IPM FOR CONTROL OF:

BEMISIA TABACI

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Insecticide Resistance Action Committee

This short document outlines Integrated Pest Management (IPM) tactics for controlling *B. tabaci* in different cropping systems, which can be helpful in relation to insect resistance management. Though IPM is not IRAC International's primary expertise, IRAC will, where appropriate, seek to enable the dissemination of information on IPM options developed by research institutions, academia, or government agencies for certain crop-pest situations through our outreach channels. IRAC International encourages IPM in the context of resistance management (RM).

IPM is an approach to manage pests in an economically viable, socially acceptable, and environmentally safe manner (Dara, 2019). IPM tactics are based on science and can be roughly characterized as combinations of cultural interventions, host plant resistance, the use of natural enemies and the use of synthetic pesticides based on economic threshold, or genetically modified crops (GMO), where appropriate.

Cultural Controls

In the open field, crop rotation is one of the most efficient ways to break pest outbreaks, alternating between host and non-host crops or reducing intercrop migrations of *B. tabaci* populations. Sanitation is also a commonly practiced tactic to keep the area in and around the crop free of broadleaf weeds that can attract whitefly. Removal of crop residues is important, especially if they are infested with whitefly. In contained production systems such as greenhouses, openings can be sealed with appropriate screening material. (Sani *et al.*, 2020)

Physical Control

Several physical control measures are available for *B. tabaci*, including the use of interception, color, and vibration.

Whitefly adults can be prevented from entering greenhouses by covering openings with nets (mesh size less than 0.4 mm) (Matsuura, A. *et.al.,* 2005), (Horowitz and Antignus, 2011).

The visual host finding behavior of whiteflies can be disrupted, by covering crop under UV blocking film (300-400 nm wavelength) (Horowitz and Antignus, 2011).

Mating behavior in whitefly is mediated by species-specific vibration signals. Generating similar vibrations artificially, can be used for mating suppression. In Japan, this new method will be introduced for whitefly control in tomatoes (Yanagisawa, R. *et.al.*, 2024).

Several products can be used to suffocate insects by blocking their spiracles. For example, sorbitan monostearate, polyglycerol ester of fatty acids, fatty acid glyceride, sunflower, cottonseed oil and hydrogenated starch hydrolysate have been introduced for the control of spider mites, aphids and whiteflies. For these products there is a lower chance for target insects to develop resistance. However, multiple applications are usually required to be effective (Tsueda, H., 2019).

Biological Control

The integration of natural enemies can be achieved through augmentative releases, as commonly practiced in greenhouses, or through conservation biological control, providing naturally occurring natural enemies with an environment which allows them to thrive.

Natural Enemies (Macroorganisms)

In greenhouses, the augmentative release of natural enemies is a common IPM strategy for controlling whitefly. Well established examples for natural enemies used for whitefly control in the greenhouse are: the aphelinid parasitoids *Encarsia formosa* and *Eretmocerus melanoscutus*, the predatory mirid bug, *Nesidiocoris tenuis* (Tanaka, S., 2024) or predatory mites of the genus *Amblyseius spp.*. Generalist predators of whitefly are for instance the lace wing, *Chrysoperla carnea*, several ladybug species (Coccinellidae) or hoverflies (Syrphidae). (Sani *et al.*, 2020).

To optimize the efficacy of natural enemies, it is important to elucidate the potential side effects of agrochemicals for non-target species. Chemical control should be selective towards the target pest species. Moreover, understanding the potential of negative sublethal effects is important. Sublethal effects on natural enemies can be surprising as certain insecticide residues can also have a positive effect. In the case of *E. formosa* for example, hormetic-like effects were described based on the numbers of hosts parasitized for residue of certain insecticides. (Sani *et al.*, 2020)

Life stages of natural enemies need to be considered carefully when integrating insecticide applications with natural enemies. Modern more selective insecticides can be less damaging to natural enemies than older broad-spectrum MoAs. They might also be less problematic because of reduced exposure of non-target species.

Microbial Control

Entomopathogenic fungi have been used for a long time for the control of whiteflies (Sani *et al.*, 2020). In many cases, entomopathogenic fungi are introduced to the crop system as fungal spores formulated as a powder or mixable concentrate, which can be applied using standard spray equipment. This is a big advantage, because integration of such products into a spray rotation program is fairly simple. The most common and popular entomopathogenic fungi used to control *B. tabaci* are *Ashersonia spp*., *Beauveria bassiana, Isaria fumosoroseus, Metarhizium anisopliae*, and *Verticillium lecanii*. Their effectiveness against *B. tabaci* can be improved through formulation and substrate. Some entomopathogenic fungi, such as *B. bassiana* and *M. anisopliae* can also be established as symbiotic endophytes, which may help in the development of more effective insect pest management strategies. (Sani *et al*., 2020)

Host Plant Resistance

Host plant resistance to whiteflies or viruses transmitted by whitefly have been successfully developed. Cultivars from different varieties of cotton, tomato, and other field crops have been screened against *B. tabaci*. Resistance traits can be of physical nature, such as the presence or density of trichomes on the leaf surface, or chemical defenses, such as secondary plant compounds or volatile organic compounds, which attract natural enemies. The selection and development of resistant cultivars against whitefly-transmitted viruses in breeding programs is quite challenging, because of the large plant screening operations required. (Li *et al*., 2023)

Successful IPM for ***B. Tabaci***

One example, for a successful integrated pest management program for controlling whitefly, is a program established in Arizona (Naranjo & Ellsworth, 2009). The case is particularly interesting, because it started with a different pest (*Pectinophora gossypiella*, pink bollworm) becoming resistant against broad spectrum insecticides. Increasing numbers of spray applications killing natural enemies were leading to incredible secondary outbreaks of *B. tabaci* populations, threatening several crop productions systems (cotton, melon and vegetables) at the same time. Key for success was the introduction of BT cotton, resistant to the initial pest problem, the pink bollworm, the introduction of selective insecticides for *B. tabaci* and later for western tarnished plant bug (*Lygus hesperus)* control. A very important component of the new control strategy is the conservation of natural enemies, often referred to as conservation biological control, based on a remarkable reduction of foliar insecticide applications and the use of novel selective modes of action. These changes also led to significant economic and environmental savings.

Another IPM program called "Basic Policy for the Promotion of Environmentally Harmonious Agriculture" was implemented in 1994, in Japan, Kochi Prefecture which is known for its efforts to promote environmentally friendly agriculture. The utilization of natural enemies has been spurred by the declining susceptibility of insect pests such as whiteflies and thrips to chemical insecticides (Adachi-Hagimori *et al.*, 2018). In 2024, in 99% of the greenhouses for eggplant and bell peppers production, the mirid bug *Nesidiocoris tenuis* and other natural enemies had been introduced, contributing to the control of whiteflies and thrips.

Finally, a successful implementation of IPM requires collaboration between all stakeholders at a regional level. This is discussed in more detail for organizing resistance management campaigns (https://irac-online.org/documents/advanced-training-module-on-irm/?ext=pdf).

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