Virtual Farmer Field Day, 28 October 2020
(125 participants; 30 min; 0.6 CEUs)

Cotton Insect Management
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Slide 1

First, I want to thank my co-presenters, Naomi Pier & Isadora Bordini, Assistants in Extension for Field Crops IPM and Cotton IPM, respectively. Next, I want to thank our stakeholders who are participating and have demonstrated great flexibility with us as we navigate the restrictions of delivering quality programs to you during a pandemic. These events take a lot of work and coordination. And, this one is special in that it would normally be an in person live event in the field. While we cannot duplicate that here, I want you to know that our group has been working hard to come up with ways to emulate "being in the field". That means we will be using ample video today. We ask that you bear with us, the technology, and the fact that none of us are Steven Spielberg or George Lucas. Much of what we are trying here, we're doing for the first time. Our topic today will be cotton insect management and that means whitefly and Lygus management as our two economic drivers of our system. Because we would normally be touring trials, **our specific focus today will be "Effective & Selective Chemistry" for the control of these two pests**. I'd welcome your questions or comments at any time. Post event, you can always reach me at peterell@cals.arizona.edu

Slide 2

Let's start with the Lygus insecticide screening trial. These are seasonal mean Lygus nymph counts per 100 sweeps. The list of chemistry includes familiar products as well as some experimentals. This group was sprayed twice on threshold, the second spray arguably was not an economic spray in that it was made close to cut-out, leaving little time for the plant to benefit from additional protected fruiting sites. Transform at 1.5 or 2 oz per acre performed equally well. Acenthrin, a mix of acephate plus bifenthrin, slipped a bit from what we normally see. This may have been because of destruction of key predators, which were otherwise very high in this trial. The experimental here worked variably.

Slide 3

This group was sprayed 3-4 times, indicating their relative ability to control Lygus successfully. PQZ had no efficacy; Celite, an organic insecticide based on diatomaceous earth, also did not control Lygus; Steward demonstrates modest efficacy against Lygus, but should be thought of as a collateral benefit of any Lepidopteran-targeted sprays made with this product.

Slide 4

This third group was sprayed only once as a way for us to understand how long residual control would last. As it happens, these experimentals performed exceptionally well, even better than our standards, which were sprayed twice.

Slide 5

Overlaid on the chart is our UA threshold guideline, which is 15 total Lygus with 4 to 8 nymphs per 100 sweeps. We normally like to see commercial products holding numbers at or below these levels. The stars just indicate the products that achieved significant reductions in seasonal nymph levels compared to the untreated check.

Slide 6 (video)

In this video, we review a plant's fruiting pattern from the Transform 2 oz entry. The goal in a late season evaluation like this is to determine what fruiting sites to protect and to understand what bolls will be taken to harvest. **About 50% final fruit retention is the objective, because that will maximize yield.** A well fruited plant will have a compact stature relative to a damaged one. Bolls are the sinks for carbohydrates produced and with a sufficient boll load, most plants will bloom out the top, cutting out hard, rather than producing an unproductive top.

Slide 7 (video)

In this video, we can examine the top of the plant to determine where the zone of cut-out occurred and how the pattern of fruiting developed both above and below cut-out.

Slide 8 (video)

Let's examine the top of the plant in this video of the untreated check, where there were no Lygus sprays made. Because our studies are of the effectiveness of Lygus chemistry and not plant compensatory abilities, we design and maintain our trials so as to minimize the potential for the plant to compensate for earlier losses to Lygus bugs, especially by attempting to prevent top crop compensation.

Slide 9 (video)

In this video, we look at Lygus damage to a cotton flower. **Lygus bugs prefer to feed on squares and other floral structures.**

Slide 10 (video)

This is a healthy, undamaged flower from the Carbine treatment.

Slide 11 (video)

Now let's fast forward to harvest time and examine the top of the crop again to see how things developed. Looking at the upper 10 nodes trimmed off of a plant from the experimental treatment, we see excellent fruit retention and only a tiny section of top crop (upper couple inches with no fruit). In contrast, we examine the upper 13 nodes at the top of an untreated check plant, 8 of which are actually from the secondary fruiting cycle or top crop that develops after cut-out. The retention is low there and the bolls produced are immature and not taken to harvest. This demonstrates that we had some success in terminating this crop before it had time to compensate in damaged plots like the UTC by producing a productive top crop. Despite these best efforts, the UTC and some of the other damaged treatments did exhibit some low rates of compensation that likely served to mask some effects of the Lygus products under study.

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Here are the yield results from the Lygus insecticide trial. Very generally, where we sprayed 1 or 2 times, we yielded better than where we sprayed more (less efficacious products) or not at all (the untreated check). However, there are not large differences from the UTC, which yielded about 2.6 bales per acre. Some of the reason for this may in fact have been some modest compensation that ultimately did occur after Lygus pressure diminished in the top of the plant, or perhaps in some back-fruiting lower on the plant. Only the experimental chemistries in white produced yields significantly higher than the UTC.

Slide 13

Can you tell which side yielded more? Left? Right? The highest yields in this trial were 3.5 bales per acre, which is quite good for such a short format season. Plus, that was about 1 bale more per acre than what we measured in our lowest yielding treatments.

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Let's now review the whitefly insecticide trial. Here are the group of entries that were sprayed twice on threshold in comparison to the UTC, which you will note says "disrupted". Because predator levels were at very high levels in this field, we decided to spray acephate on this entire trial to eliminate the predators and release the whiteflies, while also controlling Lygus. We did this twice. Either rate of Assail performed very well as did PQZ in holding large nymph levels low. This new formulation of Sivanto also performed well, though other data suggests that the maximum rate (equivalent to 14 oz per acre of Sivanto Prime) was better than the lower rate.

Slide 15

This next group of chemistry was sprayed 4 or 5 times. Celite was not effective on whiteflies, largely because it is very difficult to deliver the diatomaceous earth underneath the leaves where the eggs and nymphs are developing, despite us deploying several sprays with 16-inch drops and 90° nozzles pointing into the canopy. Miteus (fenpyroximate), as the name might suggest, is a miticide that also has some whitefly effectiveness. While it is not at a level one would deploy it solely for whitefly control, this does show that there is a collateral benefit to using Miteus when controlling mites as the primary target. These entries plus Sefina required a final, “rescue” spray after data collection was completed, because of the high and increasing whitefly populations. This was at a time when many growers would struggle to make that final spray, because the crop was so close to the application of a defoliant. Those are difficult but necessary decisions, because excellent whitefly management all season long can be lost in the final 14-28 days if a grower permits these late populations to take-off and damage open lint with the whiteflies’ excreted sugars.

Slide 16

We had one entry that we did not spray with acephate. Instead we used Carbine to control Lygus selectively. In other words, Carbine is selective in that it kills the target pest, in this case Lygus, without harming the natural enemies. By doing so, the predators that were so abundant in this field continued to suppress whiteflies even without spraying. Ultimately, we did spray one time, but that was one time less than for the standards where predators were eliminated.
Note managing whiteflies is all about preventing quality losses, which occur sooner than do yield losses. However, populations were so out of control in the UTC (and Celite) that in addition to quality problems, we would expect yield losses, too.

Slide 17

Adults were quite challenging. The dotted lines show the upper and lower bounds of the threshold. Similar patterns to what we saw before in terms of efficacy. But here you can see the lower rate of Sivanto and Sefina were a bit higher than the other effective entries. And, Miteus, a product for controlling mites, does have some efficacy against whiteflies, but it is limited.

Slide 18

Arizona is lucky to have some excellent whitefly control chemistries to use. Let's review some of them here. PQZ at 3.2 oz per acre and Sivanto HL at 7 oz per acre (or Sivanto Prime at 14 oz per acre) have excellent efficacy against whiteflies and will help keep all stages low. However, they along with our "Predator Threshold" entry, which was sprayed just once with Sivanto, represent our "fully selective" approach to whitefly management. Or, that approach that controls the target but is fully selective and safe to the natural enemies in our cotton system. Those natural enemies help us control whiteflies and other pests all season long. But we also have Assail, a partially selective product, that has excellent efficacy against whiteflies.
This is "whiteflies by the numbers", but the benefit of a virtual field day is that we can rewind the clock and take you right out to the field so that you can see what we saw this season!

Slide 19 (video)
Here I'm spraying a window pane (or picture frame) with some canola oil spray just for fun!

Slide 20 (video)

Or, really as a demonstration of what kinds of populations of whiteflies we were experiencing. Because we aren't live and in the field, Naomi and I had to get creative is demonstrating just how bad whiteflies got in this trial. Here I'm spreading that oil film evenly over the window pane.

Slide 21 (video)

Watch as I travel the length of the experimental plot (40 ft) with that window pane out in front of me.

Slide 22 (video)

To give you a better idea of what that looks like, Naomi filmed while I walked backwards in the plot so that you can see whiteflies against the background of the window pane. This is in the Untreated Check (UTC-disrupted).

Slide 23

And, this is the result! How many whiteflies are there? The correct answer, as most of you know, is “too many”! Indeed, by spraying out the predators and other natural enemies with acephate during the season, we created conditions ripe for a full-on whitefly outbreak. This is from T11 or the UTC, plot 7.

Slide 24

On the left you can see the Untreated Check, which was never sprayed for whiteflies, in contrast to one of our best performing entries, PQZ, which ultimately was sprayed twice. These photos were shot just hours before our second spray (9/9/20). So in fact, this is PQZ about 36 days after the first spray, just prior to the second spray.

Slide 25

Let's now compare the "Predator Threshold" entry compare to the two extremes. Is it closer to the Untreated Check or closer to PQZ. Bear in mind that at the moment this photo was taken, the predator threshold treatment had never been sprayed for whiteflies all season long! In essence, you are looking at two different untreated checks: Disrupted with acephate on the left and never disrupted in the middle, where Carbine was used instead of acephate to control the Lygus that were present in this trial. Those are dramatic differences and show you just how hard predators are working on your behalf to control whiteflies. The disrupted UTC is 5 times higher than PQZ and 3 times higher than the "undisrupted" check or "predator threshold" treatment just hours before it got sprayed with Sivanto.

Slide 26

Here are more examples from this year's whitefly trial. As mentioned, PQZ performed very well. Assail at the 2.3 oz per acre rate or at a 50% higher (and more costly) rate of 3.5 oz per acre performed comparably and very well. Sivanto HL at the high rate also performed well. Sefina at this point, after one spray, provided good control but at a level just under the others. Of course Celite was very similar to the Untreated Check, running at about 30 adults per leaf.

Slide 27 (video)

The results on cotton quality are catastrophic. This video shows the condition of the leaves in September when bolls were opening and exposing lint to the rain of sugary honeydew that falls from whitefly infested leaves. These sugars coat all plant parts and given enough humidity will host damaging sooty mold fungi, which discolor and weaken fibers. While one hopes never to see anything quite this bad in a commercial field, the question is can we measure sugars or “stickiness” directly in the field as a means to guide in-field decision-making? Easy answer, no! Quality losses are impossible to measure as they are happening and in fact our threshold guidelines are designed to elicit control actions well before the possibility of losing cotton quality. Instead, we have to measure insect densities…

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Measuring insect densities is exactly what we are doing here in this chart. In fact, we're measuring whitefly adult densities on a % infestation scale on the y-axis, a measurement that should be familiar to Pest Control Advisors. But now we're adding the measurement of key predator densities per 100 sweeps on the x-axis. We have been teaching these new measurements for predator thresholds over the last couple seasons. Let's look at the "Predator Threshold" entry where we tracked it on 5 different sampling dates (1-5), blue line. On the first date (1), whitefly adult infestation rate was 0 and the number of minute pirate bugs per 100 sweeps exceeded our scale (16/100, actually). On 2nd date (2), whitefly levels were up but pirate bug numbers were still very high. The 3rd date is interesting because we exceeded the pest-based threshold (gray line) and the new predator-based threshold, and pirate bugs did decline in number. The guideline would be to spray, but this was not the only piece of information available to us. We could look at whitefly large nymph levels and the levels of the other key predators. In any event, we decided not to spray and sure enough on the 4th date (4)

we had higher pirate bug numbers (45/100 and off the chart!) and lower whitefly numbers. Our 5th sample placed whitefly levels on the cusp of the “always spray zone” but still with ample pirate bug numbers (28/100). We decided to continue deferring a spray in favor of the excellent biological control taking place. But let’s consider the full suite of predator numbers available to us. Don’t panic when you see the next slide…

Slide 29

Here we show you those temporal tracings of all the whitefly adult and large nymph densities in comparison to the densities of our 6 key predators: minute pirate bugs (far left, top), crab spiders (left), Drapetis flies (right), lacewing larvae (far right, top), Collops beetles (far right, bottom) and big-eyed bugs (far left, bottom). We're not suggesting anyone needs to chart out all these outcomes, but we have him here to demonstrate the tug-of-war that occurs between predators and prey all season long. A practitioner need not track all predators at all times. Not at all! They should be tracking only those predators that are present and abundant for that field location and sampling date. The dynamics in the food web change all the time and for the same location a practitioner might switch to another predator that has become even more abundant. In other words, choose to track only the predators that are abundant on any given date. It will empower you to make better-informed, more confident spray decisions that have made the maximum use of the free biological control present in your field. We eventually did spray after the 11th sampling bout.

Slide 30

From the scary to the more familiar. While I was a boy, early on my father taught me the importance of right-sizing the tool for your situation. In this analogy, we have our tried and true measurement system of counting whiteflies. Those numbers along with our standard whitefly thresholds will help you in many cases. But now you have access to 8 new, predator thresholds. And, the one you choose to go with will be the one that is right for your situation. You can't budge a 3/4 inch bolt with a 5/8ths inch socket! The fit is just not there. And, there is no sense in tracking Collops in your field on a particular date if they aren't there. Track what is ostensibly most abundant relative to the thresholds we have made available. Only one predator threshold need be satisfied in order to defer a spray in favor of biological control. Of course if none of these predators are present at sufficient densities, there will be times when you will have to advance your sprays ahead of the standard whitefly threshold because you simply do not have enough biological control occurring in your fields, just like in our disrupted Untreated Check!

Slide 31 (video)

As further demonstration of what happens when you exclude predators from the system, consider this video that Naomi and Isadora put together on the topic. In another trial, we attempted to chemically eliminate all predators from the cotton system by season-long, repeated acephate sprays. We did this in contrast to plots where predators were left unharmed. The results are now predictably dramatic.

Slide 32

Let's return to the 2020 whitefly efficacy trial, where we can see the tracking of whitefly adult populations through time: the Untreated Check (U, gray line) is over the threshold of 3-5 adults per leaf the entire time, spiking late in the season at densities associated with yield loss, let alone quality loss; and PQZ (Z, blue line), which after one spray (black arrow) maintained low whitefly adult levels until 5 weeks later when a 2nd spray was made (black arrow). The control here was outstanding.

Slide 33

Now let's look at our "Predator Threshold" system ($, orange dashed line) where we did not disrupt plots with acephate as was done in PQZ and the UTC. Not only did whitefly levels stay low because of biological control that our system said was working, but we skipped the first spray entirely and did not have to spray until 5 weeks later! Those are real savings to a grower who elects to keep his/her system fully selective and safe to natural enemies.

Slide 34

The research that helped support the development of these predator thresholds was supplied by the Arizona Cotton Growers Association and Cotton Incorporated, along with capacity support from the USDA Extension Implementation Program, and grant-in-aid support from various agro-industries. I also want to acknowledge my close collaborators, Drs. Naranjo and Vandervoet, and their role in the development of these whitefly management systems. Finally, I wish to thank our hard-working IPM staff who conduct all the field and laboratory samplings, so important to the research that we do.

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Thanks for your attention. Please refer to these short publications for more information about using cotton insecticides and the predator threshold system.

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One final note. I would like to recognize the passing of Dr. Bob Nichols, research manager at Cotton Incorporated, who was part of our extended cotton and whitefly family. Bob was instrumental to helping our industry recognize and cope with the severe whitefly challenges we faced in the cotton industry. He supported my early research in this area as well as the research of many others at UA, USDA, and elsewhere. Rest in peace, Bob. We will miss you!