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IRAC eConnection

Insecticide Resistance Action Committee

FEATURED IRAC MEMBER:

Brad Hopkins (Dow AgroSciences) is a member of IRAC International and IRAC US. He is the IRAC liaison with Michigan State University who manage the IRAC supported Arthropod Pesticide Resistance Database (APRD).

IN THIS ISSUE:

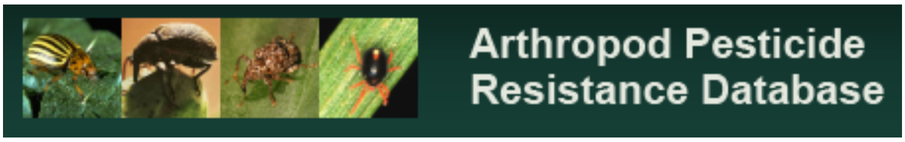
About This Issue

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 details on some changes in the management of the Arthropod Pesticide Resistance Database, an update on the status of insecticide resistance in the mosquito vectors of malaria with information on some new initiatives. IRAC continues to develop new educational resources and IRM guidelines and we outline some of the most recent examples along with other IRAC news. As we move towards the end of March, IRAC will be holding their 51st International Meeting in Philadelphia with around 45 participants expected. We will provide more details on this in the next issue.

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

Changes for the Arthropod Pesticide Resistance Database



The Michigan State Arthropod Pesticide Resistance Database (APRD) is a web-based resistance case entry system that serves as a centralized tool to access arthropod resistance information and determine the current status of arthropod resistance across the globe, with cases dating back to 1914 (www.pesticideresistance.org). The web database program has been directed by Dr. Mark Whalon and Michigan State University since the early 1990s, and co-directed by Dr. David Mota-Sanchez and Dr. Robert Hollingworth. IRAC International and IRAC US have provided advice and expertise on the database inputs and outputs, as well as financially supported the database since the early 1990s. Dr. Whalon has also received additional funding from other entities such as the USDA, CSREES Pest Management Alternatives Program, Generating Research and Extension to meet Economic and Environmental Needs (GREEN) Project #GR02-69, Michigan Agricultural Experiment Station, Michigan State University Extension and the Michigan Department of Agriculture.

At the end of 2017, Dr. Whalon will be retiring from Michigan State. IRAC would like to take this opportunity to thank Mark for all of his dedication and many years of service. Without his continued drive and commitment to operating the database, we would not have such an important resource available to us today!

During this transition, we are excited to announce that Dr. Mota-Sanchez and Dr. John Wise, will be taking on the responsibility of co-directing the resistance database for the future, with support of Entomology Department Chair Dr. Bill Ravlin. Dr. Mota-Sanchez is an Assistant Professor in the Department of Entomology and has been involved with the resistance database since the early days of its inception, has an excellent history and in-depth knowledge of its inner workings and has been the principle student data-entry trainer for the database programmers. Dr. Wise is a Professor in the Department of Entomology. He is the Director of the IR-4 Central North Region Unit and Research and Extension Coordinator of the Trevor Nichols Research Center, the largest field pesticide testing facility in the Upper Midwest, runs the Applied Insect Toxicology lab on the Michigan State campus, and has a long history of working with insect toxicology and insecticide resistance.

The resistance database went through a major transition in 2015 to 2016 and has had many improvements in functionality. The coding system for the database was antiquated and in serious need of updating to a new platform in order to make desired improvements. IRAC International supported this upgrade, which allowed the resistance database team to improve search functionality so users can search for resistance cases based on new criteria such as country of origin, insecticide mode of action or by an arthropod's family or order. In addition, multiple search criteria can now be used simultaneously, providing the ability to much more precisely query the database for resistance cases. Other improvements that are planned for the database include the addition of another category – field-evolved resistance or laboratory selected resistance – which will greatly improve our ability to segment cases that are pertinent to practical resistance and improve use for regulatory risk assessment. Drs. Whalon, Mota-Sanchez and Wise are always striving to make the resistance database as user-friendly as possible, all while constantly continuing to update new resistance cases as they are reported. In addition, the new platform enhances the ability to generate reports on resistance (see Table 1 and 2) to better understand annual changes and trends by pest, geography, chemistry, etc.

Top 20 Arthropods by Cases of Resistance	
Plutella xylostella	777
Helicoverpa armigera	758
Bemisia tabaci	578
Rhipicephalus microplus	560
Aedes aegypti	536
Spodoptera exigua	514
Spodoptera litura	510
Tetranychus urticae	479
Myzus persicae	433
Nilaparvata lugens	396
Musca domestica	358
Meligethes aeneus	355
Leptinotarsa decemlineat	296
Culex quinquefasciatus	296
Aphis gossypii	261
Blattella germanica	219
Panonychus ulmi	197
Aedes albopictus	195
Cydia pomonella	191
Frankliniella occidentalis	165

Table 1. Top 20 Arthropods by Cases of Resistance. This table shows the number of cases associated with the top twenty most resistant species reported in the database.

Top 20 Countries by Cases of Resistance	
European Union	3520
United States of America	2621
China	1923
Pakistan	1693
Australia	677
Brazil	534
India	499
Japan	453
Canada	331
Mexico	282
Spain	267
France	255
Turkey	210
Czech Republic / Czechia	198
South Korea	198
Colombia	195
Thailand	163
Greece	153
Germany	152
United Kingdom	152

Table 2. Top 20 Countries by Cases of Resistance. This table shows the total number of cases reported from the top twenty most resistant countries listed in the database arranged from the country with the most reported cases of resistance.

If you have any corrections or suggestions on how the database can be improved, please contact Dr. Mota-Sanchez at motasanc@msu.edu, Dr. Wise at wisejohn@msu.edu or Brad Hopkins, liaison from IRAC to the resistance database, at bwhopkins@dow.com.

Insecticides and insecticide resistance in the mosquito vectors of malaria

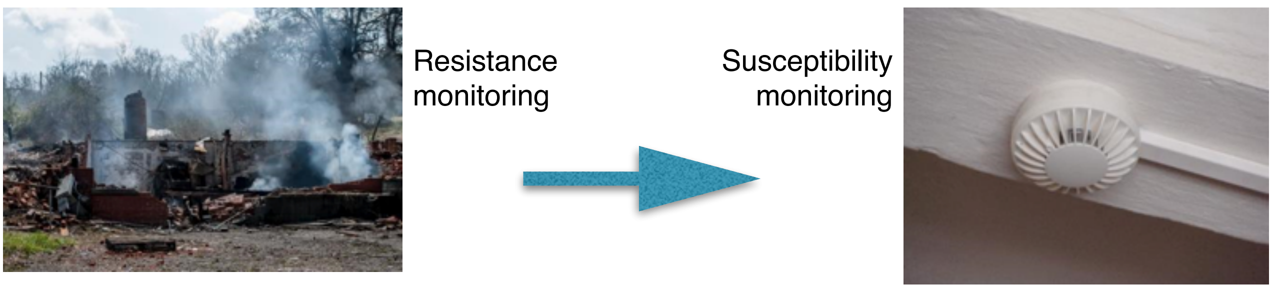
Insecticides play a key role in the prevention of insect vectored pathogens such as the plasmodium parasites that cause malaria, or Zika and Dengue virus. Since 2000 there has been a 40% reduction in the incidence of clinical malaria, with an estimated 663 million clinical cases averted. 87% of this gain has been attributed to the large scale use of insecticide treated long lasting bed nets (LLIN) and indoor residual wall spraying (IRS) (Bhatt et al, 2015). However, many now consider this success to be under threat by ever increasing levels of insecticide resistance in the anopheline vectors of malaria (Hemingway et al, 2016).

All currently recommended LLINs are impregnated with one class of insecticide, the pyrethroids. With the commendable World Health Organisation (WHO) recommendation for universal access to LLINs, for those at risk of malaria, mosquito populations in malaria endemic regions face almost constant selection pressure with pyrethroids. We shouldn't therefore be surprising that susceptibility to pyrethroids in the mosquito vectors of malaria is falling. There have even been reports of pyrethroid resistant mosquitoes entering damaged LLINs and taking blood meals (Ochomo et al, 2013). However, it has also been noted that when a malaria control programme in Ghana switched from pyrethroid to organophosphate based IRS, the incidence of parasitemia (the presence of the malaria parasites in blood) significantly fell (Ricks, 2015). Whilst not proving an underlying link between pyrethroid resistance and a reduction in malaria control, it suggests that it could be a problem.

Currently only insecticides from four IRAC mode of action sub-classes are recommended for the control of adult mosquitoes; pyrethroids (3a), DDT (3b), carbamates (1a) and organophosphates (1b). The dearth of insecticidal modes of action available for adult mosquito control has a number of reasons, including the development of public health insecticides potentially having a poor return on investment. Historically, insecticides have been developed that could be used in both agricultural and public health, e.g. pyrethroids or organophosphates. However, over the last 30 years regulatory pressure and environmental concerns have focused insecticide development on those with a limited spectrum and physical characteristics that are less suitable for use as classical mosquito adulticides. As a result, no insecticides from mode of action groups outside of 1 and 3 have been recommended by the WHO since in the 1980s.

The good news is that this is being addressed, and a number of initiatives are underway with the aim of developing novel solutions for the control of malaria vectors. These including public private partnerships, such as the Innovative Vector Control Consortium (IVCC), aimed at facilitating the research and development required to deliver novel vector control insecticides. Other initiatives are expediting the transition of novel vector control concepts to effective interventions, e.g. Innovation to Impact (I2I). The next few years will hopefully see a number of novel and effective mosquito adulticides being brought to market.

In any effective IRM programme an understanding of the susceptibility status of the target pest population to the available insecticidal modes of action is required. The most appropriate insecticide to use can then be identified. Currently, in vector control, where there are limited insecticides available, and significant insecticide resistance, it is appropriate to identify which insecticides will provide the best level of control of the mosquito population, i.e. which still provide the desired duration of protection. However, when novel insecticidal modes of action become available, measuring smaller changes in the susceptibility of the population will become an important part of the "susceptibility maintenance" programmes that should be implemented to gain the greatest utility from these new insecticides. In the context of malaria vector control, this shift from resistance to susceptibility monitoring is analogous to the use of a smoke detector, to warn of fire, rather than looking to see which buildings haven't yet been burnt to the ground.



In agriculture IRM is always more effective when implemented as part of an Integrated Pest Management (IPM) programme. Likewise in vector control, IRM or perhaps "insecticide susceptibility maintenance", should be implemented in the context of an Integrated Vector Management (IVM) programme. IVM has been defined as "a rational decision-making process for the optimal use of resources for vector control. The approach seeks to improve the efficacy, cost-effectiveness, ecological soundness and sustainability of disease-vector control" (WHO, 2014). To remain sustainable, the utility of the novel insecticides currently being developed and brought to the market need to be maintained. This can only be achieved by making the vector control programmes more resilient to resistance development, through the use of effective IRM in the context of IVM.

The ongoing activities facilitating and expediting the development of novel vector control interventions may be a once in a generation opportunity. It is therefore vital that the effectiveness of new public health tools is maintained for as long as possible through their use in "resistance resilient" vector control programmes.

The IRAC Public Health team has produced a manual outlining best practice IRM in vector control. A summarised version is also available in English and French.

Useful links:

IRAC Prevention and Management of Insecticide Resistance in Vectors of Public Health Importance: http://www.irac-online.org/documents/irm-vector-manual/?ext=pdf

IRAC Prevention and Management of Insecticide Resistance in Vectors of Public Health Importance. Summary in French: http://www.irac-online.org/documents/irm-mini-vector-booklet-french/?ext=pdf

IRAC Prevention and Management of Insecticide Resistance in Vectors of Public Health Importance. Summary: http://www.irac-online.org/documents/irm-mini-vector-booklet/?ext=pdf

IVCC: http://www.ivcc.com/

I2I: http://innovationtoimpact.org/

WHO Global Plan for Insecticide Resistance Management in malaria vectors (GPIRM): http://www.who.int/malaria/publications/atoz/gpirm/en/

References:

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Hemingway J, Ranson H, Magill A, Kolaczinski J, Fornadel C, Gimnig J, Coetzee M, Simard F, Roch, Hinzoumbe C, Pickett J, Schellenberg D, Gething P, Hoppé M and Hamon N. 2016. Averting a malaria disaster: will insecticide resistance derail malaria control? The Lancet. Published Online February 12, 2016 http://dx.doi.org/10.1016/S0140-6736(15)00417-

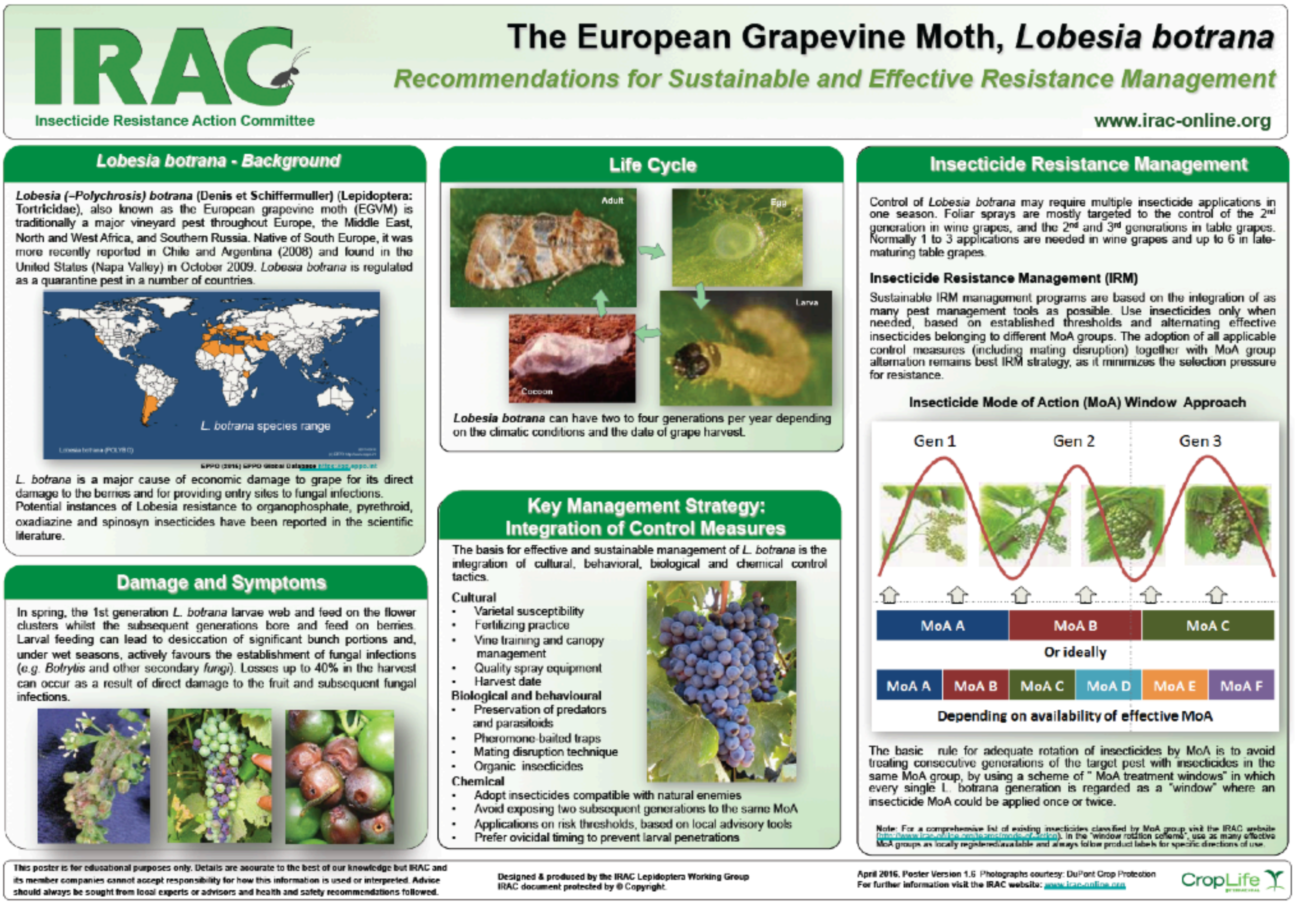
Ochomo E., Bayoh N., Walker E., Abongo B., Ombok M., Ouma C., Githeko A., Vulule J., Yan G. and Gimnig J. 2013. The efficacy of long-lasting nets with declining physical integrity may be compromised in areas with high levels of pyrethroid resistance. Malaria Journal. 12: 368-378

Ricks P. 2015. The Importance of Insecticide Resistance Monitoring to Maintain IRS Program Effectiveness, PMI Experiences in Northern Ghana. http://slideplayer.com/slide/8980543/ (Jan. 31, 2017)

WHO. 2014. Integrated Vector Management (IVM). http://www.who.int/neglected_diseases/vector_ecology/ivm_concept/en/ (Jan. 24, 2017)

New Insecticide Resistance Management Posters from IRAC

www.irac-online.org/documents/lobesia-botrana-poster/?ext=pdf



www.irac-online.org/documents/spodoptera-frugiperda-poster/?ext=pdf

IRAC News Items

Tuta absoluta Best Management Practices

The *Tuta absoluta* Task Team operating within the IRAC Lepidoptera WG have now published Best Management Practices (BMP's) to control *Tuta absoluta* and manage resistance. Shown below is the front page and table of contents of the document.

www.irac-online.org/documents/bmpsbackground-controlling-tuta-absoluta-managing-resistance/?ext=pdf


Insecticide Resistance Action Committee

Tuta absoluta: Insecticide Resistance Management Principles and Recommendations

IRAC Tuta IRM Task Team – 2017 (v6)

1. *Update Tuta presence and pest status globally*
2. *Recognize Tuta life stages, life cycle, damage, and plant symptoms*
3. *Tuta control products, resistance publications, and method to evaluate efficacy*
4. *Monitor Tuta populations*
5. *Integrate key Tuta control strategies*
6. *Understand Action Thresholds for chemical and microbiological control*
7. *Maximize pest control using adjuvants and app tech equipment*
8. *Understand Insecticide Resistance Management Principles*
9. *Implement Insecticide Resistance Management Strategies*
10. *Grower adoption of Tuta IRM: Factors that influence Growers*
11. *Examples of country MoA rotation programs*
12. *Country IRM execution guidelines*

AgBiTech joins IRAC International

AgBiTech is the latest company to join the long list of IRAC members. They are a company with a dedicated focus to expand the availability and use of Baculovirus-based bio-insecticides. AgBiTech are heavily investing in the global development, manufacturing and commercialization of high quality nucleopolyhedrovirus (NPV) products as effective tools for lepidopteran pest management to support conventional programs, and as "foundation" products in Integrated Pest Management systems. Their mission is to make NPV technology a global mainstream tool for pest management, and to help extend the effective life of vital pest control technologies, in particular genetically modified crops and new chemistries that are beginning to develop resistance.

Insecticide Resistant Strain Collection (IRSC) for Resistance Management.

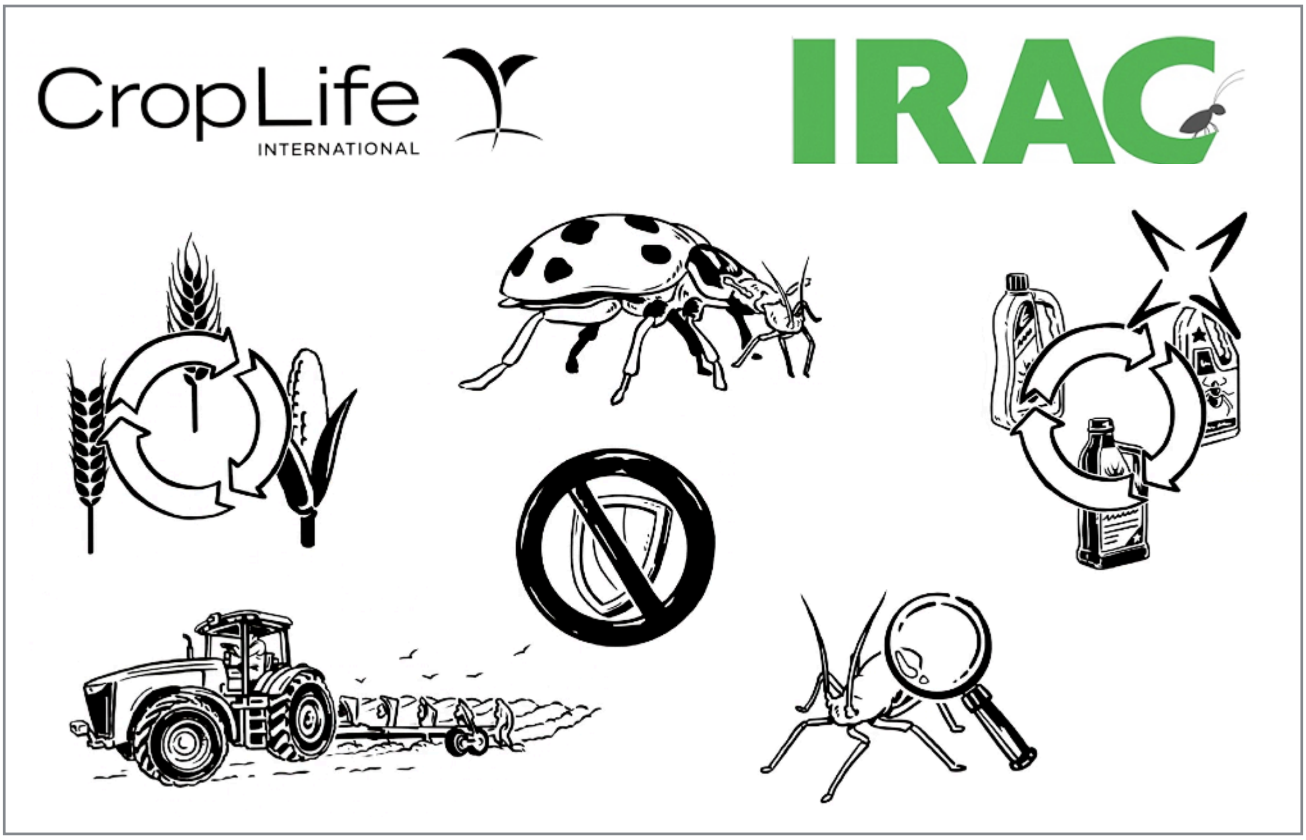
A concern in the development of new insecticides is the issue of whether or not there will be cross-resistance in pest populations due to prior insecticide use. IRAC and its member companies are pleased to announce a new resource for members: The Insecticide Resistant Strain Collection (IRSC) for Resistance Management. This collection of insecticide resistant strains will provide an invaluable tool for being able to assess the potential for cross-resistance. Strains of the resistant insects will be sent to participating IRAC companies free of charge (companies must pay the costs for shipping and have appropriate permits if they are outside of the USA). Companies can also make arrangements to have strains confidentially tested by the IRSC staff for a modest fee. Visit the web site below for a listing of the strains that are currently available.
(https://blogs.cornell.edu/scott/files/2017/03/Jeff-Scott-1-27whrwr.pdf)

Mode of Action Classification of Afidopyropen as Group 9D - Pyropenes

A MoA classification for afidopyropen as Group 9D was approved by the IRAC MoA WG and the IRAC Executive based on its unique structure (relative to pymetrozine and pyrifluquinazon) and lack of cross-resistance to pymetrozine. Afidopyropen will be added to the MoA Classification Scheme once a registration is achieved. At the moment it is listed in Appendix 6 of the Scheme (pending registration).

IRAC IRM Video now available in 6 languages plus English

The English version of the IRAC Insecticide Resistance Management Video has proved so popular that we have now translated the video into 6 other languages. These are Latin American Spanish and Portuguese, Mandarin, Japanese, French and Hindi and can be viewed on the IRAC website (http://www.irac-online.org/teams/outreach/). A second video focusing on mode of action is currently in production.



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