Journal of Applied and Natural Science
13(4), 1518 - 1523 (2021)
ISSN : 0974-9411 (Print), 2231-5209 (Online)
journals.ansfoundation.org

Research Article

Seasonal incidence and efficacy of botanical insecticides against Painted bug, *Bagrada hilaris* (Burmeister) (Hemiptera: Pentatomidae) in Indian mustard (*Brassica juncea* genotype RH 725)

Hemant Kumar*
Department of Zoology, Singhania University, Pacheri Bari, Jhunjhunu-333515 (Rajasthan), India
Sumer Singh
Department of Zoology, Singhania University, Pacheri Bari, Jhunjhunu-333515 (Rajasthan), India
Amit Yadav
Department of Entomology, Raffles University, Neemrana, Alwar-301705 (Rajasthan), India
Mahesh Kumar
Department of Zoology, Singhania University, Pacheri Bari, Jhunjhunu-333515 (Rajasthan), India

*Corresponding author. Email: he15061991@ gmail.com

Article Info
https://doi.org/10.31018/jans.v13i4.3182
Received: November 11, 2021
Revised: December 9, 2021
Accepted: December 12, 2021

How to Cite
Kumar, H. *et al.* (2021). Seasonal incidence and efficacy of botanical insecticides against Painted bug, *Bagrada hilaris* (Burmeister) (Hemiptera: Pentatomidae) in Indian mustard (*Brassica juncea* genotype RH 725). *Journal of Applied and Natural Science*, 13(4), 1518 - 1523. https://doi.org/10.31018/jans.v13i4.3182

Abstract
Bagrada hilaris (Burmeister) is a serious pest of *Brassica* crops in the North-Western region of India, inflicting crop yield losses. Therefore, the present study was conducted on seasonal incidence and management of *B. hilaris* in *Brassica juncea* genotype RH 725 at farmer's field, Kolana village, Aravalli Hills Region, Rewari, Haryana, India during *Rabi*, 2019-20 and 2020-21. This study laid out the trial in a randomized block design with three replications and six treatments viz., Neem Seed Kernel Extract (NSKE) @ 7%, Nimbecidine @ 0.03%, Neem oil @ 5%, NSKE @ 5%, Neem oil @ 7% and control (unsprayed). Observations on the incidence of *B. hilaris* showed that it appeared from 5th Standard Meteorological Week (SMW) (0.34 bugs plant^{-1}) and attained peak during 10th SMW with 5.77 bugs plant^{-1}. The incidence of *B. hilaris* exhibited significant positive correlation with maximum ($r=0.852$, $p<0.05$) and minimum ($r=0.900$, $p<0.05$) temperature, rainfall ($r=0.763$, $p<0.05$) and wind velocity ($r=0.959$, $p<0.05$). Spray of Neem oil @ 7% (83.01 %) was the most effective in reducing the *B. hilaris* population over control followed by NSKE @ 7% (81.48 %), while NSKE @ 5% (68.85 %) confirmed least effective. Seed yield in different treatments varied from 1440.5 kg ha^{-1} (NSKE @ 5%) to 1590 kg ha^{-1} (Neem oil @ 7%) against 1216 kg ha^{-1} in control. The highest incremental cost-benefit ratio was registered with NSKE @ 7% (1: 7.70) followed by Nimbecidine @ 0.03% (1: 7.41) and NSKE @ 5% (1: 6.25). The present investigation signified that the study on the seasonal incidence of *B. hilaris* in relation to weather parameters could provide information for planning pest control and management strategies. The botanicals could be used as eco-friendly and economical substitutes for chemical insecticides at farmer's fields against this insect pest.

Keywords: *Bagrada hilaris*, *Brassica*, Insecticides, Management, Seasonal incidence, Weather parameter

INTRODUCTION

Rapeseed and mustard are the major *Rabi* oilseed crops that belong to the genus Brassica and family Cruciferae (Brassicaceae). It is one of India's economically significant agricultural produces. Rapeseed and mustard are placed third as important edible oilseed crops worldwide after soybean and palm oil. At the global level, it is mostly grown in tropical and subtropical regions (Panday *et al*., 1999; Balai *et al*., 2012; Choudhary *et al*., 2014). In India, rapeseed and mustard are cultivated on about 6.23 million ha, with the production of about 9.34 million tonnes. In Haryana, it is grown in 0.61 million ha area with a production of 1.25 million tonnes (Anonymous, 2019). The main oilseed *Brassica* species cultivated in India include

Brassica juncea, *B. napus*, *B. carinata*, *B. oleracea* and *B. nigra*. Out of these, *B. juncea* (L.) Czern (Indian mustard) occupies a large area and makes an essential contribution in terms of oilseeds and edible oils production. It is mainly grown in the western to the central area of North India and in some non-traditional parts of southern India (Jat *et al*., 2019).

Ecological factors and insect pests are significant constraints that pose a severe hazard to *Brassica* from germination to harvest. It was attacked by about 50 insect species. The *Bagrada hilaris* (Burmeister) (Hemiptera: Pentatomidae), commonly referred to as the painted bug, is a major limiting factor in cruciferous crops in India. Its severe infestation at the pod formation and maturity stages cause losses of 30.1% in yield and 3.4% in oil content (Singh *et al*., 1980; Singh, 2008; Sharma and Singh, 2010). Weather parameters viz., temperature, humidity, rainfall, sunshine, wind speed and evaporation influence the incidence and thus vanishing of *B. hilaris* population (Divya *et al*., 2015; Singh *et al*., 2018). Continuous monitoring of this pest on *Brassica* crop is indispensable for devising a suitable pest management strategy.

Management of this insect pest in the *Brassica* crop is a basic need for obtaining a maximum seed yield of good quality. The use of chemicals to control insect pests leads to several problems viz., environment pollution, toxicity to pollinators and natural enemies, and adverse effects on human health (Singh, 2001). To overcome these problems, there is an immediate need to adopt environmentally safe and non-hazardous to human health approaches, like the use of botanical insecticides (Neem Seed Kernel Extract and Neemarin1500 ppm), for the management of *B. hilaris* (Kalasariya and Parmar, 2019; Vishvendra and Sachan, 2020). The earlier studies revealed that a number of chemical insecticides viz., Dimethoate 30 EC, Imidacloprid 17.8 SL, Thiamethoxam 25 WG, Malathion 50 EC, Chlorpyriphos 20 EC, Acetamiprid 20 SP and Profenophos 50 EC were largely used and found effective to control this insect pest in India (Bawaskar et al., 2017; Ratnoo et al., 2018; Kalasariya and Parmar, 2019). Formulations made of Neem oil are used in organic farming, as it repels a wide variety of pests (Isman and Murray, 2006; Mishra *et al*., 1995). The present investigation aimed to study the seasonal incidence and efficacy of botanical insecticides to control the infestation of *B. hilaris* on *Brassica* crop.

MATERIALS AND METHODS

Study area

The field experiment was conducted at the farmer's field, Kolana village, Aravalli Hills Region, Rewari, Haryana, India during *Rabi*, 2019-20 and 2020-21. The geographical position is 28°12'24.7"N latitude and 76° 21'11.0"E longitude with an altitude of 296 m. The soil of the trial site was sandy loam in texture.

Selection of the genotype

The *B. juncea* genotype RH 725 was taken from Regional Research Station, Bawal, Rewari of Chaudhary Charan Singh Haryana Agricultural University (CCS HAU), Hisar (Haryana).

Experimental design for seasonal incidence

Genotype RH 725 cultivar was sown on 20th October of both the years (2019 and 2020) in the plot of 150 m^2 area, with row to row and plant to plant distance of 30 and 10 cm, respectively. The population of *B. hilaris* was recorded at the weekly interval, starting from the first appearance to harvest. Their number was counted from thirty randomly selected and tagged plants. The data on weather parameters viz., maximum and minimum temperature, morning and evening humidity, sunshine, rainfall, wind velocity and evaporation was collected from the meteorological observatory, CCS HAU, Regional Research Station, Bawal, Rewari (Haryana).

Preparation of botanicals

Neem Seed Kernel Extract (NSKE)

1 kg of dried neem seed kernels crushed and soaked overnight in 10 litre water. Soaked material was filtered through muslin cloth and the volume of the filtrate was made to 10 litres. Dilute to 5 % (50 ml decanted solution in 1 litre of water) or 7% (70 ml decanted solution in 1 litre of water) and 1 % Teepol (10 ml $litre^{-1}$ of water) was added at the time of spraying (Anonymous, 2008).

Neem oil

Neem seeds were picked from neem plants, and these seeds were dried and extracted in the oil expeller machine. Crude oil was filtered through muslin cloth and that oil was used as per the requirement of the experiment.

Experimental design for evaluation of botanical insecticides

A trial was laid out in the randomized block design (RBD) with three replications and six treatments, including control (unsprayed). The genotype RH 725 was sown with a spacing of 30 × 10 cm, in each plot size of 4.2×3 m. Five botanical insecticides were evaluated viz., Neem Seed Kernel Extract (NSKE) @ 7%, Nimbecidine @ 0.03%, Neem oil @ 5%, NSKE @ 5% and Neem oil @ 7%. The spray was applied when the *B. hilaris* population reached the economic threshold level. The effect of insecticides was evaluated by counting nymphs and adults of *B. hilaris* from 10 randomly selected and tagged plants in each plot, a day prior (before spray) and 1st, 3rd, 7th, 10th and 15th days after spray (DAS) of insecticides.

Statistical analysis

The data relating to correlation coefficients between weather parameters and *B. hilaris* incidence; and critical difference (CD) was statistically analysed using software OPSTAT (Sheoran *et al*., 1998). Per cent reduction in *B. hilaris* population over control was calculated by using the following formula.

Per cent reduction over control = Population recorded in control (unsprayed) – Population recorded after spray / Population recorded in control (unsprayed) Eq.1

The seed yield plot^{-1} in different treatments was recorded and converted to kilogram hectare^{-1} (kg ha^{-1}) after harvest. The Incremental Cost-Benefit Ratio (ICBR) was calculated by the prevailing market price of mustard seed, cost of insecticides and labour used with the following formula (Sharma *et al*., 2017).

ICBR = Additional profit over the control ÷ Cost of treatment .....Eq. 2

RESULTS AND DISCUSSION

Effect of weather parameters on *B. hilaris* incidence

Pooled data (*Rabi*, 2019-20 and 2020-21) regarding the effect of weather parameters on *B. hilaris* incidence shown in Fig. 1. The initial incidence of *B. hilaris* was observed from 5th Standard Meteorological Week (SMW) (0.34 bugs plant^{-1}), and after that increased during subsequent weeks with a peak during 10th SMW (5.77 bugs plant^{-1}). The maximum and minimum temperature weekly during this peak was 27.9 and 12.05 °C; morning and evening humidity were 87.5 and 41%, respectively. The sunshine, rainfall, wind velocity and evaporation were 6.4 hrs., 25.65 mm, 4.05 km h^{-1} and 3.4 mm, respectively. These observations are in contradiction with the findings of a field experiment on seasonal incidence of *B. hilaris* was conducted at Junagadh, Gujarat, India by Divya *et al*. (2015), who reported that peak population on 3rd (7.05 bugs plant^{-1}) and 2nd (6.95 bugs plant^{-1}) standard week when maximum temperature ranged from 28.8-11.1 °C and minimum temperature ranged from 27.3-12.2 °C. The temperature and wind velocity influenced the incidence of *B. hilaris* more in comparison to other weather parameters. Correlation coefficients (Table 1) revealed a significant positive relationship with maximum (r= 0.852, p= 0.015) and minimum (r =0.900, p= 0.006) temperature, rainfall (r= 0.763, p= 0.046) and wind velocity (r= 0.959, p= 0.001), while non-significant positive with evening humidity (r= 0.160, p= 0.732) and evaporation (r= 0.543, p= 0.207); non-significant negative one with morning humidity (r= -0.328, p= 0.474) and sunshine hrs. (r= -0.618, p= 0.139). These results agree with those of Divya *et al*. (2015), who reported that morning relative humidity (r= -0.048 and r= -0.263) had a non-significant negative association with *B. hilaris* incidence. Present findings are also corroborated with the results of the experiment conducted by Singh *et al.* (2018) at Kumarganj, Faizabad, India, and observed a significant positive correlation between the incidence of *B. hilaris* on *Eruca sativa* genotype T-27 and minimum temperature (r= 0.2785).

Evaluation of botanical insecticides against *B. hilaris*

The pooled data regarding the efficacy of insecticides given in Table 2 revealed that before spray, *B. hilaris*

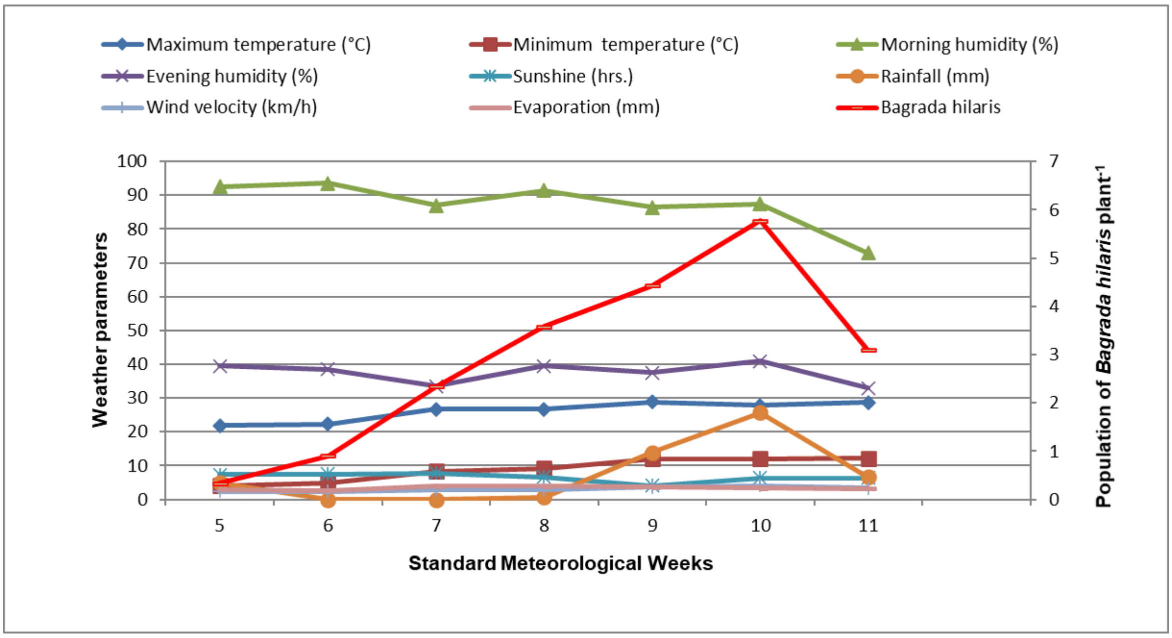

Fig. 1. *Effect of weather parameters on population of B. hilaris (Pooled data of Rabi, 2019-20 and 2020-21)*

Table 1. Correlation coefficients between incidence of *B. hilaris* and weather parameters (Pooled data of *Rabi*, 2019-20 and 2020-21)

Weather parameters	Correlation coefficient (r)	p- value
Maximum temperature (°C)	0.852*	0.015
Minimum temperature (°C)	0.900*	0.006
Morning humidity (%)	-0.328	0.474
Evening humidity (%)	0.160	0.732
Sunshine (hrs.)	-0.618	0.139
Rainfall (mm)	0.763*	0.046
Wind velocity (km h^{-1})	0.959*	0.001
Evaporation (mm)	0.543	0.207

*Significant at P= 0.05

Table 2. Efficacy of different treatments against *B. hilaris* **(**Pooled data of *Rabi*, 2019-20 and 2020-21)

Treatments	Population of *B. hilaris* (nymph and adult) $plant^{-1}$						*% Reduction 15 DAS
	Before spray	1DAS	3DAS	7DAS	10DAS	15DAS	
NSKE @ 7%	2.67(1.92)	1.77(1.66)	1.37(1.54)	1.09(1.44)	0.93(1.39)	0.85(1.36)	81.48
Nimbecidine @ 0.03%	2.80(1.95)	1.99(1.73)	1.65(1.62)	1.43(1.56)	1.25(1.50)	1.12(1.45)	75.60
Neem oil @ 5%	2.84(1.96)	2.24(1.80)	1.93(1.71)	1.69(1.64)	1.49(1.58)	1.35(1.53)	70.59
NSKE @ 5%	2.80(1.95)	2.32(1.82)	1.99(1.73)	1.73(1.65)	1.57(1.60)	1.43(1.56)	68.85
Neem oil @ 7%	2.58(1.89)	1.67(1.63)	1.25(1.50)	1.03(1.43)	0.85(1.36)	0.78(1.33)	83.01
Control	2.38 (1.84)	2.82(1.95)	3.27(2.07)	3.70(2.17)	4.24(2.29)	4.59(2.36)	
CD at 5%		0.09	0.12	0.15	0.14	0.16	
SE (m)	0.04	0.03	0.04	0.05	0.04	0.05	

*Per cent reduction in *B. hilaris* population over control 15 DAS; Figures in parentheses are square root transformations; DAS: Day after spray

population ranged between 2.38 to 2.84 bugs $plant^{-1}$. All the botanical insecticides significantly reduced the *B. hilaris* population after one, three, seven, ten and fifteen days after spray (DAS). At 1^{st} DAS, Neem oil @ 7% spray was found most effective (1.67 bugs $plant^{-1}$) against (2.82 bugs $plant^{-1}$) control and it was statistically at par with NSKE @ 7% (1.77 bugs $plant^{-1}$). The next most effective insecticide was Nimbecidine @ 0.03% (1.99 bugs $plant^{-1}$) spray, which was statistically at par with Neem oil @ 5% (2.24 bugs $plant^{-1}$). Insecticide, NSKE @ 5% was least effective, having a *B. hilaris* population of 2.32 bugs $plant^{-1}$.

Data recorded on the 3^{rd}, 7^{th}, 10^{th} and 15^{th} DAS also exhibited a similar trend of the efficacy of different botanical insecticides. The *B. hilaris* population ranged from 1. 25 to 1.99 bugs $plant^{-1}$ at 3^{rd} DAS, 1.03 to 1.73 bugs $plant^{-1}$ at 7^{th} DAS, 0.85 to 1.57 bugs $plant^{-1}$ at 10^{th} DAS and 0.78 to 1.43 bugs $plant^{-1}$ at 15^{th} DAS.

The pooled data (Table 2) on per cent reduction in *B. hilaris* population over control at 15^{th} DAS revealed that spray of Neem oil @ 7% (83.01 %) was found to be the best over the rest of the botanical insecticides. It was followed by NSKE @ 7% (81.48 %) and Nimbecidine @ 0.03% (75.60 %). Minimum reduction in *B. hilaris* population was found with Neem oil @ 5% (70.59 %) and NSKE @ 5% (68.85 %).These results are in accordance with the findings of the experiment carried out at Hisar, Haryana, India by Bawaskar et al. (2017), who concluded that Nimbecidine 1500 ppm (45.64 %) was effective in reducing the *B. hilaris* population on the *Brassica juncea* genotype RH 30. Similarly, these observations also validate with those of Vishvendra and Sachan (2020), who conducted a field experiment at Meerut, Uttar Pradesh, India, and found NSKE (40 and 43.71 %) were effective against *B. hilaris* on *B. juncea* genotype Pusa bold.

Impact of *B. hilaris* management on seed yield of *Brassica*

Data of seed yield given in Table 3 revealed that spray of insecticides was effective to protect the crop from the infestation of *B. hilaris*. The spray of Neem oil @ 7%

Table 3. Economic analysis of different treatments against *B. hilaris* (Pooled data of *Rabi*, 2019-20 and 2020-21)

Treatments	Cost of insecticides (Rs. ha^{-1})	Labour charge (Rs. ha^{-1})	Total expenditure (Labour + insecticide) (Rs. ha^{-1})	Seed yield (kg ha^{-1})	Gross income (Rs. ha^{-1})	Net return over control (Rs. ha^{-1})	ICBR
NSKE @ 7%	1260	450	1710	1567	58763	13163	1: 7.70
Nimbecidine @ 0.03%	1140	450	1590	1529.5	57375	11775	1: 7.41
Neem oil @ 5%	1550	450	2000	1449.5	54375	8775	1: 4.39
NSKE @ 5%	900	450	1350	1440.5	54038	8438	1: 6.25
Neem oil @ 7%	2170	450	2620	1590	59625	14025	1: 5.35
Control				1216	45600		

ICBR: Incremental Cost Benefit Ratio; *Mustard seed rate @ 3750 Rs. qt^{-1}

gave the maximum seed yield (1590 kg ha^{-1}), which was found superior as a comparison to the rest of the insecticides, followed by NSKE @ 7% (1567 kg ha^{-1}) and Nimbecidine @ 0.03% (1529.5 kg ha^{-1}). The lowest seed yield (1440.5 kg ha^{-1}) was registered with NSKE @ 5% and Neem oil @ 5% (1449.5 kg ha^{-1}) whereas, the seed yield recorded in control was only 1216 kg ha^{-1}.

Economics and Incremental cost-benefit ratio (ICBR)

Table 3, in respect of economics of botanical insecticides, revealed that the maximum gross income and net return over control were obtained with the use of Neem oil @ 7% (Rs. 59625 and Rs. 14025) followed by NSKE @ 7% (Rs. 58763 and Rs. 13163). In contrast, the minimum found with NSKE @ 5% (Rs. 54038 and Rs. 8438). Based on ICBR of different insecticides, NSKE @ 7% was the most economic insecticide because it gave the maximum cost profit (1: 7.70) compared with the remaining insecticides. The next profitable insecticides were Nimbecidine @ 0.03% (1: 7.41) and NSKE @ 5% (1: 6.25). The lowest ICBR was obtained from Neem oil @ 5% (1: 4.39). There appears to be no report regarding the efficacy of botanical insecticides against *B. hilaris* on *B. juncea* genotype RH 725.

Conclusion

The present study deduced that weather parameters greatly impacted the occurrence, multiplication, and disappearance of *B. hilaris* population on *Brassica juncea* genotype RH 725. Botanical insecticides like Neem oil @ 7% (83.01%) and NSKE @ 7% (81.48%) were effective in controlling the *B. hilaris* population and are safer, eco-friendly, and economically viable. Therefore, considering human health and environmental safety, it could be recommended that farmers can use botanical insecticides as an alternative to chemical insecticides to protect the *Brassica* crops against infestation of *B. hilaris*.

ACKNOWLEDGEMENTS

The authors thank the late Dr. Satyapal Yadav, Assistant Scientist, Department of Entomology, CCS Haryana Agricultural University, Regional Research Station, Bawal, Rewari, Haryana for their help and valuable suggestions.

Conflict of interest

The authors declare that they have no conflict of interest.

REFERENCES

1. Anonymous (2008). Proceedings of AICRP Group meeting on rapeseed-mustard, Bhubneswar (Orissa), Aug. 7-9.
2. Anonymous (2019). Agricultural statistics at a glance. Government of India, Ministry of Agriculture, Department of Agriculture & Cooperation, Directorate of Economics & Statistics, Krishi Bhawan, New Delhi.
3. Balai, C. M., Meena, R. P., Meena, B. L. & Bairwa, R.K. (2012). Impact of front line demonstration on rapeseed-mustard yield improvement. *Journal of Extension Education*, 12(2), 113-116.
4. Bawaskar, D. M., Yadav, S., Singh, S. P. & Nadaf, A. (2017). Efficacy and economics of seed treatment and foliar spray with insecticides against *Bagrada hilaris* (Burmeister) in Indian mustard (*Brassica juncea* L.). *Journal of Oilseed Brassica*, 8 (1), 80-88.
5. Choudhary, M., Sangha, J. K. & Grover, K. (2014). Conventional and non-conventional edible oils: An Indian perspective. *Journal of the American Oil Chemists' Society*, 91(2), 179-206.
6. Divya, C., Kalasariya, R. L. & Kanara, H. G. (2015). Seasonal incidence of mustard painted bug, *Bagrada hilaris* (Burmeister) and their correlation with abiotic factors on mustard. *Journal of Insect Science*, 28 (1), 92-95.
7. Isman & Murray, B. (2006). Botanical Insecticides, Deterrents, and Repellents in Modern Agriculture and an Increasingly Regulated World. *Annual Review of Entomology*, 51, 45–66. doi:10.1146/annurev.ento.51.110104.151146.

8. Jat, R. S., Singh, V. V., Sharma, P. & Rai, P. K. (2019). Oilseed Brassica in India: Demand, supply, policy perspective and future potential. OCL, 26, 8. doi:10.1051/ocl/2019005.
9. Kalasariya, R. L. & Parmar, K. D. (2019). Management of painted bug, *Bagrada hilaris* (Burmeister) in mustard with different spray schedules. *Journal of Entomology and Zoology Studies*, 7(3), 1157-1163.
10. Mishra, A. K., Singh, N. & Sharma, V. P. (1995). Use of neem oil as a mosquito repellent in tribal villages of mandla district, madhya pradesh. *Indian Journal of Malariology*, 32 (3), 99–103.
11. Panday, I. D., Singh, B., & Sachan, J. N. (1999). Brassica hybrid research in India: status and prospects. Proceedings of the tenth international rapeseed congress. Canberra, Australiam.
12. Ratnoo, S. D., Pandey, S. & Joshi, N. (2018). Efficacy of insecticides against painted bug *Bagrada cruciferarum* kirkaldy in mustard. *Journal of Entomology and Zoology Studies*, 6(4), 121-122.
13. Sharma, D., Yadav, S. P. & Yadav, S. (2017). Biointensive integrated management of *Lipaphis erysimi* Kalt. (Homoptera: Aphididae) in *Brassica* spp. *Journal of Applied and Natural Science*, 9 (4), 2132 -2136.
14. Sharma, P. & Singh, Y. P. (2010). Directorate of Rapeseed- Mustard Research, Indian Council of Agriculture Research, Sewar, 321303, Bharatpur (Rajasthan). *Annals National Language Journal*, 1, 47-51.
15. Sheoran, O. P., Tonk, D. S., Kaushik, L. S., Hasija, R. C. & Pannu, R. S. (1998). Statistical Software Package for Agricultural Research Workers (pp 139- 143). Recent Advances in information theory, Statistics & Computer Applications by D.S. Hooda and R.C. Hasija Department of Mathematics Statistics, CCS HAU, Hisar.
16. Singh, H. Y., Gupta, D. S., Yadava, T. P. & Dhawan, K. (1980). Post harvest losses caused by painted bug (*Bagrada cruciferarum* Kirk.) to mustard. *HAU Journal of Research*, 10, 407-409.
17. Singh, P. K. (2001). Control of mustard aphid, *Lipaphis erysimi* (Kalt.) (Homoptera: Aphididae) with minimum insecticide use. *Journal of Aphidology*, 15,139 -142.
18. Singh, S. P. (2008). Insect pest management in oilseed crops. *Indian Farming*, 58, 29-33.
19. Singh, S., Kumar, S., Singh, J., Dohare, A. P. S., Kumar, P. & Lal, M. N. (2018). Population Dynamics of Painted Bug (*Bagrada hilaris*), in Different Varieties of *Brassica* Oil Seed Crops. *International Journal of Current Microbiology and Applied Sciences*, 7, 3682-3685.
20. Vishvendra & Sachan, S. K. (2020). Evaluate the efficacy of some novel insecticides against *Bagrada hilaris*, (Burm) in *Brassica* sp. under natural condition in west UP, India. *International Journal of Fauna and Biological Studies*, 7 (5), 15-16.