

Chapter 13

Assessment of Environmental Toxicology to Arthropod Natural Enemies

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An increasingly important property of modern insecticides is an acceptable level of specificity to the target pests, with acceptably small effects on nontarget species. The dangers of broad-spectrum pesticides for natural enemies have been documented repeatedly in the past century; but the growth of the environmental movement since the 1960s, accompanied by more restrictive registration requirements, has encouraged industry to develop and users to apply more environmentally sound pesticides. However, the methods of characterizing pesticides as environmentally safe are not entirely straightforward, nor is there a consensus concerning which methods should be formally adopted. The purpose of this chapter is to examine the effects of pesticides (particularly insecticides) on natural enemies.

Pesticides can exert a variety of effects on nontarget organisms. The most obvious is death, but even those that survive may be affected in profound ways. Pesticides may affect life-history traits, such as development, longevity, and reproduction. They may alter the behavior of a natural enemy so that it feeds more or less. These effects may be acute or chronic. They may result from direct contact with the toxicant, or they may be mediated through other sources (e.g., prey or hosts in the case of predators and parasitoids).

These effects on individuals can greatly alter the size, distribution, and dynamics of nontarget populations. The magnitude of the effect is important in determining and anticipating the extent of the outcome; and it varies not only with compound, but also with rate in many cases. Nontarget effects of pesticides on arthropod natural enemies are of particular importance to pest managers because of the role these organisms play in suppressing pests. Mismanagement of natural enemies can contribute to the emergence of secondary pests or the need for additional,

Table 1. Considerations in design of bioassays for testing pesticide effects on natural enemies (after Ruberson et al. 1998)

Pertinent Issue	Considerations
Natural enemy used	Relevance to biological control Represents natural enemy guilds in system Susceptibility to pesticides
Life stages/sexes to be screened	Likely exposure to toxicant Relative susceptibility of sexes, stages
Modes of exposure to toxicant	Topical exposure Residues on substrate Inhalation of vapors Ingestion of toxified prey–host tissues Ingestion of toxified plant products (e.g., nectar, pollen, sap) Inclusion or exclusion of untreated refugia
Life history parameters to evaluate	Survival Longevity Developmental time Fecundity/fertility schedules Consumption/parasitization rates Searching behavior/rate Dispersal ability; movement Respiratory rate Population growth/reduction
Experimental scale	Plot size to compensate for dispersal capability Proximity of treatments to one another (e.g., risks of drift) Resolution of data (confounding factors)
Pesticide usage concerns	Pesticide formulation Projected use (e.g., foliar, soil) Range of recommended rates Environmental dilution: amount reaching target and target substrate in field Single vs. multiple applications Duration of exposure to pesticide in relationship to the compound's residual activity

