



Research article

The Effect of Plant Host Type on the Life History of the Painted Bug *Bagrada hilaris* (Burmeister) in the Laboratory

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ABSTRACT

The painted bug, *Bagrada hilaris* is a major pest of cruciferous crops in Iraq and worldwide, causing significant economic losses as both nymphs and adults feed on plant sap. The objective of this study was to investigate the effect of the host plant species on which the insect was reared on the growth and development of its life stages and on the life history traits of the adults. The results showed that the insect has five nymphal instars, and the study also demonstrated the effect of crop type on the duration of the nymphal instars and the total duration of the nymphal period, with shorter durations observed on radish and rapeseed crops 29.75 and 30.44 days, respectively, while the durations were 36.19 and 40.33 days on cabbage and cauliflower crops, respectively. The survival rate of the nymphal stage was also affected by the host plant type, with the highest rate observed on radish at 91.67%, while the lowest survival rate was recorded on cabbage and cauliflower at 50.00 % on both crops. The results also showed that the host plant type influenced the number of eggs laid by adult insects, with 169.00 eggs/female on radish, while adults laid 157.67 eggs/female on cauliflower. We conclude from this study that radish and rapeseeds crops are preferred by the insect due to their rapid growth and development and high survival rates compared to the cabbage and cauliflower crops.

1. Introduction

Crops belonging to the Brassicaceae family are of significant economic importance; the family is so named because the flowers are shaped like a cross. The Brassicaceae family comprises around 3,700 species and 388 genera (Ishida et al., 2014). The Brassicaceae family includes many crops such as cabbage, kale, cauliflower, radish and others. These crops are of significant health importance as they are characterised by their content of biologically active compounds such as vitamins—including tocopherol, phyloquinone and vitamin C—as well as glucosinolates, carotenoids, minerals, phenols, amino acids, lipids, carbohydrates, proteins, antioxidant enzymes and sulphur, all of which are important for maintaining human health as they help prevent many chronic diseases such as heart disease and cancer (Zhang et al., 2025; Aires, 2015; Manchali et al., 2012) .

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Crops of the Brassicaceae family are affected by numerous plant pathogens and insect pests that cause significant economic losses. One of the most important of these pests is the painted bug *Bagrada hilaris*, which infests all above-ground parts of the plant including leaves, stems, shoots and fruits. It infests plants from the onset of growth and the emergence of the first two true leaves right through to maturity, causing deformities and desiccation that lead to the death of the affected parts in severe cases. Symptoms of infestation take the form of circular or star-shaped spots of a pale yellow colour. The painted bug can also infect other crops from families other than the Brassicaceae, such as maize, beans, wheat and basil (Albornoz et al., 2024; EFSA, 2022; Palumbo et al., 2016) .

A study of the life cycle of the painted bug, *Bagrada hilaris* on crops of the Brassicaceae family is of great importance in understanding the characteristics of the insect's development and growth, from the egg stage through the various instars of the nymphal stage to the adult stage, as well as determining the survival rates at different life stages, fertility, the lifespan of males and females, and the number of eggs laid per female. This helps to understand the insect's reproductive potential and the number of generations it produces per year. Environmental conditions also play a significant role in the insect's development; the most important of these are temperature and relative humidity (Paolini et al., 2025; Al-Jboori and Al-Jassani, 2003; Al-Youssef and Al-Masoudi, 2012). The aim of this study is to identify the plant host suitable for the growth and development of the painted bug *Bagrada hilaris* by determining the survival rates, fertility, and duration of development and growth for each life stage of the insect in the laboratory.

2. Materials and Methods

2.1 Source and identification of the insect

Nymphs and adults of the painted bug, *Bagrada hilaris* were collected for laboratory study from an experimental field planted with four crops of the Brassicaceae family (rapeseed, cabbage, cauliflower and radish) at the Faculty of Agriculture, Wasit University, and from some bushes adjacent to this field. They were collected along with the plant leaves on which they were found in plastic containers and transported directly to the Entomology Laboratory at the Faculty of Agriculture, Wasit University, to study the insect's life cycle. other specimens of adult insects were placed in small glass vials measuring (1.4 × 10) cm containing 70 per cent alcohol; the vials were sealed with tight-fitting plastic stoppers and sent to the Natural History Museum at the University of Baghdad for the purpose of confirming the identification .

2.2 Laboratory rearing and maintenance of the insect

The nymphs and adults of the insect, which had been collected from the field mentioned in the previous paragraph, were placed inside four glass cages measuring 40 × 40 × 30 cm. Inside each of the four cages, one of the following plants (cabbage, cauliflower, rapeseed and radish) planted in small plastic pots for the nymphs and adults to feed on. After mating, the adults lay their eggs on the plants or in the soil within the pots. The glass cages were covered at the top with organza fabric secured with elastic bands to prevent the insects from escaping .

2.3 Study of the insect's life cycle:

The life cycle of the painted bug, *Bagrada hilaris* was studied in the laboratory at a temperature of $25^{\circ}\text{C} \pm 2$ and a relative humidity of $70\% \pm 5$ on four plants from the Brassicaceae family (radish, rapeseed, cabbage and cauliflower), using a growth chamber (GEIO TECH, of Korean origin, model GC-300 TLH), with a light cycle of 14 hours light: 10 hours dark, and a light intensity of 4,000 lux. A digital thermo-hygrometer (Anymetre model JR913) was placed inside the growth chamber to ensure that the temperature and relative humidity remained stable.

After collecting the eggs from the aforementioned rearing cages, the eggs were transferred using a brush with fine, soft bristles to 10 cm diameter glass Petri dishes containing filter paper slightly moistened with distilled water to maintain humidity, with 50 eggs per dish and three replicates for each of the four treatments. The eggs taken from each of the four crops (cabbage, cauliflower, rapeseed and radish) constituted one treatment. The trays were placed in the growth chamber mentioned previously, under the established conditions of temperature, relative humidity, and the duration and intensity of light as described above. The eggs were monitored and examined daily under a light microscope (Kruss model, German-made) to record the hatching date as soon as it was observed .

After the eggs had hatched, two nymphs were transferred into a lantern-shaped bottle 17 cm tall, with a lower opening 8.5 cm in diameter and an upper opening 6.5 cm in diameter, using a brush with soft, fine bristles. The lantern-shaped bottle was placed on a small plastic pot containing one of the plants from the cruciferous family under study, as mentioned previously. The top opening of the bottle was covered with an organza cloth to allow ventilation, and secured it with a rubber band to prevent the nymphs from escaping. In this experiment, three replicates were used for each of the four crops; each replicate comprised four experimental units, with each experimental unit containing two nymphs of one of the crops under study. The nymphal life stages and survival rates were monitored, and the nymphal instars were determined by observing moulted skins and changes in colour, shape and size between each nymphal stage .

Once the nymphs had fully developed into adults, each pair (male and female) of the newly emerged adult insects was transferred to the lantern-shaped bottle mentioned earlier – the one used for rearing the nymphs— and the lantern bottle was placed on a small plastic pot containing a plant from one of the studied cruciferous crops. A piece of black muslin was placed on the soil and around the plant to cover the soil surface inside the pot, in order to prevent egg-laying on the soil and ensure easy retrieval of the eggs, the upper opening has been covered the top opening of the bottle with organza and secured it with a rubber band to prevent the adults from escaping. Three replicates were used in this experiment, each comprising three experimental units. Daily inspections were carried out to monitor the insect's life cycle parameters, such as the pre-oviposition period, the oviposition period, the post-oviposition period, the lifespan of females and males, and the number of eggs laid on each of the four crops.

2.4 Statistical analysis

The results were statistically analysed using a completely randomised design (C.R.D.), and the least significant difference (L.S.D.) test at a significance level of 0.05 was used to compare the results (Al-Sahouki and Wahib, 1990). The Jenstat software programme was used to analyse the results .

3. Results and Discussion

3.1 Egg incubation period and hatching rate

The results shown in Table (1) indicate that the host type did not affect the egg incubation period of the painted bug, *B. hiliaris*. There were no statistically significant differences in egg incubation periods across the different plant hosts at a temperature of $25^{\circ}\text{C} \pm 2$ and relative humidity of $70\% \pm 5$, respectively. The longest incubation period was 6.43 days on cauliflower, whilst the shortest was 6.17 days on radish. These results are consistent with those found by Rohilla et al. (2004) in their study of the insect's life cycle in the laboratory on 12 host plants; they reported that the longest egg incubation period was 5.6 days on brown rapeseed, whilst the shortest was 5.1 days on wild mustard. Al-Youssef and Al-Masoudi (2012) noted that the average egg incubation period for the painted bug was 6.20 days on radish at a temperature of $24^{\circ}\text{C} \pm 4$. Al-Jboori and Al-Jassani (2003) also indicated that the average egg incubation period on rapeseed crops was 14 days at a temperature of 20°C and 6.90 days at a temperature of 27°C . The Plant Health Panel of the European Food Safety Authority (EFSA) (2022) noted that the average incubation period for eggs was 7.5 and 200 days at temperatures of 25 and 28°C , respectively. Reed et al. (2017) explained that the incubation period of eggs on broccoli crops varies with temperature, being 5.9 days at 26°C and 3.8 days at 30°C .

The egg hatching rate was also unaffected by the type of host plant on which the insect was reared (Table 1); the highest hatching rate was 97.3 per cent on radish, whilst the lowest was 94 per cent on cauliflower. These results were found to be similar to those reported by Al-Jboori and Al-Jassani (2003), who noted that the egg hatching rate on rapeseed crops at temperatures of 20 and 27°C was 98.72 per cent and 99.62 per cent respectively, and to those reported by Al-Youssef and Al-Masoudi (2014), who noted that the hatching rate on radish was 95 per cent. Madan (2015), in his study of the insect's life cycle on five crops of the Brassicaceae family, also found that the per cent of egg hatching ranged from 92.26 to 95.20 per cent, with the highest rate observed on brown rapeseed (*Brassica rapa*). Meanwhile, Reed et al. (2017) reported that the egg hatching rate was 76.7 per cent and 88.3 per cent at temperatures of 24 and 26, respectively, on broccoli plants.

3.2 Nymphal instars

It was found that the painted bug, *B. hiliaris* has five nymphal instars, as determined by monitoring moulted exoskeletons and changes in size, shape and colour. As shown in the results presented in Table 1, the duration of the nymphal instars was influenced by the host type on which the nymph was reared. It was found that the shortest duration for the growth and development of the first nymphal stage on radish was 3.00 days. The duration of the second nymphal stage varied depending on the host plant type, specifically between the rapeseed and cauliflower crops, and between these and the other two crops, the rapeseed and radish. The shortest duration for the second nymphal instar was 6.36 days on the rapeseed crop, whilst the longest was 9.33 days on the cauliflower crop. The results also showed that there was a statistically significant difference in the development periods of the third and fourth instars depending on the host plant on which the insect was reared; the shortest periods were observed on the radish crop at 5.33 and 5.67 days, whilst the longest periods were on the cauliflower crop at 8.67 and 9.00 days, respectively. As for the fifth instar, the

shortest development period was observed on the rapeseed crop, at 8.82 days, whilst the longest was on the cabbage and cauliflower crops, both at 10.33 days .

The results shown in Table (1) indicate that there is a statistically significant difference in the total duration of the nymphal stage for radish and rapeseed crops compared with those of cabbage and cauliflower. It was also found that there was a statistically significant difference in this duration between the latter two crops; the total duration of the nymphal stage for radish was 29.75 days, which was the shortest, whilst the longest duration was observed for cauliflower, at 40.33 days. Madan (2015) found that the total duration of the nymphal stage differed significantly depending on the plant family on which the plants were grown at a temperature of 28 ± 2 °C; the shortest duration for this cycle was observed in the brown rapeseed, *Brassica rapa* at 21.79 days, whilst the longest duration was observed in the Ethiopian mustard, *B. carinata* at 27.26 days. The shorter duration of the nymphal stage in this study compared with the current study is attributed to the difference in the temperature at which the nymphs were reared; as the temperature rises to a certain limit, the insect's growth and development accelerate, thereby shortening the developmental period (Pedigo, 1999) .

The results also showed a statistically significant difference in nymphal survival rates depending on the host plant; the highest survival rate for the nymphal stage was 91.67 per cent on radish, whilst the lowest was 50.00 per cent on both cabbage and cauliflower. Reed et al. (2017) reported that the survival rate for the nymphal stage was 70 per cent and 75 per cent at temperatures of 24 and 26 °C, respectively, on broccoli plants .

Table (1): Effect of crop type on egg incubation period, hatching %age, nymphal rearing periods and survival rates of the painted bug *Bagrada hilaris* at a temperature of 25 °C and 70 per cent humidity (mean $\pm$ standard deviation)

Crop	Egg incubation period (days)	Egg hatching (%)	1st nymphal instar (days)	2nd nymphal instar (days)	3rd nymphal instar (days)	4th nymphal instar (days)	5th nymphal instar (days)	Total nymphal period (days)	Nymphal survival (%)
Radish	6.17 $\pm$ 1.26 ^a	97.30 $\pm$ 2.52 ^a	3.00 $\pm$ 0.00 ^a	6.42 $\pm$ 0.29 ^a	5.33 $\pm$ 0.44 ^a	5.67 $\pm$ 0.58 ^a	9.33 $\pm$ 0.58 ^{ab}	29.75 $\pm$ 0.43 ^a	91.67 $\pm$ 14.43 ^a
Rapeseed	6.20 $\pm$ 1.31 ^a	96.00 $\pm$ 3.61 ^a	3.11 $\pm$ 0.19 ^a	6.36 $\pm$ 0.78 ^a	5.83 $\pm$ 1.35 ^{ab}	6.22 $\pm$ 0.39 ^{ab}	8.82 $\pm$ 0.95 ^a	30.44 $\pm$ 1.90 ^a	58.33 $\pm$ 38.19 ^b
Cabbage	6.33 $\pm$ 1.40 ^a	94.70 $\pm$ 5.03 ^a	3.42 $\pm$ 0.14 ^b	8.06 $\pm$ 0.82 ^b	7.11 $\pm$ 1.02 ^b	7.28 $\pm$ 0.95 ^b	10.33 $\pm$ 0.58 ^b	36.19 $\pm$ 0.57 ^b	50.00 $\pm$ 25.00 ^b
Cauliflower	6.43 $\pm$ 1.40 ^a	94.00 $\pm$ 5.29 ^a	3.00 $\pm$ 0.00 ^a	9.33 $\pm$ 0.58 ^c	8.67 $\pm$ 1.15 ^{bc}	9.00 $\pm$ 0.00 ^c	10.33 $\pm$ 0.58 ^b	40.33 $\pm$ 1.53 ^c	50.00 $\pm$ 25.00 ^b

Note: Means followed by different superscript letters within the same column are significantly different, while means followed by the same letter are not significantly different

3.3 Life history of adult females:

3.3.1 Pre-oviposition period

The results shown in Table 2 indicate that there was no significant difference in pre-oviposition duration amongst the four plant families, with the average pre-oviposition duration being 3 days. This finding is consistent with that reported by Al-Youssef and Al-Masoudi (2014), who stated that the pre-oviposition period was 3 days, and also with that of Al-Jabouri and Al-Jassani (2003), who reported pre-oviposition periods of 3 and 1.4 days at temperatures of 20 and 27, respectively.

3.3.2 Duration of egg-laying

The results indicated no statistically significant differences in the average duration of egg-laying across the different crops; the average duration of egg-laying was 19.03, 18.37, 16.33 and 15.63 days for radish, rapeseed, cabbage and cauliflower, respectively. Al-Jboori and Al-Jassani (2003) reported that the egg-laying duration was 7.3 and 6.4 days at temperatures of 20 and 27, respectively. Al-Youssef and Al-Masoudi (2014) stated that the average egg-laying duration was 8.9 days at a temperature of 24 ± 4 °C. Meanwhile, Palumbo et al. (2016) noted that the egg-laying duration for adult painted bugs ranges from 5 to 19 days, depending on temperature and the type of host plant.

3.3.3 Number of eggs laid per female

It is evident from Table (2) that the average number of eggs laid per female was highest for the radish crop, at 169 eggs/female, whilst the lowest average was recorded for the cauliflower crop, at 157.67 eggs/female, whilst the results were 167.33 and 161.33 eggs per female for the rapeseed and radish crops, respectively. Statistical analysis confirmed a significant difference in the number of eggs laid per female between the radish crop on the one hand, and the cabbage and cauliflower crops on the other; a significant difference was also found in the number of eggs laid on the rapeseed and cauliflower crops. The results of the present study were consistent with those reported by Fanti et al. (2025), who indicated that adult painted bugs may lay 154.5 ± 12.4 eggs during their lifetime. Sparks et al. (2024) also reported that females lay approximately 150 eggs during their lifetime. The Plant Health Panel of the European Food Safety Authority (EFSA, 2022) and Palumbo et al. (2016) indicated that a female can lay 100–200 eggs during her lifetime. Perring et al. (2019) stated that a female lays up to 217 eggs during her lifetime. The results of this study did not agree with the findings of Al-Jboori and Al-Jassani (2003), who reported that the average number of eggs laid by adult painted bugs on rapeseed crops was 24.2 and 25.6 eggs per female at temperatures of 20 and 27 °C, respectively. Nor did they agree with the findings of Al-Youssef and Al-Masoudi (2014), who reported that the average number of eggs laid by the insect on radish plants was 73.1 eggs per female at a temperature of 24 ± 4 °C.

3.3.4 Lifespan of adults

The results shown in Table (2) indicate that there were no statistically significant differences in the average lifespan of adult insects in any of the four crops: radish, rapeseed, cabbage and cauliflower, where the average lifespan of males was 19.67, 18.33, 16.67 and 15.67 days respectively, whilst the average lifespan of females was 22.67, 22, 20 and 19.33 days respectively. The longer lifespan of both male and female adults on radish and rapeseed crops may be attributed to these crops' ability to better meet the insects' nutritional requirements through the absorption of plant sap, compared with the cabbage and cauliflower crops. This is consistent with the findings of Huang

et al. (2014), who compared 14 different species of cruciferous crops, including radish, rapeseed and cauliflower, and found that a large number of adult *Bagrada hilaris* were attracted to radish plants to a greater extent than to the other plants.

3.3.5 Life cycle

The results shown in Table 2 indicate that the longest life cycle duration of the insect, at 66.10 days, was observed on the cauliflower crop, whilst the shortest life cycle duration was on the radish crop, at 58.58 days. The study's results also showed that females lived longer than males on all four crops studied; the longest lifespan for females was observed on the radish crop, at 22.67 days, whilst the lifespan of males on the same crop was 19.67 days, whilst the shortest lifespan for females was observed on the cauliflower crop, at 19.33 days, compared with 15.67 days for males on the same crop. These results are consistent with the findings of Madan (2015), who noted that the lifespan of females is longer than that of males; he indicated that the lifespan of females on brown rapeseed crops was 18.79 days, whilst that of males was 16.89 days. It was also found that the lifespan of females on Ethiopian mustard was 19.68 days, whilst that of males was 15.00 days.

Table (2): Effect of crop type on the life history traits of adult *Bagrada hilaris* at a temperature of 25 °C and 70 per cent humidity (mean $\pm$ standard deviation)

Female life cycle (days)	Adult longevity (days) - Female	Adult longevity (days) - Male	Number of eggs laid/female	Post-oviposition period (days)	Oviposition period (days)	Pre-oviposition period (days)	Crop type
58.58 $\pm$ 4.26 ^a	22.67 $\pm$ 3.05 ^a	19.67 $\pm$ 2.89 ^a	169 $\pm$ 4 ^a	0.00	19.67 $\pm$ 3.05 ^a	3.00 $\pm$ 0 ^a	Radish
58.64 $\pm$ 3.02 ^a	22.00 $\pm$ 3.46 ^a	18.33 $\pm$ 4.04 ^a	167.33 $\pm$ 3.51 ^{ab}	0.00	19.00 $\pm$ 3.46 ^a	3.00 $\pm$ 0 ^a	Rapeseed
62.53 $\pm$ 4.35 ^a	20.00 $\pm$ 3.46 ^a	16.67 $\pm$ 4.62 ^a	161.33 $\pm$ 4.16 ^{bc}	0.00	17.00 $\pm$ 3.46 ^a	3.00 $\pm$ 0 ^a	Cabbage
66.10 $\pm$ 4.43 ^a	19.33 $\pm$ 4.04 ^a	15.67 $\pm$ 4.62 ^a	157.67 $\pm$ 4.04 ^c	0.00	16.33 $\pm$ 4.04 ^a	3.00 $\pm$ 0 ^a	Cauliflower

Note: Means followed by different superscript letters within the same column indicate significant differences, whereas means followed by the same letter indicate no significant differences.

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