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IRAC Insecticide Resistance Action Committee

eConnection

Frank Wessels, Dow AgroSciences leads the IRAC Methods Team.

IRAC Methods Team: Aligning Resources with the Needs of Resistance Management

Prolonging the efficacy of existing pesticides through effective resistance management strategies has become increasingly important because existing products are under pressure by the development of pest resistance, shifting pest spectrums, and increasing regulatory hurdles.[1, 2] Maintaining a robust set of crop protection tools for the effective control of arthropod pests has significant implications for both agriculture and human health.[1, 2] Reliable and robust bioassay methods are essential components of an insect resistance management program that allow for the establishment of baseline susceptibility, detection, and monitoring of resistance.[3, 4] When managing the resistance of wide-spread agricultural, medical, veterinary, and urban pests, consistency in test methods makes it possible to compare data across geographies and time.

Methods to detect and monitor resistance for specific pests are distributed throughout the scientific literature. As a result, bioassay methods may be difficult to find, or may not be accessible to all researchers or pest management professionals. With the goal of establishing a single contact point for resistance management bioassays, the IRAC Methods Team provides bioassay methods that are validated and approved by its member companies for resistance detection/monitoring. In addition, the IRAC Methods Team maintains a database of methods described in the published literature. In an effort to best meet the needs of pest management professionals, the IRAC Methods Team conducted an analysis of the Arthropod Pesticide Resistance Database (APRD) [5] to evaluate the coverage of IRAC validated methods. The APRD is a global database of pesticide resistance case literature and reports that is maintained at Michigan State University and is made available online to the public.[5] Recent reports of resistance were organized by pest species and compared with the list of validated IRAC methods to determine how well the IRAC methods target the most challenging pest species.

Currently, there are 33 validated IRAC methods, targeting well over 35 pest species in 6 taxa (Table 1). The majority of IRAC approved methods were developed for major pests in three insect orders: Hemiptera, Coleoptera, and Lepidoptera.

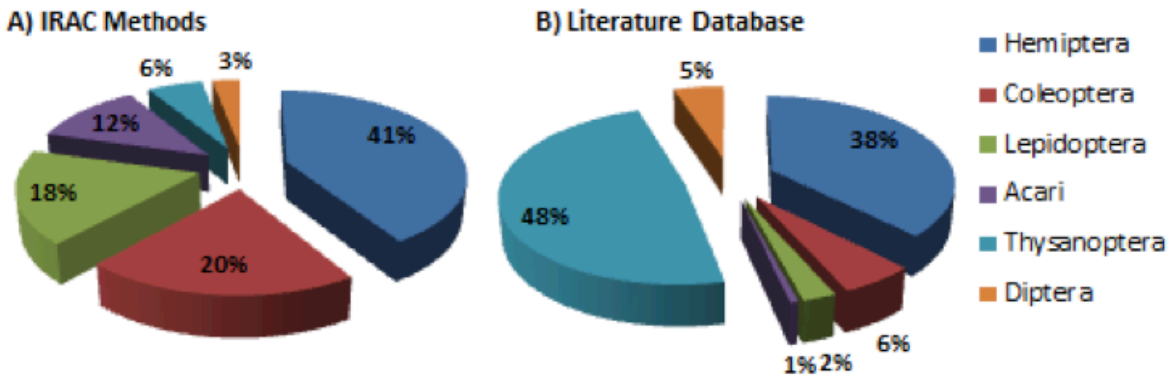

Figure 1. Percentage of A) validated IRAC methods and B) methods from IRAC literature reference database by pest taxa.

Most IRAC methods target specific pest species, but some methods can be broadly applied to several species which share similar behaviors. Methods that address multiple species are identified as "generic" methods (Table 1). When broken down by mode of action (MoA), nearly half of the chemistries validated in the IRAC methods fall into three MoA groups: acetylcholinesterase inhibitors (carbamates and organophosphates), sodium channel modulators (e.g., pyrethroids), and nicotinic acetylcholine receptor competitive modulators (e.g., neonicotinoids). In some instances, there may be multiple validated IRAC methods for a single pest species, different methods may have been optimized for different life stages (e.g. Methods No. 010 [adults] & 014 [larvae] for *Frankliniella occidentalis*) or multiple bioassay techniques may be highlighted (e.g. Methods No. 028 [feeding], 029 [topical], & 030 [contact-vial] for *Euschistus heros*) (Table 1).

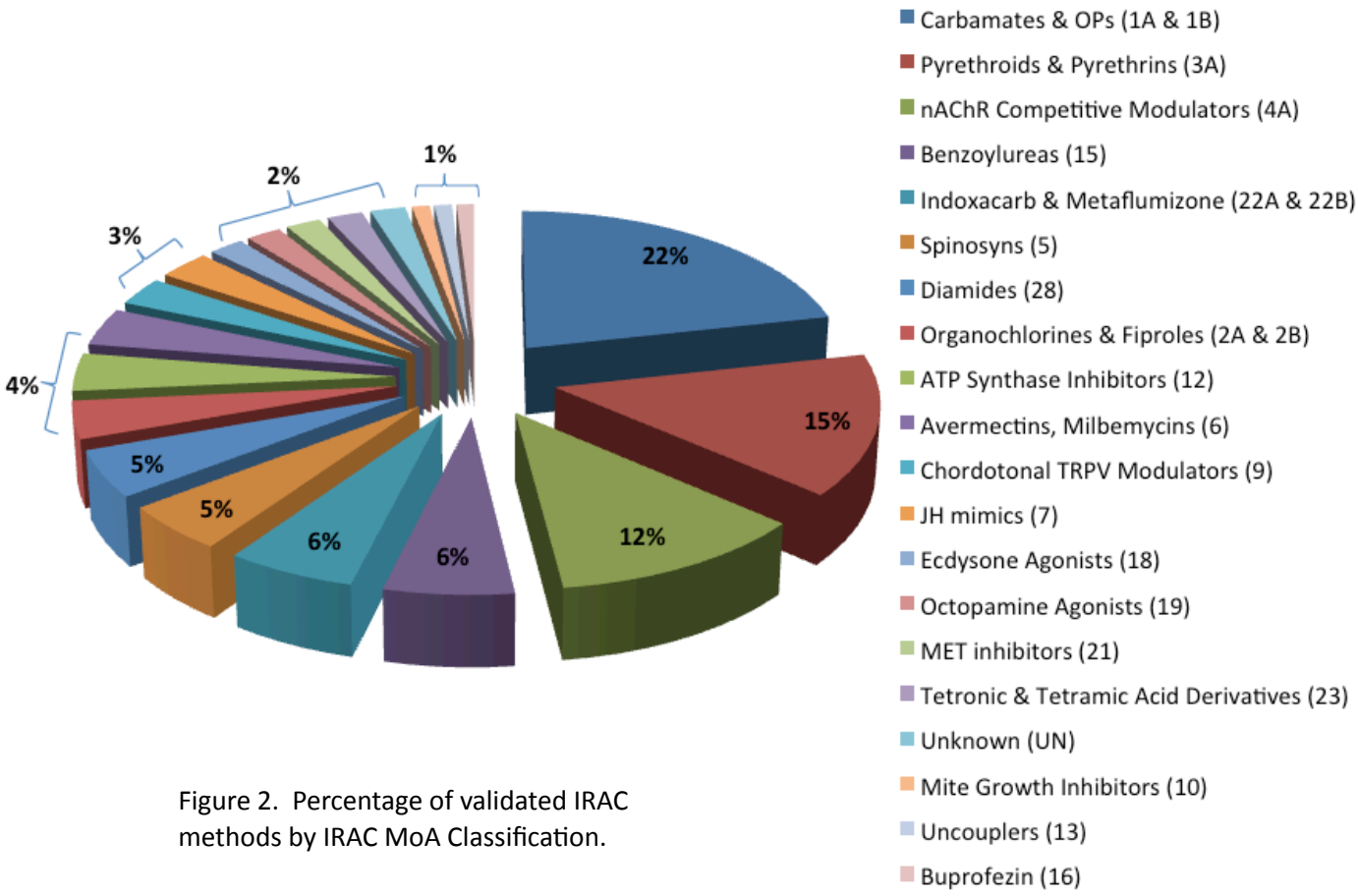

Figure 2. Percentage of validated IRAC methods by IRAC MoA Classification.

The IRAC Methods Team constantly works to improve the availability and relevance of existing methods, and has new methods in development. In recent years, the IRAC Methods Team has translated several methods into short instructional videos that broaden the accessibility and clarify the method protocols (Table 1). These methods videos have been made freely available and accessible on YouTube™ (www.youtube.com). In addition to validated IRAC methods, the IRAC Methods Team also collects and maintains a reference database of literature-based methods that are applicable for insecticide susceptibility and resistance monitoring. The literature reference database currently contains 139 references, and is organized and searchable by species. Links to the IRAC methods videos and methods literature database are all available on the IRAC website (www.irac-online.org/teams/methods).

Insecticides have become increasingly important tools in the global production of food, fiber, and for combating arthropods of medical, veterinary, and urban importance. The increasing costs of discovering and developing new insecticides, and the necessity of replacing older chemistries, emphasizes the importance of maintaining the efficacy of existing control options. Therefore, effective resistance management must be a core focus of any sustainable pest management strategy, and management professionals need the ability to reliably confirm and quantify resistance in pest populations.[8, 9] With the goal of developing, validating, and distributing methodologies for detecting or monitoring arthropod resistance, the IRAC Methods Team is constantly working to develop resources for major pest species and to anticipate future needs for resistance management. The Methods Team welcomes suggestions for new resistance monitoring methods and resources.

Table 1. List of validated IRAC Methods including the specific IRAC MoA groups validated by the IRAC

Species	Common Name	Life Stage	Validated Chemistries (IRAC MoA Group)	IRAC Method #	Method Note
Hemiptera					
Myzus persicae	green peach aphid	Adult	1A, 1B	1	
Psylla spp.		All Stages	1B, 19	2	Generic
Nilaparvata lugens & Nephotettix cincticeps	brown planthopper & green leafhopper	Nymphs & Adults	All	5	Video
Bemisia tabaci	sweetpotato whitefly	Adult	19	8	
Trialeurodes vaporariorum & Bemisia tabaci	greenhouse whitefly & sweetpotato whitefly	Adult	1B, 3A, 4A, 9B	15	
Trialeurodes vaporariorum & Bemisia tabaci	greenhouse whitefly & sweetpotato whitefly	Nymphs & Adults	1B, 3A, 4A, 7C, 9B, 16, 23	16	
Aphid		Nymphs & Adults	1A, 1B, 3A, 4A, 9B, 9C, 12A, 23	19	Generic/ Video
Myzus persicae	green peach aphid	Nymphs	28	23	
Aphis gossypii	cotton aphid	Nymphs	28	24	
Euschistus heros	neotropical brown stink bug	Adult	3A, 4A	28	
Euschistus heros	neotropical brown stink bug	Adult	3A, 4A	29	
Euschistus heros	neotropical brown stink bug	Adult	3A, 4A	30	Video
Diaphorina citri	Asian citrus psyllid	Nymphs	1A, 1B, 3A, 4A, 5, 6, 28	32	
Lygus hesperus	Western tarnished plant bug	Nymphs & Adults	1A, 1B, 3A, 4	33	
Lepidoptera					
Leucoptera malifoliella & Phyllonorycter blancardella	pear leaf blister moth & spotted tentiform leafminer	Eggs & Larvae	15	9	

Species	Common Name	Life Stage	Validated Chemistries (IRAC MoA Group)	IRAC Method #	Method Note
Cydia pomonella	codling moth	Larvae	1B, 3A, 4A, 5, 6, 7A, 7B, 15, 18, 22A, 22B, UN	17	
Plutella xylostella	diamondback moth	Larvae	1A, 1B, 2A, 2B, 3A, 5, 6, 15, 18, 22A, 22B, UN	18	
Spodoptera spp., Helicoverpa spp., Heliothis spp.		Larvae	28	20	
Tuta absoluta	tomato leafminer	Larvae	5, 22A, 28	22	Video
Leaf-eating Lepidoptera and Coleoptera		Larvae & Adults	1A, 1B, 3A, 15	7	Generic
Coleoptera					
Leaf-eating Lepidoptera and Coleoptera		Larvae	1A, 1B, 3A, 15	7	Generic
Beetles Damaging Stored Products		All Stages	1B	6	Generic
Meligethes aeneus	pollen beetle	Adult	3A	11	Video
Meligethes aeneus	pollen beetle	Adult	4A	21	Video
Meligethes spp.	pollen beetle	Adult	1B	25	Video
Meligethes aeneus	pollen beetle	Adult	22A	27	Video
Weevils and Flea Beetles		Adult	3A	31	Generic
Diptera					
Musca domestica	house fly	Adult	4A	26	
Thysanoptera					
Frankliniella occidentalis	W. flower thrips	Adult	1A, 1B, 2A, 3A, 5, 13	10	
Frankliniella occidentalis	W. flower thrips	Larvae	15	14	
Acari					
Panonychus ulmi & Tetranychus spp.	European red mite & spider mites	Eggs	10A, 12D	3	
Panonychus ulmi & Tetranychus spp.	European red mite & spider mites	Adult	1A, 12B, 12C, UN	4	
Panonychus ulmi	European red mite	Adult	21A	12	
Panonychus ulmi	European red mite	Adult	21A	13	

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IRAC Executive Member Companies

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