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BIOLOGICAL STUDIES OF SPIDER MITES ATTACKING COTTON PLANTS IN WEST TENNESSEE

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ABSTRACT

This study of the spider mites attacking cotton was conducted from June, 1965 through September, 1966. There were field observations, collections, controlled experiments and laboratory studies. Cotton fields in West Tennessee were the source of mites and the site of field experiments. The life history of *Tetranychus urticae* was investigated resulting in a description of the individual stages. Life cycle length was investigated at 72 F and 85 F. Specimens at 72 F died before completion of the experiment. At 85 F the time for completion of the life cycle was 7.9 days. A survey of the species attacking cotton in West Tennessee was conducted. Specimens were collected and identified as follows: *Tetranychus urticae, T. yusti, T. telarius, T. atlanticus, T. schoenei* and *Eotetranychus smithi*. This appears to be the first report of *Eotetranychus* being found on cotton. Spider mite infestations reached their peak in late July and continued through August; mites were on cotton in June. Weather appeared to affect infestation levels. *Tetranychus atlanticus* caused more damage than other species because it defoliated plants. Mite defoliation could be beneficial if delayed until the cotton is mature and bolls open. Natural predators are very helpful as control agents. Indiscriminate insecticide applications are partially responsible for population increases. Phorate, Kelthane, and Ethion were equally effective for controlling all stages of mites.

LIFE HISTORY AND BIOLOGY

Spider mites, sometimes called red spiders, belong to the family Tetranychidae (Class Arachinda, Order Acarina). Members of this family are herbivorous and attack a number of economically important agricultural and ornamental plants. Feeding from the underside of leaves, they suck the plant juices and cause leaf discoloration and drop.

In West Tennessee spider mites are serious pests of cotton. Damaging populations are usually localized and occur sporadically during the hot, dry periods of July and August.

The common name, spider mite, refers to the entire family Tetranychidae, established by Donnadieu in 1875. Though species from three genera of this family are known to attack cotton, members of the genus *Tetranychus* are the most serious cotton pests. Samples from infested cotton fields of West Tennessee contained six species: *Tetranychus atlanticus* McGregor, *T. telarius* (L), *T. schoenci* McGregor, *T. urticae* Koch, *T. yusti* McGregor, and *Eotetranychus smithi* Pritchard and Baker.

Reproduction is sexual or parthenogenetic. In the latter form all offspring are males. Males remain near the quiescent females during the period prior to the last molt. As soon as the young adult female emerges, copulation usually takes place. Copulation is followed by a short feeding period and then egg laying.

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The following account of the morphology and life cycle was derived from laboratory observations of *Tetranychus urticae* Koch. A summary of the stages in the life cycle and their duration is presented in Table I.

Table I. Length of life cycle at 85°F for *T. urticae* Koch.

Life Stage	Average Length in Days
Egg	2.9
Larvae	2.7
Protonymph	1.3
Deutonymph	1
Total	7.9

Adult spider mites average 0.8 mm in length; the female is somewhat larger than the male. The female's abdomen is broad and ovate while that of the male is narrow and pointed posteriorly. Body colors and markings may vary with the food material. Body colors noted include yellow, green, orange, red, black, and deep carmine. Lateral and caudal spots may or may not be present. The feeding organs are made up of the chelicerae which are fused at their bases to form the stylophore. The movable chela is modified into a long, extrusible, whip-like piercing organ. Adults and deutonymphs can spin webs. Webs are spun over the colony and vary in density with species.

Eggs are almost perfectly spherical and average 0.09 mm in diameter. When freshly laid they have a glossy appearance and range in color from pearly white to amber. The eggs are deposited singly and usually in close proximity. They may be attached to the leaf surface or to the silken web. The number of eggs laid per day may vary from 10 to 15. Henneberry (1962) found the number of progeny to be correlated with carbohydrate content of the leaf tissue. The incubation period varies with temperature; isolated eggs incubated at 72 F and 85 F hatched in 4.8 days and 2.9 days respectively. The larvae are approximately 0.2 mm in length. They have only six legs and are flesh colored except for the carmine eyes. This stage was found to average 2.7 days at 85 F. The protonymph emerges from the larval molt somewhat larger than the larva and with four pairs of legs. The body is spherical with the abdomen constituting the major portion. At 85 F, the protonumph period lasts approximately 1.3 days. The deutonymph is the last stage before the adult. The deutonymph is larger than the protonymph and looks

like a miniature adult; the body color and sex characteristics are not as pronounced as in the adult. The deutonymph period last one day at 85 F.

Average summer temperature for West Tennessee is reported to be 81 F. It appears that the 7.9 day life cycle obtained in our laboratory experiments is very close to the length of the spider mite life cycle in cotton fields of West Tennessee. These data are also similar to the findings reported by Ewing (1914).

Ecology

Spider mites can be found throughout the year in West Tennessee. Peak populations occur during the late summer months and reduction is observed by early October. During winter months spider mites are rare but overwintering females may be found on most any type of plant material that remains green; henbit and honeysuckle appear to be the most important overwintering hosts. Table II gives a summary of host plants infested and the seasons of infestation.

Table II. Host plants of spider mites.

Common Name	Botanical Name	Season	Spider Mite
Morning-glory	*Ipomoea purpurea* (L)	Spring-Fall	*Tetranychus yusti*
Polkweed	*Phytolacca americana* L.	Summer-Fall	*Tetranychus urticae*
Maypop	*Passiflora incarnata* L.	Summer-Fall	*Tetranychus yusti*
Johnson Grass	*Sorgum halepense* (L) Pers	Summer	*Tetranychus yusti*
Honeysuckle	*Lonicera japonica* Thumb	All	*Tetranychus yusti* *T. atlanticus,* *Telarius* sp.
Blackberry	*Rubus* sp.	Fall	*Tetranychus urticae*
Strawberry	*Fragaria* sp.	Spring-Fall	*Tetranychus urticae*
Pigweed	*Amaranthus spinosus* L.	Fall	*Tetranychus urticae*
Henbit	*Lamium amplexicaule* L.	Winter	Telarius group species
Dandelion	*Taraxacum officinale* Weber	Winter	Telarius group species

How spider mites move or are transferred from host to host is unknown; but it appears that source populations for cotton field infestation are on wild plants of the fence rows, ditch banks and road banks. Entrance time probably depends upon conditions of the host plant. It has been observed that when mite infestations become general, most host plants, except cotton, are relatively mature, fruiting and dying. The invasion of cotton may indicate preference for a rank succulent plant that is fruiting. It was found that infestations did not become general or economically important until late July. Infestations continued throughout August with some fluctuations depending on temperature and precipitation. The importance of weather conditions on mite populations was indicated by Canerday and Arant (1964b).

Injury to cotton by all species found in West Tennessee, except *Tetranychus atlanticus,* is usually expressed by loss of plant vigor, reduction in yields, and quality of lint and seed. Infection by *T. atlanticus* may cause complete plant defoliation and death. This species causes rapid reddening, scarring and abscission of the leaves; other species may cause severe leaf scarring, but rarely abscission. In Henderson County an entire field was defoliated by *T. atlanticus* (Fig. 1).

The economic damage by spider mites is revealed in the yield reductions. The relation of spider mite infestations to yields of cotton has been investigated at other cotton growing localities, not in Tennessee. Canerday and Arant (1964a) revealed that infestations of *T. telarius* caused very little leaf adscission, but reduced seed cotton yield by 14 to 44%.

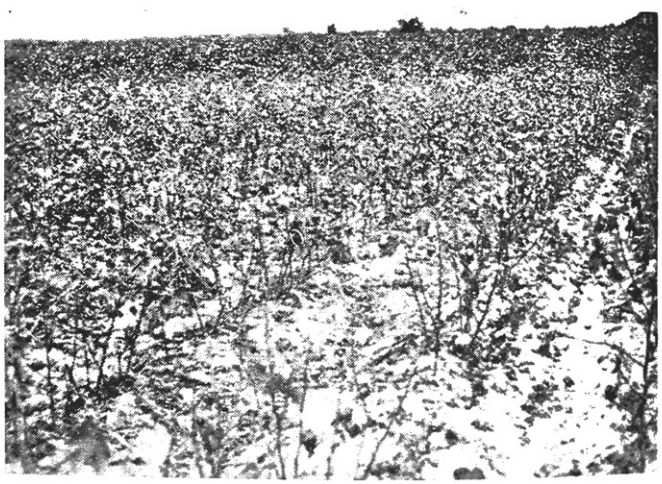

Figure 1. Cotton field defoliated by *T. atlanticus.*

An infestation in the early or middle part of the growing season could completely or partially destroy a crop; however, the defoliating damage of *T. atlanticus* could be beneficial if delayed until the bolls are mature and opening. A heavy infestation could defoliate the cotton, thereby eliminating the cost of chemical defoliation.

Control

Since these small arthropods infest one of the top money crops of Tennessee, a heavy infestation inflicts serious economic damage.

Natural control by predators is important. The most abundant spider mite predators in West Tennessee were common lace-wings (Chrysopidae) and members of the family Coccinellidae. Lincoln and McDonough Leigh (1957) stated that the principal predator of mites in Arkansas was *Scolothrips sexmaculatus* (Pergande). Other mite predators according to McGregor and McDonough (1917) are the flower bugs, *Orius insidiosus* (Say), the big-eyed bugs, *Geocoris punctipes* (Say), and members of Syriphidae.

An example of natural predator control of spider mites was observed at the Milan Field Station in 1966 where a heavy and widespread infestation occurred in an insecticide screening plot which was sprayed in caged insect tests five times in addition to one early season insecticide treatment. Some of these insecticides are contraindicated for spider mite control because they reduced the natural predators while not adversely affecting the spider mites. Similar reports have been made by Mistric (1964).

Cultural control can be effective against spider mites. Elimination of host plants, especially those that overwinter, in and around the field appears to be effective. Crop rotation might be helpful, especially where infestations appear year after year; however, this is not always feasible in an area with one major crop.

The most immediate and effective control is by use of chemicals. Three methods of chemical control were used in this investigation: furrow treatment at planting, perimeter treatment, and foliage treatment. The first two treatments were applied to see if these methods would prevent infestations. The foliage treatment was applied to compare effects of miticides on existing infestations.

In the furrow treatments Phorate and Di-Syston granules were applied at a rate of one pound per acre at the time of planting. The treatment was applied to four rows with ten rows used as a control area. No data were obtained from this plot, because an infestation did not occur. Several attempts to artifically infest the plot failed.

Perimeter treatments were applied in June at Milan Field Station and Ames Plantation in 1965, and at Milan Field Station in 1966. A number of fields were chosen at random for treatment. In these treatments a swath was made around the field with a cyclone spreader. The swath was about 30 feet wide and extended about ten feet into the field. At the Milan Field Station Phorate granules were applied at the rate of one pound per acre each year; at Ames Plantation both Phorate and Di-Syston granules were used at the rate of one pound per acre. Spider mite infestations occurred in almost every field, but not until late August when the cotton was mature. Thus, little damage was done. This method appears to delay infestations, since some fields not treated were infested as early as mid-July. It is possible that this method could be used to make heavy infestations beneficial rather than detrimental because of late season defoliation.

In the foliage treatment, Omite, Kelthane, Ethion, and Phorate were applied with a high clearance sprayer on September 17, 1966, at the rate of one pound per acre. Population counts of adults, immatures, and eggs were made before treatment and on the first, third, fifth, and seventh days after treatment. For adults, there were no significant differences in the miticides used. There was some difference in the control of immature mites; Omite being less effective than any other material in egg control. Kelthane, Ethion, and Phorate were equally effective with all stages. As expected, treatment with any of the chemicals used decreased populations at all stages as compared to untreated controls.

Literature Cited

Canerday, Don T. and F. S. Arant. 1964a. The effect of spider mite populations on yield and quality of cotton. Jour. Econ. Entomol. 57(4): 553-556.

Canerday, Don T. and F. S. Arant. 1964b. The effect of late season infestations of the strawberry spider mite, *Tetranychus atlanticus*, on cotton production. Jour. Econ. Entomol. 57(6): 931-933.

Ewing, H. E. 1914. The common red spider or spider mite. Ore. Agr. Expt. Sta. Bull. 121: 1-95.

Henneberry, T. J. 1962. The effect of plant nutrition on the fecundity of two strains of two-spotted spider mite. Juor. Econ. Entomol. 55(1): 134-137.

Lincoln, Charles and T. F. Leigh. 1957. Timing insecticide applications for cotton insect control. Ark. Agr. Expt. Sta. Bull. 588: 32-37.

McGregor, E. A. and F. L. McDonough. 1917. The red spider on cotton. U. S. Dept. Agr. Bur. Entomol. Bull. 416. 72 pp.

Mistric, W. J., Jr. 1964. Control of spider mites on cotton. Jour. Econ. Entomol. 57(6): 855-857.