

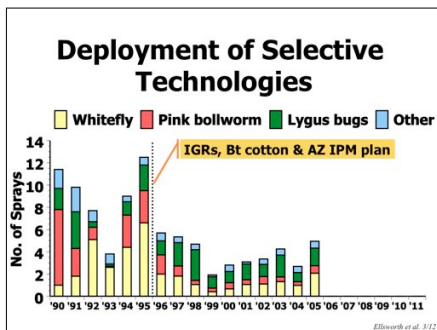


Before I begin my presentation, I wish to thank the staff of the Maricopa Agricultural Center for helping us build this field plot tour trailer along with the recently added shade structure. This has been an excellent means to showcasing what we are doing in our field research program, including today's review of our small plot insect management trials. I also need to thank the Arizona Cotton Growers Association and Cotton Incorporated for their grants in support of IPM programs as well as the support of the agrochemical industry.

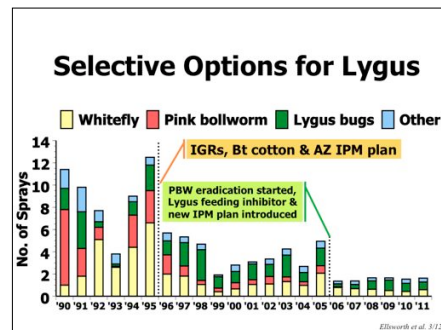


Our morning field tour focused on small plot research, which is tremendously valuable in our development of insect management tactics and strategies. We had the opportunity to see from above the impacts of *Lygus* bug, stink bugs, and whiteflies on one trial, and the innovative incorporation of natural enemy information in whitefly control decisions in another trial.

However, many times we can benefit from grower-cooperator trials. These can be done simply by splitting practices in a field or by conducting more elaborate, replicated, large-scale research. This presentation will detail the results of a 2013 trial where the grower and PCA generously agreed to set-up and follow through on a large, replicated field trial. Lydia Brown conducted all the field sampling.

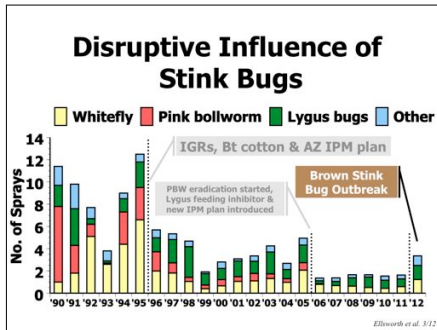


Before we launch into the data from this trial, it is important to review our history of pest management especially as it relates to the deployment of selective technologies. Together with industry, we helped growers to properly make use of the selective IGRs & Bt cotton as part of a complete IPM plan with a comprehensive outreach campaign that consisted of extensive grower and pest manager education in 1996. The results were striking. Insecticide use was cut at least by 50% over this period.

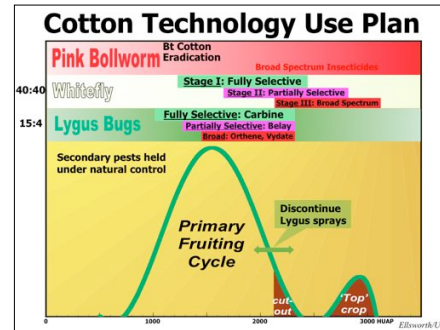


Then, we helped growers deploy a selective *Lygus* (a mirid pest) feeding inhibitor [flonicamid (Carbine)] in 2006, and the cotton industry banded together to develop a major pink bollworm eradication campaign. Under this new IPM plan, growers and pest managers throughout the state saw a continued lowering in the need for foliar insecticides, halving it once again relative to the previous period.

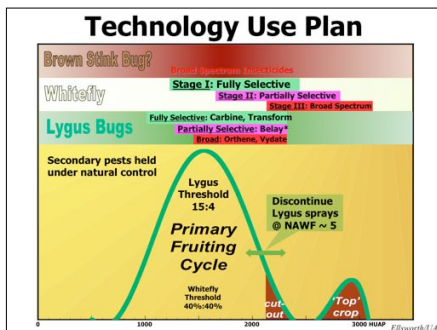
Adapted from Naranjo & Ellsworth 2009, & Ellsworth, unpubl.



However, in 2012 we witnessed the widespread presence and local outbreaks of the brown stink bug, *Euschistus servus*. The disruptive influence of these stink bugs on our overall insect management plan was apparent. Broad-spectrum insecticides, not used in over a decade, were deployed to control stink bugs, and caused disruptions that led to more frequent and costly investments in whitefly, Lygus, mite and other insect controls. 2012 saw a doubling in the number of sprays required statewide to control all insects and mites. In fact, the blue section of the bar is for "Other" insects. This is the highest level for this group since 1993. Prior to 2012, records show that our last outbreak of this particular species was 1963! So there is virtually no prior local expertise on the topic of brown stink bug management.



In the recent past, our system broke down to 3 key pests and a large array of secondary pests that never become significant, IF disruptions of natural controls do not occur. For PBW, Bt cotton is the ultimate biorational, and now with eradication, broad spectrum insecticides for its control were fading completely from our system. For whitefly, we organized our insecticides into 3-stages based on selectivity, deferring all broad-spectrum inputs until the end of the season, if needed at all. For Lygus, we had one selective insecticide, flonicamid. Cotton IPM in AZ had become an exceptionally well-developed and selective system where conservation biological control was firmly established as a key element. We also have decision-support information that guides the deployment of these valuable, selective technologies.

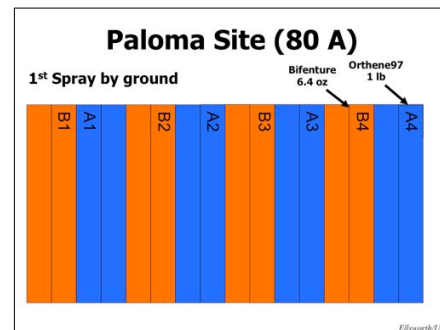


However, stink bugs change the picture. If they remain an economic threat to our production, we may see mid- and late-season needs for broad-spectrum chemistry once again. The use of these materials will further destabilize the management system, reducing our ability to hold the other key and secondary pests in check.

2013 has turned out to be every bit as challenging, if not more so, than 2012 with respect to brown stink bug management and the consequences of its control on whitefly, Lygus, and mite management.

We hope the future is not a repeat of 2012-2013. However, we can all better learn together by conducting large-scale trials on grower-cooperator fields.

Let's review one 2013 site.

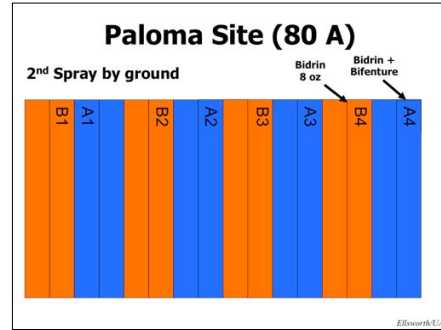


Near Gila Bend, we conducted a trial with a grower and PCA on an 80 A field. The production system was a little unusual in that the grower produces cotton on the flat and irrigates on borders from gated ditches. This conveniently gave us strips (borders) through the field, each about 5 A in size. The grower also had his own spray equipment that we used for the first spray. As with any grower trial, we discussed options and decided to strip the field (as shown in orange and blue) with two contrasted insecticides for stink bug control, bifenthrin (Bifenture) vs. acephate (Orthene97), each at their label max. rates.

This sort of replication helps us eliminate bias across a field due to various soil or other production related characteristics.

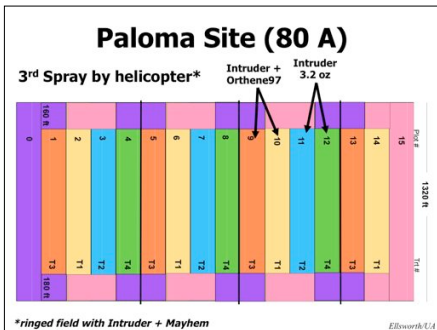


This shows the grower's spray rig putting out the 1st spray. There was nothing fancy or specialized about it. Just a standard ground rig.



As stink bugs persisted, we discussed and decided on a 2nd spray. This time Bidrin (at 8 oz/A) was used on both strips but one strip (blue) got the addition of bifenthrin (Bifenture at the full rate, 6.4 oz).

We stayed on pattern, alternating 10 acre "plots".

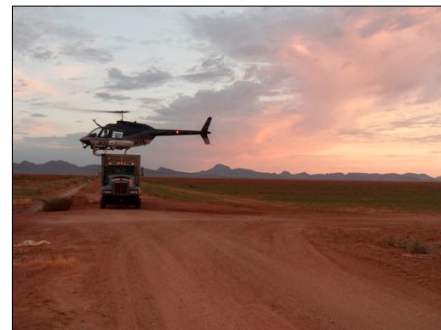


By late in the season, we were concerned about growing whitefly populations. And, we wished to preserve the integrity of the replicated experiment. So we applied acetamiprid (Intruder) at Arizona SLN permitted elevated rates (in this case at 3.2 oz / A). But we also added acephate (Orthene97) at a full 1 lb / A rate) to one set of plots.

This effectively created 4 different regimes. Plus, we sprayed Intruder + Mayhem (novaluron) in a ring around the field creating this mosaic pattern.

This is quite an intricate grower trial. We would not normally expect this in every trial. We really appreciate the cooperation of the grower and PCA here.

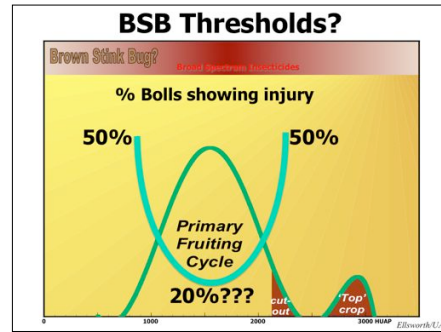
By arranging sprays in this way, we get the maximum amount of information from the test.



We are especially grateful to Tri-Rotor out of Buckeye who worked directly with us to get the 3rd spray out.

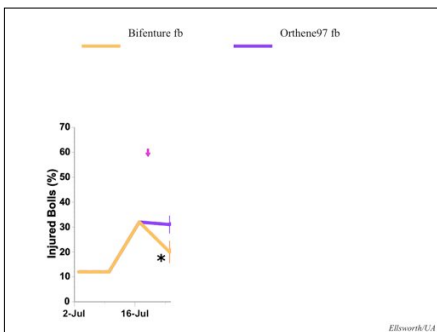


We audited all sprays to make sure they were mixed, loaded and applied properly to the designated strips.



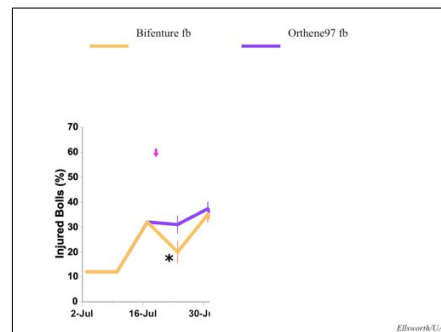
Before we look at the specific data that came from this trial, Let's examine BSB thresholds because this is a major question when making decisions about intervening with insecticides.

The primary fruiting cycle & top crop can be represented by this two-humped curve representing flowers per unit area. The dynamic threshold referred to by Dr. Phillip Roberts & tested extensively in NC, SC & GA is shaped like an inverted 'U' overlaid on the primary fruiting cycle. This suggests that boll injury percentages can be very high at the beginning & end of the fruiting curve, likely as high as 50% without sustaining economic loss. The real question is how low can we go? At peak fruiting, the most number of bolls susceptible to stink bug feeding are present. This value varies by state & region, but because our potential for losses to boll rot are less than the humid SE, we offered a suggestion that 20% might be as low as this should go. There is no specific AZ data on this question yet.

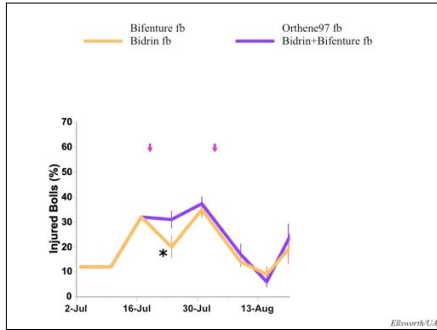


Let's examine the data. Rather than show you the whole trial's data all at once, I will step through date by date so that you can see just what we were seeing and measuring at the time (without the benefit of 20:20 hindsight).

We started at low levels in our boll sample, then climbed to over 30% & we were in peak fruiting. At that time, we discussed with the PCA & grower various options we could contrast — this is a interactive process; we don't simply dictate what should be done. We're trying to learn something. So we went with Bifenture vs. Orthene. We did get a significant lowering with Bifenture. However, one should not conclude that Orthene failed to do anything, because there was no untreated area in this trial to see where these injury lines would have gone without any sprays.



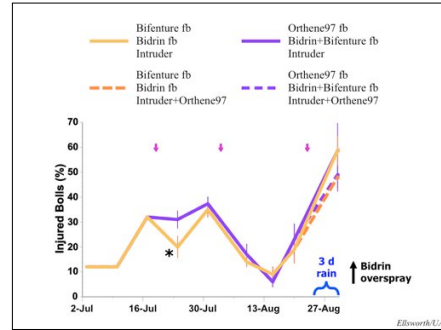
Two weeks later, injury levels increased to their pre-spray levels for both regimes. We were still fruiting well, though now on the downhill side of the fruiting curve. Another set of discussions were had and we decided to contrast two approaches that both contained Bidrin at 8 oz per acre. [Note this is the 1st use season for Bidrin in about 30 years in Arizona, but data from GA and elsewhere suggests that this is among the best options for Brown Stink Bugs.]



So we applied Bidrin both with and without the addition of Bifenture. Both regimes came down first to about 16% and then even below 10% two weeks later. We were very happy with this result, though stink bugs were still evident in the field via direct observation. By the 3rd week post-spray, fruiting was slowing down considerably but stink bug injured bolls were on the rise again.

At just 20–24% boll injury at this stage of fruiting, we were not overly concerned given the threshold relationship mentioned earlier.

However, whiteflies were becoming more of an issue and our sampling suggested a need to intervene to control these now, rather than waiting, because of the disruptions of natural enemies made with these broad-spectrum stink bug sprays.

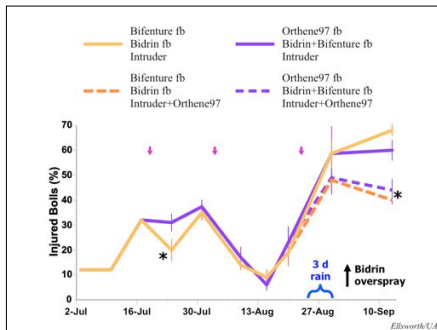


Whitefly adults in particular were a concern. So we did not wish to use the IGRs, Knack or Courier, or the other fully selective option, Oberon. Instead, we elected a high rate of Intruder, newly established last year under a 24c Special Local Needs label that permits a 50% increase in the maximum use rate.

So we applied Intruder at 3.2 oz on everything and added Orthene at 1 lb / A on half the area, spawning another set of regimes to evaluate.

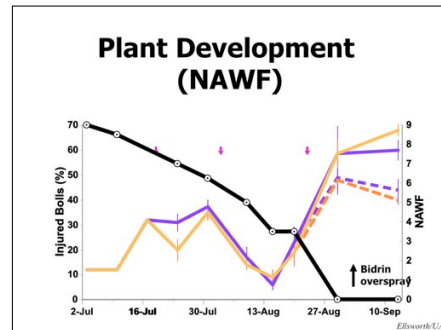
We then hit that rainy period in late August shortly after our spray.

Meanwhile, our stink bug injured boll counts continued to rise & the grower/PCA decided that they did not wish to risk any additional losses and oversprayed the entire trial with Bidrin (8 oz) about 10 days later.



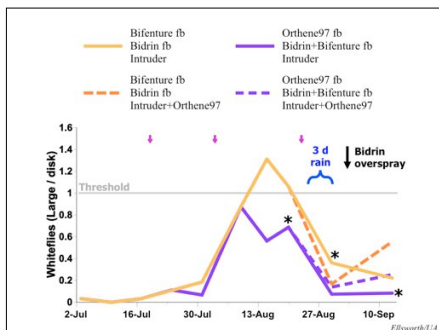
Judge for yourself as to whether the Bidrin spray was needed and/or effective. But since everything was treated the same, the integrity of our 4 spray regimes was still intact. It appears that where we used Orthene previous to the Bidrin, we got significant reductions in stink bug boll injury, albeit still at high levels around 40%. Where we used just Intruder, the effect was not as apparent.

40–60% of the bolls showing signs of injury by stink bugs may seem like a very high level. But recall the shape of our dynamic threshold, and consider where we were in fruiting.



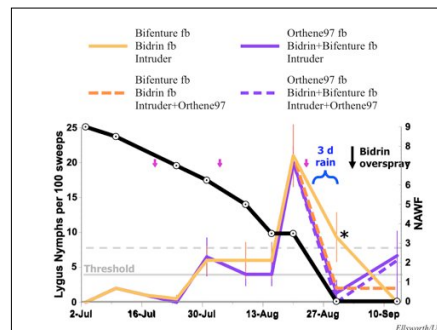
As a PCA or grower, if you measure just one aspect of plant development, this would be the one to measure for insect management, Nodes Above White Flower. NAWF is a reliable metric for tracking the fruiting curve. With it, you can track where you are and when your returns on plant protection inputs might cease to be economical. For instance, our research suggests that Lygus control beyond NAWF=4 is rarely justified economically. And, in this case, we know that the 'U' shaped dynamic threshold suggests that high rates of boll injury are tolerable very late in the fruiting curve.

At the time the Bidrin spray was made, NAWF = 0, meaning the plant was completely cut-out and no longer producing new blooms. It is true that there were still some bolls susceptible to injury. But was there enough economic return to justify this spray? We just don't know the answer to this question yet.



Obviously, the PCA and grower contend with more than just stink bugs, and in fact we made one whitefly targeted spray. So let's look at the whitefly numbers. Large nymphs per disk (3.88 sq. cm.) is the gold standard for understanding the progress of any whitefly population, I would say especially when following broad-spectrum insecticide use that might suppress adults and mask real problems underlying the dynamic.

In this case, whiteflies were very low to begin with and only slowly increased until our 1st two sprays were made. This finally pushed populations above our threshold of 1 large nymph per disk. We sprayed with Intruder and all levels declined significantly and quickly. In reality, most of our whitefly pressure was on the edge of one side of the field where they were elevated all season long. But the Intruder spray worked very well.



Lygus are another key pest we must consider. Let's examine levels in this trial. Our threshold is 15 total Lygus with at least 4 nymphs per 100 sweeps. We have seen good results with this and even worked with levels up to 8 nymphs per 100 sweeps successfully.

Here we see nymphs per 100 sweeps. We increased over threshold around the beginning of August. But since we were coming in with Bidrin, which has some limited activity on Lygus, we simply continued to monitor closely. By the 3rd week of August, we hit a spike in Lygus activity. However, we were already below 4 NAWF, an area where returns on Lygus controls are quite iffy. You can see, too, that whether we used Orthene or not, Lygus levels declined as they normally do in a field that is all cut-out. Lygus will generally leave the field at this point.



This was a quick look at an important and intricate trial. I hope it inspires you to consider working with us in the future so that we can gain ground on this problem more quickly through joint, grower-cooperator research. We would like to thank the PCA and grower who collaborated on this project. Their time and energy on this was above and beyond what we normally expect. We also thank the supporters of our IPM program.

The Arizona Pest Management Center (APMC) as part of its function maintains a website, the Arizona Crop Information Site (ACIS), which houses all crop production and protection information for our low desert crops, (<http://cals.arizona.edu/crops>), including a copy of this presentation.

Photo credit: J. Silvertooth