

# Cross Commodity Management of Whiteflies and Chemical Efficacy in Arizona

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## **Abstract**

*The Western Growers Association and Arizona Cotton Growers Association worked cooperatively with a group of University of Arizona scientists, Arizona Department of Agriculture officials and regional pest control advisors to develop general guidelines for managing whiteflies and specific recommendations for Applaud and Admire use. This was achieved by identifying differences in crop production, insecticide use, and whitefly population dynamics on key host crops within three distinct growing regions in Arizona. Data was compiled that when graphically illustrated identified important, multidimensional interactions within cropping systems. Based on the patterns resulting from our analysis, initial recommendations have been formulated to harmonize chemical use across commodities by restricting Applaud use to only once per crop season in use windows, with additional guidelines for reducing the possibility of exposing successive whitefly generations to the same mode of action. The diversification and limitation of Admire and other active ingredients, and the employment of cultural practices are also be considered. Should this model of cooperation be successful, valuable and scarce modes of action may also be shared in the future within diverse, integrated use systems.*

## **Introduction**

During the past decade, the silverleaf whitefly in Arizona has been relegated to a managed pest. This was achieved through the development of management programs in cotton, melons and vegetables which utilized cultural practices, selective insecticides, sampling and monitoring plans, and optimally-timed insecticide use. Growers in all commodities have been quick to adopt and modify these management strategies as new insecticide compounds are made available. Admire® (Section 18) in melon and vegetables, and Danitol® in cotton, were first available to Arizona growers in 1993. However, due to excessive use, pyrethroid efficacy was significantly reduced in some growing areas by 1995. In response, the Arizona Cotton Growers Association (ACGA) requested limited use of and received an emergency exemption for two insect growth regulators, Knack® and Applaud®. Availability of the IGRs made possible the UA Integrated Resistance Management program that promoted non-chemical management of whiteflies, in conjunction with a three-stage chemical use strategy designed to maximize the longevity of insecticide modes of action. Implementation of this program has since reduced insecticide use for whitefly management overall, and provided for recovery of pyrethroid efficacy.

Admire continues to provide consistent whitefly control on melons and leafy vegetables. However, the lack of registered foliar insecticides available in melons prompted the Western Growers Association (WGA) in 1998 to request an emergency exemption for Applaud on melons. A Section 18 label is now available on melons to control whitefly and help sustain Admire efficacy. Because whitefly exposure to Applaud may soon overlap among melons, cotton and fall vegetable crops, cooperation will be needed among growers to harmonize insecticide use among commodities, to cover management needs of the respective groups, and to protect long-term Applaud efficacy. In addition, preserving Admire efficacy is critical for managing whiteflies and sustaining alternative chemistries in vegetables and melons.

In 1998, the leadership within the WGA and ACGA met to discuss the possibilities of developing a cross-commodity approach for managing whiteflies and sustaining long term insecticide efficacy. A Cross-Commodity Growers Working Group was formed, and discussions focused on formulating practical pest management guidelines for cotton, melon and vegetable growers in Arizona. Participants also included representatives from the Arizona Vegetable Growers Association, Yuma Vegetable Shippers Association, Arizona Cotton Research and Protection Council, Cotton Incorporated, and Arizona Department of Agriculture. A technical committee comprised of UA scientists, ADA personnel and local PCAs was formed to address cross commodity issues and develop short- and long-term recommendations for managing whiteflies and sustaining chemical efficacy.

## **Procedures**

Our goal was to take the first step in understanding whitefly management across Arizona cropping systems and begin formulating practical management guidelines (chemical, cultural, etc) for cotton, vegetable and melon production. The objectives for this group were to:

- initially develop insecticide use guidelines for 1999/2000 growing seasons
- identify potential vulnerabilities for the short term (2-3 years)
- develop a long term strategy for overall stabilization of susceptibility in whitefly populations and possibilities of the introduction of new chemistries.

## **Identification and Description of Regional Cropping Systems**

Based on our initial objective our preliminary goals were to outline the current chemical and cultural whitefly management practices used in and across commodities, by specific regions where cotton/melons/vegetables interface. We also felt it necessary to outline specific guidelines for IGR/chemical use for cotton, fall melons and spring melons in 1999. To a limited extent we attempted to identify present and future problems relative to cross commodity management. Listed below is the information from our goals which we were able to adequately identify.

**Three distinct growing regions that differ in planting and harvest dates, distribution of crop acres, cropping patterns, relative whitefly abundance and insecticide usage were identified and described.**

*Yuma:* Yuma County and the Parker Valley  
*Central AZ- Low:* Maricopa County including Harquahala Valley, and Pinal County.  
*Central AZ-High:* Salome, Wenden and Aguila.

**Generalized differences in regional melon growing acreage were identified.**

*Yuma:* Spring melons acres (May/June harvest) in greater abundance than fall melon acres (August planting)  
*Central AZ -Low:* Spring melon acres (June/July harvest) in greater abundance than fall melons acres (August planting).  
*Central AZ-High:* Fall melon acres in greater abundance than spring/summer acres (continuous production)

**Identification of Admire (imidacloprid) use patterns on Melons.**

	<b>Application Periods for Admire on Melons</b>		
	<b>Spring</b>	<b>Summer</b>	<b>Fall</b>
<b>Yuma</b>	January-March	none	August
<b>Central-Low</b>	none	none	August
<b>Central-High</b>	after May 1	June-July	August

## **Potential application periods for Applaud on crops within each cropping region was estimated.**

### Spring Melons:

*Yuma:* With the exception of early planted melons, most melons typically require a foliar spray (synergized pyrethroid) to suppress whitefly populations before harvest (May-June). The window for Applaud use during the spring would probably extend from mid-April to June 1.

*Central-Low:* On the average, 60-70% of the melons will be harvested before whiteflies traditionally build up to numbers which require augmented sprays. Presumably, 30% of the melon acres (primarily honeydews and watermelons) normally require a foliar spray. The window for Applaud use would exist from June 1-July 1 on 30-40% of melon acres in this region.

*Central AZ-High:* Similar to Central AZ-low, foliar sprays are not normally required until after May 1<sup>st</sup>. At least 50% of the spring crops won't be sprayed with synergized pyrethroid. Melons grown after June 1<sup>st</sup> usually typically require a foliar spray to control whiteflies. Potentially, because of spring/summer/fall production, Applaud use could extend from mid May through July.

Fall Melons: With Admire used in each Region for whitefly management, there is less need for foliar sprays.

*Yuma:* Depending on temperatures and other insect pest activities, Applaud could possibly be needed in late September-October.

*Central AZ-Low:* Movement out of urban areas and cotton may result in some acres requiring an Applaud application, but as long as Admire continues to provide control there may not be a large need for foliar sprays.

*Central AZ-High:* Similarly, there is the potential for no need of foliar sprays following Admire in fall melons.

### Cotton:

*Yuma:* The window for IGR use has been predominantly from July 1-Aug 15, resulting from earlier whitefly build up via spring melons, and earlier crop termination.

*Central Arizona-Low & High:* It was agreed that IGR's are generally needed between July 1 and mid-September. It was agreed that 90-95% of IGRS use in cotton in Central AZ high and Az low was used in a 60 day window in July-August.

## **Identification of Resistance Risks and Potential Chemical Use Patterns**

The primary purpose for identifying the above factors was to focus our intentions on rationally determining management approaches for the long term sustainability of product efficacy. Management of chemistries and modes of action should be based primarily on whitefly population dynamics, and to a lesser extent, cropping patterns. We are attempting to base resistance risk on populations which are exposed to the same/different modes of action. Once the variables interacting within regional cropping systems are identified, we believe recommendations for IGR use can be modified based on potential exposure of whitefly populations within a region rather than on a crop by crop basis. We are focusing our considerations within a 6-month window (Apr-Oct) when whitefly populations will be exposed to Applaud and Admire.

The number of Applaud sprays that would be potentially made during the 6-month whitefly window will be critical for sustaining product efficacy and raises an important question: If Applaud can be used 1 time in each crop, how many times would it be used in a year? Asked perhaps more appropriately, how many times can a whitefly population be exposed to Applaud during the Apr-Oct window and still maintain field efficacy? Assuming that the

potential exists for a 6 month reversion of susceptibility during the winter (Nov-Mar), what is the possibility of limiting Applaud to no more than 2-3 applications during the April-Oct window (ie. once per crop in spring melons, cotton and fall melons). The challenge will be to prevent successive whitefly generations from Applaud exposure, irrespective of crop.

Thus, we proceeded to further define the interactions among the chemical use patterns and whitefly population dynamics within each regional cropping system. We accomplished this by compiling data for crop production, insecticide use, and simulated whitefly population dynamics for key host crops within the three distinct growing regions in Arizona. Graphs were constructed that when overlaid identified important, multidimensional interactions within cropping systems. Below is a description of the methods we used to construct our graphs.

**Data Compilation and Construction of Graphs** (Figures 1-6)

A. Description of Cropping systems: Data consisted of the number of acres for each host crop within each region. This was estimated using the 1997 Arizona Agricultural Statistics for Yuma and Maricopa Counties. Within Maricopa County, Central High and Low were differentiated by estimates from the PCA's working in those areas. The estimates of acres occurring during each month was further estimated by JCP using information from 1998 AZ Ag Statistics and PCAs.

B. Description of Insecticide Usage: Data consisted of the amount of each insecticide class used on each crop during the respective growing season. This was estimated using insecticide (1080) use data for vegetables provided by Will Sherman (AZ Ag Stat Service, Phoenix, AZ) and input from the technical committee. To derive a specific insecticide usage, the number of acres estimated for that time period was multiplied by the estimated % of insecticide used. Based on our discussion above, Applaud use on melons was also projected in overall use for a region.

C. Relative Whitefly Population Abundance: *Bemisia* seasonal cycles (dates of adult emergence for each generation) for each region were estimated using a model developed by DeGrande-Hoffman, Naranjo, et al. at the USDA-ARS, Western cotton Research Lab, Phoenix, AZ. Weather data from 30-yr normals for each location were used for temperature inputs. Adult whitefly emergence data for each generation was predicted from the *Bemisia* model using a Mar 1, April 15, and May 1 initial oviposition dates associated with adult activity on cotton seedling for Yuma, Maricopa and Aguila, respectively. On the calendar date that each generation was predicted, relative whitefly abundance for each crop was estimated by multiplying an index value (see Table 1 below) by the number of acres estimated to be present during that month. The resulting estimates based on index value \* host acreage is meant to reflect relative whitefly abundance presently occurring in each cropping region. Data used to determine the index and seasonal values was derived from the following sources: Ellsworth et al. 1997, Palumbo and Hannan 1997, Palumbo et al 1995, Palumbo et al 1996, Palumbo and Coates 1996, Tonhasca et al 1994, Watson et al. 1992, Yee et al. 1997.

**Table 1. Index Values for Estimating Relative Whitefly Abundance in 1998-1999**

Index Value	Estimated Whitefly Abundance	
	Adults/leaf	Nymphs/cm <sup>2</sup>
0	0	0
.5	Present	0
1	<1	<2
2	1– 5	2– 5
3	5– 10	5– 10
4	10–25	10–25
5	>25	>25

## Results

Figures 1-3 illustrate the distinct differences among the three growing regions. The annual distribution of treated acres differs in each growing region relative to active ingredients, and crop diversity and abundance. Overlaid with these graphs are whitefly population dynamics, with relative abundance on crops for each predicted generation. Whitefly populations have the potential to develop 13, 12, and 10 generations/year in Yuma, Central AZ low, and Central Az high, respectively. These graphs also show that peak chemical use for each region occurs when both crop acreage and whitefly abundance are greatest. They also identify the time of year when whitefly abundance is lowest, as well as potential genetic bottlenecks.

Figures 4-6 illustrate identified and modified use windows for potential Applaud use in melons and cotton in each growing region as identified by the technical committee. The small white boxes represent the time that Applaud may potentially be needed for whitefly control during the growing season, relative to predicted occurrences of whitefly generations. Again the need and timing of Applaud use varies between each region. The modified use patterns represent the time that Applaud or alternatives should be used based on the guidelines provided in Table 2. Our recommendations attempt to address cross-commodity Applaud use across all regions. In the future, specific Applaud recommendations may be required for each individual region.

Ideally, these strategies were formulated to optimize whitefly management and maximize the efficacy and longevity of insecticide chemistries used for whitefly control across commodities. We recognize, that under certain conditions these practices may be difficult to implement, but emphasize they may be necessary for sustainability of chemical efficacy in Arizona cropping systems.

## Discussion

This technical committee was successful in identifying regional variation in cropping systems, seasonality and relative abundance of treated and untreated hosts, relative whitefly population dynamics, genetic bottlenecks and limitations in chemical diversity within the major agricultural communities in Arizona. These efforts resulted in the development of general guidelines for managing whiteflies and specific recommendations for Applaud and Admire use. Our understanding of the complexity involved in describing multiple-cropping systems was further enhanced by compiling data for crop production, insecticide use, and simulated whitefly population dynamics for key host crops within three distinct growing regions in Arizona. Graphs were constructed that when overlaid identified important, multidimensional interactions within these multi-crop communities. Based on the patterns resulting from our analysis, initial recommendations have been formulated to harmonize chemical use across commodities by restricting Applaud use to only once per crop season in use windows, with additional guidelines for reducing the possibility of exposing successive whitefly generations to the same mode of action. The diversification and limitation of Admire and other active ingredients, and the employment of cultural practices should also be considered. Should this model of cooperation be successful, future applications of this type of information can be used for discussing the potential vulnerability of chloronicotinyls, use patterns for new, novel active ingredients, implementation of new IPM tactics and refinement of cultural management practices in multi-crop communities.

## Literature Cited

- Ellsworth, P.C., J. Diehl, I.W. Kirk, and T.J. Henneberry. 1997. Whitefly Growth Regulators: Large Scale Evaluation, pp. 279-293. *In* J.C. Silvertooth (ed) 1997 Cotton Report, University of Arizona, College of Agriculture Series P-108.
- Palumbo, J.C. and T.A. Hannan. 1997. Commercial field performance of Knack on cotton in the Yuma Valley, pp. 294-305. *In* J.C. Silvertooth (ed) 1997 Cotton Report, University of Arizona, College of Agriculture Series P-108.
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Palumbo, J.C. and W.E. Coates. 1996. Air-assisted electrostatic application of pyrethroid and endosulfan mixtures for sweetpotato whitefly, control, and spray deposition in cauliflower. *J. Econ. Entomol.* 89: 970-980.

Tonhasca, A., J.C. Palumbo, & D.N. Byrne. 1994. Distribution patterns of *Bemisia tabaci* (Homoptera:Aleyrodidae) in cantaloupe fields in Arizona. *Environ. Entomol.* 23: 949-954.

Watson, T.F., J.C. Silvertooth, A. Tellez, and L.Lastra. 1992. Seasonal dynamics of sweetpotato whitefly in Arizona. *Southwest. Entomol.* 17:149-167.

Yee, W.L, N.C. Toscano, J.C. Palumbo, M.J. Blua, and H.A. Yoshida. 1997. Seasonal populations trends and densities of *Bemisia argentifolii* on Alfalfa in southern California and Arizona. *Environ. Entomol.* 26:241-249.

**Table 2. Guidelines for Management of Whiteflies and Chemical Efficacy Across Commodities**

<p><b>General Guidelines</b></p> <p><i>Avoid Problems Through Cultural Management</i></p> <ul style="list-style-type: none"> <li>• Crop sanitation, crop sequence, crop placement</li> <li>• Agronomic considerations</li> <li>• Prompt removal of post-harvest residue</li> </ul>
<p><i>Scouting, Sampling and Detection</i></p> <ul style="list-style-type: none"> <li>• Apply insecticides only when necessary</li> <li>• Utilize recommended sampling procedures and action thresholds.</li> </ul>
<p><i>Ensure Effective Chemical Use</i></p> <ul style="list-style-type: none"> <li>• No more than 2 uses per active ingredient per season.</li> <li>• No more than 2 uses of pyrethroids per season.</li> <li>• When applying foliar insecticides, maximize coverage and optimize spray deposition. <ul style="list-style-type: none"> <li>▸ Ground applications should utilize air assist or high volume sprays.</li> <li>▸ Directed sprays on infested portions of plant should be used whenever possible.</li> </ul> </li> <li>• Treat whole fields when applying IGRs</li> <li>• Use only recommended products and rates necessary to accomplish desired control.</li> <li>• Do not apply insecticides below labeled rates.</li> </ul>

**Table 2. -Guidelines continued.**

<b>Specific Guidelines for Applaud® and Admire®</b>
<p>The guiding principles behind these recommendations are to maximize utility, efficacy and longevity of these valuable active ingredients for all commodities, and minimize the risk of resistance. The objectives of our guidelines are to optimize frequency of use (e.g., number of applications /season or year), avoid sequential exposure of multiple generations of whiteflies across commodities, and to encourage cooperation and communication among all growers within regional cropping systems.</p> <p><b><u>Applaud Use Recommendations</u></b></p> <ul style="list-style-type: none"><li>• Limit Applaud use to <i>1 application</i> per crop season.</li><li>• Restrict Applaud use to no more than <i>3 applications</i> per year in a multi-crop community.</li><li>• Do not expose multiple, sequential generations of whitefly to Applaud.</li><li>• Coordinate treatments of adjacent fields such that, when thresholds indicate the need for Applaud applications:<ul style="list-style-type: none"><li>▶ they are made within 1 week (within the same whitefly generation), or</li><li>▶ the interval between Applaud sprays is <math>\geq 4</math> weeks, or <math>\geq 2</math> whitefly generations.</li></ul></li><li>• If a field requires treatment for whiteflies and an adjacent field has been treated with Applaud within 28 days (see previous statement), use an alternative chemistry with a different mode of action.</li><li>• Assuming Admire is used on lettuce, use alternatives to Applaud (pending registration) for controlling whiteflies in lettuce.</li></ul>
<p><b><u>Admire Use Recommendations</u></b></p> <ul style="list-style-type: none"><li>• Do not use a foliar formulation of imidacloprid (Provado®) in cotton, except for chronic aphid problems.</li><li>• Do not apply Provado on crops that have been planted or side dressed with Admire.</li><li>• Whenever possible, consider foliar alternatives (pyrethroids, endosulfan, Applaud) to Admire use for whitefly control in the following conditions:<ul style="list-style-type: none"><li>▶ Fall lettuce crops planted after temperatures have declined and there is no significant source (i.e. alfalfa, cotton or melons) of whiteflies within a one mile radius.</li><li>▶ Fall lettuce and cole crops that are planted after whitefly movement subsides and are harvested before aphid populations typically become abundant (eg., Oct 10 ~ Nov 10 in Yuma).</li><li>▶ Early-spring planted melons which traditionally harvest before the emergence of F2-F3 generations (see Fig 4-6).</li></ul></li><li>• When appropriate, consider an alternative foliar spray program ( MSR®, Provado, endosulfan, Orthene®) rather than a preventative Admire treatment for aphid control on spring lettuce and cole crops.</li></ul>

**Useful References Associated with General and Specific Guidelines**

- Sampling Plans and Action Thresholds for Whiteflies on Spring Melons, *UA Coop Extn, IPM Series No. 1*
- Sampling Whitefly Adults in Cotton, *UA Coop Extn, IPM Series No. 2*
- Whitefly Management in Arizona Cotton 1996, *UA Coop Extn, IPM Series No. 3*
- Using Admire on Desert Vegetable Crops, *UA Coop Extn, IPM Series No. 5*
- Sampling Sweetpotato Whitefly Nymphs in Cotton, *UA Coop Extn, IPM Series No. 6*
- The 1996 Whitefly Resistance Management Program for Arizona Cotton, *UA Coop Extn, IPM Series No. 8*
- Melon Insect Pest Management in Arizona, *UA Coop Extn, IPM Series No.11*
- Management of Aphids and Thrips in Leafy Vegetables, *UA Coop Extn, 1998 Vegetable Report, Series P-115*

Figure 1.

### Yuma

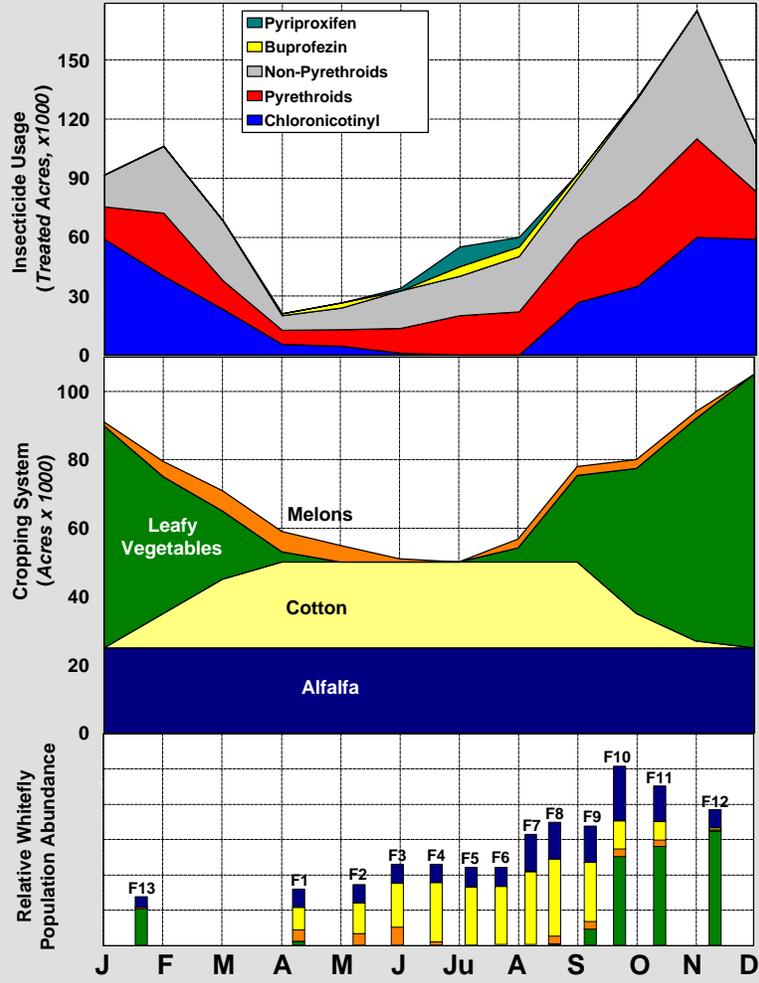


Figure 2.

### Central Arizona- Low

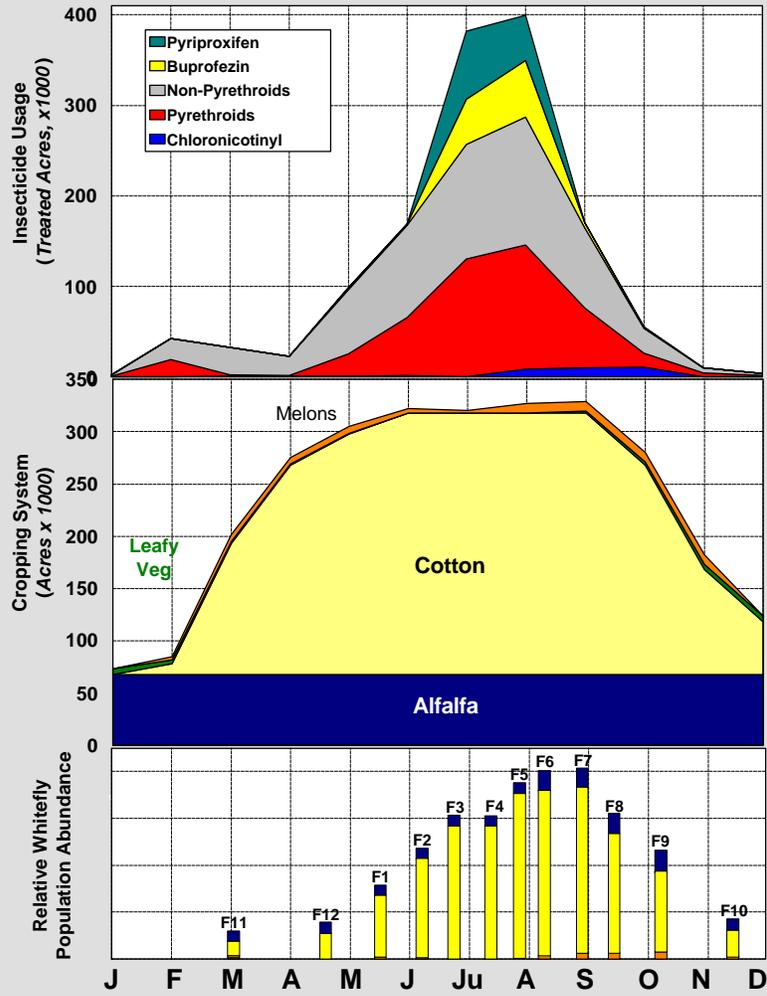


Figure 3.

### Central Arizona- High

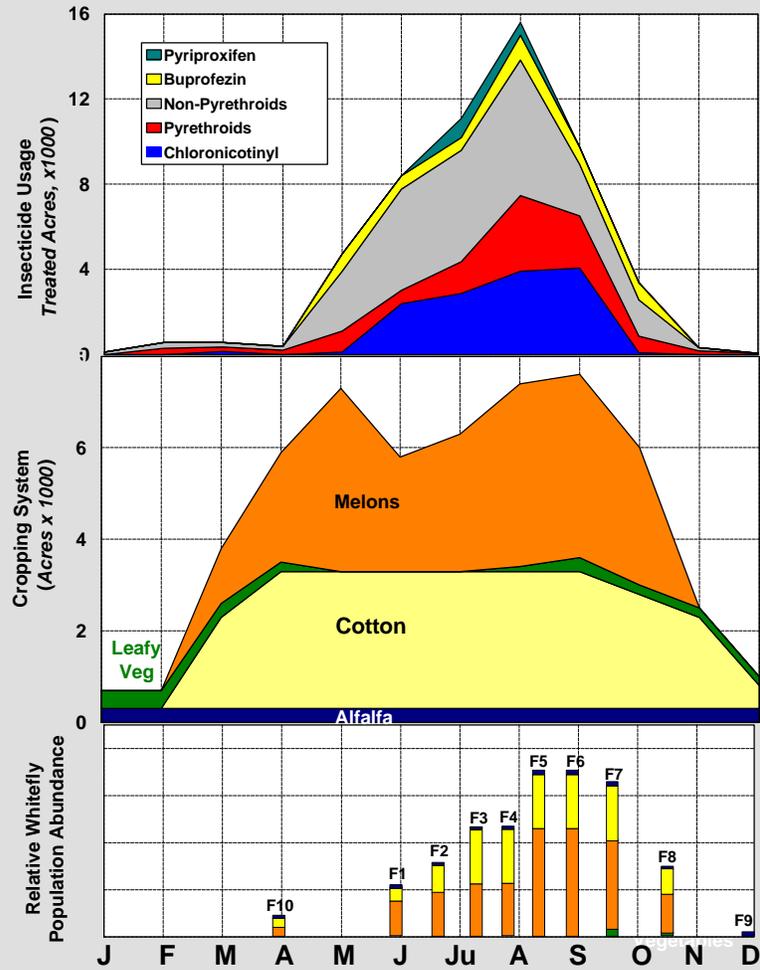
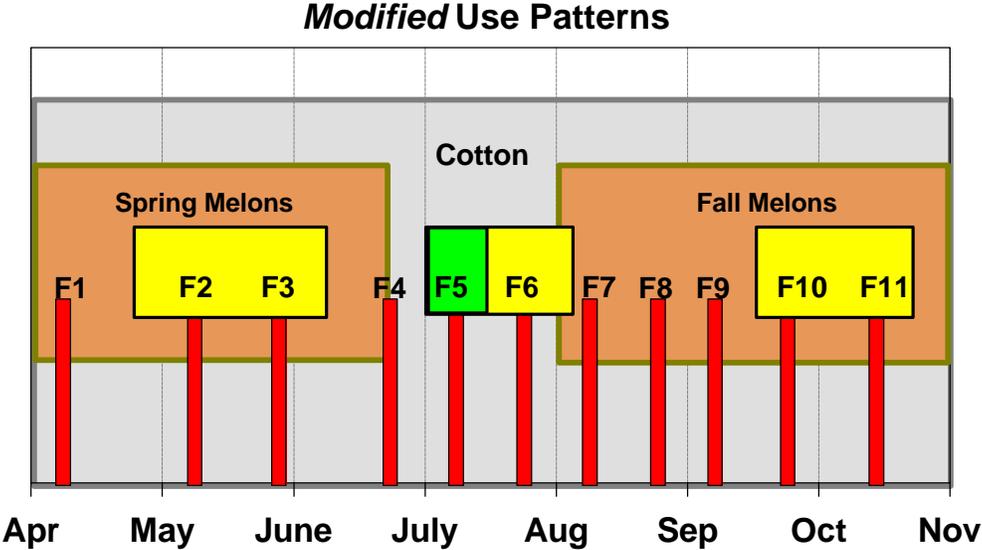
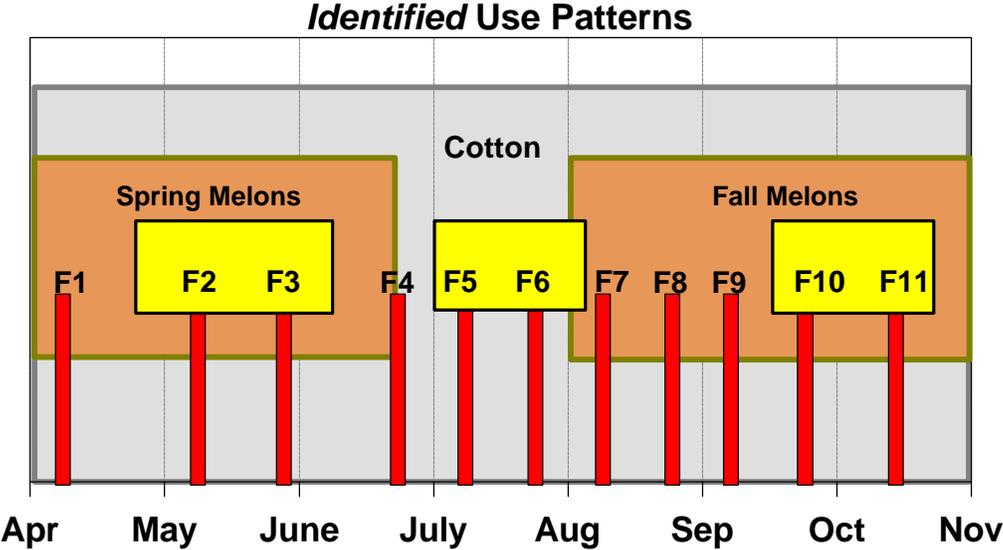


Figure 4. Cross-Commodity Applaud Windows - Yuma



 Use an alternative insecticide for whitefly management

Figure 5. Cross-Commodity Applaud Windows - Central AZ Low

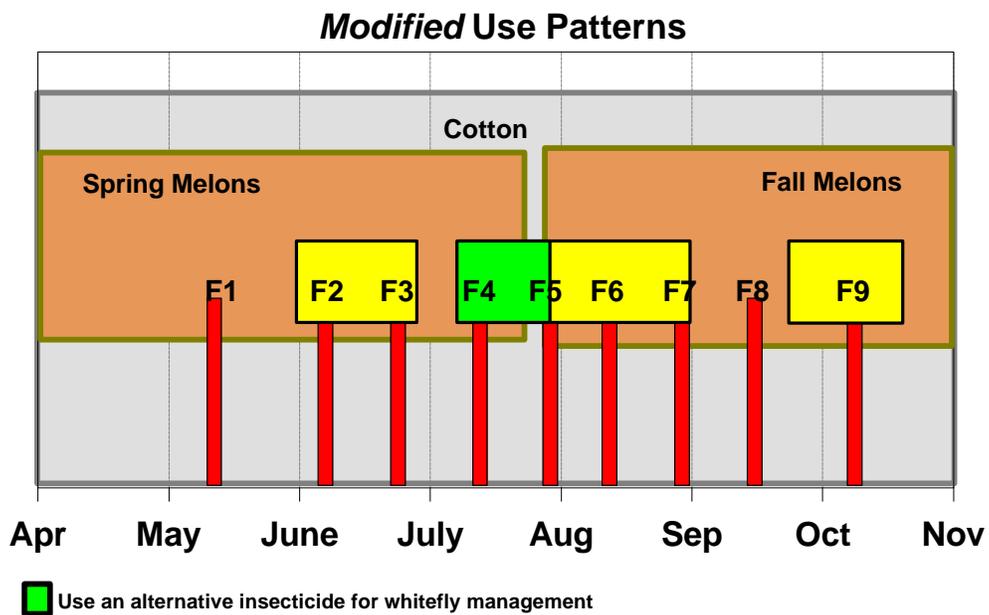
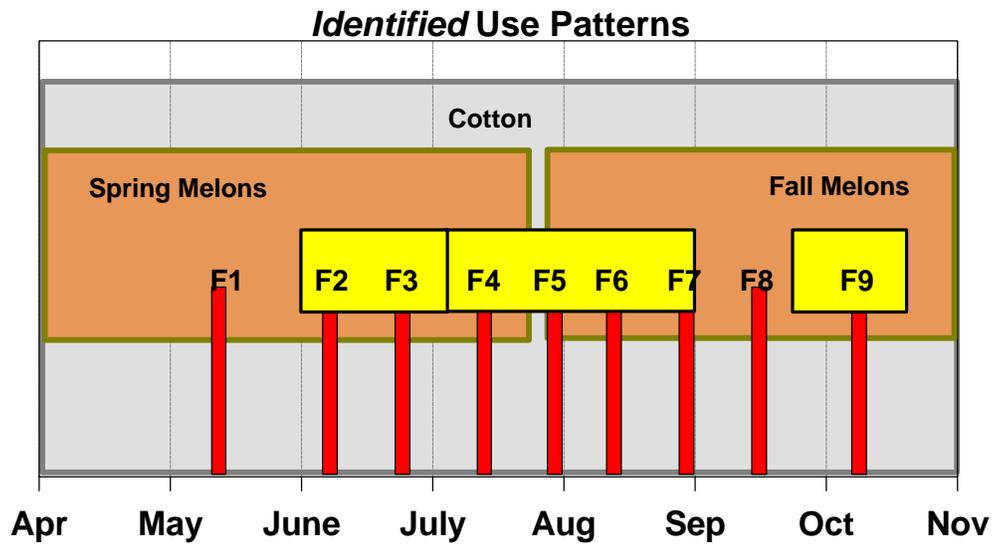


Figure 6. Cross-Commodity Applaud Windows - Central AZ High

