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Determination of Biology and Prey Preference of the Predator Insect, *Xylocoris flavipes* (Reuter) (Heteroptera: Anthocoridae) Against Storage Pests

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ABSTRACT

This study was carried out to determine the biology of *Xylocoris flavipes* Reuter (Heteroptera: Anthocoridae), an important predator of stored product pests, and its prey preference on some warehouse pests. The study was conducted under laboratory conditions at 25±2ºC temperature and 55±10% humidity. *Ephestia kuehniella* Zeller (Lepidoptera: Pyralidae) eggs were used to determine the biology of *X. flavipes*. *E. kuehniella*, *Tribolium confusum* Jacquelin du Val (Coleoptera: Tenebrionidae), and *Trogoderma granarium* Everts (Coleoptera: Dermestidae) larvae were utilized to detect the prey preferences of *X. flavipes*. The mean development time (days) of five nymphs, female and male adults of *Xylocoris flavipes* on *E. kuehniella* eggs were as follows: 4.2±0.63; 3.1±0.57; 2.9±0.57; 3.0±0.00; 4.5±0.53; 104.2±17.01; 114.6±12.34, respectively. The average egg consumption for the aforementioned stages was: 5.0±1.76; 9.9±3.07; 9.1±6.01; 13.3±4.14; 22.5±4.79; 515.6±75.46; 286.2±24.39, respectively. Although mature male *X. flavipes* survived longer than females, females consumed more *E. kuehniella* eggs than males. The mean oviposition period of the females was 36.7±12.39 days, and the average laid egg number was 117.3±29.86. The consumed *E. kuehniella* eggs and larvae, *T. confusum*, and *T. granarium* larvae during the predator nymph period were on average 63.1±6.01; 49.6±2.76; 26.8±3,52; 12.8±4.29, respectively. The average development time (days) of the nymphs for the aforementioned consumption stages were 16.4±1.96; 15.4±0.52; 16.2±1.14; and 21.6±4.62, respectively. The consumed *E. kuehniella* eggs and larvae, *T. confusum*, and *T. granarium* larvae during the predator adult period were on average 570±231.32; 249.5±142.10; 218.1±110.57; 22.2±6.23, respectively. The average development time (days) of the adults for the aforementioned consumption stages were 87.5±30.92; 75.9±41.18; 89.3±43.55; and 24.5±7.18 days, respectively. *X. flavipes* preferred mostly *E. kuehniella* eggs among the preys during the nymph and adult stages, and least *T. granarium* larvae.

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Depo Zararlılarına Karşı Predatör Böcek, *Xylocoris flavipes* (Reuter) (Heteroptera: Anthocoridae)'in Biyolojisi ve Av Tercihinin Belirlenmesi

ÖZET

Bu çalışma, depolanmış ürün zararlılarının önemli bir predatörü olan *Xylocoris flavipes* Reuter (Heteroptera: Anthocoridae)' nin biyolojisi ve bazı depo zararlıları üzerindeki av tercihini belirlemek amacıyla yürütülmüştür. Çalışma 25±2ºC sıcaklık, %55±10 neme ayarlı laboratuvar koşullarında yapılmıştır. *Xylocoris flavipes*'in biyolojisinin belirlenmesinde *Ephestia kuehniella* Zeller (Lepidoptera: Pyralidae) yumurtaları, av tercihinde ise *E. kuehniella*, *Tribolium confusum* Jacquelin du Val (Coleoptera: Tenebrionidae) ve *Trogoderma granarium* Everts (Coleoptera: Dermestidae) larvaları kullanılmıştır Çalışma sonucunda, *X. flavipes*'in ergin dişi, erkek ve beş nimf döneminin *E. kuehniella* yumurtalarında ortalama gelişme süreleri sırasıyla

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104.2±17.01; 114.6±12.34; 4.2±0.63; 3.1±0.57; 2.9±0.57; 3.0±0,00; 4.5±0.53 gün, ortalama tükettikleri yumurta sayıları sırasıyla 515.6±75.46; 286.2±24.39; 5.0±1.76; 9.9±3.07; 9.1±6.01; 13.3±4.14; 22.5±4.79 adet bulunmuştur. Erkek *X. flavipes* bireyleri dişilerden daha uzun süre hayatta kalmıştır ve dişiler erkek bireylerden daha fazla *E. kuehniella* yumurtası tüketmişlerdir. Dişi bireyin ortalama ovipozisyon süresi 36.7±12.39 gün, bıraktığı ortalama yumurta sayısı ise 117.3±29.86 adet olarak belirlenmiştir. Nimf döneminde depo zararlılarından *E. kuehniella* yumurta, birinci ve ikinci dönem larvası, *T. confusum*, *T. granarium* birinci ve ikinci dönem larvalarından sırasıyla ortalama 63.1±6.01; 49.6±2.76; 26.8±3.52; 12.8±4.29 adet olarak ortalama sırasıyla 16.4±1.96; 15.4±0.52; 16.2±1.14; 21.6±4.62 günde; ergin döneminde ise 570±231.32; 249.5±142.10; 218.1±110.57; 22.2±6.23 adet şeklinde sırasıyla 87.5±30.92; 75.9±41.18; 89.3±43.55; 24.5±7.18 günde tüketmiştir. *Xylocoris flavipes* nimf ve ergin dönemlerinde avlarından en fazla *E. kuehniella* yumurtası, en az *T. granarium* 1. ve 2. dönem larvalarını tercih etmiştir.

Biyoloji
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INTRODUCTION

Pests, rodents, and microorganisms cause about 10%quantitative and qualitative loss in stored products (Prevett, 1975). The geography and climate conditions of Türkiye are favorable for pest development. The pests are especially deleterious for stored products in the Southern parts of Türkiye (Ferizli & Emekçi, 2010). Pest residues as body parts and various secretions deteriorate crop quality. High pest contamination density in stored commodities accelerates processes such as molding, heat, and fermentation. Consumption of pest-containing commodities also leads to potential health risks. The general approaches to get rid of the pests are crop destruction or pesticide application. Pest management in stored products encounters many limitations including restrictions on many pesticides worldwide and progress of insecticide resistance in pest populations. Therefore, environment-friendly sustainable approaches are required (Bell et al., 1996). Many parasitoids and predators are used for biological control in Integrated Pest Management (IPM) systems (Schöller & Flinn, 2000; Schöller et al., 2006). Insect natural enemies could be a potential solution for the biological control of pests (Haines, 1984; Brower et al., 1995; Hokkanen et al., 1995; Zettler &Arthur, 2000). There are 22 predator and parasitoid species known in storage ecosystems. *Xylocoris flavipes* (Reuter) (Hemiptera: Anthocoridae) is a predator of many stored crop pests. This bug is commercially produced and sold for biological control in crop storage in North America (Mason & Huber, 2001; Taro et al., 2008). The presence of predator mites has been detected in vegetable fields in our country (Kaymak et al., 2023). Similar studies exist. However, the predator *X. flavipes* was not detected in warehouses and was not used. The potential of the biological agent *X. flavipes* as a predator of stored product pests was first evaluated by Jay et al. (1968). Ballal et al. (2013) noted that *X. flavipes* are an important predator of stored product pests. *X. flavipes* is a predator bug of many storage pests and has the potential for use in biological control programs. Because *X. flavipes* is able to regulate populations of stored-product pests, this study concentrates on the investigation and incorporation of this valuable predator as a biological control agent in Türkiye. This study was carried out to determine the biology of *X. flavipes*, an important predator of stored product pests, and its prey preference on some crop storage pests.

MATERIALS AND METHODS

Ephestia kuehniella Zeller (Lepidoptera: Pyralidae), Jacquelin du Val (Coleoptera: Tenebrionidae), *Trogoderma granarium* Everts (Coleoptera: Dermestidae) crop storage pests and *X. flavipes* predator were cultured and produced in Iğdır University, Faculty of Agriculture, Department of Plant Protection, Entomology laboratory. In the study, 5 lt plastic containers, (9 × 1.5 cm) of petri dishes, 25 ml glass bottles with cork stoppers, filter paper, gauze, rubber, flour, wheat, bulgur, rice, incubator, soft tip brush, plastic tube, binocular stereo microscope were used. The study was conducted under laboratory conditions at 25±2°C temperature and 55±10% humidity.

Definition of *Xylocoris flavipes* Biology on *Ephestia kuehniella* Eggs

Same day eggs of *X. flavipes* were laid in petri dishes containing blue cardboard paper on the bottom. In the study, 10 petri dishes each with 10 predator eggs were used. Egg hatching was tracked, and *X. flavipes* first instar nymphs were released after egg hatching. The instars were fed with daily laid eggs of *E. kuehniella*. 20 eggs per petri dish adhered to the cardboard strips using water and a soft-tipped brush. Cardboard strips were checked every 24 hours, and the number of consumed eggs was recorded and replaced with new ones. This process continued until *X. flavipes* matured and died. Average egg consumption and days of life stages for *X. flavipes*1st, 2nd, 3rd, 4th, and 5th instar nymph, as well as adults, were determined (Table 1).

Table 1. Average life period (in days) of nymphs and adults of *Xylocoris flavipes* and number of consumed Ephestia kuehniella eggs

Çizelge 1. Xylocoris flavipes'in nimf ve ergin dönemlerinin süresi ve bu dönemlerde tükettikleri Ephestia kuehniella yumurta sayıları

Biological Stages of *Xylocoris flavipes*	Average life cycle Days±SD (Min.-Max.)	Average consumed *Ephestia kuehniella* Eggs±SD (Min.-Max.)	P
1. Nymph	4.2±0.63 (3-5)	5.0±1.76 (2-7)	<0.001
2. Nymph	3.1±0.57 (2-4)	9.9±3.07 (5-15)	0.383
3. Nymph	2.9±0.57 (2-4)	9.1±6.01 (0-19)	<0.001
4. Nymph	3.0±0.00 (3-3)	13.3±4.14 (7-21)	<0.001
5. Nymph	4.5±0.53 (4-5)	22.5±4.79 (17-30)	<0.001
Total	17.7 (14-21)	59.8 (31-92)	
Female adult	104.2±17.01 (76-122)	515.6±75.46 (427-629)	<0.001
Male adult	114.6±12.34 (100-131)	286.2±24.39 (259-319)	<0.001

The abdomen of females has a longitudinal symmetrical elongated appearance on both sides and in the males, there is a left offset and ventral notch on the left side of the 8th and 9th segments. Adults of *X. flavipes* is dark brown to black with rostrum 3 and antennas 4 segmented. Female adults have long symmetrical abdomens from the laterals, and the abdomen of the male adult is tilted to the left (Fig. 1g, h)

Detection of Xylocoris flavipes Preoviposition, Oviposition, and Postoviposition Times on *Ephestia kuehniella* Eggs

X. flavipes adults were placed in pairs (1♀, 1♂) in one petri dish containing blue cardboard on the base and the experiment was conducted with 10 replications. The adults were fed with *E. kuehniella* eggs adhered to the cardboard strips using water and a soft-tipped brush. The period until the first egg lay of the female adult was recorded as preoviposition. The Petri dishes were checked every 24 hours, and the number of eggs laid by *X. flavipes* was recorded and placed in other petri dishes. This process continued until female adults stop laying eggs and this period was recorded as oviposition. The days between oviposition (stop laying eggs) and death of *X. flavipes* female was recorded as postoviposition.

Consumption of *Ephestia kuehniella* Eggs and Larvae, and Larvae of Tribolium confusum and *Trogoderma granarium* by Pre-mature and Adult Stages of *Xylocoris flavipes*

1st and 2nd instar nymph and one adult of *X. flavipes* were placed separately in a petri dish with filter paper on the bottom and the experiment was conducted with 10 replications. 20 eggs of *E. kuehniella* per petri dish were adhered to the cardboard strips using water and a soft-tipped brush. Every 24 hours, the number of consumed *E. kuehniella* eggs was recorded and new cardboard strips were added. This process continued until nymphs of *X. flavipes* matured and their adults died. Likewise, one nymph and one adult of *X. flavipes* were placed separately per 25 ml bottles with cork stoppers, and 10 bottles per nymph and adult were used. 20 first and second-stage larvae of *E. kuehniella* were added to each bottle. Consumed *E. kuehniella* larvae at intervals of five days were counted and replaced with new ones. This process continued until the predator nymphs matured and the adults died. Flour was added to the bottles to feed *E. kuehniella* larvae. The method applied for the consumption of *E. kuehniella* larvae was also applied for the consumption of *T. confusum* and *T. granarium* larvae. The production of *Tribolium confusum* pest was carried out by considering the work of Gökçe et al. (2021).

Statistical Analysis

Descriptive statistics were determined for the average egg consumption (number) and lifespan (days) of the nymph and adult periods. However, the width and length data of the nymph, adult, and egg periods; days of preoviposition, oviposition, and postoviposition and the number of eggs laid; Mean, standard error, and minimum-maximum values were calculated for the larvae and eggs (number) consumed and the time (day) data consumed in the prey preferences of adults and nymphs. Shapiro and Levene tests were applied to the above-mentioned data and the normal distribution and constant variance assumptions of the data were examined. One-way analysis of Variance (ANOVA) followed by the Tukey test was applied to the data providing the hypotheses and pairwise group comparisons were made. Since the data on the number of harmful larvae consumed by adults did not meet the assumptions of normal distribution and constant variance, it was subjected to the Kruskal-Wallis test, which is a non-parametric method, and then Dunn's test for pairwise group comparisons. The experiments were conducted with 10 replications.

Figure 1. *Eggs of Xylocoris* flavipes (a), 1st nymph (b), 2nd nymph (c), 3rd nymph (d), 4th nymph (e), 5th nymph (f), adult male (g) and adult female (h)

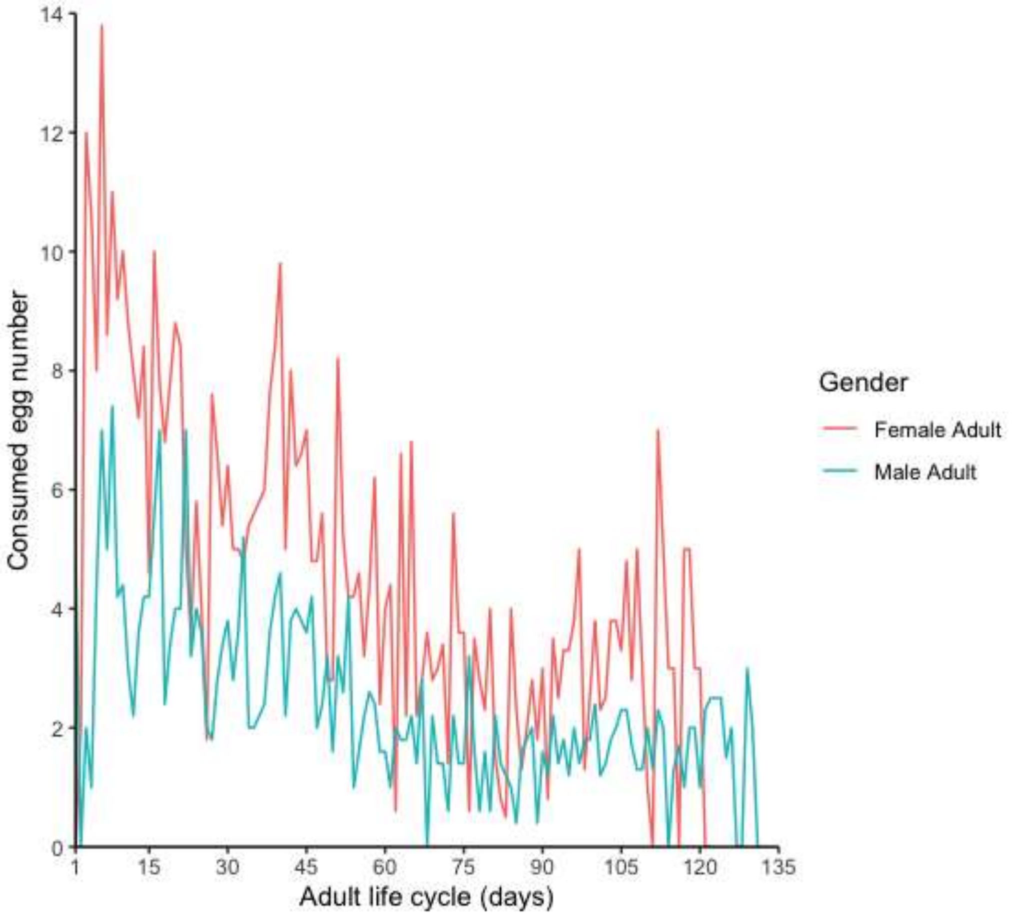
Şekil 1. Xylocoris flavipes'in yumurtası (a), 1. nimf (b), 2. nimf (c), 3. nimf (d), 4. nimf (e), 5. nimf (f), ergin erkek (g) ve ergin dişi (h)

RESULTS AND DISCUSSION

Definition of *Xylocoris flavipes* and Biology on *Ephestia kuehniella* Eggs

Eggs of *X. flavipes* is cylindrical (ellipsoid) with a white-yellowish transparent cover on one side, turning to orange when the nymph exits approaches, as well as with reddish eyes and scent glands (Fig. 1a). Egg hatching time was estimated average as 5.2±0.42 days. 1st Stage nymphs are generally light orange with red eyes and visible scent glands with transparent antennae, rostrum, and legs (Fig. 1b). The development time of the 1st stage nymph was estimated to average 4.2±0.63 days (Table 1). The 2nd stage nymph has similar characteristics to the 1st stage nymph but with more prominent scent glands (Fig. 1c) and an average development time of 3.1±0.57 days (Table 1). The 3rd stage nymph has a darker color than the 2nd stage nymph (Fig. 1d) with a development time of average 2.9±0.57 days. The 4th stage nymph has a dark orange, brown color (Fig. 1e) with development time of average 3.0±0.00 days (Table 1). The 5th stage nymph looks like the adult with light brown color (Fig 1f) and development time of average 4.5±0.53 days (Table 1). The 5th stage nymph consumed the highest number of *E. kuehniella* eggs and the 1st stage nymph the lowest as illustrated in

Table 1. Figure 2 shows that the egg consumption *of X. flavipes* was highest in the 5th nymphal stage (peaking on day 4 with an average of 9 eggs) and lowest in the 1st nymphal stage. The life cycle for female adult was average 104.2±17.01 days, and 114.6±12.34 days for the male (Table 1).The consumed *E. kuehniella* eggs for female adult was average 515.6±75.46 eggs, and 286.2±24.39 eggs for the male as seen in Table 1. It was determined that *X. flavipes* adult females consumed more *E. kuehniella* eggs than males (Figure 3).



Şekil 2. *Xylocoris flavipes*'in nimf dönemlerinin gelişme süreleri ve tükettikleri *Ephestia kuehniella* yumurta sayıları arasındaki ilişkiyi gösteren çizgi grafiği

Figure 2. Line graph showing the relationship between development time of Xylocoris flavipes nymph stages and consumed Ephestia kuehniella eggs.

The female adult's highest egg consumption was during day 6th with an average of 14 eggs, and the male adult's highest egg consumption was during day 8th with an average of 7 eggs. Arbogast et al. (1971) and Awadallah and Tawfik (1972a) reported that adults of X*. flavipes* are bright brown to dark in color and about 2 mm tall. Additionally, gender detection is most easily made from the abdomen. Lokanath (2012a) reported that the average development times of the *X. flavipes* nymph stages using *C. cephalonica* eggs under laboratory conditions were 3.2±1.30; 2.8±0.84; 2.8±0.86; 3.2±0.84; 3.6±0.65. These results are consistent with our findings. However, the life cycle was reported to be 22.4±1.42 days for the female adult, and 24.4±1.80 days for the male adult. These results are much lower than our findings (Table 1). The males lived longer than the females which was consistent with our results. Parajulee et al. (1994), Rahman et al. (2009) determined in their research that females of the biological agent consumed more prey than male hunters. Russo (2004) reported 24.4 days and Awadallah and Tawfik (1972b) stated 21.7 days life period for the adults. These findings are lower than our results (Table 1).

Detection of *Xylocoris flavipes* Preoviposition, Oviposition and Postoviposition Times on *Ephestia kuehniella* Eggs

Xylocoris flavipes laid eggs randomly about 4.9±1.37 days after mating (Table 2). The preoviposition, oviposition and post-oviposition times of the predator were examined on 10 female adults and the mean preoviposition time was on average 4.9±1.37 days. The oviposition and post-oviposition times were about 36.7±12.39 and 1.1±0.99 days, respectively (Table 2).

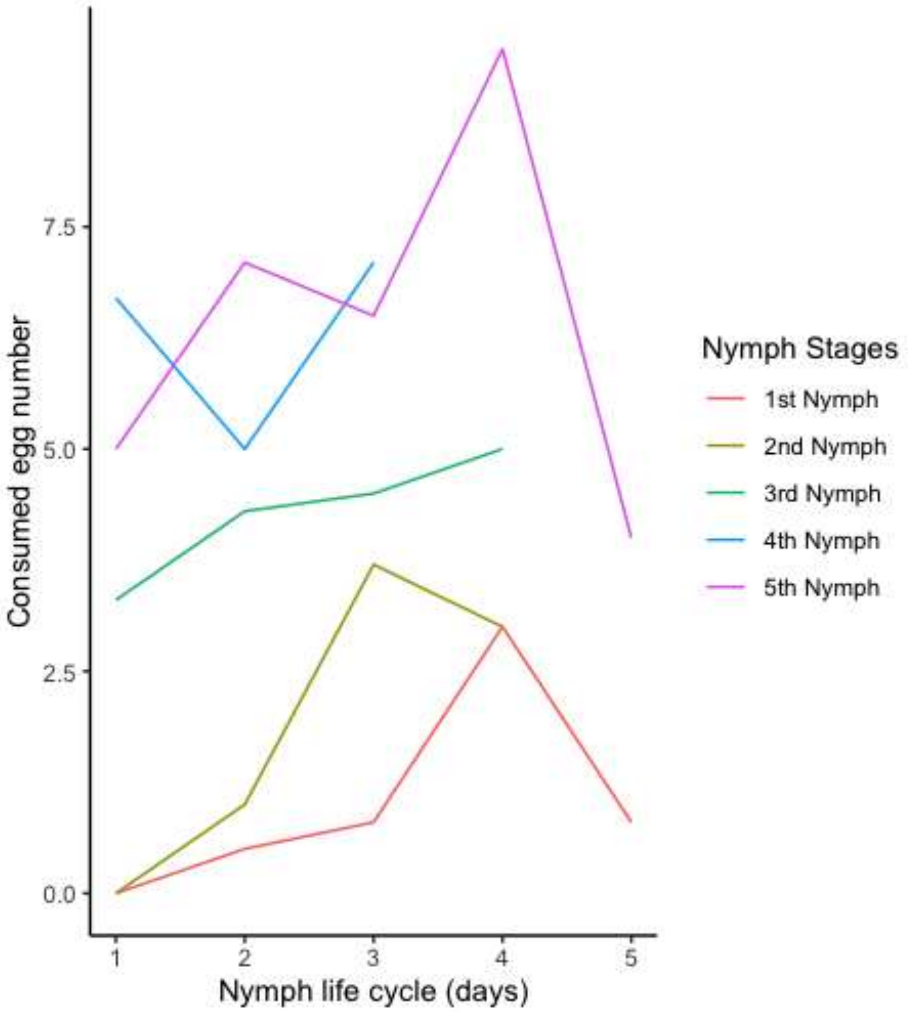


Figure 3. The relationship between development time of female and male adult of Xylocoris flavipes and number of *Ephestia kuehniella* eggs they consume

Şekil 3. Xylocoris flavipes'in ergin erkek ve dişi dönemlerinin gelişme süreleri ve tükettikleri Ephestia kuehniella yumurta sayıları arasındaki ilişki

Table 2. Average preoviposition, oviposition and postoviposition development times and laid eggs by *Xylocoris flavipes*

Çizelge 2. Xylocoris flavipes'in preovipozisyon, ovipozisyon, postovipozisyon dönemlerinin ortalama gelişme süreleri ve bırakılan ortalama yumurta sayısı

Stage	AverageDays±SD (Min.-Max.)	AverageEggs±SD (Min.-Max.)
Preoviposition	4.9±1.37 (3-8)	0.0±0.00 (0-0)
Oviposition	36.7±12.39 (20-62)	117.3±29.86 (73-175)
Postoviposition	1.1±0.99 (0-3)	0.0±0.00 (0-0)

The average number of eggs laid by the female adult during oviposition was 117.3±29.86 with minimum egg number of 73 and maximum 175 eggs per female (Table 2). It was found that there was a positive linear relationship (r=0.85) between the number of eggs laid by *X. flavipes* females and the consumption of *E. kuehniella* eggs, and as the number of eggs laid by predator females increased, the consumption of *E. kuehniella* eggs also increased (Figure 4).

Lokanath (2012b) reported that under laboratory conditions using *Corcyra cephalonica* (Stainton) eggs, female adults of *X. flavipes* laid 24-32 eggs during the oviposition period lasting for 23-28 days. Rahman (2004) found that the average total highest egg numbers produced by female *X. flavipes* when fed with *Tribolium castaneum* (Herbst) and *T. confusum*

(Jacquelin du val) were 98.65±1.81, 97.05±1.73, respectively. Arbogast (1975) stated about 30 eggs for 29 days; Awadallah and Tawfik (1972c) found about 41.6 eggs for 17.5 days; Rahman (2007) reported on average 27.27±2.52 eggs during oviposition.

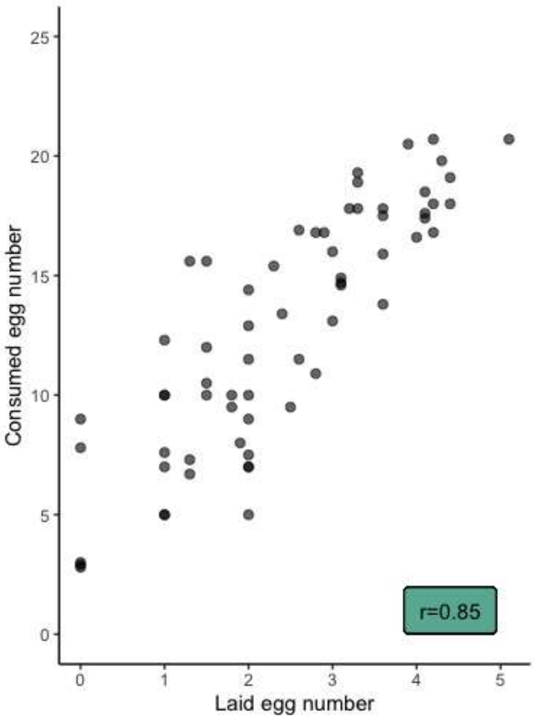


Figure 4. The relationship between X. flavipes female adult laid eggs and consumption of *E. kuehniella* eggs.

Şekil 4. Xylocoris flavipes'in ergin dişisinin ovipozisyon döneminde tükettiği Ephestia kuehniella yumurta sayısı ile yumurtladığı yumurta sayısı arasındaki ilişki

Consumption of *Ephestia kuehniella* Eggs and Larvae, and Larvae of *Tribolium confusum* and Trogoderma granarium by Pre-mature and Adult Stages of *Xylocoris flavipes*

It was determined that *X. flavipes* nymphs consumed about 63.1±6.01 *E. kuehniella* eggs, and the adults consumed 570±231,32 eggs (Table 3). Mean development times for nymph and adults of *X. flavipes* during *E. kuehniella* egg consumption are 16.4±1.96; 87.5±30.92, respectively. The average consumed *E. kuehniella* larvae was 49.6±2.76 for nymphs, and 249.5±142.10 for adults of *X. flavipes* with an average development time of 15.4±0.52 days, 75.9±41.18 days, respectively. The average consumed *T. confusum* larvae was 26.8±3.52 for nymphs, and 218.1±110.57 for adults of *X. flavipes* with an average development time of 16.2±1.14 days,89.3±43.55 days, respectively. The average consumed *T. granarium* larvae was 12.8±4.29 for nymphs, and 22.2±6.23 for adults of *X. flavipes* with an average development time of 21.6±4.62 days, 24.5±7.18 days, respectively (Table 3). As shown in Figure 5, *X. flavipes* nymphs consumed the most *E. kuehniella* larvae and the least *T. granarium* larvae. Similarly, *X. flavipes* adults consumed most *E. kuehniella* larvae and the least *T. granarium* larvae (Figure 6).

X. flavipes nymph and adults preferred most *E. kuehniella* eggs and least *T. granarium* larvae. *E.kuehniella* eggs were consumed more because of their small size, and *T. granarium* larvae were preferred less because they were extremely hairy. LeCato and Collins (1976) looked at the maximum number of prey that a predator could consume in a lifetime. They used *T. castaneum* as the prey species and determined that X. flavipes could consume an average of 539 eggs, 34 larvae, or 14 pupae in a laboratory environment. Schöller and Prozell (2011) reported that the predator *X. flavipes* could suppress *T. confusum* in small amounts or a thin layer of flour.

Çizelge 3. *Xylocoris flavipes*'in nimf ve ergin dönemlerinin ortalama gün ve bu dönemlerde tükettikleri depo zararlıları ortalama av miktarları

Table 3. Average development times and pray consumption for nymph and adults of Xylocoris flavipes

		Xylocoris flavipes nymph		*Xylocoris flavipes* adult	
Type of prey	Period of hunt	Average Consumption ±SD (Min.-Max. Piece)	Average Day ±SD (Min.-Max.)	Average Consumption ±SD (Min.-Max. Piece)	Average Day ±SD (Min.-Max.)
Ephestiakuehniella	Egg	63.1±6.01 (55-76)	16.4±1.96 (14-20)	570±231.32 (289-895)	87.5±30.92 (55-135)
Ephestiakuehniella	Larvae	49.6±2.76 (44-53)	15.4±0.52 (15-16)	249.5±142.10 (36-421)	75.9±41.18 (10-126)
Triboliumconfusum	Larvae	26.8±3.52 (22-32)	16.2±1.14 (15-18)	218.1±110.57 (50-381)	89.3±43.55 (30-145)
Trogodermagranarium	Larvae	12.8±4.29 (8-20)	21.6±4.62 (17-28)	22.2±6.23 (15-31)	24.5±7.18 (12-37)

The reason for the higher egg consumption compared to larvae could be the smaller size and immobility of the eggs. LeCato and Davis (1973) found that *X. flavipes* preferred certain pest species and stages to others probably due to pest size and sclerotization stage. It was detected that prey size was the most important factor affecting early and late-stage larvae consumption of *T. castaneum*, *Oryzaephilus* *surinamensis* Linnaeus, *P. interpunctella* Hübner and *Lasioderma serricorne* Fabricius. Early-stage larvae were more consumed than late stage. *L. serricorne* larva is small but hairy and sticky. Consequently, the preference for small-sized prey was confirmed.

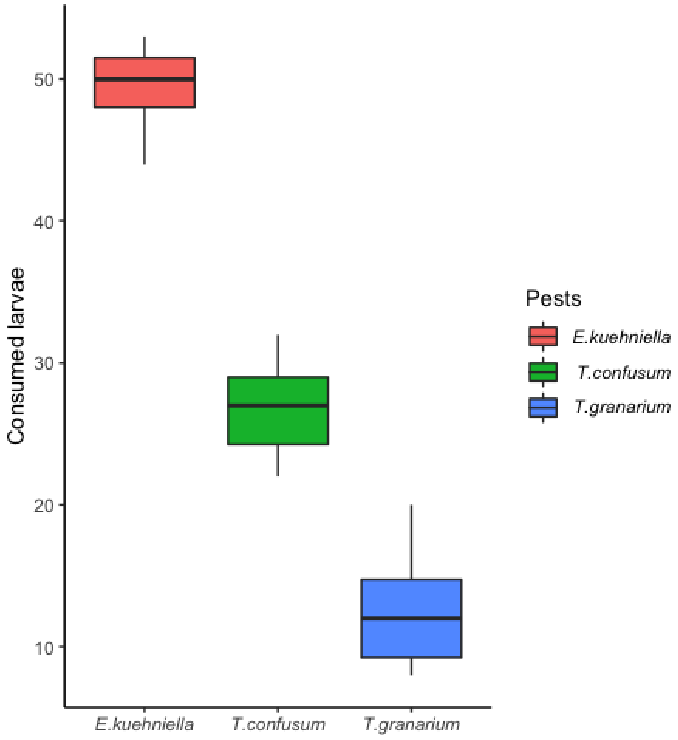


Figure 5. Boxplot showing the number of consumed larvae of *Ephestia kuehniella*, *Tribolium confusum* and *Trogoderma granarium* by *Xylocoris flavipes* nymps.

Şekil 5. Xylocoris flavipes nimf döneminin kutu diyagramına göre tükettiği Ephestia kuehniella, Tribolium confusum and Trogoderma granarium larva sayısı

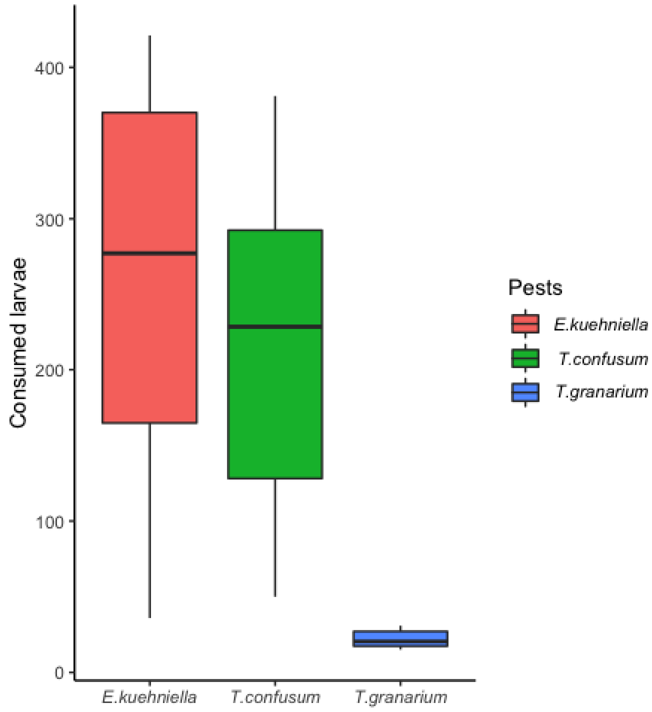


Figure 6. Boxplot showing the average consumed larvae of *Ephestia kuehniella*, *Tribolium confusum* and *Trogoderma granarium* by *Xylocoris flavipes* adults.

Şekil 6. *Xylocoris flavipes ergin döneminin kutu diyagramına göre tükettiği Ephestia kuehniella, Tribolium confusum and Trogoderma granarium larva sayısı*

CONCLUSIONS

Insect damage is one of the biggest problems facing managers of stored grain ecosystems worldwide. In the study, it was seen that one of the biological agents that can reduce insect damage with biological control, which is one of the integrated control methods, is the predator *X. flavipes*. *X. flavipes* preferred the most *E. kuehniella* eggs and the least *T. granarium* larvae as prey in adult and nymph stages. *E. kuehniella* eggs were consumed more as prey because they were smaller, and *T. granarium* larvae were less preferred because they contained excessive hair. The mean number of *E. kuehniella* eggs (63.1±6.01; 570±231.32) consumed in *X. flavipes* nymph and adult stages found too much is higher than the number of larvae (49.6±2.76; 249.5±142.10). It is thought that the prey is smaller and immobile because the predator consumes more eggs than the larva. In this study, it was concluded that the *X. flavipes* predatör would be succesful in suppressing harmful insect populations of stored products. It also reveals that mass culture of *X. flavipes* can be established on *E. kuehniella* eggs in the laboratory for easy and abundant supply of the insect as a biological control agent. When the producers interviewed within the scope of research were asked to state the reasons for using the biological control method in combating pests in order of importance, their first two choices were, respectively, "Because I care about human health" and "To avoid polluting the natural environment"(Sayın et al., 2020). Support for biological control should be increased for human and environmental health.

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Authors' contributions

The authors contributed equally to the article. All authors read and approved the final manuscript.

Conflict of Interest Statement

The authors of the article declare that there is no conflict of interest between them.

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