New Frontiers in Red Spider Research

John A. Naegele
Department of Entomology
Cornell University

In research, like in selling, the best way to guarantee going backwards is to stand still. For this reason we have adopted the forward look in red spider studies in that we have established an aggressive coordination of basic and applied research on the two-spotted mite. The applied wing of our research effort has been supported for a number of years by the state as well as by grower interest—in particular Roses Incorporated. In addition to this applied research we carried for a number of years a small amount of basic research. This basic research however was somewhat limited in scope because of the limitation of funds. Recently with the aid of federal funds and the cooperation of several members of the Department of Entomology and the Department of Plant Breeding, we have been able to expand the program of basic research and employ two Ph.D's trained in the basic sciences, Dr. William McEnroe and Dr. Kailash Mehrotra.

One of the early discoveries of Dr. McEnroe was in the area of water balance in the two-spotted mite. As has been said before the two-spotted mite is a small balloon of water and maintaining proper water balance is therefore a major problem. One of the mechanisms for maintaining water balance discovered by Dr. McEnroe has been the mites ability to shut off or open its breathing apparatus. It does this by pulling its "head" in or sticking its "head" out under conditions of either low humidity or high humidity. This basic application was immediately employed in a practical application in that we reasoned that placing mites in a moist environment and in the presence of a fumigant should bring about improved control. Preliminary experiments this summer have demonstrated that mites fumigated under conditions of high humidity are very effectively killed. Thus a basic discovery has been applied directly and immediately for practical results.

Basic research on the enzymes associated with the nervous system of mites has also been carried on by Dr. Mehrotra as well as Dr. McEnroe. Dr. Mehrotra has demonstrated that mite nerves work very similarly to mammal nerves in that those enzyme systems that are present in mammal nerves are also present in mite nerves. Because of Dr. Mehrotra's work we now know that a substance called actylcholine is present in the nerves of mites and that this apparently is responsible for the transmission of the nervous impulse from nerve to nerve. In addition we know from work with radioactive isotopes done by Dr.

(*Continued on page 8*)

(*Continued from page 1*)

Mehrotra that actylcholine is made by another enzyme called cholineactylase. In addition, Dr. McEnroe by freezing mites and slicing them has been able to stain the brain of mites with a compound that apparently reacts only with a specific enzyme, namely cholinesterase, in the brain and nerves of the mites. Thus it would seem that we have a nerve enzyme system similar to mammals in that actylcholine is present to make the nerves fire, cholinesterase is present to break down the actylcholine to stop the nerves from firing all the time, and cholineactylase is present to put together the molecule actylcholine when it has been broken apart by cholinesterase. We know that many poisons inhibit or break down cholinesterase thus allowing large quantities of actylcholine to build up in the mite. Presumably these large quantities of actylcholine are responsible for the poisoning of mites, since when large quantities of actylcholine are present and are not broken down the mites nerves continue to fire and the mite dies of exhaustion, convulsions, and discordination. The meaning of this information in regard to resistance is not entirely clear but several experiments have suggested that both resistant and non-resistant mites have about the same level of these various enzymes. This in turn would suggest that resistant mites have the possibility of preventing the poison from getting to the target site where the nerve enzymes are. The validity of these theories are yet to be tested, but if found valid they may have far reaching effects, particularly in regard to control.

Another important aspect of basic mite study is the manner in which mites obtain energy from their food. Dr. Mehrotra, in particular, has been interested in how mites obtain energy from sugars. From his work it appears that there are two alternate pathways of sugar metabolism in the mites. This suggests that perhaps resistant mites have the possibility of obtaining energy from sugar in an alternate way than normal and consequently can rely upon this alternate means of obtaining energy from sugar when their normal pathway is blocked by poison.

The manner in which mites behave has also been of particular interest to us. We know, for example, that they are very sensitive to heat, to humidity and appear also to be sensitive to light. Their response to these environmental factors is of concern to us because we are attempting to use their response as markers of their degree of resistance or intoxication to a given poison. We know for example that mites dislike high heat levels and will rapidly move away from them, and that they prefer very humid areas and will rapidly move toward a very humid area. The reaction of mites to light is as yet not clear.

Although the two-spotted mite has been known as a pest for many years, the biology of this pest is not known very well.In particular the factors which are responsible for the production of the overwintering stage are not clear. We know that the overwintering stage is a very important stage in the two-spotted mite and that it is physiologically different, for it does not feed and is not influenced by extremes of temperature. In addition, the influence of temperature on the field development of mites has been known in a general way but many of the specific details of temperature and its affect on development are not as yet known. Work in this area is progressing, but is limited

because of limited environmental control facilities.

Applications of promising acaracides have been going on all year as well as laboratory screening work to weed out good compounds from not so good compounds. This work has resulted in the further testing, development, and we hope, commercialization of Bayer 30686 and Bayer 28589. These materials have been extremely effective. We hope they continue to be so.