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Biological Traits and Life Table Parameters A and B Biotype of *Bemisia tabaci* (Genn.) on Cotton and Rapeseed

Mohammad Amin Samih[1], Mehdi Zarabi[2], Maryam Yazdani[3] and Mohammad Rouhani[4*]
[1]Department of Plant Protection; Faculty of Agriculture; Vali-e-Asr University; Rafsanjan - Iran. [2]Department of Plant Protection; College of Plant and Animal Sciences; Abureihan campus of Agriculture; University of Tehran; Iran. School of Agriculture, Food and Wine; University of Adelaide; South Australia - Australia. [4]Department of Plant Protection; Faculty of Agriculture; Razi University; Kermanshah - Iran

ABSTRACT

The aim of this work was to construct life table of Bemisia tabaci *(Gen.) A and B (silverleaf whitefly B. argentifolii Bellows and Perring) biotype (Hem.: Aleyrodidae) on two host plants; cotton, (*Gossypium hirsutum *L.) and rapeseed, (*Brassica napus *L.). Experiments were conducted in a growth chamber under 24 ± 2ºC, 55±3% RH and 16:8 (L:D) h photoperiod on caged plants of cotton* G. hirsutum *L. (Varamin 76 variety) and rapeseed* B. napus *L. (global variety. The intrinsic rate of natural increase (r_m), net reproductive rate (R_0) and mean generation time (T) for* B. tabaci *A biotype was 0.1010 females per female per day, 18.4075 females per female and 30.079 day (d) on cotton; 0.1286, 30.6760 and 26.77 d on rapeseed; and for B biotype (*B. argentifolii*) those above respective parameters averaged 0.1033, 27.8426 and 32.74 d on cotton and 0.1750, 40.75 and 21.27 d on rapeseed. The total survival of A and B biotype from the egg to adult on cotton was 22.08 and 22.25, respectively. The results showed significant differences between the two biotype reared on either host plant for gross reproductive rate (GRR), net reproductive rate (R_0 or NRR), intrinsic rates of increase (r_m), finite rate of increase (λ), doubling time (DT) and mean generation times (T_c). To obtain a better understanding of the biology of these biotypes, Stable age distribution (C_x) and some other aspects of life history related to their hosts were also studied. Based upon the results, both biotypes showed a greater reproduction capacity on rapeseed than on cotton. Thus, rapeseed was more suitable host than cotton for two biotypes and this was an important factor in host plant selection for optimizing the control strategies of these major pests.*

Key words: *Bemisia argentifolii*, *Bemisia tabaci*, Cotton, Life-table, Rapeseed

INTRODUCTION

The silverleaf whitefly, *Bemisia argentifolii* Bellows and Perring (Bellows et al. 1994), which was called B-biotype of *B. tabaci* (Gennadius) (Hemiptera: Aleyrodidae) (Byrne and Miller 1990) and cotton whitefly *B. tabaci* (Genn.) are extreme economic pests for many crops in the world (Rosell et al. 1997; Oliveira et al. 2001; Perring 2001; Musa and Ren 2005; Kakimoto et al. 2007). However, there is some doubt whether *B. argentifolii* is a separated species or a strain of *B. tabaci* (Brown et al. 1995; Calvitti and Remotti 1998, Dinsdale et al. 2010). Following the description of the B biotype searching for and describing *B. tabaci* biotypes became something of a cottage industry, with somewhere between 33 and 38 having been described to-date (Xu et al. 2010; Dinsdale et al. 2010). The evidence for species status within *B. tabaci* complex has been bolstered by Dinsdale et al. (2010) using a DNA barcoding method. De Barro et al. (2011) have

*Author for correspondence: Rouhani_valiasr@yahoo.com

reported that *Bemisia tabaci* has long been considered a complex of 11 well-defined high-level groups containing at least 24 morphologically indistinguishable species.

The economical losses is caused by the whiteflies directly by sucking the plant sap (Musa and Ren 2005), or indirectly through the transmission of plant viruses (Rubinstein et al. 1999; Jones 2003). In addition both adults and nymphs excrete honeydew, which can promote the growth of sooty moulds, which affect the market price of the product, and reduce plant photosynthesis and effectiveness of insecticides (Gerling et al. 1980; Palumbo et al. 2000).

Main factors of regulating the whiteflies biology and population dynamics are temperature (Enkegaard 1993; Cui et al. 2008; Guo et al. 2012), host plant suitability (Yano 2003; Kakimoto et al. 2007), natural enemies (Liu and Stansly 1998; Headrick et al. 1999; Nava-Camberos et al. 2001) and management practices (Musa and Ren 2005). However, chemical control approaches are still valuable integrated pest management (IPM) tools that help to maintain or improve crop yield. Chemical control of adult and immature stages is difficult, because they live underside of the leaves, have high reproductive rate and feed on wide range of hosts (Mound and Halsey 1978).

Cotton and rapeseed are widely cultivated in Iran as a supplementary source of fiber and oil. They are considered to play an important role in human nutrition. The *B. tabaci* and *B. argentifolii* were first reported in cotton fields of Iran by Kiriukhin (1947) and Samih et al. (2006), respectively. These two biotypes are also common pests of cotton and rapeseed in Iran, which cause serious damage (Samih and Izadi 2006). Also, both of them are key pests on greenhouse plants.

The selection of simple demographic models such as life tables provides the most comprehensive portrayal of biology, population dynamics, and survival, development, and reproduction capabilities of a population under various conditions that can be used subsequently as a tool in designing of pest management strategies (Musa and Ren 2005). The aim of this study was to investigate the development and reproduction of cotton and silverleaf whiteflies on the two host plants, cotton (*Gossypium hirsutum* L. (Malvaceae)) and rapeseed (*Brassica napus* L. (Brassicaceae)) in order to understand its biological attributes and potential as a basis for sound pest management strategies.

MATERIALS AND METHODS

Experimental plant and insect

The seedlings of cotton (*G. hirsutum* L variety, Varamine 76) and rapeseed (*B. napus* L. variety Global) were planted in flower pot. Plants were grown in a chamber at 25ºC with 16:8 h (L: D) photoperiod. The colonies of *B. tabaci* A and B (*B. argentifolii*) biotype were collected from the cotton fields in seven provinces (Fars, Golestan, Kerman, Markazi, Qom, Semnan and Tehran) in Iran. The purity of adult population of the species was checked using the RAPD-PCR technique (Samih et al. 2006; Samih et al. 2007). The whiteflies were selected from a continuous stock colonies, which were maintained under controlled conditions in environment growth chamber at 24 ± 2ºC with 65 ± 3% relative humidity and 16:8 h (L: D) on cotton. Each biotype was reared on both cotton and rapeseed for three generations separately and were used in the experiments. Overall, four treatments were prepared as following: 1- B biotype reared on rapeseed 2- B biotype reared on cotton 3- A biotype reared on rapeseed 4- A biotype reared on cotton.

Development and survival of immature

The experimental design followed the approach of Wang and Tsai (1996). To assess the development and survival of immature, 50 pairs of whitefly adults were aspirated from the rearing stock colony into a Plexiglas's cage (25 × 60 cm). After 4 h, the whitefly adults were removed. The number of eggs was 50 eggs per plant and biotype. A minimum of four replications was used per treatment (in total ≥ 200 eggs per treatment) and each replication was formed by one plant. Following eclosion, after crawlers settled down on the leaf surface, each first instar nymph was encircled with a felt tip pen and numbered by digital microscope Dino (connectable to notebook). Development and survival were recorded at 24 h intervals. When the whitefly reached the red-eyed pupa stage, the leaves were detached from the plant and were placed in plastic cages (13 × 10 × 3 cm), which were covered with fine mesh cloth for ventilation. Experiments were conducted in a growth chamber under 24 ± 2ºC, 55 ± 3 % RH and 16:8 (L: D)h photoperiod. The

percentages of survival, sex ratio and developmental time were calculated by Excel and analyzed by using of SPSS 16 (SPSS Inc., Chicago, IL, USA).

Life table and demographic parameters

The newly emerged whitefly adults from the cohort population were separated according to sex. Each pair of whitefly (female and male) was placed in an individual rearing plastic cage (13 × 10 × 3 cm) containing treated leaf. Sixteen cages were used for each treatment and repeated for four times. Every 24 h, female were transferred to a new leaf and the laid eggs were counted under a stereomicroscope. Daily observations were recorded until the death of all the females. Numbers of newly laid eggs and the life span of the female adults were recorded daily to calculate the fecundity and longevity, respectively. Females that died within the first 24 h of experiment or those produced no eggs, were excluded from the analysis. The bioassay plants were kept in the same experimental conditions as described above.

Life table analysis

The stable population model of Lotka $\sum_{x=0}^{\omega} e^{-rx} l_x m_x = 1$ is a basic quantitative means for describing the population dynamics. The basic assumptions of this demographic model are the stability of birth and mortality rates, lack of immigration and considering of only one sex (female). The survival at the corresponding time (lx) and the number of female eggs laid per female per day according to sex ratio (m_x) for each age interval (x) per day was the basic values of demographic parameters. From the fertility and survival schedules, population growth parameters were calculated using the following formula as suggested by Carey (1993), according to the method of Birch (1948) and Lin (1964).

Intrinsic rate of increase (r) (1t)= $\sum_{x=0}^{\omega} e^{-rx} l_x m_x = 1$;

Finite rate of increase (λ) (per day)= $\lambda = e^{r}$; Net reproductive rate (NRR) (eggs per female);= $R_0 = \sum_{x=\alpha}^{\beta} l_x m_x$; Mean generation time, (T) (day),= $T = \frac{\ln(R_0)}{r}$; Doubling time, (DT) (day),= $DT = \frac{\ln 2}{r}$

α = age of first reproduction; β= age of last reproduction; ω= last possible day of life; x= age in days; lx = survivorship at the corresponding time mx = number of female according to sex ratio laid per female per day

The means and standard errors of the life table parameters were estimated by using the jackknife method. For the statistical analysis, each mean value was shown with its standard error (± SEM). The effect of host plant on developmental time, reproduction period and adult longevity were analyzed with two-way ANOVA, in which there were two factors: whiteflies and plants, each with two levels (A and B biotype in the first, and cotton and rapeseed in the second). If significance differences were detected, multiple comparisons were made using the least significant difference test (LSD) procedure ($P < 0.05$). Statistical analysis was carried out using SPSS 16 software. Differences in R_0, Tc, λ, dt and r_m values were tested for the significance by estimating the variances through the jackknife procedure (Meyer et al. 1986; Maia et al. 2000). The jackknife procedure was used to estimate the variance for r_m and the other population parameters (Meyer et al. 1986). Algorithms for jackknife estimating of the means and variances were described only for r_m. Similar procedures were used for the other parameters (R_0, T_c, λ, and DT). Square root transformed of data was analyzed by SPSS 16 software. Demographic parameters were subjected to two-way analysis of variance, followed by LSD multiple and Duncan's range test ($P = 0.05$).

RESULTS

In this study, B and A biotype completed their development and produced offspring on cotton and rapeseed.

Development time and longevity

Developmental time of different immature stages and adult longevity of B and A biotype on cotton are presented in Table 1. Evidently, there were no significant differences for both the biotypes between developmental time for the immature stages (pre-adult duration) on the cotton according to ANOVA. The egg-stage of both B and A biotype took 10.75 and 10.58 days, respectively at 24ºC. In both biotype, developmental period of the settled 1st instars was on average 4 - 5 days that for the 2nd and 3rd instars was 2 days, and for the 4th

instars and pupal stage 1-2 days. Mean adult longevity of B and A biotype was 5.42 and 4.55 days, respectively. Thus, A biotype had a shorter life cycle and longer adults' longevity than B biotype. Similar results were found for immature stages and adult longevities, percentages of survival, sex ratio of B and A biotype on rapeseed.

Table 1 - Development (in days) of B (*Bemisia argentifolii*) and A (*Bemisia tabaci*) biotype reared on cotton at 24ºC. Numbers between brackets represent standard error.

Species	Egg Duration (day)	1st instar (day)	2nd instar (day)	3rd instar (day)	4th instar (day)	Pupae (days)	Total preadult duration(day)	Adult longivity(day)
B biotype	10.75(0.62)	4.75(0.25)	2(0.0)	2(0.0)	1.5(0.28)	1.5(0.28)	22.25(0.6)	5.42(0.55)
A biotype	10.58(0.25)	4.25(0.25)	2(0.0)	2(0.0)	1.5(0.28)	1.25(0.25)	22.08(0.22)	4.55(0.2)

The results of total female eggs per female per day (Gross fecundity-m_x) are shown in Figure 1. The maximum egg laid, its day of occurrence and the end of oviposition period for B biotype females, which were collected from the rapeseed and cotton were 5.64, 29.5 and 42.5; 1.93, 28.5 and 47.5, respectively. The maximum egg laid; its day of occurrence and the end of oviposition period for A biotype females, which were collected from the rapeseed and cotton were 3.25, 28.5 and 38.5; 2.83, 43.5 and 47.5, respectively.

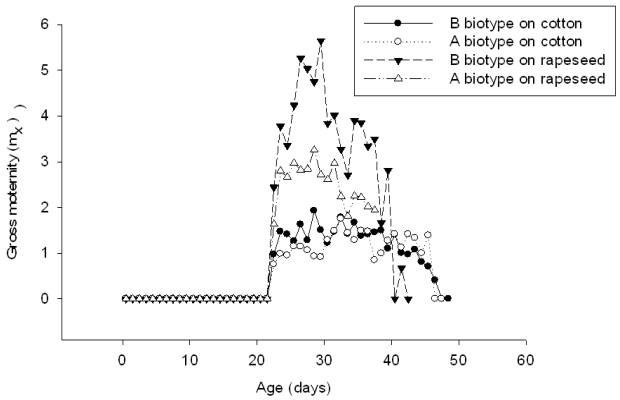

Figure 1 - Mean of female eggs per female per day (m_x) when A and B biotype were reared on rapeseed and cotton

Life table and demographic parameters

Results showed the significant difference between the host plant per biotype for Gross Reproductive Rate (GRR) (d.f. = 3, F = 3719, p = 0.001). Net Reproductive Rate (R_0) (d.f. = 3, F = 2083, p= 0.000), Intrinsic Rate of Increase (r_m) (jackknife estimate of r_m) (d.f .= 3, F = 82.86, p = 0.000), Finite Rate of Increase (λ), (d.f .= 3, F = 85.38, p = 0.000), Doubling Time (DT) (d.f. = 3, F = 43.59, p = 0.000) and Mean Generation Time (T) (d.f. = 3, F = 22.79, p = 0.000) at the 1% probability level indicated that the host plants had a significant impact on biological performance of both studied whiteflies. As shown in Table 2, the populations, which were reared on rapeseed had a significant higher value for the intrinsic rate of increase, finite rate of increase, gross reproductive rate and net reproductive rate than those, which were reared on the cotton, This showed that rapeseed was a more suitable host for the development and reproduction of two biotype than cotton. Furthermore, these life parameter values for B biotype fed on rapeseed were significantly higher than A biotype. Besides, doubling time and generation time for B biotype were the lowest with 3.97 and 21.27 days, respectively in comparison with other populations.

Table 2 - Means of population parameters of B (*Bemisia argentifolii)* and A biotype reared on rapeseed and cotton (Numbers between brackets represent standard error).

Variable	B biotype reared on rapeseed	B biotype reared on cotton	A biotype reared on rapeseed	A biotype reared on cotton
Gross reproductive rate (GRR) (eggs per female)	68.00(0.41)a	32.22 (0.2126)c	43.57 (0.254)b	30.5 (0.212)d
Net reproductive rate (R_o) (female/female/ generation)	40.75 (0.256)a	27.84 (0.196)c	30.47 (0.127)b	18.41 (0.2)d
Intrinsic rate of increase (r) (1/t)	0.175 (0.0027)a	0.103(0.003)c	0.128(0.002)b	0.101(0.005)c
Finite rate of increase (λ) (day)	1.191 (0.003)a	1.109 (0.0037)c	1.137 (0.003)b	1.106 (0.0061)c
Doubling Time (DT) (day)	3.97(0.062)c	6.81 (.22)a	5.42 (0.11)b	7.14 (0.35)a
Mean generation time (T) (day)	21.27(0.36)c	32.74 (1.12)a	26.77(0.6)b	30.07 (1.59)a

Similar letters in rows indicate no significant difference at the level of 5% according to LSD and Duncan's test.

The means of stable age distribution (C_x) (in different age classes; egg stage, settled 1st instars, 2nd instars, 3rd instars, 4th instars and pupa) were 0.65, 0.14, 0.048, 0.038, 0.03 and 0.022 for B biotype and 0.58, 0.15, 0.055, 0.05, 0.042 and 0.012 for A biotype, respectively when both biotype were reared on cotton. Proportions for pre-imaginal period and adult periods were 0.93 and 0.07 for B biotype; 0.91 and 0.082 for cotton whitefly, respectively (Table 3).

Table 3 - Stable age distribution coeficients (Cx) of B and A biotype of *Bemisia tabaci* reared on cotton at 24ºC.

Species	Incubation period	1st instar	2nd instar	3rd instar	4th instar	Pupae	Preimaginal period	Adult
B biotype	0.65	0.14	0.048	0.038	0.03	0.022	0.93	0.07
A biotype	0.58	0.15	0.055	0.05	0.042	0.012	0.91	0.082

DISCUSSION

Pest species of insects are notoriously prone to escape the tools deployed in the management efforts against them. This is particularly true in herbivorous insects (Downie 2010). When a previously successful tactic fails, the insect population apparently adapts to it and is often considered to be a new or distinct entity, and is given the non-formal category 'biotype'. The entities falling under the umbrella term 'biotype' are not consistent either within or between the biotypes and their underlying genetic composition and origins, while generally unknown, are likely heterogeneous within and variable between the biotypes. In some cases, race or species may be more appropriate referents. Some examples of applications of the concept in the context of host plant resistance are discussed. It is argued that the term 'biotype' and its applications are overly simplistic, confused, have not proved useful in current pest management and lack predictive power for future management (Downie 2010).

Samih and Izadi (2006) reported that the two whiteflies species showed significant difference on their gross fecundity and fertility rates and no significant difference on their gross hatch rate, net fecundity and fertility rates, mean age net fecundity and fertility, eggs per female per day and fertile eggs per female per day. They believed that oviposition range of *B. tabaci* based on the temperature, host, plants and insect biotype was significantly variable and showed that the gross fecundity and fertility rates, gross hatch rate, and net fecundity and fertility rates were greater on rapeseed than on cotton.

The developmental times of B biotype (22.28 d) reared on cotton in this study were nearly equal to those reared on cotton (23.6 d) and poinsettia (23.2 d) at about 25ºC (Bethke et al. 1991) and on sweet pepper (21.5 d) at 26ºC (Muniz and Nombela 2001). The fecundity of B biotype reared on rapeseed (68 eggs) was higher than on cotton (51.2 eggs) (Bethke et al. 1991) and less than on poinsettia (85.0 eggs) (Bethke et al. 1991), tobacco (72.3 eggs) (Enkegaard 1993) at about 25ºC, and on alfalfa, broccoli, cantaloupe, cotton and zucchini (40.6 - 70.6 eggs) at 27ºC (Yee and Toscano 1996). This study demonstrated that the type of host plant had a significant effect on the development, survival and reproduction of B and A biotype. These findings generaly agreed with other related studies about these whitefly biotype (Coudriet et al. 1985; Bethke et al. 1991; Powell and Bellows 1992a, b; Enkegaar 1993; Simmons 1994; Yee and Toscano 1996; Nava-Camberos et al. 2001).

Enkegaard (1993) recorded values of r_m, λ, T and DT for the B strain of *B. tabaci* (= *B. argentifolii*) at 25º on poinsettia plants as 0.087, 1.091, 43.0887 and 7.94, respectively. These values were less than those found for B biotype reared on cotton and rapeseed in the current study. Based on the fact the developmental rate and reproduction was mainly dependent on food quality, food quantity, temperature and kind of host plants, the high values of r_m indicated susceptibility of a host plant to insect attacks and vice versa.

Tsai and Wang (1996) compared the suitability of eggplant, cucumber, tomato, sweet potato and garden bean for a Florida population of *B. argentifolii.* They reported that the pest intrinsic rates of increase (r) on these hosts, was 0.192, 0.153, 0.138, 0.134 and 0.12, respectively at 25º, 80-90 % RH and a 14L10D h photoperiod though these values were higher than those that obtained in the present study for a *B. argentifolii* population collected in Iran.

Cui et al. (2008) investigated the effects of heat shock on two whitefly species, *Teialeurodes*

vaporariorum (Westwood) and *B. tabaci* biotype B and showed the significance of heat shock in relation to dispersal, distribution and population dynamics of the two whitefly species. Gou et al. (2012) demonstrated the ability of *B. tabaci* biotype B to survive long-term high-temperature stress, which were important for understanding its population distribution under global warming. Musa and Ren (2005) stated that the developmental period from the egg to adult varied from 27.8 days on garden beans to 18.2 days on soybeans. They also showed that the fecundity of *B. tabaci* on soybean, cowpea and garden bean were 160.85 ± 19.04, 153.07 ± 15.65 and 98 ± 13.02, respectively. The intrinsic rate of increase (r_m), finite rate of increase (λ) and net reproductive rate (R_0) on soybeans were 0.1875, 1.2041 and 82.15, respectively. Present study showed that A biotype was less adapted to rapeseed and cotton than soybean in the study by Musa and Ren (2005). On the other hand, A biotype was highly adapted and showed the greater preference for soybean than rapeseed and cotton.

Yang and Chi (2006) studied the life history of *B. argentifolii* on tomato based on the age-stage, two-sex life table at 15, 20, 25, 28, 30, and 35ºC and found its intrinsic rate of increase (r) as 0.1469 at 25ºC, which was different with the present results. On the other hand, they mentioned that the mean generation time of *B. argentifolii* on tomato at 25ºC was 28.4, which was closer to the mean value of the present study. Also, r_m of A biotype decreased on both the hosts, while r_m of B biotype increased only when it was reared on rapeseed and decreased when reared on cotton. The recent results were similar to Yang and Chi (2006) when *B. argentifolii* was reared on tomato. The intrinsic rate of natural increase (r_m) of B biotype (*B. argentifolii)* and A biotype reared on cotton (0.1033 and 0.1010, respectively) in this study was closed to Lin and Ren (2005) results on B biotype of *B. tabaci* reared on cotton rose hibiscus (*Hibiscus mutabilis* L.) (0.1032) at 26 ± 2ºC, related humidity of 75 – 90 % and a photoperiod of 14:10 h (L : D). They showed that, in comparison with tomato, cotton rose hibiscus and cotton, rapeseed was the most suitable host plant for *B. argentifolii*.

Calvitti and Remotti (1998) found that the intrinsic rate of increase of *B, argentifolii* varied from 0.11 on *S. oleraceous* to 0.004 for *Euphorbia dendroides*, which meant that *B. argentifolii* established its colony on wild plants in the absence of cultivated host plants such as tomato, squash, ornamental plants, poinsettia, cotton and rapeseed. The present results demonstrated that this pest attack to rapeseed also occurred in the absence of main host same as cotton. Luo et al. (2008) reported the developmental times between 20.8 to 24.2 d and the intrinsic rate of natural increase (r_m) between 0.0844 to 0.1121 for *B. argentifolii* when it reared on six cotton cultivars at 27 ± 1ºC. This was closer to the present results (23.75 and 0.1033, respectively). Also, Bethke et al. (1991) reported that the developmental times of *B. argentifolii* reared on cotton and poinsettia were 23.6 and 23.2 days at about 25ºC, which was very close to the present report (23.75 d). This was 21.5 d on sweet pepper at 26ºC (Muniz and Nombela 2001).

Kakimoto et al. (2007) studied the developmental time, intrinsic rate of natural increase (r_m), net reproductive rate (R_0) and the mean life time fecundity of *B. argentifolii* raised on four commercial vegetables such as eggplant, cucumber, sweet pepper and tomato at 25ºC. They found the developmental time of pest as 21.8 d on eggplant, 22.4 d on cucumber, 22.7 d on sweet peper and 25.6 d on tomato. In comparing with the present work, this parameter on cotton and rapeseed was shorter than on tomato while was longer on other vegetables. They mentioned that the intrinsic rate of natural increase (r_m) and net reproductive rate (R_0) was 0.168 and 185.1 on eggplant; 0.153 and 130.7 on cucumber; 0.143 and 73.1 on sweet pepper; and 0.110 and 36.1 on tomato, respectively. In this study, the r_m of reared B biotype was decreased on cotton when it was compared with the reared one on rapeseed while it was higher than all these vegetables. Also, the mean life-time fecundity of *B. argentifolii* on eggplant, cucumber, sweet pepper and tomato were 221.3, 167.6, 92.3 and 62.9 eggs, respectively. In this study, the life-time fecundity for B biotype reared on rapeseed was higher than tomato while was lower than on the other vegetables, but it was much lower on cotton and rapeseed than all other plants for A biotype. The results Kakimoto et al. (2007) in comparing with the present work showed that eggplant, cucumber and sweet pepper were more suitable host plants for *B. argentifolii* than rapeseed and cotton.

Liu and Stansly (1998) reported the intrinsic rate of increase (r) and finite rate of increase (λ) of *B. argentifolii* reared on *Hibiscus rosa-sinensis* that were 0.105 and 1.22, respectively. Certainly, all

values of r_m for *B. argentifolii*, which were recorded by Liu and Stansly (1998), Yang and Chi (2006), Kakimoto et al. (2007) Luo et al. (2008) and this work showed that *H. rosa- sinensis* and cotton were poor hosts for *B. argentifolii* in comparing with other hosts such as eggplant, tomato, sweet potato, cucumber, garden bean and rapeseed. Based on the present findings, the fecundity of B biotype (68 eggs) reared on rapeseed was higher than on cotton (51.2 eggs), but it was lower than on poinsettia (85.0 eggs) (Bethke et al. 1991) and tobacco (72.3 eggs) (Enkegaard 1993) at about 25ºC. Yee and Toscano (1996) reported the range of 40.6 – 70.6 eggs for alfalfa, broccoli, cantaloupe, zucchini and cotton at 27°C. The intrinsic rate of natural increase (r_m) of B biotype and A reared on cotton (0.1033 and 0.1010, respectively) in present study were almost equal to r_m for Q-biotype of *B. tabaci* reared on tomato (0.106) at 25 ± 1ºC, 60 ± 5% RH and L14:D10 h (Bonato et al. 2007).

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