

Although research continues on all components of an integrated management program for *Lygus*, current recommendations provide a fundamental base on which to build a program for managing *Lygus* while also managing for susceptibility to our current insecticides. Key to sustaining susceptibility of *Lygus* is limiting insecticide use to the lowest practical levels. This is best accomplished by careful sampling, careful assessment of thresholds, selection of the right compound for the job, and, most of all, avoidance of the problem from the start. Current recommendations are detailed below in light of the most recent research findings. (Also see *Lygus in Cotton No. 1: Identification, Biology & Management*).

While the specific solutions described here are for Arizona cotton only, the tenets of susceptibility management are equally relevant across all regions and all crops. They are in their simplest forms: 1) *limit insecticide use to the lowest practical level*; 2) *diversify insecticide use patterns*; and 3) *partition insecticides among crops and pests such that modes of action are segregated as much as is practically possible*.

Limit Insecticide Use

Insecticide resistance is commonplace in systems that depend on insecticides. Although all tools of resistance management (e.g., diversifying our insecticides, rotating or mixing chemistries, etc.) need to be explored in overcoming the “inevitability” of resistance, the best thing we can do at all times is to limit insecticide use to the lowest practical level. The remainder of this paper focuses on how to achieve these lowest levels: 1) *sample adequately*; 2) *optimally time insecticide use* 3) *use efficacious compounds (i.e., avoid “empty” applications)*, and 4) *avoid the problem through all other measures possible*.

Sampling

Beltwide, any of a dozen or more methods are used to sample *Lygus*. In Arizona, we currently recommend the use of a sweep net combined with square damage surveys and a knowledge of crop growth and development. The sweep net should be used to obtain samples of 25 sweeps from each of four sites within an average-sized field. Taking fewer sweeps than this and at fewer locations through the field can subject the user to higher error rates and may lead to poorly-timed applications. Half-grown squares should also be collected in groups of 25 from each of four locations. A half-grown square is a square with bud tissues representing about

50% of the total volume of the square. Each square should be collected at random and examined internally by splitting it longitudinally with a knife or by hand. Damaged squares are discolored internally with one or more brown, shriveled anthers. In addition to these methods, the practitioner should have some knowledge of crop development relative to the fruiting cycle and the production objectives.

Timing Insecticide Use

With the sampling information in hand, the grower or the advisor must make decisions to treat based on thresholds. *Our current recommendations in Arizona are to treat when levels are: 1) 15–20 total Lygus per 100 sweeps; and/or 2) 25% of the squares with signs of damage; and 3) Lygus nymphs are present*. The third criterion is important, because *Lygus* adults are difficult to control with insecticides and can be transitory, especially when adjacent to alfalfa that is periodically cut. Also, *Lygus* eggs take approximately seven days to hatch under our conditions and most of our insecticides fail to control them directly. Thus, waiting for the appearance of nymphs ensures that the spray will be most effective. Otherwise, a re-treatment is often required. These threshold criteria serve as guidelines, and adjustment is required to accommodate all scenarios of crop development and production objectives. For example, earlier levels of *Lygus* should be watched more closely, while *Lygus* during or past cut-out should be left untreated at densities well above these threshold levels. Our most recent findings would suggest considering the proportion of any sample that is nymphs. A sweep sample that reveals only adults, even at relatively high levels, is of potentially less concern than a sweep sample that has one third or more nymphs present, even at lower densities overall.

In a test of *Lygus* thresholds using NuCOTN 33B in 1997, we tested three *Lygus* action levels and an untreated check in a randomized latin square design. The levels per 100 sweeps and the number of sprays required for each were: 7.5 (4 sprays), 15 (2 sprays), 30 (1 spray), and untreated (0 sprays). Interestingly, not only did yields plateau at 15 *Lygus* per 100 sweeps (3.3 bales/A), but they decreased significantly thereafter. In other words, yields were significantly higher in the 15-threshold than in all other treatments including the more “conservative” 7.5-threshold (3.1 bales/A). Various factors can cause this result, including loss of beneficials to increased sprays, secondary outbreaks, pest resistance, and “subliminal” phytotoxicity (i.e. cotton plants sprayed with organophosphates have temporarily reduced

rates of photosynthesis.) Suffice it to say, however, that two additional sprays to accomplish lower yields is added incentive to adopt a susceptibility management plan and limit insecticide use.

Choose the Right Compound

Once the decision is made to spray and all other avenues of avoiding this have been exhausted (see next section), the user needs to select the best insecticide for the job while still considering the needs of diversifying the chemical arsenal. Results from testing of comparative insecticide performance is relatively straightforward and surprisingly uniform across years and across sites. Currently, our recommendations are to use Orthene® (=acephate), Vydate C-LV®, or Monitor® as first choices. Endosulfan or dimethoate may also provide some level of suppression, but are considered second tier compounds, most useful when trying to address some other primary problem. Synthetic pyrethroids have not shown consistent efficacy and are not recommended for *Lygus* control in Arizona. *Combinations of insecticides have not performed better than appropriately chosen solo materials.* In most situations, no more than two sprays should be used against *Lygus* per season. Rotating these two sprays between organophosphates (e.g., Orthene or Monitor) and the carbamate (Vydate) may be a prudent rotation until other modes of action become available.

To further evaluate these recommendations, a series of commercial, grower-cooperator and small-plot trials were conducted in 1997. Five locations in four counties of Arizona were sites for replicated on-farm testing of *Lygus* control chemicals. While each location was unique in terms of the progress of the infestation and crop development, the results were extremely consistent. Adult numbers were transitory and often refractory to the sprays. Nymph numbers, however, declined precipitously in virtually all post-spray evaluations. *In no case did a combination spray significantly out-perform or out-yield the less costly and less disruptive singular sprays of either Orthene or Vydate.* Most of the insecticides tested were at their highest labelled rates whether used alone or in combination.

There was no additive, synergistic, or economic advantage to mixing insecticides for Lygus control. So, one major stride that can be made in limiting insecticides is to choose the proper material at an appropriate rate and discontinue mixing with additional insecticides for *Lygus* control. Growers and their advisors often mix compounds but at lower than optimal rates. This is particularly destructive to any susceptibility management plan, because it results in “empty” sprays—the ones that do not work but result in continued selection pressure. Growers should instead opt for the appropriate insecticide at the optimal rate (often higher) that works. Combinations for the control of a larger pest spectrum are sometimes required; however, this is an overused tactic for “hedging” an application. Once the pest spectrum

is identified and sampled properly, a singular material can be selected appropriately more often than is currently happening. *Mixing chemistry as a standard practice, unless otherwise indicated as with whiteflies, should be avoided if at all possible.*

Small plot trials in 1997 revealed very similar trends to the commercial-scale trials. Orthene or Vydate used alone performed and yielded as well and usually better than all of the combination materials tested, even Orthene+Vydate. Some insecticides were such poor choices that they failed to control *Lygus* and resulted in higher levels of *Lygus* and other pests than in the untreated check. Pyrethroids failed to control *Lygus*, except when mixed with a *Lygus*-effective compound. Fipronil (Regent®), a new insecticide soon to be registered in cotton, provided control of *Lygus* equivalent to Orthene or Vydate. As disrupting as *Lygus* sprays tend to be on the natural enemy fauna of a cotton field, growers should make sure they are using the right material.

Avoid the Problem

The first and best step towards susceptibility management is to avoid the need to treat *Lygus* at all. Though not always possible, this should be an objective of any IPM plan in cotton. For *Lygus*, there are several measures that can be followed. Plant early, produce your crop early, and terminate early. Avoid planting near known *Lygus* sources, especially safflower and alfalfa. Where this is not possible, use these sources as trap or catch crops. Then treat them before *Lygus* “escape” (safflower), or strip-cut or otherwise manage the availability of the host-trap (alfalfa) so that *Lygus* are never forced to leave. Use tolerant or resistant varieties when available; some pubescent cotton varieties have reported “tolerance” to *Lygus* and other plant bugs. Do not water-stress your cotton. Even though *Lygus* prefer well-watered cotton, withholding water to manage *Lygus* is definitely the case of the cure killing the patient. Manage your other pests with a minimum of foliar insecticides by using IGRs for whiteflies and Bt cotton for pink bollworm. This will help lower insecticide selection forces in your crop and conserve your natural enemy community.

References

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Peter Ellsworth, IPM Specialist
Jon Diehl, Research Specialist
Department of Entomology, Maricopa Agricultural Center,
Maricopa, AZ

