

Q-Biotype Whitefly Work Session, Dallas, TX

Arizona Whitefly Management Plan

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Central Issue

- **What did it take to generate a successful & sustainable management strategy for B-biotype whitefly in Arizona?**
 - Cooperation
 - Organized & comprehensive educational campaign
 - Research-based technical plan...
 - **A highly motivated user community!**

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This presentation was invited by Larry Antilla (ACRPC). He requested that I present the Arizona whitefly management plan that was developed in the mid-1990's to confront the B-biotype of *B. tabaci*. The description of the plan itself was secondary to my charge to outline the steps taken to develop this highly successful program.

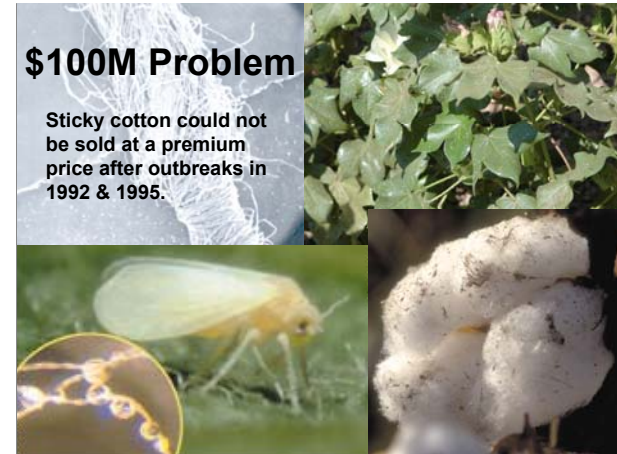
So my interpretation of my charge was this. The first three points were quite obvious elements necessary to be successful. The fourth occurred to me upon further reflection of what took place in 1995 and 1996. Without a doubt, you need to have the attention of your user community. In essence they need to have some sort of motivation to listen, learn and change behaviors.

Overwhelming Insect Pressure



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To understand, in part, the motivation that existed within our clientele, one only needs to see the level of insect pressure that was present in the early 1990's. This video was shot in 1992 on the campus of a community college located within the city limits of Phoenix. Truly this was everyone's problem.



A 100 million dollar problem starts with honeydew dropping on leaves, and cotton fibers, and finishes (if it can be processed at all) with knotted fabrics or yarns (pictured in the background). All are of very low quality and generally undesirable. And most times, the lint cannot even be processed and worse yet causes costly shutdowns of modern mills for cleaning. At the grower level, local outbreaks that deliver sticky cotton to the marketplace are penalized indefinitely as being a "sticky" cotton area. Since the stickiness itself is not routinely or reliably measured, marketers play it safe by avoiding buying fiber from whole areas where previous episodes of sticky cotton have occurred. This has a chilling effect on cotton prices locally.

Cooperation

- **Agrochemical industry**
 - Development & delivery of key chemistries
 - Willingness to cooperate with both voluntary and mandatory limits on usage
 - Partner in educational program
- **Regulatory involvement**
 - AzDA: sponsor of Section 18; willingness to take-on additional certification & oversight responsibilities
 - EPA: approval of dual Section 18, two a.i.'s for single target due to efficacy considerations
- **Grower leadership (ACGA / ACRPC)**
 - Implementation of oversight function of AzDA & compliance monitoring
 - Endorsement of set of guidelines & chemical use plan
 - Development of economic justification for Section 18

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Cooperation among industry, regulatory community, and the grower leadership was critical to our success. Valent and AgrEvo had pyriproxyfen and buprofezin in development. Our program included a section 18 request for the use of these compounds, restricted to just one use each per season as a proactive resistance management tactic. We needed both compounds, because our small plot testing indicated that one use of either alone would be inadequate to provide season-long protection from risks of contamination with sugars. AzDA agreed to “certify” growers and pest control advisors for usage of the IGRs, based entirely on their mandatory attendance / participation to educational meetings and workshops held around the state. The grower leadership embraced the guidelines, supported the need for mandatory education, and with ACRPC helped to justify the Section 18’s economic analysis. ACRPC took over the compliance monitoring function of the AzDA, which was not budgeted otherwise to address this new enforcement activity.

Cooperation (2)

- **Responsive & relevant research community**
 - USDA: redirected financial & human resources; organized USDA 5-yr plan & brokered communication
 - Cotton Inc.: support of problem-solving research; partner in communication & education
 - University: research / extension scientists dedicated to problem-solving research, adaptive & validation demonstration, & education / outreach

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Cooperation operated at the level of the research community as well, which responded in kind by re-directing lines of research in many laboratories throughout the UA, UC and USDA systems. Further, USDA managed a large effort to support communication among scientists by organizing a national 5-yr planning process that included annual reviews and meetings. Cotton Incorporated infused much needed funding for many of the problem-solving research programs. Land-grant Universities took the lead in developing applied research and outreach specific to the whitefly problem through Cooperative Extension.

Organized & Comprehensive Educational Campaign

- **Actively deployed programs of outreach**
- **Research-based guidelines**
- **Informal / formal publications and advisories**
- **Mandated “education” for certification**
 - Meetings, workshops, live demo’s
- **Demonstrations**

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At the heart of successful deployment was an organized and comprehensive educational campaign. This was not a passive or ad hoc process. This was a pre-planned and comprehensive activity that incorporated written and verbal delivery of guidelines and advisories. A session of mandatory workshops that included presentations, discussion, and live demonstrations of the impact of IGRs on whiteflies were held throughout the state. Over 700 growers and PCAs were educated and therefore “certified” for use of the IGRs in 1996. The two companies, ACGA, ACRPC, USDA, and UA were all collaborators in this program. In addition, large-scale, commercially-relevant demonstrations were initiated in a 200-acre replicated experiment at the Maricopa Agricultural Center to identify and demonstrate best practices for managing whiteflies. This was an ambitious collaboration between USDA, UA, ACGA, and Cotton Inc.

Technical Plan

- **Focus on those tools needed to immediately address the problem**
- **Integrated Pest Management Plan**
- **Major elements of sampling and effective chemical use**
 - For immediate relief
- **Foundation in avoidance**
 - For both short-term & long-term success

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Some might put the technical plan first and surely it is very important. But ultimately, it comes last, if only because had the other elements not been in place, Cooperation and an Organized & Comprehensive Educational Campaign, the existence of a technical plan would have made little difference. This plan was based in IPM and focused on immediate term tactics of sampling and effective chemical use, while still grounded in the foundation of avoidance.

Damage to Cotton: Direct, Yield Loss



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Excreted Sugars Host Sooty Molds



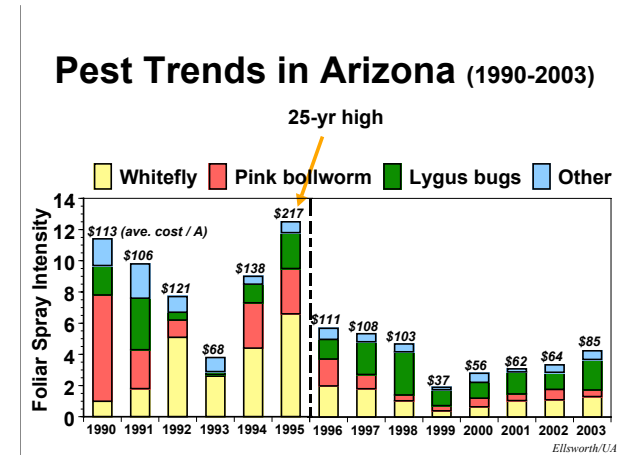
Ellsworth/UA

Once again, a motivated user community is needed. They need to be ready to learn. Experiences, like in 1992 where levels of wfs were yield-limiting, were key to “conditioning” growers to learning better management practices.

However, it is the threat of “sticky cotton” that drove this industry mandate.



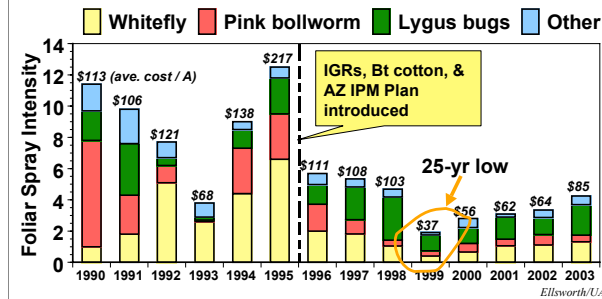
It also has a chilling effect on pest management. Desperate attempts to control this pest resulted in many, many sprays. When this animal arrived at our borders in the early 1990s, we did not know how or when to control it. The result was a great deal of indiscriminate spraying with very broad spectrum chemistries that were destructive to other advances in IPM and were, now we realize, counterproductive. For the grower, huge spray bills were all the motivation they needed to want to learn about the new wf management plan.



In this chart, we see the statewide average foliar spray intensities for the last 14 years in Arizona cotton. Broken down by major cotton pests, we can see that 1992 required more than 5 sprays to combat the whitefly. 1993 appears to have gained some ground with fewer sprays, but this is an artifact of the grand confusion that existed in the agricultural community. Many growers, exasperated by the 1992 episode, planned for and implemented a very abbreviated production season in 1993. This allowed them to limit their sprays for whiteflies but seriously eroded yields. By 1995, we hit an all time high of over 12.5 sprays for all pests, 6.6 sprays for whiteflies alone. Even at this level, the whitefly estimate is likely low because many were reluctant to report such high numbers of sprays against this singular target. I suspect that an even greater proportion of the spraying done this year was attributable to the whitefly.

The introduction of our new wf management plan in 1996 coincided with a precipitous drop in insecticide use...

Arizona IPM Plan Introduced



...in that year, we introduced two new insect growth regulators (IGRs), Bt cotton was also introduced, and we introduced a detailed IPM plan that was aggressively supported with a comprehensive educational plan. The results were dramatic as you can see. A 25-yr low in insecticide use was experienced in 1999 when just fewer than 2 sprays were needed on average for control of all pests. Whitefly sprays in recent years have stabilized to about 1 spray on average, though 2005 will likely report somewhat elevated inputs and individual examples of lost control due to a variety of reasons.

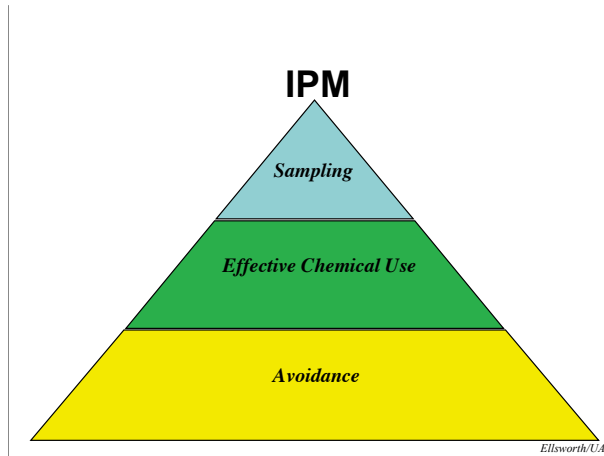
Whitefly IPM...

...depends on 3 basic keys

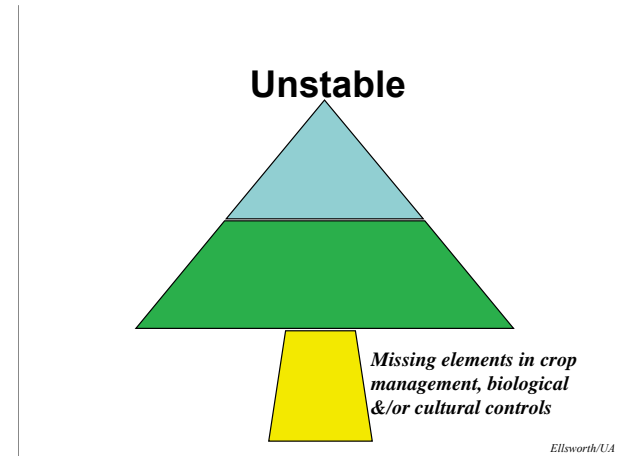


Using a pyramid metaphor, let's look at what was and continues to be our operational IPM plan. At its simplest, it is just 3 keys to management, Sampling, Effective Chemical Use, and Avoidance. One can break this down further and examine each building block of the pyramid and see an intricate set of interrelated tactics and other advances that have helped to stabilize our management system.

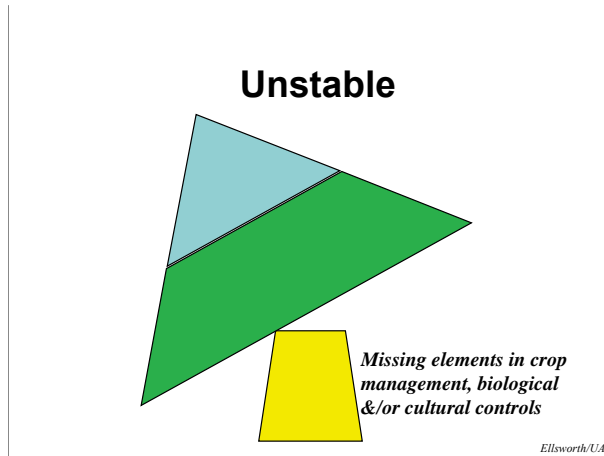
Time constraints will prevent me from dwelling in great detail on each building block, but I would like to spend time on some of the more major and immediate elements of this program, keeping in mind that I am a firm believer that the whole is worth more than the sum of its parts. Let's quickly review some of the elements of this IPM plan.



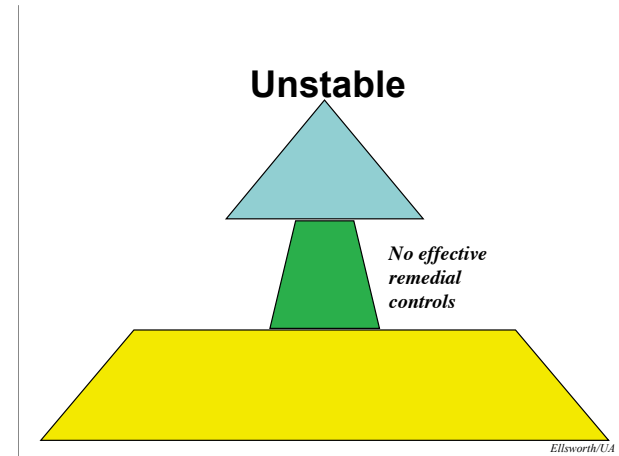
The metaphor is also convenient when communicating to growers the concepts of IPM.



If the foundation elements are not practiced, and many were required in 1996, then these missing elements shrink the foundation on which we can rest the balance of our management plan.

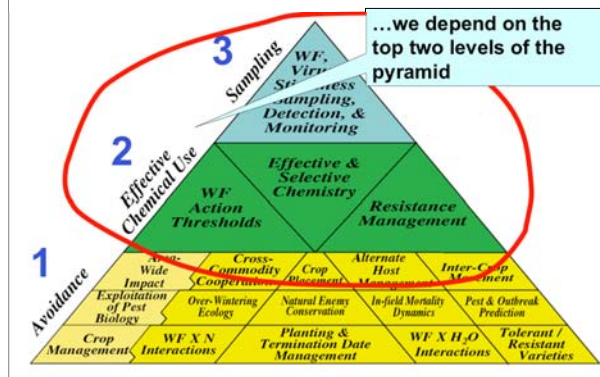


Clearly, this is an unstable system.



Similarly, however, by 1995, we were at threat of not having effective remedial controls. This situation, too, even with a broad foundation in avoidance will collapse.

When SWF are damaging...



Ultimately when whiteflies become damaging, we become even more dependent on the upper portions of the pyramid, Sampling and Effective Chemical Use. And this was an area of intense development when whiteflies first arrived in our state. We knew nothing about how to sample them or how or when to control them initially (1990-1992).

Quick Leaf Turn



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However, advances were made quickly, and ultimately led to a very streamlined sampling system for adults that included a quick leaf turn method...

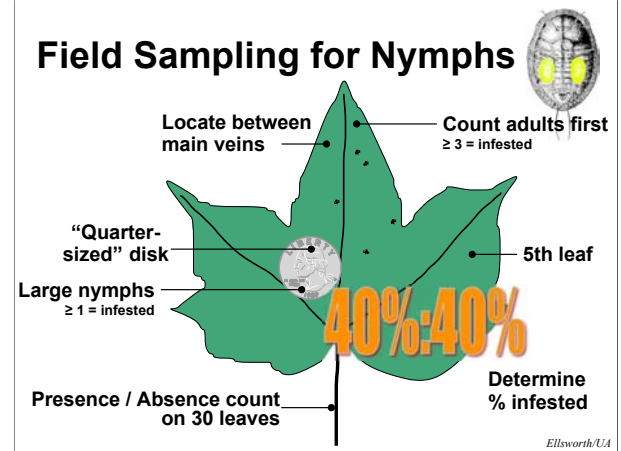
Infested Leaf (≥ 3 adults)



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For evaluating adult infestations of cotton...

Field Sampling for Nymphs

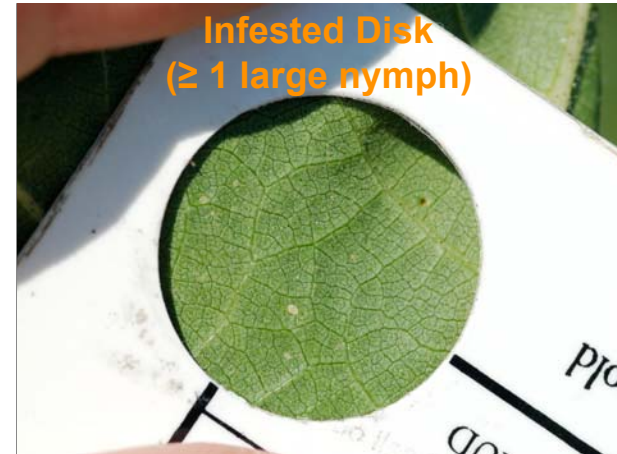


...as well as a detailed sampling plan for large nymphs, crucial to the proper timing and deployment of the IGRs. One detaches the 5th leaf and examines an area between the major veins that is about a quarter in size for large nymphs. In this way, one can determine the percentage infestation for large nymphs and for adults.

Between Mid & Lateral Vein



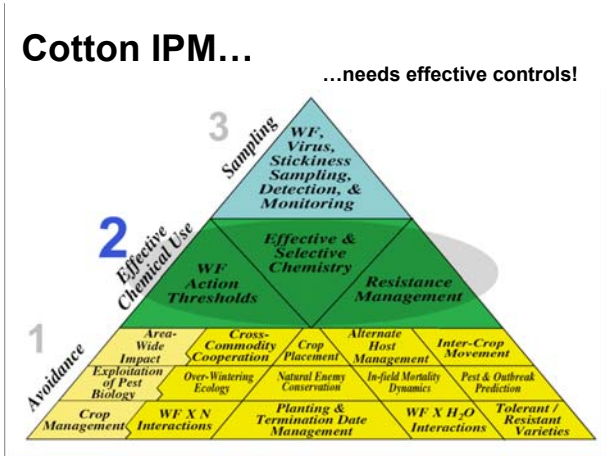
While this can be practiced with the naked eye, we distributed hand lenses and other tools for identifying the target area for inspection (washers, plastic cards with a properly-sized hole punched out, and/or custom-built loupes).



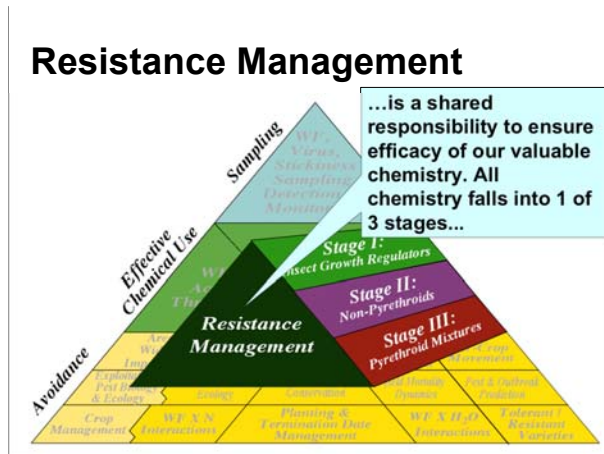
So in this example once again, it is unimportant that a scout see all 3 nymphs. Only 1 is needed for this disk to be considered infested.



Only large instars are counted (3rds and 4ths) as pictured here.



With immediate term solutions needed for industry survival, our attention had to be focused on “effective chemical use”. I won’t dwell on the chemistry, which was absolutely key, but conclude this talk with mention of the resistance management plans that were developed and disseminated.



Neonicotinoids: A Major New Class of Chemistry

- imidacloprid (**Admire**/Confidor, Provado [Leverage], Gaucho, Gaucho Grande)
- thiamethoxam (Centric, Actara, **Platinum**, Cruiser)
- acetamiprid (**Intruder**, Assail, Rescate)
- clothianidin (Poncho, Clutch, Belay)
- thiacloprid (Calypso)
- dinotefuran (Venom, Safari)

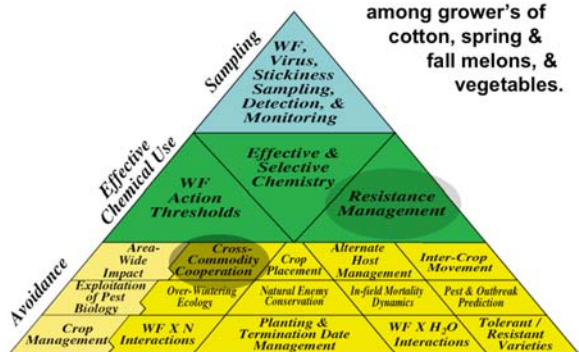
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The IRM plan breaks down into 3 stages with focus on the usage of IGRs first, followed by non-pyrethroids and pyrethroid mixtures (no more than two uses) if needed. This was based in our research that suggested the selective benefits (and therefore efficacy) of the IGRs were best if deployed first against the wf population. Each was limited to one use only. That restriction continues today via the label (for Knack) and voluntary compliance (for Applaud, now Courier, which actually permits two applications on the label). The voluntary restriction on pyrethroids as a class stems from data from Tim Dennehy's and other's who showed that our synergized pyrethroids were subject to resistances in these populations.

The neonicotinoid class of chemistry is one of the richest discoveries of molecules that are toxic to insects in decades. Imidacloprid is key to the management of melons and winter vegetables. However, thiamethoxam and now acetamiprid in cotton complicate our goals to preserve this class indefinitely. As a result, our management plans have not stood still. We continue a cross-commodity dialog that serves to develop new guidelines that are aimed to benefit the entire industry.

Whitefly X-IPM...

...depends on cooperation among grower's of cotton, spring & fall melons, & vegetables.



Cross-commodity cooperation can be key to the sustainability of a resistance management plan, and in Arizona, we have achieved some remarkable agreements and so far excellent cooperation among growers of several key whitefly crop hosts.

Sharing Neonicotinoids

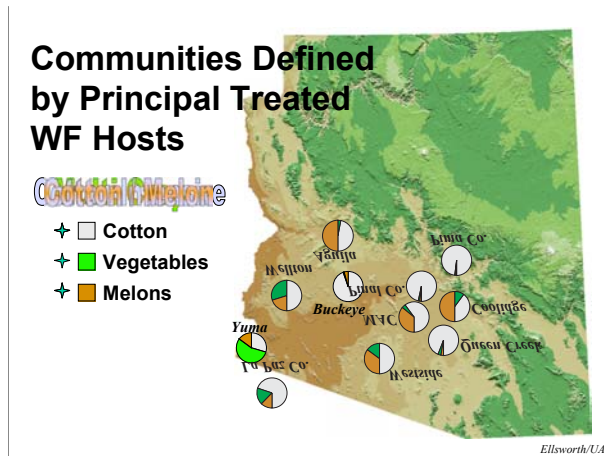
Summary Guidelines: Maximum number of uses per crop season for neonicotinoids in three different cropping communities.

Community	Cotton	Melons	Vegetables
Multi-Crop	0	1*	1**
Cotton / Melon	1	1*	—
Cotton-Intensive	2	—	—

*Soil only; **Soil or Foliar

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Under John Palumbo's leadership, we developed a stakeholder-driven set of guidelines that in essence restricts neonicotinoids as a class to just two uses per cropping community. Several years of effort can be distilled down to this single table.



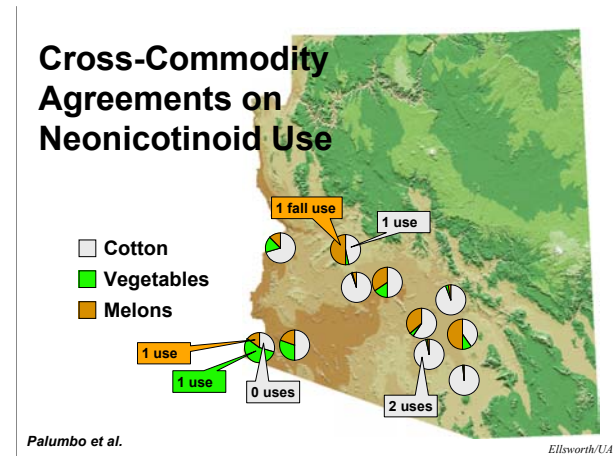
Through a dialog with the agricultural sector, John Palumbo and others worked through a new approach in developing and disseminating resistance management guidelines. First, John recognized that the potential risks of resistance may in fact be different among cropping communities in Arizona. So we defined communities by the whitefly hosts grown within them, say within a 2 mile radius of one another.

We have instances like in Yuma which are very complex and include significant acreages grown in melons, cotton and vegetables.

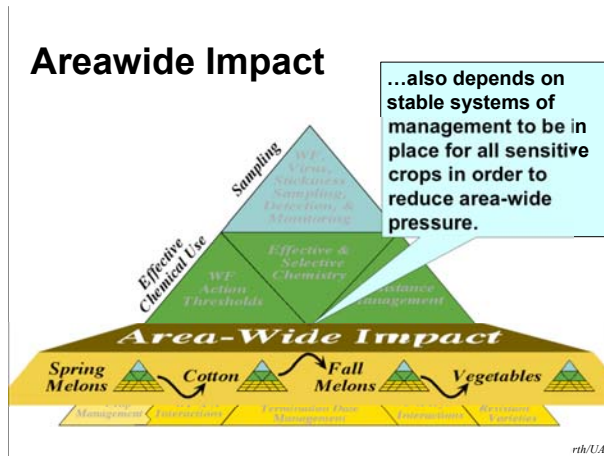
In other areas, the system is relatively simple and resembles a cotton monoculture as far as whiteflies are concerned.

Then there are some places where a melon / cotton biculture exists.

Of course each area is different throughout the state and the guidelines are sensitive to these differences...

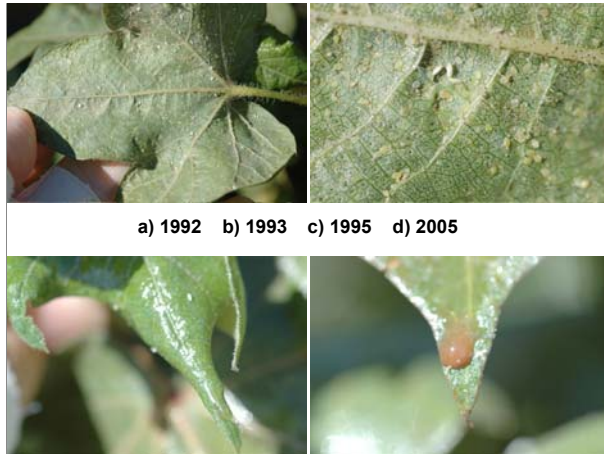


The most radical idea that we are implementing is in our multicrop communities where producers of cotton recognize the value of having the neonicotinoid class function well in this system (e.g., imidacloprid in veggies and melons). But this recognition is made tangible by them foregoing the use of all neonicotinoids in cotton in these areas. Compliance is voluntary, but we have a project to measure this explicitly in Arizona. We suspect there were “infractions” in 2005, but generally good compliance otherwise.



As mentioned earlier, a well conceived IPM program for cotton is not enough to manage whiteflies sustainably in complex cropping systems. In parts of Arizona, spring melons might be followed by cotton, followed by fall melons, and later winter vegetables, though not necessarily on the same piece of ground. So having functional systems of management, including resistance management, in each commodity is key to managing a shared pest like whiteflies no matter what biotype we are dealing with.

This is the point in my talk when I generally ask the audience to identify the year in which this photo was taken -- a leaf from 3-leaf(!) cotton encrusted with nymphs. Most shout out 1992, 1993, 1995; however, this photo is from 2005 from the Yaqui Valley of Mexico in southern Sonora. This large agricultural valley was plagued in 2005 by whiteflies. The reasons may be complex, but certainly include some factors that operate on wf dynamics in desert locations, like high winter rainfall feeding large abundances of host plants throughout the landscape, many of which were left unmanaged in fallow fields and non-agricultural lands. But there were many factors, some of which were a warning sign for us in the low deserts of AZ and CA.



Quiz, what year were each of these photos taken.
 Answer: 2005, and in Arizona. Yes, scenes of excess sugars / honeydew and masses of whiteflies in cotton were seen in 2005. Though these were taken from experimental plots, similar problems were experienced in some limited instances and often where the fundamentals of management were ignored or at least poorly practiced. The areawide dynamic caused by these lapses can be significant and cause problems for neighboring fields. We clearly all need to be re-educated on the basics of wf management so these scenes can be eliminated altogether.



Thank you for your attention. It would be impossible to recognize everyone who had a role in the successful implementation of this management plan. The list is long, as it needed to be in order to be successful.