J. Crop Prot. **2025, 14 (1): 61-73**

Research Article

Influence of fodder beet cultivars on the life history traits of *Spodoptera exigua*

Fariba Sohrabi[1], Mohammad Ali Mirhosseini[1*], Jamin Ali[2] and Ahmet Bayram[3]

1. Department of Plant Protection, Faculty of Agriculture and Natural Resources, Persian Gulf University, Bushehr, Iran, P. O. Box: 75169-13817.
2. College of Plant Protection, Jilin Agricultural University, Changchun 130118, China.
3. Department of Plant Protection, Faculty of Agriculture, Dicle University, 21280 Diyarbakir, Turkey.

Abstract: The beet armyworm, *Spodoptera exigua* (Hubner) (Lepidoptera: Noctuidae), poses a significant threat to beet plants, adversely affecting their yield. This study assessed the demographic parameters of this pest on seven commercial fodder beet cultivars, including “Kyros”, “1025”, “Geryty”, “Alianka”, “Laciana”, “Kara”, and “Enermax” under controlled laboratory conditions (27 ± 1 °C, 65 ± 5% RH, 16:8 h L: D). We selected 70 eggs, each less than 12 hours old, from a laboratory-reared generation and monitored their development, mortality, and oviposition daily until the death of the last individual. Data were analyzed using age-stage two-sex life table approach. The duration of the immature stages varied significantly among cultivars, with the total developmental period ranging from 23.79 days on “1025” to 33.25 days on “Laciana”. Immature survival rates also differed, with the highest survival recorded for “1025” (88.57%) and the lowest for “Kyros” (37.14%). Net reproductive rates (R_0) were highest for “Alianka” (385.81 offspring) and lowest for “Laciana” (110.97 offspring). The intrinsic rate of increase (r) varied across cultivars, with values of 0.149, 0.214, 0.160, 0.180, 0.125, 0.156, and 0.193. Our findings indicate that “1025” is the most susceptible cultivar to the beet armyworm, while “Laciana” is the most resistant. These results are valuable for developing targeted beet armyworm management programs in different fodder beet cultivation regions.

Keywords: Beet armyworm, Demography, Pest management, Plant resistance, Life table

Introduction

The use of pest-resistant cultivars is regarded as a fundamental tool in sustainable insect pest management systems due to their economic, ecological and environmental benefits (Gu *et al*., 2008; La Rossa *et al*., 2013; Smith, 2021). Integrated Pest Management (IPM) encompasses various strategies to manage pest populations while minimizing environmental impact sustainably (Zhou *et al*., 2024). Among these strategies, the use of pest-resistant cultivars is essential. Resistant plants may reduce the survivorship, growth rate, and fecundity of

Handling Editor: Yaghoub Fathipour

*Corresponding authors: m.mirhosseini@pgu.ac.ir
Received: 13 October 2024, Accepted: 24 April 2025
Published online: 18 May 2025

herbivorous insects or indirectly enhance the effectiveness of natural enemies by prolonging the developmental time of the pests (Sharma and Ortiz, 2002; Smith and Clement, 2012). By reducing the need for chemical insecticides, resistant cultivars preserve biodiversity and restore natural enemy populations, further enhancing ecosystem resilience (Kennedy, 2008).

The beet armyworm, *Spodoptera exigua* (Hubner) (Lepidoptera: Noctuidae), is a cosmopolitan polyphagous herbivore that infests a wide range of economically significant crops and various wild hosts (Abdullah *et al*., 2000; Zheng *et al*., 2011). Plants in the Chenopodiaceae family, including fodder beet, are the crucial vegetable crops cultivated in tropical and subtropical regions worldwide. *Spodoptera exigua* is a major pest of beet crops in many areas globally (Ehler, 2004; Talaee *et al*., 2017; El Husseini, 2019). As the cultivation of fodder beet expands in response to increasing livestock demands, understanding the interactions between *S. exigua* and different cultivars is crucial for developing effective pest management strategies.

Management of *S. exigua* is mainly relies on insecticides, leading to resistance to many synthetic insecticides (Wolfenbarger and Wolfenbarger, 2010; Su and Sun, 2014; Wang *et al*., 2021), the destruction of its natural enemies (Sertkaya *et al*., 2004; Liu *et al*., 2016), and severe outbreaks of this pest globally (Hafeez *et al*., 2022). Therefore, exploring alternative IPM tactics, such as plant resistance, is an exciting and effective control strategy (Edwards and Singh, 2006; Sohrabi *et al*., 2016). Recent advancements in plant breeding technologies have facilitated the development of cultivars with enhanced resistance to pests, making it imperative to evaluate these options in the context of existing pest management challenges.

The life table technique is valuable for screening host plant resistance to insect pests (Carey, 2001; Farahani *et al*., 2012; Karimi-Malati *et al*., 2012; Bozkurt and Akkopru, 2021). Estimating life table parameters of an insect, such as development, survival rate, and fecundity, can help to understand insect population dynamics under specific environmental conditions (Southwood and Henderson, 2000). The intrinsic rate of increase (r), estimated from life table data, is critical for evaluating the intrinsic growth rate of insect populations and predicting the resistance of plant cultivars to insect pests (Mehrkhou, 2013; Bozkurt and Akkopru, 2021).

The age-specific life table is a common tool for assessing insect biology and host adaptation (Southwood, 1978; Kakde *et al*., 2014). This method is based solely on the life process of female insects, excluding males, developmental stages, and individual differences (Birch, 1948). The age-stage, two-sex life table includes the sex ratio and the stage differences of insects in the data analysis (Huang and Chi, 2011). It can precisely analyze and clarify the effects of environmental factors on individual development and population growth of an insect species (Tian *et al*., 2022). Some researchers have studied the effects of host plant cultivars on the biology and life table of *S. exigua*. In a study conducted by Karimi-Malati *et al*. (2012), different cultivars of sugar beet had significant effects on the population growth rate of *S. exigua*. The Renger cultivar showed lower suitability as a host plant for this pest than three other tested cultivars. Talaee *et al*. (2017) emphasized that identifying sugar beet genotypes with intrinsic resistance benefits the IPM of *S. exigua*. Farahani *et al*. (2012) found that soybean cultivars significantly affected the population growth parameters of the beet armyworm and that the partially resistant cultivars L17 and BP were most effective against *S. exigua*.

The effect of fodder beet cultivars on *S. exigua* performance has not been reported in previous studies. Given the increase in the cultivation of this crop for livestock feed, the current study evaluated and analyzed the development, survival, and reproduction of *S. exigua* on seven commercial fodder beet cultivars using the age-stage, two-sex life table technique. The selection of resistant fodder beet cultivars can improve the management of this pest and reduce the use of chemical insecticides in field crops, ultimately contributing to sustainable agricultural practices.

Materials and Methods

Fodder beet cultivars

Seeds of the seven most commonly sown fodder beet cultivars, including “Kyros”, “Alianka” and “Enermax” from DLF company, “Laciana” and “Geryty” from KWS company, and “1025” and “Kara” from Sugar Beet Seed Research Institute of Iran were provided by the Sugar Beet Seed Research Institute in Karaj, Iran. The seeds were sown in the research field at the Faculty of Agriculture, Persian Gulf University (29°12'54.1" N, 51°13'57.1" E, and 70 m above sea level). No pesticides or fertilizers were applied. After three weeks, the same aged leaves of fodder beet cultivars were transferred to the laboratory daily, washed with distilled water, and used to rear *S. exigua* larvae.

Insect rearing

The beet armyworm larvae were collected from fodder beet cultivation areas in the Borazjan region and reared on leaves of each fodder beet cultivar in ventilated plastic containers (18 × 24 × 10 cm) within a growth chamber maintained at 27 ± 1 °C, 65 ± 5% relative humidity, and a photoperiod of 16:8 (L: D). This temperature has previously been shown to be suitable for developing and reproducing *S. exigua*. (Dai *et al.,* 2017). To minimize the effects of previous host plant cultivars, larvae were reared separately on each fodder beet cultivar for two generations before the experiments.

Life table study

Fifteen pairs of *S. exigua* adults from the second generation were transferred to a plastic container (10 cm in diameter, 16 cm in height) to obtain eggs. White paper strips (1 cm wide, 15 cm long) were placed inside the container to serve as oviposition sites for the female moths. The moths were fed with 10% honey solution. An initial cohort of 70 eggs, all less than 12 hours old, was used per host plant cultivar.

Upon hatching, first-instar larvae were individually placed in ventilated plastic Petri dishes (8 cm diameter by 1.5 cm height). Fresh leaves from each tested cultivar were provided daily as food for the larvae. Larvae were monitored daily until pupation. Each pupa was placed singly in a clear plastic vial (4 cm diameter by 9 cm height). The duration and survivorship of each immature stage were recorded on each fodder beet cultivar. Male and female pupae were distinguished based on the position of their genital and anal openings on the terminal segments (Steppuhn and Bandoly, 2016). After adult emergence, each pair of adults was placed in a plastic container (12 cm diameter by 8 cm height) with mesh lids and paper strips for egg laying. The moths were fed with 10% honey solution. The longevity of males and females and the number of eggs laid per female were recorded daily until the last adult died.

Data analysis

The life table data of *S. exigua* on different fodder beet cultivars were analyzed using on the age-stage, two-sex life table theory with TWOSEX-MSChart software (Chi and Liu, 1985; Chi, 1988; Chi, 2022; Chi *et al*., 2022). Variance and standard error of the parameters, such as the development time of different stages, male and female longevities, adult and total pre-oviposition periods, oviposition days, fecundity, immature survival, and population growth parameters (r, GRR, R_0, λ, T and DT) were calculated using a bootstrap procedure with 100,000 samples (Huang and Chi, 2012). The paired bootstrap test was used to compare these parameters among different cultivars. Figures were created using Microsoft Excel version 2019.

Results

The effects of seven fodder beet cultivars on various developmental parameters of *S. exigua,* including the duration of different stages, fecundity, and the percentage of immature survival, are summarized in Table 1. The data indicate significant variations in the duration and survival rates of immature stages, as well as in the longevity of adults (both male and female), adult pre-oviposition period (APOP), total pre-oviposition period (TPOP), oviposition days, and fecundity when the pest was fed different cultivars (Table 1). The “Kyros” and “Laciana” cultivars resulted in the longest egg incubation periods. In contrast, the “1025” cultivar was associated with the shortest larval, pupal, and total pre-adult durations, while the “Laciana” cultivar had the longest durations (Table 1). The adults emerging from the “Alianka” cultivar experienced the longest pre-oviposition period (3.90 days), which was not significantly different from those on the “Kara” (3.50 days) and “Kyros” (3.46 days) cultivars. The total pre-oviposition period (TPOP) of *S. exigua* was shortest on the “1025” cultivar and longest on the “Laciana” cultivar. The “Kyros” cultivar also recorded the lowest oviposition days, which did not significantly differ from those on the “Geryty” and “Laciana” cultivars. Regarding longevity, the “Enermax” cultivar was associated with the highest male longevity, while the “Kara” cultivar yielded the longest female longevity, although differences among cultivars were not statistically significant. Females emerged from the “Kara” cultivar had the lowest fecundity, with no significant difference compared to those on the “Laciana”, “Geryty”, and “Kyros” cultivars. The highest percentage of immature survival was found on the “1025” and “Alianka” cultivars (Table 1).

Figure 1 illustrates the age-stage-specific survival rate (s_{xj}) of *S. exigua* reared on seven different fodder beet cultivars. The survival curves extend to 60 days for the “Laciana” cultivar and 46 days for the “1025” cultivar, indicating the longest and shortest total life spans, respectively. Adults (both male and female) appeared earlier in the “1025” cultivar compared to the other cultivars (Fig. 1). The pupal survival rate in the “1025” cultivar reached 0.92, which was higher than in the other cultivars, suggesting that *S. exigua* experienced the lowest egg and larval mortality on this cultivar. In contrast, the highest larval mortality (45.7 %) was observed on the “Laciana” cultivar (Fig. 1).

Table 1 Effect of different fodder beet cultivars on duration of different life stages (days), fecundity (eggs/female), and immature survival (%) (mean ± SE) of *Spodoptera exigua*.

Parameter	Kyros	1025	Geryty	Alianka	Laciana	Kara	Enermax
Egg	3.29 ± 0.07 a	3.01 ± 0.01 c	3.09 ± 0.04 bc	3.03 ± 0.02 c	3.20 ± 0.05 ab	3.06 ± 0.04 c	3.06 ± 0.03 c
Larva	18.94 ± 0.31 b	14.44 ± 0.15 d	18.79 ± 0.43 b	18.6 ± 0.31 b	22.89 ± 0.49 a	16.44 ± 0.39 c	16.32 ± 0.27 c
Pupa	6.62 ± 0.125 bcd	6.40 ± 0.10 d	6.87 ± 0.13 ab	6.83 ± 0.09 b	7.31 ± 0.22 a	6.56 ± 0.09 cd	6.74 ± 0.09 bc
Pre-adult	29.58 ± 0.55 b	23.79 ± 0.18 d	28.56 ± 0.46 b	28.39 ± 0.33 b	33.25 ± 0.58 a	25.98 ± 0.47 c	26.13 ± 0.29 c
Total lifespan	38.08 ± 1.18 b	34.45 ± 0.62 c	37.24 ± 0.86 b	38.81 ± 0.57 b	42.00 ± 0.80 a	36.37 ± 0.71 bc	36.62 ± 0.87 bc
APOP	3.46 ± 0.37 abc	2.65 ± 0.42 bcd	2.44 ± 0.20 d	3.90 ± 0.32 a	2.73 ± 0.28 cd	3.50 ± 0.27 ab	2.18 ± 0.11 d
TPOP	32.69 ± 0.80 b	25.83 ± 0.46 e	31.00 ± 0.82 bc	31.55 ± 0.50 b	35.53 ± 1.16 a	29.36 ± 0.75 cd	27.95 ± 0.34 d
Oviposition days	4.00 ± 0.51 c	7.22 ± 0.55 a	4.94 ± 0.56 bc	6.72 ± 0.44 a	5.47 ± 0.75 abc	6.91 ± 0.48 a	6.18 ± 0.44 ab
Male longevity	7.82 ± 1.40 b	10.42 ± 0.98 ab	9.65 ± 1.28 ab	9.43 ± 0.88 ab	8.59 ± 0.73 ab	8.39 ± 0.82 b	11.17 ± 1.14 a
Female longevity	8.99 ± 1.32 bcd	10.93 ± 0.85 abc	7.68 ± 0.86 d	11.32 ± 0.75 ab	8.93 ± 0.89 cd	11.96 ± 0.47 a	9.67 ± 0.80 bcd
Fecundity	737.27 ± 118.26 ab	904.55 ± 97.86 a	548.91 ± 95.55 b	871.19 ± 81.31 a	517.87 ± 110.00 b	477.87 ± 60.18 b	933.04 ± 101.51 a
Immature survival (%)	37.14 ± 5.77 e	88.57 ± 3.80 a	64.29 ± 5.73 bc	84.29 ± 0.04 a	45.71 ± 5.97 de	58.57 ± 5.87 cd	75.71 ± 0.05 ab

The means within each row followed by different letters are significantly different ($P \leq 0.05$, paired bootstrap test). APOP: Adult pre-oviposition period. TPOP: Total pre-oviposition period.

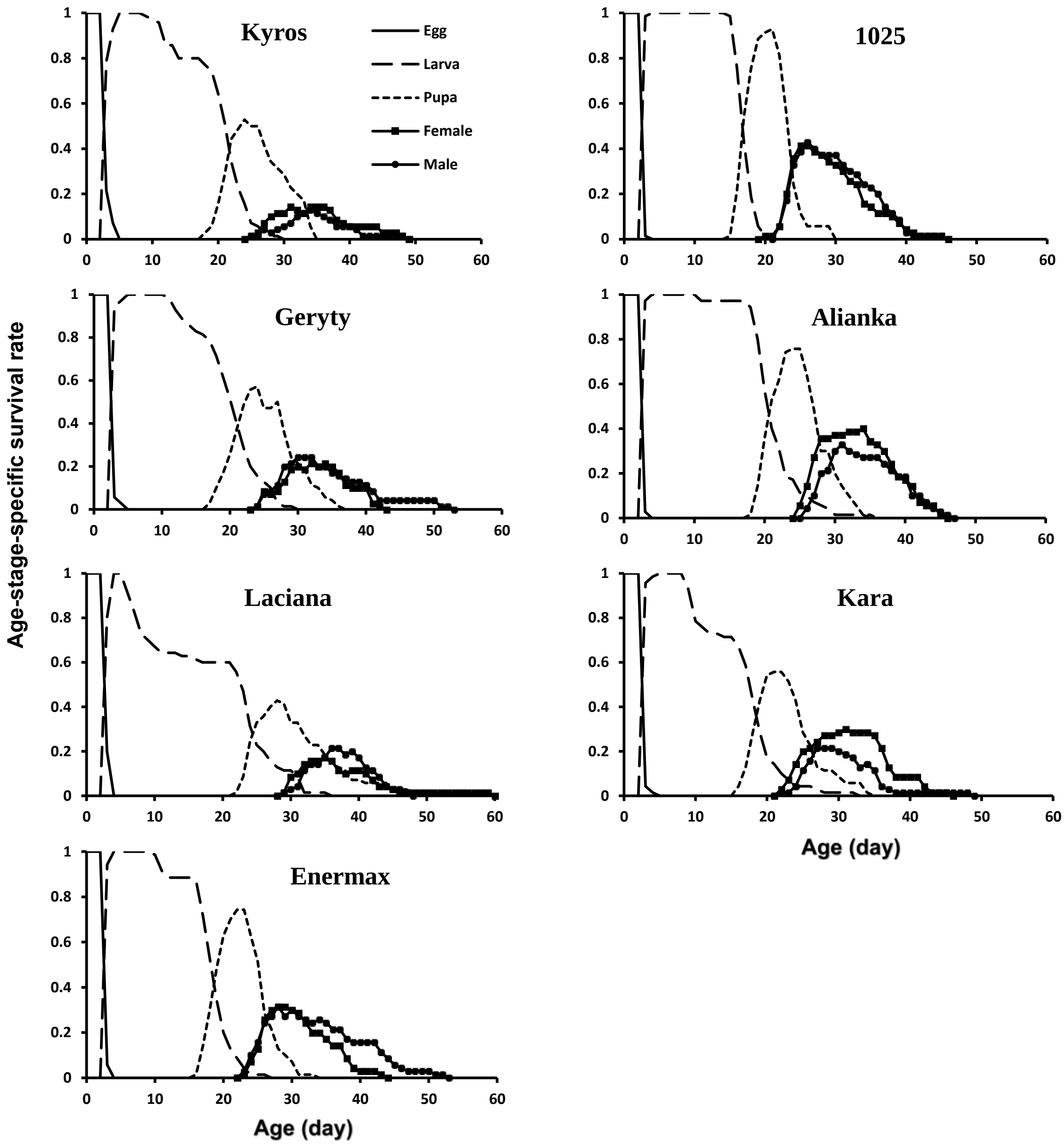

Figure 1 Age-stage-specific survival rate (s_{xj}) of *Spodoptera exigua* reared on seven fodder beet cultivars.

The age-specific fecundity (m_x) and survivorship (l_x) of *S. exigua* on different treatments are illustrated in Figure 2. The earliest maximum age-specific fecundity occurred on the "1025" cultivar at age 26 days. The highest maximum values of m_x were observed on the "1025" (105.03 egg/female/day) and "Kara" (108.86 egg/female/day) cultivars, while the lowest value was on the "Laciana" cultivar (33.16 egg/female/day). The age-specific fecundity curves extend to day 57 for the "Laciana" cultivar and day 38 for the "Enermax" cultivar. The age-specific survival rate curves demonstrated that more than 90% of the pest population survived on the "1025" and "Alianka" cultivars at day 25, while less than 55% of the population survived on the "Laciana" cultivar at the same time (Fig. 2).

Figure 3 depicts the age-stage-specific life expectancy (e_{xj}) of *S. exigua* on different fodder beet cultivars. Typically, life expectancy decreases with age, as only aging-related mortality factors are considered. The highest e_{xj} value for *S. exigua* was 35.6 day for the egg stage on the "Alianka" cultivar. The increase in the larval life expectancy curve for *S. exigua* on the "Laciana" cultivar after day 6 indicates higher mortality in early instar larvae compared to late instars (Fig. 3).

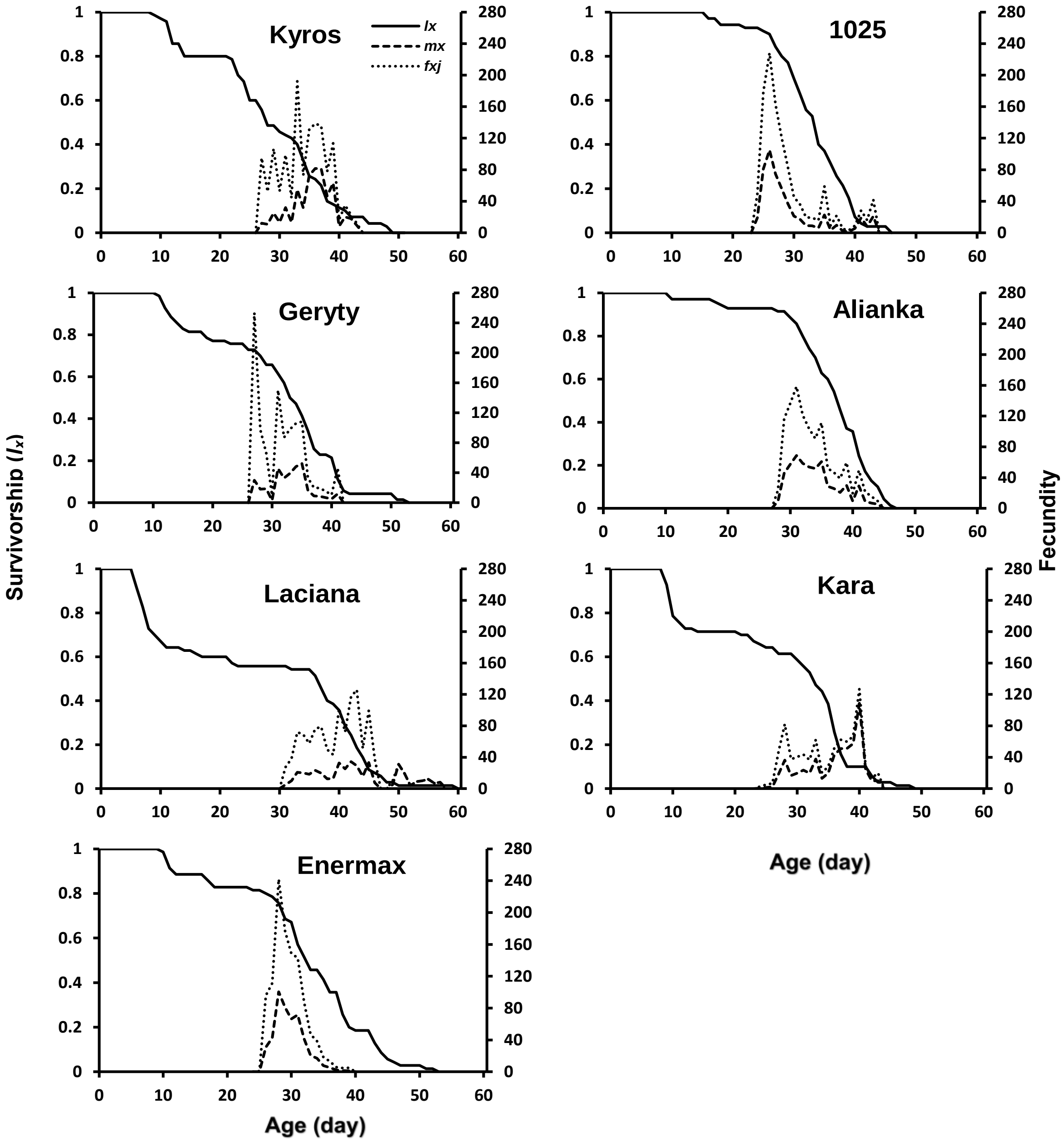

Figure 2 Age-specific survivorship (l_x), Age-specific fecundity (m_x) and Age-stage-specific fecundity (f_{xj}) of *Spodoptera exigua* reared on seven fodder beet cultivars.

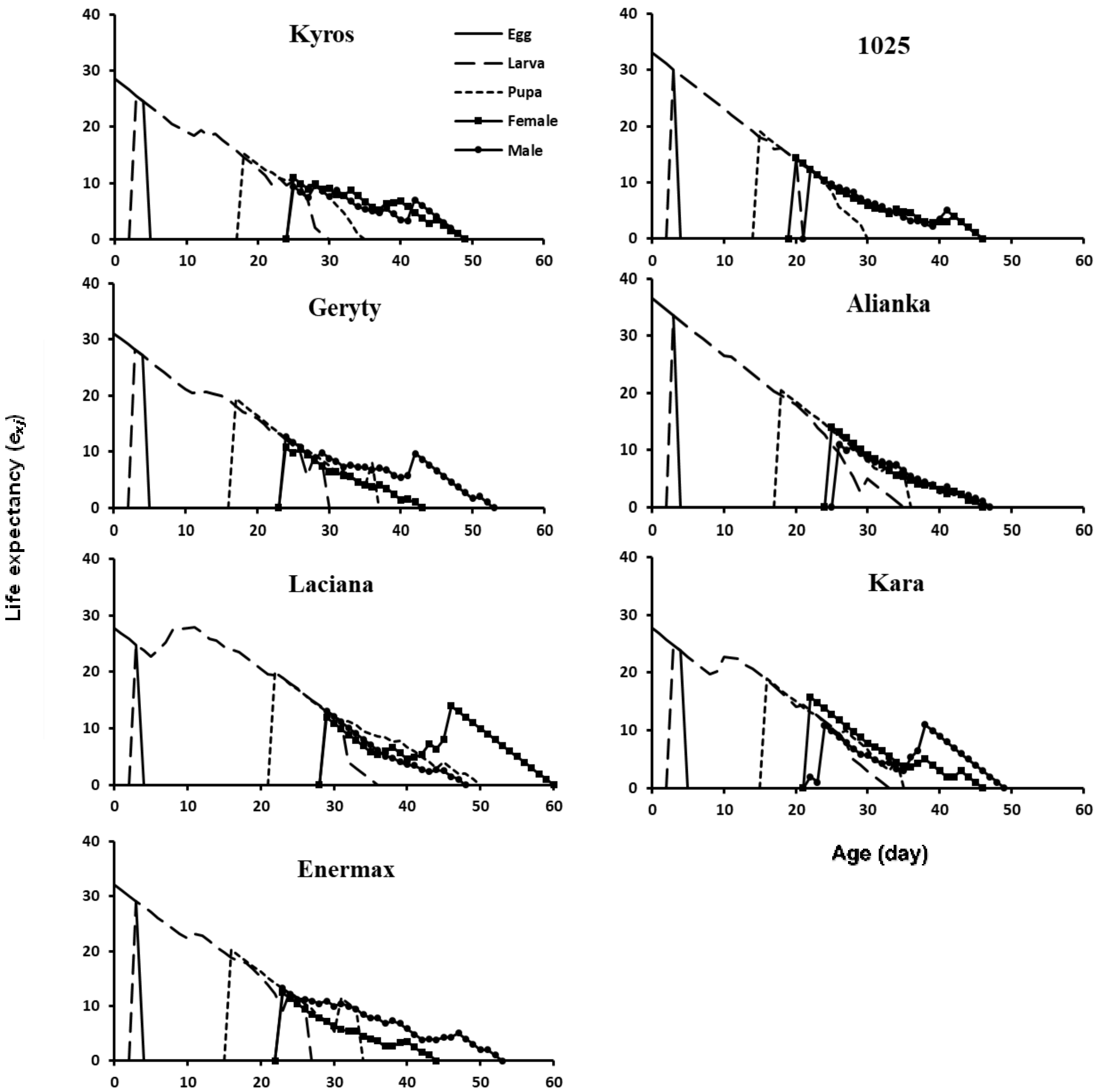

Figure 3 Age-stage-specific life expectancy (e_{xj}) of *Spodoptera exigua* reared on seven fodder beet cultivars.

Table 2 summarizes the population growth parameters of *S. exigua* feeding on various fodder beet cultivars. Statistical analyses reveal no significant differences in the gross reproductive rate (*GRR*) among the cultivars. The highest net reproductive rate (R_0) for *S. exigua* was recorded when feeding on the "Alianka" cultivar, which did not differ significantly from those on the "1025" and Enermax cultivars. In contrast, the "Laciana" cultivar had the lowest R_0 value. The "1025" cultivar also supported the highest values of the intrinsic rate of increase (r) and the finite rate of increase (λ) for *S. exigua*, while the "Laciana" cultivar had the lowest values for these parameters. Additionally, the mean generation time (T) was significantly longer for *S. exigua* feeding on the "Laciana" cultivar (37.66 days) and shorter for those on the "1025" (27.70 days) cultivar. The shortest population doubling time (*DT*) was observed on the "1025" cultivar (Table 2).

Table 2 Life table parameters (mean ± SE) of *Spodoptera exigua* reared on seven fodder beet cultivars under laboratory conditions.

Parameter	Kyros	1025	Geryty	Alianka	Laciana	Kara	Enermax
GRR (offspring/individual)	593.71 ± 156.83 a	527.53 ± 105.50 a	343.41 ± 77.72 a	570.11 ± 85.08 a	424.94 ± 133.06 a	565.11 ± 101.10 a	489.13 ± 88.98 a
R_0 (offspring/individual)	157.99 ± 43.62 cd	374.74 ± 66.61 a	172.51 ± 42.26 bcd	385.81 ± 62.73 a	110.97 ± 34.06 d	157.01 ± 33.14 cd	319.90 ± 62.81 ab
r (day^{-1})	0.149 ± 0.010 de	0.214 ± 0.007 a	0.160 ± 0.010 cd	0.180 ± 0.006 bc	0.125 ± 0.008 e	0.156 ± 0.009 d	0.193 ± 0.007 b
λ (day^{-1})	1.161 ± 0.012 de	1.239 ± 0.009 a	1.174 ± 0.011 cd	1.975 ± 0.008 bc	1.133 ± 0.010 e	1.169 ± 0.010 d	1.213 ± 0.009 b
T (day)	33.92 ± 1.13 b	27.70 ± 0.28 d	32.13 ± 0.79 b	33.05 ± 0.45 b	37.66 ± 1.04 a	32.35 ± 0.89 b	29.89 ± 0.32 c
DT (day)	4.64 ± 0.35 ab	3.24 ± 0.11 e	4.32 ± 0.28 bc	3.85 ± 0.14 cd	5.54 ± 0.41 a	4.43 ± 0.25 b	3.59 ± 0.13 d

The means within each row followed by different letters are significantly different ($P \leq 0.05$, paired bootstrap test).

Discussion

The current study revealed that these seven fodder beet cultivars differed significantly in their suitability for *S. exigua*, as evidenced by variations in its life history and demographic parameters. Previous researches have also documented considerable variation in beet armyworm life history across different plant cultivars (Farahani *et al*., 2012; Karimi-Malati *et al*., 2012; Mehrkhou, 2015; Mardani-Talaee *et al*., 2016). However, differences in the plant cultivars used, the experimental conditions, and the methodologies employed, such as female-based analysis approaches in these studies, make direct comparisons of life table parameters challenging. Understanding these differences helps contextualize the potential for resistance among various cultivars. Karimi-Malati *et al*. (2012) showed that different sugar beet cultivars can affect *S. exigua* immature development time, which ranged from 27.35 days on the FD0005 cultivar to 28.51 days on the Renger cultivar. In contrast, the current study observed a wider range of this parameter, spanning from 23.79 to 33.25 days. Karimi-Malati *et al*. (2012) also reported the lowest net reproductive rate (253.59 female offspring per female) and intrinsic rate of increase (0.2229 day^{-1}) on the Renger cultivar. In the current study, the lowest net reproductive rate (110.97 offspring) and intrinsic rate of increase (0.1250 day^{-1}) were observed on the "Laciana" cultivar, which are significantly lower than those reported by Karimi-Malati *et al*. (2012). Saeed *et al*. (2010) found that *S. exigua* exhibited the highest survival rate (80.8%) and intrinsic rate of increase (0.2 day^{-1}), and the shortest immature developmental time (23.7 days) on cauliflower compared to peas and wheat. The findings on cauliflower are roughly comparable to those observed with the "1025" cultivar in the current study. These differences could be attributed to variations in nutritional factors, such as carbon and nitrogen content in different cultivars and defensive metabolites, which can directly influence development and fecundity (Awmack and Leather, 2002).

The longest immature development time and highest pest mortality occurred on the "Kyros" and "Laciana" cultivars. According to the slow-growth–high-mortality hypothesis, cultivars that extend the development time of pre-adult stages in herbivorous insects can aid in pest management, as prolonged development increases their exposure to natural enemies, leading to higher mortality rates (Benrey and Denno, 1997). However, most of the observed mortality in these two cultivars occurred during the early instar larval stages. This phenomenon can be considered a double-edged sword in pest management, presenting benefits and drawbacks. On one hand, inducing pest mortality before significant crop damage occurs can benefit crop management by reducing the pest population size in subsequent generations. Conversely, early-stage mortality reduces the number of insects available to the third trophic level and prevents some individuals from growing into larger prey items. This may negatively impact predator and parasitoid populations if the herbivore (second trophic level) fails to reach a sufficient size or survive long enough for natural enemies to complete their development (Saeed *et al*., 2010).

The quality of plant cultivars can significantly impact pest population dynamics by affecting their development time and reproductive success (Shirinbeik Mohajer *et al*., 2022). Factors such as immature survival rate, development time, and fecundity affect the intrinsic rate of increase (*r*); this parameter can serve as the most appropriate index for evaluating insect performance on various host plants and assessing their resistance (Southwood and Henderson, 2000). The highest *r* value on the "1025" cultivar suggests that this cultivar is a more suitable host than the others, with *S. exigua* potentially exhibiting greater reproductive success on it. In contrast, *S. exigua* had the lowest *r*-values on the "Laciana" and "Kyros" cultivars due to reduced immature survival rates and extended pre-adult development times on these cultivars, indicating that they are the least favourable and most resistant hosts. These host effects, which diminish pest fitness, can be beneficial for pest management by reducing pest resistance to applied pesticides or enhancing exposure to natural enemies due to prolonged immature development.

Understanding the levels of pest resistance in various cultivars, the potential for pest population growth, and pest biology to specific cultivars can be critical components of any integrated pest management (IPM) program. This knowledge is crucial for effectively detecting and monitoring pest infestations, choosing the proper cultivars and guiding crop breeding efforts. An insect's diet has been demonstrated to influence its survival and reproduction, and that herbivorous insects rely on the quantity and quality of nutrients in their host plants. The use of resistant cultivars can reduce pest survival rates and reproductive success, thereby enhancing the effectiveness of other components of an IPM strategy, such as biological and chemical control approaches (Du *et al*., 2004). Our findings indicate that the "Laciana" and "Kyros" cultivars are the least suitable for *S. exigua* and can be considered resistant. Although further studies are required to assess the performance of these cultivars against *S. exigua* in open-field conditions and their interactions with the natural enemy complex, these findings provide valuable information for designing an integrated beet armyworm management program. In conclusion, identifying and utilizing resistant cultivars like "Laciana" and "Kyros" holds promise for managing *S. exigua* and contributes to the sustainability of agricultural practices.

Conflict of interests

The authors declare no conflict of interest.

Acknowledgements

This research was supported by the Department of Plant Protection, Persian Gulf University, Bushehr, Iran, which is greatly appreciated. We also thank Dr. Mohammad Amin Kohanmoo (Department of Plant Genetic and Production Engineering, Persian Gulf University) for his assistance in providing the cultivar seeds.

References

Abdullah, M., Sarnthoy, O., Tantakom, S., Isichaikul, S. and Chaeychomsri, S. 2000. Monitoring insecticide resistance development in beet armyworm, *Spodoptera exigua* (Hübner) (Lepidoptera: Noctuidae). Agriculture and Natural Resources, 34(4): 450-457.

Awmack, C. S. and Leather, S. R. 2002. Host plant quality and fecundity in herbivorous insects. Annual Review of Entomology, 47: 817-844.

Benrey, B. and Denno, R. F. 1997 The slow growth high mortality hypothesis: a test using the butterfly. Ecology, 78: 987-999.

Birch, L. C. 1948. The intrinsic rate of natural increase of an insect population. Journal of Animal Ecology, 17: 15-26.

Bozkurt, S. and Akkopru, E. P. 2021. Effects of five different melon (*Cucumis melo* L.) cultivars on population growth of *Aphis* *gossypii*. Plant Protection Science, 57(4): 310-317.

Carey, J. R. 2001. Insect biodemography. Annual Review of Entomology, 46(1): 79-110.

Chi, H. 1988. Life-table analysis incorporating both sexes and variable development rates among individuals. Environment Entomology, 17(1): 26-34.

Chi, H. 2022. TWO SEX-MSChart: a computer program for the age-stage, two-sex life table analysis. [accessed 2022 April]. http://140. 120.197.173/ Ecology/Download/TwosexMSChart.zip.

Chi, H., Guncan, A., Kavousi, A., Gharakhani, G., Atlihan, R., Salih Ozgokce, M., Shirazi, J., Amir-Maafi, M., Maroufpoor, M. and Taghizadeh, R. 2022. TWOSEX-MSChart: the key tool for life table research and education. Entomologia Generalis, 42: 845-849.

Chi, H. and Liu, H. 1985. Two new methods for the study of insect population ecology. Bulletin of the Institute of Zoology, Academia Sinica, 24: 225-240.

Dai, H. Q., Zhang, G. L. and Zhang, W. 2017. Temperature dependent development parameters and population life table of beet armyworm, *Spodoptera exigua* (Hübner) (Lepidoptera: Noctuidae). Arthropods, 6(4): 117-125.

Du, L., Ge, F., Zhu, S. and Parajulee, M. N. 2004. Effect of cotton cultivar on development and reproduction of *Aphis gossypii* (Homoptera: Aphididae) and its predator *Propylaea japonica* (Coleoptera: Coccinellidae). Journal of Economic Entomology, 97: 1278-1283.

Edwards, O. and Singh, K. B. 2006. Resistance to insect pests: What do legumes have to offer? Euphytica, 147: 273-285.

Ehler, L. E. 2004. An evaluation of some natural enemies of *Spodoptera exigua* on sugar beet in northern California. Biocontrol, 49: 121-135.

El Husseini, M. M. 2019. Effect of the fungus, *Beauveria bassiana* (Balsamo) Vuillemin, on the beet armyworm, *Spodoptera exigua* (Hübner) larvae (Lepidoptera: Noctuidae), under laboratory and open field conditions. Egyptian Journal of Biological Pest Control, 29(1): 52.

Farahani, S., Talebi, A. A. and Fathipour, Y., 2012. Life table of *Spodoptera exigua* (Lepidoptera: Noctuidae) on five soybean cultivars. Psyche: A Journal of Entomology, 2012(1): 513824.

Gu, H., Edwards, O. R., Hardy, A. T., and Fitt, G. P. 2008. Host plant resistance in grain crops and prospects for invertebrate pest management in Australia: an overview. Australian Journal of Experimental Agriculture, 48(12): 1543-1548.

Hafeez, M., Ullah, F., Khan, M. M., Li, X., Zhang, Z., Shah, S., Imran, M., Assiri, M. A., Fernandez-Grandon, G. M., Desneux, N. and Rehman, M. 2022. Metabolic-based insecticide resistance mechanism and ecofriendly approaches for controlling of beet armyworm *Spodoptera exigua*: a review. Environmental Science and Pollution Research, 29: 1746-1762.

Huang, Y. B. and Chi, H. 2011. The age-stage, two-sex life table with an offspring sex ratio dependent on female age. Journal of Agriculture and Forestry, 60: 337-345.

Huang, Y. B. and Chi, H. 2012. Age-stage, two-sex life tables of *Bactrocera cucurbitae* (Coquillett) (Diptera: Tephritidae) with a discussion on the problem of applying female age specific life tables to insect populations. Insect Science, 19(2): 263-273.

Kakde, A. M., Patel, K. G. and Tayade, S. 2014. Role of life table in insect pest management- A review. IOSR Journal of Agriculture and Veterinary Science, 7(1): 40-43.

Karimi-Malati, A., Fathipour, Y., Talebi, A. A. and Bazoubandi, M. 2012. Comparative life table parameters of beet armyworm, *Spodoptera exigua* (Lep.: Noctuidae), on four commercial sugar beet cultivars. Journal of Entomological Society of Iran, 32: 109-124.

Kennedy, G. G. 2008. Integration of insect-resistant genetically modified crops within IPM programs. Journal of Agricultural and Food Chemistry, 56(11): 3835-3841.

La Rossa, F. R., Vasicek, A., Lopez, M. C. 2013. Effects of pepper (*Capsicum annuum*) cultivars on the biology and life table parameters of *Myzus persicae* (Sulz.)

(Hemiptera: Aphididae). Neotropical Entomology, 42: 634-641.

Liu, Y., Li, X., Zhou, C., Liu, F. and Mu, W. 2016. Toxicity of nine insecticides on four natural enemies of *Spodoptera exigua*. Scientific Reports, 6(1): 39060.

Mardani-Talaee, M., Nouri-Ganbalani, G., Naseri, B., Hassanpour, M., Mottaghinia, L. and Mansouri, S. M. 2016. Comparative life table parameters of the *Spodoptera exigua* (Hübner) (Lepidoptera: Noctuidae) on corn hybrids under laboratory conditions. Journal of Entomological Society of Iran, 35(4): 17-27.

Mehrkhou, F. 2013. Effect of soybean varieties on nutritional indices of beet armyworm *Spodoptera exigua* (Lepidoptera: Noctuidae). African Journal of Agricultural Research, 8(16): 1528-1533.

Mehrkhou, F. 2015. Comparative demographic parameters of beet armyworm, *Spodoptera exigua* (Lep.: Noctuidae) on four commercial sugar beet cultivars. Journal of Entomological Society of Iran, 35(1): 11-18.

Saeed, S., Sayyed, A. H. and Ahmad, I. 2010. Effect of host plants on life-history traits of *Spodoptera exigua* (Lepidoptera: Noctuidae). Journal of Pest Science, 83: 165-172.

Sertkaya, E., Bayram, A., and Kornosor, S. 2004. Egg and larval parasitoids of the beet armyworm *Spodoptera exigua* on maize in Turkey. Phytoparasitica, 32: 305-312.

Shirinbeik Mohajer, S., Golizadeh, A., Hassanpour, M., Fathi, S. A. A., Sedaratian-Jahromi, A. and Abedi, Z. 2022. Interaction between biological parameters of *Panonychus citri* (Acari: Tetranychidae) and some phytochemical metabolites in different citrus species. Bulletin of Entomological Research, 112: 509-519.

Sharma, H. C., and Ortiz, R. 2002. Host plant resistance to insects: an eco-friendly approach for pest management and environment conservation. Journal of Environmental Biology, 23(2): 111-135.

Smith, C. M. and Clement, S. L. 2012. Molecular bases of plant resistance to arthropods. Annual Review of Entomology, 57: 309-328.

Smith, C. M. 2021. Conventional breeding of insect-resistant crop plants: still the best way to feed the world population. Current Opinion in Insect Science, 45: 7-13.

Sohrabi, F., Nooryazdan, H., Gharati, B. and Saeidi, Z. 2016. Evaluation of ten tomato cultivars for resistance against tomato leaf miner, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) under field infestation conditions. Entomologia Generalis, 36(2): 163-175.

Southwood, T. R. E. and Henderson, P. A. 2000. Ecological Methods. Third edition, Blackwell Science, Oxford, USA, 575 p.

Southwood, T. R. E. 1978. The construction, description and analysis of age-specific life-tables. In: Ecological methods: with particular reference to the study of insect populations. Springer, Dordrecht, 356-387 pp.

Steppuhn, A. and Bandoly, M. 2016. Bioassays to Investigate the Effects of Insect Oviposition on a Plant's Resistance to Herbivores. Bio-protocol, 6 (11): e1823.

Su, J. and Sun, X. X. 2014. High level of metafumizone resistance and multiple insecticide resistance in field populations of *Spodoptera exigua* (Lepidoptera: Noctuidae) in Guangdong Province, China, Crop Protection, 61: 58-63.

Talaee, L., Fathipour, Y., Talebi, A.A. and Khajehali, J. 2017. Screening of potential sources of resistance to *Spodoptera exigua* (Lepidoptera: Noctuidae) in 24 sugar beet genotypes. Journal of Economic Entomology, 110(1): 250-258.

Tian, X. Y., Gao, Y., Ali, M. Y., Li, X. H., Hu, Y. L., Li, W. B., Wang, Z. J., Shi, S. S., Zhang, J. P. 2022. Impact of temperature on age–stage, two-sex life table analysis of a Chinese population of Bean Bug, *Riptortus pedestris* (Hemiptera: Alydidae). Agriculture, 12(9): 1505.

Wang, P., Yang, F., Wang, Y., Zhou, L., Luo, H., Zhang, S. and Si, S. 2021. Monitoring the resistance of the beet armyworm (Lepidoptera: Noctuidae) to four insecticides in Southern China from 2014 to 2018. Journal of Economic Entomology, 144: 332-338.

Wolfenbarger, D. A. and Wolfenbarger, D. J.

2010. Beet armyworm (Lepidoptera: Noctuidae): selection for resistance to insecticides by a five strain cross. Tropical Agriculture, 87: 175-181.

Zheng, X. L., Cong, X. P., Wang, X. P. and Lei C. L. 2011. A Review of Geographic Distribution, overwintering and migration in *Spodoptera exigua* Hübner (Lepidoptera: Noctuidae). Journal of the Entomological Research Society, 13: 39-48.

Zhou, W., Arcot, Y., Medina, R. F., Bernal, J., Cisneros-Zevallos, L. and Akbulut, M. E. S. 2024. Integrated Pest Management: An Update on the Sustainability Approach to Crop Protection. ACS Omega, 9, 40: 41130-41147.

ارزیابی تأثیر ارقام چغندر علوفه‌ای بر ویژگی‌های زیستی کرم برگ‌خوار چغندر *Spodoptera exigua*

فریبا سهرابی[1]، محمدعلی میرحسینی[1*]، جامین علی[2] و احمِت بایرام[3]

۱- گروه گیاه‌پزشکی، دانشکده کشاورزی و منابع طبیعی، دانشگاه خلیج‌فارس، بوشهر، ایران.

۲- دانشکده گیاه‌پزشکی، دانشگاه کشاورزی جیلین، چانگ‌چون ۱۳۰۱۱۸، چین.

۳- گروه گیاه‌پزشکی، دانشکده کشاورزی، دانشگاه دیکل، ۲۱۲۸۰ دیارباکر، ترکیه.

پست الکترونیکی نویسنده مسئول مکاتبه: m.mirhosseini@pgu.ac.ir

دریافت: ۲۲ مهر ۱۴۰۳؛ پذیرش: ۴ اردیبهشت ۱۴۰۴

چکیده: کرم برگ‌خوار چغندر، *Spodoptera exigua* (Hubner) (Lepidoptera: Noctuidae)، یک تهدید جدی برای گیاهان چغندر محسوب می‌شود که میزان تولید آن‌ها را به‌شدت تحت تأثیر قرار می‌دهد. در این پژوهش پارامترهای دموگرافی این آفت روی هفت رقم تجاری چغندر علوفه‌ای شامل "Kyros"، "۱۰۲۵"، "Geryty"، "Alianka"، "Laciana"، "Kara" و "Enermax" در شرایط آزمایشگاهی (۱ ± ۲۷ درجه سلسیوس، رطوبت نسبی ۵ ± ۶۵ درصد و روشنایی ۱۶ ساعت در شبانه‌روز) مورد بررسی قرار گرفت. برای شروع آزمایش ۷۰ تخم با عمر کم‌تر از ۱۲ ساعت از نسل پرورش یافته در آزمایشگاه انتخاب و رشدونمو، مرگ‌ومیر و میزان تخم‌ریزی روزانه تا مرگ آخرین فرد بررسی شد. تجزیه و تحلیل داده‌ها براساس تئوری جدول زندگی دوجنسی ویژه سن-مرحله رشدی انجام شد. طول دوره رشدونمو مراحل نابالغ آفت به‌طور معنی‌داری تحت تأثیر این ارقام قرار گرفت به‌طوری که طول دوره رشدونمو کل از ۲۳/۷۹ روز روی رقم "۱۰۲۵" تا ۳۳/۲۵ روز روی رقم "Laciana" متفاوت بود. نرخ زنده‌مانی مراحل نابالغ نیز روی ارقام مختلف، متفاوت بود که بالاترین آن برای رقم "۱۰۲۵" (۸۸/۵۷ درصد) و پایین‌ترین آن روی رقم "Kyros" (۳۷/۱۴ درصد) ثبت شد. بیش‌ترین نرخ خالص تولیدمثل (R_0) متعلق به رقم "Alianka" (۳۸۵/۸۱ نتاج) و کم‌ترین آن مربوط به رقم "Laciana" (۱۱۰/۹۷ نتاج) بود. نرخ ذاتی افزایش جمعیت (r) آفت با تغذیه از این ارقام متفاوت بود و به‌ترتیب ۰/۱۴۹۲، ۰/۲۱۳۹، ۰/۱۶۰۳، ۰/۱۸۰۲، ۰/۱۲۵۰، ۰/۱۵۶۳ و ۰/۱۹۲۹ بر روز به‌دست آمد. یافته‌های ما نشان داد که رقم "۱۰۲۵" حساس‌ترین رقم به کارادرینا است، درحالی‌که رقم "Laciana" مقاوم‌ترین رقم به این آفت است. این نتایج می‌تواند در توسعه برنامه‌های مدیریتی کرم برگ‌خوار در مناطق مختلف کشت چغندر علوفه‌ای مورد استفاده قرار گیرد.

واژگان کلیدی: کرم برگ‌خوار چغندر، دموگرافی، مدیریت آفت، مقاومت گیاه، جدول زندگی