INTERNATIONAL JOURNAL OF AGRICULTURE & BIOLOGY
1560–8530/2006/08–3–302–305
http://www. fspublishers.org

Age Specific Reproduction Parameters of Cotton Whitefly (*Bemisia tabaci*) and Silverleaf Whitefly (*B. Argentifolii*) on Cotton and Rapeseed

M.A. SAMIH[1] AND H. IZADI
Department of Plant Protection, Faculty of Agriculture, Vali e Asr University, Rafsanjan 7713936417 Iran
[1]Corresponding author's e-mail: samia_aminir@yahoo.com

ABSTRACT

The age specific reproduction parameters of sweet-potato whitefly, *Bemisia tabaci* (Genn.) and silverleaf whitefly, *Bemisia argentifolii* Bellows and Perring (Hom: Aleyrodidae) were studied in the laboratory on cotton and rapeseed. Infested leaves containing nymphs and pupae of either were collected from cotton fields in Iran. Experiments were conducted in a growth chamber under 24 ± .2ºC, 55 ± 3% RH and 16:8 h (L: D) photoperiod on caged plants of cotton, *Gossypium hirsutum* L. (*Var*. Varamin 76) and rapeseed, *Brassica napus* L. (*Var*. Global). Gross fecundity rate and gross fertility rate, for *B. tabaci* reared on cotton and rapeseed were 66.38; 84.54 and 45.57; 56.91, respectively and for *B. argentifolii* these parameters averaged 71.85; 131.4 and 48.93; 87.01 on the respective host plants. The results revealed significant differences between species/host plants for gross fecundity rate, gross fertility rate, mean age gross fecundity and fertility, mean age hatch, parameters but there were no significant differences in gross hatch rate, net fecundity rate, net fertility rate, mean age net fecundity and fertility, number of eggs female^{-1}/day^{-1} and daily reproductive rate in both species. The study revealed a greater reproduction capacity of both whitefly species on rapeseed than cotton.

Key Words: *B. tabaci; B. argentifolii;* Whitefly; Age specific reproduction parameters

INTRODUCTION

The sweet-potato whitefly *Bemisia tabaci* (Genn.) is comprised of species-complex with 20 biotypes (Bedford *et al*., 1994). Some of them like silverleaf whitefly strain *Bemisia argentifolii* Bellows and Perring (Hom. Aleyrodidae) is very polyphage species with more than 500 hosts (Bellows *et al*., 1994). This and other biotypes of *B. tabaci* turned in to a deterrent factor in producing several vegetables and crops, because of using vast chemical poisons (Mound & Halsey, 1978). Nutrition, oviposition, mating and growth of nymphs occur under surface of leaf (Coudriet *et al.,* 1985). This method of nutrition and reproduction reduces the effect of pesticides. Anyhow, the reported growth and reproductive rate differs for this pest. One part of this difference can originate from the population of specific species (Gerling *et al.,* 1986). The population of every species has a different host range (Costa & Russel, 1975) and difference in growth and reproduction arising from rearing on different plant hosts (Coudriet *et al*., 1985; Gerling *et al*., 1986). In addition, the temperature (Butler *et al*., 1985) and age of leaf (Arx von *et al.,* 1983) also influence growth and reproduction rate of *B. tabaci.* Samih (2003a, b; 2004a, b & c) made a comparison between dispersion and biology of local populations of *B. tabaci* species complex in Iran. A renewed interest in the systematic of the *Bemisia* occurred in the mid- 1980s when a whitefly species was found causing severe damage to ornamental plants in the southwestern United States (Price *et al.,* 1987). Based on morphological similarity with *B. tabaci*, which had existed in the area since 1894 (Russell, 1975) it was identified as a strain or biotype of this species.

Various designations were given to this new strain (Florida strain, poinsettia strain, B-strain, biotype B) (California strain, cotton strain, A-strain, type A) (Bharathant *et al.,* 1990; Byrne & Miller, 1990; Bethke *et al.,* 1991; Perring *et al.,* 1991 & 1992). Further research revealed that the B-strain was different from the A-strain in a range of biological and host-related characters. Differences between the two strains have been reported as to their respective host ranges, biological parameters when studied on various hosts, whitefly-host relationships, plant physiological disorders, transmission of viruses, and allozymic patterns. Age specific reproduction parameters were calculated using method and model of Carey (1993). In the current study, the model was applied for the cotton whitefly and silverleaf whitefly reared on two host plants: cotton and rapeseed under laboratory conditions. For determination of biological parameters and making life table of different population, significant difference were tested from the $H_0 = 0$ hypothesis. The knowledge extracted from these modeles can be useful for optimizing control strategies of these major pests.

MATERIALS AND METHODS

Insects and host plants. The net populations of two whitefly species were obtained from Samih's researches by using morphological, biological and molecular researches (Samih, 2003a, b; 2004a, b). In this study the infested cotton leaves containing nymphs and pupae were collected from Darab, Qom, Saveh, Gonbad, Gorgan, Varamin, Garmsar, Orsoiieh (Kerman) and Shooshtar cotton fields in Iran. Plant pots (35 by 35 cm) containing 2/3 leaf mould and 1/3 clay-pit were prepared for cultivating cotton and rapeseed. The varieties of cotton and rapeseed used in the experiments were Varamin 76 and Global, respectively.

Life table and demographic parameters. Infested leaves with pupae of each whitefly population were placed with the petioles immersed in water. After 24 h, 50 male and female adults were collected using an aspirator. Sex of collected adults was checked under a stereomicroscope and male were separated from females based on their smaller size and narrower end of their abdomen. After 24 h, the adults were transferred on caged cotton and rapeseed plants for oviposition, approximately 100 - 200 eggs were kept for studying development and survival of the nymphs and life table of *B. abaci* and *B. argentifolii* on either host plant. The adults produced from these eggs were used for assessing reproduction. For each treatment, sixty 24-h-old female adults were used (four plants with 15 females each per treatment). One female adult was placed together with two males in clip cages on 15 leaves (one leaf for every female) from the middle parts of the host plants; the remaining leaves were cut. After 24 h of release, the transferring of the female to the new leaf continued until the death of the adult. This experiment was conducted in four repetitions thoroughly randomized. Regarding to the two available species, two hosts, and fifteen adults at every repetition, four pots (two pots for cotton plant & two pots for rapeseed plant) were selected for every repetition. For holding every adult over a leaf, the clips cages were used. All of the experiment were carried out in a growth chamber, under 24 ± 2ºC, 55 ± 3% RH and 16:8 h (L: D) photoperiod on cotton, *Gossypium hirsutum* L. and on rapeseed (*Brassica napus* L.).

The basic values of calculation consisted of age (x), midpoint survivorship at the corresponding time (L_x); number of female eggs laid according to sex ratio laid per female per day (M_x) by which the main demographic parameters were calculated through following formulae.

Gross fecundity rate = $\sum_{x=\alpha}^{\beta} M_x$; gross fertility rate = $\sum_{x=\alpha}^{\beta} h_x M_x$; gross hatch rate = $\dfrac{\sum_{x=\alpha}^{\beta} h_x M_x}{\sum_{x=\alpha}^{\beta} M_x}$; net fecundity rate = $\sum_{x=\alpha}^{\beta} L_x M_x$; net fertility rate = $\sum_{x=\alpha}^{\beta} L_x h_x M_x$; mean age gross fecundity = $\dfrac{\sum_{x=\alpha}^{\beta} x M_x}{\sum_{x=\alpha}^{\beta} M_x}$;

mean age gross fertility = $\dfrac{\sum_{x=\alpha}^{\beta} x h_x M_x}{\sum_{x=\alpha}^{\beta} h_x M_x}$; mean age net fecundity = $\dfrac{\sum_{x=\alpha}^{\beta} x L_x M_x}{\sum_{x=\alpha}^{\beta} L_x M_x}$; mean age net fertility = $\dfrac{\sum_{x=\alpha}^{\beta} x h_x L_x M_x}{\sum_{x=\alpha}^{\beta} h_x L_x M_x}$; mean age hatch = $\dfrac{\sum_{x=\alpha}^{\beta} x h_x}{\sum_{x=\alpha}^{\beta} h_x}$; eggs female^{-1} day^{-1} = $\dfrac{\sum_{x=\alpha}^{\beta} L_x M_x}{\sum_{x=\varepsilon}^{\omega} L_x}$; fertile eggs female^{-1} day^{-1} = $\dfrac{\sum_{x=\alpha}^{\beta} L_x h_x M_x}{\sum_{x=\varepsilon}^{\omega} L_x}$.

α = age of first reproduction; β = age of last reproduction; ω = last possible day of life; x = age in days; Lx = midpoint survivorship at the corresponding time Mx = number of female eggs laid according to sex ratio laid per female per day hx = fraction of eggs laid by female age x, which hatch.

Above parameters were calculated using Excel 2002 software and according to the method of Carey (1993). The obtained data were analyzed by SPSS 10 software. Demographic parameters were subjected to one way analysis of variance, followed by Duncan's multiple range test (p = 0.05). Data were square root transformed before analysis.

RESULTS AND DISCUSSION

The results of the variance analysis of the different age specific parameters are shown in Table I. There was a significant difference among treatments (host plant/species) for gross fecundity rate, gross fertility rate, mean age gross fertility and mean age gross fecundity at the 1% probability level indicating that the host plant had a significant impact on biological activities of both whiteflies studied. There was

Table I. Results of variance analysis (mean square) related to age specific reproduction parameters in two species of *Bemisia* reared on rapeseed and cotton

Variable		Mean square	F	Sig.
Gross fecundity rate	Between groups	3455.046	12.089	0.001**
	Within groups	285.790		
Gross fertility rate	Between groups	1425.814	8.875	0.002**
	Within groups	160/652		
Gross hatch rate	Between groups	0.00039	0.313	0.816ns
	Within groups	0.00125		
Net fecundity rate	Between groups	476.595	0.875	0.481ns
	Within groups	544.793		
Net fertility rate	Between groups	178.238	0.699	0.57ns
	Within groups	255.018		
Mean age gross fecundity	Between groups	25.804	6.256	0.008**
	Within groups	4.125		
Mean age gross fertility	Between groups	25.086	6.851	0.006**
	Within groups	3.662		
Mean age net fecundity	Between groups	4.022	1.207	0.349ns
	Within groups	3.331		
Mean age net fertility	Between groups	3.720	1.481	0.269ns
	Within groups	2.512		
Mean age hatch	Between groups	0	0	0
	Within groups	0		
Fertile eggs / female / day	Between groups	0.203	1.581	0.254ns
	Within groups	0.128		
Eggs / female / day	Between groups	0.603	2.079	0.158ns
	Within groups	0.290		

Significant difference in 1% probability level significant difference in 5% probability level

Table II. Comparison of means related to age specific reproduction parameters in two species of *Bemisia* reared on rapeseed and cotton

variable	Silverleaf whitefly reared on rapeseed	Silverleaf whitefly reared on cotton	cotton whitefly reared on rapeseed	cotton whitefly reared on cotton
Gross fecundity rate	131.04a (±3.42)	71.85b (±6.99)	84.54b (±8.29)	66.38b (±12.05)
Gross fertility rate	87.01a (±3.87)	48.93b (±5.35)	56.91b (±6.49)	45.57b (±8.64)
Gross hatch rate	0.66a (±0.0263)	0.67a (±0.0117)	0.66a (±0.0201)	0.68a (±0.0086)
Net fecundity rate	42.83a (±4.71)	19.09a (±2.44)	21.45a (±3.18)	32.14a (±22.05)
Net fertility rate	26.44a (±2.63)	12.61a (±1.84)	13.59a (±1.188)	21.97a (±5.59)
Mean age gross fecundity	30.35b (±0.355)	34.99a (±1.302)	30.31b (±1.334)	34.44a (±0.722)
Mean age gross fertility	30.61b (±0.161)	35.1a (±1.194)	30.42b (±1.264)	34.51a (±0.781)
Mean age net fecundity	28.17a (±0.634)	30.32a (±1.05)	28.40a (±1.122)	29.54a (±0.752)
Mean age net fertility	28.57a (±0.28)	30.55a (±0.917)	28.55a (±1.027)	29.7a (±0.73)
Mean age hatch	37.5d (±0.00)	37.5c (±0.00)	37.5b (±0.00)	37.5a (±0.00)
Fertile eggs / female / day	0.93a (±0.0849)	0.42a (±0.0518)	0.5a (±0.048)	0.56a (±0.34)
Eggs / female / day	1.51a (±0.171)	0.63a (±0.069)	0.79a (±0.12)	0.83a (±0.48)

no significant difference between treatment (host plants/species) for gross hatch rate, net fecundity rate, net fertility rate, mean age net fecundity, mean age net fertility, eggs $female^{-1}$ day^{-1} and fertile eggs $female^{-1}$ day^{-1}.

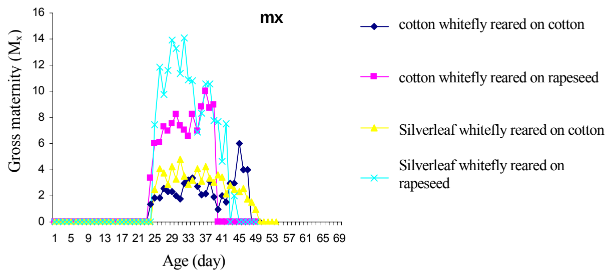
Mean values for the calculated age specific parameters are shown in Table II. In both species, gross fecundity rate, gross fertility rate, gross hatch rate, net fecundity rate and net fertility rate were greater on rapeseed than on cotton, suggesting that rapeseed is a more suitable host for development and reproduction of both species. The silverleaf whitefly showed higher reproduction rates than the cotton whitefly on either host plant.

The process of oviposition by every female at each day (M_x) for the studied populations is shown in Fig. 1. The maximum egg laying and its day, the beginning of oviposition and the end of oviposition of the all adults as collected from silverleaf whitefly reared on rapeseed were 14.05, 32, 24 and 46 for silverleaf whitefly reared on cotton were 4.82, 31, 24, 54 for cotton whitefly reared on rapeseed were 10, 37, 24 and 49 and for cotton whitefly reared on cotton were 6, 45, 24 and 49, respectively.

Comparison evaluation of curve area $\sum Mx$ indicated that silverleaf whitefly had maximum $\sum Mx$ where as this area for cotton whitefly was minimum. This is necessary to note that by using this method, only overall oviposition in each treatment has been compared, but in a more precise manner we can compare the numerical data obtained by using integral of curve area.

Number of egg laied by female of biotype B when reared on egg-plant, tomato, apple potato and bean at 25 ±

Fig. 1. The diagram of changes in oviposition for every female at day in two species of *Bemisia* reared on rapeseed and cotton



2ºC was 223.7, 167.5, 77.5, 66 and 83.5, respectively (Bethke *et al.,* 1991). The overal egg layed by whiteflies in this research is also in the mentioned range and other study carried out by Bethke *et al.* (1991) revealed that maximum egg for the same biotype when cotton-derived colony was reared on cotton at 25 ± 2ºC was 31.8 ± 6.1 and for poinsettia-derived colony when reared on plant was 85 ± 0.94. In the present study for cotton-derived and reared colony ranged between 101.96 to 42.58. Enkegaard (1993) reported that maximum egg per each female on cotton at 25ºC was 78.1. Different studies indicated that in natural insectariums maximum egg for cotton whitefly varied between 48 to 394, but in present study this was of 43 - 203.3 Butler *et al.* (1983) reported that at 26.7ºC and 32.2ºC the number of eggs were 72 and 81, respectively while the number of egg was obtained as 127.5 and 344 by Arex *et al.* (1983) and Dittrich *et al.* (1986), respectively. Musa and Ren (2005) showed that the fecundity on soybean, cowpea and garden bean were 160.85 ± 19.04, 153.07 ± 15.65 and 98 ± 13.02, respectively. In this study the intrinsic rate of increase (r_m), the finite rate of increase (λ) and net reproductive rate (R_0) on soybeans were 0.1875, 1.2041 and 82.15, respectively. Experimental evidence in our investigation indicated that *Bemisia abaci* is highly adapted and shows greatest preference for soybean than rapeseed and cotton. High values of r_m indicate susceptibility of a host plant to insect attacks, while a low value indicates that the host-plant species is resistant to attack. These results indicate that oviposition range of cotton whitefly based on temperature, host, place and insect biotype is significantly variable.

REFERENCES

Arx, R.E. von, J. Baumegartner and V. Delucchi, 1983. A model to simulate the population dynamics of *Bemisia tabaci* (Genn.) (Homoptera-Aleyrodidae) on cotton in the Sudan Gezira. *Zeitschrift Fur Angewandte Entomologie,* 96: 341–63

Bedford, I.D., R.W. Briddon, J.K. Brown, R.C. Rosell and P.G. Markham, 1994. Geminivirus transmission and biological characterization of *Bemisia tabaci* (Gennadius) biotypes from different geographic regions. *Annals of Appl. Biol.,* 125: 311–25

Bellows, J., T.M. Perring, R.G. Gill and D.H. Headrick, 1994. Description of a species of *Bemisia* (Homoptera: Aleyrodidae). *Annals of the Entomological Society of America*, 87: 195–206

Bethke, J.A., T.D. Paine and G.S. Nuessly, 1991. Comparative biology, morph metrics and development of two populations of *Bemisia tabac* (Hom: Aleyrodidae) on cotton and poinsettia. *Annals of the Entomological Society of America*, 84: 407–11

Bharathan, N., W.R. Graves, K.R. Narayanan, D.J. Schuster, H.H. Bryan and R.T. Mcmillan, 1990. Association of double-stranded RNA with whitefly-mediated silvering in squash. *Pl. Pathol.,* 39: 530–8

Byrne D.N. and W.B. Miller, 1990. Carbohydrate and amino acid composition of phloem sap and honeydew produced by *Bemisia tabaci. J. Insect Physiol.,* 36: 433–9

Butler, G.D., T.J. Henneberry and T.E. Clayton, 1983. *Bemisia tabaci* (Genn.) (Homoptera-Aleyrodidae) development, oviposition and longevity in relation to temperature. *Annals of the Entomological Society of America,* 76: 310–3

Butler, G.D., T.J. Henneberry and E.T. Natwick, 1985. *Bemisia tabaci.* 1982 and 1983 population in Arizona and California cotton fields. *Southwestern Entomol.,* 10: 20–5

Carey, J.R., 1993. *Applied Demography for Biologists with Special Emphasis on Insects,* P: 105. Oxford University Press. New York

Costa, A.S. and L.M. Russell, 1975. Failure of *Bmisia tabaci* to breed on cassava plants in Brazil (Homoptera: Aleyrodidae). *Ciencia e Culture*, 27: 388–90

Coudriet, D.L., D.E. Meyerdrik, N. Prabhaker and A.N. Kishaba, 1985. Variation in developmental rate on different hosts and overwintering of the sweet-potato whitefly *Bemisia tabaci* (Genn.) (Homoptera: Aleyrodidae). *Environ. Entomol.*, 14: 516–9

Dittrich, V., S.O. Hassan and G.H. Ernest, 1986. Development of a new primary pest of cotton in the Sudan: *Bemisia tabaci* whitefly. *Agric. Ecosys. Environ.*, 17: 137–42

Enkegaard, A., 1993. The poinsettia-strain of the cotton whitefly *Bemisia tabaci* (Homoptera: Aleyrodidae) biological and demographic parameters on poinsettia (*Euphorbia pulcherima*) in relation to temperature. *Bulletin of Entomol. Res.*, 83: 535–46

Gerling, D., A.R. Horowitz and J. Baumegartner, 1986. Autecology's of *Bemisia tabaci. Agric. Ecosys. Environ.*, 17: 5–19

Mound, L.A. and. S.H. Halsey, 1978. *Whitefly of the World.* A systematic catalogue of the (Homoptera: Aleyrodidae) with host plant and natural enemy data. British Museum (Natural History), London

Musa, P.D. and S.X. Ren, 2005. Development and reproduction of *Bemisia tabaci* (Homoptera: Aleyrodidae) on three bean species. *Insect Sci.,* 12: 25–30

Perring, T.M., A. Cooper, D.J. Kazmer, C. Shields and J. Shields, 1991. New strain of sweet-potato whitefly invades California vegetables. *California Agric.*, 45: 10–2

Perring, T.M., A. Cooper and D.J. Kazmer, 1992. Identification of the poinsettia strain of *Bemisia tabaci* on broccoli by electrophoresis. *J. Econ. Entomo.*, 85: 1278–84

Price, J.F., D.J. Schuster and D.E. Shorts, 1987. Managing the sweet-potato whitefly. *Greenhouse Grower*, 55–7

Russell, L.M., 1975. Collection records of *Bemisia tabaci* (Genn.) in the United States (Hemiptera: Homoptera: Aleyrodidae) *Cooperative Economic Insert Report,* 25: 229–30

Samih, M.A., K. Kamali, A.A. Talebi, S. Moharramipour and Y. Fathipour, 2003a. Comparative Study on the age specific reproduction parameters of the 10 regional populations of *Bemisia tabaci* (Genn.) (Hom. Aleyrodidae) in Iran. *Agric. Sci.,* 13: 51–61

Samih, M.A., K. Kamali, A.A. Talebi and M. Jalali, 2003b. A comparative study on the life table parameters of local populations of cotton whitefly, *Bemisia tabaci* in Iran. *J. Entomol. Soc. Iran*, 23: 1–18

Samih, M.A., K. Kamali, A.A. Talebi and Y. Fathipour, 2004a. A comparative Study of the Population Parameters of Local Populations of *Bemisia tabaci* in Iran. *J. Sci. Technol. Agric. Natural Resources,* 7: 215–23

Samih, M.A., K. Kamali, A.A. Talebi and M. Jalali-Javaran, 2004b. A Comparative Study on the Biological Parameters of 11 Local Populations of *Bemisia tabaci* (Genn.) in Iran. *J. Agric. Sci. Natural Resources*, 11: 101–8

Samih, M.A., M. Jalali-Javaran, K. Kamali and A.A. Talebi, 2004c. Investigation on genetic diversity of local populations of *Bemisia tabaci* species complex using RAPD-PCR markers in Iran. *Proc. 15th Int Plant Protection Congress,* P: 653. Beijing-China

(Received 02 November 2005; Accepted 10 March 2006)