Population Performance of *Thrips palmi* (Thysanoptera: Thripidae) on Cucumber Infected with a Mosaic Virus[1]

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ABSTRACT

Densities of larval, adult, and total populations of melon thrips, *Thrips palmi* Karny, a non-vector, were significantly higher on leaves of cucumber infected with watermelon mosaic virus 1 than on healthy cucumber leaves. Diseased leaves were also significantly smaller and contained lower levels of nitrogen than healthy leaves. Possible mechanisms affecting the thrips population differences between infected and healthy plants are discussed.

Increased survival and fecundity are common responses of arthropods feeding on host plants exposed to a variety of environmental stressors, including pathogens (White 1984). For example, viral infections of plants may enhance feeding and population growth of their insect herbivores. This has been documented for aphids (Kennedy 1951, Baker 1960, MacKinnon 1961, Markkula and Laurema 1964, Miller and Coon 1964, Laurema et al. 1966, Macias and Mink 1969, Singh et al. 1974, Hodgson 1981, Ajayi and Dewar 1983, Montllor and Gildow 1986), mites (Wilson et al. 1955, Thresh 1964, 1967), leafhoppers (Severin 1946, Maramorosch 1958, Jayaraj and Seshadri 1967, Purcell 1988), beetles (Gibbs 1980, Hare and Dodds 1987), and thrips (Carter 1939, Yudin et al. 1987).

In spring 1987, a field planting of cucumber, *Cucumis sativus* L., designed originally for a study of melon thrips (*Thrips palmi* Karny) impact on crop physiology and yields, began to show incidence of watermelon mosaic virus 1 (WMV-1) infection. This situation thus presented further opportunity to examine the effects of plant viral infection on a herbivore population. Little information is available on the population ecology of *T. palmi*, a major economic pest of cucurbits and other food and fiber crops in parts of the Orient and Pacific Basin (Johnson 1986). No previous work has recorded the interaction between diseased hosts and this non-vector species. The present study reports preliminary observations on the population performance of *T. palmi* on WMV-1-infected cucumber as compared to that on disease-free plants.

The experimental cucumber planting (cv. Burpee Hybrid) was established in late April 1987 at the University of Hawaii's Poamoho Experimental Farm. Evidence of viral infection was first discovered in late May.

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Watermelon mosaic virus can spread rapidly through a crop (Wolfenbarger 1966, Adlerz 1987). Therefore, in mid-June, before infection had become totally widespread, a sample of 20 each of healthy and infected leaves, from as many plants of each category, was collected. Leaf appearance was considered a valid criterion for selection of samples, as plants exhibiting no symptoms of WMV-1 infection yield no detectable viral incidence (Yeh et al. 1984). An equivalent degree of maturity in healthy and diseased leaves was approximated by selecting leaves of both categories from a similar position below the vine apex.

In the laboratory, the abaxial surface of each leaf was carefully examined under a dissecting microscope, and counts made of larval and adult thrips. Preliminary observations of cucumber leaves showed that thrips were concentrated on abaxial, and essentially absent from adaxial, surfaces, confirming previous reports (Nishio et al. 1983). Surface area of each leaf was estimated with a plexiglas overlay marked in cm^2 units. Thrips densities were adusted to number per cm^2 of leaf surface, and these data transformed (log [x+1]) to approximate normality (Southwood 1978). Significance of differences in thrips density and leaf area was assessed by *t* test. Bioassay determination of the virus and bulk analyses of healthy and diseased leaves for total nitrogen and nitrate nitrogen were made by the Agricultural Diagnostic Service Center, University of Hawaii.

TABLE 1. Population density of *Thrips palmi*, surface area, and nitrogen content (N) associated with watermelon mosaic virus 1-infected and healthy cucumber leaves.

	Leaf Sample (n=20)	
	Infected	Healthy
Thrips density		
Larvae[a]	0.2505 (0.0731, 0.4574)	0.0517 (0.0211, 0.0833)
Adults[b]	0.0718 (0.0404, 0.1040)	0.0351 (0.0229, 0.0475)
Total[a]	0.3213 (0.1346, 0.5387)	0.0867 (0.0463, 0.1286)
Leaf surface area[c]	225.8 ± 5.50	317.3 ± 7.13
Total N (%)	3.90	4.21
Nitrate N (ppm)	920	1010

[a]Back-transformed mean number (99.9% confidence limits) per cm^2 leaf surface.
[b]Back-transformed mean number (99% confidence limits) per cm^2 leaf surface.
[c]Mean area in cm^2 (± SE).

Diseased leaves were significantly smaller (t_{38} = 10.16, P<0.001) than healthy leaves (Table 1). Infection produced the yellow-green mottled pattern typical of mosaic diseases (Matthews 1981); healthy leaves were a uniform dark green. Nitrogen levels were higher in healthy than in diseased leaves (Table 1).

Densities of the larval, adult, and total thrips populations were all significantly higher (t_{38} = 3.65, 2.76, and 4.09; $P<0.001$, 0.01, and 0.001, respectively) on diseased than on healthy leaves (Table 1). Larvae and feeding damage tended to be concentrated in basal areas flanking the petiole, whereas adults were more dispersed over the leaf surface.

Larger herbivore populations on viruliferous plants have been attributed to altered host morphology, physiology, or attractancy (Maramorosch 1980). In the present case, differences existed between diseased and healthy cucumber leaves in at least two characteristics: nitrogen levels and color. These may have influenced the differences in *T. palmi* abundance.

Lower nitrogen levels in host plant tissues may promote population growth in some herbivorous arthropods, including thrips (Jones 1976). For example, studies on *Heliothrips haemorrhoidalis* (Bouché) by Wittwer and Haseman (1945) showed an inverse correlation between nitrogen content of spinach leaves and thrips density and feeding damage. However, no previous studies of thrips populations, in relation to diseased hosts, have analyzed plant tissues for nutrients. The lower nitrogen levels recorded here may have contributed to the higher *T. palmi* densities on WMV-1-infected cucumber leaves.

Alternatively, differences in leaf color might, in large part, account for differences in *T. palmi* abundance between diseased and healthy cucumber leaves. Yudin et al. (1987) found significantly higher thrips densities (primarily *Frankliniella occidentalis* [Pergande]) on lettuce infected with tomato spotted wilt virus than on healthy lettuce, and suggested the lighter shade of green of the diseased plants was more attractive to colonizing adults. In assessing color preference in thrips, these authors found the lighter colors of yellow and light green to be more attractive than darker greens. Similarly, Yamamoto et al. (1981) found *T. palmi* more attracted to traps of yellow and light green than to darker colors. Adult *T. palmi* may therefore have been attracted to diseased cucumber leaves in higher numbers because of their lighter yellowish or greenish-yellow hues. After attracting and retaining more adults, diseased leaves might then exhibit increased oviposition and larval hatch. The more than four-fold difference in larval densities between infected and healthy leaves (Table 1) supports this view. Controlled demographic studies are needed to determine conclusively the primary mechanisms influencing *T. palmi* population differences between virus-infected and healthy hosts.

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