

Have Distances Traveled by the Sweet Potato Whitefly Been Underestimated?

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Abstract

The importance of the sweet potato whitefly to Arizona vegetable continues to ebb and flow from year to year. Over the last 25 years much of this likely is tied to the invasion by different strains. As we continue to study this insect, an aspect of importance to their management is their ability to disperse. In past studies we have determined how far they are capable of flying in a day's time, 95% migrate 1.6 miles. We are now investigating their ability to fly multiple days. If they do migrate on more than 1 day, we must readjust our estimates of their influence on surrounding fields.

Introduction

The sweet potato whitefly, *Bemisia tabaci*, has been a significant pest of vegetable crops and cotton since populations greatly expanded in the early 1980s. Some attribute this to the extensive use of pyrethroid insecticides. A more likely explanation, however, given our current understanding of the extreme differences in subsets of the sweet potato whitefly species, is that there was an introduction of a new strain, strain A, into our production system. A similar occurrence likely took place in the late 1980s with the arrival of strain B, and now we face the possibility of a reoccurrence with the arrival on nursery stock of a third strain, strain Q. Strain Q has not been reported in the field in Arizona, but has been seen there in Florida. The fact that these invasions are responsible for increased numbers of sweet potato whiteflies is likely, but unproven.

Regardless of cause, it is undeniable that the sweet potato whitefly is often present in large numbers and needs to be better understood from a pest management perspective. One the most impressive aspects of sweet potato whitefly behavior, a phenomenon that could be of consequence to growers (see below), is the ability of these insects to migrate between crops in southwestern agricultural systems. Past experiments show that sweet potato whiteflies are capable of sustained flight in the laboratory for at least 3 hours. This was learned by examining whitefly flight behavior in a laboratory setting using a vertical chamber (Fig. 1).

The operation of the chamber remains simple. The Arizona chamber consists of a large, 18 ft³, open-fronted box with a central opening in the roof into which fits a smaller open box containing a sodium vapor light (sky cue). Mounted on the side of the chamber is a blue/green light source that simulates a plant cue. Muslin screens dampen air turbulence. The draft is regulated not by changing the fan speed, but by adjusting the chamber aperture. This is done manually using a handle. The setting of the aperture is constantly adjusted to keep the flying insect 7 inches below the screen of the light box. Digital readings from an anemometer measure wind flow generated by the overhead fan and are recorded by a computer.

These data are an indirect measure of insect rate of ascent. Insects ignoring the plant cue while flying towards the sky cue for an extended period are identified as being migratory. This behavior fits accepted definitions of migratory behavior.

These laboratory data concerning sustained flight were corroborated in field studies conducted in Yuma. Sweet potato whiteflies were marked and their distribution following dispersal across an 8-mile² grid was noted. A significant portion of the whitefly population dispersed farther than 1.6 miles in a 4-hr period. This could easily carry them into a new crop. We did not ask if this insect flew a similar distance the following day.

We now find that we may have been underestimating the distances traveled by these whiteflies when migrating. This is because we now have preliminary information indicating these insects fly on more than one day. We are often asked questions such as, “How far away must an unplowed watermelon field be before I do not have to worry about those whitefly populations affecting my crops? – or – How far is this plant disease going to spread in a season?” Answers that we were comfortable providing in the past may not be correct. We may have to adjust our response based on new results.

There is currently disagreement between the relative importance of long-range migration from Mexico and Central America as opposed to local intercrop migration by whiteflies across the growing season as a contributor to whitefly populations. We currently believe that there are large resident sweet potato whitefly populations in Arizona that simply move into crops as new sites become available. We also believe such long-range flight was not within the capabilities of the sweet potato whitefly. We need better empirical evidence, however.

Materials and Methods

To determine whether the sweet potato whitefly flies on multiple days we returned to the flight chamber. Whiteflies were reared on cowpeas. Leaf punches with large nymphal populations were taken from leaves and placed in Petri dishes containing agar-filled bottoms. The next day, newly emerged whiteflies were placed individually in similar dishes. The following day, these insects were transferred to small vials and placed in the flight chamber. They were given 3 minutes to fly toward the sky cue. We counted as having flown any insect that initiated any flight, regardless of whether it simply flitted from the vial or flew for as long as 18 minutes. Additional analyses are necessary. The proportion initiating flight, their rate of ascent, and number that continued to fly toward the sky cue were recorded¹. After being in the chamber, insects were returned to new Petri dishes with new leaves. This process was repeated for up to 10 consecutive days (8 were more usual) or until the individual whiteflies were either lost or died.

Results and Discussion

To date we have observed a total of 98 individual whiteflies². We did find that certain of these whiteflies flew on multiple days (Fig. 2). This figure indicates that 50% of observed whiteflies flew on Day 1. Of

¹ If they continued to fly toward the sky cue and ignored the plant cue, they were identified as being migratory.

² In the beginning, most insects are lost, squashed, or disappeared into the ethers. As techniques improved, our sample size has increased.

those that flew on Day 1, 47% flew on Day 2. These data are shown to Day 10. Although we present our data on consecutive day flights above, we do not know the importance of multiple day flights toward total lifetime movement by individual insects. What we have not yet determined, for example, is whether or not insects that flew on Day 5 also on Day 2. This information is available, but data have not yet been analyzed. We also have information that shows that some females had flights as many as 10 days following emergence. No male flew after Day 5.

We also know on which day whiteflies flew the longest (Fig. 3). The most flights and the longest flights took place on Day 1. This figure is somewhat deceiving since very few whiteflies were available to fly on Day 7; many were lost by that time. On that day there we have information on 15 only insects. Of the seven that flew, one flew for 5 min., 12 sec., greatly biasing the data.

Of the 98 insects that we observed, only two engaged in migratory flight, i.e., they flew toward the sky cue for an extended period while ignoring the plant cue. Neither of these flew a second day. From previous studies, we know that it is the migratory individuals that fly between crops. Of the others that flew, even those flying as long as 18 minutes were engaged in foraging flight. This would keep them in the fields where they originated. We are confident we will be able to answer questions about sweet potato whiteflies migrate on several days once our data is all collected. This will provide a clearer picture of how whiteflies can travel as adults.

We have learned the following in our laboratory studies.

- Our longest male flight was 30 min., 38 sec.
- Our longest female flight was 17 min., 35 sec. Of those flying for > 100 sec, none flew again
- One female flew 5 of 7 days
- We have egg deposition data that are yet to be explored
- We know how fast they were flying and for how long, so we can estimate distance traveled.

These data need to be explored more fully.

Our future objectives include adding to our laboratory data set. We also realize that our conclusions on distances traveled will have to be corroborated with field data. Can these insects survive for a second day of a flight having experienced the stress of being airborne under field conditions? What is the effect of wind on movement? We hope to begin these experiments in the field in Yuma next summer.

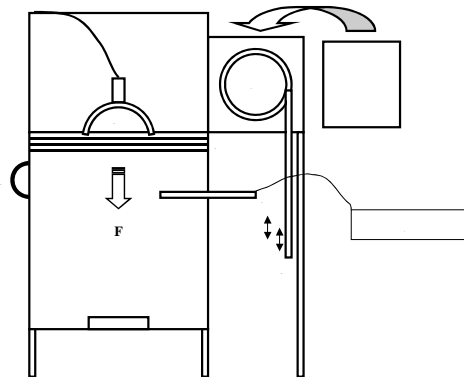


Fig. 1. Diagrammatic vertical section of flight chamber, A = 550 nm light source, B = sodium vapor lamp,

C = aperture, D = squirrel cage fan, E = muslin screens, F = air flow direction, G = anemometer, H = handle, and I = computer.

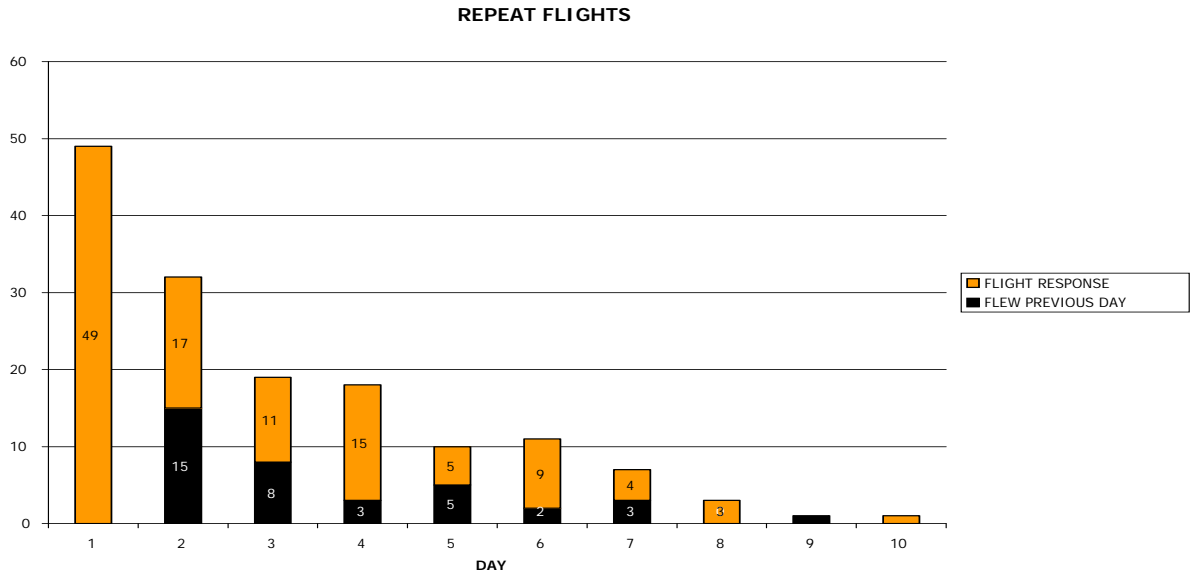


Fig 2. Results of days on which whiteflies fly as related to flight on previous day.

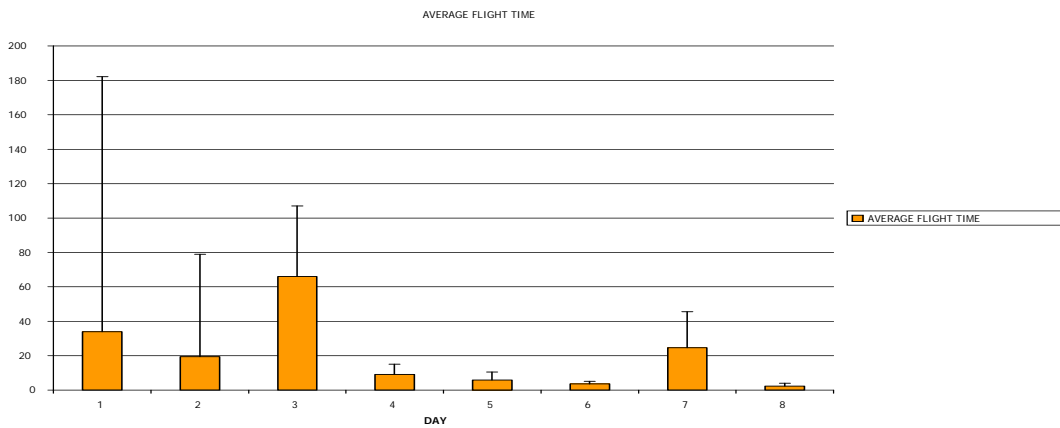


Fig.3. Average flight time, by day, of the sweet potato whitefly.