IRAC
Insecticide Resistance Action Committee
eConnection

FEATURED IRAC MEMBER:

Clint Pilcher (DuPont Pioneer) joined the IRAC Plant Biotechnology Team in 2011, and became Team Leader earlier this year. He also represents the Team on the IRAC Steering Group.

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About This Issue

Welcome to another IRAC eConnection Newsletter. As always we try to bring you interesting and informative articles about the work of IRAC and insecticide resistance news from around the world.

In this issue we have summaries of position papers from the Biotechnology Team, details of two updated posters from the Sucking Pest Team on *Myzus persicae* and *Diaphorina citri,* the resistance status of cereal aphids in Northern Europe and a statement from IRAC International on IRM considerations when using both traditional chemistries and traits.

Remember, if you have any news or resistance topics of interest, please let us know us so that we can inform others in the IRAC Network. We hope you enjoy the issue.

IRAC Plant Biotechnology Team White Papers

The IRAC Biotechnology Team recently produced three white papers covering different aspects of insect resistance management for biotech crops which can be downloaded from the IRAC website. Team members summarize the key points from these papers below.

Insect Resistance Management (IRM) for Transgenic Crops in Small-Holder Agricultural Systems

Insects are capable of developing resistance to any pest management tactic, transgenic insect-protected crops are no exception. The consequences of insects developing resistance to transgenic crops will include; loss of revenue to growers due to yield loss, increased costs associated with more aggressive management measures and alteration to crop practices. It is incumbent on technology providers to take proactive measures to delay its onset and develop insect resistance management programs for transgenic crops.

Developing IRM programs in agricultural systems that are dominated by small holders where the economic and practical considerations vary from industrial agricultural systems deserve special consideration. This guide provides an overview of important elements to a proactive IRM program and includes recommendations for IRM in small-holder agriculture systems. These elements include: 1) refuge guidelines, 2) best management practices, 3) education and communication, 4) monitoring, and 5) on-going research.

Critical to small-holder agriculture systems, economic and practical realities are especially important and should complement the scientific basis of any recommended IRM program. Developers must take into account the economic, social and rural agricultural community. In addition, regulators should encourage technology providers to simplify and harmonize IRM programs for similar transgenic products. The full paper can be found at: http://www.irac-online.org/documents/irm-in-small-holder-systems/?ext=pdf.

IRAC Plant Biotechnology Team White Papers (Contd.)

Industry Perspectives on Insect Resistance Monitoring for Transgenic Insect-Protected Crops

Resistance monitoring is a fundamental component of insect resistance management (IRM) programs, the goal of which is to maintain product value to customers. This paper provides a consensus of IRAC member views regarding monitoring for insect resistance to transgenic crops. Resistance monitoring provides a means of detecting reductions in susceptibility of target insect pests to insecticides or *Bt* proteins that could reduce the economic value of the product; the primary goal being to detect resistance early enough to effectively deploy resistance mitigation measures and modify the IRM strategy.

Top left picture: Plant assay containers incubating in grower chamber
Bottom left picture: Burlese funnels used to extract larvae from root mats
Right picture: Larval corn rootworm samples extracted from different treatments
Photographs courtesy of Steve Thompson, DuPont Pioneer

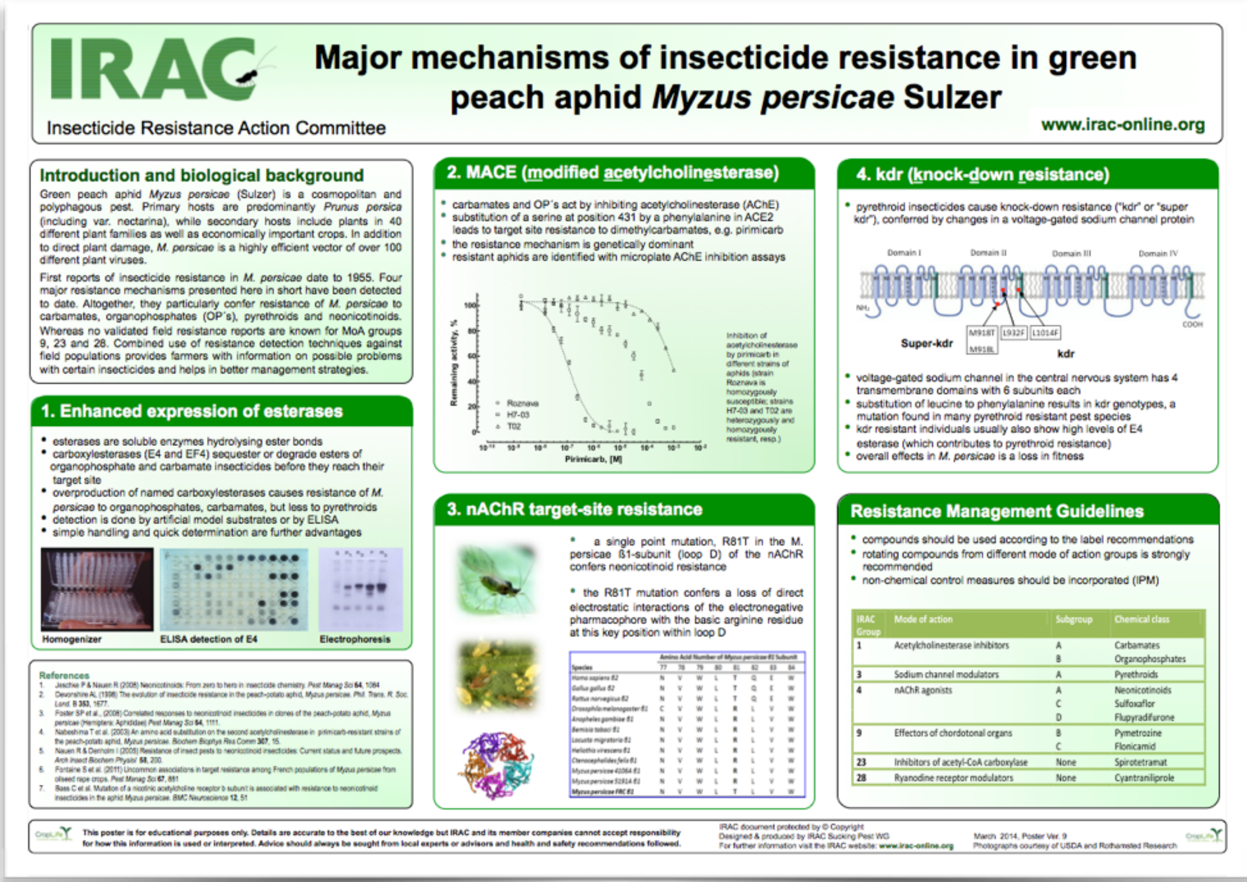
Topics in the paper include an overview of properties of a successful resistance monitoring program, what pest species to monitor, where to focus monitoring, laboratory field-based monitoring approaches, appropriate characterization of field collections, and interpretation of bioassay data. The paper closes with a summary of IRAC members' commitment to sustainability and transparency pertaining to resistance monitoring. The full paper can be found at: http://www.irac-online.org/documents/industry-perspectives-on-ir-monitoring/?ext=pdf

Seed Blends for Resistance Management of Insect-Protected Transgenic Crops

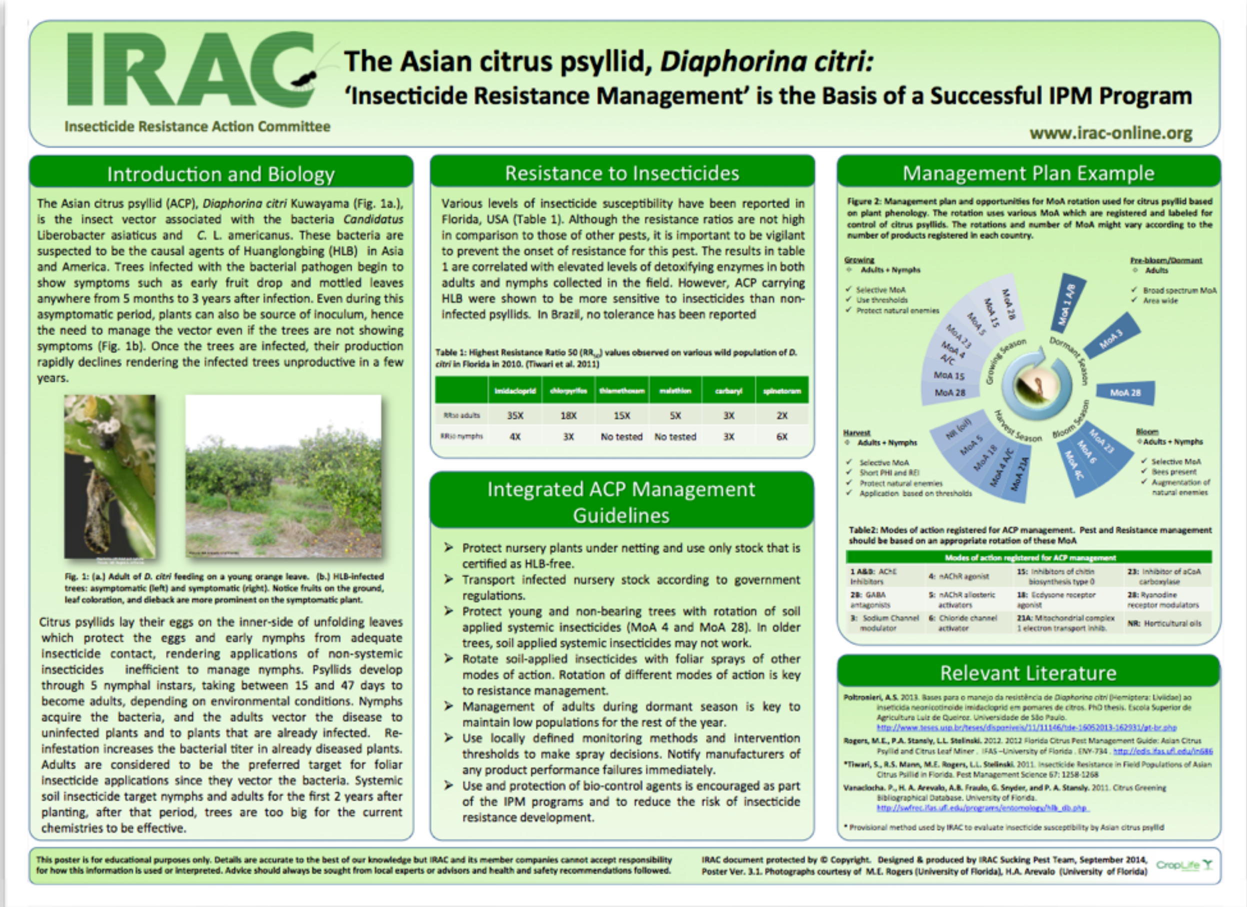
The benefits and disadvantages of providing "refuge in the bag" are complex and the balance depends on a range of system-specific biological, agricultural, and operational considerations. While blended refuge products assure that growers plant appropriate refuges for their insect-protected biotech crops, movement of larvae between refuge and traited plants can reduce the effective refuge size and increase survival of insects that are heterozygous for resistance alleles. IRAC recognizes that for a blended refuge strategy to be successful for a given pest/crop system, it must be widely adopted among the biotech trait providers. The IRAC Position Paper describes the technical and practical issues that must be considered when evaluating blended refuge and provides guidance on decision making. In general, if a planted refuge is biologically warranted to promote product durability, larval movement between traited and refuge plants is not expected to seriously compromise durability, and grower implementation of a separate refuge is known or expected to be low, seed blends can be a valuable option for refuge deployment. The full paper can be found at: http://www.irac-online.org/documents/seed-blends-for-irm/?ext=pdf

Recently updated posters from the IRAC Sucking Pest Working Group

Download the *Myzus persicae* poster: http://www.irac-online.org/documents/myzus-persicae-irm-poster/?ext=pdf



Download the *Diaphorina citri* poster: http://www.irac-online.org/documents/diaphorina-citri-irm-poster/?ext=pdf



Pyrethroid resistant grain aphids – a challenge for cereal growers in Northern Europe.

Recent surveys of the grain aphid (*Sitobion avenae*) in the United Kingdom and Ireland have revealed the presence of pyrethroid resistant aphids. If they spread, these resistant aphids could present a new challenge to cereal growers in other parts of Europe.

The grain aphids have been identified as being resistant by an adaption of the sodium channel which forms part of the nervous system in insects and is the site of action of the pyrethroid insecticides. This modification at the target site of pyrethroids is known as the L1014F *kdr* mutation. The mutation is well known in other agricultural and public health pests such as the green peach aphid (*Myzus persicae*) and house fly (*Musca domestica*). What is different to other species is that in this case all the aphids have been found to be heterozygous (single copy) for the resistance allele.

Although the aphids have been demonstrated as having only a relatively low level of resistance to pyrethroid insecticides (up to 40 times less susceptible than insects without the mutation) this shift in sensitivity has been shown to reduce the performance of pyrethroid sprays when the percentage of resistant aphids reach high enough levels. Since their first detection in 2011, resistant aphids have been identified in several English and Irish counties, but the frequency of resistant individuals has not been high enough to cause problems everywhere. Control problems have mainly been focused around Suffolk, Norfolk and Cambridgeshire. Surveys in other European countries have shown that resistant aphids are much rarer in mainland Europe, with only a small number of resistant grain aphids found in parts of Germany and none found in limited surveys of France and Denmark.

Grain aphid (*Sitobion avenae)*
Photo courtesy of Kansas Department of Agriculture Archive, bugwood.org

The grain aphid is only one of the key species of aphid considered to be pests of cereal crops in Europe. There is currently no indication of pyrethroid resistance in the other species, which include the bird-cherry oat aphid (*Rhopalosiphum padi*), the rose-grain aphid (*Metopolophium dirhodum*) and further eastwards in Europe, the Russian wheat aphid, (*Diuraphis noxia)* and the Spring green aphid (*Schizaphis graminum*).

The resistant grain aphids currently present a challenge to farmers in the UK and Ireland and the concern is that the problem may spread to other areas of Europe. At present, there are few registered insecticides with different modes of action available to farmers (seed treatment or foliar applications) for the control of cereal aphids. This makes it difficult to rotate insecticides with different modes of action, which is the most commonly recommended form of resistance and pest management. In the UK the only other foliar applied insecticides apart from the pyrethroids are organophosphates and carbamates which share the same mode of action (IRAC Group 1). In other countries other insecticide modes of action such as chlordotonal organ modulators (IRAC Group 9) and nicotinic acetylcholine receptor agonists (IRAC Group 4) are available. The situation might get more difficult, if further uses are restricted or insecticides are banned from the market.

If you observe the reduced performance of pyrethroid insecticides against cereal aphids in your region, please work with either your local plant protection organization or pyrethroid manufacturer to determine whether resistance is the cause of the problem and encourage them to report their findings to IRAC.

Resistance management advice for the UK is provided by the Insecticide Resistance Action Group (IRAG) and can be found at www.pesticides.gov.uk/Resources/CRD/Migrated-Resources/Documents/I/IRAG_Grain_Aphid_Guidance_Sept_2012.pdf, whilst more details on the mechanisms of resistance can be found in: Foster *et al*. A mutation (L1014F) in the voltage-gated sodium channel of the grain aphid, *Sitobion avenae*, is associated with resistance to pyrethroid insecticides. Pest Management Science (2013) DOI 10.1002/ps.3683 (http://onlinelibrary.wiley.com/doi/10.1002/ps.3683/abstract)

Links to French and German language versions of this document can be found on the IRAC Sucking Pest Team page at: http://www.irac-online.org/teams/sucking-pests/

IRAC International Statement: Considerations for the resistance management value of using insecticidal chemistry on transgenic crops expressing insecticidal proteins.

Chemical insecticides can be applied to conventional and transgenic crops expressing insecticidal proteins. Insecticidal chemistry may be applied to transgenic crops for a number of reasons, particularly to broaden the range of pests controlled or increase the level of target pest control. In certain circumstances, the application of chemical insecticides to transgenic crops also may be considered for insecticide resistance management (IRM) purposes.

All currently commercialized synthetic insecticidal chemistries offer an alternative mode of action to the insecticidal proteins expressed in transgenic plants and there is little evidence for cross-resistance between these chemistries and the insecticidal proteins*. Therefore the combined use of synthetic insecticidal chemicals and proteins which target the same insect pest offers the potential for an IRM tactic that could be beneficial for preserving the susceptibility of the target insects to both components. However, negative IRM impacts may arise if chemical insecticides are applied to a non-transgenic refuge as this reduces the population of insects that are susceptible to the plant expressed protein. Therefore when selecting refuge size and structure, it is important to take into account chemical insecticide application programs.

When considering a pest management program, it is important to take into account IRM considerations for both the transgenic trait (i.e. refuge adoption) and the chemistries being employed (both foliar applied and seed treatments). The following should be considered when assessing the IRM value of applying chemical insecticides to transgenic crops expressing insecticidal proteins:

1) An IRM benefit of the combined use of insecticide chemistry and transgenic crops expressing insecticidal proteins will only occur while the target insect population is exposed simultaneously to lethal doses of both the insecticide chemistry and the insecticidal protein(s).

2) For there to be an IRM benefit, the insecticide should be applied to the transgenic crop but not the refuge. In cases where both the transgenic crop and the refuge are treated with the insecticide, the IRM benefits will be neutralized. In circumstances where only the refuge is sprayed, this will have a negative effect on IRM for the transgenic crop. Despite the neutral or negative effects on IRM, insecticide sprays applied to the refuge may offer other benefits such as improved pest control.

3) In most cases, a refuge-in-a-bag (RIB) strategy does not allow for the selective application of chemical insecticides only to the transgenic plants, and therefore the impact of chemical applications to both the transgenic plants and the embedded refuge is unlikely to provide an IRM benefit.

4) The application of insecticides to a field that contains, or is suspected to contain, a significant proportion of target pests that are resistant to the transgenic crop can provide local suppression of the pest population and slow the geographic spread of the resistant insects. This use of insecticides can therefore provide area-wide IRM benefits.

5) The combined effects of the chemical insecticide and the expressed insecticidal proteins will be less effective and potentially detrimental if resistance has or is already developing to either the chemical or the protein(s).

*Not including foliar applied sprays which are based on *Bacillus thuringiensis* proteins.

IRAC News Snippets

★ A new IRAC Country Team is in the process of being set up in Argentina working in conjunction with the industry association CASAFE.

★ The Arthropod Pesticide Resistance Database which is maintained by the Michigan State University with support from IRAC, is in the process of being updated with a new platform, improving data entry, usability and search functionality.

★ The IRAC Coleoptera Working Group is in the process of collecting and collating the pollen beetle monitoring results for 2014. The results will be available in early 2015 and presented in a poster format as per previous years.

Conferences & Symposia

★ ASTMH 63rd Annual Meeting, New Orleans, Louisiana, Nov. 2-6, 2014

★ 62nd ESA Annual Meeting, Portland, Oregon, Nov. 16-19, 2014

★ 8th International IPM Symposium, Salt Lake City, Utah, March 23-26, 2015

★ Resistance 2015, 7th Intl. Meeting, Rothamsted, UK, Sept 14-16, 2015

Links to the websites for the conferences and symposia can be found on the IRAC Events Page at: http://www.irac-online.org/events/

Feedback

The eConnection is prepared by the IRAC International Communication & Education Working Group and supported by the 13 member companies of the IRAC Executive. If you have information for inclusion in the next issue of eConnection or feedback on this issue please email aporter@intraspin.com

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FURTHER INFORMATION

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