Novel Measurement of Group Adoption of IPM in Diverse Cropping Communities

Peter C. Ellsworth[1], John C. Palumbo[2], Al Fournier[1], Yves Carrière[3] & Christa Ellers-Kirk[3]

University of Arizona, Department of Entomology & Arizona Pest Management Center,

[1]Maricopa, AZ, [2]Yuma, AZ, [3]Tucson, AZ

Rationale

As Extension scientists, we are accountable for ensuring that our science-based IPM recommendations are effective, practical, and economically feasible for growers to adopt. If growers fail to adopt IPM practices, then why not? Their answers help us evaluate and modify our approach.

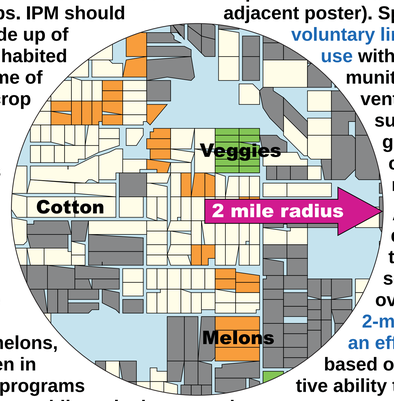
Evaluation of federally funded IPM programs is mandated by the National IPM Roadmap. In addition to providing effective pest control, IPM programs are expected to result in measurable reductions in economic, health, and environmental risks.

This innovative project:

- Evaluates adoption of unique IPM guidelines that transcend individual fields to account for the spatial distribution of crops in an area;
- Quantitatively assesses group adoption of IPM practices by growers in a multi-crop system;
- Uses emerging spatial analysis tools;
- Relies on stakeholder input to improve IPM research, education, and practice.

Scale

Ideally, IPM principles should be applied beyond the level of individual pests, fields and crops. IPM should span landscapes made up of multiple crops and inhabited by various pests, some of which migrate from crop to crop.



Arizona's low desert production system is our target for the development and implementation of such "higher-level" IPM programs. Because we produce multiple crops year-round (e.g., cotton, melons, vegetables, etc.), often in close proximity, IPM programs here are challenged by mobile, polyphagous, multivoltine pest species, such as the silverleaf whitefly (*Bemisia tabaci* Genn. [Biotype B] = *B. argentifolii* Bellows & Perring).

Arizona IPM guidelines for whitefly management (Palumbo et al. 2003) are based on cross-commodity interactions and ultimately, unprecedented cooperation in pest and resistance management (see adjacent poster). Specifically, they place voluntary limits on neonicotinoid use within diverse crop communities in order to prevent continuous exposure of whitefly generations across crops (table, lower right).

A crop community is defined by its production of whitefly-sensitive host crops over an annual cycle. A 2-mile radius represents an effective "community," based on the whitefly's putative ability to migrate and reproduce among crops.

Three main cropping communities can be found in Arizona (see map below):

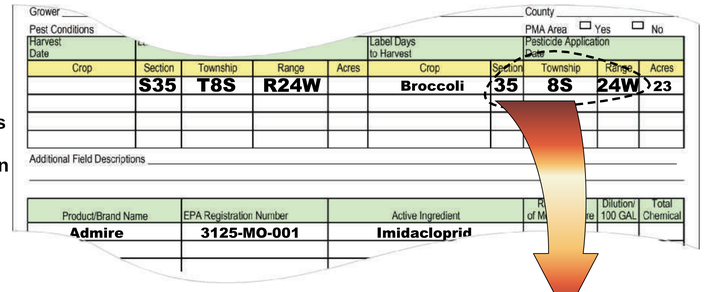
- Cotton-Intensive (CI);
- Cotton / Melon (CM); and
- Multi-Crop (MC), with cotton, melons & vegetables grown in close proximity.

Approach

Data needed to quantify group adoption of the IPM guidelines will be extracted from an Arizona Department of Agriculture database. The state requires pest managers (PCAs) & applicators to submit written prescriptions for each custom application of pesticides (Form L-1080, see example at right). The L-1080 form includes:

- Chemical applied;
- Target crop;
- Pest being treated;
- T.R.S. (Township, Range, and Section), a geographic reference that can be linked to GIS maps.

Because the spatial scale of relevance transcends individual fields, it is impossible to assess adoption of these guidelines (Palumbo et al. 2003) based on individually reported grower activities. The analysis must consider the set of all practices by multiple pest managers within crop communities.



Grower _____ County _____

Pest Conditions PMA Area ☐ Yes ☐ No

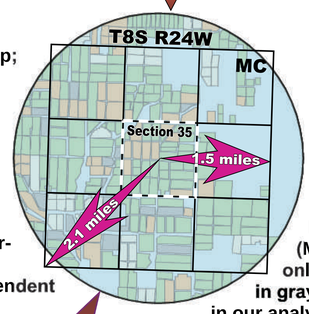
Harvest Date					Label Days to Harvest		Pesticide Application Date		
Crop	Section	Township	Range	Acres	Crop	Section	Township	Range	Acres
	S35	T8S	R24W		Broccoli	35	8S	24W	23

Additional Field Descriptions _____

Product/Brand Name	EPA Registration Number	Active Ingredient	R of M	re	Dilution/ 100 GAL	Total Chemical
Admire	3125-MO-001	Imidacloprid				

Our approach includes:

- Cotton fields geo-referenced in a GIS map;
- Melon & vegetable crops, including field locations and pesticide applications, derived from 1080 dataset and reports from field personnel;
- Pesticide use data overlaid on GIS maps, enabling spatially-dependent hypothesis testing;

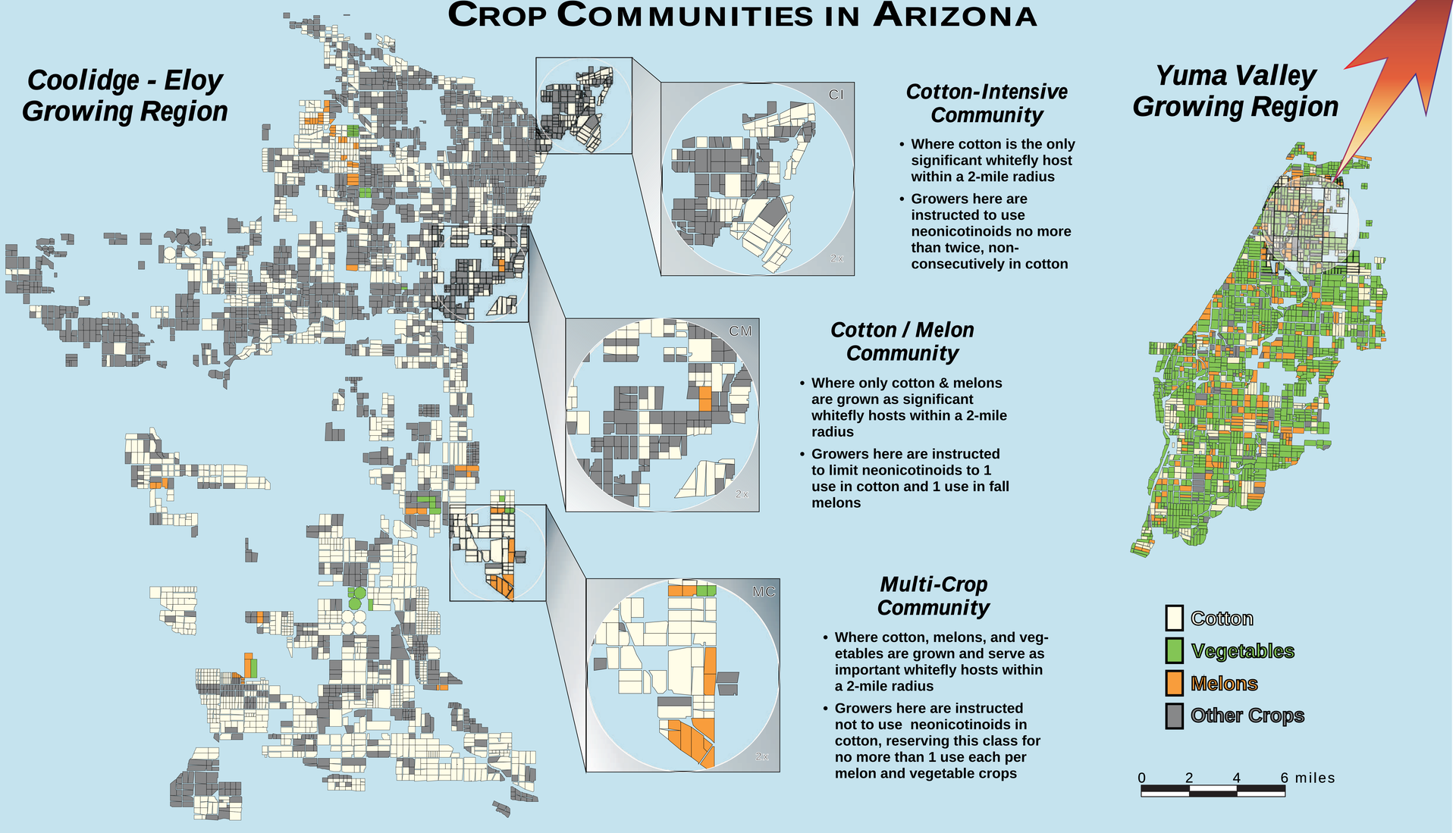


- Each section (from T.R.S. on 1080 form) = 1-mile square, made up of an average of 8–10 cultivated fields;
- "Community" approximated by the focal section surrounded by 8 adjacent sections, taken together;
- Geo-referenced 9-section cluster (9 sq. miles) approximately equivalent to 2-mile radius (12.6 sq. miles) definition of a community provided in the guidelines.

Based on 1080 data, each 9-section community will be labeled as Cotton-Intensive (CI), Cotton / Melon (CM), or Multi-Crop (MC). Areas containing only non-host crops (shown in gray) will not be considered in our analyses.

To assess adoption of the IPM guidelines in a given year, a large number of sections will be sampled randomly from GIS maps in each region of interest (e.g., Yuma Valley or Coolidge-Eloy region; see maps at left).

Crop Communities in Arizona



Cotton-Intensive Community

- Where cotton is the only significant whitefly host within a 2-mile radius
- Growers here are instructed to use neonicotinoids no more than twice, non-consecutively in cotton

Cotton / Melon Community

- Where only cotton & melons are grown as significant whitefly hosts within a 2-mile radius
- Growers here are instructed to limit neonicotinoids to 1 use in cotton and 1 use in fall melons

Multi-Crop Community

- Where cotton, melons, and vegetables are grown and serve as important whitefly hosts within a 2-mile radius
- Growers here are instructed not to use neonicotinoids in cotton, reserving this class for no more than 1 use each per melon and vegetable crops

Hypotheses

We will evaluate compliance with certain IPM recommendations from Palumbo et al. (2003). Comparisons between levels of compliance will be made within communities (e.g., neonicotinoid use in specific crops among subregions within a large Multi-Crop Community), among communities (e.g., neonicotinoid use in cotton fields among Cotton-Intensive, Cotton / Melon, and Multi-Crop Communities), or across time (e.g., neonicotinoid use in cotton in specific regions before and after the occurrence of an event hypothesized to impact use of neonicotinoids, such as the introduction of a new compound).

Neonicotinoid* Limitations:
Maximum usage by crop per season

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

**Seed, Soil or Foliar*

These comparisons will be designed to test specific hypotheses about the impact of economic, educational, historical, temporal, and geographical factors on compliance with IPM recommendations. For example, we expect that neonicotinoid use in cotton fields should vary by community as follows: CI (2 uses) > CM (1 use) > MC (0 uses). Thus, we will test the hypothesis that compliance within these communities has changed significantly through time. Moreover, we will assess whether the occurrence of a specific event (e.g., issuance of an educational bulletin) was associated with the pattern of change in compliance within each community. Such assessments could be used to infer the role of specific events in impacting compliance to the IPM requirements.

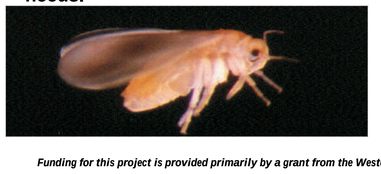
Engagement

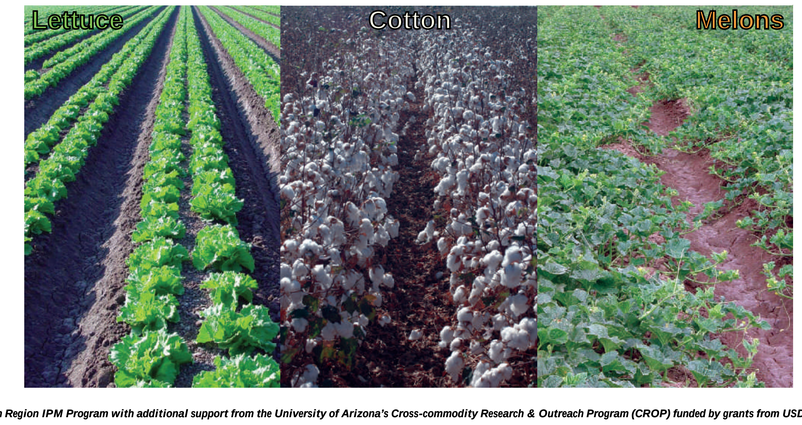
Information from the quantitative evaluation of adoption of the IPM guidelines will be used as the basis for qualitative research with growers designed to identify system-specific barriers to adoption.

For example, if compliance to the neonicotinoid use recommendations is shown to be much lower in mixed-crop communities than in other community types, interviews with growers may reveal constraints, pest issues, economic considerations, etc., that may not have been apparent to specialists and stakeholders at the time the guidelines were formulated.

Based on what we learn, we will engage growers in additional dialog to help us:

- Improve extension education efforts by addressing any lack of knowledge or understanding of the guidelines;
- Guide additional research by identifying needs, where existing products or recommendations fail to address pest management concerns; and
- Revise the guidelines themselves especially where they are not practical and/or fail to meet adopter's specific needs.





Convergence

Availability of the 1080 data and GIS maps, as well as Arizona's unique cross-commodity IPM program, provide a rare opportunity to evaluate IPM, its adoption and implementation, to a level that spans multiple crops and pests over entire agroecosystems.

Our goal is to improve the scientific quality and practicality of the IPM Guidelines, based on quantitative evaluation data and grower input. Ultimately, this is expected to result in increased IPM adoption across crops and improved area-wide pest management and resistance management.

This effort is part of an ongoing feedback-loop through which the IPM guidelines were formulated, communicated to growers, and now are being evaluated and revised.

Ultimately, we hope that our methodology will serve as a model for quantitative evaluation of IPM and stakeholder engagement as outlined in the IPM Roadmap.

Reference

Palumbo, J.C., P.C. Ellsworth, T.J. Dennehy, R.L. Nichols. 2003. Cross-commodity Guidelines for Neonicotinoid Insecticides in Arizona. IPM Series No. 17. Publ. No. AZ1319. University of Arizona, College of Agriculture and Life Sciences, Cooperative Extension, Tucson, Arizona. URL: *http://cals.arizona.edu/pubs/insects/az1319.pdf*

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