

# IDENTIFYING SHORT-RANGE MIGRATION BY THE SWEET POTATO WHITEFLY

David N. Byrne<sup>1</sup>, John C. Palumbo<sup>1</sup>, T. V. Orum<sup>2</sup> and Robin J. Rathman<sup>1</sup>

## Abstract

*Populations of the sweet potato whitefly, Bemisia tabaci, have been shown to consist of both migratory and trivial flying morphs. The behavior of these forms as part of the process of short-range migration needed to be examined under field conditions. Insects were marked in a field of cantaloupes using fluorescent dust. During the first growing season traps, used to collect living whiteflies, were placed along 16 equally spaced transects (22.5° apart) radiating out from the field to a distance of up to 0.6 miles. Wind out of the northeast consistently carried migrating whiteflies to traps placed along transects in the southwestern quadrant because cold air drainages dictate wind direction during early morning hours. For this reason, during the second season traps were laid out in a rectangular grid extending 3 miles to the southwest of the marked field. If dispersal was entirely passive or wind directed patterns could be described using a diffusion model. Statistical examination of the data, however, demonstrate that the distribution on all days was patchy. Traps in the immediate vicinity of the marked field caught more whiteflies than the daily median. Large numbers were also collected from around the periphery of the grid. Whiteflies were far less prevalent in the grid's center. As a result, the distribution of captured whiteflies can be described as bimodal. These patterns confirm behavior observed in the laboratory, i.e., a portion of the population are trivial fliers that do not engage in migration and are consequently captured in traps near the field and a portion initially ignore vegetative cues and fly for a period of time before landing in distant traps. This second population comprises the second peak in the model that appeared 1.6 miles from the marked field. On a localized level, 1.6 miles seems to be how far whiteflies move in a day. Earlier studies indicate that whiteflies only fly one day.*

---

Departments of Entomology<sup>1</sup> and Plant Pathology<sup>2</sup>, University of Arizona, Tucson, AZ 85721, byrne@ag.arizona.edu

## Introduction

The sweet potato whitefly, *Bemisia tabaci* (Gennadius) is an increasingly important agricultural insect worldwide. The application of pesticides is the principal control option available to growers. This strategy has become increasingly less effective in recent years as a result of heightened levels of pesticide resistance. Optional strategies such as cultural control techniques are needed. One possible set of alternatives is to alter crop placement and to manipulate irrigation schedules based upon models that predict when, where and how far whiteflies are going to migrate. The development of such techniques requires a better understanding of whitefly flight behavior (more specifically short-range migration). Much of this information has already been generated in the laboratory, but these experiments needed to be corroborated with field studies.

Microclimatic factors, particularly wind, affect insect dispersal. Small insects are generally thought to be passive fliers and therefore dependent on air currents to carry them to new sites. In these situations distribution patterns frequently reflect wind-flow patterns.

## Materials and Methods

Field experiments conducted in 1992 concentrated on the impact of wind flow on the directionality of flight by *B. tabaci*. Studies were completed on seven different dates during August, September, and October at the University of Arizona's Yuma Valley Agricultural Center. Mountains to the north and east provided cold air drainages that dictate wind direction. This corresponds with the period of the day during late summer and early fall when most whitefly flight takes place in the Southwest.

A 1.0 acre circular field was planted with cantaloupe in late July to serve as a whitefly source for the trapping studies. Whitefly populations were allowed to increase in this plot. In early July the area around the cantaloupe field was surveyed for placement of muffin fan traps along a series of 16 transects (22.5<sup>o</sup> apart). The melon field was surrounded by fallow ground in all directions at distances of at least 350 ft.

The evening before each sampling day (between 1700 and 1900 h) the melon field was dusted with 90 kg of Day-Glo® fluorescent pigment. The traps were turned on between 0600 and 0700 h the morning of each sampling day. After 3 hours, whiteflies were collected from the traps into individual vials using a battery-driven, hand-held vacuum.

Field experiments whose aim was to examine patterns of migration and dispersal for the sweet potato whitefly were conducted at the YAC from July through October 1993. Again, a 1.0 acre melon field planted in June and replanted in August was used as a whitefly source. Experiments were initiated when populations had reached or exceeded 10 adult whiteflies per leaf.

Based on 1992 data we concentrated traps in the area away from the direction of the early morning prevailing winds. The area west and southwest of the melon field was surveyed for placement of the passive muffin fan traps (114 during July and August and 121 traps

during September and October). Traps were placed at ground level along an existing network of roads, canals, ditches and fields. The most distant traps were approximately 3.0 miles from the melon field.

As in 1992, the evening before each sampling date (i.e., between 1700 and 1900 hours) the melon field was dusted with Day-Glo® pigment. Between 0930 and 0945 (3 h after the traps had been turned on) whiteflies were again collected into individual vials from the traps using hand-held vacuums. Whiteflies were sorted (marked versus unmarked and dead versus alive).

## Results and Discussion

For each sampling date in 1992 the relationship between wind flow and the number of whiteflies captured in traps in the direction opposite the prevailing wind was evaluated. The directional component of their movement was further demonstrated. If marked whiteflies moved away from the field in a diffusion pattern you would expect equal numbers of whiteflies would be caught along all transects. As stated, whiteflies were predominantly captured in traps placed southwest of the marked field, being carried there by winds blowing out of the northeast

To examine the patterns of whitefly distribution across our grid in 1993 we established distance classes described by arcs at 210 ft. intervals from the center of the marked source field for each trapping day. The number of traps in each distance class varied, so an average number of whiteflies per trap was calculated for each distance class. The proportion of whiteflies for each distance class was computed by dividing the average number of whiteflies per trap by the sum of the averages over all distance classes. We averaged the proportion for each distance class across the eight sampling days. This provides the proportion of whiteflies expected in any given distance class and thus represents a probability plot by distance. A plot of these data is shown in Fig. 1, which clearly depicts a bimodal distribution with one peak appearing very close to the marked field and a second peak appearing at approximately 1.6 miles. This indicates how far white fly on the one day they do so.

Data analysis and maps of indicator trap counts further highlight the patchy distribution of our dispersing whiteflies. On every date except September 30th, in at least one direction, sample variogram values increased with lag distance. For clarity, sample variograms only in the direction of the most obvious spatial structure are shown. The range of lag distances over which variogram values increase to a plateau can be associated with patch size. Only on October 7th was there a sample variogram that suggested a trend in the data by demonstrating a parabolic shape. In general, the variogram analysis suggests a patchy pattern with no obvious gradients.

Two principal features were evident when we examined the findings of our field experiments: dispersal was largely wind-directed and whitefly distribution following dispersal was patchy and not diffuse.

Wind patterns in the desert Southwest are more predictable than elsewhere (Brown *et al.*, 1994). Preliminary analysis of weather patterns in 1992 and 1993 indicated that prevailing winds in the early morning in the Yuma Valley were routinely from the northeast and followed cold air drainages. Information for the Yuma Valley farm indicate that the down drainage flow pattern (from the Northeast) is very evident in the early morning hours from 5 to 10 am in September and October. Conditions during that time of the year are then ideal for facilitating whitefly migration. Large populations are exiting cotton because irrigation water has been terminated. Light winds are blowing in a consistent direction during the time of day when most flights are observed. These factors account for the strong directional component of our whitefly patterns of migration.

Almost all of the sampling dates show greater trap catches near the marked field and on the periphery of the grid than in the center of the grid. The trap catch does not indicate a simple diffusion pattern, a pattern that might be expected if dispersal was passive across featureless topography. Our patterns had a more patchy component and the distribution can be described as bimodal. We believe that this may be explained by the existence in whitefly populations of two distinct morphs, a trivial flying morph and a migratory morph. Insects caught in the immediate vicinity of the source field are likely trivial fliers, while those caught on the grid perimeter are thought to be migratory individuals. The explanation for the relative paucity of whiteflies caught in the middle of the grid is that migratory whiteflies do not respond to vegetative cues until they have flown for a given period of time.

Our studies have shown that the greatest distance marked whiteflies have been trapped is 3.0 miles from a source field. Since whiteflies were consistently captured in the most distant traps, the effective migrational range of *B. tabaci* may be considerably greater than this. Future experiments will be conducted with an expanded grid to further define the effective migrational range of *B. tabaci*.

