DIFFERENCES BETWEEN COTTON AND MELON IN HOST ACCEPTANCE BY *BEMISIA TABACI*

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Abstract

Field and greenhouse experiments were conducted to evaluate the attractiveness of melon plants relative to cotton plants. The objectives were to quantify the differences between melons and cotton in terms of the number of adult whiteflies that settle on either plant, then determine the level of oviposition on each plant type. The ultimate goal was to determine if higher attractiveness to melons by *Bemisia tabaci* may be exploitable by using melons as a trap crop for cotton. Two different greenhouse studies established the greater attractiveness of whiteflies to cotton in addition to higher oviposition on melons. Adult settling and oviposition rates were greater on melon in the greenhouse experiment that used whole plants and for which whiteflies were free to move from plant to plant. A similar pattern was observed in the cylinder cage tests, but the differential in adult settling and oviposition between melons and cotton, although highly significant, was not as great as the greenhouse test. Large differences in settling and oviposition were also observed in field studies that explored the use of melons as a perimeter trap crop around cotton. Significant reductions in whitefly densities were observed in cotton plots surrounded by melon trap crop compared to cotton plots without a perimeter planting of melons. Both greenhouse and field results suggest that melons can attract and hold dispersing whiteflies and result in a reduced infestation in cotton.

Introduction

Crop damage and destruction by infestations of *Bemisia tabaci* (Genn.) have occurred in many commodities grown in both protected and unprotected environments. Well over 500 species of plants are colonized by *B. tabaci*, but the more impressive detail may be the large and diverse number of crops aggressively attacked by this tiny homopteran insect. In the arid Southwest, vegetable, melon, and field crops rotated year round are all subject to heavy infestations by *B. tabaci*, thus requiring intensive management to prevent economic losses. Although attack of these diverse crops at times appears to be indiscriminate, closer observations in the field usually reveal differences in densities of *B. tabaci* on various crop hosts grown in close proximity to one another. In particular, melons have been widely recognized as highly attractive to *B. tabaci*, especially the Type B strain often referred to as the silverleaf whitefly. From the time of the first eruptions in California and Arizona of this new whitefly strain, melons have been highly vulnerable to *B. tabaci* infestations because of the large numbers of whiteflies attracted in addition to the high colonization rates.

Differences in attractiveness and overall suitability among plant and crop hosts provide an opportunity to control the cropping environment as part of a pest management program. Trap cropping involves the manipulation of crop stands in time and space with the objective of concentrating a pest species within the trap crop rather than the main crop (Hokkanen, 1991). Whiteflies are amenable to trap crop management because of their high polyphagy and their differential utilization of various hosts. Another reason whiteflies are good candidates for trap crop management is that their seasonal population development shows a regular and predictable pattern in accordance with crop succession and calendar time. For example, dispersal into cotton fields in central Arizona tends to occur from mid- to late July. Cultivation of a trap crop could be planned in anticipation of when whiteflies would be most likely to immigrate into a susceptible crop. Concentration of *B. tabaci* into a perimeter trap crop could then be followed by intensive management in the trap crop.

The objective of the present study was to quantify the difference between cotton and melons in attractiveness to *B. tabaci* with a series of greenhouse and field experiments. A further objective was to begin work on the feasibility of using a melon trap crop to concentrate and manage whiteflies within the trap crop as protection for the main cotton crop.

Methods and Materials

Cylinder Cage Experiments

A series of tests were conducted using acetate cylinders 0.6 m high by 0.28 m diameter. Three equidistant slots were cut into the cylinder wall at a height of 0.46 m and were large enough for fully expanded melon and cotton leaves to be inserted into the interior space of each cylinder. The tops of the cylinders were covered with nylon organdy to retain whiteflies within the cylinder space. The leaves projecting into the cylinder interiors remained attached to their plants. A foam-rubber collar was sandwiched around each leaf petiole and then snugly fit into the rectangular slots in the cylinder walls so that no whiteflies would be able to escape from the interiors. Once all cylinders were fitted with their complement of leaves and all openings sealed, they were ready to be infested with adult whiteflies. Adult whiteflies were aspirated from colonies maintained on both melon and cotton plants. Approximately 120 adults were collected into an aspiration tube, then transferred through a sleeve opening to be released inside each cylinder cage. Prior to the release, each cylinder cage was placed beneath a hanging fluorescent light fixture that provided overhead light only; all other ambient light in the release room was turned off or blocked. The tube containing the adults was fastened to the bottom center of each cylinder cage, then the plug released to allow the adults to escape. Above the release point of the whiteflies, 2 cotton leaves and 1 melon leaf projected into the interior space of each cylinder. Two cotton leaves were used to just 1 melon leaf to acknowledge the differential that would be present in the field if a melon perimeter trap crop was used to protect a cotton field.

As many as 18 cylinders were set up at one time and infested with adult whiteflies. Release of whiteflies took place at midday, and then each cylinder was transported into a greenhouse and set on a bench for the remainder of the experiment. A series of 5 counts were made beginning at 18:00 on the day of released, then followed by 2 days of counts in the morning and at dusk. Each leaf projecting into the cylinder spaces was closely viewed from outside the cylinder walls. Whitefly counts were tabulated for each leaf and each cylinder over the 2.5 day period. Following the last count, the test leaves were collected from each cylinder for egg counts. Adult whitefly counts were expressed as the mean number (±SEM) from all cylinder cages for each of the cotton leaves and the melon leaf.

Greenhouse Experiments

Two identical experiments were conducted in 2 small greenhouses with dimensions of 2.5 x 3.1 m. Prior to the start of each experiment, the experimental greenhouses were vacated and cleaned of all vegetation and cobwebs that might interfere with whiteflies to be released. Small melon and cotton plants (4-6 true leaves) were grown in 10 cm pots in an insect-free greenhouse, then transferred to the experimental greenhouses. A total of 16 plants of each type, melon and cotton, were arranged into a randomized complete block design with 4 blocks consisting of 8 plants each, 4 cotton and 4 melon randomized within each block. The 4 plant blocks were arranged on a bench on one side of each greenhouse. Whiteflies were collected separately from a cotton culture and from a melon culture. Approximately 1200 adults were released into each of the 2 greenhouses. Whiteflies collected from the cotton culture and released were referred to as the "Cotton Source" whereas those collected from the

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melon culture and released were hence referred to as the "Melon Source". The respective whiteflies were released on the opposite sides of the greenhouses where the melon and cotton plants were arranged. Evaporative cooling fans were switched off prior to their release so as not to interfere with their flight across the greenhouses to the test plants. Releases were made in the mid afternoon, then followed by leaf counts over the next 2.5 days. Sufficient spacing between plants was arranged so as to facilitate counting of whiteflies on the undersides of cotton and melon leaves. A mechanic's mirror was used for all counts in order not to disturb whiteflies settled on leaves of the test plants. Following the 5th and final count, all leaves were collected from each test plant for egg counts. Whitefly adult and egg counts were expressed as the mean number (±SEM) of whiteflies per leaf at each leaf node.

Field Experiments

Four replicate fields in isolation of one another were prepared at MAC and planted with cotton in mid-April, 1999. Each field consisted of 3 subplots 140' long and planted i) 24 rows wide with DP-5415, ii) 24 rows wide with DP-33B, or iii) 20 rows wide with DP-5415 and 2 rows on either side planted with melons. The subplots were separated from each other by 20 ft with the DP-33B in between both DP-5415 subplots. The planting of melons was divided into an early and late planting to insure a robust cover of melons from the period of early July through late September. To achieve this goal, the early planting was sown in mid-May and the late planting was sown 5-6 weeks later in the second half of June. Only a single row of melons was sown each for the early and late plantings on either side of the 20-row subplot of DP-5415. In addition, a 10' area at the head and tail of each 20 row subplot of DP-5415 were planted with a single melon plant in every other row. Treatment of the first planting of melons with the systemic insecticide Admire® was delayed until late June when the first few adult whiteflies began to appear on the melons. The melon plants at this point were in the 4-6 true leaf stage. By holding back treatment with Admire®, the effective period of treatment could be extended into late July-early August. In contrast, Admire® application to the late melon planting was made in the cotyledon to first true leaf stage because of the heavier presence of whiteflies that demanded immeditate protection.

Treatment with Admire® was followed by an application of Applaud®+Thiodan® (0.35 lb ai/a and 1.0 lb ai/a, respectively) when whiteflies began to reach a density of approximately 10-15 small nymphs per melon leaf. The inclusion of Thiodan® with Applaud® was to prevent adult whiteflies from scattering into the cotton main crop following the spray treatment. The same adult knockdown strategy was employed a few weeks later (Thiodan® only) when the early melon planting was disked and the late planted melons assumed sole responsibility for trapping immigrating whiteflies.

Evaluations of whitefly infestations in the melon-surrounded subplot of DP-5415 and the DP-5415 subplot not surrounded by melons were made on a weekly basis beginning the first week of July through the third week of September. Each subplot was subdivided into 5 strata of 4 rows each. Leaf disks from the 5th mainstem node leaf down from the terminal were collected from 24 plants within each stratum each week. The number of eggs, small nymphs and large nymphs on each disk were counted.

Results

Cylinder Cage Experiments

The relative numbers of adult whiteflies settled upon either one of the two cotton leaves, or the melon leaf, was close to identical in all 3 experiments. Once the adult whiteflies were released and settled, there was apparently little shifting among leaves based on the consistent levels at each time interval. In experiment 3, however, there was gradual movement away from the 2 cotton leaves to increased settlement on the single melon leaf. The differences of 2:1 or greater in the case of adult whitefly mean numbers on melon relative to either one of the two cotton leaves was also displayed in the egg count. In some cases, i.e. experiment 1, the differential was approximately 5:1 in favor of melon leaves.

Greenhouse Experiments

The differential between cotton and melon plants was more pronounced in the 2 greenhouse experiments in terms of mean whitefly adult and egg densities. The mean numbers of whitefly adults on cotton leaves compared to melon leaves ranged between 8-31-fold greater on melon leaves. Egg densities on melon leaves exceeded those on cotton leaves between 8-56-fold. There was little difference in results with respect to the origin of the whiteflies used in the greenhouse experiments. However, there was a marked tendency for more eggs overall to be deposited on leaves if the whiteflies originated from the melon colony.

Field Experiments

Whitefly densities in the melon-surrounded subplots of DP-5415 were consistently lower than the unprotected DP-5415 subplots. On 7 consecutive dates between 2 August and 13 September, the density of eggs in the melon-protected subplots was significantly lower than that in the unprotected subplots. Similarly during this same time span, the density of small and large whitefly nymphs was significantly lower in the melon-protected plots on 6 of 7 dates. The magnitude of the differences in densities between subplots was often 2-3 fold. However, despite the consistently lower densities in the melon-protected cotton, nymphal densities eventually exceeded currently practiced action thresholds for treatments with IGRs (Ellsworth et al., 1996).

Discussion

Bemisia tabaci consistently demonstrated a much higher affinity for melons compared to cotton. Whether or not this natural difference can be exploited into a trap crop management program depends on the ease with which this innovative cultural practice could be implemented in the field. Although the melon-protected cotton had lower densities of whiteflies throughout the July-September period compared to the unprotected cotton, the densities in the melon-protected cotton still exceeded the IPM guidelines that govern when treatment with the IGRs Applaud® and Knack® should commence against whiteflies in cotton. If the IPM guidelines had been strictly adhered to in this study, then the melon trap crop would have been effective only in delaying the timing of the first spray treatment by about 2 weeks. Considering the awkwardness involved with the additional agronomic and pest management inputs required for growing a trap crop peripheral to the cotton main crop, the melon trap crop approach would probably have limited appeal if the same treatments with IGRs are eventually required.

References

Ellsworth, P.C., J.W. Diehl & S.E. Naranjo. 1996. Sampling sweetpotato whitefly nymphs in Cotton. IPM Series No. 6. The University of Arizona, Cooperative Extension Publication #196006. Tucson, AZ. 2pp.

Hokkanen, H.M.T. 1991. Trap cropping in pest management. Ann. Rev. Entomol. 36: 119-138.

Table 1. Mean number (±SEM) of eggs on each of 3 leaves used in the cylinder cage experiments.

Experiment No.	Cotton Leaf 1	Cotton Leaf 2	Melon Leaf
1	182 ± 25	189 ± 30	1,096 ± 90
2	471 ± 62	504 ± 53	1,168 ± 153
3	823 ± 131	796 ± 109	1,940 ± 122

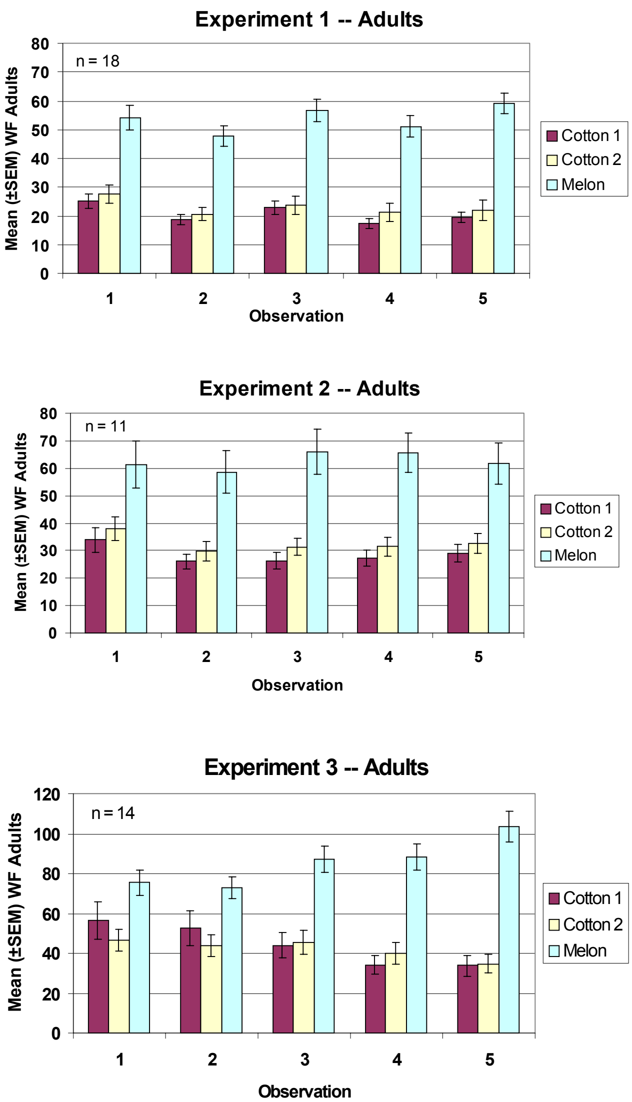
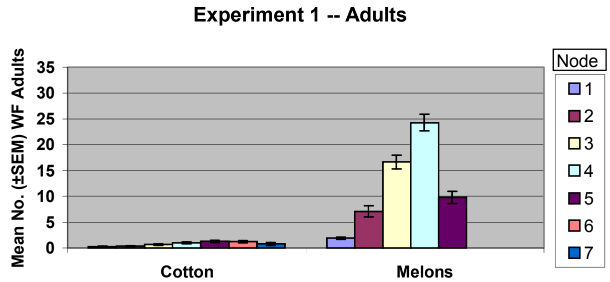
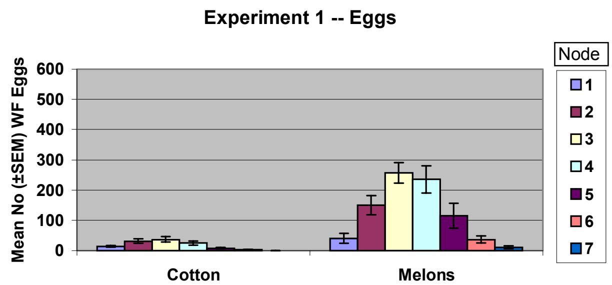


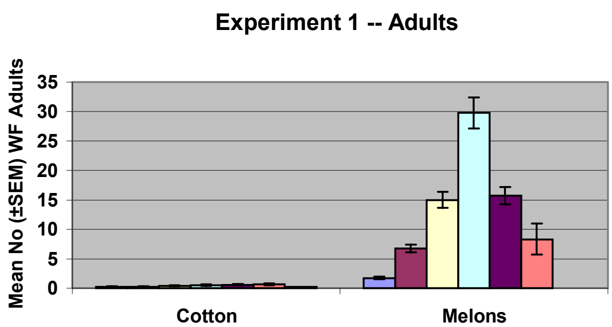
Figure 1. Differences between melon and cotton in adult whitefly densities over 5 consecutive observations at 12 h intervals in 3 separate experiments.

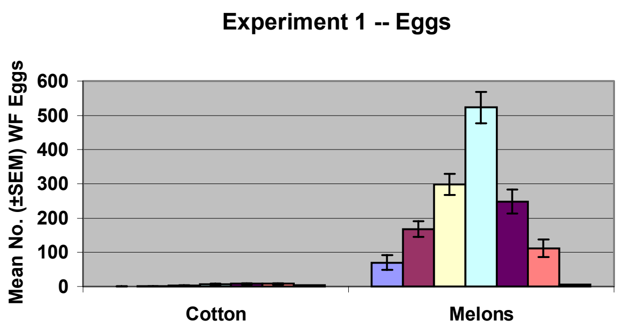
Experiment 1. Whitefly Source: Cotton Culture.



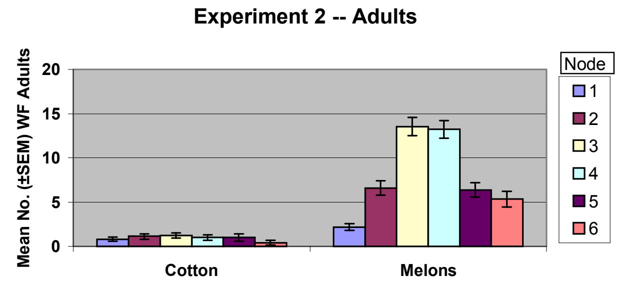


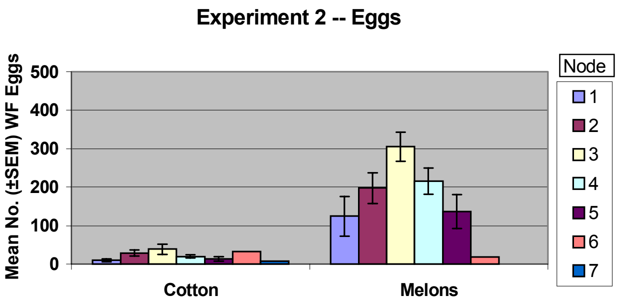
Experiment 1. Whitefly Source: Melon Culture.



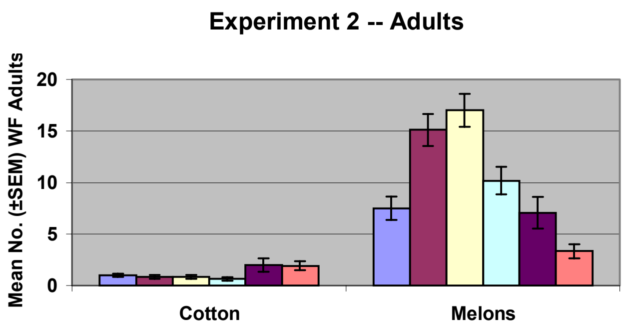


Experiment 2. Whitefly Source: Cotton Culture.





Experiment 2. Whitefly Source: Melon Culture.



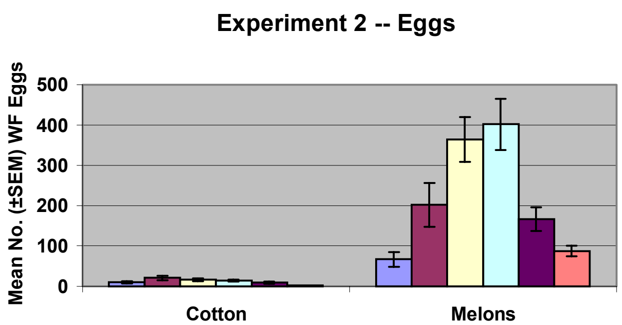
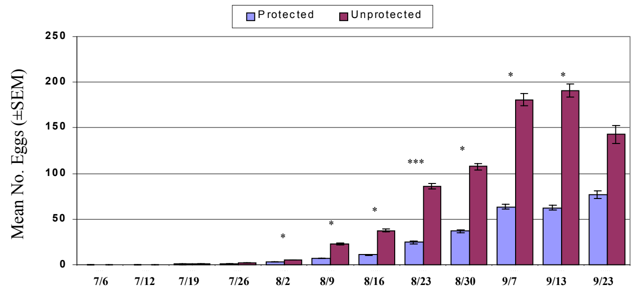


Figure 2. Two separate experiments conducted in small greenhouses with melon and cotton plants set up in a randomized complete block design. Adult whiteflies released in 1 greenhouse originated from a melon culture, while the same approximate number released simultaneously in a 2nd greenhouse originated from a cotton culture. A repeat of this experiment resulted in an almost identical outcome (Experiment 2).



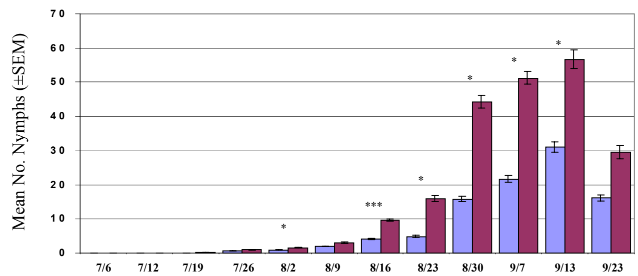


Figure 3. Field experiment comparing whitefly densities (eggs or nymphs) in cotton plots either with a perimeter trap crop of melons or without melons as a perimeter crop. Asterisks over pairs of bars indicate statistically significant differences.