FECUNDITY AND EGG HATCHABILITY OF TWOSPOTTED SPIDER MITE, *TETRANYCHUS URTICAE* KOCH (ACARI: TETRANYCHIDAE) REARED ON NINE SOYBEAN GENOTYPES[1]

Jo Ann Canal Wheatley[2] and David J. Boethel[3]

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ABSTRACT

Nine genotypes of soybean, *Glycine max* (L.) Merrill, were tested for their effect on fecundity and egg hatchability of twospotted spider mites, *Tetranychus urticae* Koch. Fecundity of both virgin and mated females was significantly affected by soybean genotypes and by the mites' mating status. The cultivar 'Tracy M' demonstrated antibiosis to *T. urticae* by reducing egg production. Plant Introduction 227687, which has demonstrated resistance to soybean insects, did not inhibit egg production by mites. DSR 352 and PI 227687 were the most susceptible genotypes in the study. Mated females laid more eggs than virgin females. Hatchability of eggs was not affected by soybean genotype or mating status.

Key Words: *Tetranychus urticae*, host plant resistance, soybean genotypes, *Glycine max*.

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INTRODUCTION

Plant-feeding spider mites of the family Tetranychidae are important pests of soybean, *Glycine max.* (L.) Merrill, in areas where hot, dry conditions occur (Poe 1980). In other areas, mites are potentially serious pests when normal weather gives way to the droughty conditions that favor their development. Considered the most destructive pest of soybeans in California's interior valleys (Carlson 1969), mites have also occurred in outbreak populations in Delaware (Baker and Connell 1961). The literature contains scattered references to similar sporadic outbreaks. Injury results in defoliation with corresponding reduction in dry matter production and yield.

Previous investigators (Parameswarappa et al. 1974; Bailey and Furr 1975; Cadapan 1976; Carlson et al. 1979; Rodriguez et al. 1983) have approached mite resistance in soybeans by examining host plant parameters and responses such as foliage damage, dry-matter production, and yield. A study (Mohammad 1984) that focused on mite biology measured population growth, life span, and fecundity. However, none of the previous studies have addressed the impact of cultivar differences on hatchability of eggs. Our study investigated fecundity and hatchability of twospotted spider mite eggs when the female mites were reared on nine genotypes of soybean. In addition, fecundity and hatchability were examined for both fertilized and unfertilized females because differences in these traits could indicate a mechanism affecting the male population.

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[2] Department of Crop Science, California Polytechnic State University, San Luis Obispo, CA 93407 (USA).

[3] Department of Entomology, Louisiana Agricultural Experiment Station, Louisiana State University Agricultural Center, Baton Rouge, LA 70803 (USA).

MATERIALS AND METHODS

Soybean Genotypes

Soybean genotypes used included six commercial cultivars from three maturity groups (Dairyland 'DSR 352' and 'Williams,' Group III; 'Clark 63,' Group IV; and 'Davis,' 'Tracy M,' and 'Centennial,' Group VI) and three plant introductions (PIs 171451, 227687, and 229358). 'Williams,' 'DSR 352,' and 'Clark 63' are three soybean cultivars commonly grown in the midwestern United States that also are grown in the interior valleys of California, where spider mites have been the major arthropod pest. 'Davis,' 'Centennial,' and 'Tracy M' are commonly grown in Louisiana and other southeastern states. Each of the three PIs used have demonstrated resistance to several insect pests in previous studies (Van Duyn et al. 1971; Clark et al. 1972; Hatchett et al. 1976; Smith and Gilman 1981; Orr and Boethel 1985).

Soybeans were raised in the greenhouse during May and June, 1986. The beans were grown in Sunshine Mix®, a commercial potting mix, using standard greenhouse procedures. When the plants reached the V4 (Fehr and Caviness 1977) stage of development, the second trifoliate leaf was removed and examined in the lab. If present, extraneous fauna was physically removed. Leaf disks (22 mm diam) were punched from the leaflets and ten disks placed adaxial side up, on a pad of moistened cotton wadding in one of six large, uncovered Petri dishes (150 mm diam) that made up an experimental block. A block of six dishes was set up weekly for five consecutive weeks. The Petri dishes were placed in a growth chamber and maintained at 31°C, 50% RH (± 5%), photoperiod of 14:10 L/D.

Spider Mites

Mites used were initially obtained from cotton plants in a greenhouse on the campus of Louisiana State University, Baton Rouge, LA. A lab culture was maintained on Henderson bush lima beans (*Phaseolus limensis* var. *limenanus* MacFadyen) under ambient conditions, ca. 23°C, and 45% RH. A photoperiod of 14:10 L/D was maintained for colony rearing.

Three females mites from the colony were placed on each leaf disk and allowed to lay eggs for 24 hrs, after which the females were removed. Parental females were uniformly young colonizers chosen from fresh, upper leaves on the lima bean plants. Disks were checked daily for egg hatch and subsequent development of the mites. Because it is difficult to differentiate between immature males and females, all mites on each disk were allowed to develop to the adult stage, and then the population of each disk was reduced to one female. Females that developed on a disk on which no males had emerged were virgin females, while females that developed on disks simultaneously with male adults were presumed to have mated, since mating usually occurs immediately after the last molt of the female (Boudreaux 1963). Females and males were also allowed to remain together for 24 hrs to ensure that mating had occurred. The experiment consisted of 205 virgin females and 151 mated females.

Adult female mites were allowed to lay eggs for 5.5 days and then were removed from the disks and the eggs counted. Under conditions similar to this test, *T. urticae* reared on the same nine soybean genotypes had been found to reach peak egg production in 5 days (unpublished data). As a definitive check on maternal mating status, mites were allowed to develop to the deutonymph or teneral adult stage for sexing. Since *T. urticae* is capable of arrhenotokous reproduction, virgin females produced males only while mated females produced female and male progeny. Sexed progeny were counted and removed daily until all eggs had hatched or had failed to develop normally and were obviously not going to hatch.

Analyses of variance were conducted on both fecundity and percent hatchability using a general linear models procedure (SAS Institute 1982). Means that differed at the 5% level of significance were separated by Duncan's multiple range test (Duncan 1955).

RESULTS

Fecundity

Soybean genotypes exerted significant effects ($F = 10.61$, $df = 8{,}50$, $P < 0.0001$) on total egg production (Table 1). Mites laid fewest eggs on 'Tracy M' compared with all other genotypes of soybean. The highest egg production count was recorded on 'DSR 352' and PI 227687, both of which had ca. a 2-fold increase in egg production compared with 'Tracy M.' The other six genotypes fell into an intermediate category.

Table 1. Fecundity of *T. urticae* females on nine genotypes of soybean. Baton Rouge, LA 1986.

	Virgin females		Mated females		Marginal means		
Genotype	n	$\bar{x}$ eggs	n	$\bar{x}$ eggs	n	$\bar{x}$ eggs*	SE
DSR 352	22	58.7	12	64.0	34	60.6 a	2.13
PI 227687	28	54.3	18	62.3	46	57.4 a	1.60
Williams	24	45.7	17	50.2	41	47.5 b	2.09
PI 171451	17	39.2	15	48.3	32	43.5 b	1.88
Clark 63	23	40.8	15	46.1	38	42.9 b	2.43
Davis	30	44.7	22	46.0	52	45.3 b	1.49
PI 229358	23	44.6	18	41.8	41	43.4 b	1.97
Centennial	19	44.8	15	39.5	34	42.8 b	1.86
Tracy M	19	30.2	19	41.3	38	35.8 c	1.99
Marginal means†		45.4 A		48.4 B			

* Means in columns followed by the same letter are not significantly different, $\alpha = 0.05$; Duncan's (1955) multiple range test.

† Means in rows followed by the same letter are not significantly different ($F = 14.28$, $df = 1, 50$, $P = 0.0004$).

Mating status significantly affected fecundity ($F = 14.28$, $df = 1, 50$, $P = 0.0004$). The average mated mite laid 6.6% more eggs than a virgin female. Although egg production was affected by both plant genotype and mating status, no interaction of genotype and mating status occurred ($F = 0.47$, $df = 8, 50$, $P = 0.8682$).

Hatchability

Although a numerical difference was present, there was no significant difference ($\alpha = 0.05$) in percent hatchability of eggs produced by either mated or unmated

T. urticae females. The mean percent hatch for all mites in the study was 96.3% and ranged from a low of 93.9% on PI 171451 to a high of 98.3% on Centennial. An arcsine transformation was done on hatchability percentages, but the differences were still not statistically significant.

DISCUSSION

Fecundity

Twospotted spider mites lay 90 to 100 eggs during an average life span of 30 days (Jeppson et al. 1975). During the 5.5 days allowed in the test for oviposition, both virgin and mated female mites produced about half their average egg numbers. Soybean plant introductions that have demonstrated insect resistance in previous studies were not resistant to twospotted spider mites. Total egg production for mites on plant introductions varied from most susceptible (PI 227687), to intermediate resistance (PIs 229358 and 171451). The cultivar 'Williams,' which has demonstrated field tolerance to spider mites (Cadapan 1976; Carlson 1979; Rodriguez et al. 1983), failed to exhibit resistance in our study that tested antibiosis. 'Tracy M' inhibited egg production to a significant extent in both virgin and mated *T. urticae.* A selection from Tracy, 'Tracy M' is tolerant to the herbicide metribuzin. 'Tracy' and 'Tracy M' have also been identified as being intermediate in resistance to feeding by foliar-feeding insects (E. E. Hartwig, personal communication). Both have been used as intermediate checks in screening breeding lines for resistance to insect soybean pests.

Although it has been assumed that the fertilization status of *T. urticae* females has no effect on fecundity (Overmeer and Harrison 1969; Helle and Overmeer 1973), Wrensch and Young (1975) found that fertilized females produced about 12% more eggs than unfertilized females. In an earlier study, Boudreaux (1969) noted that in a related species, *T. neocaledonicus* Andre, unfertilized females produced fewer eggs than fertilized females. The present work supports the observation that fertilized females of *T. urticae* produce more eggs than unfertilized females regardless of diet. In the present study, there were only two instances in which virgin females produced more eggs than mated females on a specific genotype (Table 1). The mean number of eggs laid by mated females was 6.6% greater overall than that for virgin females.

Hatchability

Plant resistance among cultivars found in fecundity comparisons was not detected in hatchability. Because there were no significant differences in percent hatchability among any of the soybean genotypes for virgin or mated mites, resistance as reflected by differential hatchability was not exhibited. The overall percent egg hatchability in our study was 96.3%, very similar to that reported by Wrensch and Young (1975) who found hatchability of eggs to be uniformly high (marginal mean = 95.3%) for both fertilized and unfertilized females. We conclude therefore that the male population was not affected, at least to the extent that could be measured by a difference in hatchability between haploid and diploid individuals.

Conclusion

The cultivar 'Tracy M' shows potential as a line with resistance to twospotted spider mite. The plant introductions used in this study have shown high degrees of resistance to a wide range of soybean insect pests. However, not only was resistance among the plant introductions not exhibited to twospotted spider mites, but in the case of PI 227687, susceptibility was also found. Advanced breeding lines and commercial cultivars having these lines as parents may be susceptible to severe attack by spider mites under hot, dry growing conditions.

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