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Research Article

STUDIES ON THE BIOLOGY OF *BAGRADA HILARIS* ON SOME *BRASSICA* SPECIES OF JAMMU REGION (J&K)

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ABSTRACT

Bagrada hilaris (Burmeister), (Hemiptera: Pentatomidae), is native to Africa. It was first reported in the United States in June of 2008 in the county of Los Angeles, California (Arkelian, 2008). *Bagrada hilaris* is an important polyphagous pest in India. It is a serious pest of Brassicaceae crops. Biology of *Bagrada hilaris* was studied in detail on mustard crop during the period of Oct. to May 2015. It underwent the hemimetabolous type of development and the studies on biology of *B. hilaris* indicated that female laid 100 eggs in two to three weeks. Eggs were oval and dirty white. The duration of eggs lasted for an average of 6.0 $\pm$ 0.79. There were five nymphal instars which completed their development in 17.8 $\pm$ 3.16 days. The total life cycle from egg laying to adult emergence completed in 19-28 days with an average of 23.8$\pm$ 3.49 days. The female lived longer (26.5 $\pm$ 1.11days) than the male (20.3 $\pm$ 1.20 days).

INTRODUCTION

Agriculture is the backbone of man's existence. Cultivation of plants is one of man's oldest occupations. India is an agro-based country where more than 75% of Indian population depends on agriculture. Mustard is an important oil seed crop. It belongs to family Brassicaceae (also known as mustard family) and genus *Brassica*. The genus *Brassica* includes over 150 species of annual, biennial or rarely perennial herbs, mostly native to the north part of the old world. The different species have spread to the sub-tropics and tropics as cold season crops. The cultivated *Brassica* species may be divided into 2 distinct types-the vegetable types (Broccoli, cabbage, cauliflower, turnip and rutabaga) and oil seed types (mustard). In India, the main oilseed crops are *Brassica campestris* and *B.juncea*. Three distinct varieties have evolved from *Brassica campestris* in India-Brown sarson, yellow sarson and tori, restricted to distinct eco-geographical regions. Mustard seeds are indeed very rich in phyto-nutrients, minerals, vitamins and anti-oxidants. The seeds are high in essential oils as well as plant sterols. Some of important sterols include such asbrassicasterol, campesterol, sitosterol, avenasterol and stigmasterol. Some of glucosinolate and fatty acids in the seeds include sinigrin, myrosin, erucic, eicosenoic, oleic, and palmitic acids. The seeds are an excellent source of essential B-complex vitamins such as folates, niacin, thiamin, riboflavin, pyridoxine (vitaminB-6), pantothenic acid. Seeds and its oil has traditionally been used to relieve muscle pain, rheumatism and arthritic pain. It is an economically important crop grown in the Jammu region and serve as a potential host of many insect pests. Of these insects, *Bagrada hilaris* is one of the major insect pest. It causes significant damage to the crop and affects its yield. Because of having so much food value and economic importance it becomes an important aspect to know more about this crop and little work has been done on the biology of bagrada bug. Keeping this in view, the present work was done in the Jammu region (J&K).

MATERIALS AND METHODS

The study was conducted in the study area from October 2014 to May 2015 at three different stations of Jammu region viz. Rajouri, Jammu and Samba in the crop fields and also in the laboratory. The standing crop was scanned properly and *Bagrada hilaris* was found as one of the serious pest. Eggs were collected from the crop fields and were kept in the lab condition for incubation in Petri-dishes. Newly hatched nymphs were transferred to other Petri-dishes which were lined by moist filter paper and provided with fresh leaves. Filter paper and food were changed after every second day. Nymphs were observed daily and data was recorded with regards to moulting, duration and size of each nymphal instars. All life stages were recorded morphometrically. The mode and extent of damage caused by the adults as well as by nymphs were

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studied by observing the symptoms of damage in the crop fields and also in the laboratory.

RESULTS AND DISCUSSION

Distribution*:* South Asia, Middle East, Europe, East Africa, and USA (California and Arizona).

Common names: Bagrada bug, painted bug, mustard bug, mustard painted bug, colourful bug or harlequin bug which has caused major confusion with another harlequin bug, *Murgantia histrionica.* The bagrada bug is smaller than the harlequin and has a different colour pattern.

Host plant: The primary host plants of the bagrada bug are cruciferous crops including broccoli, cauliflower, cabbage, kale, turnip, radish, mustard, arugula, rutabaga, collard greens and broccoflower. However, other plants, weeds and crops can become infested as well, including Bermuda grass, sorghum, sudan grass, lambsquartes, ashvagandha, pill-pod spurge, potato, canola, cotton, corn, sunflowers, papaya, capers, cantaloupe, pearl millet, sugar cane, and wheat (Hill 1975; Singh and Malik 1993). Legumes such as snap peas, green beans, and mung beans may become infested. Bagrada bugs can be found aggregating and attempting to feed on many other plants that are non-hosts (Reed *et al.*, 2013).

Life cycle of Bagrada hilaris

Mating Period and Copulation: Mating was observed in 3-4 days old adults. Males using antennae to touch female's body then males mount a female and start to antennate the female's antennae and genitalia. Finally the male dismounts and start to copulate by putting his last pair of legs on the female's abdomen and coupling his genitalia with those of the female. After the contact of male, the head of the female slightly lowered and abdomen raised to allow the male to mate (Fig 3). Both male and female bugs stood in an end to end position with their abdomens higher than their heads. During the process of copulation both the individuals continue to feed and move. Females bugs were larger and stronger than males which determines the direction of movement and drags the male along with her. Morning and evening time was preferred for copulation.

Oviposition: After copualtion was done, the couple disperses. Female moves over the plant for selection of site for egg laying. Females laid eggs in the soil beneath host plants but may also oviposit on leaves and stems. It took 10-12 hours.

Eggs: Eggs were commonly laid singly and close together but a cluster of 1-3 eggs were also observed. The freshly laid eggs were oval and dirty white and showed reticulation on chorion under microscope and as the embryos mature, the eggs color changed from dirty white to orange-red and finally turned pink before hatching (Fig 4). A single female can be laid 100 eggs in two to three weeks.

Incubation period: The duration of incubation period lasted for 5-7 days with an average of 6.0 ± 0.79days. In winters, the incubation period can be as long as 19-21 days. Incubation period which causes emergence of nymphs which are orange to red color from eggs. Azim and Shafee (1986) reported an incubation period of 2–5 days. Singh and Malik (1993) reared the bugs on Indian mustard seeds in the laboratory at different times of year reporting an incubation period of 6.22 in April (25.5–34°C), 3.28 in May (28–30°C) and 6.27 at (28^0C; no month given).

Nymphal instars: The painted bug passes through five nymphal instars to become an adult. Newly moulted nymphs of all stages are orange-red but legs, head and thorax darken quickly to black (Fig 5). Verma *et al.,* (1993) reported stadia for the first through fifth instars of 3.33, 4.00, 4.31, 4.54, and 3.82 d, respectively, on Indian mustard (*Brassica juncea* L.), under controlled conditions.

Ist instar: The newly hatched nymph was bright orange with red eyes. After hatching, they remain with the empty egg chorion for several hours. They do not feed but soon become active and move away from the chorion. There were no marks on the body of newly hatched nymph. As it developed the color changed to reddish brown and just before moulting it turns red. The head, antennae, legs and the margin of the thoracic segment become light black or smokey. Duration of the first instar lasted for 2-3days with an average of 2.45 ± 0.41days**.** The first instar nymph was measured 1.23 ± 0.32mm in length and 0.73 ± 0.03mm in width.

2nd instar*:* Newly emerged second instar nymph was bright orange but it changes to red before moulting. Duration of the second instar lasted for 2-4 days with an average of 3.70 ± 1.20 days .The second instar nymph was measured 1.34 ± 0.03 mm in length and 1.05 ± 0.03 mm in width.

3rd instar*:* The third instar nymph was reddish in color with blackish marking on the abdomen. Duration of the third instar was 3-5 days with an average of 4.0 ± 0.79 days. The third nstar nymph was measured 1.78 ± 0.19mm in length and 1.37 ± 0.05mm in width.

4th instar*:* The fourth instar nymph was reddish with very distinct markings. The head was more or less triangular. Duration of the fourth instar lasted for 3-4 days with an average of 3.48 ± 0.41 days. The fourth instar nymph was measured 2.29 ± 0.14 mm in length and 1.60 ± 0.08 mm in width.

5th instar*:* It resembles the adult but is of smaller size. Backwardly elongated notum formed the well developed wing pads. The genital appendages began to make their appearance. The fifth instar nymph assumed the colourtion of adult and all the markings became well developed. Duration of the fifth instar lasted for 4-5 days with an average of4.48 ± 0.41days. The fifth instar nymph was measured 5.16 ± 0.09 mm in length and 3.02 ± 0.02 mm in width.

Adults: Adult bugs were black with orange and white markings and the shield-shaped body. Adult bugs were 5-7 mm long (Fig 1). While they had wings, they were more commonly seen walking than flying. The female was larger than the male and measured 7.06 ± 0.05 mm length and 3.97 ± 5.29mm width as compared to male with 5.6 ± 0.24 mm length and 3.02 ± 0.02mm width. Adults were active and present on plants during the day.

Damage symptoms: Both adults and nymphs suck sap from all parts of the plant. Adult bugs excrete a resinous substance which spoils the crop (Fig 2). Young plants wilt and wither as a result of the attack. Quality and quantity of yield was affected

when grown up plants were infected. *Bagrada hilaris* also infested harvested crop in threshing floor. As the standing crop of mustard was harvested in April or May, this bug shifted standing crop to harvested crops which was lying in the fields. When harvested crop was dry and the absence of cruciferous crops which act as a primary host for this bug, the adult of painted bug might have shifted to other hosts plants which were growing in and around the fields in search of green vegetables and moisture.

Fig1 Adult

Fig2 Damage caused by both adult and nymphs.

Fig3 Mating pair

Fig4 Eggs

Fig 5 Nymphal instars

Table 1 Body length and width from egg to adult stage of *Bagrada hilaris*

Developmental Stages	Length (mm)		Width (mm)	
	Range	Mean ± SD	Range	Mean ± SD
Egg	0.87– 1.0	0.93 ± 0.05	0.55 – 0.75	0.64 ± 0.07
Nymphal instars:-				
1st instar	1.0– 1.12	1.23 ± 0.32	0.70 – 0.77	0.73 ± 0.03
2nd instar	1.30– 1.39	1.34 ± 0.03	1.0 – 1.09	1.05 ± 0.03
3rd instar	1.50– 2.0	1.78 ± 0.19	1.30 – 1.45	1.37 ± 0.05
4th instar	2.0– 2.45	2.29 ± 0.14	1.5 – 1.69	1.60 ± 0.08
5th instar	5.0– 5.29	5.16 ± 0.09	3.0 – 3.04	3.02 ± 0.02
Adult:-				
Male	5.29– 5.90	5.6 ± 0.24	3.0 – 3.04	3.02 ± 0.02
Female	7.0– 7.12	7.06 ± 0.05	3.94 – 4.0	3.97 ± 5.29

Table 2 Duration of *Bagrada hilaris development*

Developmental Stages	Duration(Days)	
	Range	Mean± SD
Incubation Period	5.0 – 7.0	6.0 ± 0.79
Nymphal instars:-		
1st instar	2.0 – 3.0	2.45 ± 0.41
2nd instar	2.0 – 4.0	3.70 ± 1.20
3rd instar	3.0 – 5.0	4.0 ± 0.79
4th instar	3.0 – 4.0	3.48 ± 0.41
5th instar	4.0 – 5.0	4.48 ± 0.41
Total Nymphal period Total Life Cycle duration	14.0 – 21.0	17.8 ± 3.16
Adult Longevity	19.0 – 28.0	24.0 ± 3.87
Female	19-28	23.8± 3.49
Male	25-28	26.5 ± 1.11
	19-22	20.3 ± 1.20

CONCLUSION

Bagrada hilaris is an invasive pest that feeds mainly on Brassicaceous plants. Both adult and nymphal stages feed upon the host plant. Adult females feed longer and cause greater damage than males do. Feeding damage by bagrada bug is characterised by star shaped chlorotic lesions that may become necrotic. It can damage stems and developing seed pods of mature oilseed *Brassica* crops resulting decreases the yield and market value of the crop. This study was also designed to know about the insect pests associated with Brassicaceous crops in the Jammu region (J&K). The findings recommended that this pest is difficult to control without the use of pesticides because of its high reproductive potential, unique oviposition behaviour, broad host range and lack of significant natural enemies. Thus the use of pesticides help to minimize the loss caused by *Bagrada hilaris.*

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