ACARICIDE RESISTANCE AND GENETIC AFFINITIES OF SOME SELECTED POPULATIONS OF TETRANYCHUS URTICAE KOCH IN NEW ZEALAND.

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ABSTRACT

A study of resistance to acaricides in a number of populations of the two-spotted spider mite, Tetranychus urticae, in New Zealand had been carried out. Natural genetic and cytoplasmic incompatibilities between populations were also investigated with a view to possible biological control of the pest. Facets of acaricide resistance that were studied included multi-resistance, cross-resistance, negatively correlated resistance and the inheritance of resistance. Chemicals used included an organophosphate representative (parathion-methyl), a carbamate (formetanate), an ungrouped compound (tricyclohexyltin hydroxide) and an organochlorine (dicofol). Cross-resistance was demonstrated between parathion-methyl and formetanate in five populations obtained from widely separate areas of New Zealand. The resistance to parathion of three strains was found to be inherited as a single dominant character and transmissible by both sexes. Cytoplasmic factors (or nucleo-cytoplasmic interactions) and minor genes were found to contribute slightly to the expression of total resistance. No resistance to tricyclohexyltin hydroxide (Plictran) and dicofol (Kelthane) was detected.

High degrees of incompatibility (haploid egg lethality) were observed in the hybrids of crosses between the various populations. Chromosomal rearrangements in balanced heterozygous conditions, in conjunction with the cytoplasm, were considered to be important factors determining the interpopulational sterilities. The interpopulational incompatibility phenomenon was found to be multifactorial and not associated with the resistance factor. The egg

mortalities of some backcross series which remained constantly high in spite of several crossings, implicated that the introduction of normal males to a resistant mite population in an enclosed area (e.g. in a glasshouse) might be a worthwhile proposition in the integrated control of spider mites. Backcross hybrids, on allowing to multiply randomly, were capable of forming new gene combinations, leading consequently to the formation of new strains which were genetically different from the original parents used in the backcross series.

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CHAPTER 1

INTRODUCTION

'Can insects become resistant to sprays?. That now historical question was asked by Melander (1914) in 1914. Following the introduction of DDT in the early 1940s, the answer was clearly, yes, and the problem of resistance has had a profound influence ever since on the orientation of entomological research, Such influence is obvious since the development of resistant populations of insects will threaten man's hopes for improvement of his health standards and protection of his food reserves. While only 8 insect species were known to have developed resistance prior to 1940 (Brown, 1961a), the number of resistant strains began a sharp upward trend soon after the introduction and use of DDT and other synthetic organic insecticides. The history of insecticide resistance since then virtually parallels the history of insecticide development. Up to 1967, resistance had developed in 224 species of insects and acarines. Of these 97 are of public health or veterinary importance and 127 attack field or forest crops or stored products (Brown, 1972).

In similar vein, the control of spider mites (Acarina: Tetranychidae) did not constitute a problem until about two decades ago when resistance to agricultural insecticides became widespread.

The first case of resistance in mites probably occurred in 1937, when Compton and Kearns (1937) found inadequate control by Selocide sprays of a two-spotted spider mite population. Selocide resistance was a prelude to the unlimited resistance development which set in after the war, following the use of synthetic insecticides. In many situations, the Tetranychids were promoted from the role of a minor pest to that of a major one as a result of the use of DDT (Helle, 1965a).

An extraordinary genetic potential to adapt to various environments, plus subjection to the high selection pressure encountered in the commercial growing areas, are factors that make the frequency of the resistance phenomenon high in the family Tetranychidae. For these very reasons, the two-spotted spider mite, Tetranychus urticae, has recently been the most difficult to control among all the pests that confront horticulturists and agriculturists (Naegele and Jefferson, 1964). In spite of control measures, many orchardists and ornamentalists suffer economic loss due to defoliation, reduced tree vigour, poor fruit colour, or small fruit brought on as a result of mite feeding. The major problem in the chemical control of spider mites throughout the world is the continued development of strains resistant to the common chemical compounds. Each year, the problem becomes more severe with the number of non-effective types ever increasing, especially the organophosphorus compounds.

The resistance of insects of medical interest, such as Anopheles, Aedes and Musca, had been extensively studied for many years (Brown, 1960). Research on the resistance of agricultural pests had been done but on a smaller scale. As the chemical control of spider mites threatens to develop into a neck and neck race between the chemical industry and the resistance response of the mites, the desirability of an exhaustive investigation into the biological background of the organism, and the physiological and genetical base of the resistance become evident.

Genetic principles and methodology have been invaluable both from the point of view of understanding the development, spread and regression of resistance, and in providing pure strains for fundamental investigations on the interrelationships of genes, enzymes and toxicological responses to insecticides. From the practical standpoint, knowledge of the genetic identity of phenotypes has made possible the detection of genes for resistance in field strains prior to the use of insecticides or during the course of control operations, thus indicating the advisability of change to another insecticide. Additionally, information from hybridization, indicating reproductive barriers or genetic isolation, obtained during the course of studies on the genetics of resistance, has generated considerable interest in the feasibility of genetic control of insect populations.

With the various problems in mind, the aims of the present research are:

1) to determine the distribution of acaricide resistance among the two-spotted spider mite populations in certain selected areas of New Zealand.
2) to determine the effectiveness of particular groups of acaricides under laboratory conditions.
3) to study cross-resistance, multiple-resistance and negatively-correlated resistance patterns in the resistant populations chosen.
4) to study the mechanism of inheritance of the resistances in these populations.
5) to study the patterns of genetic and cytoplasmic incompatibility that occurs among the chosen populations of spider mites.