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The Impact of Bean Varieties on the Life table and Population Dynamics of the Black Bean Aphid, *Aphis fabae* Scopoli (Hemiptera: Aphididae)

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ABSTRACT

The black bean aphid, *Aphis fabae* Scopoli (Hemiptera: Aphididae) is a significant pest of common beans worldwide, causing damage both through direct feeding and by transmitting viruses. The selection of resistant varieties is the primary strategy in integrated pest management for controlling *Aphis fabae* Scopoli. The study of the development, reproduction, and population parameters of the black bean aphid was conducted on two different bean cultivars, Gina and Romano, under controlled conditions. Life table parameters were estimated using the age-stage, two-sex life table method. Population parameters were found to be lower in the Romano variety compared to Gina. The results indicated that bean cultivars significantly impacted the biology of *A. fabae*, with Gina being the most favorable cultivar for its life cycle. These findings could be applied to the development of a pest management program targeting this aphid.

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Introduction

Bean (*Phaseolus vulgaris* L., Fabaceae) is an annual herbaceous plant species belonging to the *Phaseolus* genus of the Fabaceae family. It is known that there are approximately 230 species of beans worldwide, with *P. vulgaris* being the most widely cultivated species (Uysal, 2002; Günay, 2005). Beans are extensively used not only in human nutrition but also in various industries, including cosmetics, animal feed, and dye production (Singh et al., 2007). As one of the most widely produced vegetable species in Türkiye, beans are cultivated in almost all regions of the country. Beans are a highly nutritious crop, rich in vitamins (A, B1, and B2), minerals (iron, phosphorus, and calcium), and proteins (18–31.6%) (Pekşen et al., 2005).

According to the 2024 agricultural production data, the total area cultivated for dry beans in Turkey was 918,620 decares, yielding a total production of 279,000 tons. In the same year, fresh bean production was carried out on 368,600 decares, resulting in a yield of 507,061 tons. When evaluated specifically for Van province, the area cultivated for dry beans was 5,250 decares, with a production of 1,409 tons. For fresh beans, 5,176 decares were cultivated in Van, yielding a total production of 8,218 tons (TUIK, 2024). During the growing season, various pests and diseases can cause substantial yield losses in bean crops. Aphids account for 58% of pest control measures (Balkaya et al., 1999).

The black bean aphid is recognized as one of the most widespread and significant aphid species globally (Esmaeili-Vardanjani et al., 2013). It is also considered a major pest in bean production areas, causing substantial economic losses (Banks and Nixon, 1958; 1964), and is one of the primary pests of beans (Yaşarakıncı and Hıncal, 1999).

Aphis fabae, a typically anholocyclic species (Barbagallo and Stroyan, 1982), forms large colonies, particularly damaging leguminous crops and sugar beets. It feeds on the phloem, leading to direct damage, inhibits plant growth by inducing sooty mold formation, and causes significant yield losses (Parker and Biddle, 1998; Shannag and Ababneh, 2007). Additionally, it has been identified as a vector for approximately 30 plant viruses (Powell et al., 2006; Blackman and Eastop, 2017; El-Amri, 1999).

Control measures are mainly based on chemical applications, and the species has developed resistance to certain synthetic insecticides, including carbamates and organophosphates (Emden and Harrington, 2017).

Aphids have an extremely rapid growth and development rate, allowing insecticide resistance to be passed from generation to generation at a fast pace (Dixon & Kindlmann, 1998). In recent years, with the adoption of the Integrated Pest Management (IPM) approach, the use of environmentally friendly alternatives to synthetic insecticides has gained increasing importance (Yılmaz and Polat Akköprü, 2020).

In particular, the use of pest-resistant cultivars during production significantly enhances the success of pest management (Smith, 1989 and 2005). Numerous studies have been conducted on the resistance of different bean cultivars to various pests (Vafaei et al., 2006; Ahmadi et al., 2007; Fathipour et al., 2006). However, research on *A. fabae* resistance in bean cultivars, as well as studies on their biology and life tables, remains limited.

The nutritional quality of the host plant is a key factor in increasing the fertility rate of pests, and consequently, in enhancing their intrinsic reproductive value and population growth rate (Phelan et al., 1995; Awmack and Leather, 2002). The developmental parameters of pests are effectively measured using life table data. Therefore, the life table is a crucial tool for evaluating the overall performance of a pest insect on its host plant (Polat Akköprü et al., 2015).

Due to the significance of aphids and their negative impact on the quantity and quality of bean production, this study was conducted to select *A. fabae*-resistant cultivars in order to improve ongoing Integrated Pest Management (IPM) programs.

Materials and Methods

Under controlled settings, the studies were carried out in climatic chambers with 16 hours of light and 8 hours of darkness, a temperature of 25±1°C, and a relative humidity of 60±10%.

Selection and Preparation of Plant Material

Seeds of the bean varieties *Phaseolus vulgaris* 'Gina' (F1) and 'Romano' (F1), which are widely cultivated worldwide, were commercially obtained and used in the experiments. A total of 60 seeds, 30 each of the Romano and Gina bean varieties, were planted in pots measuring 15x10x10 cm, filled with a 2:1 soil+peat mixture. The water requirements of the plants were determined based on calculations made until seed germination, and the plants were watered regularly. Additionally, a diluted nutrient solution was applied to both bean varieties in the pots according to the plants' needs.

Mass Rearing of Black Bean Aphid (Aphis fabae)

The black bean aphid was collected from the field and introduced into climate-controlled chambers (25°C temperature, 60±5% relative humidity, and a 16:8-hour light-dark cycle). The aphids were reared on the Gina and Romano bean varieties. To eliminate the potential effects of previous host plants, the aphids were allowed to complete at least one generation on both bean varieties before being used in the experiments.

Construction of the Life Table of Aphis fabae Fed on Different Bean Varieties

The experiments were set up by releasing adults from the stock culture onto the leaves of at least 30 seedlings of each variety. The leaves were enclosed in cylindrical leaf cages (clips) with a diameter of 3 cm and a height of 3 cm, covered with chiffon mesh on the upper surface. When the adults started reproducing, only a single nymph was kept on each leaf, while the adults and any additional nymphs were removed. The biological parameters of the *Aphis fabae* populations reared on the bean varieties, including pre-adult development time, adult longevity, pre-reproductive period (APRP), total pre-reproductive period (TPRP), reproductive period, and daily and total offspring production, were recorded from the time the nymph's reached adulthood until their death.

Data Analysis

The developmental time, survival, and fecundity of *A. fabae* were analyzed using an age-stage, two-sex life table to account for variations in developmental rates among individuals (Chi and Liu, 1985; Chi, 1988). To facilitate the statistical analysis of raw data and the calculation of life table parameters, we utilized the TWOSEX-MSChart computer program (Chi, 2025a). Additionally, a population projection for *Aphis fabae* was conducted using the Timing-MSChart package (Chi, 2025b), estimating the population size the pest would reach after 30 days.

The raw data was used to determine the age-specific survival rate (l_x), age-specific fecundity (m_x), and age–stage-specific survival rate (s_{xj}) of female adults, where x stands for age and j for stage. Subsequently, population parameters—including the intrinsic rate of increase (r), finite rate of increase (λ), net reproductive rate (R_0), and mean generation time (T) (Chi and Liu, 1985)—as well as age–stage-specific life expectancy (e_{xj}) (Chi, 1988) and age–stage reproductive value (v_{xj}) (Fisher, 1958; Huang and Chi, 2012) were determined using established formulas from the literature. To estimate the population parameters' variances and standard errors, the bootstrap method with 100,000 resamplings was used (Polat Akköprü et al., 2015). The results for different varieties were compared using a paired bootstrap test based on the confidence interval of the difference (Wei et al., 2020).

Findings

Pre-Adult Development Period of Aphis fabae on Different Bean Varieties

The total pre-adult development period was recorded as 7.96±0.12 days on the Gina variety and 8.76±0.20 days on the Romano variety (Table 2). According to statistical analysis, the total pre-adult development period of *Aphis fabae* did not differ significantly between these two varieties. The mortality rate of *Aphis fabae* fed on the Gina variety was found to be higher compared to the Romano variety (Table 2).

The age- and stage-specific survival rate (s_{xj}) represents the probability that a newly deposited individual will survive to age 'x' and stage 'j', and the overlaps between stages and transitions between stages are detailed in the sxj curves.

Table 1. Pre-adult development periods of Aphis fabae reared on different bean varieties

Varieties	n	N1	N2	N3	N4	Total Preadult	Preadult Mortality
Gina	90	1.86±0.05a	2.05±0.06a	2.04±0.06	2.03±0.09	7.96±0.12a	%23
Romano	90	2.03±0.08a	3.21±0.16b	1.93±0.12a	1.67±0.11b	8.76±0.20a	%17

a, b: The difference between Gina and Romano bean varieties is statistically significant (T-test); x̄: Mean; SH: Standard Error

Table 2. Oviposition period (APOP), Total oviposition period (TPOP), Oviposition days, Fecundity, and Longevity of Planococcus ficus (mean ± SE) of Aphis fabae reared on different bean varieties

Varieties	(APOP) (day^{-1})	(TPOP) (day^{-1})	Oviposition (day)	Fecundity (nymphs/female)	Adult longevity (d)
Gina	0.23± 0.05a	8.191±0.151a	9.09±0.285a	23.12±0.88a	16.6 ±0.643a
Romano	0.14± 0.06a	8.900± 0.21b	7.04±0.27b	16.38±0.62b	15.71±0.523a

a, b: The difference between Gina and Romano bean varieties is statistically significant (T-test).; x̄: Mean; SH: Standard Error

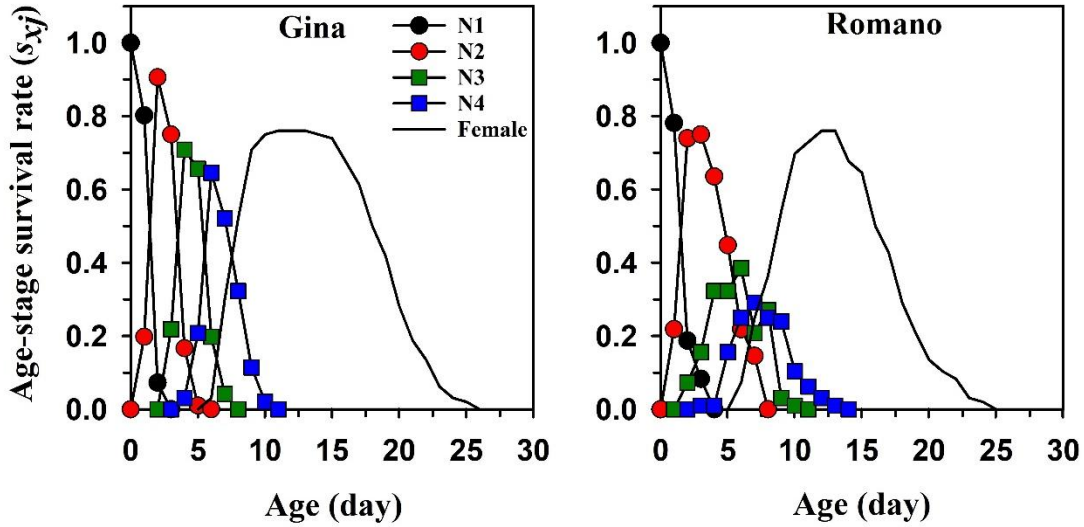

Figure 1. Stage-specific survival rates (*Sxj*) of *Aphis fabae* nymphs reared on different bean varieties

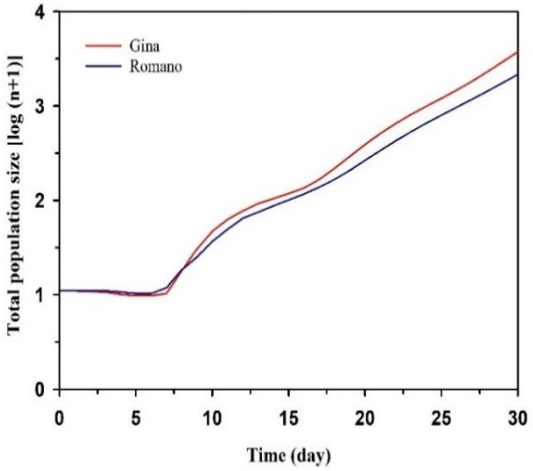

Figure 2. Growth potential of Aphis fabae fed with different variety of bean plants (number of occurrences at the end of the 30th day)

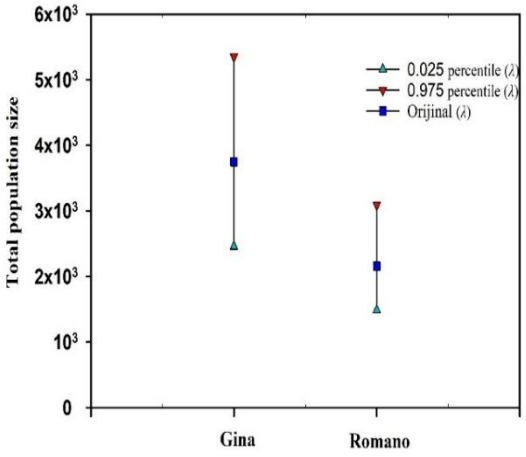

Figure 3. Confidence intervals for the population growth of Aphis fabae feeding on different variety of bean plants on 30th day

The lowest probability of survival for a newly deposited *A. fabae* nymph until adulthood was found to be 0.76 (on the 12th day) for the Gina variety and 0.76 (on the 13th day) for the Romano variety (Figure 1).

It was estimated that the total population size of the pest on day 30 would be higher in the Gina variety (Figure 2). To investigate the variability of population growth, the original cohort's total population sizes and the population growth limit (λ) obtained with 100,000 artificial replications based on 0.025 and 0.975 bootstrap percentages are shown in Figure 3. The analysis showed no high level of uncertainty in the population growth of aphids feeding on different bean varieties.

Reproductive Values and longevity of Aphis fabae Fed on Bean Varieties

The APRP of *Aphis fabae* did not differ significantly between the Gina and Romano bean varieties. However, TPRP was found to be longer on the Romano variety (8.900±0.21 days) compared to the Gina variety

(8.191±0.151 days) (Table 3). The shortest reproductive period (7.04±0.271 days) and the lowest fecundity value (16.38±0.62) were observed on the Romano variety (Table 3). No significant difference was found between the two varieties in terms of adult longevity.

The highest values for m_x (2.50) and l_xm_x (1.72) were obtained for *Aphis fabae* reared on the Gina variety. The lowest age-specific survival rate (l_x), age-specific fecundity rate (m_x = 2.00), and net maternity rate (l_xm_x = 1.58) were observed on the Romano variety (Figure 4).

Population Parameters of Aphis fabae on Bean Varieties

The effect of the bean varieties on the population parameters of *A. fabae* was found to be statistically significant. For the Gina variety, the intrinsic rate of increase (r = 0.228), finite rate of increase (λ = 1.256), net reproductive rate (R_0 = 17.58), and mean generation time (T = 12.55 days) were determined. For the Romano variety, these values were intrinsic rate of increase (r = 0.207), finite rate of increase (λ = 1.230), net reproductive rate (R_0 = 13.47), and mean generation time (T = 12.51 days) (Table 3). The population parameters for the Romano variety were observed to be lower compared to those of the Gina variety.

The age- and stage-specific life expectancy (e_{xj}) of *Aphis fabae* reared on the Gina and Romano bean varieties was determined to be 15.70 and 16.60 days, respectively (Figure 5). The highest reproductive values (v_{xj}) for *Aphis fabae* reared on the Gina and Romano varieties were found to be v8 = 10.37 and v7 = 10.27 days, respectively (Figure 6).

Table 3. Population parameters of *Aphis fabae* reared on different bean varieties (r, intrinsic rate of increase (day^{-1}); λ, finite rate of increase (day^{-1}); R_0, net reproductive rate (offspring/individual); T, mean generation time (days) (Mean ± S.E.)

Varieties	r (day^{-1})	λ (day^{-1})	R_0 (offspring)	T (day)
Gina	0.228± 0.006a	1.256± 0.007a	17.58±1.205a	12.554±0.162a
Romano	0.207± 0.006b	1.230± 0.007b	13.47±0.815b	12.518±0.251a

a, b: The difference between Gina and Romano bean varieties is statistically significant (T-test).; x̄: Mean ; SH: Standard Error

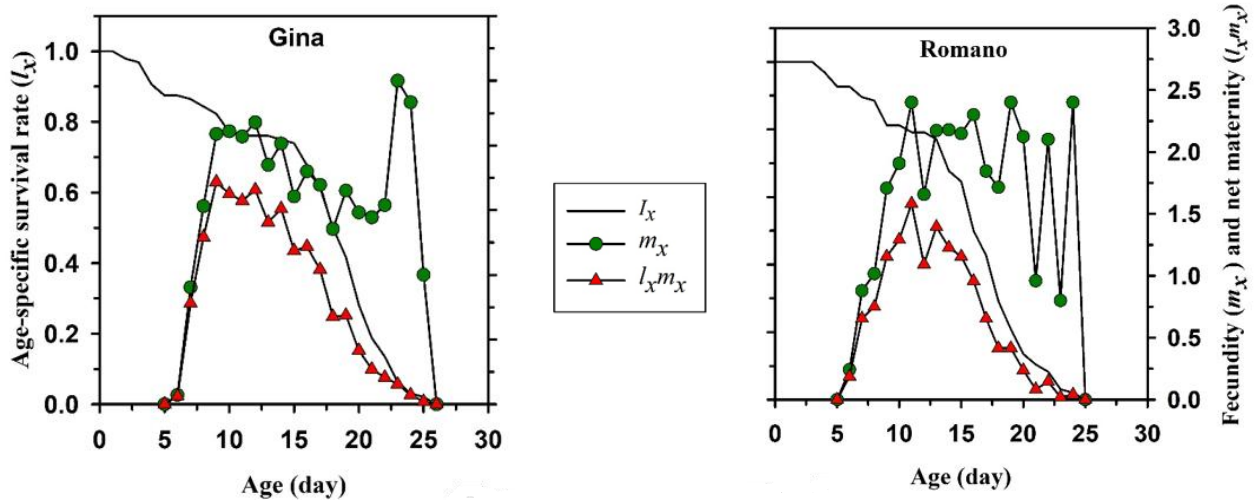

Figure 4. Age-specific survival rate (l_x), age-specific fecundity (m_x), and age-specific maternity value (l_xm_x) of *A. fabae* reared on different bean varieties.

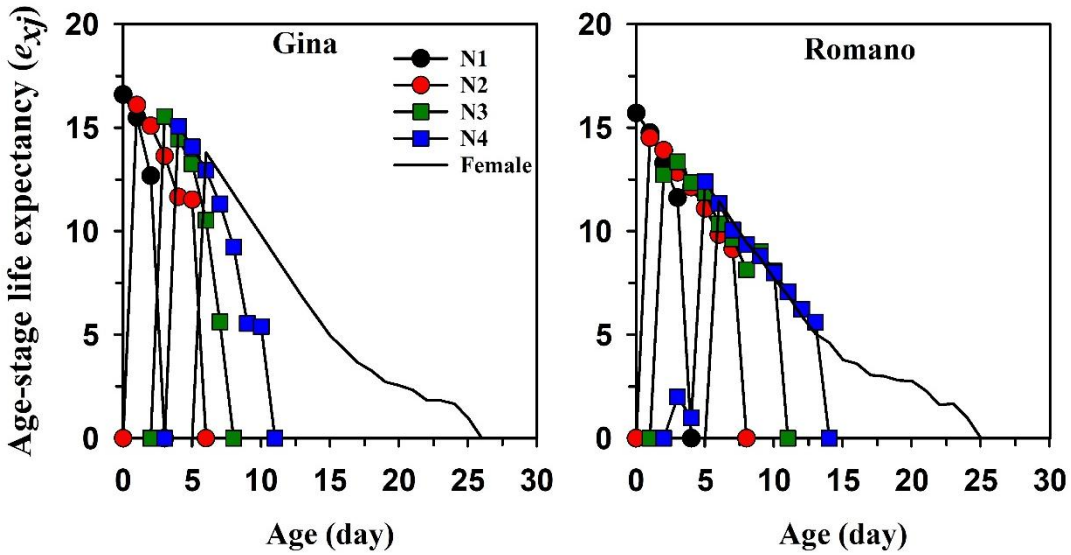

Figure 5. Age- and stage-specific life expectancy (e_{xj}) of *Aphis fabae* reared on different bean varieties

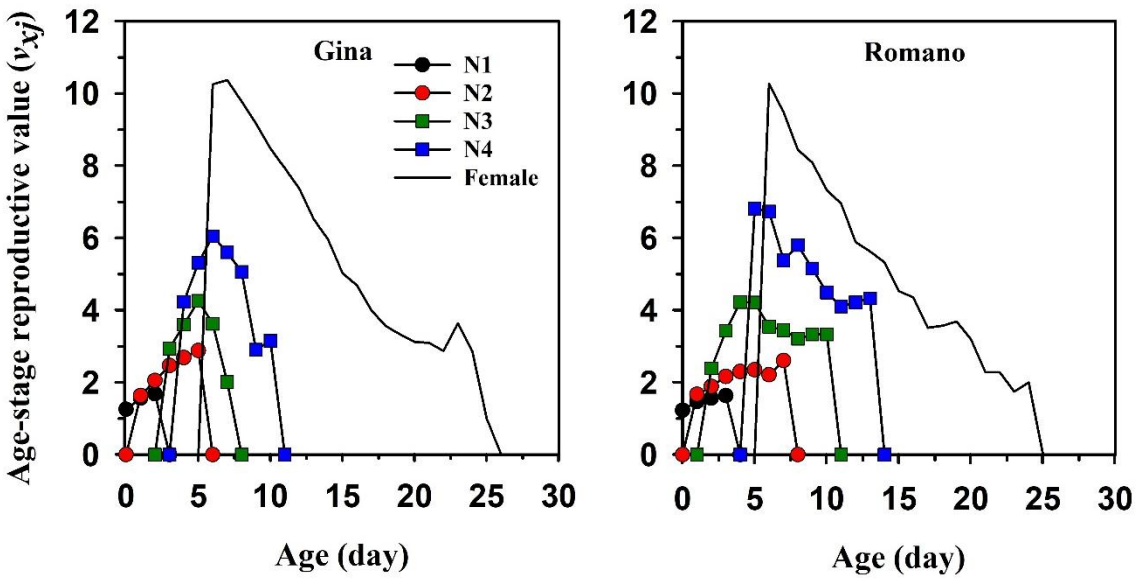

Figure 6. Age- and stage-specific reproductive value (v_{xj}) of *Aphis fabae* reared on different bean varieties.

Discussion and Conclusion

Aphids cause significant nutrient loss by feeding on the phloem tissues of plants (Douglas, 2003). Additionally, they can reproduce parthenogenetically, either partially or entirely, without the presence of males during their life cycle. This mode of reproduction provides them with a distinct reproductive advantage by doubling their intrinsic rate of population increase (*r*) compared to sexually reproducing individuals (Dixon, 1992). Due to these characteristics, aphids are widely used as model organisms in research on plant-insect interactions (Powell et al., 2006; Shigenobu and Yorimoto, 2022).

Plants play a significant role in aphid host selection and acceptance through their morphological, nutritional, and biochemical properties (Dixon and Kindlmann, 1998). It has been determined by different researchers that the performance of any aphid species can be significantly influenced by different plants or different varieties of the same plant (War et al., 2012; Qayyum et al., 2018; Hong et al., 2019; Ali et al., 2021; Baral et al., 2021;). Life tables are useful tools for evaluating the performance of pest insects on their host plants. They provide integrated and comprehensive information about their biology, enabling accurate predictions of pest population growth rates (Tuan et al., 2016; Chang et al., 2016).

In this study, the performance of *Aphis fabae* on two bean varieties, Gina and Romano, was evaluated using life table parameters. The results showed that the pre-adult development period, reproductive parameters, and population growth rates of *Aphis fabae* were influenced by the bean variety. The Gina variety supported higher reproductive rates and population growth compared to the Romano variety, which may be grounded to differences in the nutritional and biochemical composition of the two varieties. These findings highlight the importance of host plant characteristics in shaping aphid population dynamics and provide valuable insights for integrated pest management strategies.

The intrinsic rate of increase (*r*), finite rate of increase (λ), and net reproductive rate (R_0) are the key parameters that most directly influence the contribution of pest development, survival, and reproduction to population growth. (Polat Akköprü et al., 2015).

It was determined that *Aphis fabae* reared on the Romano bean variety exhibited a slower developmental rate, lower daily fecundity, delayed reproductive peak, and consequently lower population parameters compared to those reared on the Gina variety. In particular, the reduced values of the intrinsic rate of increase (*r*) and finite rate of increase (λ) suggest that the pest is less inclined to feed on the Romano variety. It is well-established that fluctuations in these parameters can result in considerable changes in the pest population size (Goundoudaki et al., 2003).

Ayvaz and Akça (2014) reported that the intrinsic rate of increase (*rm*) of *A. fabae* on the Gina bean variety was 0.333 aphids/aphid/day, identifying Gina as a resistant variety against the pest. In our study, although '*r* 'value for the Gina variety was found to be 0.228 day^{-1}, which differs from the literature, the Romano variety demonstrated superior performance against the pest.

Aphid population dynamics are shaped by a range of factors, such as environmental conditions, host plant attributes, and the presence of natural enemies (Sun et al., 2022; Brabec et al., 2014). These elements significantly impact aphid populations by influencing aspects like reproduction, development, survival, and dispersal. According to Shah (2017), the quality of host plants is critical for insect growth and development, determining the plant's suitability as a food source. Additionally, studies have shown a strong link between plant physiological traits, which are highly heritable, and the level of insect resistance (Frelichowski and Juvik, 2001).

Although the specific resistance mechanisms of the Gina and Romano bean varieties were not identified in this study, the reduced performance of *Aphis fabae* on the Romano variety may be attributed to plant resistance factors such as antibiosis, antixenosis, or tolerance (Kant ve diğerleri, 2015; Smith, 2005). These mechanisms can negatively affect aphid survival and reproduction or help plants better withstand pest damage, thereby contributing to the observed

differences in aphid population parameters.This study highlights the importance of using life tables to evaluate the influence of host plants on aphid performance. Understanding these interactions is essential for the development of resistant plant varieties and the implementation of sustainable pest management strategies. Further research is warranted to identify specific plant traits that confer resistance or susceptibility to aphid infestations.

In the current study, no clear data were found in the literature regarding the resistance mechanisms of the Gina and Romano bean varieties. However, the observed lower pest potential on the Romano variety is presumed to be associated with the aforementioned resistance mechanisms. Several previous studies have demonstrated that different bean varieties can significantly influence aphid performance, thereby contributing to the identification of resistant cultivars (Mwangi et al., 2008; İpekkeşen, 2019; Ayvaz and Akça, 2014). By assessing the population parameters of *Aphis fabae* on different bean varieties, this study offers practical insights for agricultural pest management. Integrating these findings into cultivation practices can assist farmers in selecting suitable plant varieties to reduce aphid infestations. Moreover, considering the host preferences of the pest, such strategies aim to minimize crop losses and decrease reliance on insecticides.

References

Ahmadi, M., Fathipour, Y. & Kamali, K. (2007). Population growth parameters of *Tetranychus urticae* (Acari: Tetranychidae) on different bean cultivars. *Journal of Entomological Society of Iran*, *26*, 1–10.

Ali, J., Covaci, A. D., Roberts, J. M., Sobhy, I. S., Kirk, W. D. & Bruce, T. J. (2021). Effects of cis-jasmone treatment of brassicas on interactions with *Myzus persicae* aphids and their parasitoid Diaeretiella rapae. *Frontiers in Plant Science*, *12*, 711896.

Awmack, C. S. & Leather, S. R. (2002). Host plant quality and fecundity in herbivorous insects. *Annual review of entomology*, *47*(1), 817-844.

Ayvaz, T. and Akça, İ., (2014). Aphis fabae scopolı (Hemıptera: Aphıdıdae)'nin farklı fasulye çeşitlerinde bazı biyolojik parametrelerinin belirlenmesi / Determination of some biological parameters of aphis fabae scopoli (Hemiptera: Aphididae) on different bean varieties. 73 s. http://libra.omu.edu.tr/tezler/107107.pdf

Balkaya, A., Yanmaz, R., Bozoğlu, H. & Gülümser, A. (1999). Samsun ilinin fasulye yetiştiriciliği yönünden durumunun belirlenmesi. *Karadeniz Bölgesi Tarım Sempozyumu Bildirileri, 1*, 51.

Banks, C. J. & Nixon, H. L. (1958). Effects of the ant, *Lasius niger* L., on the feeding and excretion of the bean aphid, *Aphis fabae* Scop. *Journal of Experimental Biology*, *35*(4), 703-711.

Banks, C. J. & Macaulay, E. D. M. (1964). The feeding, growth and reproduction of *Aphis fabae* Scop. On *Vicia faba* under experimental conditions. *Annals of Applied Biology, 53*(2), 229-242.

Baral, S., Thapa, R. B., Jha, R. K., Joshi, S. L., & Aryal, S. (2021). Simulation of Stage-structured population growth of *Myzus persicae* (Suzler)(Hemiptera:Aphididae) based on age-stage, two sex life table. *Nepal Journal of Science and Technology*, *20*(1), 51-60.

Barbagallo, S. & Stroyan, H.L.G. (1982) Biological, ecological and taxonomic notes on the aphid fauna of Sicily. Frustula Entomologica, Nuova Serie, 3, 1–182.

Blackman, R. L. & Eastop, V. F. (2017). Taxonomic issues. In *Aphids as crop pests* (pp. 1-36). Wallingford UK: CABI.

Brabec, M., Honěk, A., Pekár, S. & Martinková, Z. (2014). Population dynamics of aphids on cereals: Digging in the time-series data to reveal temperature-driven regulation. *PLoS ONE, 9*(9), e106228.

Chang, C., Huang, C. Y., Dai, S. M., Atlihan, R. & Chi, H. (2016). Genetically engineered ricin suppresses *Bactrocera dorsalis* (Diptera: Tephritidae) based on demographic analysis of group-reared life table. *Journal of Economic Entomology*, *109*(3), 987-992.

Chi, H. & Liu, H. (1985). Two new methods for the study of ınsect populatıon ecology. *Bull. Inst. Zool. Academia Sinica, 24*(2), 225–240.

Chi, H. (1988). Life-table analysis incorporating both sexes and variable development rates among ındividuals. *Environmental Entomology*, *17*(1), 26–34.

Chi, H., (2024a). TWOSEX-MSChart: a computer program for the age stage, two-sex life table analysis. National Chung Hsing University, Taichung, Taiwan. Available on: http://140.120.197.173/Ecology/prod02.htm

Chi, H., (2024b). TIMING-MSChart: a computer program for the population projection based on age-stage, two-sex life table. National Chung University in Taiwan. (http://140.120.197.173/ ecology/prod02.htm)

Dixon, A. F. G. & Kindlmann, P. (1998). Population dynamics of aphids. In *Insect Populations In theory and in practice: 19th Symposium of the Royal Entomological Society 10–11 September 1997 at the University of Newcastle* (pp. 207-230). Dordrecht: Springer Netherlands.

Dixon, A. F. G. (1992). Constraints on the rate of parthenogenetic reproduction and pest status of aphids. *Invertebrate Reproduction & Development*, *22*(1-3), 159-163.

Douglas, A. E. (2003). Buchnera bacteria and other symbionts of aphids. *Insect symbiosis*, *1*, 23-38.

El-Amri, A. (1999). Identification of vectors and natural hosts of Faba Bean Necrotic Yellows Virus in Morocco. 27-31.

Emden, H. V. & Harrington, R. (Eds.). (2017). Aphids as Crop Pests. (p. 576). CABI, Wallingford. https://doi.org/10.1079/9781780647098.0000

Esmaeili-Vardanjani, M., Askarianzadeh, A., Saeidi, Z., Hasanshahi, G. H., Karimi, J. & Nourbakhsh, S. H. (2013). A study on common bean cultivars to identify sources of resistance against the black bean aphid, *Aphis fabae* Scopoli (Hemiptera: Aphididae). *Archives of Phytopathology and Plant Protection*, *46*(13), 1598-1608. https://doi.org/10.1080/03235408.2013.772351

Fathipour, Y., Ahmadi, M. & Kamali, K. (2006). Life table and survival rate of *Tetranychus urticae* (Acari: Tetranychidae) on different bean varieties. *Iranian Journal of Agricultural Sciences*, *37*(1), 65–71.

Frelichowski, J. E., Jr. & Juvik, J. A. (2001). Sesquiterpene carboxylic acids from a wild tomato species affect larval feeding behavior and survival of *Helicoverpa zea* and *Spodoptera exigua* (Lepidoptera: Noctuidae). *Journal of Economic Entomology, 94*(5), 1249-1259.

Goundoudaki, S., Tsitsipis, J. A., Margaritopoulos, J. T., Zarpas, K. D. & Divanidis, S. (2003). Performance of the tobacco aphid *Myzus persicae* (Hemiptera: Aphididae) on Oriental and Virginia tobacco varieties. *Agricultural and Forest Entomology*, *5*(4), 285-291.

Günay, A. (2005). Sebze Yetiştiriciliği. Cilt 2. İzmir. 531s

Hong, F., Han, H. L., Pu, P., Wei, D., Wang, J. & Liu, Y. (2019). Effects of five host plant species on the life history and population growth parameters of *Myzus persicae* (Hemiptera: Aphididae). *Journal of Insect Science*, *19*(5), 15.

İpekkeşen, D. (2019). *Aphis craccivora* Koch. (Hemiptera: Aphididae)'nin farklı fasulye çeşitleri üzerinde bazı biyolojik parametrelerin belirlenmesi (Yüksek lisans tezi, Dicle Üniversitesi, Fen Bilimleri Enstitüsü, Bitki Koruma Ana Bilim Dalı). Yükseköğretim Kurulu Ulusal Tez Merkezi.

Kant, M. R., Jonckheere, W., Knegt, B., Lemos, F., Liu, J., Schimmel, B. C. J. & Aharoni, A. (2015). Mechanisms and ecological consequences of plant defence induction and suppression in herbivore communities. *Annals of Botany, 115*(7), 1015-1051. https://doi.org/10.1093/aob/mcv054.

Mwangi, S. N., Deng, A. L. & Kamau, A. W. (2008). Response of Kenyan varieties of common bean, *Phaseolus vulgaris* L., to infestation by *Aphis fabae* Scopoli. *African Entomology, 16*(2), 196-202. https://doi.org/10.4001/1021-3589-16.2.196

Parker, W. E., and A. J. Biddle. (1998). Assessing the damage caused by black bean aphid (*Aphis fabae*) on spring beans., 1077-1082.

Pekşen, E. & Artık, C. (2005). Antibesinsel Maddeler ve Yemeklik Tane Baklagillerin Besleyici Değerleri. *O.M.Ü. Zir. Fak. Dergisi, 20*(2), 110-120.

Phelan, P. L., Mason, J. F. & Stinner, B. R. (1995). Soil-fertility management and host preference by European corn borer, *Ostrinia nubilalis* (Hübner), on *Zea mays* L.: A comparison of organic and conventional chemical farming. *Agriculture, ecosystems & environment, 56*(1), 1-8.

Polat Akköprü, E., Atlihan, R., Okut, H. & Chi, H. (2015). Demographic assessment of plant cultivar resistance to ınsect pests: A case study of the dusky-veined walnut aphid (Hemiptera: Callaphididae) on five walnut cultivars. *Journal of Economic Entomology, 108*(2), 1–10.

Powell, G., Tosh, C. R. & Hardie, J. (2006). Host plant selection by aphids: Behavioral, evolutionary, and applied perspectives. *Annual Review of Entomology, 51*, 309-330.

Qayyum, A., Aziz, M. A., Iftikhar, A., Hafeez, F. & Atlihan, R. (2018). Demographic parameters of *Lipaphis erysimi* (Hemiptera: Aphididae) on different cultivars of Brassica vegetables. *Journal of Economic Entomology, 111*(4), 1885-1894.

Shah, T. H. (2017). Plant nutrients and insects development. *International Journal of Entomology Research, 2*(6), 54-57.

Shannag, H. K., & J. A. Ababneh (2007). Influence of black bean aphid, *Aphis fabae* Scopoli on growth rates of faba bean., 344-349.

Shigenobu, S. & Yorimoto, S. (2022). Aphid hologenomics: current status and future challenges. *Current Opinion in Insect Science, 50*, 100882.

Singh, R. J., Chung, G. H. & Nelson, R. L. (2007). Landmark research in legumes. *Genome, 50* (6), 525-537.

Smith, C. M. (1989). *Plant resistance to insects: A fundamental approach*. John Wiley & Sons.

Smith, C. M. (2005). *Plant resistance to arthropods: Molecular and conventional approaches*. Springer. https://doi.org/10.1007/1-4020-3702-3

Sun, J., Tan, X., Li, Q., Francis, F. & Chen, J. (2022). Effects of different temperatures on the development and reproduction of *Sitobion miscanthi* from six different regions of China. *Frontiers in Ecology and Evolution, 10*, 794495.

Tuan, S. J., Yeh, C. C., Atlihan, R. & Chi, H. (2016). Linking life table and predation rate for biological control: a comparative study of *Eocanthecona furcellata* (Hemiptera: Pentatomidae) fed on *Spodoptera litura* (Lepidoptera: Noctuidae) and *Plutella xylostella* (Lepidoptera: Plutellidae). *Journal of Economic Entomology, 109*(1), 13-24.

TUIK. (2024). *Türkiye İstatistik Kurumu*. https://data.tuik.gov.tr [accessed :18 04 2025].

Uysal, F. (2002). Kalite Fonksiyonunun Türkiye'de Baklagil Dış Satımına Etkileri. *Akdeniz Üniversitesi Sosyal Bilimler Enstitüsü Yüksek Lisans Tezi*, 114.

Vafaei, F., Nejad, K. H. I., Chaichi, P. T. & Valizadeh, M. (2006). The study of laboratory biology of two-spotted spider mite (*Tetranychus urticae* Koch) on five bean cultivars of two species.

War, A. R., Paulraj, M. G., Ahmad, T., Buhroo, A. A., Hussain, B., Ignacimuthu, S. & Sharma, H. C. (2012). Mechanisms of plant defense against insect herbivores. *Plant signaling & behavior, 7*(10), 1306-1320.

Wei, L., Jing, B. & Li, H. (2020). Bootstrapping promotes the RSFC-behavior associations: An application of individual cognitive traits prediction. *Human Brain Mapping, 41*(9), 2302-2316.

Yaşarakıncı, N. & Hıncal, P. (1999). İzmir ilinde örtü altı fasulye yetiştiriciliğinde bulunan zararlılar ile doğal düşmanları ve popülasyon gelişmeleri üzerinde araştırmalar. *Bitki Koruma Bülteni, 39*(3-4), 137-150.

Yılmaz, M. & Polat Akköprü, E. (2020). Determination of population parameters of *Chrysoperla carnea* (Stephen) (Neuroptera: Chrysopidae) fed on walnut aphids, *Chromaphis juglandicola* (Kaltenbach) (Hemiptera: Aphididae) and *Panaphis juglandis* (Goeze) (Hemiptera: Callaphididae). *Turkish Journal of Agriculture-Food Science and Technology, 8*(8), 1656-1661.