Antibiotic Resistance of Canola Cultivars Affecting Demography of *Spodoptera exigua* (Lepidoptera: Noctuidae)

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ABSTRACT

Spodoptera exigua (Hübner) was studied in laboratory (25±1ºC, 60±5% RH, and 16:8 L:D h) exploring the antibiotic effects of 10 canola cultivars (Sarigol, SLM_{046}, $Hayula_{420}$, RGS_{003}, Opera, Okapi, Licord, Modena, Zarfam and Talaye) on its demographic parameters. The age-stage, two-sex and the traditional female age-specific life tables were constructed by using the demographic data. The larval period was longest on Modena (17.53 days) and pupal period was longest on Opera (8.96 days). The longest and shortest development time of immature stages lasted 29.96 and 25.82 days on Talaye and Okapi, respectively. Male adult longevity was longest on Okapi (14.93 days) and shortest on $Hayula_{420}$ (9.14 days), and female adult longevity was longest on Zarfam (18.04 days) and shortest on $Hayula_{420}$ (8.07 days). Based on the two-sex life table, the net reproductive rate (R_0), intrinsic rate of increase (r), and finite rate of increase (λ) were highest on Okapi (352.96 offspring per individual, 0.201 and 1.223 day^{-1}, respectively). The lowest value of R_0 was recorded on Opera (152.73 offspring per individual) and lowest value of r and λ on Talaye (0.142 and 1.153 day^{-1}, respectively). The mean generation time (T) took longest time on Modena (36.41 days) and shortest on Okapi (29.06 days). The results of this study showed that 'Okapi' was the most suitable canola cultivar for reproduction and population growth of *S. exigua*, which revealed higher susceptibility of 'Okapi' to this pest.

Keywords: Beet armyworm, Two-sex life table, Population growth.

INTRODUCTION

Beet armyworm *Spodoptera exigua* (Hübner) is a destructive polyphagous insect pest with worldwide distribution. *Spodoptera exigua* feeds on more than 50 plant species from 10 plant families around the world. It has been reported for the first time from Iran by Afshar in 1938 and it attacks several agricultural crops like canola (Keyhanian *et al.*, 2005).

Resistance of arthropods to insecticides and residue of conventional pesticides in agricultural crops has convinced managers and scientists to find alternative strategies to control pests. Host plants with deleterious compounds may reduce survival rate, size or weight, longevity and reproduction of herbivorous arthropods or they may have an indirect effect by increasing the exposure of the arthropod to its natural enemies as a result of prolonged development time (Ali and Gaylor, 1992; Greenberg *et al.,* 2001; Chen *et al.,* 2008). Selecting host plants with partial resistance to herbivorous insects is a major method for controlling insect pests in integrated management (IPM) programs.

It is important to understand the basic biology and population parameters of arthropod herbivores to assess resistance of host plants to conduct convenient control strategies (Sedaratian *et al.*, 2011). Therefore, careful consideration is needed to make a correct decision in selecting the appropriate cultivar to cultivate. The intrinsic rate of increase is the most appropriate biological

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index to evaluate the suitability of different host plants and assess plant resistance level to an insect herbivore.

Different canola cultivars have different primary and secondary metabolites (Soufbaf *et al.*, 2012, that is expected to cause different effects on performance of *S. exigua*. Golizadeh *et al.* (2009), Soufbaf *et al.* (2010a, b), and Fathi *et al.* (2011) tried to assess the effect of different canola cultivars on performance of *Plutella xylostella* (L.), but no study has been conducted regarding the effect of canola cultivars on *S. exigua* so far.

Attention to develop a practical program in control of polyphagous insects engaged many researchers in study of herbivore-host plant interactions. Many studies on *S. exigua* performance on different host plants have been conducted so far (e.g. Azidah and Sofian-Azirun, 2006; Saeed *et al.*, 2009; Karimi-Malati *et al.*, 2012 ; and Mehrkhou *et al.*, 2012). For this insect pest, researchers have examined different host plants such as sugar beet (Karimi-Malati *et al.*, 2012), soybean (Farahani *et al.*, 2011b; Mehrkhou *et al.*, 2012), maize and cotton (Farahani *et al.*, 2011a). They all proved that different host plants affect life table parameters of *S. exigua*, especially the intrinsic rate of increase. Karimi-Malati *et al.* (2012) found the significant effect of different sugar beet cultivars on population parameters of *S. exigua*. Farahani *et al.* (2011a, 2012) also demonstrated the profound effect of various host plants on the life table parameters of *S. exigua*. In the current study, we determined the suitability or inferiority of different canola cultivars to *S. exigua*. Determining the effect of different canola cultivars on life table and other biological parameters of *S. exigua* is an initial step toward substituting non-chemical methods in an IPM program.

MATERIALS AND METHODS

Insect Rearing and Experimental Conditions

The initial population of *S. exigua* was originally collected from beet fields of Qazvin, Iran, in May 2010. The seeds of 10

canola cultivars (Sarigol, SLM$_{046}$, Hayula$_{420}$, RGS$_{003}$, Opera, Okapi, Licord, Modena, Zarfam and Talaye) as host plants were obtained from Seed and Plant Improvement Research Institute and planted in the research field of Faculty of Agriculture, Tarbiat Modares University, Tehran.

The moths were reared on ten canola cultivars separately for two generations to adapt with new host plants in growth chamber at $25\pm 1°C$, $60\pm 5\%$ RH, and 16:8 (L:D) h.

Age-stage, Two-sex Life Table

At least 100 eggs of *S. exigua* laid within 24 hours of the experiment by laboratory-reared females were used to start trials on each plant cultivar. The newly emerged larvae were placed individually in Petri dishes (8 cm diameter×2 cm height) with a hole covered with a fine mesh net for ventilation. The newly emerged larvae were fed by fresh leaves of different canola cultivars tested. The petioles of the detached leaves were inserted in water-soaked cotton to keep them fresh. The eggs and larvae were checked daily and their developmental time were recorded. The pre-pupae were transferred to plastic containers (3 cm diameter×5 cm height) to develop to pupae. The incubation, larval, pre-pupal and pupal periods, developmental time of immature stages, and their mortality were recorded daily. Upon emergence, the adult females were paired with males and transferred to the oviposition container (11 cm diameter×12 cm height), covered by fine mesh for ventilation. The adults were fed on 10% honey solution impregnated onto cotton wool. The number of eggs produced and adult longevity were also recorded daily. The monitoring continued until the death of the last individual in the cohort.

The life history raw data were analyzed according to the age-stage, two-sex life table theory (Chi, 1988). The age-stage specific survival rate (s_{xj}) (where x= age in days and j= stage); the age-stage specific fecundity

(f_{xj}) (daily number of eggs produced per female of age x); the age-specific survival rate (l_x); the age-specific fecundity (m_x) [daily number of eggs divided by all individuals (male and female) of age x]; and the population growth parameters [the intrinsic rate of increase (r)]; the finite rate of increase (λ); the gross reproductive rate (*GRR*); the net reproductive rate (R_0) and the mean generation time (T) were calculated accordingly by using the TWOSEX-MS Chart programme (Chi, 2013). The TWOSEX-MS Chart is available at http://140.120.197.173/Ecology/prod02.htm (Chung Hsing University) and http://nhsbig.inhs.uiuc.edu/wes/chi.html (Illinois Natural History Survey). The means and standard errors of the population parameters were estimated by using the Bootstrap procedure (Huang and Chi, 2013; Khanamani *et al.*, 2013). In the bootstrap procedure, a sample of *n* individuals was randomly taken from the cohort with replacement and calculated the $r_{i\text{-}boot}$ for this bootstrap sample as follows (Khanamani *et al.*, 2013; Safuraie-Parizi *et al.*, 2014):

$$\sum_{x=0}^{\omega} e^{-r_{i\text{-}boot}(x+1)} l_x m_x = 1$$

Where, the subscript *i-boot* represents the *i* bootstrap, and l_x and m_x are calculated from the *n* individuals selected randomly with replacement. Generally, the data on the same individual are repeatedly selected. We repeated this procedure *m* times (*m*= 10,000) and computed the mean of these *m* bootstraps as:

$$r_B = \frac{\sum_{i=1}^{m} r_{i\text{-}boot}}{m}$$

The variance (VARr_B) and standard error (SEr_B) of these *m* bootstraps were calculated as:

$$VARr_B = \frac{\sum_{i=1}^{m} (r_{i\text{-}boot} - r_B)^2}{m-1}$$

$$SEr_B = \sqrt{VARr_B}$$

The same methods were used for the corresponding estimates of the finite rate of increase (λ), gross reproductive rate (*GRR*), net reproductive rate (R_0) and mean generation time (T).

The two-sex life table bootstrap-values of the *S. exigua* on different canola cultivars were compared using the Tukey–Kramer procedure. In addition, age-specific female life table parameters were calculated using only female data.

RESULTS

Biological Parameters

Our results showed no significant difference in the incubation period of *S. exigua* reared on different canola cultivars (F= 8.67; df= 9, 640; P> 0.05). However, there was a significant variation in the larval period of *S. exigua* fed on different canola cultivars (F= 38.91; df= 9, 627; P< 0.0001) (Table 1).

The pupal period was significantly different among canola cultivars tested (F= 3.76; df=9, 538; P< 0.0001). The results showed that the pupal period of *S. exigua* fed on Opera was the longest, while the larvae fed on Okapi had the shortest pupal period. Developmental time of the immature stages (sum of incubation, larval and pupal periods) was the longest on Talaye followed by Modena and the shortest on Okapi (F= 29.17; df= 9,529; P< 0.0001). There was significant difference in adult longevity reared on different canola cultivars. Actually, the longest female longevity was recorded on Zarfam (F= 12.92; df= 9, 272; P< 0.0001), whereas male longevity was the longest on Okapi followed by Licord (F= 13.14; df= 9,530; P< 0.0001) (Table 1). The survivorship (l_x) curves of *S. exigua* on ten canola cultivars are shown in Figure 1, which was highest on Okapi (0.85) and lowest on Talaye (0.60) at adult emergence.

Table1. Mean (±SE) development duration of different immature stages and adult longevity of *Spodoptera exigua* on ten canola cultivars.[a]

Immature	Sarigol	SLM046	Hayula420	RGS003	Opera	Okapi	Licord	Modena	Zarfam	Talaye
Egg	3.43 ± 0.05^a	3.43 ± 0.05^a	3.42 ± 0.06^a	3.43 ± 0.07^a	3.419 ± 0.07^a	3.43 ± 0.09^a	3.43 ± 0.07^a	3.44 ± 0.07^a	3.43 ± 0.07^a	3.42 ± 0.07^a
Larva	13.90 ± 0.18^c	14.19 ± 0.25^c	13.51 ± 0.20^c	13.92 ± 0.27^c	14.13 ± 0.20^c	13.53 ± 0.20^c	14.06 ± 0.20^c	17.53 ± 0.30^a	16.52 ± 0.35^b	17.47 ± 0.37^a
Larval instars										
L1	3.23 ± 0.05^d	3.24 ± 0.05^d	3.46 ± 0.06^c	3.21 ± 0.05^d	3.51 ± 0.07^{bc}	3.29 ± 0.06^d	3.05 ± 0.04^e	3.65 ± 0.06^b	3.60 ± 0.07^{bc}	3.88 ± 0.07^a
L2	2.63 ± 0.11^a	2.60 ± 0.11^a	2.44 ± 0.09^a	2.54 ± 0.09^a	2.51 ± 0.10^a	1.90 ± 0.11^b	1.78 ± 0.27^b	2.63 ± 0.09^a	2.39 ± 0.09^a	2.46 ± 0.09^a
L3	2.42 ± 0.07^{bc}	2.43 ± 0.08^{bc}	2.18 ± 0.08^c	2.68 ± 0.12^{abc}	2.41 ± 0.10^{bc}	2.29 ± 0.12^c	3.11 ± 0.43^a	2.84 ± 0.18^{ab}	2.71 ± 0.13^{abc}	2.94 ± 0.19^{ab}
L4	2.33 ± 0.09^d	2.64 ± 0.10^{cd}	2.48 ± 0.09^{cd}	2.49 ± 0.09^{cd}	2.59 ± 0.08^{cd}	2.36 ± 0.06^d	2.82 ± 0.07^c	4.15 ± 0.09^a	3.40 ± 0.09^b	3.86 ± 0.09^a
L5	3.06 ± 0.09^c	3.33 ± 0.10^{bc}	3.03 ± 0.08^c	3.29 ± 0.14^{bc}	3.13 ± 0.11^c	3.58 ± 0.14^b	3.97 ± 0.13^a	4.01 ± 0.13^a	4.04 ± 0.13^a	4.11 ± 0.11^a
Pupa	8.63 ± 0.12^{ab}	8.73 ± 0.11^{ab}	8.55 ± 0.09^b	8.69 ± 0.13^{ab}	8.96 ± 0.10^a	8.17 ± 0.11^c	8.55 ± 0.10^b	8.74 ± 0.12^{ab}	8.57 ± 0.11^b	8.65 ± 0.14^{ab}
Development time	26.70 ± 0.19^{cde}	27.09 ± 0.32^{cd}	26.11 ± 0.26^e	26.44 ± 0.27^{de}	27.39 ± 0.26^c	25.82 ± 0.25^e	26.69 ± 0.25^{cde}	29.94 ± 0.30^a	29.09 ± 0.35^b	29.96 ± 0.46^a
Mature										
Female	9.38 ± 0.74^{ed}	11.11 ± 0.74^d	8.07 ± 0.41^e	10.30 ± 0.74^e	10.13 ± 1.01^{ed}	11.83 ± 0.94^{cd}	12.00 ± 0.96^{cd}	13.93 ± 0.89^{cb}	18.04 ± 0.89^b	15.64 ± 0.88^b
Male	9.79 ± 0.36^c	12.82 ± 0.83^{ab}	9.14 ± 0.57^c	11.33 ± 0.99^{bc}	13.38 ± 1.44^{ab}	14.93 ± 0.63^a	14.90 ± 0.75^a	13.19 ± 1.43^{ab}	13.74 ± 1.05^{ab}	14.62 ± 0.91^a

[a] The means followed by the same letters in each row are not significantly different (Duncan's multiple range test, $\alpha= 0.01$).

Age-stage Specific Survival Rate and Fecundity

The age-stage specific survival rates (s_{xj}) of *S. exigua* (Figure 2) show the probability that a new born will survive to age *x* and develop to stage *j*. These curves also show the survivorship and stage differentiation as well as the variable developmental rate.

The mean number of offspring produced by *S. exigua* individuals of the age *x* and stage *j* per day is shown with the age-stage specific fecundity (f_{xj}) in Figure 1. Since only females produce offspring, there is only the single curve f (*x*, female). The start of oviposition of the first female on Sarigol, SLM046, Hayula420, RGS003, Opera, Okapi, Licord, Modena, Zarfam and Talaye occurred at the age of 27, 26, 24, 26, 27, 25, 26, 29, 27, and 29 days, respectively. The highest daily fecundity [peak of f (*i*, female)] of *S. exigua* on the above-mentioned cultivars was 88.83, 137.35, 111.83, 115.96, 83.09, 188.88, 182.28, 97.44, 103.13, and 78.79 eggs, respectively, which occurred at the age of 28, 29, 28, 28, 32, 26, 30, 36, 30, and 32 days, respectively.

Two-sex Life Table Parameters

According to the age-stage, two-sex life table, the population parameters were calculated based on data of the entire cohort (both sexes and the variable developmental rates among individuals) (Table 2). The *S. exigua* cohort reared on Talaye had the lowest intrinsic rate of increase (*r*), whereas the cohort on Okapi had the highest value of this parameter. Moreover, the net reproductive rate (R_0) was lowest on Opera and highest on Okapi. In addition, the gross reproductive rate (*GRR*) of *S. exigua* was significantly higher on Okapi compared with the other cultivars. The finite rate of increase (λ) was found minimum on Talaye whereas the maximum value was recorded on Okapi. Moreover, the mean generation time (*T*) varied from 29.06 days on Okapi to 36.41 days on Modena.
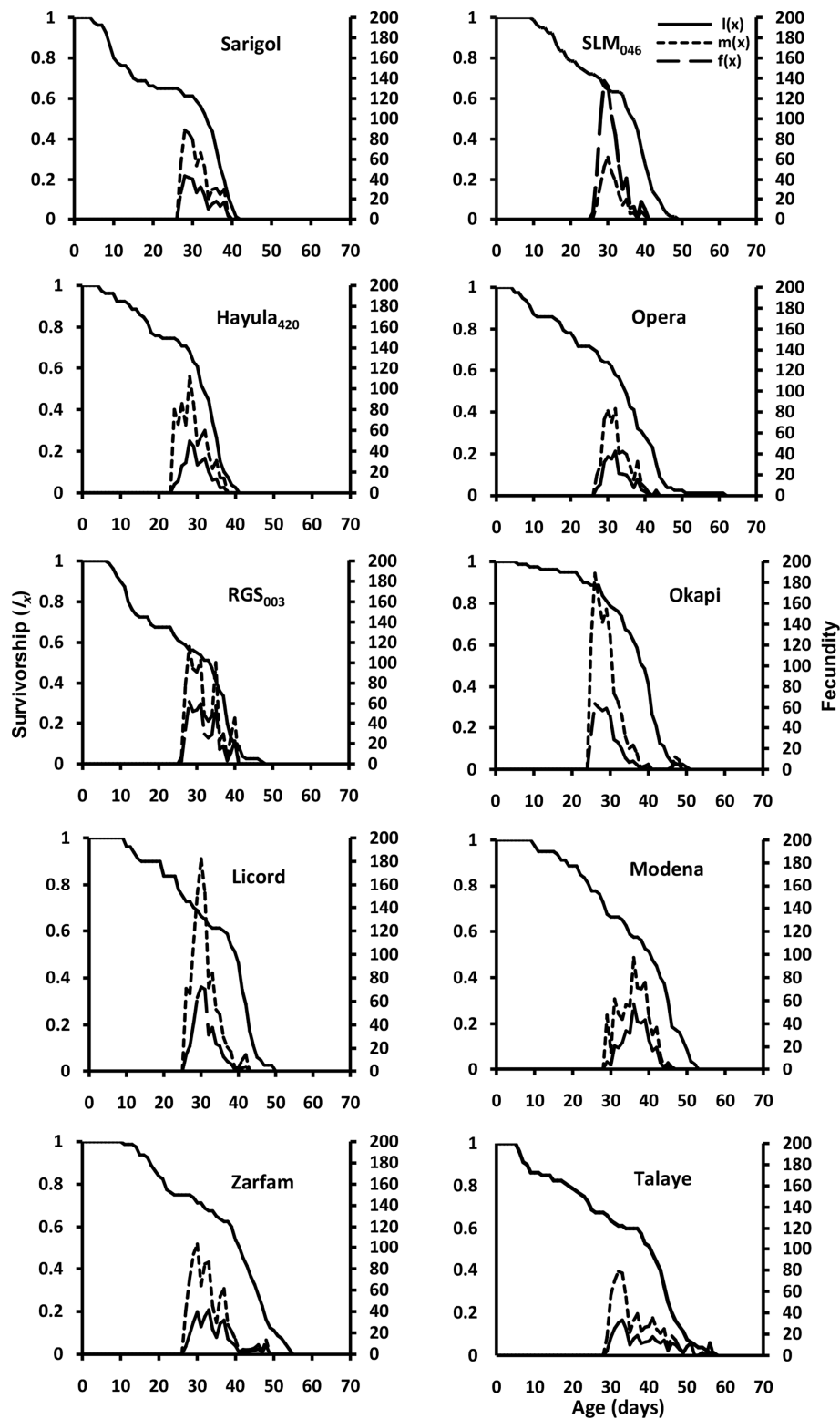
Figure 1. Age specific survivorship (l_x), age-stage specific fecundity of female (f_{xj}) (offspring) and age specific fecundity (m_x) of *Spodoptera exigua* on ten canola cultivars using the age-stage, two-sex life table.
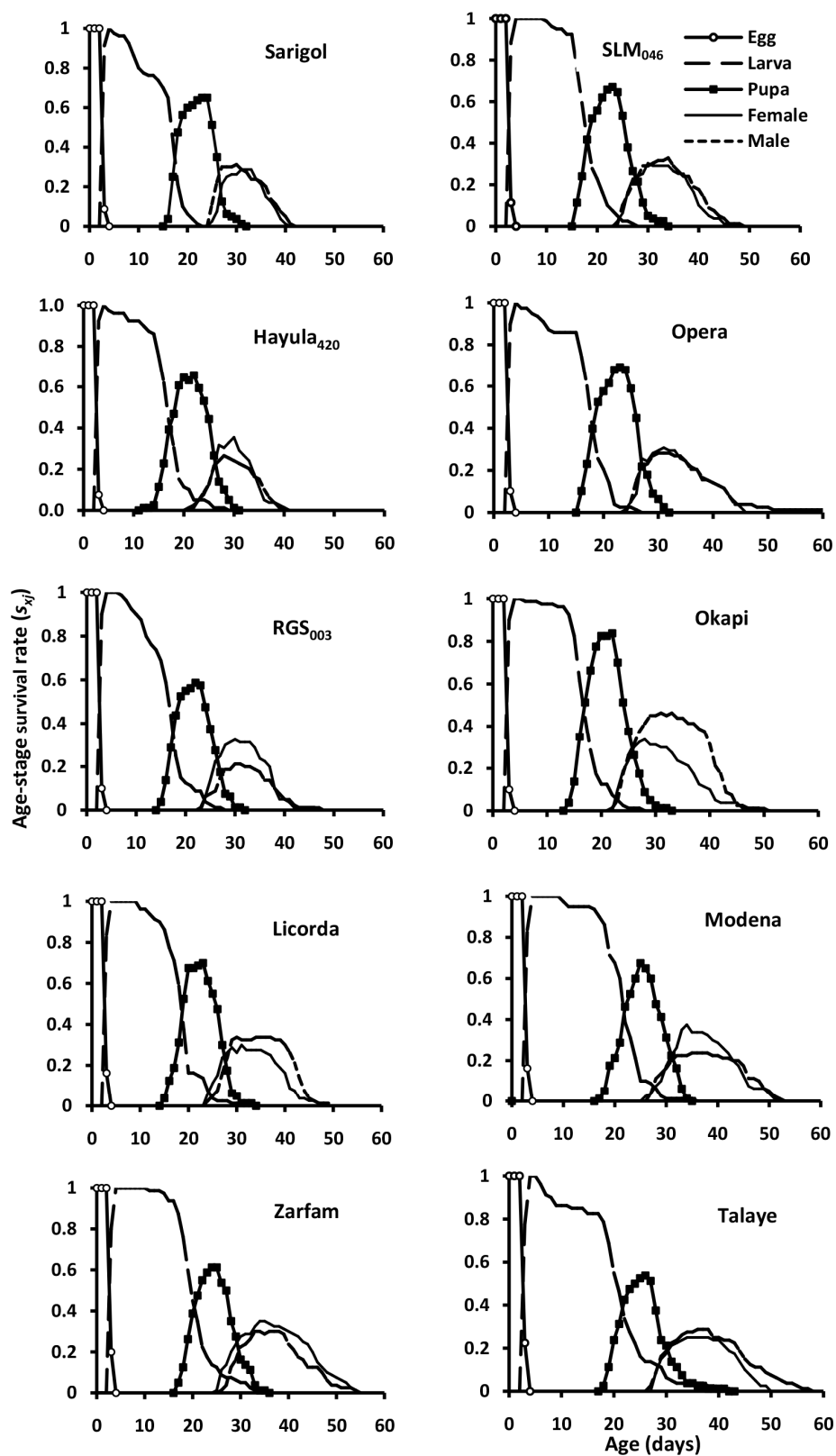
Figure 2. Age-stage specific survival rate (s_{xj}) of *Spodoptera exigua* on ten canola cultivars.

Table 2. Age-stage, two-sex and female age-specific life table parameters (Means±SE) of *Spodoptera exigua* on ten canola cultivars.[a]

Canola cultivars	*GRR* (Offspring/Individual)	R_0 (Offspring/Individual)	*r* (Day^{-1})	*λ* (Day-1)	*T* (Day)
Sarigol	310.403±54.354[a]	164.776±32.613[bc]	0.163±0.007[bcd]	1.177±0.008[bcd]	31.106±0.472[c]
	310.070	164.525	0.169	1.185	29.544
SLM$_{046}$	335.161±59.558[a]	210.716±41.738[bc]	0.170±0.007[bc]	1.185±0.008[bc]	31.355±0.415[c]
	333.872	209.987	0.176	1.192	29.881
Hayula$_{420}$	315.009±54.645[a]	181.588±34.000[bc]	0.176±0.007[b]	1.192±0.009[b]	29.401±0.490[d]
	315.048	181.632	0.183	1.201	27.807
RGS$_{003}$	427.479±74.226[a]	227.485±41.943[bc]	0.172±0.006[bc]	1.188±0.007[bc]	31.304±0.390[c]
	473.182	227.812	0.179	1.196	29.664
Opera	277.529±45.258[a]	152.734±28.864[c]	0.155±0.006[cde]	1.167±0.007[cde]	32.291±0.415b[c]
	278.471	153.269	0.161	1.174	30.729
Okapi	440.858±71.624[a]	352.960±58.743[a]	0.201±0.006[a]	1.223±0.007[a]	29.066±0.338[d]
	442.820	353.2	0.209	1.232	27.474
Licord	437.015±71.532[a]	283.548±51.026[ab]	0.180±0.006[b]	1.197±0.007[b]	31.197±0.381[c]
	436.260	283.237	0.187	1.205	29.580
Modena	396.742±60.094[a]	225.849±40.287[bc]	0.148±0.006[de]	1.160±0.006[de]	36.414±0.594[a]
	396.220	225.525	0.153	1.165	34.560
Zarfam	361.287±60.031[a]	234.549±44.538[bc]	0.164±0.007[bcd]	1.178±0.008[bcd]	33.177±0.711[b]
	360.644	233.775	0.169	1.185	31.172
Talaye	339.135±67.688[a]	161.537±31.599[bc]	0.142±0.006[e]	1.153±0.007[e]	35.551±0.711[a]
	342.621	161.287	0.147	1.158	33.377

[a] The means followed by the same letters in each column are not significantly different (Tukey–Kramer). Data in the first row for each cultivar are related to the age-stage, two-sex life table, and data in the second row for each cultivar are related to the age-specific female life table.

The female age-specific life table parameters are shown in Table 2. There was a little difference between the same life table parameters estimated by female-based and two-sex methods. The obtained *r* values of the two-sex procedure were lower than the female-based procedure on all canola cultivars tested. The all *T* values estimated by the two-sex procedure were higher than those estimated by the female-based procedure.

DISCUSSION

Various factors such as host plants and environmental conditions could considerably affect the life cycle of *S. exigua* (Ali and Gaylor, 1992; Chen *et al*., 2008; Karimi-Malati *et al*., 2014a,b). Although populations are affected by large number of factors, there is a positive correlation between host plant suitability and the intrinsic rate of increase of such populations (Soufbaf *et al*., 2012). The intrinsic rate of increase (*r*) is an important indicator of population dynamics, which have been shown to be affected considerably by extrinsic and intrinsic factors such as certain glucosinolate, cardenolids, plant volatiles, waxes, leaf morphology as well as host plant nutritional quality or combination of these factors (Soufbaf *et al*., 2010a, b; 2012). Comparison of the intrinsic rate of increase often provides considerable insight in evaluating host plant suitability to herbivorous arthropods in integrated pest management programs (Fathipour and Sedaratian, 2013). The value of *r* determines whether a population increases exponentially (*r* > 0), remain constant in size (*r* = 0), or declines to extinction (*r* < 0). Our results showed that canola cultivars significantly affected *r* value of *S. exigua*.

Our results revealed that *S. exigua* can complete its life cycle on all canola cultivars tested and demonstrated the significant effect of these cultivars on developmental time and life table parameters of this pest. These findings, which were in agreement

with the previous studies, revealed the obvious effect of host plants on developmental time and life table parameters of *S. exigua* (Saeed *et al.*, 2009; Farahani *et al.*, 2011a, 2012; Karimi-Malati *et al.*, 2012; Mehrkhou *et al.*, 2012). Plant nutritional quality referencing to primary and secondary metabolites in many plants may affect herbivores biology and ecology considerably (Soufbaf *et al.*, 2012). Twelve glucosinolates have been detected in canola leaves (Velasco *et al.*, 2008) that might reflect the reason of different effects of canola cultivars on life table parameters of *S. exigua.*

By careful observation of the three completed generations of the moths on each canola cultivar before the main trials, we found that there was no variation in incubation period of *S. exigua* on different canola cultivars, similar to the results of Farahani *et al.* (2011a, b) and Mehrkhou *et al.* (2012). No difference in incubation period indicated that different host plants could not be much effective on this developmental period. On the other hand, the results indicated that different canola cultivars affected larval period and developmental time of immature stages of *S. exigua*. The same conclusion was made by preceding investigation by Farahani *et al.* (2011a, b). Based on our findings, the shortest larval period was on Hayula$_{420}$, and the longest on Modena. This suggests that Hayula$_{420}$ was a better nutrient source for larval growth compared with the other cultivars tested. The larval food affected the pupal period, which has been reported by other researchers too (e. g. Yoshida and Parrella, 1992; Soufbaf *et al.*, 2010a). However, it is not in agreement with the findings reported by others who found that pupal period was relatively constant on different host plants (Greenberg *et al.*, 2001). Although the pupal period of *S. exigua* on canola cultivars tested here was significantly different, these time periods were relatively close together (ranged from 8.17 days on Okapi to 8.96 days on Opera). Abdullah *et al.* (2000) rated pupal period of

S. exigua on soybean as 8.50 days, nearly the same as canola cultivars.

Slower developmental time of a herbivore on a particular host plant means a longer life span, usually a lower reproductive ability, slower population growth, and increased exposure to natural enemies. A faster developmental time on a particular host plant may allow a shorter life cycle and more rapid population growth and may also reduce generation time. In the present study, total developmental time of *S. exigua* varied from 25.82 to 29.96 days on different canola cultivars. Developmental time of immature stages of *S. exigua* has been recorded more on wheat (33.0 days), less on cauliflower (23.7 days) and close to canola on pea (27.2 days) (Saeed *et al.*, 2009).

Longer feeding and developmental time of *S. exigua* on the cultivar Talaye may allow longer opportunity for the use of biological control agents that could be considered as a susceptible stage. Susceptible stages in life cycle of any insect pests can be a key target in population management programs with lower control cost (Soufbaf *et al.*, 2010b).

Our findings are not in agreement with that of Saeed *et al.* (2009) but in agreement with Azidah and Sofian-Aziron (2006), Abdullah *et al.* (2000) and Farahani *et al.* (2011a, b) about females and males longevity. These differences could be in terms of different secondary metabolites in different host plants that provide essential nutrients for herbivores (Saeed *et al.*, 2009). However, Tisdale and Sappington (2001) believe that adult diet affects the beet armyworm longevity. In the present study, longer longevity for males on canola cultivars was demonstrated. Mehrkhou *et al.* (2012) also indicated longer longevity for males on soybean.

Since the intrinsic rate of increase (*r*) is a key parameter that represents many biological characteristics such as fecundity, survivorship, and developmental time and adequately summarizes the physiological qualities of an animal in relation to its capacity to increase, it would be the most appropriate parameter to evaluate the

performance of an insect on different host plants as well as the host plants resistance. The higher value of *r* indicates the susceptibility of a host plant to insect feeding, while the lower value indicates that the host plant species is resistant to the pest. The *r* value of *S. exigua* ranged from 0.142 day^{-1} on Talaye to 0.201 day^{-1} on Okapi, which is the repercussion of lower mortality and shorter developmental time of the pest fed on Okapi. Based on what we achieved in the present study, Talaye and Modena were virtually the unsuitable cultivars to *S. exigua,* while Okapi was found to be a suitable cultivar to *S. exigua.*

Ebrahimi *et al.* (2009), Soufbaf *et al.* (2010a, b) and Fathi *et al.* (2011) studied the effect of different canola cultivars on demographic parameters of *Plutella xylostella* (L.). Opera and RGS_{003} were reported as the least favorable canola cultivars to *P. xylostella* by Fathi *et al.* (2011) and Soufbaf *et al.* (2010a), respectively. Both of the mentioned cultivars were unsuitable to *S. exigua* too in our study. Zarfam, SLM_{046}, and Modena were categorized as the most nutritious cultivars to *P. xylostella* by Ebrahimi *et al.* (2009), Soufbaf *et al.* (2010a) and Fathi *et al.* (2011), respectively. However, Zarfam and Modena were mentioned as suitable cultivars to *S. exigua* in the present study.

Knowing the influence of canola cultivars on demographic parameters of *S. exigua* may help us to understand its population dynamics and improve pest management strategies. However, further information is required to better understand the other components of integrated pest management programs.

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تأثیر مقاومت آنتی بیوز ارقام مختلف کلزا بر پارامترهای دموگرافیک Spodoptera exigua (Lepidoptera: Noctuidae)

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چکیده

اثرات آنتی بیوزی ده رقم کلزا شامل Sarigol، SLM₀₄₆، RGS، Hayula₄₂₀، Opera، Okapi، Licord، Modena، Zarfam و Talaye روی پارامترهای دموگرافیک *Spodoptera exigua* (Hübner) در شرایط دمایی ۲۵±۱ درجه سلسیوس، رطوبت نسبی ۶۰±۵ درصد و دوره نوری ۱۶ ساعت روشنایی و ۸ ساعت تاریکی مورد بررسی قرار گرفت. با استفاده از داده های به دست آمده، جدول زندگی دو جنسی و تک جنسی تشکیل شد. طولانی‌ترین طول دوره نمو لاروی و شفیرگی به ترتیب روی ارقام Modena (۱۷/۵۳ روز) و Opera (۸/۹۶ روز) به ثبت رسید. طولانی‌ترین و کوتاه‌ترین طول دوره نمو قبل از بلوغ به ترتیب ۲۹/۹۶ و ۲۵/۸۲ روز روی ارقام Talaye و Okapi مشاهده شد. بیشترین میانگین طول عمر حشرات کامل نر روی رقم Okapi (۱۴/۹۳ روز) و کمترین میزان روی رقم Hayula₄₂₀ (۹/۱۴) و بیشترین میانگین طول عمرحشرات کامل ماده روی رقم Zarfam (۱۸/۰۴ روز) و کمترین میزان روی رقم Hayula₄₂₀ (۸/۰۷ روز) بود. بر اساس جدول زندگی دوجنسی بیشترین نرخ خالص تولید مثل (R₀)، نرخ ذاتی افزایش جمعیت(r) و نرخ متناهی افزایش جمعیت (λ) روی رقم Okapi (به ترتیب ۳۵۲/۹۶ تخم به ازای هر فرد، ۰/۲۰۱ بر روز و ۱/۲۲۳ بر روز) و کمترین R₀ روی رقم Opera (۱۵۲/۷۳ تخم به ازای هر فرد)، و کمترین r و λ روی رقم Talaye (به ترتیب ۰/۱۴۲ و ۱/۱۵۳ بر روز) بود. متوسط زمان یک نسل (T) دارای بیشترین مقدار روی رقم Modena (۳۶/۴۱ روز) و کمترین مقدار روی رقم Okapi (۲۹/۰۶ روز) بود. با توجه به نتایج کسب شده رقم Okapi نسبت به سایر ارقام مورد بررسی رقم مناسب تری برای تولید مثل و رشد جمعیت *S. exigua* تشخیص داده شد که نشانگر حساسیت بالای این رقم نسبت به آفت مذکور می باشد.