POPULATION RELATIONSHIPS OF SPIDER MITES AND TYPHLODROMID MITES ON APPLE TREES IN CENTRAL ILLINOIS

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Much controversy exists on the importance of species of typhlodromid mites (family Phytoseiidae) as predators of spider mites (Beglarov, 1957; Collyer, 1956; Clancy and Pollard, 1952; Huffaker, 1958; Lord, 1949 and 1956; Marshal and Morgan, 1956; and many others). Interactions between spider mites, their predators, and their environments are extremely complex. It is the purpose of this paper to present a few observations on the densities of spider mites and typhlodromid mites found on apple trees.

Methods

Henderson and McBurnie (1943) designed a brushing machine which has proved highly successful for rapidly estimating spider populations. Morgan *et al.* (1955) found that this machine removed 100% of the active stages and 98.8% of the eggs of spider mites on leaves of Delicious apple trees. Morgan *et al.* reported the same efficiency in the removal of eggs and active stages of typhlodromid mites and other predaceous mites. In every case they found more typhlodromid mite eggs by using the Henderson and McBurnie brushing procedure than were recorded by direct observation with the aid of a microscope.

I have used the Henderson and McBurnie brushing machine procedure since 1953 and have found it satisfactory for estimating spider mite populations; however, typhlodromid mites move more rapidly and are more easily disturbed by light and jarring than are spider mites. These factors reduce the effectiveness of the brushing machine procedure for estimating populations of typhlodromid mites. Often direct counts gave population estimates several times higher than the brushing machine procedure. In this study I have, therefore, used the more direct method of hand picking the leaves and counting the numbers of mites present on the leaves, with the aid of a microscope.

During the spring and summer of 1954, 1955, 1956, and 1957, samples were collected at intervals of about one week from three lots of Jonathan apple trees at Urbana, Illinois. Each lot consisted of four trees of nearly the same age and size. The samples consisted of 25 leaves picked at random from each tree in each lot. The 100 leaves from each lot were put in a plastic bag and taken to the laboratory where the mites were counted within 30 minutes after sampling time.

The first lot of trees received no chemical treatment during the four years of the study and presumably in years preceding the study. These trees will be referred to as "unsprayed".

The second lot of trees was incidentally sprayed with DDT in the course of a Dutch elm disease control program. This program started

in 1949 with two foliar applications of 6% DDT with a mist blower and continued until 1954 when a 12% DDT prefoliar treatment was substituted for one of the foliar treatments. In 1955, 1956, and 1957, only a 12% DDT prefoliar spray was used. The apple trees in this lot will be referred to as "D D T treated".

Although there was year-to-year variation, the third lot of trees received treatments on approximately the following schedule each of the four years of the study:

Dormant: DN 289, 2 qts. per 100 gals. water.

Prepink: (about April 20-30) lime sulfur, 2.5 gals., or organic mercury according to directions on the label, plus microfine sulfur, 4 lbs., or Vancide M, 2 lbs. per 100 gals. water.

Pink: (about first week in May) 2 lbs. lead arsenate, 2 lbs. Vancide M or 3 lbs. microfine sulfur and 1 lb. additional fungicide.

Calyx: (in mid-May) lime sulfur 2.5 gals. per 100 gals. water.

6 or 7 Cover Sprays: (ending in August) 2 lbs. DDT 50% W.P., 2 lbs. lead arsenate (stopped in June) various fungicides, and 2 lbs. malathion 25% W.P. per 100 gals. water.

These trees will be referred to as receiving a "recommended control program".

Observations on Predators

Typhlodromus pomi (Parrott) and *T. rhenanus* (Ouds.) appear to be the most important spider mite predators on apple trees in central Illinois. About 91% of the predators on the unsprayed trees were *T. rhenanus*, about 60 % on the DDT treated trees were *T. pomi*, and about 38% of the predators on the trees receiving a recommended control program were *T. pomi*. The other observed predators were: a snout mite, *Bdella depressa* Ewing; an undetermined mite belonging to the family Raphignathidae; a thrip, *Scolothrips pallidus* (Beach); an aphis-lion, *Chrysopa* sp.; and four species of ladybird beetles, *Adalia bipunctata* (L.), *Cycloneda munda* (Say), *Hippodamia convergens* Guer., and *Stethorus punctum* (Lec.).

Population Relationships

Figure 1 shows the number of *Typhlodromus rhenanus* and the total number of spider mites per 100 leaves on the samples from the unsprayed trees for the four seasons. In 1954, 1956, and 1957, spider mites were not found until July or August, and did not become abundant enough to cause damage. In 1955, spider mites were present in June and became abundant enough to cause damage during July. During the three years in which no spider mite damage occurred, *T. rhenanus* was collected before the spider mites appeared and was present in about a one to one predator-prey ratio. In 1955, when the spider mite damage occurred, the spider mites got the jump on the predaceous mite in June. However, *T. rhenanus* became abundant about two weeks later and the spider mite population dropped rapidly. Thus it seems there is a relationship between low spider mite populations and the presence of *T. rhenanus*. The only species of spider mite occurring on the unsprayed trees was the two-spotted spider

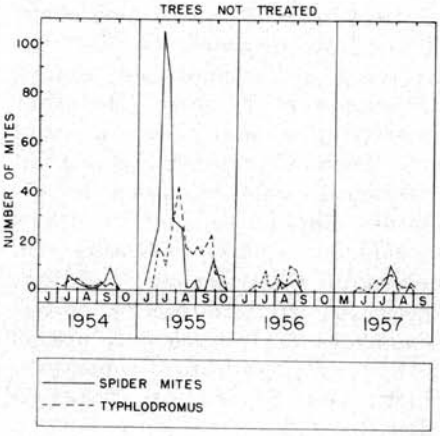

FIG. 1.—Number of spider mites and typhlodromid mites per sample of 100 apple leaves on untreated trees.

mite, *Tetranychus telarius* (L). It comprised 41.4% of the mite population for the four years; the rest of the mites were *Typhlodromus rhenanus*.

Figure 2 shows the number of *T. pomi* and the total number of spider mites per 100 leaves on the samples from the DDT-treated trees for the four seasons. In all four seasons the spider mites caused serious injury to these trees. This was evidenced by bleached appearing leaves and by spots and streaks of dead leaf tissue. Most of the damage was caused by the clover mite early in the season. In August and September of all four years, the two-spotted spider mite became abundant enough to cause injury. The clover mite, *Bryobia praetiosa* Koch, made up 87.3%, the two-spotted spider mite 7.9%, the European red mite, *Panoychus ulmi* (Koch), 0.2%, and *T. pomi* 4.6% of the total four-year population of these species. The ratio of *T. pomi* to spider mites was about 1:27 on the DDT-treated trees.

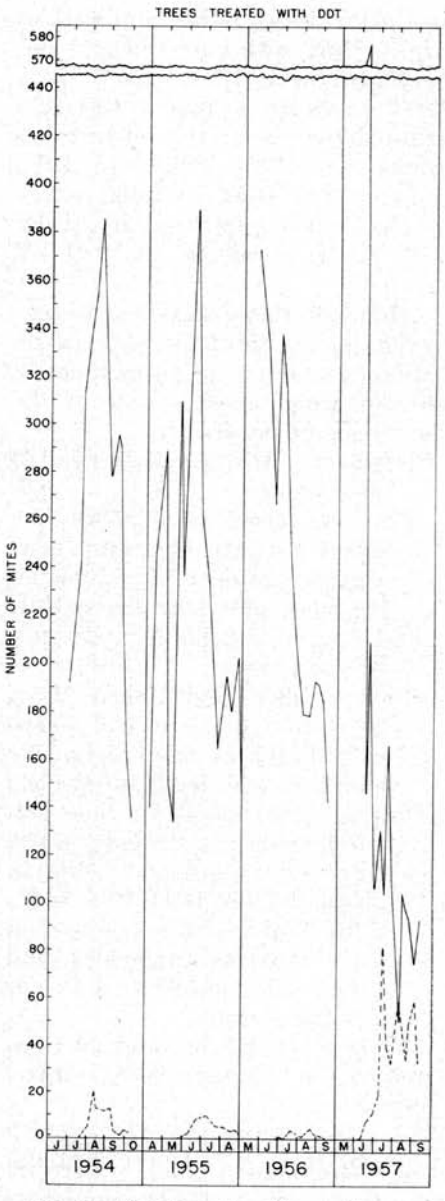

FIG. 2.—Number of spider mites and typhlodromid mites per sample of 100 apple leaves on trees treated with DDT.

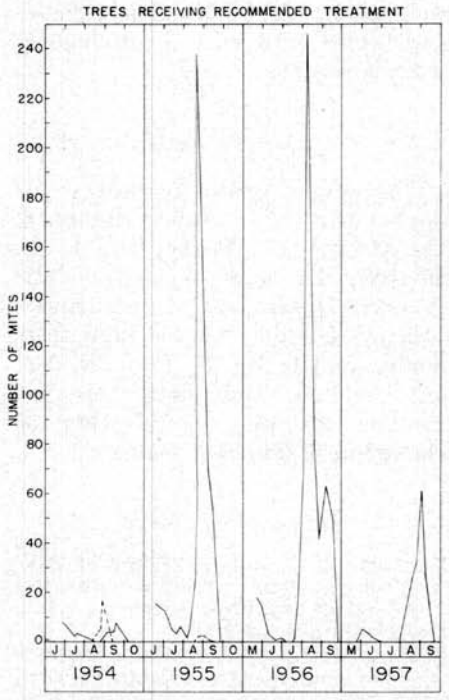

FIG. 3.—Number of spider mites and typhlodromid mites per sample of 100 leaves on trees treated with a recommended orchard spray program, including DDT and malathion.

Figure 3 shows the number of *T. pomi* and the total number of spider mites per sample of 100 leaves on the trees managed under a recommended control program for four years. In 1956 and 1957 no *T. pomi* were collected on these trees. In 1955 and 1956 the two-spotted spider mite caused injury in August and September. Under this control program, 77.2% of the total number of mites present were the two-spotted spider mites, 11.5% clover mites, 8.9% European red mites, and only 2.4% were *T. pomi*. The ratio of *T. pomi* to spider mites was about 1:44 on these trees.

Effects of Spider Mites on Fruit Yields

The average annual yield of fruit was estimated to be 0 to 0.25 bushels per tree on the unsprayed trees, 0.25 to 2 bushels per tree on the DDT-treated trees, and 2 to 5 bushels per tree under a recommended control program. The quality of fruit was superior under the recommended control program, because of less disease and insect damage.

Discussion

On apple trees that had no chemical treatment, spider mites were not abundant enough to cause damage, except on one occasion. In the absence of chemical treatment, *T. rhenanus* appears to be an effective predator of the two-spotted spider mite, *Tetranychus telarius*. On the trees treated with DDT, the clover mite, *Bryobia praetiosa*, was a serious problem in the spring, and the two-spotted spider mite was a problem during the summer. On the trees receiving recommended treatment, spider mite damage occurred during the last half of the season in two years and was for the most part caused by the two-spotted spider mite. The clover mite and the European red mite appeared as potential problems, but caused little damage. On the DDT-treated trees and on trees receiving a recommended treatment, the principal predator was *Typhlodromus pomi*, rather than *T. rhenanus* as on the trees receiving no chemical treatment.

Ristich (1956) reported complete or nearly complete kills of *T. fallacis* (Garm.) with DDT, parathion, chlorobenzilate, Systox, lindane, tox-

aphene, Ovex, heptachlor, dieldrin, and malathion. Huffaker and Kennett (1953) found that Systox, TEPP, parathion and Ovotran were harmful to *T. reticulatus* Ouds. I have also found aramite, malathion, and DDT harmful to typhlodromid mites. Huffaker and Kennett further reported that in their parathion-treated strawberry plots, *T. reticulatus*, a very effective predator of the cyclamen mite (*Tarsonemus pallidus* Banks), was replaced by *Typhlodromus occidentalis* Ouds., a parathion-tolerant predatory mite. *T. occidentalis* was found to be a less effective predator of the cyclamen mite than *T. reticulatus*. It seems that a parallel case occurs on the apple trees which I have studied. *T. rhenanus* appears to be an effective predator of spider mites, but appears to be eliminated by chemical treatment. *T. pomi* seems to be more tolerant of chemical treatment, but is a poorer predator than *T. rhenanus*.

Summary

These observations indicate that predation by *Typhlodromus rhenanus* has a deterrent action on the development of infestations by spider mites. Chemical treatments tend to change the proportional relationships of typhlodromid mites to prey species, the species of typhlodromid mites present, and the proportional relationships of typhlodromid mites to other predators. The replacement of *T. rhenanus* by *T. pomi* results in greater spider mite damage or a greater potential toward spider mite damage on the chemically treated trees. The advantage of natural control, however, is outweighed by the production of more and better fruit with a satisfactory spray program.

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