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Selected Factors Influencing The Abundance of Banks Grass Mite in Sorghum

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SUMMARY

Banks grass mite, *Oligonychus pratensis* (Banks), population densities changed in correlation to host phenology. Prior to sorghum boot development, spider mite numbers were low. These population levels increased, however, as the plant approached reproductive maturation. Maximal population densities developed at, or just prior to, host plant senescence.

Total soluble leaf sugar concentrations fluctuated in response to the physiological state of sorghum development. Prior to the boot stage of development ca. 1.2 mg sugar was present per 6 cm^2 leaf tissue; whereas, at boot stage, sugars increased to ca. 2.8 mg/6 cm^2 leaf tissue. This increase may have been caused by a temporary decrease in metabolic activity in the reproductive portion of the plant prior to blooming thereby removing less sugar from the leaves. Soluble leaf sugars decreased to ca. 1.3 mg/6 cm^2 leaf tissue during the grain development stages. Data indicated that sugars were translocated from the leaves to the developing seeds, resulting in decreased leaf sugar concentration. As the plants approached maturity, less sugar was required for grain fill, resulting in an increase in leaf sugars. Slight variations in total soluble leaf sugar concentrations occurred in leaves at different locations on the plant. These variations may have resulted from shading of lower leaves.

Application of parathion to sorghum apparently resulted in increased spider mite numbers significantly greater than on non-treated plants. Parathion-treated sorghum plants supported more spider mite colonies with more unit area per colony than did non-treated plants. But spider mite numbers were less per unit area of colony in parathion-treated plants than non-treated plants. The data indicated that parathion application resulted in spider mite dispersal from the localized dense colonies. This dispersal resulted in a release of the reproductive-inhibition associated with crowding. Significantly higher spider mite numbers occurred on water-stressed sorghum plants than on sorghum receiving sufficient moisture by irrigation.

SELECTED FACTORS INFLUENCING THE ABUNDANCE OF BANKS GRASS MITE IN SORGHUM

David H. Kattes and George L. Teetes*

In 1967 and 1968, infestations of Banks grass mite, *Oligonychus pratensis* (Banks) Acari: Tetranychidae, were observed in several counties of the Texas High Plains (Cate and Bottrell 1971). Such infestations were generally confined to older plants. Pate and Neeb (1971) observed the Banks grass mite to be more serious each year in the Trans-Pecos area of Texas. This was due, in part, to increased mite population levels as well as failure to obtain adequate control with acaricides approved for use on sorghum.

Presently, the mite problem is not so severe on the Texas High Plains as it is in the Trans-Pecos area. However, with continuing insecticide use for greenbug control and increasing resistance to selected pesticides, these mites pose a major threat to sorghum production. To better understand the mechanisms causing spider mite outbreaks, information is required regarding the interaction between mites and their host plant and the environmental factors influencing both (Van de Vrie, McMurtry, and Huffaker 1972).

MATERIALS AND METHODS

Effects of Grain Sorghum Phenology on Spider Mite Populations

This study was designed to monitor seasonal changes in mite population density in sorghum and to investigate the vertical stratification of leaf sugars and vertical migration of mites. The study was conducted on the Donald Terrel farm located in Hale County near Plainview, Texas. The field contained 145 rows, 45.7 m long on 101.5 cm centers. Grain sorghum hybrid "Niagara Oro T" was planted May 18, 1975, at a rate of ca. 10.1 kg seed/ha.

One application of parathion at 0.6 kg AI/ha to the entire test area was required July 14, 1975, to prevent plant damage due to greenbug infestation. The single treatment was effective, and no further treatments were required.

Each week, 10 plants were selected at random, and the number of female mites and mite predators were recorded on each leaf of each plant. Using a modified anthrone reagent method (Sunderwirth, Olson, and Johnson 1964), total soluble sugar concentrations were determined for leaves of 5 of the 10 plants. Each leaf was cleansed in the field using a water saturated cloth, and a 6 cm² disc was removed from either side of the midrib at the approximate midpoint of the leaf. Samples of leaf tissue were obtained via a hole punch. Leaf discs from 10 leaves of each plant were placed in a vial containing 5 ml of 80 percent ethyl alcohol. The vial was then submerged in a mixture of acetone and dry ice (liquified CO_2).

The vials were returned to the laboratory and submerged in boiling water (97.7°C) for ca. 30 minutes. This procedure extracted soluble leaf sugars which entered the alcohol solvent (Sunderwirth, Olson, and Johnson 1964). A 1 ml aliquot of the alcohol-sugar solution from each sample was transferred to a separate vial. The remaining 4 ml were discarded.

Ten ml of the anthrone reagent were added to each vial containing a 1 ml sample of the sugar solution. Such vials were capped and placed in a 95°C water bath for 15 minutes. Various shades of blue developed as a result of varying sugar concentrations in the sample. Heated solutions were placed under tap water and cooled to near room temperature. The concentration of sugars was determined using an Evelyn colorimeter calibrated at 620 mu which measured the optical density of the bluish-colored solution.

A series of concentrations (0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7 mg/ml solvent) of glucose in 80 percent ethyl alcohol served as standards, as well as a test of the suitability of the anthrone reagent and colorimeter. The optical densities of the various concentrations of glucose were directly proportional to increasing sugar concentrations. The reagent was discarded if variance of greater than 5 percent occurred in the standard curve.

Effects of Pesticide Applications on Spider Mites Infesting Sorghum

A test was conducted in 1974 to study a possible mechanism of insecticide induced outbreaks of spider mites on grain sorghum in the High Plains of Texas. The

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test was located on the Donald Terrel farm near Plainview, Texas.

The test field consisted of 138 rows, 333.8 m long with 101.6 cm row centers. The grain sorghum variety "McNair 650" was planted May 5, 1974, at ca. 10.1 kg of sorghum seed per ha. Fertilizer (11-37-0) was applied prior to planting at a rate of 156.8 kg/ha, and 244 kg/ha of anhydrous ammonia was applied post-emergence.

Applications of disulfoton (3.2 kg AI/ha) July 18 and 26, 1974, were necessary for reduction of greenbug populations. On July 5, 1974, parathion was applied at a rate of 3.4 kg AI/ha to 10 adjacent rows using a Hahn Hi-Boy®, high clearance spray machine. The 10 rows were located 33.5 m into the field from the west side.

Mite counts were obtained from 10 randomly selected plants from both the parathion-treated area and the surrounding check. Active stages of mites and mite eggs were counted separately. Counts of the active stages of mite development were not segregated.

Additional information collected included the number of spider mite colonies per plant, the size of each colony, and the number of mites in each colony. Predator counts also were recorded.

Effects of Water Stressed Sorghum on Spider Mite Populations

To determine the effects of moisture stress on the total soluble sugar content of sorghum leaves and subsequent effect on mite numbers, a test was conducted at the Texas Agricultural Experiment Station at Halfway, Texas. The test area consisted of 52, 101.6 cm sorghum rows, 243.8 m long. The grain sorghum variety "McNair 650" was planted May 20, 1975, at an approximate rate of 7.8 kg sorghum seed/ha. Two applications of parathion insecticide were necessary to prevent damage by greenbugs on July 17 and August 7.

The test was divided into plots containing 26 rows. One-half of the plots were irrigated when the soil moisture declined to a level recommended by C. W. Wendt* (personal communication), based on moisture levels and plant growth stage. These levels were based on the phenological state of plant development and available soil moisture. The alternate plot was irrigated shortly after emergence and received no additional water except from rain.

Soil moisture levels were estimated using Irrometer® tensiometers. A tensiometer was placed on rows 8, 16, and 24 of each plot at approximately 61.0, 121.9, and 182.9 m, respectively, into the field. The tensiometers were read and calibrated weekly.

Total leaf sugar content was determined by sampling 10 randomly selected plants from each plot. Analytical procedures were the same as those previously described.

Mite numbers were counted weekly on 10 marked plants of each plot. The plants were selected on alternate rows beginning on the third row from the exterior of each plot. Each plant marked was approximately 80 feet from its closest, neighboring marked plant.

Charles Wendt, soil and water research scientist, Texas A&M University Agricultural Research and Extension Center, Lubbock.

RESULTS AND DISCUSSION

Effects of Sorghum Phenology on Leaf Sugar Levels and Spider Mite Population Levels

Data collected in 1974 (Figure 1) indicated peak spider mite densities concomitant with host senescence, which agreed with previously reported research (Ehler 1974). However, data collected in 1975 indicated that peak numbers occurred during early dough stage (Figure 2). Discrepancies in mite population densities may be attributed to abiotic factors associated with the study area. Frequent, light rains occurring during August 1975 possibly caused the sudden decrease in mite numbers (Ward 1975).

Total soluble leaf sugar concentrations of sorghum fluctuated during the reproductive phase of grain sorghum development (Figure 3). Prior to the boot stage of plant development (July 14), total soluble leaf sugars averaged 1.2 mg per 6 cm² of leaf tissue. D. Kreig* (personal communication) suggested that this may have resulted from a temporary decrease in metabolic activity in the plant's reproductive portion prior to blooming.

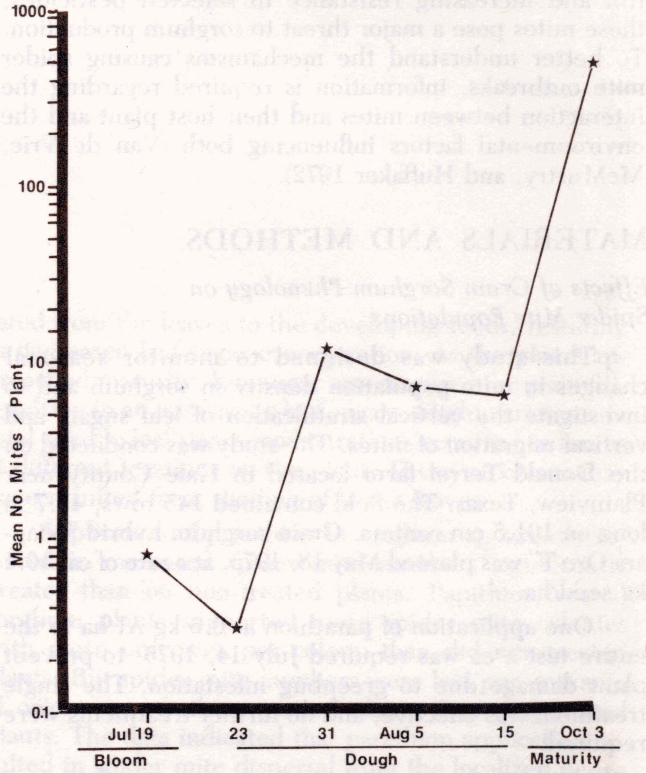

Figure 1. Seasonal abundance of spider mites infesting sorghum in the Texas High Plains, 1974.

Daniel Kreig, plant physiologist, Texas A&M University-Texas Tech University Cooperative Research Unit, Lubbock.

At the blooming stage (July 21 and 28) total soluble leaf sugars decreased to 1.3 mg per 6 cm² leaf tissue. Between plant bloom and maturity (July 28, 1975 to August 25, 1975) total soluble sugar concentration remained stable. This stability in soluble sugar concentrations was indicative of sugars produced by the leaves being transported to the developing seed (Eilrich et al. 1964).

Soluble sugar concentrations of individual sorghum leaves were also compared. No significant difference (5 percent confidence levels) occurred in soluble sugar concentrations between leaves.

No correlation was found between the fluctuating soluble leaf sugars and spider mite numbers (Figure 4).

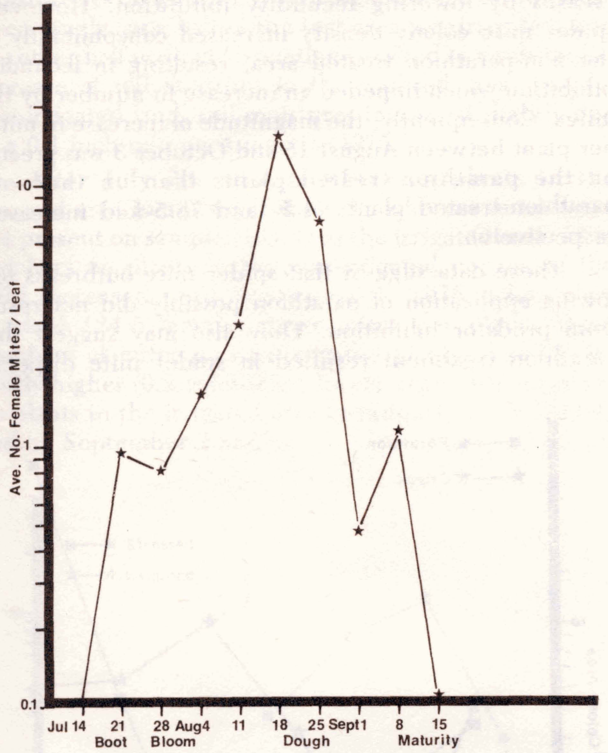

Figure 2. Seasonal abundance of spider mites infesting sorghum in the Texas High Plains, 1975.

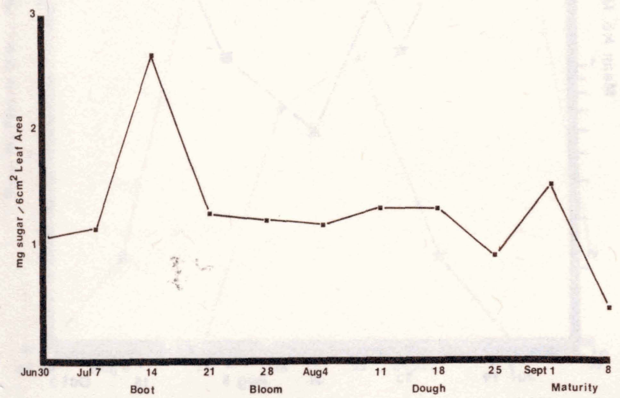

Figure 3. Total soluble leaf sugar concentration changes in response to phenology of sorghum.

Effects of Pesticide Applications on Spider Mite Populations in Grain Sorghum

Spider mite numbers increased following the application of parathion insecticide (Figure 5). Initially, large spider mite numbers were present in the parathion-treated area. However, disulfoton applied July 18, 1974, to control greenbugs reduced spider mite numbers on plants in both the check and the parathion-treated areas. An additional application of disulfoton on July 26, 1974, reduced mite numbers in the parathion treatment below that in the check.

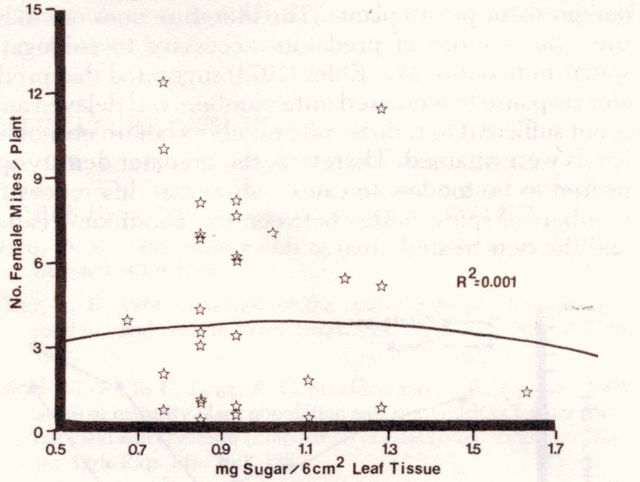

Figure 4. Correlation between total soluble leaf sugars concentration and spider mite numbers in sorghum.

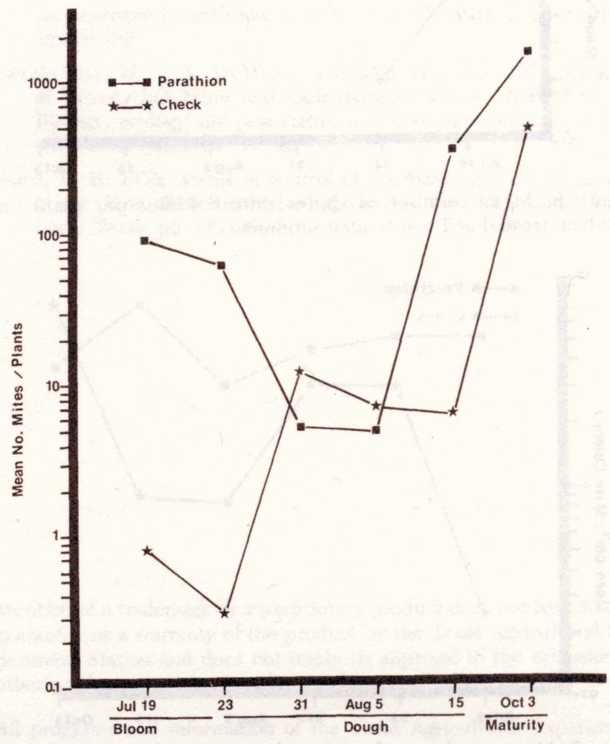

Figure 5. Seasonal abundance of spider mites infesting parathion-treated and non-treated sorghum.

Between August 5 and 15, spider mite numbers in the parathion treatment increased from 5 to 357 per plant (Figure 5). However, the number of spider mites in the check area remained relatively stable (7 to 6.4 mites per plant). On October 3, spider mite population densities were 1,629 per parathion-treated plant and 494 per non-parathion treated plant. An application of phorate (1.1 kg AI/ha) on October 5, 1974, decimated the spider mite population and no further counts were made.

Samples taken on each sample data indicated that spider mite predator populations were always less than one predator per 10 plants. The literature does not indicate the number of predators necessary to subjugate spider mite outbreaks. Ehler (1974) suggested that predator response to increased mite numbers was delayed and is not sufficient to reduce mite numbers before economic levels were attained. Therefore, the predator density appeared to be too low to cause substantial differences in numbers of spider mites between the parathion-treated and the non-treated areas.

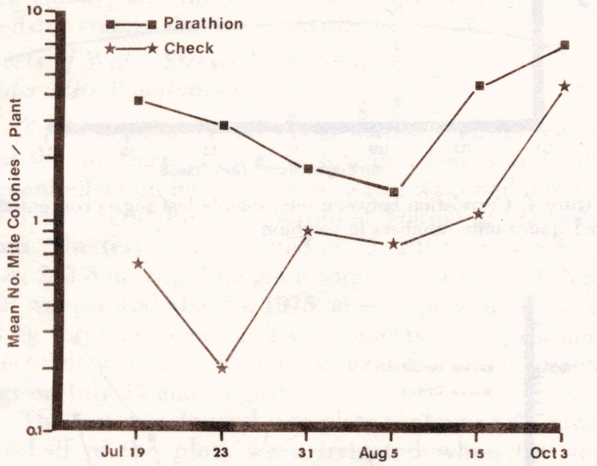

Figure 6. Mean number of spider mite colonies per plant on parathion-treated and non-treated sorghum.

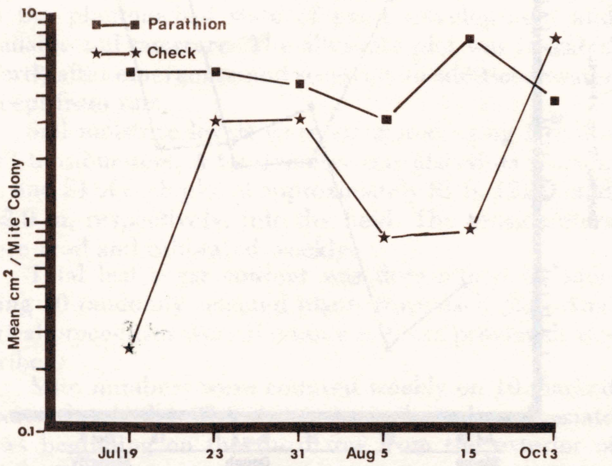

Figure 7. Mean area per spider mite colony on parathion-treated and non-treated sorghum.

Parathion-treated plants supported more spider mite colonies than non-treated plants (Figure 6). The area occupied per colony was also greater on the parathion-treated plants than on non-treated plants (Figure 7). However, on several sample dates (i.e., July 31, August 5 and 15) parathion-treated plants supported fewer mites per unit colony space than the non-treated plants (Figure 8).

Between August 5 and 15, mite numbers increased on the parathion-treated plants (Figure 6). Mite numbers decreased, however, in the non-parathion treated area during the same time interval. The less dense colonies on plants following the parathion treatment prior to August 15 may have facilitated rapid population increases by lowering fecundity inhibition. However, spider mite colony density increased concomitantly in the non-parathion treated area, resulting in fecundity inhibition which impeded an increase in number by the mites. Consequently, the magnitude of increase in mites per plant between August 15 and October 3 was greater on the parathion-treated plants than on the non-parathion-treated plants (4.5- and 78.5-fold increases, respectively).

These data suggest that spider mite outbreaks following application of parathion possibly did not result from predator inhibition. They also may suggest that parathion treatment resulted in spider mite dispersal

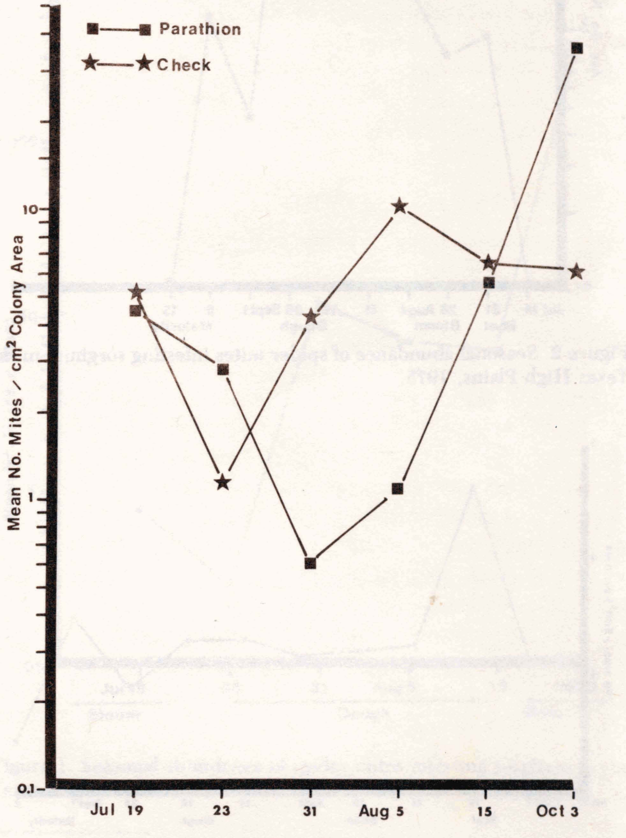

Figure 8. Mean number of spider mites per unit area of colony space on parathion-treated and non-treated sorghum.

from dense colonies, thus overriding the inhibition of fecundity effects of crowding (Davis 1952). Davis (1952) noted similar effects on *Tetranychus multisetes* McGregor, after application of DDT.

Effects of Water Stressed Sorghum on Spider Mite Population Levels

Soil moisture levels varied throughout the growing season. Prior to July 28, frequent rains totaling as much as 3.8 inches maintained soil moisture at high levels. However, at the plant bloom stage of development (July 28), soil moisture had decreased to 50 centibars, and irrigation of blooming grain sorghum was recommended.

Recommendation to irrigate was based on soil moisture levels and the physiological stage of the crop. Accordingly, one half of the test area was irrigated, and the other half was not. Irrigation resulted in a substantial increase of soil moisture in the watered area. On the non-irrigated land, soil moistures increased slightly due to a 0.1 inch rain on August 1, 1975.

After July 28, mite numbers on plants in the stressed area increased (Figure 9), whereas mites were not present on sampled plants in the irrigated area. Mite numbers on plants in the non-irrigated portion of the field increased until September 1, 1975, when they reached 124.6 female spider mites per plant. Mean numbers of mites on non-irrigated plants were significantly higher (0.2 confidence levels) than mite numbers on plants in the irrigated area on August 11, 18, and 25 and on September 1 and 8.

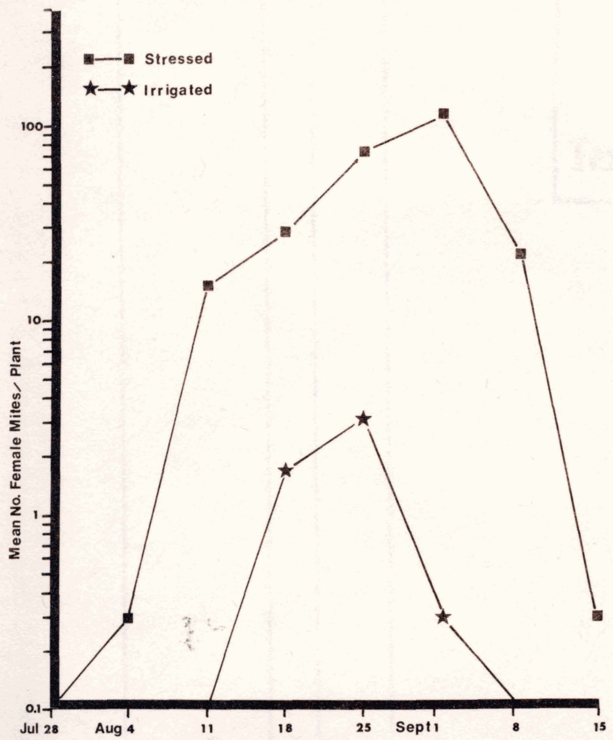

Figure 9. Mean adult female spider mite population levels per week on water-stressed and non-stressed sorghum.

The number of spider mites on plants in the irrigated area increased to 3.4 mites per plant on August 25, 1975. Spider mite densities decreased between September 8 and 15 in both areas (Figure 9). This decrease was expected as mite populations reportedly decrease at plant senescence (Ehler 1974). No substantial differences occurred between concentrations of total soluble leaf sugars of sorghum plants in the irrigated and non-irrigated areas.

In another experiment not described in this article, several rates of urea fertilizer applied to sorghum did not affect the spider mite populations densities, nor did significant changes in total leaf sugars occur as a result of the treatments.

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