Journal of Oilseed Brassica, 7 (2) : 163-168, July 2016

Population dynamics of *Bagrada hilaris* (Brumeister) on Indian mustard under semi arid conditions of Haryana, India

Bawaskar DM, Sunita Yadav*, SP Singh, KM Kumarnag and AV Nadaf

Department of Entomology, CCSHAU, Hisar, Haryana-125004, India
**Corresponding author: sunitayadav10@rediffmail.com*
(*Received: 4 April 2016: Revised: 12 May 2016; Accepted: 6 June 2016*)

Abstract

Population dynamics study of *Bagrada hilaris* on RH 30 showed that the pest reached its peak population twice in the cropping season, once at the seedling stage, and another at the maturity stage on both early, and late sown crop. The maximum population on early sown crop was observed with its first, and second peak observed on 48th SW, and 12th SW, respectively. While in the late sown crop the peaks in the pest population were noticed on 50th SW, and 17th SW of 2013-14, and 2014-15. The pest population had significant positive correlation with maximum temperature, and sun shine hours on both early, and late sown crops. However, the correlation with minimum temperature was non-significantly positive in early sown crop compared to significant positive correlation in late sown crop. Morning, and evening relative humidity showed highly negative significant correlation with the pest population. Wind speed had a significant negative effect on painted bug population in crop sown early in the season while the effect was positive, and non-significant in late sown crop. All weather parameters contributed to *B. hilaris* population fluctuation to the extent of 66 to 69, and 46 to 86 per cent during 2013-14, and 2014-15 respectively.

Keywords: *Bagrada hilaris, correlation, Indian mustard, population dynamics*

Introduction

Rapeseed–mustard crops in India are grown in diverse agro-climatic conditions ranging from north-eastern/north-western hills to down south under irrigated/rainfed, timely/late sown, saline soils, and mixed cropping. Among which, the painted bug, *Bagrada hilaris* (Burmeister), (Hemiptera: Pentatomidae) is an important pest of crucifer crops in India (Rai, 1976; Singh, 2008), and abroad throughout Asia, Africa, some Islands of southern Europe such as Malta, and Pantelleria (Italy), California, and Arizona (Palumbo and Natwick, 2010 and Reed *et al*., 2013). It is a serious pest of rapeseed mustard and found active during seedling stage (October-November) (Vora *et al*., 1985), and at harvest stage (March-April) (Singh and Malik, 1993 and Singh, 1996). The painted bug has been reported active throughout the year, and infest various crucifers during winter where it causes considerable damage (Batra, 1958 and Sandhu, 1975).

A number of workers have attributed outbreaks of *B. hilaris* under favourable weather factors (Srivastava *et al*., 1972; Dhaliwal and Goma, 1979; Singh and Malik, 1993). However, detailed studies on the influence of different biotic, and abiotic factors on *B. hilaris* population under agro-climatic conditions of Haryana, on rapeseed mustard are lacking. The knowledge of pest population dynamics in relation to biotic, and abiotic factors is a prerequisite for developing weather based pest forecasting system. Studies on seasonal abundance, and population fluctuations will help in formulating effective management strategies against the pest in rapeseed-mustard agro-ecosystem.

Materials and Methods

The population dynamics of *B. hilaris* was recorded on Indian mustard (Cv: RH 30). Variety RH 30 was sown early during first half of October, and late during second half of November at the Research Area of Oilseeds Section, Department of Genetics and Plant Breeding, CCSHAU, Hisar, India during 2013, and 2014. The recommended agronomic practices were followed. The plot size was 20 m × 5 m, and the row to row, and plant to plant distances as 30 cm, and 10 cm, respectively. In the initial stage of crop, the observation on *B. hilaris* was taken on the basis of total population of adults, and nymphs in one meter row of plants in ten randomly selected rows. However, in the later stage of crop growth (fully grown stage) the population of painted bug was recorded on 10 randomly selected plants diagonally tagged in the plot. The observations were made on weekly basis. The data on various meteorological parameters were obtained from Department of Agrometeorology, CCSHAU, Hisar, Haryana, India, and correlated with *B. hilaris* population.

Results and Discussion

Population dynamics of *B. hilaris* on early sown rapeseed-mustard cultivar RH-30

As evident from Fig. 1 the pest remained active on the crop at the seedling, and maturity stage of the crop growth during the period of study (October to March, 2013-14) i.e. during 43rd to 52nd standard week (SW), and 10th to 13th SW. There were two major peaks of *B. hilaris* populations. Peak populations of painted bugs were recorded during 48th, and 12th SW with numbers as high as 6.55 and 6.01 bugs per meter row length, respectively.

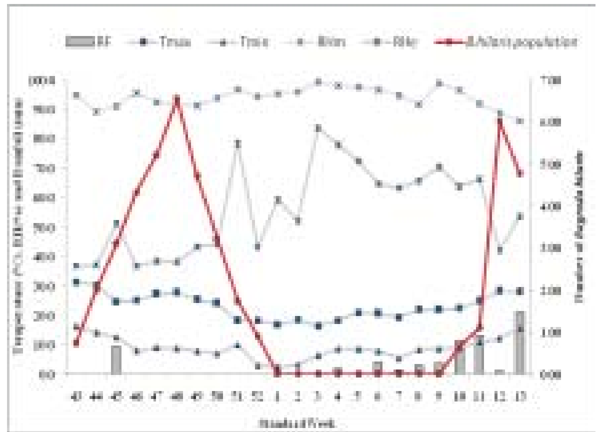

Fig.1. Population dynamics of *B. hilaris* on early sown rapeseed-mustard crop Cv. RH-30 during different standard weeks in the year 2013-14

Nevertheless, the population of painted bugs remained quite high during 43rd to 48th SW (0.73 to 6.55 bugs/ meter row length), and again during 10th to 12th SW (0.65 to 6.01 bugs/ meter row length).

Almost similar trend activity of painted bug population was observed during 2014-15. The pest remained active on the crop at the early, and later stage of the crop during the period under study (October to March, 2014-15) i.e., during 43rd to first SW, and 10th to 13th SW. Two closer peaks of *B. hilaris* populations were observed during the seedling stage, with an additional peak at maturity

Table 1: Correlation between weather parameters and *B. hilaris* population on early sown rapeseed-mustard crop during 2013-14 and 2014-15

Weather Parameters	Painted bug, *B. hilaris* population	
	2013-14	2014-15
Maximum Temperature (°C)	0.659**	0.629**
Minimum Temperature (°C)	0.359NS	0.315NS
Morning Relative Humidity (%)	-0.662**	-0.673**
Evening Relative Humidity (%)	-0.663**	-0.692**
Wind Speed (km/hr)	-0.329NS	-0.418*
Bright Sun shine hours (hrs)	0.448*	0.517*
Rainfall (mm)	0.075NS	-0.066NS

*significant at 5% ** significant at 1%

Table 2: Regression analysis between all weather parameters and *B. hilaris* population on early sown rapeseed-mustard crop

Year	Regression Equation	R^2 value (%)
2013-14	Y=41.04+0.18Tmax-0.03Tmin -0.04RHm+0.48RHe -1.10WS+0.20BSS-0.40PE + 0.04RF	66
2014-15	Y=5.97+0.66Tmax-0.47Tmin-0.16RHm+0.38RHe -0.68WS-0.374BSS+ 0.08PE + 0.08RF	69

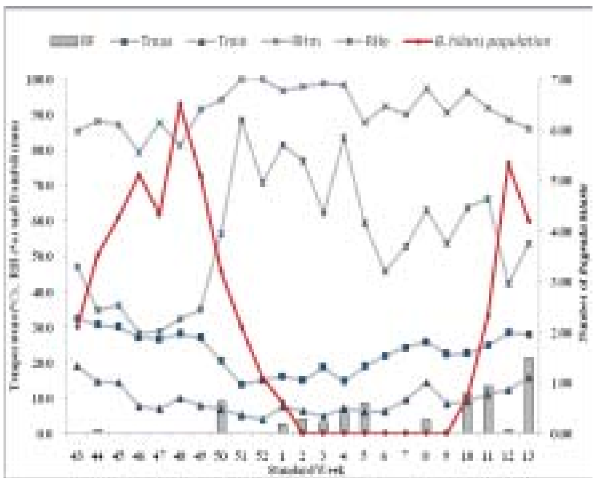

Fig. 2. Population dynamics of *B. hilaris* on early sown rapeseed-mustard crop Cv. RH 30 during different standard weeks in the year 2014-15

stage (Fig. 2). Peak populations of painted bugs were recorded during 46th, 48th, and 12th SW with numbers as high as 5.11, 6.50, and 5.33 bugs per meter row length, respectively.

Correlation of painted bug population with maximum temperature was found highly positively significant during 2013-14, and 2014-15 (Table 1). Morning and evening relative humidity showed highly negative significant correlation with the pest population. On the other hand, sunshine hours had a significant positive correlation with painted bug population. Minimum temperature showed non-significant positive correlation with the painted bug population during the observation period. Wind speed had a negative significant effect on painted bug population during 2014-15. The correlation between rainfall, and painted bug population was non-significant. All weather parameters contributed to *B. hilaris* population fluctuation to the extent of 66-69 per cent during different years (Table 2).

Population dynamics of *B. hilaris* on late sown rapeseed-mustard cultivar RH-30

As evident from Fig 3 the pest remained active on the crop at the seedling, and maturity stage of the crop during the period under study (October to March, 2013-14) i.e., during 47th to 52nd standard week (SW) and 10th to 17th SW. There were two major peaks of *B. hilaris* populations. Peak populations of painted bugs were recorded during 50th, and 17th SW with numbers as high as 8.91, and 8.60 bugs per meter row length, respectively. Nevertheless, the population of painted bugs remained quite high during 47th to 50th SW (2.53 to 8.91 bugs/ meter row length), and again during 10th to 17th SW (0.89 to 8.60 bugs/ meter row length). Almost similar trend of painted bug activity was observed during 2014-15. The pest remained active on the crop at the early, and later stage of the crop during this period (October to March, 2014-15) i.e., during 46th to first SW, and 10th to 17th SW. Peaks

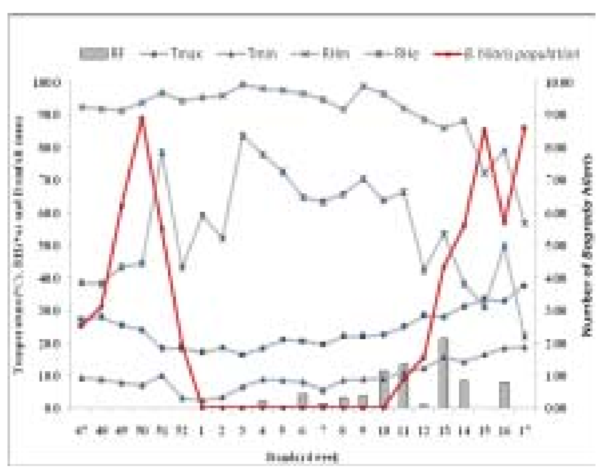

Fig 3. Population dynamics of *B. hilaris* on late sown rapeseed-mustard crop Cv. RH-30 during different standard weeks in the year 2013-14

Table 3. Correlation between weather parameters, and *B. hilaris* population on late sown rapeseed-mustard crop during 2013-14, and 2014-15

Weather Parameters	Painted bug (*B. hilaris*) population	
	2013-14	2014-15
Maximum Temperature (°C)	0.707^{**}	0.594^{**}
Minimum Temperature (°C)	0.611^{**}	0.555^{**}
Morning Relative Humidity (%)	-0.695^{**}	-0.533^{**}
Evening Relative Humidity (%)	-0.666^{**}	-0.456^{*}
Wind Speed (km/hr)	0.180^{NS}	0.148^{NS}
Bright Sun shine hours (hrs)	0.656^{**}	0.495^{*}
Rainfall (mm)	-0.042^{NS}	0.049^{NS}

*significant at 5% ** significant at 1%

of *B. hilaris* populations were observed during the seedling stage, and at maturity stage (Fig. 4). Peak populations of painted bugs were recorded during 50^{th}, and 17^{th} SW with numbers as high as 7.23 and 7.92 bugs per meter row length, respectively. The results of the present studies got support from observations recorded by Joshi *et al*. (1989) as they observed painted bug population at higher densities on the crop sown 1^{st}, and 15^{th} November. Similarly, Tiwari and Saravanan (2009) reported more *B. hilaris* infestation on the crop sown later in the season with the population reaching its maximum towards the crop maturity stage (16th SW).The possible reasons for the higher population levels of painted bugs on the late sown crop may be the migration pest that had multiplied early in the season both at the seedling stage, and maturity stages of the crop. It can be concluded that both on the early, and late sown crop the infestation of the *B. hilaris* occurs in two distinct phases with a peak at seedling, and maturity stage of the crop.

Correlation of painted bug population with maximum, and minimum temperature, and bright sunshine hours were significantly positive. The maximum temperature ranging from 13.8 to 38.7°C was observed during the experimental period with temperature above 20°C favouring the population build up of the pest. Similar positive effect of maximum, and average temperature on the painted bug population was also reported by Lakshminarayana and Phadke (1987), Verma *et al*. (1993), Tiwari and Saravanan (2009) and Nagar *et al*. (2011). Minimum temperature had a non-significant positive correlation with population build up of painted bug on early sown crop. However, the correlation was significantly positive with *B. hilaris* population on the late sown crop as earlier reported by Nagar *et al*. (2011). Pest was unable to survive, and multiply when the minimum temperature reached below 7 ^{O}C in the months of January, and February with zero infestation. The pest became active with the increase in the minimum temperature in the months of March, and April with its peak population towards the pod formation stage. Sunshine

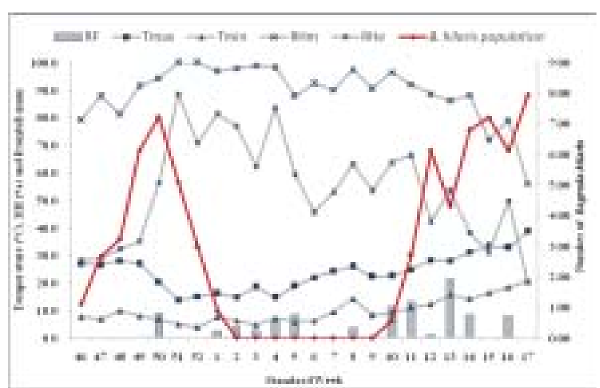

Fig 4. Population dynamics of *B. hilaris* on late sown rapeseed-mustard crop Cv. RH-30 during different standard weeks in the year 2014-15

Table 4. Regression analysis between all weather parameters, and *B. hilaris* population on late sown rapeseed-mustard crop

Year	Regression Equation	R^2 value (%)
2013-14	Y=38.17+1.02Tmax-1.05Tmin -2.032RHm-2.012RHe -0.02WS+0.70 BSS-1.65PE -0.03RF	86
2014-15	Y=30.02+0.14Tmax-0.18Tmin +1.09RHm-1.14RHe -0.05WS-0.046 BSS- 0.36PE +0.02RF	46

hours during the study period varied between 0.8 to 9.3 hrs with the optimal sunshine of above 7 hours congenial for the growth and development of the pest. The direct relationship between sunshine hours, and temperature could be the possible reasons for positive correlation between the pest population and sunshine hours. The present findings are in agreement with the observations recorded by Singh (1996) who recorded a significant positive correlation between painted bug population, and sunshine hours on mustard crop.

Morning, and evening relative humidity was found significantly negatively correlated with pest population during 2013-14, 2014-15 (Table 3). The crop growth period influenced by periods of low relative humidity (54-63 %) in early growth stages have favoured the multiplication of painted bug during October–November. Humidity increased up to 90 percent during the months of January, and February witnessing a rapid decline in the *B.hilaris* population. However, the population showed an increasing trend during the months of March, and April, which recorded a mean relative humidity at 65-74 per cent. The negative effect of increased humidity levels on the painted bug population was best illustrated in the studies of Singh and Malik (1993), Tiwari and Saravanan (2009) and Nagar *et al*. (2011) reported that relative humidity of 54 per cent was optimal for the rapid multiplication of the pest but higher relative humidity ranges were unfavorable for the survival of the pest.

Wind speed had a non-significant effect on the painted bug population during 2013-14, and 2014-15. The correlation between rainfall, and painted bug population was non-significant. The population of the bug increased with corresponding increase in the wind velocity during the study period. Moderate wind velocities i.e., 4- 6 km/hr may play a role in the dispersal of pest, thereby influencing the survival, and development of the pest. The studies of Singh (1996), and Nagar *et al*. (2011) which recorded significant positive effect of wind speed on the population build up of the painted bug supported the trend observed during the present studies. However, Tiwari and Saravanan (2009) reported a non-significant positive correlation between wind velocity, and *B. hilaris* population. This difference may be due to the changes in the ecological conditions of the locality, sowing time, and cultivar used in the present study.

The correlation between rainfall, and painted bug population was non-significant. During the present studies rainfall did not affect the *B. hilaris* population significantly both on early, and late sown mustard crop. The experimental period experienced relatively low rainfall never exceeding a total rainfall of 25 mm, which failed to exhibit any significant influence on the painted bug. The present findings are in accordance with the studies of Singh (1996), and Nagar *et al*. (2011) as they recorded no influence of rainfall on the population fluctuation of *B. hilaris*. However, Tiwari and Saravanan (2009) reported a significant positive correlation between bug population, and rainfall which contradicts the results of the present studies. Significant negative effect of rainfall on the painted bug population was observed by Verma *et al*. (1993). The observed differences may be due to changes in the agro-ecological conditions of the study site, and cultivar used.

All weather parameters contributed to *B. hilaris* population fluctuation to the extent of 46 to 86 per cent during different years (Table 4). The present studies concluded that all the weather parameters together contributed to 66-69 per cent variations in the population of *B. hilaris* on early sown mustard crop. Whereas, on the late sown crop the population fluctuation of the painted bug was influenced to the extent of 46-86 per cent. The computed model for the prediction of the population fluctuation is in corroboration with models earlier developed by Singh (1996) as it was noticed that combined action of all the abiotic factors contributed to 92.81 and 93.82 per cent variations in the population dynamics of *B. hilaris*.

Acknowledgements

The authors are grateful to the CCS Haryana Agricultural University, Hisar, Haryana, India for providing the necessary facilities, and encouragement for this study.

References

Batra HN. 1958. Bionomics of *Bagrada cruciferarum* Kirk. (Heteroptera: Pentatomidae) and its occurrence as a pest of mustard seeds. *Indian J Entomol* **20**: 130-135.

Dhaliwal HS, Goma BD. 1979. Seasonal abundance of various insect pests on cauliflower seed crop in the lower hills at Solan. *Indian J Ecol* **6**: 101-109.

Joshi ML, Ahuja DB, Mathur BN. 1989. Loss in seed yield by insect pests and their occurrence on different dates of sowing in Indian mustard (*B. juncea*). *Indian J Agril Sci* **59**: 166-168.

Laxminarayana M, Phadake KG. 1987. The intrinsic rate of natural increase of *Bagrada hilaris* Brumeister on rapeseed crop. *J Oilseeds Research* **4**: 211-214.

Nagar R, Singh YP, Singh R, Singh SP. 2011. Biology, seasonal abundance and management of painted bug *(Bagrada hilaris* Burmeister) in Eastern Rajasthan. *Indian J Entomol* **73**: 291-295.

Palumbo JE, Natwick ET. 2010. *The bagrada bug (Hemiptera: Pentatomidae): A new invasive of Cole crops in Arizona and California*. Plant Health Progress http://www.plantmanagementnetwork.org/sub/php/brief/2010/*bagrada*.

Rai BK. 1976. Pests of oilseed crops in India and their control. Indian Council of Agricultural Research Publication, New Delhi. p. 121.

Reed DA, Palumbo JC, Perring TM, May C. 2013. *Bagrada hilaris* (Burmeister), a new stink bug attacking cole crops in the southwestern United States. *J Integr Pest Manag* **4**: http://dx.doi.org/10.1603/IPM13007.

Sandhu GS. 1975. Seasonal movement of the painted bug *Bagrada cruciferarum* Kirkaldy from cruciferous plants to graminaceous plants and its occurrence as a serious pest of maize, sorghum, pearlmillet during spring in Punjab. *Indian J Entomol* **37**: 215-217.

Singh H. 1996. Studies of seasonal abundance, extent of losses and biology of painted bug, *Bagrada hilaris* (Brumeister) on different hosts. Ph.D. Thesis, CCS Haryana Agricultural University, Hisar.

Singh H, Malik VS. 1993. Biology of painted bug (*Bagarada cruciferarum*). *Indian J Agril Sci* **63**: 672-674.

Singh S. 2008. Insect pest management in oilseed crops. *Indian Farming* **58**: 29-33.

Srivastava AS, Nigam PM, Awasthi BK. 1972. Survey of pests on mustard crop. *Labdev J Sci Technol* (B) *Life Sci* **10**: 165-166.

Tiwari SK, Saravanan L. 2009. Life history and seasonal activity of Painted Bug, (*Bagrada hilaris*) (Burm.) infecting mustard in Allahabad, UP. *Pestology* **33**: 21-23.

Verma AK, Patyal SK, Bhalla OP, Sharma KC. 1993. Bioecology of painted bug (*Bagrada cruciferarum*) (Heteroptera: Pentatomidae) on seed crop cauliflower (*B. oleracea* var. *botrytis* sub var. *cauliflora*). *Indian J Agril Sci* **63**: 676-678.

Vora VJR, Bharodia RK, Kapadia MN. 1985. Pests of oilseed crops and their control: Rape and Mustard. *Pesticides* **19**: 38-40.