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Life Table Parameters of Grape Mealybug *Planococcus ficus* (Signoret, 1875) (Hemiptera: Pseudococcidae) On Different Vine Varieties

Asma Unlubiti *Planococcus ficus* (Signoret) (Hemiptera: Pseudococcidae)'un Farklı Asma Çeşitleri Üzerinde Biyolojisinin Saptanması

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ABSTRACT

In this study, the biology of grape mealybug, *Planococcus ficus* (Signoret, 1875) (Hemiptera: Pseudococcidae), was investigated in different grape varieties under laboratory conditions at 25 ± 1°C temperature, 65 ± 5% relative humidity, and 16:8 hours light:darkness photoperiod. Life tables of four different grapevine cultivars of *Planococcus ficus* were created, two of which are for wine (Emir, Kalecik karası) and two for table grapes (Yalova incisi, Trakya ilkeren). The results determined that the most suitable vine varieties for pest development were Emir and Yalova incisi, which are white grape varieties. The Yalova incisi and Emir cultivars were determined to be the most suitable host plants, with the highest values of life table parameters [generation time = 31.6.4 ± 0.96 days, net reproductive rate = 32.3 ± 10.0 females/female/offspring, r = 0.1 ± 0.01 females/female/day, gross reproductive rate = 99.1 ± 16.99 nymphs/female] and (T0 = 38.4 ± 1.22 days, R0 = 40.8 ± 11.53 females/female/offspring, r = 9.7 ± 0.01 females/female/day, gross reproductive rate = 155.1 ± 12.14 nymphs/female).

Keywords: Grape varieties, life table, *Planococcus ficus*, Turkey

ÖZ

Bu çalışmada, Asma unlubiti, *Planococcus ficus* (Signoret) (Hemiptera: Pseudococcidae)'un laboratuvar koşullarında dört farklı üzüm çeşidi üzerinde ikisi şaraplık üzüm çeşitleri (Emir, Kalecik karası) ve ikisi sofralık üzüm çeşitleri (Yalova incisi, Trakya ilkeren) üzerinde 25 ± 1°C sıcaklık, %65 ± 5 orantılı nem koşullarında ve uzun gün (16: 8, A:K) aydınlatmalı iklim dolaplarında biyolojisi araştırılmıştır. Sonuçlar, *P. ficus*'un gelişimi için en uygun konukçu üzüm çeşitlerinin beyaz üzüm çeşitleri olan Emir ve Yalova incisi çeşitleri, yaşam tablosu parametrelerinin en yüksek değerlerine sahip en uygun konukçu bitkileri olarak belirlenmiştir (T0 = 31,6,4 ± 0,96 gün, R0 = 32,3 ± 10,0 dişi/dişi/yavru, r = 0,1 ± 0,01 dişi/dişi/gün, GRR = 99,1 ± 16,99 nimf/dişi) ve (T0 = 38,4 ± 1,22 gün, R_0 = 40,8 ± 11,53 dişi/dişi/yavru, r = 9,7 ± 0,01 dişi/dişi/gün, GRR = 155,1 ± 12,14 nimf/dişi).

Anahtar Kelimeler: Asma çeşitleri, yaşam çizelgesi, *Planococcus ficus*, Türkiye

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Introduction

Vine (*Vitis vinifera* L.) (Vitaceae) is a cultivated plant widely grown in temperate climates with high agricultural value. It is known that Turkey, which is located in the most favorable climatic zone in terms of grape growing in the world, has the oldest and deepest-rooted viticulture heritage, as well as is one among the regions constituting the homeland of the grapevine (Çelik, 1998). The vine, which is considered a single species, is rich in variety and is thought to have more than 10,000 varieties in the world.

There are many disease factors, mites, and harmful insect species that negatively affect yield and quality in Turkey's vineyards (Kaplan & Bayhan, 2016a, 2016b, 2017, 2018; Kaplan et al., 2016). It has been determined that the grape mealybug, *Planococcus ficus* (Signoret, 1875) (Hemiptera: Pseudococcidae),

has become increasingly common in vineyards in recent years and has begun to cause damage to vines (Düzgüneş 1982; Lodos 1982; Kaydan et al., 2004).

Planococcus ficus is a cosmopolitan species and has spread all over the world it has been stated that it causes serious economic damage, especially in the vineyards of Pakistan, Mediterranean countries, Argentina, and South Africa (García Morales et al. 2016). *Planococcus ficus*, a polyphagous pest, causes economic damage not only to vines but also to 32 different plants belonging to 24 families (García Morales et al., 2016). The pest prevents both the product from polluting and the photosynthesis of the plant by causing the development of plants to stretch, the leaves to shrink, the amount of product to decrease as a result of feeding by absorbing the plant sap on the trunk, branches, shoots, leaves, and fruits of the vine, on the other hand (Koztarab & Kozár, 1988). This pest also shows a symbiosis with closteroviruses, causing the "leafroll" disease in vines. With this disease, defoliation, delay in fruit ripening, and loss of quality in the product are observed (Ball et al., 2003; Joyce et al., 2001).

Knowing the population dynamics and biology of the pests that cause economic losses in agricultural products is extremely important in terms of precautions that can be taken. This information provides the basic information necessary for the construction of life charts of an organism's development, survival, and reproductive performance under certain conditions. With life tables, a detailed mathematical summary of the biology of a species can be obtained. For this reason, in this study, life tables of *P. ficus* were created on four different grape varieties (Yalova incisi, Trakya ilkren, Emir, and Kalecik karası) grown specifically for Turkey, two for the table and two for wine.

Methods

Host Plant Culture

Cuttings from four different grapevine varieties in the vineyard plot of Çukurova University Pozantı Agricultural Research Center (POZMER) were planted in pots with a diameter of 28 cm and a depth of 25 cm, containing a mixture of sand + fertilizer + soil (1:1:1). The plants that were used in the study had been grown under controlled conditions in a climate cabinet. The temperature was maintained at 25 ± 2°C, the relative humidity (RH) at 60 ± 10%, and a photoperiod of 16:8 hours of light and darkness. To avoid any disruption in host plant production, 40 saplings were produced from each grape variety, and 30 were used in the experiment.

Mealybug Culture

Adult and preadult individuals brought to the laboratory with their host were placed together with the host plant in plastic jars with ventilation holes covered with fine. Sprouted potato tubers were used to feed the pest. These plastic jars containing the pest were placed in another plastic tub filled, labeled, and the development of individuals was ensured. Stock cultures (25 ± 2°C, 60 ± 10% RH, and 16:8 hours light:darkness photoperiod) were placed in climate chambers. To maintain stock culture, cultures were renewed every 2 weeks and maintained until the end of the experiment.

Experiments

Studies on the biology of *P. ficus* have been conducted on vine leaves. In the experiments established for each host on the vine leaves, the fresh leaf of the host was removed, and leaf discs were cut from the leaf for the water agar medium according to the petri dish. These leaf discs were placed in 6 cm diameter plastic petri dishes with water agar in them, with their lower surfaces facing up. Two 1 cm diameter holes were drilled on the lids of the petri dishes to provide ventilation, and these holes were closed by sticking tulle fabric. The experiments were conducted in a climate cabinet (25 ± 2°C, 60 ± 10% RH, and 16:8 hours light:darkness photoperiod). Thirty replicates (individual insects) were used for each host plant. Petri dishes 6 cm in diameter were used for these experiments. Daily recordings were made for the preoviposition, oviposition, and postoviposition stages of the female insects, as well as the survival parameters for both males and females.

Statistical Analysis

Data analysis was conducted using one-way analysis of variance and Duncan's test ($p \leq .05$). The statistical analysis was performed using IBM Statistical Package for the Social Sciences Statistics (IBM SPSS Corp., Armonk, NY, USA), version 23.0. The population growth parameters of *P. ficus* on the four vine varieties (Emir, Kalecik karası, Yalova incisi, and Trakya ilkeren) were analyzed using an age-stage, two-sex life table based on the methods outlined by Chi and Liu (1985) and Chi (1988). The data from the life table were analyzed using the TWOSEX-MSChart developed by Chi in 2017.

Results

The vine mealybug successfully completed its life cycle on four different host plants: Emir, Kalecik karası, Yalova incisi, and Trakya ilkeren. The mean developmental periods of the preadult stages varied between 27.1 and 34.2 days for females and between 28.1 and 30.9 days for males (Table 1). The shortest developmental time for females was observed on Yalova incisi, with an average of 27.1 ± 0.87 days, while for males, it was on Yalova incisi as well, with an average of 28.1 ± 0.63 days. Comparatively, the developmental times (preadult) for both female and male mealybugs were longer on Yalova incisi compared to Kalecik karası, Trakya ilkeren, and Emir. The differences in developmental time of the preadult stages among the plant species were found to be statistically significant ($p < .05$).

The vine mealybug completed its life cycle on Emir, Kalecik karası, Yalova incisi, and Trakya ilkeren. The Mean developmental periods of preadult stages were found between 27.1 and 34.2 days for females and between 28.1 and 30.9 days for males (Table 1). The shortest female developmental time obtained was 27.1 ± 0.87 days on Yalova incisi and 28.1 ± 0.63 days for males on Yalova incisi. Female and male developmental times (preadult) on Yalova incisi were longer than when mealybug reared on Kalecik karesi, Trakya ilkeren, and Emir. Significant differences were found between plant species for the developmental time of preadult stages ($p < .05$).

The survival rate (lx) and female offspring production (mx) of *P. ficus* females on different hosts were calculated, and other parameters related to the life table were obtained. As a result, the generation time (T0) of *P. ficus* was determined as 32.6 ± 0.28 days for Kalecik Karası, 34.2 ± 3.11 days for Trakya İlkeren, and 31.6 ± 0.96 days for Yalova İncisi, respectively. The longest generation time was found to be 38.4 ± 1.22 days for the Emir variety (Table 2). The net reproductive rate (R0) of the pest was calculated as 0.5 ± 0.30 females/female/offspring for Trakya İlkeren, followed by 10.5 ± 5.65 females/female/offspring for Kalecik Karası, 32.3 ± 9.99 females/female/offspring for Yalova İncisi, and 40.8 ± 11.53

Table 1.
Developmental Time (Mean ± SE) of Planococcus ficus Individuals on Four Host Plants

Host Plants	Egg Stage		First Nymphal Stage		Second Nymphal Stage		Third Nymphal Stage		Total Preadults	
	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
Emir	5.1 ± 0.7^{a} (*n* = 9)	5.5 ± 0.3^{b} (*n* = 13)	8.9 ± 1.6^{b} (*n* = 9)	7.2 ± 0.60^{a} (*n* = 13)	11.9 ± 1.5^{c} (*n* = 9)	8.3 ± 0.6^{a} (*n* = 13)	8.3 ± 1.47^{c} (*n* = 9)	7.7 ± 0.7^{a} (*n* = 13)	34.2 ± 1.08^{b} (*n* = 9)	28.6 ± 0.87^{a} (*n* = 13)
Trakya ilkeren	4.0 ± 0.0^{a} (*n* = 2)	4.4 ± 0.2^{a} (*n* = 13)	9.5 ± 4.5^{b} (*n* = 2)	7.7 ± 0.76^{ab} (*n* = 13)	9.5 ± 8.50^{bc} (*n* = 2)	7.7 ± 0.7a (*n* = 13)	8.00 ± 2.0^{c} (*n* = 2)	8.8 ± 0.56^{a} (*n* = 13)	31.00 ± 2.00^{b} (*n* = 2)	29.4 ± 0.73^{ab} (*n* = 13)
Yalova incisi	6.6 ± 0.2^{c} (*n* = 15)	5.9 ± 0.3^{b} (*n* = 7)	6.3 ± 0.70^{a} (*n* = 8)	7.0 ± 0.62^{a} (*n* = 7)	7.4 ± 1.03^{a} (*n* = 15)	8.1 ± 0.6^{a} (*n* = 7)	6.9 ± 0.4^{b} (*n* = 8)	7.1 ± 0.40^{a} (*n* = 8)	27.1 ± 0.87^{a} (*n* = 8)	28.1 ± 0.63^{a} (*n* = 7)
Kaleck karası	4.0 ± 0.0^{a} (*n* = 3)	5.2 ± 0.26^{b} (*n* = 13)	9.7 ± 1.33^{b} (*n* = 3)	8.4 ± 0.58^{b} (*n* = 13)	8.0 ± 1.53^{ab} (*n* = 3)	8.6 ± 0.69^{a} (*n* = 13)	6.0 ± 0.58^{a} (*n* = 3)	8.6 ± 0.55^{b} (*n* = 13)	27.7 ± 0.33^{a} (*n* = 3)	30.9 ± 0.53^{b} (*n* = 13)

Note: Columns followed by the same letters are not statistically different according to the Duncan's (5%) test.
n = Number of adults.

females/female/offspring for Emir. The highest net reproductive rate was observed in the Emir variety. The inherent reproductive capacity of *P. ficus*, expressed as the intrinsic rate of increase (r), varied among different grapevine varieties. The intrinsic rate of increase (r) was calculated as −2.0 ± 0.01 females/female/day for Trakya İlkeren, 0.1 ± 0.01 females/female/day for Yalova İncisi, 9.7 ± 0.01 females/female/day for Emir, and 7.2 ± 0.01 females/female/day for Kalecik Karası. Statistical analysis indicated significant differences among different grapevine varieties (Table 2).

When comparing the average generation times (T) of *P. ficus* on different hosts and varieties, it was determined that the longest duration was observed in the Emir variety, while the shortest duration was found in the Yalova İncisi variety. Furthermore, considering the net reproductive rate (Ro) of *P. ficus*, it was highest in the Emir variety and lowest in the Trakya İlkeren variety. These results suggest that Emir and Yalova İncisi varieties are the most suitable host plants for mass production studies and can potentially lead to higher pest populations, indicating their potential as harmful plants in commercial production areas.

The total preoviposition period of *P. ficus* was determined as 32.0 ± 2.00 days in Trakya İlkeren, 27.1 ± 0.87 days in Yalova İncisi, 27.7 ± 0.33 days in Kalecik Karası, and 34.2 ± 1.07 days in Emir. According to these results, the shortest total preoviposition period was observed in Yalova İncisi (27.1 ± 0.87 days), while the longest period was found in Emir. Duncan test ($p < .05$) indicated a statistically significant difference among grapevine varieties (Table 3). The oviposition period of *P. ficus* was determined as 3.0 ± 2.00 days in Trakya İlkeren, 8.3 ± 0.41 days in Yalova İncisi, 8.7 ± 1.20 days in Kalecik Karası, and 8.9 ± 0.39 days in Emir. The postoviposition period of *P. ficus* was determined as 12.0 ± 1.00 days in Trakya İlkeren, 2.5 ± 0.26 days in Yalova İncisi, 2.3 ± 0.33 days in Kalecik Karası, and 2.1 ± 0.22 days in Emir. The postoviposition period was completed in a shorter time in Emir, while it took a longer time in Trakya İlkeren. When evaluating the life span of female individuals in populations feeding on different grapevine varieties, it was determined as 46.0 ± 3.00 days in Trakya İlkeren, 36.9 ± 0.79 days in Yalova İncisi, 37.7 ± 0.88 days in Kalecik Karası, and 44.2 ± 1.13 days in Emir. Statistical analyses revealed a significant difference among the different grapevine varieties used in the study.

The average number of female eggs laid by females feeding on Trakya İlkeren was the lowest with 7.5 eggs, followed by Yalova İncisi with 120.88 eggs and Kalecik Karası with 105.33 eggs. The highest number of female eggs was observed in the Emir variety with 135.89 eggs. The statistical analysis indicated a significant difference among the varieties (Table 3; Duncan $p < .05$). In conclusion, the life span of *P. ficus* females and the average total number of eggs laid varied between 7.5 and 135.89 eggs/female among different grapevine varieties.

The durations of preoviposition, oviposition, and postoviposition stages in cotton mealybugs were found to be influenced by the host species. The host plants that exhibited the highest fecundity and longest longevity in cotton mealybugs were Emir, with an average of 135.9 nymphs per female and a life span of 47 days, followed by Yalova incisi, with an average of 120.9 nymphs per female and a life span of 40.8 days. In a study conducted by Çalışkan-Keçe (2019), it was determined that eggplants were particularly favorable host plants for enhancing cotton mealybug fecundity.

Figure 1 shows the survival rates of *P. ficus* on different host plants. This figure helps to interpret each stage of *P. ficus* in terms of survival rates. According to Figure 1, Yalova incisi was a better host than Kalecik karesi, Trakya ilkeren, and Emir. The life table parameters are given in Figure 2.

Table 2.
Life Table Parameters of Planococcus ficus on Four Host Plants (n = 30, Mean ± SE)

Host Plant	rm	λ	R0	T	GRR
Emir	9.7 ± 0.01^{d}	1.1 ± 0.01^{a}	40.8 ± 11.53^{c}	38.4 ± 1.22^{c}	155.1 ± 12.14^{d}
Trakya ilkeren	−2.0 ± 0.01^{a}	1.0 ± 0.01^{a}	0.5 ± 0.30^{a}	34.2 ± 3.11^{ab}	2.3 ± 1.41^{a}
Yalova incisi	0.1 ± 0.01^{b}	1.1 ± 0.01^{a}	32.3 ± 10.0^{c}	31.6 ± 0.96^{a}	99.1 ± 16.99^{c}
Kalecik karası	7.2 ± 0.01^{c}	1.1 ± 0.01^{a}	10.5 ± 5.65^{b}	32.6 ± 0.28^{a}	26.2 ± 13.15^{b}

Note: Within columns means followed by the same letter are not statistically different according to the Duncan's test (5%).
GRR = Gross reproductive rate.

Table 3.
Reproduction and Survival Parameters of Planococcus ficus on Four Host Plants (n = 30, Mean ± SE)

	Preoviposition	Oviposition	Postoviposition	Fecundity	Longevity	
					Female	Male
Emir	34.2 ± 1.07[b]	8.9 ± 0.39[b]	2.1 ± 0.22[a]	135.9 ± 7.21[c]	44.2 ± 1,13[b]	2.8 ± 0.87[a]
Trakya ilkeren	32.0 ± 2.00[b]	3.0 ± 0.00[a]	12.0 ± 1.00[c]	7.5 ± 0.50[a]	46.0 ± 3.00[b]	4.0 ± 0.88[b]
Yalova incisi	27.1 ± 0.87[a]	8.3 ± 0.41[b]	2.5 ± 0.26b	120.9 ± 8.51[b]	36.9 ± 0.79[a]	3.9 ± 0.93[b]
Kalecik karası	27.7 ± 0.33[a]	8.7 ± 1.20[b]	2.3 ± 0.33a	105.3 ± 18.22[b]	37.7 ± 0.88[a]	3.8 ± 0.63[b]

Note: Within columns means followed by the same letter are not statistically different according to the Duncan's test (5%).
n = Number of adults.

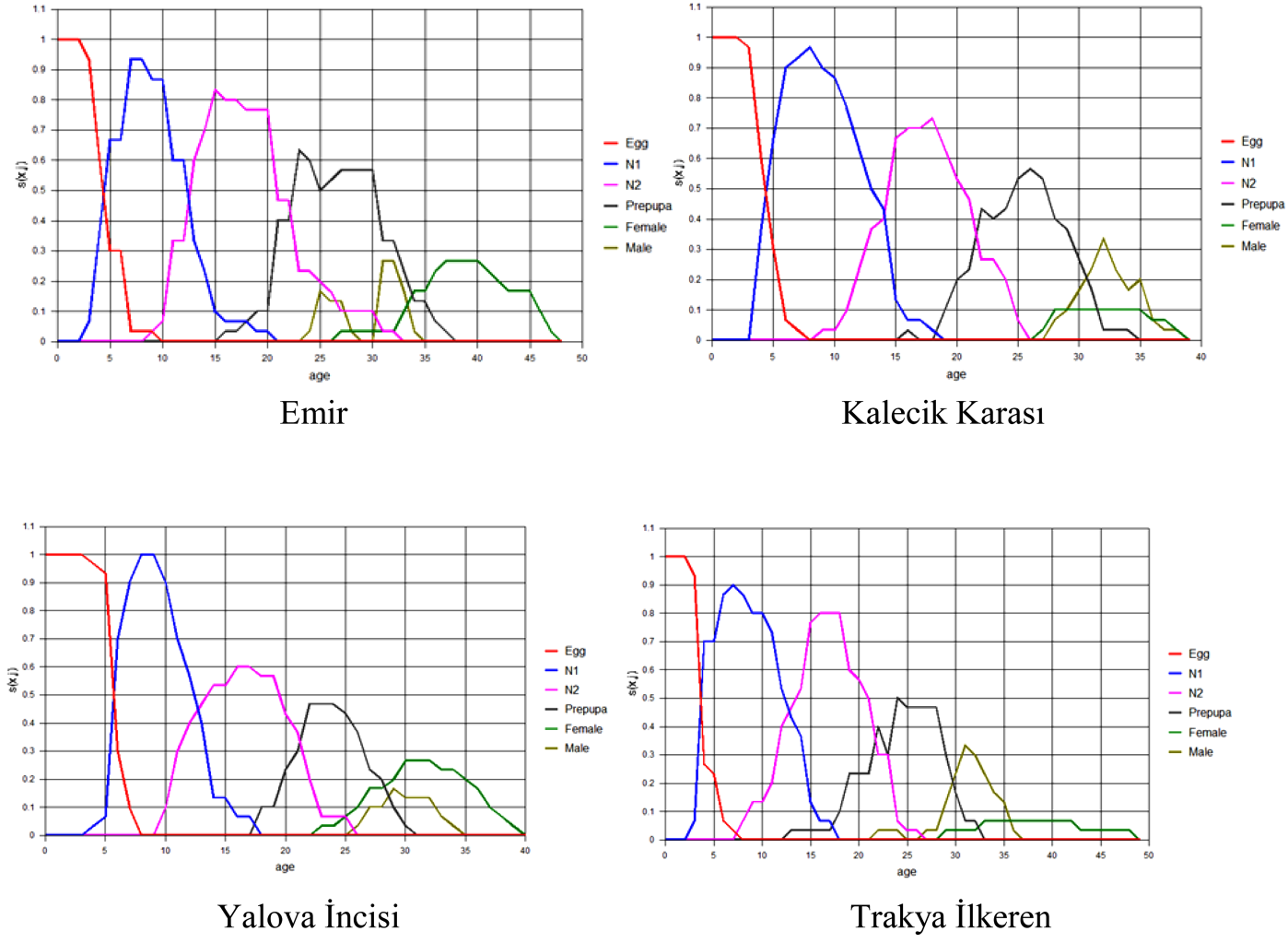

Figure 1.
Survival Ratio of Planococcus ficus for Each Stage on Four Host Plants.

Based on the findings of this study, significant variations were observed in the biological characteristics of *P. ficus* across different host plant species. Among the host plants examined, Yalova incisi exhibited the most favorable conditions for the development of the vine mealybug. The development time of the vine mealybug on Yalova incisi (27.1 days) and Kalecik karası (27.7 days) was notably superior to that on Trakya ilkeren and Emir.

Discussion

The population parameters of *P. ficus* varied significantly among different host plant species. Yalova incisi emerged as the most favorable host in this study. The intrinsic rate of increase (rm) and net reproduction rate (R0) are crucial indicators for assessing insect population growth (Goundoudaki et al., 2003). The data presented in this study exhibited the highest values of rm and R0 with Emir and Yalova incisi host plants, highlighting their suitability for the population increase of *P. ficus*. Whereas, the lowest values were on Kalecik karası and Trakya ilkeren. In Walton (2004) study, the T reproductive period of vine mealybug on the Waltham Gross grape variety was determined to be 38 days at 25°C and 60% humidity. Mohamed (2017), from studies on grape mealybug, formed the life table of vine mealybug, *P. ficus* (Signoret, 1875)

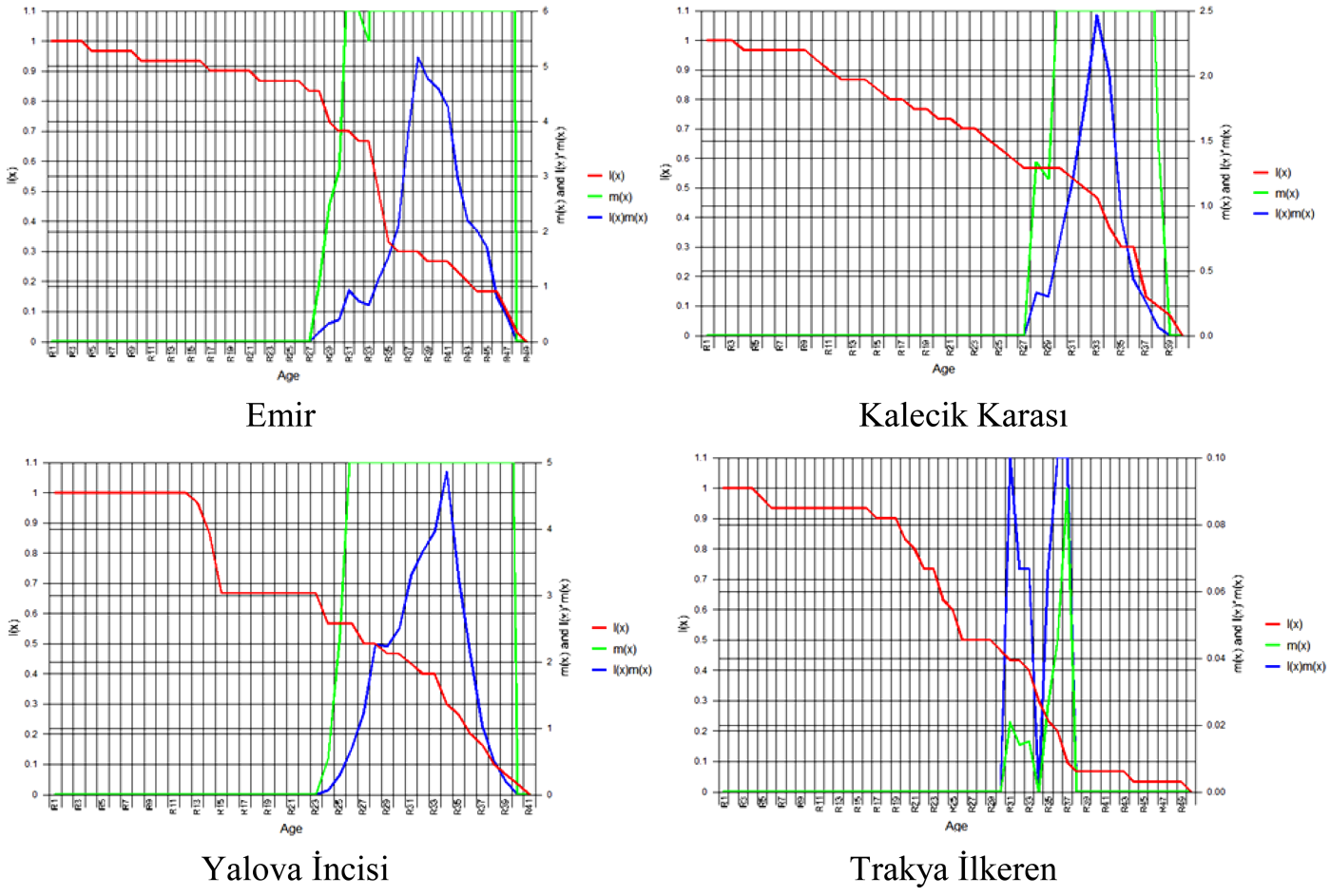

Figure 2.
Age-Specific Life Table Graphics (l_x, m_x, l_xm_x) of Planococcus ficus on Four Host Plants.

(Hemiptera: Pseudococcidae) in some ornamental plants. In the study, it was determined that the highest mortality rate in the nymphal stages of the pest was 32.02%, 42.05%, and 56.63% for all hosts, and the total mortality rate was 35.89%, 48%, and 64.50%, respectively. As a result, it was determined that *P. ficus* preferred *Hedera helix* more than *Pittosporum tobira* and *Nerium oleander*.

Conclusion and Recommendations

According to the obtained results, when comparing the oviposition period, preadult developmental stages, and total number of eggs laid with other host plants, it was determined that Emir and Yalova İncisi were the most suitable hosts for *P. ficus*. On the other hand, Trakya İlkeren and Kalecik Karası varieties were found to be the least preferred hosts. When examining the natural conditions in which *P. ficus* is found, it is necessary to obtain life table data under different temperature and humidity conditions in future studies.

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References

Ball, J., Battaniye, M., Beede, R., Bentley, W., Bettiga, L., Burton, S., Coviello, R., Daane, K., Gill, R., Gonzalez, D., Gispert, C., Godfrey, K., Guillen, M., Hashim, J., Haviland, D., Hirschfelt, D., Ingels, C., Leavit, G., Lynn, K., Malakar-Kuenen, R., et al. (2003). *Current status of the vine mealybug, Planococcus ficus, in Calofornia*. http://ucce.ucdavis.edu/files/filelibrary/1650/8695.pdf

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

Chi, H., & Liu, H. (1985). Two new methods for the study of insect population ecology. *Bulletin of the Institute of Zoology Academia*, *24*, 225–240.

Chi, H. (2017). *TWOSEX-MS Chart: A computer program for age-stage, two-sex life table analysis*. http://140.120.197.173/Ecology/

Çalışkan-Keçe, A. F. (2019). Life table parameters of cotton mealybug, *Phenacoccus solenopsis* Tinsley, 1898 (Hemiptera: Pseudococcidae) on four different plants. *Türkiye Entomoloji Dergisi*, *43*(3), 271–278.

Çelik, S. (1998). *Bağcılık (Ampeloloji)* (*Cilt 1*, 425 p). Anadolu Matbaa Ambalaj San. ve Tic. Ltd. Şti.

Düzgüneş, Z. (1982). Türkiye'de bulunan Pseudococcidae (Homoptera: Coccoidae) türleri üzerinde incelemeler. Ankara Üniversitesi Ziraat Fakültesi Yayınları, s.56. Ankara, Türkiye. *Entomologia Experimentalis et Applicata*, *98*, 49–57.

García Morales, M., Denno, B. D., Miller, D. R., Miller, G. L., Ben-Dov, Y., & Hardy, N. B. (2016). ScaleNet: A literature-based model of scale insect biology and systematics. *Database*. http://scalenet.info. [CrossRef]

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. [CrossRef]

Joyce, A. L., Hoddle, M. S., Bellows, T. S., & Gonzalez, D. (2001). Oviposition behaviour of *Coccidoxenoides peregrinus*, a parasitoid of *Planococcus ficus*. *Entomologia Experimentalis et Applicata*, *98*(1), 49–57. [CrossRef]

Kaplan, M., & Bayhan, E. (2016a). Weeds in vineyard areas in Mardin Province and determined Thrips species on weeds. *Plant Protection Bulletin*, *56*(2). https://dergipark.org.tr/tr/pub/bitkorb/issue/24346/258049

Kaplan, M., & Bayhan, E. (2016b). Mardin ili bağ alanlarındaki örümcek (Araneae) türlerinin belirlenmesi. *Türkiye Entomoloji Bülteni*, *6*(3), 255–259. [CrossRef]

Kaplan, M., & Bayhan, E. (2017). The determination of control possibilities against harmful Thrips species in vineyard areas in Mardin Province. *Plant Protection Bulletin*, *57*(4), 433–446 . [CrossRef]

Kaplan, M., & Bayhan, E. (2018). The determination of population fluctations of Thysanoptera species in the vineyard areas of Mardin Province. *Bitki Koruma Bülteni*, *58*(1), 27–34.

Kaplan, M., Bayhan, E., & Atakan, E. (2016). Mardin ili bağ alanlarındaki Thysanoptera türleri, mevsimsel yoğunlukları ve yayılış alanlarının belirlenmesi. *Türkiye Entomoloji Bülteni*, *6*(2), 161–168 . [CrossRef]

Kaydan, M. B., Ülgentürk, S., Zeki, C., Toros, S., & Gürkan, M. O. (2004). Studies of Pseudococcidae (Homoptera: Coccoidea) fauna of Afyon, Ankara, Burdur and Isparta provinces, Turkey. *Turkish Journal of Zoology*, *28*, 219–224.

Kosztarab, M., & Kozár, F. (1988). *Scale insects of Central Europe* (456 p). Akad. Kiado.

Lodos, N. (1982). *Türkiye entomoloji II* (542 p). Ege Üniversitesi Matbaası.

Mohamed, G. (2017). Comparative life table parameters of the vine mealybug, *Planococcus ficus* (Signoret) (Hemiptera: Pseudococcidae), fed on some ornamental plants. *Journal of Plant Protection and Pathology*, *8*(3), 119–124. [CrossRef]

Signoret, V. (1875). Essai sur les cochenilles ou gallinsectes (Homoptères – Coccides), 15e partie. *Annales de la Socété Entomologique de France (Serie 5)*, *5*, 305–352.

Walton, V. M., & Pringle, K. L. (2004). Walton Vine mealybug, *Planococcus ficus* (Signoret) (Hemiptera: Pseudococcidae), a Key Pest in South African vineyards. A review. *South African Journal of Entomology and Viticulture*, *25*(2). [CrossRef]