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Comparisons of Traps and Visual Searches of Foliage for Monitoring Aphid (Heteroptera: Aphididae) Population Density in Broccoli[1]

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ABSTRACT

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Myzus persicae (Sulzer), *Hyadaphis erysimi* (Kaltenbach), and *Brevicoryne brassicae* (L.) were the most numerous aphid species collected in water and sticky traps and observed on the foliage of broccoli in two successive plantings during 1980 and 1981 in Santa Ana, Calif. Cylindrical sticky traps were more effective than water traps for collecting aphids. Correlation coefficients were low or not significant for comparisons of alatae from water or sticky traps and whole-plant aphid surveys in both plantings. Catches from water and sticky traps were not consistently correlated. Aphid collections from traps in untreated plots and traps in plots sprayed with pesticides were not significantly different, supporting the hypothesis that airborne aphid populations are relatively uniform.

Interest in trapping as a technique for monitoring aphid dispersal has increased during the last 20 years in several countries. O'Loughlin (1963) studied the seasonal occurrence of aphids and the relative efficiencies of water-filled yellow traps and wind-vane sticky traps in Australia. Medler and Ghosh (1968) reported on a regional network of traps designed to survey aphid migration patterns in the central United States. In England, Heathcote et al. (1969) reported that both suction traps and yellow sticky traps were more effective than a crop inspection program for predicting the first seasonal immigration of several important aphid species. Canadian scientists have used trap plants, yellow sticky traps, and suction traps to document the annual flight patterns of migrant aphids attacking vegetables in Ontario (Elliott 1971, 1980, Elliott and Kemp 1979).

Few researchers have attempted to relate the number of aphids caught in traps to actual field populations. Zettler et al. (1967) compared aphid catches from bean leaf samples with black sticky traps and found the counts were "similar." Zettler (1967) reported that counts from sticky traps were "in agreement" with the number of aphids collected from bean leaves. However, statistical relationships between sampling techniques and field populations were not presented. One objective of our study was to determine the correlations between trap catches and actual field populations of aphids. Because various trapping techniques are being used for aphid surveys, a second objective was to statistically document the association between aphid collections from water and sticky traps, two of the most common trapping methods currently employed to measure aphid migration. The influence of pesticide application on trapping is also discussed.

Materials and Methods

All experiments were conducted in two successive 0.4-ha plantings of 'De Cicco' broccoli at the University of California's South Coast Field Station in Santa Ana, Calif., during 1980 and 1981. Both crops were direct-seeded in single-row beds, sprinkle irrigated until emergence, and furrow irrigated thereafter. Row centers were 0.76 m apart in the fall, and 1.0 m apart in the winter planting. The fall crop was planted on 22 August 1980, thinned on 9 and 10 September, and harvested 27 October. The winter planting was seeded on 11 November 1980, thinned on 15 December, and harvested 5 February 1981. A buffer of at least 7 m of broccoli and 10 m of bare earth surrounded the entire test area to help reduce any 'edge effect' or influence of windbreaks as reported by Lewis (1969).

Twenty-four plots, each six rows wide by 20 m long, were established such that individual plots were separated by at least 5 m of broccoli. Three treatments were evaluated in a randomized block design. Six plots were sprayed with pirimicarb (0.28 kg of AI/ha) when aphid populations exceeded 5 to 10 per plant. Another six plots were treated when aphid density reached 100 per plant. The remaining 12 plots were not treated, and served as controls. Pirimicarb was applied to the fall crop on 12, 19, and 26 September and 2 October, and to the winter planting on 8 January. Plots with aphid densities of 5 to 10 per plant were treated on all dates listed; plots with aphid populations exceeding 100 per plant were sprayed on 2 October. Aphids were separated by species for six of the control plots and for the treated plots; aphid counts from the six additional control plots were used in analyses which were not species specific.

Each plot was monitored weekly for aphid density per plant by a stratified-random 10-plant sampling technique described by Trumble (1982a,b). Water traps, modified from a design by Moericke (1951), were placed in each plot and checked weekly. The traps were 30 by 35 by 12.7 cm, fitted with a rectangle (3 by 8 cm) of screen (100 by 100 mesh) to prevent overflow, and painted a bright yellow (Brilliant Yellow No. 55-302, PPG Industries, Inc., Pittsburgh, Pa.). Because colors vary in attractiveness depending on the aphid species tested (Eastop 1955, Robertson and Klostermeyer 1958), yellow was chosen on the basis of studies by Kring (1967) which demonstrated a preference for yellow by the aphid species commonly found on broccoli. Total yellow surface area per trap was 1,050 cm^2, as viewed from above. As plant height increased, the water traps were elevated

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to keep the tops of the traps at the height of the upper foliage to improve aphid-catching efficiency (Evans and Medler 1966). Several drops of liquid detergent were added each week to reduce the surface tension of the water in the traps.

Each plot also contained a yellow, cylindrical sticky trap patterned after a design by Broadbent et al. (1948) which was improved by Heathcote (1957a) and standardized by van Emden (1972). Water and sticky traps were aligned E-W with each type of trap alternating in the easternmost portion in every other plot. Sticky traps were constructed by attaching a 3.78-liter, 12.7-cm-diameter white paper can to a redwood stake, painting the can yellow, and slipping a 5-mil-thick, clear plastic sheath over the can. A cardboard lip, extending 2 cm horizontally from the bottom of the can, prevented the plastic from falling. The plastic was coated with Tack Trap and replaced weekly. Total area was 1,200 cm². The bottoms of the traps were located ca. 90 cm above the soil surface.

Trapped aphids were removed by soaking the plastic sheath for ca. 0.5 h in solvent in battery jars. The solvent dissolved the sticky material, freed the aphids, and did not damage the plastic. The aphid-solvent mixture was poured through screen (100 by 100 mesh) which collected the aphids. The insects were then easily transferred to 80% ETOH, and both the solvent and plastic were reused. This method proved more rapid and efficient than the serial transfer procedure described by Zettler (1967) and was used throughout this study. Aphid species were identified by using a dissecting microscope. Both water and sticky traps were operated between thinning and head formation, the plant stage which can tolerate some insect damage without economic loss (Kennedy and Oatman 1976).

Analysis of aphid counts from broccoli plants was described by Trumble (1982a). Mean aphid collections from water and sticky traps were generated by the Proc Means procedure of the statistical analysis system (SAS) (Helwig and council 1979). Correlation coefficients were produced by the Proc Corr procedure of SAS. Figures 1 to 4 are based on data from plots which did not have pesticides applied before the specified sampling dates.

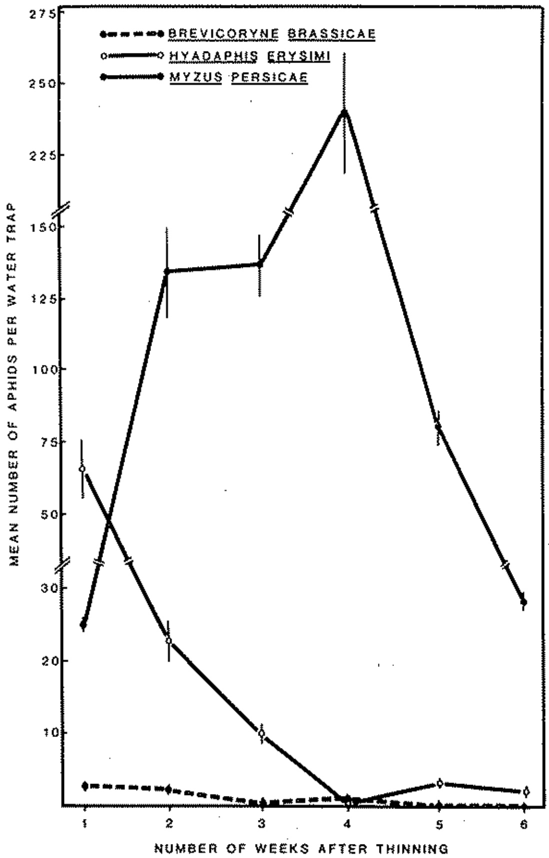

FIG. 1.—Mean collections of key aphid species per water trap between thinning and heading during a fall broccoli crop in 1980. Brackets on data points delineate SE.

Results and Discussion

The green peach aphid (GPA), *Myzus persicae* (Sulzer), the turnip aphid, *Hyadaphis erysimi* (Kaltenbach), and the cabbage aphid, *Brevicoryne brassicae* (L.), were the most numerous aphids collected from traps and observed on broccoli foliage. The potato aphid, *Macrosiphum euphorbiae* (Thomas), *M. ambrosiae* (Thomas), the greenbug, *Schizaphis graminum* (Rondani), and *Aphis spiraecola* Patch also were trapped, but since these species either occurred at low densities on broccoli or did not accept broccoli as a host, they were not included in the analysis presented here.

Figures 1 and 2 show water and sticky trap collections of aphids during the fall planting. GPA was the most common species collected in both types of traps. *H. erysimi* was less numerous than GPA, but was trapped more frequently than *B. brassicae*. Figures 3 and 4 show aphid collections during the winter planting. GPA was the most common species collected in water traps, but *B. brassicae* predominated in sticky traps. In contrast to reports by Heathcote (1957a), more *B. brassicae* and GPA were collected from sticky traps than from water traps. This variation cannot be explained on the basis of trap sizes, since traps of similar dimensions were used in both studies. Zettler et al. (1967) also found more GPA in water traps than on sticky traps, but since the water traps were yellow and the sticky traps were black, comparisons with the aforementioned experiments may not be valid.

Correlation coefficients (r) between trap catches and aphid counts from plants were small and of little predictive value. During the fall, aphid populations exceeded 200 per plant, and the relationships of alatae on plants vs. alatae from sticky traps were only significant ($P < 0.05$) for GPA ($r = 0.83$) and *H. erysimi* ($r = 0.79$). Water trap collections of *H. erysimi* were correlated with numbers of aphids on foliage ($r = 0.70$), but no significant correlations occurred between GPA or *B. brassicae* in water traps vs. alatae counts on nearby plants. Aphids reached a max density of only 15 per

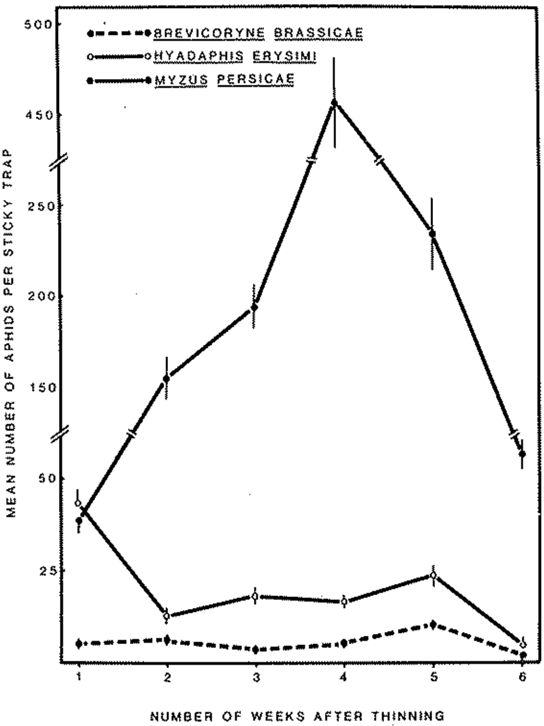

FIG. 2.—Mean collections of key aphid species per sticky trap betwen thinning and heading during a fall broccoli crop in 1980. Brackets on data points delineate SE.

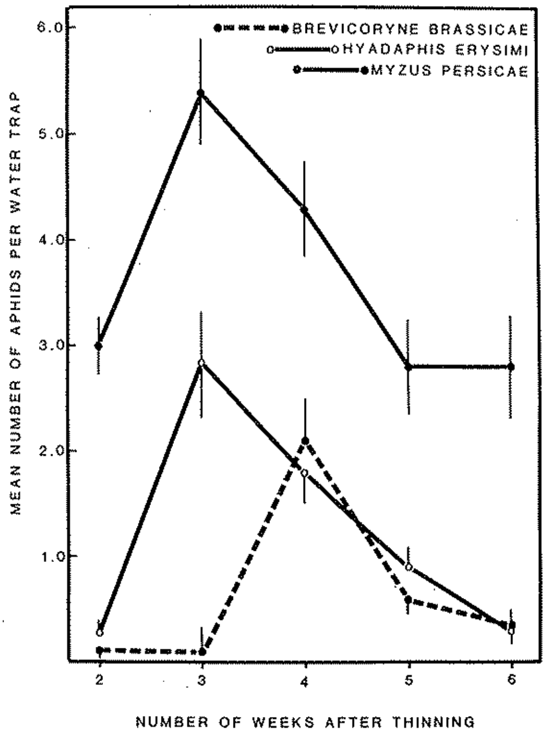

FIG. 3.—Mean number of alatae collected per water trap for three key aphid species during 1980 and 1981 in a winter planting of broccoli. Brackets on data points delineate SE.

plant in the winter planting, and no significant relationships were found between sticky traps or water traps and migrant aphids on foliage.

Additional comparisons of total aphid counts from plants (alatae plus apterae) vs. sticky traps produced correlation coefficients of r = 0.67 for GPA and r = 0.75 for *B. brassicae* during the fall planting, but no correlation coefficients were significant in the winter planting. Fall water trap collections of *B. brassicae* were related to total aphid counts from plants (r = 0.74), but water traps were not correlated with aphid counts from foliage during the winter. When all alates on sticky traps, regardless of species, were compared with all alatae per plant, the correlation was low (r = 0.82). Counts including all migrants collected in water traps were not significantly correlated with counts of alatae from broccoli. Thus, trapping as a method for surveying aphid density in the field may be only marginally useful. The use of traps to monitor aphid migrations to determine the potential for virus outbreaks as suggested by Heathcote (1957b) and Elliott and Kemp (1979) may be the most useful application of the trapping technique.

The total aphid collections (all species) from sticky traps were not significantly correlated with total water trap catches during either the fall or winter crops. When compared on a species-by-species basis, sticky trap catches were related to water trap catches for *H. erysimi* (r = 0.80) and GPA (r = 0.93) only during the fall planting. Therefore, data from water and sticky traps may not be statistically compatible throughout the year, and surveys incorporating multiple trap designs, such as those reported by Medler and Ghosh (1968), may be improved by utilizing a consistent trap design. However, other authors have documented correlations between trap plants and suction traps (Elliott 1971, 1980), sticky traps and plant counts (Heathcote et al. 1969), and suction and sticky traps (Elliott and Kemp 1979) when combinations of traps were used to monitor aphid dispersal at widely spaced locations (>3 km).

In spite of a reduction in aphid density on plants sprayed with pesticides, no differences in total aphid collections or counts of individual species were detected between catches from traps located in untreated plots vs. collections from traps in plots sprayed with pesticides at either aphid density level. This observation was similar to reports by Zettler (1967) which stated there were no significant differences in trap counts within 1- to 3-acre (ca. 0.4- to 1.2-ha) bean fields, and that the airborne winged aphid populations were relatively uniform over large areas. Thus, aphid trapping techniques would not be suitable for assessing pesticide efficacy. No significant correlations were found between trap catches and counts of aphids from plants in treated plots. However, the effect of pesticide residues on survival or repellency was not investigated, and the lack of significant relationships from this portion of the test may be an artifact

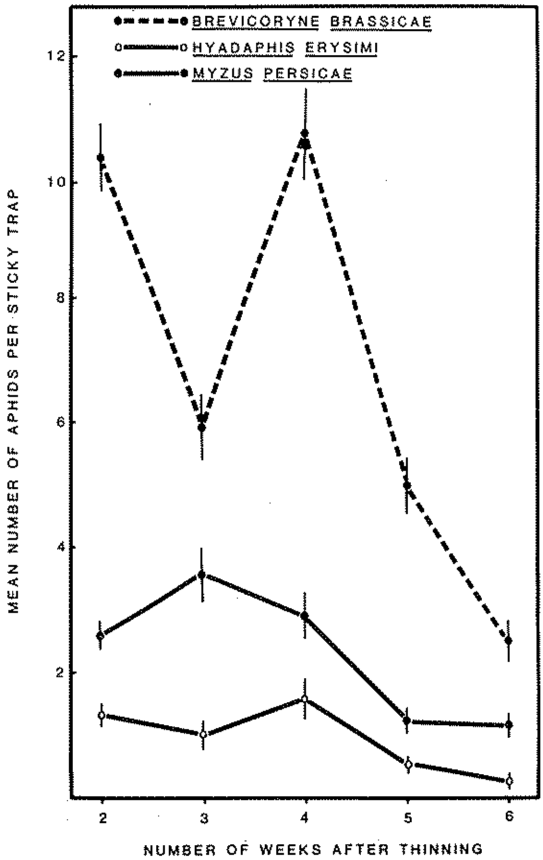

FIG. 4.—Mean number of alatae collected per sticky trap for three key aphid species during 1980 and 1981 in a winter planting of broccoli. Brackets on data points delineate SE.

of the incorporation of pesticides into the experimental design.

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