DEVELOPED RESISTANCE TO AZINPHOSMETHYL IN A PREDATOR-PREY MITE SYSTEM IN GREENHOUSE EXPERIMENTS (1)

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Susceptible predatory, Amblyseius fallacis (GARMAN), and prey mites, Tetranychus urticae KOCH, developed comparable levels of resistance to azinphosmethyl when provided with unlimited food and similar selection treatments over 22 generations. Susceptible populations of each when hybridized with limited numbers of resistant mites, incorporated the resistance rapidly and at comparable rates when selected for 5-8 generations. When selected together as interacting populations at 75% selection of the prey, but higher selection of the predator, prey developed only limited resistance after 9 selections, but predators developed appreciable resistance, equal to the susceptibility level of the prey. Data are discussed in relation to developed resistance to azinphosmethyl observed in field populations of spider mites and predators in apple orchards.

Present day crop protection mandates use of all available pest control techniques in an efficient integrated pest management (IPM) program. Implicit in the IPM concept is the integration of 2 commonly incompatible classes of control tactics: biological and chemical controls. Many pests are quick to develop strains resistant to pesticides whereas natural enemies are in general, slower in developing resistant (R) strains and thus are often absent, or present at very low levels on crops where non-selective pesticides are applied (CROFT & BROWN, 1975). In comparison, reports of pesticide resistance number 281 for agricultural pest species but only 13 for their natural enemies (FAO, 1977; CROFT & STRICKLER, 1981).

Two main theories have been proposed to explain the large difference in number of cases of resistance reported for arthropod pests versus natural enemies (reviewed in CROFT & MORSE, 1979). They include a differential detoxification theory which explains these differences by the greater long term exposure of pests to secondary plant compounds which have conferred to them a greater preadapted detoxification potential as compared to natural enemies. A 2nd theory is based on the food supply dependence of natural enemies on their hosts or prey (the pest). Following chemical application to a pest-natural enemy habitat, a phytophagous pest has an essentially unlimited plant food supply.

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on which to survive and reproduce. The natural enemy, however, must find a relatively scarce food supply (the pest) in addition to surviving pesticide treatment. At high selection levels of the pest, natural enemies face starvation or must migrate out of the treated area, there interbreeding with wild types with dilution of resistance factors.

Research relating to the 2nd theory using pesticide susceptible (S) populations of the predaceous mite, Amblyseius fallacis (GARMAN) and the two-spotted spider mite, Tetranychus urticae KOCH is the subject of this report. In 2 earlier publications, limited data from 2 selection experiments were reported by CROFT & MORSE (1979) and MORSE & CROFT (1979). Herein more extensive results of 8 selection experiments with both mite species in greenhouse experiments are reported.

CROFT & MORSE (1979) reviewed the basic biological features of A. fallacis and T. urticae which may influence resistance development (see GEORGHIOU & TAYLOR, 1977). These 2 mites present an ideal pest-natural enemy system in which to study comparative rates of resistance development. Both species are very similar with respect to developmental stages and rates, size, diapause, sex ratio, etc. (see table 1 : CROFT & MORSE, 1979). In addition both species occupy similar plant substrates and distribute themselves in like manners over the plant throughout their life cycles. Resistance to organophosphates in both species (T. urticae to parathion, HERNE & BROWN, 1969; A. fallacis to azinphos-methyl, CROFT et al., 1976) in most cases is due to a single, dominant or semi-dominant gene factor. Differences between the 2 species include (1) while both produce diploid♀ and haploid♂ T. urticae can produce♂ without mating whereas A. fallacis cannot (recently work by HELLE et al. (1978) has indicated the possibility of biparental♂ in other similar phytoseiid mites), (2) the mode of food uptake is different (predator verses herbivore), (3) due to its need to search for prey, A. fallacis has a faster rate and extent of movement, and (4) A. fallacis is intrinsically more susceptible to organophosphate insecticides than is T. urticae.

Under the conditions of the present study, these differences between the 2 mite species were not considered significant in favoring 1 species over the other in the development of resistance. The ability to produce♂ without fertilization by T. urticae would be important only under extremely low population density conditions (present only in the initial stages of experiment 8). The 2nd and 3rd differences between the 2 species might result in somewhat greater exposure of the predator to the toxicant (through secondary poisoning or increased exposure due to greater movement). Although the 2 species were selected over somewhat different dosage ranges in these experiments (see table 2) it is assumed that comparison of relative changes in resistance levels between the 2 species would be valid.

METHODS

The origins and pesticide histories of the mite strains used in these selection studies are shown in table 1. It would appear that most A. fallacis populations found in the wild have been selected by O-P insecticides to some degree (CROFT, unpubl. data). Over the period 1970-1974, approximately 35 strains from different regions in the U.S.A. were tested before what is believed to be a S strain was obtained. CROFT et al. (1976) described the procedure used to obtain the S strain collected in 1974 from a remote fish and game management area near Lansing, Michigan (Rose Lake Area) which had no known history of pesticide use.

Similarly, a variety of T. urticae strains that previously had been identified as unexpo-