POPULATION FLUCTUATIONS OF CITRUS MEALYBUG [Planococcus citri (Risso) (Hemiptera: Pseudococcidae)] ON DIFFERENT HOST PLANTS

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Abstract

Some biological parameters (development period, adult longevity, sex ratio, preoviposition, oviposition, and post oviposition periods, daily and the total number of eggs, hatching ratio and time) of Planococcus citri Risso (Hemiptera: Pseudococcidae) studied on 4 different host plants (Citrussinensis L., Citrus limon L., PunicagranatumL., Solanumtuberasum L.ve CucurbitamoschataDuchesne) and 3 different temperatures (20±1°C, 25±1°C ve 30±1°C) and %60-65 relative humidity in climate cabinets. The longest preadults period of P.citri was found on pomegranate at all temperatures, the shortest one was determined on Cucurbita moschata Duchesne. The most suitable temperature for the biology of this pest was determined as 25±1°C. In addition, the lowest number of eggs was recorded on Punica granatum, the highest one was found on Cucurbita moschata Duchesne. These obtained biological parameters in this study revealed that this pest showed significant biological differences in terms of different host plants and temperatures.

Keywords: *Citrus mealybug, Planococcus citri, temperature, hostplant, Turkey*

1. INTRODUCTION

Citrus mealybug [*Planococcus citri* Risso (Hemiptera: Pseudococcidae)] is one of the most important pests of citrus and ornamental plants, especially cause damages to orange and grapefruit species in Turkey. This pest can overwinter every biological stage under the woods, between the plant stem cuts, and sometimes in the root collars. Citrus mealybug starts to feed with plant sap under sepal leaves when the fruit has occurred and complete its generation in one month at 26 ±1 ˚C, % 60-65 relative humidity. Generally, 4-5 generations are seen in citrus orchards in the Mediterranean region. One female lay approximately 300-400 eggs during its lifetime. Eggs are covered with mealy wax secretion. Nymphs are mobile and start to search for suitable places for feeding when eggs are hatched. Female individuals become adults after 3 nymphal stages, and males become adults after 2 nymphal stages, prepupa and pupal stages. The first nymphal stages of. *P. citri* is oval, long, dirty pinkish and the antenna have 6 segments. Nymphs generally look like adults but are smaller than adults. Male individuals have one pair of wings and this pest reproduce with parthenogenesis. There are many studies conducted about the biology, ecology, and population dynamics of *P.citri* (Polat, 2005; Anonim, 2008; Artar, 2008; Uygun ve ark., 2010;Satar et al., 2013; Satar and Karacoğlu, 2017).

This study was conducted to determine the most suitable control period against *P. citri*, which cause economically important damages to citrus and ornamental plants in the Mediterranean and Aegean Regions. The preadult developmental, pre-oviposition, oviposition, and post-oviposition periods, daily and total longevity and fecundity and some biological characteristics of *P. citri* were aimed to determine at different temperatures and different host plants.

2. MATERIAL AND METHOD

This study was carried out to detect some biological characteristics of Citrus mealybug (*Planococcuscitri*Risso) in Muğla Sıtkı Koçman University Science Faculty, Biology Department, Applied Entomology Laboratory on 5 different host plants (*Citrus sinensis* L.**,** *Citrus limon* L.,

Punica granatum L., *Solanum tuberasum* L. *Cucurbitamoschata*Duchesne) and 3 different temperatures (20±1 °C, 25±1 °C, 30±1 °C) in 2016.

2.1. Mealybug Culture

Planococcuscitri was collected from several citrus orchards of Ortaca (Muğla) in 2016. The mealybug cultures have occurred on potato sprouts in climate rooms at 25 ± 2°C, 60 ± 10% R.H., and 16L: 8 D photoperiod in 5 different host plants as 3 citrus species, potato and pumpkin.

2.2. Experimental Design

Experiments have been carried out climate cabinets in Applied Entomology Laboratory from Muğla Sıtkı Koçman University, Science Faculty, and Biology Department and were done in climate cabinets on 5 different host plants at 20±1ºC, 25±1ºC, 30±1ºC, % 65±5 relative humidity, and 16L: 8D.

The mated Adult Female individuals were placed into orange, lemon, pomegranate, potato and pumpkin in different cages. The biological characteristics of laid eggs and hatched nymphs were observed. Adult male and female individuals were placed into different culture jars same day for mating. Thus, pre-oviposition, oviposition, and post-oviposition periods, mean and total laid eggs per female were determined on 5 different host plants. When nymphs reached the adult stage, sexuality was recorded with sex rate. In addition, the developmental periods of I., II., III. stages of female nymphs, and developmental periods of I., II. stages of the male nymph, prepupa ve pupal stages, and longevity for males and females were determined during this study.

2.3. Statistical Analysis

Analysis has been done by IBM SPSS 23 STATISTICS. One-way ANOVA and Duncan tests ($p<0.05$) have been used for comparisons of experiments characters.

3. RESULTS AND DISCUSSION

This study revealed some biological characteristics of *P.citri* such as the developmental period, fecundity, and rate of hatched eggs on 5 different host plants and 3 different temperatures

P. citri completed its development on 5 different host plants. According to the results of this study, the difference between host plants had important effects on preadult stages, male/female ratio, pre-oviposition, oviposition, and post-oviposition periods, adult longevity, and total laid eggs.

The results of this study were given in Table 1-3.

Table 1. All development stages parameters of *Planococcus citri* on different host plants at 20±1

20 °C

	Female			Male		Adult Longevity			EGG					
	I. Stage	II. Stage	III. Stage	I. Stage	II. Stage	Prepupa+Pupa	Female	Male	Pre-oviposition	Oviposition	Post- oviposition	The number of daily eggsı	Total number of eggs	The Hatching ratio	The Hatching period
Citrus sinensis	9,10±0,56 bc (6-11)	8,40±0,30 b (8-11)	9,90±0,54 ab (7-12)	7,30±0,26 b (6-9)	5,40±0,22 b (5-7)	10,30±0,49 ab (7-12)	24,50±0,58 b (21-35)	3,20±0,35 a (1-4)	8,70±0,53b (5-11)	11,70±0,42b (13-17)	3,90±0,48bc (3-7)	32,70±0,96 b (1-71)	128,10±6,53 c (45-129)	90,80±1,70 a (82,92)	5,20±0,75 a (2-8)
Citrus limon	10,20±0,51 ab (6-12)	9,60±0,56 ab (5-13)	8,50±0,56 bc (6-13)	10,60±0,60 a (7-13)	6,40±0,45 ab (5-8)	9,40±0,65 bc (5-12)	28,60±1,24 a (28-39)	3,20±0,29 a (2-4)	10,80±0,62a (7-12)	16,80±0,35a (16-19)	6,50±0,45a (5-8)	35,90±0,37 ab (1-78)	220,64±18,42 c (45-179)	90,50±2,08 a (82,92)	4,90±0,62 a (2-7)
Punica granatum	11,30±0,77 a (5-14)	11,30±0,78 a (5-14)	11,30±0,90 a (6-14)	9,20±0,89 ab (5-12)	7,60±0,49 b (4-9)	11,70±0,86 a (7-15)	18,30±0,91 c (16-30)	3,20±0,53 a (1-5)	7,40±0,86b (5-11)	11,60±0,60c (9-14)	2,80±0,35c (2-5)	27,10±1,18 c (1-36)	117,40±10,28 c (45-114)	80,80±2,05 b (73-88)	5,10±0,78 a (1-8)
Solanum tuberasum	11,20±0,89 ab (6-13)	10,60±1,00 a (5-14)	8,70±0,70 bc (6-12)	8,90±0,58 ab (5-11)	6,10±0,58 a (3-9)	8,20±0,61 cd (4-11)	22,60±0,68 b (14-34)	3,30±0,30 a (1-4)	8,70±0,76b (6-12)	12,80±0,85c (6-15)	5,20±0,55ab (2-7)	33,90±1,70 b (1-75)	295,30±9,24 b (51-596)	91,20±2,44 a (82,92)	5,00±0,61 a (1-7)
Cucurbita moschata	7,90±0,70 c (5-9)	8,30±0,39 b (7-10)	7,40±0,52 c (5-10)	8,10±0,94 b (3-11)	5,30±0,49 b (2-8)	7,20±0,71 d (3-10)	30,00±0,86 a (27-43)	3,60±0,37 a (1-5)	11,70±0,36a (10-14)	18,40±0,87a (14-22)	4,60±0,54b (3-7)	38,30±2,12 a (1-37)	389,20±52,27 a (47-398)	91,00±1,16 a (82,92)	5,10±0,79 a (2-8)

Table 2. All development stages parameters of *Planococcus citri* on different host plants at 25±1 °C

25 °C															
	Female			Male		Adult Longevity						EGG			
	I. Stage	II. Stage	III. Stage	I. Stage	II. Stage	Prepupa+Pupa	Female	Male	Pre-oviposition	Oviposition	Post- oviposition	The number of daily eggss	Total number of eggs	The Hatching ratio	The Hatching period
Citrussinensis	8,30±0,44 bc (6-10)	7,80±0,57 c (5-11)	8,90±0,48 b (7-11)	6,40±0,47 b (4-9)	4,10±0,37 c (3-6)	9,10±0,43 ab (7-11)	24,30±0,73 c (15-32)	2,82±0,35 a (1-4)	8,20±0,51 bc (5-11)	13,10±0,64 bc (9-15)	3,20±0,46 dc (1-6)	22,60±2,19 bc (1-68)	118,20±1,45 c (42-124)	94,00±0,86 a (76-95)	5,70±0,68 a (2-7)
Citrus limon	9,10±0,37 abc (6-10)	8,70±0,39 bc (7-11)	7,30±0,51 bc (7-11)	9,20±0,80 a (5-12)	5,80±0,55 ab (4-9)	8,40±0,54 bc (5-11)	27,80±1,26 b (24-36)	2,10±0,37 a (1-4)	10,50±0,47 a (8-12)	13,40±0,37 bc (14-17)	4,10±0,52 ab (2-7)	25,90±0,10 ab (1-75)	163,50±6,15 c (42-172)	94,80±3,24 a (76-94)	5,10±0,62 a (2-7)
Punicagranatum	10,70±0,66 a (5-11)	10,90±0,73 a (5-13)	10,60±0,81 a (6-14)	8,10±0,70 ab (5-12)	6,70±0,39 a (4-8)	10,40±0,65 a (7-14)	18,70±0,18 d (15-25)	2,90±0,48 a (1-5)	6,10±0,45 d (5-9)	10,10±0,27 d (9-11)	2,10±0,40 c (1-5)	19,50±2,10 c (1-33)	105,90±12,69 c (42-110)	76,70±1,53 b (73-88)	5,80±0,64 a (3-8)
Solanumtuberasum	9,80±0,75 ab (6-13)	9,70±0,71 ab (6-13)	8,30±0,59 b (6-11)	8,00±0,59 ab (5-11)	5,30±0,30 bc (4-7)	7,10±0,64 cd (4-8)	22,70±1,23 c (13-30)	2,40±0,42 a (1-4)	7,10±0,48 cd (5-10)	11,40±0,74 cd (6-14)	4,10±0,48 ab (2-6)	24,50±2,32 abc (1-72)	283,20±5,82 b (48-591)	94,30±2,19 a (76-94)	5,70±0,33 a (4-7)
Cucurbitamoschata	7,50±0,58 c (5-9)	7,10±0,34 c (5-9)	6,30±0,47 c (5-9)	7,30±0,81 ab (3-10)	4,80±0,57 bc (2-8)	6,40±0,74 d (3-10)	29,10±0,97 a (16-37)	2,70±0,36 a (1-4)	9,30±0,57 ab (7-12)	15,20±1,04 a (9-18)	5,10±0,62 a (1-7)	30,20±2,49 c (1-34)	376,20±57,96 a (44-392)	94,00±0,96 a (74-95)	5,80±0,77 a (2-8)

Table 3. All development stages parameters of *Planococcus citri* on different host plants at 30±1 °C

30 °C															
	Female			Male		Adult Longevity						EGG			
	I. Stage	II. Stage	III. Stage	I. Stage	II. Stage	Prepupa+Pupa	Female	Male	Pre-oviposition	Oviposition	Post- oviposition	The number of daily eggss	Total number of eggs	The Hatching ratio	The Hatching period
Citrussinensis	7,10±0,45 cb (5-10)	6,20±0,55 c (5-9)	8,40±0,33 ab (7-10)	5,20±0,48 b (2-7)	3,20±0,24 b (3-5)	7,90±0,45 ab (6-10)	20,30±0,47 bc (15-30)	1,70±0,21 a (1-3)	7,00±0,49 bc (5-10)	11,20±0,51 bc (9-14)	2,10±0,54 ab (1-6)	20,90±2,59 b (1-70)	116,70±1,45 c (44-131)	92,50±1,00 a (80-93)	4,00±0,77 a (2-8)
Citrus limon	8,00±0,49 abc (6-10)	7,70±0,53 bc (5-10)	6,20±0,53 cd (4-9)	8,00±0,73 a (5-11)	4,20±0,32 b (2-5)	6,70±0,30 bc (5-8)	22,30±0,93 b (11-27)	1,60±0,26 a (1-3)	6,20±0,55 cd (4-9)	10,10±0,58 c (6-12)	3,00±0,57 a (1-5)	23,20±1,46 ab (1-77)	161,00±5,67 c (44-179)	92,30±0,66 a (79-93)	3,80±0,44 a (2-6)
Punicagranatum	9,20±0,86 a (5-12)	9,40±0,58 a (9-12)	9,60±0,49 a (6-11)	6,70±0,71 ab (4-11)	5,30±0,44 a (4-8)	8,90±0,65 a (6-12)	16,00±0,93 d (10-20)	1,90±0,23 a (1-3)	5,00±0,57 d (2-6)	9,40±0,40 d (7-11)	1,60±0,22 b (1-3)	19,10±1,07 b (1-34)	101,10±11,80 c (44-118)	79,60±2,02 b (79-93)	4,00±0,61 a (1-5)
Solanumtuberasum	8,70±0,60 ab (6-13)	8,60±0,68 ab (6-12)	7,00±0,59 bc (5-10)	7,00±0,59 ab (5-11)	4,10±0,34 b (2-6)	6,10±0,73 c (4-11)	19,30±1,24 c (18-32)	1,90±0,40 a (1-4)	8,20±0,48 ab (7-11)	12,40±0,80 ab (10-17)	1,70±0,33 ab (1-4)	22,70±2,49 ab (1-74)	281,30±7,19 b (50-297)	92,90±2,19 a (80-93)	3,90±0,54 a (1-7)
Cucurbitamoschata	6,10±0,62 c (5-9)	6,30±0,49 c (4-9)	5,10±0,45 d (3-8)	6,10±0,78 ab (3-10)	3,10±0,40 b (2-6)	5,10±0,48 c (3-8)	26,40±1,01 a (17-34)	1,10±0,10 a (1-2)	9,30±0,53 a (7-12)	14,10±0,94 a (8-17)	3,00±0,33 a (2-5)	27,80±2,13 a (1-36)	373,90±57,43 a (46-399)	92,40±0,87 a (80-92)	3,80±0,61 a (2-7)

Planococcus citri completed preadult stages at 3 different temperatures (20 ±1°C, 25 ±1°C and 30 ±1°C). *Cucurbita moschata* Duchesne was found the shortest, *Purnica granatum* was found as the longest in terms of pre-adult stages (Table 1, 2, 3). There are many studies conducted about the effects of host plant differences on the biological parameters of insects (Price et al., 1980; Kaydan et al., 2004). Similarly, host plants are one of the most important factors in terms of biological parameters of insects and some studies have been carried out about host plant-insect interactions (Gullan, 2000; Chong ve ark., 2003; Polat, 2005; Artar, 2008; Ataş ve Kaydan, 2014).

The shortest preoviposition period was detected as 5 days on *Punica granatum* at 30 °C, the longest preoviposition was recorded as 11.7 days on *Cucurbita moschata* at 20°C. The longest oviposition period was found as 18.4 days on *Punica granatum* at 20 °C, the shortest one was seen as 9.4 days on *Cucurbita moschata* at 30 °C. The longest post-oviposition period was found as 5.2 days on *Punica granatum* at 20°C, the shortest one was recorded as 1.6 days on *Cucurbita moschata* at 30°C. Polat (2005) revealed that the Preoviposition period of *P.* Citri was 6-10 days on *Kalanchoe blossfeldiana* Poelln, 7-13 days on *Syngonium podophyllum* Schott, 6-10 days on *Schefflera arboricola* (Hayata), and 5-10 days on *Nerium oleander* L. Chong et al. (2003) studied the oviposition period of *Phenacoccus madeirensis* on chrysanthemum and found 14 days at 15 °C, 12.7 days at 20 °C, and 8.4 days at 25 °C. Lema and Herren (1985) found that the oviposition period of *Phenacoccus manihoti* (Matile-Ferrero) was 37 days at 20 °C and laid 585 eggs during the oviposition period.

There were significant differences found in the number of eggs laid by female individuals on different host plants at 20 ±1°C. The lowest number of eggs was found on *Punica granatum* (117.40 eggs/female), the highest number of eggs was found on *Cucurbita moschata* (389.20 eggs/female). Similarly, Artar (2008) revealed that the number of *Pseudococcus longispinus* (Targioni Tozetti) nymphs were found higher on *Begonia Xelatior* (273.50 nymph/female), found lower on *Chrysalidocarpus lutescens* (H.Wendl.) (213.33 nymph/female). Ataş and Kaydan (2014) studied the number of *Pseudococcus comstocki*(Kuwana) eggs on different host plants and found higher laid eggs on *Morus alba* L. (138.54 eggs), and lower laid eggs on *M. Nigra*.

According to the results of this study, significant differences was found between host plants in terms of the number of eggs at 25 ±1°C. The lowest number of eggs was recorded on *Punica granatum* (105.90 eggs/female), the highest number of eggs was found on *Cucurbita moschata* (376.20

eggs/female). *Nerium oleander*, *Schefflera arboricola*, *Kalanchoe bleossfeldiana* and *Sygonium podophyllum* were studied with regards to the number of laid eggs by *Planococcus citri* and the number of eggs on *S. Arbicola* was found the lowest, the highest number of eggs was found on *S. podophyllum* (Polat, 2005).

The preadult stage was found as 21.70, 23,10, 28.20, 24.30 and 18,00 days on *C. sinensis*, *C. limon*, *Punica granatum*, *Solanum tuberosum*, *Cucurbita moschata* respectively at 30 ±1 °C. Similar situations were seen on preoviposition, oviposition and post-oviposition periods and adult longevity. Similarly, Arai (1996) studied preadult stages of *P. Cryptus* on Satsuma mandarin and found 25.3 days at 25 °C. Kim et al. (2008) found that the total development period of the nymphal stages of *Pseudococcus cryptus* Hempel was 17.4 days at 28 °C. These results and our study's results may not show similarity because of differences between temperatures and host plants.

There were significant differences seen between host plants in terms of the number of eggs at 30±1°C. The lowest number of eggs were found on *Punica granatum* (101.10 eggs/female), the highest number of eggs were found on *Cucurbita moschata* (373.90 eggs/female). Kim et al. (2008) found that *P. Cryptus* laid maximum 111 eggs at 28 °C.

According to the results of this study, the comparison between different host plants and different temperatures in terms of some biological parameters of *P. Citri* (The development of Predault stages, male/female ratio, preoviposition, oviposition and post-oviposition periods, adult longevity, and the number of laid eggs) showed that *Cucurbita moschata* was found more suitable host plant and 25°C was found more suitable temperature for the mass rearing of *P. citri* with statistical analysis during this study. The optimal development temperature of insects is generally between 25-28 °C and' %60-70 relative humidity. These results give an opinion about *P. citri* can cause damage in which stage and at which temperature.

The biology of Citrus mealybug should be known well to develop a successful control strategy against this pest. The obtained biological parameters within this study help to estimate the pest population and biological stages (I., II. and III. nymphal stages or adult) and to detect the most suitable time of control against this pest. These results may be helpful for commercial farmers. In addition, this study may be basic and contribute other studies in other studies in terms of scientific perspective. Moreover, the most suitable host plant *Cucurbita moschata* may be mass-reared in laboratory conditions and may be helpful for the control of this pest. It is known that the parasitoids of this pest cannot overwinter in Turkey conditions therefore the mass-rearing of this pest may be done on *Cucurbita moschata* and may be helpful for future laboratory and field studies.

The most suitable temperature and humidity were found at 25 °C and %65±5 respectively. Thank to this study, farmers may be warned to release biological control agents or to start chemical control for developing early warning systems when the temperature is 25 °C in field conditions. Thus, applications can be done on time and the natural balance will not be affected negatively. Öncüer (2004) showed that the control strategy may be successful, if all factors, which affects the population dynamics of pests, should be evaluated with early warning systems. In addition, an economical damage threshold should be followed, the time of this threshold may be predicted to warn farmers to develop successful control management.

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REFERENCES

1. Anonim, 2008. *Nar Hastalık ve Zararlıları,* Tarım ve Köyişleri Bakanlığı, Ankara, 32s.
2. Arai, T., 1996. Temperature-dependent developmental rate of three mealybug species, *Pseudococcuscitriculus* Green, *Planococcuscitri* (Risso), and *Planococcuskraunhiae* (Kuwana) (Homoptera: Pseudococcidae) on citrus. Japanese Journal of Applied Entomology and Zoology, 40: 25–34.
3. Artar, G., 2008. *Pseudococcuslongipinus* (Targioni-Tozzetti) (Homoptera: Pseudococidae)'un laboratuvar koşullarındafarklı süs bitkileri üzerinde bazı biyolojik özelliklerinin saptanması. Ankara Üniversitesi Fen Bilimleri Enstitüsü Bitki Koruma Anabilim Dalı, Yüksek Lisans tezi, 62s.
4. Ataş., M., ve Kaydan, B., 2014. *Pseudococcuscomstocki* (Kuwana) (Hemiptera: Pseudococcidae)'nin farklı sıcaklık koşullarında ve iki dut türü üzerinde gelişme ve üremesinin incelenmesi. Türk. entomol. derg., 38 (1): 71-81, ISSN 1010-6960 71.
5. Chong, J.H., Oetttin, R.D. and Van Iersel, M. W. 2003 Temperature effects on the development, survival and reproduction of the Madeira Mealybug, *Phenacoccusmadeirensis* (Green) (Homoptera: Pseudococcidae), on chrysanthemum. Annals of the Entomological Society of America. 96(4): 539- 543.
6. Gullan P. J. 2000. Identification of the immature instars of mealybugs (Hemiptera: Pseudococcidae) found on citrus in Australia Australian Journal of Entomology 39 (3), 160–166.
7. Kaydan, M.B., Ülgentürk, S., Zeki, C.andToros, S. 2004. Studies on Pseudococcidae (Homoptera:Coccoidea) fauna of Afyon, Ankara, BurdurandIsparta Provinces, Turkey. Turk. J. Zool. 28:219-224.
8. Kim S. C., J. H. Song and D. S. Kim, 2008. Effect of temperature on the development and fecundity of the cryptic mealybug, *Pseudococcuscryptus*, in the laboratory. Journal of Asia-Pacific Entomology, 11: 149–153.
9. Lema,K. M., andHerren,H. R., 2005. The influence of constant temperature on population growth rates of the cassava mealybug, *Phenacoccusmanihoti*.EntomologiaExperimentalis et Applicata, 38(2): 165-169.
10. Öncüer, C. 2004. Tarımsal Zararlılarla Savaş Yöntemleri ve İlaçlar. Adnan Menderes Üniversitesi Yayınları No. 19, 5. baskı, 424 s.
11. Polat, F., 2005. *Planococcuscitri* (Risso) (Homoptera: Pseudococcıdae)'nin farklı saksılı süs bitkilerinde bazı biyolojik özelliklerinin araştırılması. Ankara Üniversitesi Fen Bilimleri Enstitüsü Bitki Koruma Anabilim Dalı, Yüksek Lisans tezi, 100 s.
12. Price, P. W., C.E. Bouton, P. gross, B. A. McPheron, J. N. Thompson and A. E. Weis. 1980. Interactions among three trophic levels: influence of plant interactions between insect herbivores and naturel enemies. Ann. Rev. Ecol. Syst., 11: 41-65.
13. Satar, S., and Karacaoğlu, M.,2017. Bioecological characteristics of *Planococcuscitri*Risso, 1813 (Hemiptera: Pseudococcidae) under constant and alternating temperatures. Turkish Journal of Entomology, 41 (2), 147-157.
14. Satar, G., F. H. Ateşand S. Satar, 2013. Effects of different insecticides on life stages of *Planococcuscitri*Risso (Hemiptera: Pseudococcidae). IOBC-WPRS Bulletin 95: 183-190.
15. Uygun, N., Ulusoy, M.R., Karaca, İ., ve Satar, S., 2010. Meyve ve Bağ Zararlıları, Özyurt Matbaacılık, Ankara, 347s.