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PRELIMINARY REPORT ON SWEETPOTATO WHITEFLY CRAWLER MOVEMENT ON COTTONS

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Abstract

Sweetpotato whitefly (SPW), *Bemisia tabaci* (Gennadius) crawlers are vulnerable to environmental stress when searching for feeding sites under the extremes of heat conditions in southwest cotton growing area in the summer. Dispersal on plants may be a limiting factor in population dynamics in the field. We examined dispersal behavior differences on field grown cotton leaves in the laboratory in 1999 and 2000. Three out five crawlers released on lower leaf surfaces remained at the origin of releases, but all six crawlers released on upper leaf surfaces moved away from the release point origin. Compared with lower leaf surfaces, crawlers released on upper leaf surfaces stopped 7X more often but spent 70% less time per stop. They changed directions 7X more often and took 2X longer to travel 1.0 mm distance compared with crawlers released on lower leaf surfaces.

Introduction

Sweetpotato whitefly (SPW) is a worldwide economic pest. Adverse environmental stress during the first instar (crawler) dispersal on plants may be a limiting factor in population dynamics in the field in the summer (Summers et al. 1996). Temperatures frequently exceed 38ºC and humidity as low as 10% or less often occur in the southwestern desert areas. Crawlers are also exposed to numerous predaceous arthropod species during disposal. Thus, crawlers are vulnerable to abiotic and biotic factors when searching for minor leaf veins for feeding (Cohen et al. 1996a). Results of some studies suggested that crawlers in some cases settle within a few millimeters from their released points on the leaf surfaces (Price and Taborsky 1992, Summers 1997, Simmons 2002). In other cases, they may travel more than 200 mm away before settling (Summers et al. 1996). They have been reported to move from leaf to leaf, from upper to lower leaf surfaces whether the upper leaf surface is up or down, in relation to the sky, and behavioral activity during dispersal may differ on different plant species (Summer et al. 1996, Summers 1997, 2002, Simmons 1999, 2002). Crawlers have been reported to travel at a rate of 2.3 mm per minute (Cohen *et al.* 1996b) and for as long as 32 minutes (Simmons 2002). The distances from the points of release on leaf surfaces to feeding sites have been measured with a microscope micrometer or with the aid of video cameras (Price and Taborsky 1992, Cohen et al. 1996b, Simmons 2002).

We report here results of preliminary studies on the behavior of SPW crawlers on leaf surfaces of field grown cottons using a monitoring system designed for continuously recording details of dispersal on upper and lower leaf surfaces.

Materials and Methods

Equipment

The monitoring equipment consisted of two "Night Shot" digital video camera recorders (Model Digital 8, DCR-TR7000 NTSC, Sony Corp., Japan). The cameras were mounted on a black metal stand (Fig. 1). The lens of one camera was oriented to the upper leaf surface and that of the second camera to the lower leaf surface. The cameras are connected to a high resolution COLOR QUAD with playback zoom controller (Model Robot MV87 Colorguard, Sensormatic Electronics Corp., Taiwan), a time-lapse video cassette recorder (Model TLS-7000, Sanyo Electric Co., Ltd., Japan), and a video monitor (Panasonic, Model CT-13RNR, Caucus, NJ). A 2.5 cm diameter metal ring situated between the two cameras supported a leaf clip-cage containing a leaf with petiole inserted into a floral tube containing a water-nutrient solution.

The leaf clip-cages for confining crawlers on leaves were constructed from 3.8 cm diameter by 1.8 cm deep clear plastic petri dishes (Falcon® 3001, Becton Dickinson Labware, Lincoln Park, NJ). Petri dish tops and bottoms were replaced with transparent plastic sheets printed with 2 mm grids (Fig. 2). The total useable area of a cage was 7.1 cm^2. A 5 mm diameter ventilation hole was drilled in the side of each leaf cage. A hinged hair clip was attached to the petri dish for attachment to the leaf. A 4 mm wide styrofoam ring glued on the bottom and top edges of the petri dish cushions the leaf and seals the cages at the leaf surfaces. Leaf clip-cages were offset, leaving one-third of the leaf unenclosed to allow crawler movement from side to side of the leaf. Average weight of clip-cages was 6.79±0.04 (SE) g.

Experiment

Tests were conducted in the laboratory using group designs for field grown cotton (*Gossypium hirsutum* L., cv. Deltapine 5415 plants) leaves with upper or lower leaf surfaces facing upward. Leaves from 5^{th} cotton leaf nodes on plant main stem terminals were detached shortly after daybreak. Petiole ends were cut in water, fitted into a floral tube as shown in Figure 1. The leaf clip-cage with the leaf was placed on the leaf-cage wire support between the two cameras. In each test, the enclosed leaf occupied about two thirds of the 7 cm^2 leaf area of the cage (Fig. 2). About 3.5 cm of leaf perimeter edge was available for the crawler to move from one leaf surface to the other. One newly hatched crawler reared on greenhouse grown cotton was identified by number and transferred using a camel hair-brush to an upward facing, caged upper or lower leaf surface. The crawlers were placed 1 cm from the leaf edges. Eleven crawlers were released individually on separate leaves. Crawler movement following each release was monitored for 48 h. Temperature and humidity during the studies averaged 23.2-24.4°C and 23.5% RH, respectively, as measured with a sensor-data logger (Hobo®, Onset Computer Co., Pocasset, MA). The studies were conducted from 4 October 1999 to 6 March 2000.

Data Analyses

Data were analyzed by Chi-square tests using MSTATC microcomputer program (Anonymous, 1989).

Results and Discussion

Crawlers activities following their release on upper or lower leaf surfaces of cotton leaves from field grown plants varied widely under laboratory condition. Movement time (h) following crawler releases to locations of sessile sites or crawler disappearances ranged from 0.00 to 8.42 h (Table 1). One crawler stopped for 2.58 h and traveled 5.84 h following its release. Duration of crawler stops ranged from 15 seconds to over 1.85 h and travel rates ranged from 9.5 to 71.8 sec/mm. Of 11 crawlers studied, three crawlers released on lower leaf surfaces were found in the sessile condition where they were released. Two crawlers stopped one time, before they became sessile. All six crawlers released on upper leaf surfaces moved at least once before becoming sessile. Four crawlers released were found under styrofoam ring edges of leaf cages and two escaped. One crawler stopped 23 times between movements and another traveled to the edge of the styrofoam cage ring edges on hour 8.42 after release. On average, crawlers released on upper leaf surfaces of leaves from field grown cotton stopped 7 compared with less than one stop following release on lower leaf surfaces. On average, crawlers released on upper leaf surfaces stopped 7X more often with 72% less time per stop, changed directions 7X more often, and took 2X longer to travel 1.0 mm distance compared with those released on lower leaf surfaces.

B. tabaci crawler stage movements and possibly movements of immature stages of other whitefly species have been suggested as an indication of the susceptibility of a plant species to infestation (Summer et al. 1996, Simmons 1999, 2002). Crawler movement may also be a response to a feedback stimuli indicating an acceptable feeding site or some other leaf surface cue. Our results agree with earlier reports of other authors that crawlers prefer to settle on lower leaf surfaces (e.g. Summers et al. 1996). Proximity of minor veins has been suggested as an important factor in determining sessile site location of crawlers (Chu et al. 1995). However, the authors and others have not found it unusual to observe adults feeding and ovipositing followed by successful nymphal development to maturity on upper leaf surfaces (Chu et al. 1993, 1995, Lynch and Simmons 1993, Simmons 1994, 1999, Summers 1997 2002). Recent evidence indicates that stylets of SPW nymphs are long enough to enable them to reach feeding sites in minor leaf veins from any location on upper leaf surfaces. The results suggesting that nymph positioning on leaf surfaces is not a limiting factor in location of feeding sites (Freeman *et al.* 2001). Reasons for the whieflies preference for lower leaf habitats of whiteflies are unknown. Further studies are warranted since this knowledge may provide clues to pursue in developing whitefly host plant resistance.

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Table 1. Chi-square analyses of sweetpotato whitefly crawler movements in the laboratory following releases on upper or lower leaf surfaces of field grown cotton plants.

	No. crawler		**Crawlers moved**			
			Stops		**Movements**	
Leaf source	**not moved**	**moved**	**No.**	**Seconds/ stop**	**Direction change (no.)**	**Seconds/ mm**
Lower leaf	3	2	1.0 b	1738 a	10.0 a	22.8 a
Upper leaf	0	6	7.0 a	489 b	71.5 a	46.4 a

*Means of a pair comparison not followed by the same letters are significant by Chi-square test.

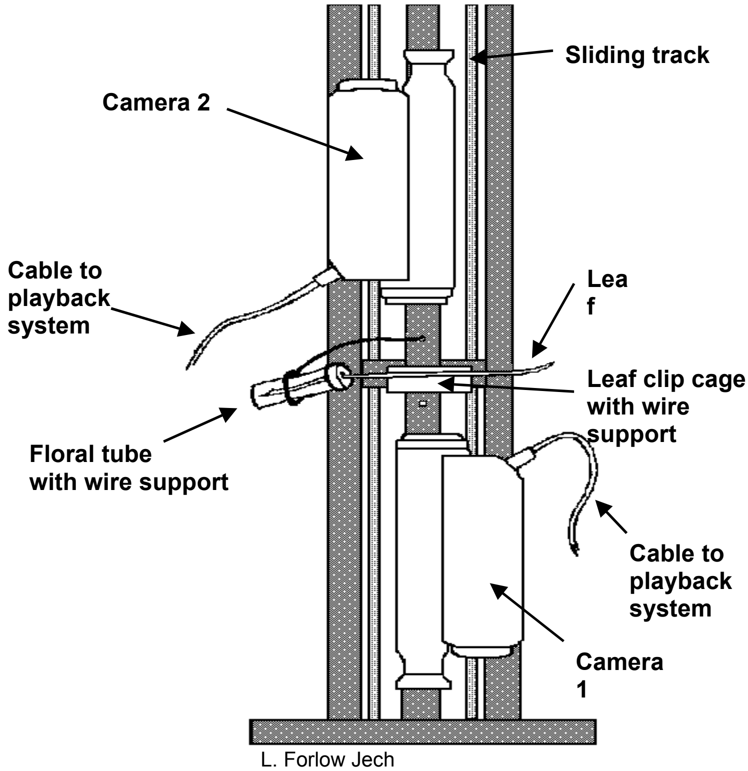

Figure 1. A camera system designed for monitoring movement of sweetpotato whitefly crawlers.

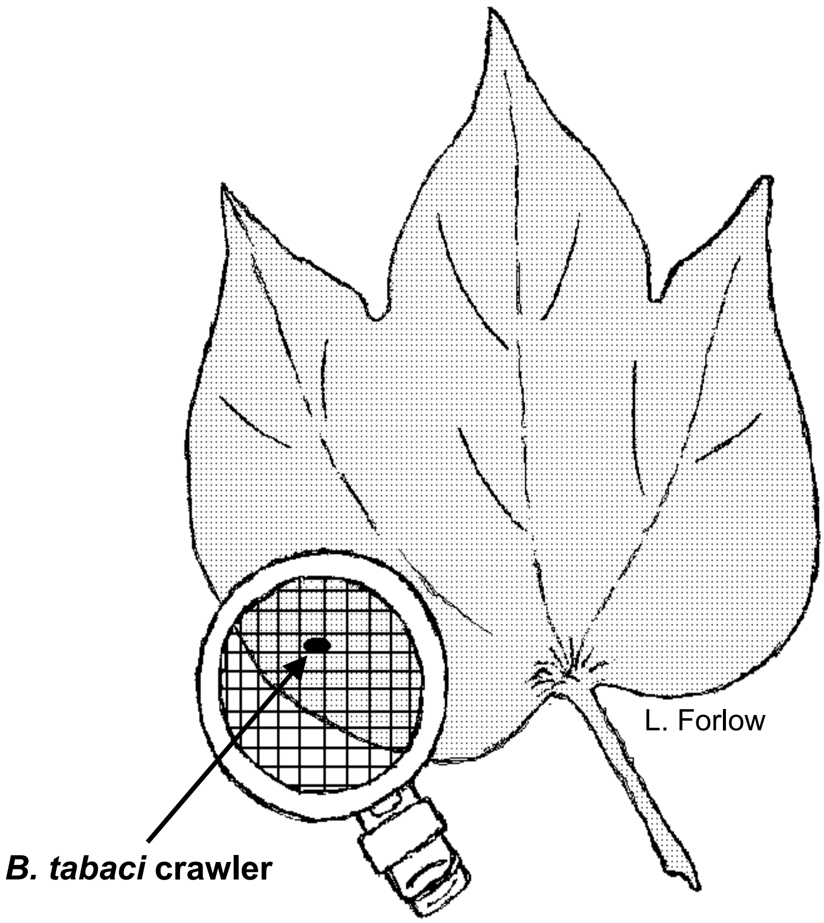

Figure 2. A leaf clip-cage with the enclosed leaf blade.