WERA-60 State Reports Submitted in 2010 by members of WERA-60: Arizona, New Jersey, Georgia and Michigan.

Arizona

WERA-060: Resistance
Arizona: Annual Resistance Status Report
November 8, 2010
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&
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Statewide Whitefly (Bemisia tabaci) Resistance Monitoring Program

Statewide monitoring of whitefly resistance to pypriproxyfen, buprofezin, neonicotinoids, spiromesifen and synergized pyrethroids has been conducted in Arizona for over a decade. Work previously done in Dr. Tim Dennehy's lab is now being carried on by Dr. Xianchun Li.
Findings: Field populations of B biotype whitefly are still susceptible to buprofezin and spiromesifen, but have developed medium to high levels of resistance pyriproxyfen and synergised pyrethroids. . Both cytochrome P450 monooxygenases (P450) and glutathione Stransferases
(GST) are involved in whitefly resistance to pyriproxyfen. We have also detected
low to medium levels of neonicotinoid resistance in whitefly populations collected from melon fields since last year. All these resistant populations are susceptible to novel chemistries including rynaxypyr, cyazypyr, spirotetramat, and pyrifluquinazon, based on current research.

We have also monitored the resistance of Q biotype whitefly populations collected from ornamentals. All Q populations we have tested are resistant to the insecticides currently used for control of the B biotype whiteflies.

We conducted a 4-year study of pyriproxyfen resistance dynamics relative to field performance. Ellsworth & Dennehy showed that despite the moderate resistance levels measurable in whitefly populations, Knack performance in the field remained very high and unchanged from levels measured during this product's introduction to Arizona cotton (1996–1999). Several factors are likely at play, but "bioresidual" as suggested by Ellsworth and Naranjo (see Ellsworth & Martinez-Carrillo 2001; Naranjo, 2001; Naranjo & Ellsworth 2009a,b) plays an important role in overcoming, mitigating or otherwise masking resistance effects on field performance.

We have also examined long-term trends in field performance of soil applied imidacloprid in the control of whiteflies in lettuce and broccoli. Palumbo has shown that despite rather modest reductions in susceptibility in lab bioassays, field performance of Admire (and similar products) is at about 50% of what was possible 15 years ago. Furthermore, Palumbo has measured pest manager behaviors and found a high degree of foliar oversprays for whitefly control that were once not required after soil applications of Admire. These effects are most prominent in the fall crop when whitefly pressure is highest and spray intensities are very high in melons, especially, because of the need to prevent virus transmission.

Suppressing Resistance to Bt Cotton with Sterile Insect Releases (pink bollworm)
(Tabashnik et al., in press) (Tabashnik et al., in press)

Transgenic Bacillus thuringiensis (Bt) crops are grown widely for pest control, but insect adaptation can reduce their efficacy. The predominant strategy for delaying pest resistance to Bt crops requires refuges of non-Bt host plants to provide susceptible insects to mate with resistant insects, yet this approach has limitations including variable farmer compliance. Here we report the benefits of an alternative strategy where sterile insects are released to mate with resistant insects and refuges are scarce or absent. Computer simulations show that this strategy works in principle against pests with recessive or dominant inheritance of resistance. In a large-scale, four-year field deployment of this strategy in Arizona, pink bollworm (Pectinophora gossypiella) resistance to Bt cotton did not increase. A multi-tactic eradication program incorporating this strategy reduced pink bollworm abundance by more than 99% while eliminating insecticide sprays against this key invasive pest.

In Arizona, monitoring of pink bollworm field populations showed no net decrease in susceptibility to Cry1Ac from 1997 to 2005, when the non-Bt cotton refuge percentage was >25% every year, or from 2006 to 2009, when sterile insects were released and the mean refuge percentage was 7.3%. DNA screening for the three known cadherin mutations linked with pink bollworm resistance to Cry1Ac detected no resistant alleles during 2006 to 2009 (n = 2499). Based on larval survival on diet treated with Cry1Ac, bioassays detected a single resistant individual in 2006 (n = 3822), but no resistant individuals were found in 2007 or 2008. Bioassays also detected no larvae resistant to Cry2Ab in 2007 or 2008 (n = 2572). In 2009, this pest was so scarce in Arizona that we could not collect enough individuals to conduct bioassays.

Revising Cross-Commodity Guidelines & Other Educational Efforts

We are engaged in a Pest Management Alternatives Program (PMAP) grant (Li, Palumbo, Ellsworth & Fournier) to evaluate resistance management concerns for whitefly chemical controls across multiple crops. We are conducting research on cross-resistance dynamics (lab efficacy trials), statewide resistance monitoring, field measurement of product performance, chemical rotations, and impact on non-target organisms, pesticide use trends analyses and stakeholder acceptance of new chemical use guidelines. As part of this project, we are revising cross-commodity IPM guidelines for whitefly control. Impact: The anticipated impact is promotion of statewide adoption of cross-commodity pesticide use practices that will help sustain important chemical tools for whitefly management across key crops in Arizona.

In cooperation with the Arizona Crop Protection Association (AzCPA) and the Arizona Department of Agriculture, we revised and expanded an out-of-date training manual to support state licensing of Pest Control Advisors (PCAs). This project involved nearly 20 University of Arizona faculty, industry partners and PCA reviewers. The authors take an integrated crop management / integrated pest management approach. The manual includes sections on managing resistance, including herbicide and insecticide resistance management, and resistance issues specific to transgenic Bt cotton. The manual, published in 2010, is available from the AzCPA. The PCA licensing exam has been revised to conform to the new study materials. The PCA licensing exam has been revised to conform to the new study materials.

No Herbicide Resistance Detected in Arizona

Dr. William B. McCloskey investigates any claim of herbicide resistant weed populations in Arizona by collecting seed from suspected resistant populations and conducting herbicide trials side by side with known susceptible populations in the greenhouse. To date, there have been no confirmed instances of herbicide resistant weed populations in Arizona, including any resistance to glyphosate despite the presence of resistant weed populations in surrounding states.

Tools for Evaluating Resistance Management Practices in Arizona

We continue to develop data, tools and resources to support evaluation of IPM adoption, resistance management, and other pest management practices. This includes development of a 20-year historical database of Arizona Pesticide Use Reporting (PUR) data in partnership with the Arizona Department of Agriculture. This effort has received a funding boost through two successful Arizona Department of Agriculture Specialty Crop Block Grants that will partially support a database specialist position for the next 3 years. We have integrated IRAC, HRAC and FRAC mode of action tables into the database that will help facilitate resistance-related data queries. Impact: These data are used to respond to federal information requests as reported on the Arid Southwest IPM Network website (http://ag.arizona.edu/apmc/Arid_SW_IPM.html).

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New Jersey

WERA-060 Annual Report for New Jersey
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Fungicide resistance management in vegetable crop production continues to be a major focus in New Jersey as well as the rest of the mid-Atlantic region (PA, DE, MD, and VA). The 4th edition of the Fungicide Resistance Management Guidelines for Vegetable Crop Production in the mid-Atlantic Region was published in 2010. Since 2007, over 8,000 of these guides have been distributed to growers, extension agents and specialists, crop consultants, and industry representatives throughout the region representing to our best estimates between 75,000 to 100,000 A of commercial vegetable production. A 5th edition of the resistance management guide will be published and distributed in 2011. In 2010, vegetable pathologists in the region published a fungicide resistance management table for tomato crops grown in the Northeastern US. This FRAC table is useful for all tomato production in the thirteen states included the Northeast region of the US. This FRAC table is available on-line via Rutgers University (www.njveg.rutgers.edu) or at the online peer-review journal Plant Health Progress. A similar FRAC table for fungicide resistance management in cucurbit powdery and downy mildew was developed and distributed in 2009, and is available at the peer-reviewed online journal, Crop Management.

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Georgia

Herbicide-Resistance – Georgia – 2010

In 2010, glyphosate-resistant Palmer amaranth (Amaranthus palmeri) is the most widespread herbicide resistance problem in the state. It has been confirmed in 52 counties in Georgia, predominantly the cotton growing counties in south Georgia. It is estimated that by the 2011 growing season, glyphosate-resistant Palmer amaranth will infest all Georgia cotton-producing counties. In a number of counties, double-resistant glyphosate and ALS-resistant Palmer amaranth has been confirmed. Any of the ALS-resistant Palmer amaranth in Georgia has been confirmed to be resistant to all groups of ALS-inhibiting herbicides. ALS-resistant Palmer amaranth has been confirmed in 61 counties in Georgia.

Triazine-resistant Palmer amaranth was confirmed in central Georgia in 2008. This is a metabolism (enhanced GST) biotype and does not have cross-resistance to other non-chloro-s-triazines. Currently, we are conducting greenhouse studies on 30 selections that are suspected to be atrazine, glyphosate and ALS-resistant.

In 2010, ACCase-resistant Lolium multiflorum from Franklin County, Georgia. It has been tested to be sethoxydim and diclofop-methyl resistant, but is susceptible to clethodim. Double-resistant Lolium multiforum resistant to ALS and ACCase herbicides has been characterized on 100 to 500 acres. Specifically, these have been confirmed to be resistant to diclofop-methyl and mesosulfuron-methyl.

Michigan: Arthropod Pest Resistance Database

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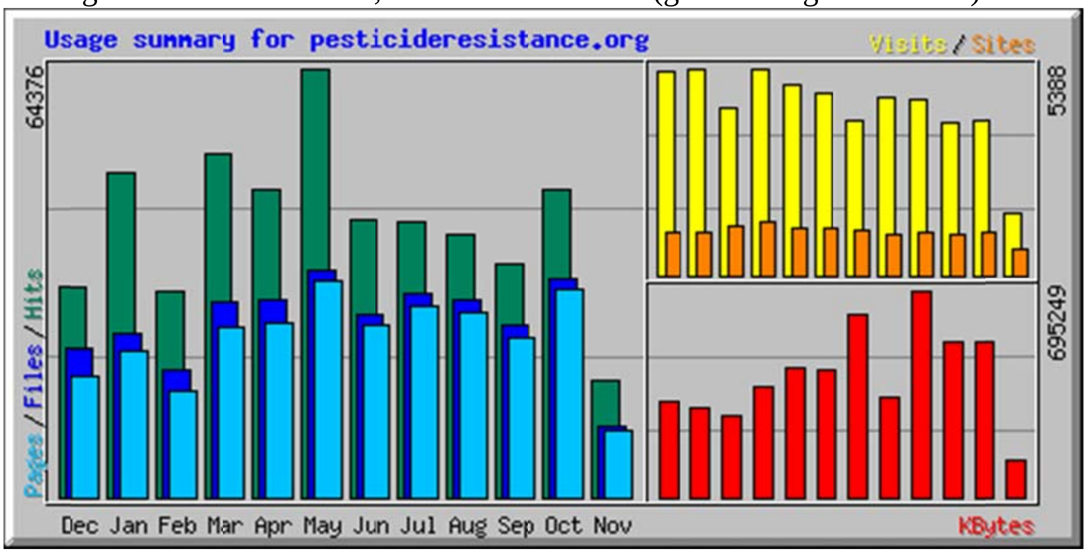
The Arthropod Pesticide Resistance Database (APRD www.pesticideresistance.org) was created by Michigan State University with the intent to establish a source of pesticide resistance information for scientists, researchers, government officials, and industry specialists. With this information, resistance management practitioners can develop and refine IPM programs to prolong decreasing susceptibility. The occurrence of pesticide resistance frequently leads to the increased use, overuse, and even misuse of pesticides that pose a risk to the environment, phytosanitation, market access, global trade, and threats to public health. Resistance can also result in serious economic loss and social disruption. The APRD's mission is to report cases of arthropod adaptation to insecticides since the 1900s. APRD has documented nearly 600 species and 9,456 cases of pesticide resistance, most of which have occurred over the last 60 years of intensive pesticide use. In 2010, hundreds and hundreds of new cases of resistance were added to the APRD. The representative sample of these new cases can be seen below in Table 1. This table demonstrates the wide array of different pests, their locations, and the insecticide they are resistant to. APRD's managers intend that arthropod pesticide resistance reporting should contribute to designing better integrated pest management (IPM) programs through selection of diversified management materials and strategies; and in the end contribute to the world's effort to reduce hunger, improve food security and assure human and animal health.

In May, 2010 the APRD website experienced one of its busiest months yet with more than 64,000, nearly 5,000 of those staying for 15 minutes or longer. Typically the APRD sustains more than 500,000 search-related visits annually lasting longer than 15 minutes. As the growing season begins to come to a close, the number of visits (green in Figure 1 below) to the site



decreases slightly, which is a reoccurring annual trend. Nearly 1/3 of the monthly traffic to the APRD is from US educational institutions (.edu) while a large portion of others are from EU, India, Japan and China. The APRD has over 400 registered users from 46 different countries. These users represent scientific researchers, government officials, private and industrial employees, as well as members of non-profit organizations.

Figure 1. Graph indicating usage statistics for the APRD for 2010. Projected future work on the APRD will consist of using software such as ArcGIS to create powerful and informative maps detailing a species' level of resistance and its geographic location. Preliminary work has been carried out on European pollen beetle resistance throughout Europe using IRAC data. GIS can help make better decisions regarding policy and allows for improved communication between scientists, government officials, and the public.

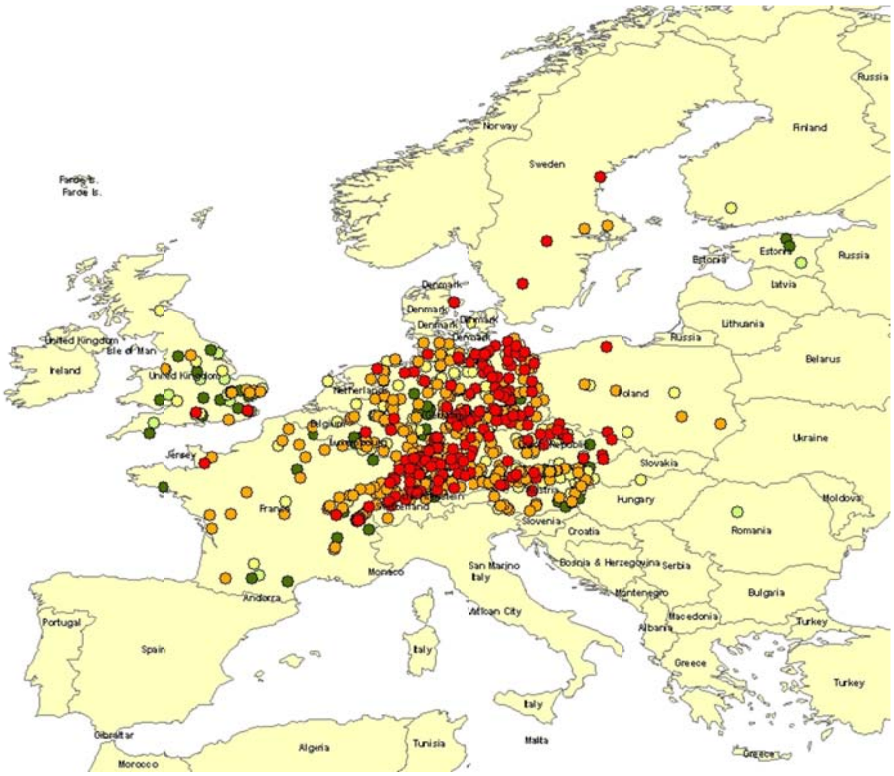


Figure 2. Map of European pollen beetle resistance. Light green = highly susceptible, green = susceptible, yellow = moderately resistant, orange = resistant, and red = highly resistant.

Table 1. A sample of new cases added in 2010. Includes species, the location it was collected, and the compound it is resistant to.

Species	Location	Compound
cydia pomonella	USA	azinphos-methyl
aleurothrixus floccosus	Spain	butocarboxim
amblyseius fallacis	Canada	permethrin

Species	Location	Compound
lycoriella mali	USA	permethrin
lucilia cuprina	Australia	diflubenzuron
boophilus microplus	Mexico	diazinon
frankliniella occidentalis	Spain	acrinathrin
diadegma insulare	Mexico	permethrin
musca domestica	USA	imidacloprid
helicoverpa zea	USA	cypermethrin
cimex lectularis	USA	deltamethrin
nasonovia ribisnigri	France	endosulfan
panonychus ulmi	Turkey	chlorpyrifos
myzus persicae	USA	methomyl
helicoverpa armigera	Pakistan	profenofos
helicoverpa armigera	USA	bifenthrin
culex quinquefasciatus	USA	permethrin
pediculus humanus capitis	Argentina	permethrin
tetranychus cinnabarinus	China	abamectin
laodelphax striatellus	China	chlorpyrifos
trialeurodes vaporariorum	Germany	pymetrozine
spodoptera litura	Germany	emamectin benzoate
trialeurodes vaporariorum	UK	imidacloprid
helicoverpa punctigera	Australia	fenvalerate
panonychus citri	China	spirodiclofen
musca domestica	Argentina	dichlorvos
bemisia tabaci	Brazil	imidacloprid

Species	Location	Compound
oryzaephilus mercator	Senegal	lindane
oxya chinensis	China	paraoxon
amblyseius womersleyi	Japan	methidathion
acarus siro	UK	pirimiphos-methyl
rhipicephalus sanguineus	Panama	amitraz
bemisia tabaci	USA	imidacloprid
sitophilus zeamis	Brazil	phosphine
tetranychus urticae	Brazil	fenpyroximate
aedes aegypti	Venezuela	chlorpyrifos
tetranychus urticae	UK	tebufenpyrad
aphis gossypii	Cameroon	dimethoate
myzus persicae	Greece	imidacloprid

Michigan: Resistant Pest Management Newsletter Mark Whalon, Robert M. Hollingworth, Brittany Harrison

The Resistant Pest Management (RPM) Newsletter was developed to spread knowledge of resistance around the world. The goal of the RPM Newsletter is to inform researchers, industry workers, pesticide policy bureaucrats and field personnel worldwide of ongoing changes and advances in pesticide resistance management, provide an archival resource to national and international policy leaders, and enhance communication of ideas among resistance managers worldwide. Since its 1989 inception, the Newsletter has published over 655 articles, including 35 articles in 2009. The Bi-annual publication has 1,137 electronic subscribers (mostly in government, libraries, and academia), and hard copies are now part of 58 libraries serial listings worldwide. Example countries with serial listings include the United States, Germany, Italy, the United Kingdom, India, Japan, Taiwan, Egypt, Kenya, Costa Rica, Australia, Malaysia, Indonesia, Iran, Jordan, Mauritius, Mexico, Pakistan, China, Spain, Tanzania and New Zealand. The newsletter can be viewed online at http://whalonlab.msu.edu/Newsletter/index.html and has received 15,536 visitors since October 2010. In part, as a result of these efforts (Arthropod Resistance Database and RPM Newsletter) we have helped to pioneer and perpetuate WERA-060 outreach to national, international, USDA/CSREES projects, etc. that address pesticide resistance and resistance management policy not only in the Upper Midwest but across the US, EU and the world. These efforts are a key note of this important process, and we have developed these communication tools into a strong cooperative network with other Land Grant universities, government organizations and the Insecticide Resistance Action Committee (CropLife International) internationally to deliver up-to-the-minute resistance information via the www.