POPULATION DYNAMICS, HOST PREFERENCE AND SEASONAL DISTRIBUTION PATTERNS OF WHITEFLY, *BEMISIA TABACI* (GENN.) IN MIDDLE EGYPT

M. E. Foda
Faculty of Agriculture
Ain Shams University
Cairo, Egypt

Abstract

Population dynamics, host plant association and distribution patterns of cotton whitefly (CWF), *Bemisia tabaci* (Genn.) were studied on cotton, cucumber, cantaloupe and tomato in middle Egypt.

Some host-plants (cucumber and cantaloupe) enhanced whitefly development more than the others (cotton and tomato). Prediction models were also, constructed to simulate the temperature-development relationship on the tested host plant.

Oviposition and feeding responses comparisons for *B. tabaci* were tested in multi-choice situation whereas preference performance relationships were also studied under no choice situation. Whitefly preferred cotton and tomato for adult feeding and cucumber and cantaloupe for oviposition and immature feeding. A pronounced effect was noticed for host plants on different statistics of individual development and population growth.

Distribution characteristics of whitefly were also studied and used to develop a presence-absence sampling procedure as a simple and quick method for determination of population changes through the season.

Introduction

Whitefly, *Bemisia tabaci* (Gennadius) has become one of the most serious pests of cotton, vegetable crops and ornamentals in Egypt (Makadey, 1993) and around the world, particularly in the tropics and subtropics (Byrne *et al.*, 1990). The area of incidence, severity of damage and number of hosts has also increased rapidly (Perring *et al.*, 1990).

Movements of cotton into fall vegetable crops cause a severe disease complex and dispersal from late winter and early spring vegetable crop host back to cotton in early summer appears to complete the cycle (Watson and Silvertooth, 1993).

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Chemical control of whitefly becomes difficult costly and may cause secondary pests outbreak. For these reasons, alternative approaches are urgently needed to reduce the heavy reliance on insecticides for management of whitefly.

Critical to success of this new approach is an understanding of population dynamics, host preference, and sequence and distribution patterns. Recent studies have demonstrated that the capacity of whitefly to select specific feeding and/or oviposition sites in combination with variation in the host plant. Suitability is accompanied by different rates of development and population growth (Dodge *et al.*, 1970; Zalom & Natwick, 1987; Thompson & Pellmer, 1991 and Gergis & Toscano, 1994).

Dewel and Cherry (1981) tested different sampling methods of whitefly among and within cotton plants and they found strong tendency for aggregation.

Distribution patterns of whitefly in fields of spring-grown cantaloupe were also studied by Tonhasco *et al.*, (1994).

In this study, I investigated the spatial distribution of adults and immature stages, host preference and population dynamics of whitefly.

Materials and Methods

Data were collected in cotton and vegetable crop fields in Middle Egypt. The purpose of this investigation was to study the population dynamics, host preference and distribution characteristics and patterns of whitefly, *B. tabaci* on cotton, tomato, cucumber and cantaloupe.

Leaves of each host were artificially infested with newly emerged whitefly adults, using a small clip-on cage similar to that used by Natwick and Zalom (1987) and replicated ten times for each treatment. A pair of whitefly adults (male and female) was transferred to each cage, using an aspirator and allowed to oviposit. Developmental times for various stages were obtained for each host plant over a wide variety of temperatures throughout the seasons.

Thermal thresholds (to), developmental rates (1/y) and thermal requirements (DD) were estimated according to the methods of Sevacherian *et al.* (1976).

Oviposition and Feeding Host Preference (Multi-Choice Situation)

Twenty-five leaves were inspected weekly to estimate the mean number of whitefly adults and immatures per leaf. The mean number of adults was used as the preference index of adult feeding, whereas the mean number of immatures was used as the index of oviposition preference on the tested host plants.

Spatial Distribution

Samples of 25 leaves (apical, medium and basal) were examined weekly and replicated four times. The mean values of density (x) were transformed to the relationship $x^{1-0.5b}$ to relate density (x) to the spatial distribution of the whitefly population (Southwood, 1976 and Stiener, 1990).

Population Growth Statistics

The following statistics, described by Birch (1948) were derived from the data: Net reproductive rate (Ro), finite rate of increase (F) and population doubling time (Dt).

Distribution Characteristics

The relationship (over the sampling period) between the mean (x) and variance (S^2) for leaf samples within each category was described using the method of Taylor, 1970 and Iowa, 1980a.

Host Plant Suitability (Non-Choice Situation)

Developmental times, fecundity and survivorship patterns were obtained for each host plant using a small clip-on cage.

Results and Discussion

Development of whitefly was found to be decreased as the temperature decreased up to 32˚C. Based on linear regression of developmental rates on temperature, lower and upper thermal thresholds, thermal requirements and population growth parameters were tested on the different host plants (Table 1).

Whitefly, *B. tabaci* showed the best response on cucumber and cantaloupe, as indicated from the higher values of population growth parameters in comparison to those obtained on cotton or tomato.

In conclusion, results indicate that the changes of developmental periods have the greatest effect on the population growth rate, followed by the effect of change in fecundity. However, the changes in the mortality of immature stages, longevity of adults and maturation period have a weak influence on these rates. Yano *et al.* (1989) obtained similar results concerning the effect of life-history components on the rate of population growth of sweet potato whitefly on tomato, cucumber, eggplant and sweet pepper.

Temperature-Dependent Development Models

Two mathematical models were used to simulate the temperature development relationship for different host plants, i.e. linear regression (x-intercept) and nonlinear (logistic curve), Table (2).

Host Preference (Feeding and Oviposition)

Based on the numbers of adult cotton whitefly per leaf in a multi-choice situation (Table, 3). The following preference ranking was obtained: cotton> cantaloupe> cucumber> tomato. Oviposition host preference, based on the mean number of immatures per leaf, showed a completely different ranking as follows: cucumber> cantaloupe> tomato> cotton.

Host Plant Suitability

Host plant suitability is defined as the aspects of the host that affect the performance of immature or adults utilizing that plant as food or oviposition (Singer, 1986). Since generations of CWF overlap, the development and growth of a population can be used as parameters for host suitability (Caswell and Hans, 1980). Thus, cucumber and cantaloupe showed a higher suitability rates as hosts for whitefly, based on the values of thermal thresholds (to), effective heat units (DD), rate of development and other population growth parameters (Table, 1). With these data, we can obtain insight in how strongly different components of the life history influence population dynamics. Furthermore, it is a very useful tool for generating ideas about developing efficient control programs in the system has a large influence on CWF population growth reduction.

Distribution Characteristics

The relationship between log variance and log mean was linear for all variables. The value for the aggregation coefficient (b), derived from regression equation, in all cases was >1, indicating the aggregation distribution for whitefly through the cotton season (Table, 4) and the values of the Taylor's (b) varied significantly among different leaf levels. This finding is supported by the work of Taylor *et al.* (1976), demonstrating the concept of a species-specific index for aggregation.

Presence-absence Sampling Procedures

The variance stabilizing transformation of the mean value on middle leaves for whitefly were $x^{0.24}$ and $x^{0.1}$ for adult and immature stages, respectively (Table, 4). Parameters for aggregations of transformed mean (dependent variable) as a function of percentage leave bearing whitefly were insensitive the use of pesticides. Regression equations were used to predict the mean number of CWF per leaf, depending on the percentage of infested leaves (Table, 5).

The ultimate goal of this study is to reduce reliance on pesticides in whitefly control programs by choosing the proper timing for application, using simple method for sampling its populations and depending on the accurate models for prediction as well as the possibility of using the suitable pesticide for adults or immatures on the preferred host plants.

References

Natwick, E.T. and F.G. Zalom (1987). Development of sweet potato whitefly in small cages on cotton plants. Florida Entomologist, **70 (4):** 427-431.

Sevacherian, V.; V.M. Stern and A.J. Mueller (1976). Heat accumulation for timing lygus control measures in safflower-cotton complex. J. Econ. Ent., **69 (4):** 399-402.

Singer, M.C. (1986). The definition and measurement of oviposition preference in plant feeding insects. In: Insects plant relations. (Eds. Miller, J. and T.A. Miller), pp. 65-94.

Southwood, T.R.E. (1966). Ecological methods. Methuen. London. 391 pp.

Steiner, M.Y. (1990). Determining population characteristics and sampling procedures for the western flower thrips and the predatory mite, *Amplyosius cucumber* on green house cucumber. Environ. Ent., **5:** 1604-1613.

Taylor, L.R. (1970). Aggregation and transformation of counts of *Aphis fabae* Scop. on beans. Ann. Appl. Biol., **65:** 181-189.

Tonhasco, A; J.C. Palumbo and D.N. Byrne (1994). Distribution patterns of *Bemisia tabaci* (Homoptera: Aleyrodidae) in cantaloupe fields in Arizona. Environ. Ent., **23 (4):** 949-954.

Yano, E.; J.C. Van Lenterrn; R. Rabbinge and P.M. Hulspas-Jordaan (1989). The parasite-host relationship between *Encarsia Formosa* (Hymenoptera: Aphelinidae) and *Trialeurodes vaporariorum* (Homoptera: Aleyrodidae) XXXI. Simulation studies of the population growth of greenhouse whitefly on tomato. Agricultural University Wageningen Papers, **89:** 55-73.

Table 1. Developmental parameters and growth statistics for *B. tabaci* on four-host plant.

	Host plant			
Statistic	**Cotton**	**Cantaloupe**	**Cucumber**	**Tomato**
Dr	0.05	0.052	0.048	0.05
To	10.4	10.2	10.3	10.5
DD	355.5	346	341.5	362
Ro	54	81.5	86.5	59.5
FR	1.013	1.016	1.014	1.012
DT	670	52.6	50	67.5

Dr = Development rate, to = threshold of development
DD = Thermal Requirements, Ro = net revenue,
FR = Finite rate of increase, DT = Doubling Time

Table 2. Temperature development relationship for *B. tabaci* (pre-adult) on certain host plants.

Host plant	Linear	Logistic
Cotton	y = 0.027 + 0.003x	$y = 0.062/1 + e^{2.19-0.13x}$
Cantaloupe	y = 0.028 + 0.003x	$y = 0.063/1 + e^{2.22-0.11x}$
Cucumber	y = 0.030 + 0.003x	$y = 0.066/1 + e^{2.17-0.10x}$
Tomato	y = 0.029 + 0.003x	$y = 0.065/1 + e^{2.24-0.14x}$

Table 3. Mean numbers of *B. tabaci* adults and immatures per 2.5 cm^2 of leaf on certain hosts in a choice situation.

Host plant	Adults	Immatures
Cotton	63.5	11.5
Cantaloupe	59.3	42.5
Cucumber	55	48
Tomato	44.5	36

Table 4. Comparison of the coefficient of Taylor's power low between cotton leaves for *B. tabaci*.

		Coefficient			
Leaf strata	**Stage**	**Log a**	**b±s.e.**	**r^2**	**$x^{1-0.56}$**
Apical	Adult	0.355	1.05	0.92	$x^{0.475}$
	Immatures	0.301	1.39	0.89	$x^{0.305}$
Middle	Adult	0.416	1.52	0.93	$x^{0.240}$
	Immatures	0.382	1.67	0.90	$x^{0.165}$
Basal	Adult	0.491	1.66	0.94	$x^{0.17}$
	Immatures	0.395	1.12	0.88	$x^{0.44}$

Table 5. Linear regression of mean number or transformed mean number/leaf and percent of leaves infested with adult or immatures of *B. tabaci*.

Stage	Mean	r^2	Transformed	r^2
Adult	y = 1.49 + 0.023x	0,9	y = 1.19 + 0.009x	1
Imm.	y = 1.53 + 0.026x	0,89	y = 1.28 + 0.010x	1