Evaluation of Extension Guidelines for Whitefly Management
IPM Proposal 2005

Project Leaders: Peter C. Ellsworth, Al Fournier, Yves Carriere, John Palumbo
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Location: Yuma, La Paz, Mohave, Maricopa, Pinal, Pima, Graham, Greenlee, and Cochise Counties.

Situation/Critical Issue to be Addressed:
Whitefly (WF, *Bemisia tabaci* Biotype B) is a highly mobile, polyphagous pest of cotton, melons, and vegetable crops with the potential to cause serious economic damage across cropping systems in Arizona. Effective cross-commodity whitefly management guidelines have been developed by University of Arizona Cooperative Extension and disseminated among grower communities. The practices outlined in the guidelines have improved community-wide management of whitefly. Strategic use of selective, environmentally safe, chemistries has helped to maximize natural enemies and other ecological sources of pest mortality, and thereby reduce the need for broad-spectrum insecticides. This has helped stabilize our management systems and reduced the potential for insecticide resistance development.

There is a national need to quantitatively assess adoption of IPM practices and to understand barriers to the adoption of IPM and related cropping practices that minimize risks to human health, the economy, and the environment. There is also an urgent local need to measure community-wide adoption of the Extension whitefly management guidelines in Arizona. Furthermore, there is a need to understand barriers to adoption of the guidelines through stakeholder dialog and to modify Extension efforts and/or the guidelines themselves to enhance grower adoption.

A number of situational factors in Arizona present a unique opportunity to quantitatively evaluate grower adoption of the Extension whitefly management guidelines while simultaneously developing a model for similar multi-system IPM evaluation with national implications for IPM assessment. The availability of a high percentage of agricultural pesticide use data (PUD) in Arizona through 1080 reporting forms and other reporting practices, along with GIS maps and new analytical technologies make it feasible to quantify insecticide use practices across agricultural communities, including those related indicators for adoption of the Extension whitefly management guidelines. The proposed project will provide for ground-truthing of data generated through 1080s, surveys, and other means to dramatically improve the quality of data available for analysis. The analytical approach and technology that will be used to accomplish the objectives of this proposal have been tested in other systems. Carriere et al. have demonstrated how this analytic approach can be used to assess and evaluate the strategic use and placement of non-Bt cotton refuges required by resistance management guidelines enforced through licensing agreements with growers. In addition, we have used these same techniques to provide science-based solutions and interpretation of Lygus movement among multiple crops in central Arizona. This led directly to specific

IPM recommendations that encourage isolation of sensitive crops at specified distances from source crops for this polyphagous pest. The goals of this proposal are consistent with a major focal area of the Arizona Pest Management Center, IPM Assessment, are in-line with regional pest management priorities of stakeholders and with the goals of the National IPM Roadmap to measure advancement of management practices along the IPM continuum.

Outcomes - Impacts:

Short-term:

- Improved knowledge and understanding of community-wide adoption of WF management guidelines, including barriers to adoption.
- Education of growers and other stakeholders about the guidelines and improvement of Extension efforts.
- Increased effectiveness of whitefly management.
- Improved communication between stakeholders and U of A Extension.
- Development and integration of data and technologies to facilitate IPM assessment activities, including WF management guidelines.

Medium-term:

- Data collected will provide input into a PMSP for WF management in AZ and desert SW.
- Development of a better, more responsive approach to IPM guidelines generation, evaluation, and outreach/education.

Long-term:

- Maintenance of effective low-impact chemistries for WF control will reduce broad-spectrum pesticide inputs, preserve natural mortality factors and maintain ecological stability of cropping systems. This will help to ensure good yields and maintain economic and environmental health for growers and the citizens of Arizona. It is likely to reduce human health risks from pests and to minimize adverse effects on the environment from over-use of non-selective pesticides.
- This innovative, spatially-explicit, multi-crop IPM evaluation effort is the next logical step in the progression of IPM assessment. This can serve as a model for similar multi-system IPM assessment efforts in other states and regions, as a means of measuring progression along the IPM continuum, consistent with the goals of the National IPM Roadmap.

Plan for Evaluation:

The impact of these efforts will be evaluated based on the products produced and their short-term impact on Arizona whitefly management, whitefly resistance management, insecticide inputs, and grower/PCA/stakeholder knowledge and understanding of the WF guidelines. Explicitly, the project undertaken here will be evaluating penetration of the cross-commodity management concepts already disseminated over the last two years (Palumbo et al. 2003). The ultimate impact of this project (potentially beyond the one-year term of this funding) will be measured based on the adoption of our model approach to multi-system IPM assessment by other states and regions.

Outputs:

Activities:

- Modification of spatially-explicit analytical techniques previously developed to analyze other entomological datasets (e.g., Carriere et al. 2004a, b; Carriere et al. 2005, in review).
- Data collection and database development.
- Involvement of stake-holders in an ongoing dialog related to this effort will allow us to be more responsive to their needs and to understand real and potential barriers to adoption of the Extension whitefly management guidelines. These efforts will include clinics, meetings, workshops, seminars, newsletters, research reports, Extension bulletins and other written communication, as well as the ACIS website.

Products:

- Improved WF Management guidelines and/or an understanding of the challenges to their adoption.
- Development of a model for multi-system IPM adoption assessment within a spatially-explicit context.

Participation:

Participants in this project will include University Specialists and researchers, Extension personnel (campus, counties and research stations), growers, pest managers, agricultural industrial partners, state and federal regulators. Ultimately, the benefits of this project will serve the citizens of Arizona and the U.S. by maintaining effectiveness of whitefly control across key commodities in the state.

Inputs:

- Time and energy of researchers and technicians for database development, data collection and analysis, and development of analytical framework.
- Time and energy of IPM Program Manager to develop grower/pest manager questionnaire instruments for ground-truthing of data, and to understand factors that affect adoption of the guidelines.
- External funding through a WR-IPM Research and Extension proposal is likely (funding was recommended to national reviewers, 4/05). However, funding caps in this program result in our effort being funded at a lower rate than was initially proposed in a previous proposal (4/04) ($60,000 over 2 years). U of A funds would leverage federal dollars and allow us to scale-up the outreach efforts related to this project.

Estimated Budget: $7,000 for salary support of technicians involved in data collection and database development; salary support for the IPM Program Manager to cover collection and ground-truthing of data; funds to support meeting logistics and publication of revised IPM Extension management guidelines for whitefly control (if needed) or other publications related to this effort.

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EVALUATION OF EXTENSION GUIDELINES FOR WHITEFLY MANAGEMENT – 2005 IPM PROPOSAL

SITUATION	INPUTS	OUTPUTS		OUTCOMES – IMPACT		
		Activities	Participation	Short	Medium	Long Term
Effective Extension cross-commodity whitefly (WF) management guidelines have been developed and disseminated among grower communities. The practices outlined in the guidelines have improved community-wide control of this important polyphagous pest through strategic use of selective chemistries that help maximize natural enemies and reduce broad-spectrum insecticide inputs while minimizing the potential for insecticide resistance development to maintain the efficacy of these important management tools. There is a national need to quantitatively assess adoption of IPM practices and an urgent local need to measure community-wide adoption of the WF management guidelines in Arizona. Furthermore, there is a need to understand barriers to adoption and to modify Extension efforts and/or the guidelines themselves to enhance adoption. Availability of agricultural pesticide use data, along with GIS maps and analytical technologies make it feasible to quantify pesticide use practices across agricultural communities, including adoption of the WF management guidelines. The analytical approach and technology proposed to accomplish the objectives of this proposal have been tested in other systems (e.g., Carriere et al. 2004a, b; Carriere et al. 2005, in review). The goals of this proposal are consistent with a major focal area of the Arizona Pest Management Center, IPM Assessment, and are in-line with regional pest management priorities of stakeholders and with the goals of the National IPM Roadmap to measure advancement of management practices along the IPM continuum.	Time and energy of researchers and technicians for database development, data collection and analysis, and development of analytical framework. Time and energy of IPM Program Manager to develop grower/pest manager questionnaire instruments and interviews for ground-truthing of data, and understanding factors that affect adoption of the guidelines. Funds to contribute to salary support for research technicians, and IPM Program Manager. **External funding** through a WR-IPM Research and Extension proposal is likely (funding was recommended to national reviewers, 4/05). Efforts exceed the potential budget ($60,000 over 2 years) due to institutional caps on awards ($60,000 over 2 years). U of A funds would leverage federal dollars and allow us to scale-up the outreach efforts related to this project.	Modification of spatially-explicit analytical techniques previously developed to analyze other pest management datasets (e.g., Carriere et al. 2004a, b; Carriere et al. 2005). Data collection and database development. Involvement of stake-holders in an ongoing dialog related to this effort will allow us to be more responsive to their needs and to understand real and potential barriers to adoption of WF guidelines. These efforts will include clinics, meetings, interviews, workshops, seminars, newsletters, research reports, Extension bulletins and other written communication, including the ACIS website. **Products:** improved WF Management guidelines and/or an understanding of challenges to adoption. Development of a model for multi-system IPM adoption assessment within spatial contexts.	Participants in this project will include University Specialists and researchers, Extension personnel (campus, counties and research stations), growers, pest managers, agricultural industrial partners, state and federal regulators. Ultimately, the benefits of this project will serve the citizens of Arizona and the U.S. by maintaining effectiveness of whitefly management across key commodities in the state.	Improved knowledge and understanding of community-wide adoption of WF management guidelines, including barriers to adoption. Education of growers and other stakeholders about the guidelines and improvement of Extension efforts. Increased effectiveness of whitefly control. Improved communication among stakeholders. Development and integration of data and technologies to facilitate IPM assessment activities, including WF management guidelines.	Data collected will provide input into PMSP for WF management in AZ and desert SW. Develop better, more responsive approach to IPM guidelines generation, evaluation, and outreach / education.	Maintenance of effective low-impact chemistries for WF control will reduce broad-spectrum insecticide inputs, preserve natural mortality factors and maintain ecological stability of cropping systems. This will help to ensure good yields and maintain economic and environmental health for growers and the citizens of Arizona. It is likely to reduce human health risks from pests and minimize adverse effects on the environment from over-use of non-selective pesticides. This innovative multi-crop IPM evaluation effort is the next logical step in the progression of IPM assessment. This can serve as a model for similar multi-system IPM assessment efforts in other states and regions, as a means of measuring progression along the IPM continuum, consistent with the goals of the National IPM Roadmap.

THE UNIVERSITY OF ARIZONA
Cooperative Extension
IPM Series No. 17
cals.arizona.edu/pubs/insects/az1319.pdf
AZ1319 – 5/2003

Cross-commodity Guidelines for Neonicotinoid Insecticides in Arizona

SUMMARY

Arizona enjoys a sustained recovery from the devastating whitefly outbreaks of the early 1990's. This success is built on an IPM strategy that includes the use of selective and effective chemistry. Admire® has been a key soil insecticide protecting vegetables and produce throughout Arizona and is the first member of a burgeoning class of chemistry known as the neonicotinoids. New members of this valuable, reduced-risk, class of chemistry are now available to agricultural producers, placing a burden on users of these compounds to adopt science-based plans for sustaining their efficacy. This consensus document represents our best efforts to share this chemistry among different agricultural interests. Our goal is to preserve the long-term efficacy of the neonicotinoids and protect growers' interests in sustainable and economical whitefly management. Through identification of crop communities (i.e., 'multi-crop', 'cotton-intensive', and 'cotton / melon') common to Arizona agriculture, we have designed sensible plans of use that should allow access to this valuable chemistry for everyone, while protecting it from resistance.

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Developed in collaboration with and endorsed by

Arizona Crop Protection Association
Arizona Cotton Growers Association
Cotton Incorporated
Western Growers Association

Neonicotinoids & Whitefly Management

During the past decade, the silverleaf whitefly (*Bemisa tabaci*, Biotype B) has been relegated to a managed pest in Arizona. This was achieved through the development, adoption and implementation of management programs in a partnership between the University and growers. Growers are quick to adopt new guidelines that have been developed in response to pest crises and other significant events.

Our Goal: Given the tremendous value of this insecticide class to all parties involved, secure the long-term efficacy of the neonicotinoids and protect growers' interests in sustainable and economical whitefly management.

The recent registration of several new neonicotinoid compounds on cotton, melons and vegetables has expanded the number of compounds available for whitefly control on these crops. Admire® (imidacloprid), the first compound registered within this class of chemistry, has been used effectively in melons and vegetables for whitefly and aphid control since 1993. The sustained efficacy of Admire over the past 10 years exceeds the expectations of many who speculated that whiteflies would quickly evolve resistance. However, no field failures have been reported so far, in part perhaps, because imidacloprid has been used sparingly in cotton and other summer crops. The recent registration of new members of this class of chemistry, Intruder® (acetamiprid) and Centric® (thiamethoxam), may lead to much greater use of this class in cotton against whiteflies. If not used judiciously, successive whitefly generations could be exposed to several neonicotinoid compounds on a variety of different crops throughout the year. Such a scenario places increased selection pressure on exposed whitefly populations and thereby increases the risk of resistance.

All interested parties including agrochemical industry, University researchers, growers, and pest control advisors (PCAs) have worked together to outline below some common-sense guidelines that take into account the use patterns of neonicotinoids for whitefly control and the cropping communities in which they will be used.

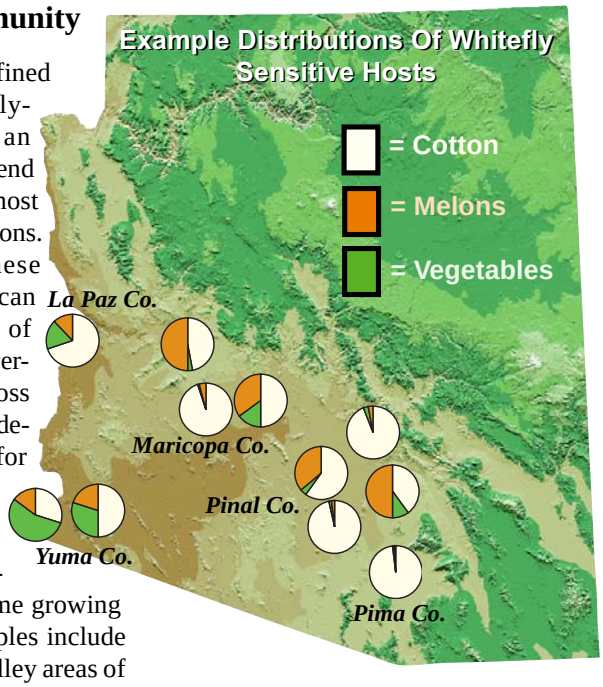
The objective of these guidelines is to optimize frequency of insecticide use (e.g., number of applications / season or year) to avoid sequential exposure of multiple generations of whiteflies across commodities. Ideally, these strategies will enhance whitefly management and maximize the longevity of all compounds used for their control. We recognize in certain situations these management practices may be difficult to implement and even occasionally run counter to strictly short-term interests; however, more disciplined use will now be necessary to accommodate new products and contribute to long-term sustainability of the neonicotinoid chemistry on desert crops.

Suggested Minimum Rates & Crop Uses for Neonicotinoid Insecticides Registered in AZ

Active Ingredient	Product Name	Type of Application	Minimum Rate	Control Interval	Registered Crops
acetamiprid	Intruder	Foliar	2 oz	14–28 d	Cotton
imidacloprid	Admire	Soil	16–20 oz	45–60 d	Melons, Lettuce, Cole
imidacloprid	Provado	Foliar	3.75 oz	7–10 d	Lettuce, Cole (aphids)
thiamethoxam	Actara	Foliar	4 oz	7–14 d	Lettuce, Cole
thiamethoxam	Centric	Foliar	2 oz	7–14 d	Cotton
thiamethoxam	Platinum	Soil	8 oz	45–60 d	Melons, Lettuce, Cole

Defining a Crop Community

A crop community can be defined by its production of whitefly-sensitive host-crops over an annual cycle. Whiteflies depend on this annual sequence of host plants to survive over generations. Sequential exposure of these generations to insecticides can accelerate the development of resistance. Because of the diversity of systems and needs across the state, there are specific guidelines for neonicotinoid use for each crop community:



- ***Multi-Crop Community.*** A diversity of whitefly host-crops is grown within the same growing area or location. Good examples include the Yuma, Gila, and Dome Valley areas of Yuma County, where cotton, melons, cole crops, lettuce, and other vegetable crops are grown within 2 miles of each other during the course of a year.

- ***Cotton / Melon Cropping Community.*** Cotton and melons are grown within 2 miles of each other during the course of a year. Examples include areas within western Maricopa and Pinal Counties.

- ***Cotton-Intensive Community.*** Cotton is the dominant whitefly host-crop grown during the course of a year. An example of this community would be areas such as the Buckeye Valley and Pima County.

Neonicotinoid Use Guidelines for Each Crop Community

These guidelines balance the immediate need for pest control with the long-term need to conserve effective chemistry. Not all guidelines are popular, but do represent our best attempts at advising grower usage of this valuable chemical class. Benefits are maximized for everyone, just like in whitefly management currently, if everyone adopts these guidelines together.

Cotton-Intensive Community: These guidelines apply to crop communities in central Arizona (e.g., Buckeye, Marana) or wherever cotton production is isolated from both melons and vegetables. The insect growth regulators (IGRs; Knack® and Courier®), non-pyrethroids, and pyrethroid combinations have usually been used for whitefly management in these areas.

- No more than two neonicotinoid uses per cotton crop [soil, foliar or seed (e.g., Gaucho® or Cruiser®) treatment].

- Foliar neonicotinoid sprays should usually be used in Stage II of the Arizona Whitefly IPM Program (following a Stage I, IGR application; Ellsworth et al. 1996) to maximize the IGR chemical and biological residual, which provides economic benefits in controlling whiteflies long-term while suppressing other pest insects.

- Sprays should not to be applied consecutively, but rotated with alternate chemistries (other Stage II non-pyrethroid combinations, or Stage III pyrethroid combinations).

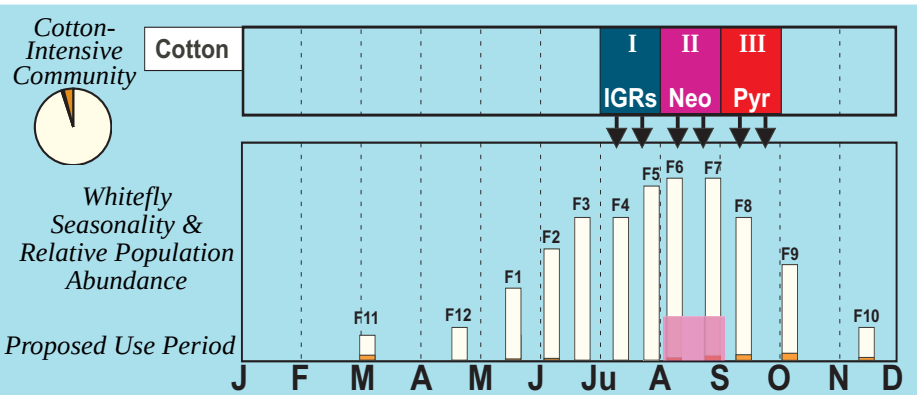
- Under conditions where a July (or earlier) use of an IGR is not required (i.e., due to low and late pressure), a neonicotinoid (Stage II) may be used prior to or instead of an IGR.

- When thresholds are reached in July (or earlier), a Stage I IGR should be used, followed by Stage II non-pyrethroids (including neonicotinoids), and Stage III pyrethroid combinations, if necessary.

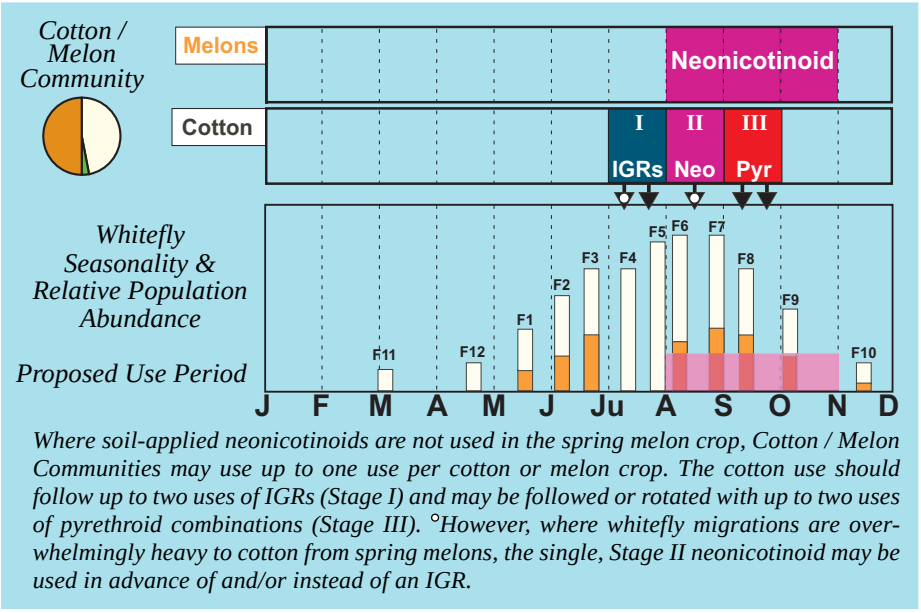
Cotton / Melon Community: The following recommendations apply for crop communities in central Arizona (e.g., Aguila, Harquahala, Waddell / Litchfield and parts of Pinal County) or wherever melon crops coincide with cotton production (i.e., within 2 miles of each other). These guidelines specifically apply to communities where soil applied neonicotinoids (Admire or Platinum®) are not used on spring melons, but are used on fall melons. IGRs and conventional combinations are used in cotton.

Melons:

- Use a foliar neonicotinoid spray no more than once in spring melons, if



A new use period for neonicotinoids (in Stage II) is proposed for Cotton-Intensive Communities, where up to two, non-consecutive foliar uses are permitted per cotton season. These uses should follow up to two uses of IGRs (Stage I) and may be followed or rotated with up to two uses of pyrethroid combinations (Stage III).



Where soil-applied neonicotinoids are not used in the spring melon crop, Cotton / Melon Communities may use up to one use per cotton or melon crop. The cotton use should follow up to two uses of IGRs (Stage I) and may be followed or rotated with up to two uses of pyrethroid combinations (Stage III). °However, where whitefly migrations are overwhelmingly heavy to cotton from spring melons, the single, Stage II neonicotinoid may be used in advance of and/or instead of an IGR.

allowable. Alternate between Courier (8 oz / A; buprofezin) and a pyrethroid (Capture® @ 6 oz / A or Danitol® @ 10 oz / A) plus endosulfan (1 qt / A), if necessary.

- Do not apply a foliar neonicotinoid spray on fall melons following the use of a soil application of Admire (imidacloprid) or Platinum (thiamethoxam).

Cotton:

- No more than one neonicotinoid use per cotton crop (soil, foliar or seed treatment).
- Foliar neonicotinoid sprays should be used only in Stage II of the Arizona Whitefly IPM Program (i.e., following an IGR application; but see next paragraph) to maximize the biological benefits and chemical residual of the IGRs and minimize the number of whitefly generations potentially exposed to neonicotinoids. This use will often completely or mostly overlap with fall melon uses of a soil neonicotinoid, and thus minimize resistance risks.
- Migrations of whiteflies out of nearby spring melons present unusual problems for cotton growers. For cotton near melons not using a soil neonicotinoid, one foliar neonicotinoid may be used early in cotton (i.e., June or early July) to provide effective control of adults. In these cases, a Stage I, IGR may follow the single use of a foliar neonicotinoid (Stage II). Furthermore, if Courier (buprofezin) or pyrethroid mixtures with endosulfan are used in the spring melons, the first spray in cotton should be either Knack (Stage I, IGR) or, if adult levels are overwhelming, a foliar neonicotinoid (Stage II, non-pyrethroids).

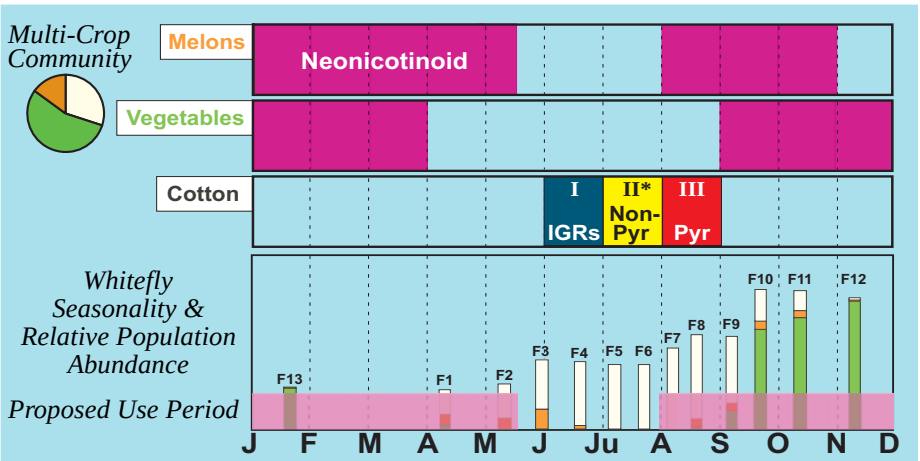
Multi-Crop Community: These guidelines apply to multi-crop communities similar to Yuma Valley where Admire (imidacloprid) has been the primary insecticide used for whitefly management on vegetables and melons, and whitefly insect growth regulators (IGRs), non-pyrethroids*, and pyrethroid combinations have been used in cotton.

Cotton:

- Do not apply any neonicotinoid product to cotton (Centric, Intruder, Provado®, or Leverage®).

Melons & Vegetables:

- Not more than one neonicotinoid use (soil or foliar) per crop. Soil at-planting uses are recommended for fall vegetables and all melon crops. Split applications are not recommended.
- Do not apply a foliar neonicotinoid spray following the use of a soil application of Admire (imidacloprid) or Platinum (thiamethoxam).
- As long as other effective active ingredients are available (i.e., endosulfan, Orthene®, Capture, Fulfill®, dimethoate, Metasystox-R®), do not apply more than one foliar neonicotinoid spray per crop for aphid control on spring lettuce and cole crops planted in the absence of Admire or Platinum.
- Neonicotinoids (soil or foliar) should not be applied in Yuma County after April 1 or before August 1.
- For less susceptible fall planted lettuce crops (e.g., October planting window in Yuma Valley where the crop is planted after whitefly movement subsides and is harvested before aphids typically become abundant), consider using non-neonicotinoid alternatives for whitefly and aphid control.



A new use period for neonicotinoids is proposed for Multi-Crop Communities, where only one soil or foliar use is permitted per melon or vegetable crop, and no uses in cotton.

Don't Forget the Fundamentals

Never forget the fundamentals of pest management. When control of pests requires chemicals, selection pressure is inevitable. As a result, every effort should be made to limit the use of all whitefly chemistry by making use of proven guidelines for whitefly management. This approach saves money, protects our environment, and reduces risks of resistance.

Avoid Problems Through Cultural Controls

- Actively invest in crop sanitation, crop sequence, and crop placement tactics.
- Maintain crop health and adequate plant-water relations.
- Promptly remove all post-harvest residues in all crops.

Scouting, Sampling and Detection

- Use research-based sampling procedures and action thresholds.
- Apply insecticides only when necessary.

Ensure Effective Chemical Use

- No more than 2 uses of any compound (i.e., active ingredient) per season.
- No more than 2 uses of the pyrethroid chemical class per crop season.
- No more than 2 uses of the neonicotinoid chemical class per year within a cropping region.
- No more than 1 use each of buprofezin and pyriproxyfen (IGRs) per season.
- Apply insecticides by directed ground sprays to optimize spray deposition whenever possible.
- Do not apply insecticides below labeled or recommended rates. Application of sub-lethal rates of any insecticide may result in poor product performance, insect damage, and an increased risk of resistance.
- Use only recommended neonicotinoid products and rates necessary to accomplish desired control.

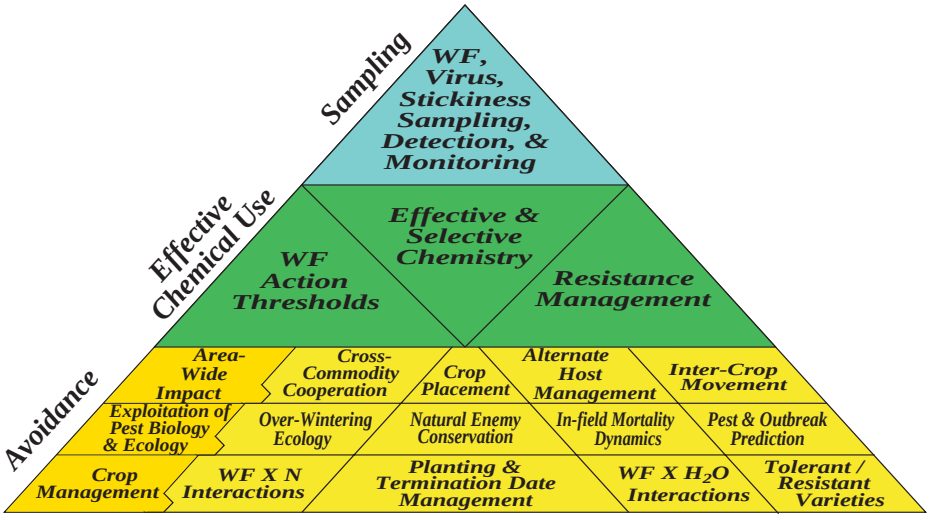
***Summary Guidelines**: Maximum number of uses per crop season for neonicotinoids in three different cropping communities.*

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

**Soil only; **Soil or Foliar*

Sensible Limits

Guidelines for the sensible limits on a valuable new class of chemistry, the neonicotinoids, are provided for three different crop communities that exist in Arizona. These guidelines are flexible and allow grower access to this effective group of insecticides, while providing prudent measures for preserving their efficacy indefinitely. With areawide adoption of these guidelines, growers should have even more options for pest control while minimizing the risks of resistance. Each cropping community, as defined by the proximity and diversity of crops grown within 2 miles of each other, has access to up to two uses of the neonicotinoid class per year. These voluntary limits should provide for at least 4 generations of whiteflies annually that are not exposed to the neonicotinoid class. Through areawide implementation of this refugia strategy, whiteflies may remain susceptible to the neonicotinoid class for the forseeable future. This will pay dividends to growers of all crops in Arizona for many years to come.



Whitefly managemant can be viewed conceptually as a pyramid-like structure of sampling and effective chemical use built upon a solid foundation of avoidance practices. Important among these avoidance practices is the element of areawide impact, which depends, in part, on cross-commodity cooperation in efforts such as resistance management.

Reference

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This and other documents of interest relating to crop production / protection are available on the Arizona Crop Information Site at *http://cals.arizona.edu/crops*

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