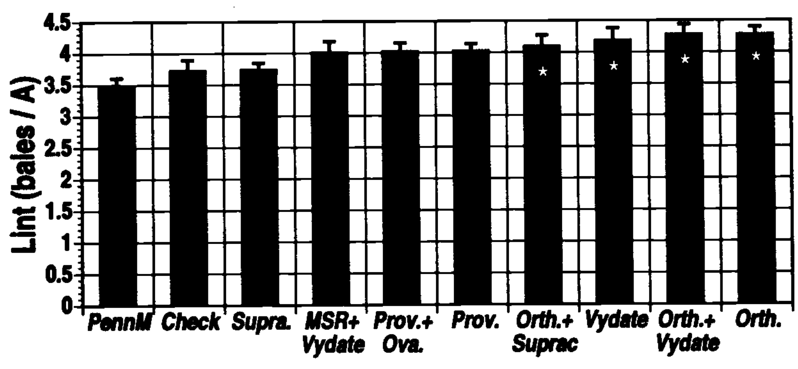


Figure 10. Yield Responses to *Lygus* Chemical Control, MAC. * = significantly different from the untreated check.

# Experimental Chemistry
## 20 GPA, Ground (F-4)

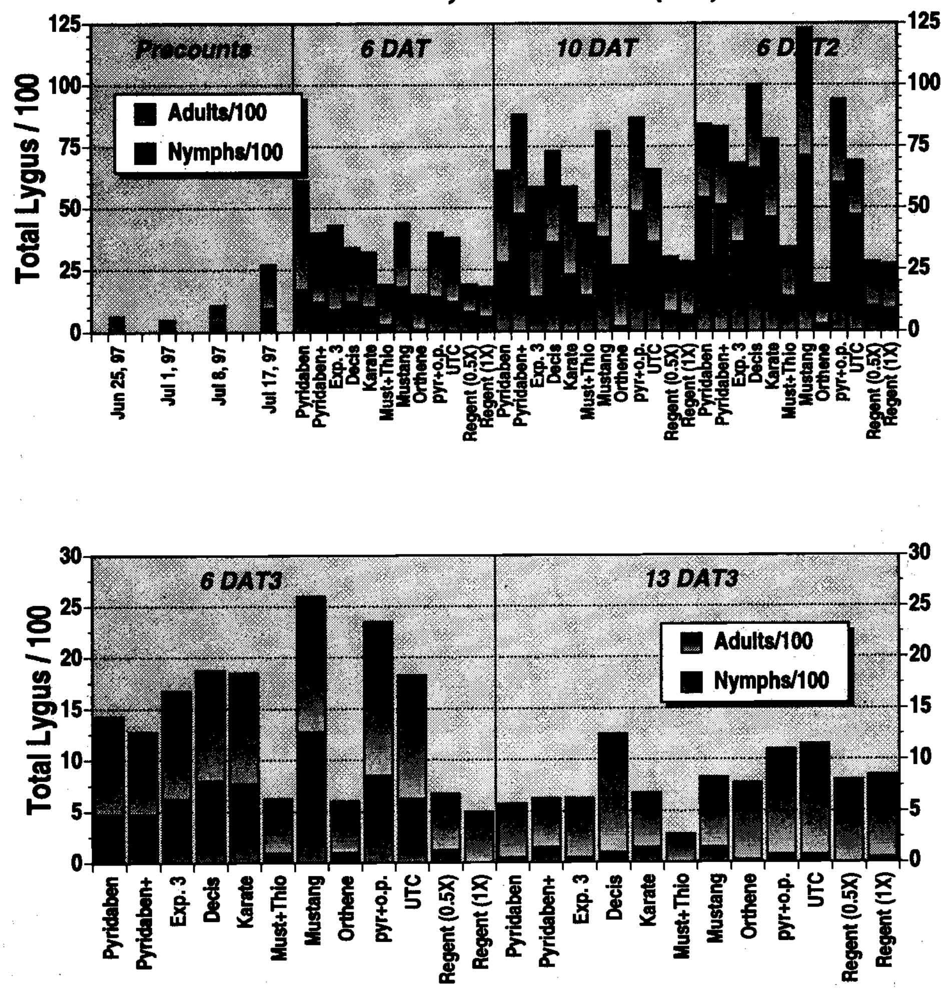


Figure 11. *Lygus* Densities in Response to Experimental & Pyrethroid Chemical Controls, MAC. Four precount and 5 post-count evaluations of *Lygus* densities (total *Lygus* / 100 sweeps) are shown as adults (light portions of bars) and nymphs (dark portions of bars) per 100 sweeps. Populations were very high in this test; however, only Orthene or the two rates of Regent provided consistent and significant levels of *Lygus* suppression. Pyrethroids alone did not suppress *Lygus* significantly relative to the check; however, Mustang + Thiodan did provide some level of suppression. Abbreviations: Pyridaben+=Pyridaben+surfactant, Must=Mustang, Thio=Thiodan, pyr+o.p.=experimental pyrethroid + organophosphate premix, DAT=days after treatment.

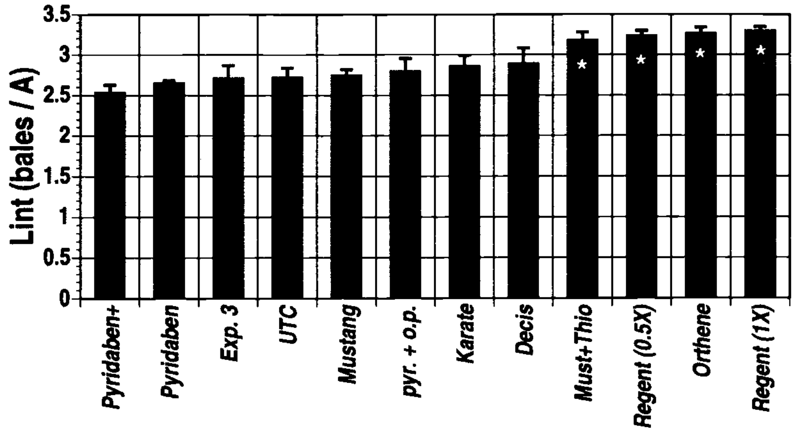


Figure 12. Yield Responses to Experimental & Pyrethroid *Lygus* Chemical Controls, MAC. * = significantly different from the untreated check (Dunnett's Test, $P < 0.05$). All others are not significantly different from each other or the check. Abbreviations: Pyridaben+=Pyridaben+surfactant, Must=Mustang, Thio=Thiodan, pyr+o.p.=experimental pyrethroid + organophosphate premix.