University of Florida Book of Insect Records
Chapter 15 *Resistant to Most Insecticides*

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The green peach aphid, Myzus persicae *(Homoptera: Aphidae), is resistant to more insecticides than any other insect. Two other agricultural pests that are notoriously resistant, the Colorado potato beetle,* Leptinotarsa decemlineata *(Coleoptera: Chrysomelidae) and the diamondback moth,* Plutella xylostella *(Lepidoptera: Plutellidae), are strong runners-up.*

Since Melander (1914) first reported insecticide resistance, the subject has received ever greater attention due to increasing inability to control agricultural pests and disease vectors through chemical means (Forgash 1984, Georghiou 1986).

A population is considered resistant if its response to an insecticide in detection tests drops significantly below its normal response (Georghiou & Mellon 1983). In 1984 there were 1797 cases of resistance in arthropods (including all species and all insecticides), and by 1991, resistance to at least one insecticide had been recorded for 504 species (Georghiou 1986, Georghiou & Lagunes-Tejada 1991). A population may develop cross resistance to several closely related chemicals, in the absence of selection pressure against each, when one compound causes selection for a detoxication mechanism common to both. More serious is multiple resistance, the presence of separate detoxication mechanisms for unrelated insecticides, selected for independently (French et al. 1992). By 1984 at least 17 insect species were resistant to all major classes of insecticides (Georghiou 1986).

There are several ways to define "most resistant" insect, including frequency of resistant genes in a population or geographic range of resistant populations (Forgash 1984, Georghiou 1986), and even seriousness of control failure, given the enormous economic and social costs of multiple resistance. In this paper, "most resistant" is limited to degree of cross and multiple resistance, the champion being the species with documented resistance to the greatest number of insecticides.

Methods

Secondary literature and advice from entomologists provided initial candidates. CD-ROM databases of AGRICOLA and *CAB Abstracts* were searched for the years 1984-1994 for references to insecticide resistance in the principal candidates.

Results

In terms of the total number of insecticides to which populations are resistant, the two candidates closest to the champion are the Colorado potato beetle, *Leptinotarsa decem-lineata* (Say) (Coleoptera: Chrysomelidae), resistant to 37 compounds as of 1989, and the diamondback moth, *Plutella xylostella* L. (Lepidopotera: Plutellidae), resistant to 51 compounds, also in 1989. However, the insect species with populations resistant to the greatest number of insecticides is the green peach aphid, Myzus persicae (Sulzer) (Homoptera: Aphidae), which has documented resistance to 71 synthetic chemical insecticides (Georghiou & Lagunes-Tejada 1991).

Discussion

Species that have developed resistance to most insecticides used against them include the cotton leafworm, *Spodoptera littoralis*, in Egypt; the cattle tick, *Boophilus microplus*, in Australia; the housefly *Musca domestica*; and many species of *Anopheles* mosquitoes worldwide (Forgash 1984, Georghiou 1986).

Two of the most striking examples of resistant insect species are the Colorado potato beetle and the diamondback moth, both of which have developed extensive populations resistant to all synthetic insecticides registered for use against them, as well as biological insecticides like *Bacillus thuringiensis* (see Results) (Georghiou 1986, Hare 1990, Jansson & Lecrome 1990, Olkowski et al. 1992, Yu & Nguyen 1992, Talekar & Shelton 1993). The Colorado potato beetle has been especially devastating to potato on Long Island and other parts of the northeast United States, while the diamondback moth has been most uncontrol-lable on crucifers throughout Southeast Asia (Forgash 1984). Furthermore, their resistance has been influential in the development of IPM strategies, and both cases demonstrate the risk of reliance on one control method (Hare 1990, Olkowski et al. 1992, Talekar & Shelton 1993). Additionally, these cases highlight the importance of monitoring pest populations for insecticide resistance and incorporating resis-tance management into integrated control measures.

Many would therefore argue that the rapidity with which populations of these two species develop resistance to newly applied insecticides, leading to inherent difficulties in their chemical control, would make them the champions of the category "resistant to most insecticides." However, the green peach aphid, while receiving less attention in terms of its resistance, has a greater number of documented cases of resistance to individual insecticides, and therefore is the most resistant according to the definition utilized here.

This has important implications for integrated control strategies, since *M. persicae*, in addition to causing direct damage to various crop species, is the most efficient vector of several viruses attacking potato and other crops (Radcliffe et al. 1991), resulting in severe economic losses. Perhaps because of the high number of cases of resistance in this species, resistance management programs are being refined. With the determination that the biochemical resistance mechanism in *M. persicae* is based on increased levels of Esterase-4, biochemical assay techniques have been developed to monitor populations for resistance (Scott 1990).

As a vector of plant disease, a low population density of green peach aphids can cause severe economic losses, so multiple resistance in this species is a serious matter. Given the severe resistance problem already present, the refinement of Integrated Pest Management programs for the green peach aphid is vital, and should be pursued with as much effort as has been extended to IPM programs for the Colorado potato beetle and the diamondback moth.

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