Indian Journal of Ecology (2024) 51(2): 397-400
DOI: https://doi.org/10.55362/IJE/2024/4249

Manuscript Number: 4249
NAAS Rating: 5.38

Population Dynamics of Mustard Aphid in Relation to Weather Parameters and Effect of Predators on Aphid Population

Arun Kumar, Mukesh Kumar Mishra*, Rakesh Pandey, A.K. Singh, B.K. Singh and S.K. Singh

Department of Entomology, Banda University of Agriculture & Technology, Banda-210 001, India
**E-mail: mishraent@gmail.com*

***Abstract*:** The experiments were conducted to assess the population dynamics of mustard aphid (*Lipaphis erysimi*) and its important predators on three dates of sowing at Banda. The occurrence of mustard aphid was started from 52nd Standard Week (SW) and continued till harvest (12th SW). The population ranged from 0.15 to 26.31, 0.11 to 259.34 and 0.03 to 305.49 aphids/10 cm central twig/plant, respectively on timely, mid late and late sown crop. Four predators *viz*., *Coccinella septempunctata*, *Coccinella* spp. (unidentified), *Cheilomenes sexmaculata* and Syrphid fly (*Episyrphus balteatus*) were recorded at different stages of the crop growth. The population of predators was significantly increased with an increase in the aphid population from 7th to 10th SW among the different dates of sown crops. A mixed type of significant level of correlation coefficient had shown among mustard aphid and weather parameters and even the dates of sown crops. The multiple stepwise linear regression equations showed weather parameters greatly influenced the aphid population at timely and mid late sown mustard crops, however the aphid predators were more influenced at mid-late and late sown mustard crops and both abiotic and biotic factors played a vital role in growth multiplication, development and distribution of mustard aphid.

***Keywords*:** Population dynamics, *Lipaphis erysimi*, Predators, Correlation, Weather parameters

Rapeseed (*Brasssica rapa* L) is one of the major oilseed crops grown in Rabi season in India and ranks third in total acreage (19.8%) and production (9.8%) of the world (Anonymous 2019). However, its production and productivity are much influenced with the biotic and abiotic stresses. In case of biotic stresses, among 38 insects associated with *Brassica* at different stages of its growth, the mustard aphid, *Lipaphis erysimi* (Kaltenbach), continues to be the key pest damaging oilseed brass. It is the major limiting factor causing up to 96% yield losses from the seedling stage to maturity (Shylesha et al 2006) and a decrease of about 15% in oil contents. Both nymphs and adults suck the cell sap from different parts of the plant i.e., inflorescence, leaf, stem, twig and pods. Biotic factors, such as *Coccinella septempunctata* (Linnaeus), *C. transversalis* (F.) and *Harmonia axyridis* (F.), green lacewing, *Chrysoperla carnea* (Stephens); syrphid fly, *Xanthogramma scutellaris* (Fab.) are the major natural enemies on insect pests of mustard that directly inhibit the pest population. Among these, *C. septempunctata* and *C. transversalis* are considered as major dominating predators of aphids and range between 5 to 20 per cent predation in the field (Singh et al 2018). Abiotic parameters also play a vital role in the population build-up of mustard aphids. Their positive or negative association with the pest population gives a place to develop suitable management strategies against the pest. Repeatable and reliable management decisions can be made based on monitoring information. Therefore, considering the above fact, the present investigation was envisaged to information on the population dynamics of mustard aphid, its predators in relation to weather parameters in Bundelkhand region of Uttar Pradesh.

MATERIAL AND METHODS

The present investigation was conducted during 2019-20 and 2020-21 at Banda University of Agriculture and Technology, Banda, Uttar Pradesh, India (24º 53′ 25º 55′ N latitude, 80º 07′ 81º 34′ E longitudes). The rapeseed variety BSH-1 was raised at three different dates *viz.,* timely sown (15th October), mid-late sown (05th November) & late sown (25th November) following recommended package of practices during *rabi* 2019-20 and 2020-21**.** Data were recorded on the population of mustard aphid and its natural predators on their natural host rapeseed by following standard sampling methodology given by Singh and Lal, (1999). Observations were recorded from 400 m^2 area for each date of sowing.

Mustard aphid: At initial stage population was quite low, thus count was made on leaves and shoots as well. After the stem elongation, populations were recorded at weekly intervals from 120 randomly selected plants with aphids counted from top 10 cm apical shoot (Singh and Lal 1999) from the time of appearance till harvest.

Predators: Observations on the population of predators was recorded at weekly interval by visual counting the total number of grubs and adult beetles / plant for coccinellids and total number of maggots /10 cm apical twig for syrphid fly separately on each date of sown crops.

Statistical analysis: For study the impact of weather parameters on the population build-up of mustard aphid and their natural predators, the meteorological data (weekly mean) on temperature (maximum and minimum), relative humidity (maximum and minimum), rainfall (mm) and wind speed (kmph) were obtained from meteorological observatory of the College of Agriculture, BUA&T, Banda for the experimentation period. Correlation coefficients were worked out for the population build-up (means of pooled data of two cropping seasons) of mustard aphid in relation to their predators and weather parameters. Further, step-wise linear regression model was developed for estimating alate aphid with the climatic parameters namely, temperature (maximum and minimum), relative humidity (maximum and minimum), rainfall (mm) and wind speed (kmph). The data were analyzed by using OPSTAT online software developed by CCSHAU, Hisar.

RESULTS AND DISCUSSION

Population build-up of mustard aphid and their predators: The evident of the pooled mean data that mustard aphid first appeared in the last week of December (52nd SW) on all three dates of sown crop and continued till harvest of the respective date of sown crop (Table 1, Fig. 1). The population attained its peak in 7th SW on timely and mid-late sown crops, where the aphid population was 14.19 and 158.25 aphids/10 cm top apical terminal shoot, respectively, however on late sown crop the peak was observed in 8th SW where the population was reached up to 222.19 aphids/10 cm top apical terminal shoot. Mehnaj et al (2017) also observed the appearance of mustard aphid and its peak activity in 51st SM and 8th SW, respectively. Similarly, the peak activity of mustard aphids between 6th to 8th SW recorded by Singh et al (2018). Meena et al (2019) also recorded comparatively lower incidences of aphid population on crops sown by mid-October, whereas in mid-late and late sown crops, significantly higher numbers of aphid's infestation were observed by Srivastava and Prajapati, 2012. Observations on the natural predators revealed that the prevalence of two groups of predators *viz*., coccinellids beetles (*Coccinella septempunctata*, *C. transversalis* and *Cheilomenes sexmaculata*) and Syrphid fly (*Episyrphus balteatus*) (Table 1). Among the date of sown crops, comparatively higher population of coccinellids and syrphid fly were recorded on the crop sown by 25th November (late sown). The population of predators have significantly increased with an increase in the aphid population. Mishra and Kanwat (2018) also observed high larval populations of predators coincided with peaks in the aphid population. The trend of the occurrence of the predators in present study conformity with Dwivedi et al (2018), where peak activity of coccinellids and shyrphids between 6th to 12th SW.

Correlation between aphid population and their predators: The population of both the predators (coccinellids and shyrphids) had positive correlation with mustard aphid in all the date of sown crops (Table 2). The population of coccinellid had a significant correlation in timely sown and highly significant correlation in late sown. Whereas, the population shyrphid fly had a significant correlation in timely sown and highly significant correlation in mid-late and late sown crops with mustard aphid. It is clear that, the population of predators increased gradually with an increase of aphid population and then resulting in gradual decrease in aphid population. Singh et al (2018), also reported that mustard aphid, *L. erysimi* were showed a high positive correlation with predators. In present study the peak activity of predators occurred in later crop stage, when the aphid population was maximum in the field. The peak activity syrphids was recorded in 8th and 9th SW and then gradually decreased with decrease in aphid population revealing a positive correlation between population of aphid and syrphids. The syrphids play a positive role in reduction of aphid population in the field. Similar results were also observed by Devi et al (2011).

Correlation between population of mustard aphid and abiotic factors: The minimum temperature and rainfall had non-significant correlation on all the dates of sown crop, whereas maximum temperature had significant positive correlation with mustard aphid only on the mustard crop sown

Table 2. Correlation(r) coefficient of aphid with their predators and weather parameters

Sowing time	Coccinellids	Syrphids	Temperature (°C)		Relative humidity (%)		Wind speed (kmph)	Rainfall (mm)
			Minimum	Maximum	Minimum	Maximum		
Timely	0.661*	0.571*	-0.060	0.134	-0.033	-0.024	-0.829**	0.200
Mid late	0.528	0.756**	0.083	0.341	-0.191	0.181	-0.697*	-0.006
Late	0.766**	0.892**	0.453	0.612*	-0.587*	-0.566*	0.039	0.024

** Highly significant at 1% level of significance; *Significant at 5% level of significance

by 15th November (Table 2). Similarly, minimum and maximum relative humidity both had nonsignificant correlation on timely and mid-late sown crops but a significant negative correlation with mustard aphid at late sown crops. The population of mustard aphid showed a highly significantly negatively correlation in timely sown, a significant negative correlation at mid-late sown and nonsignificant positive correlation on late sown crop with wind speed. A positive correlation with temperature and significant negative correlation with relative humidity have also observed by Zia and Haseeb (2019). Srivastava and Prajapati (2012) also observed the significant relation with temperature on late sown crop, negative as well as positive association with relative humidity and negative nonsignificant correlation with rainfall in their study at Bundelkhand of Madhya Pradesh. There was mixed type correlation among the different dates of sown crops and is in partial agreement with the results of Ali and Rizvi (2012)

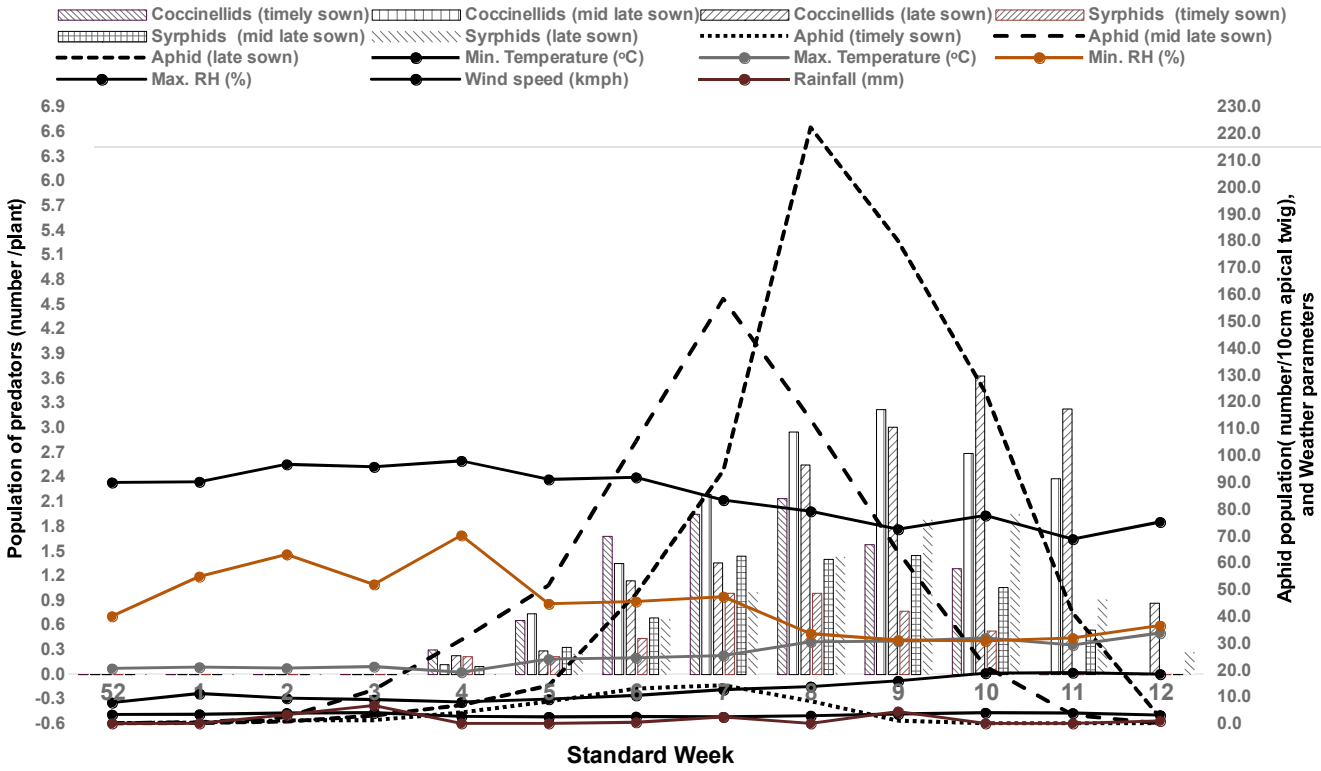

Fig. 1. Relation of mustard aphid (*Lipaphis erysimi*) with their predators and weather parameters.

Table 3. Stepwise regression equations for estimating the influence of weather parameters on the incidence of alate mustard aphid during 2019-21 (Pooled)

Particulars	Sowing dates	Regression equation	R^2
Aphid population	Timely sown	$Y= -27.58 + 1.43*T_{Min.} -0.02*T_{Max.} -0.20*RH_{Min.} + 0.67*RH_{Max.} -10.10*WS + 0.10*RF$	0.89
		$Y= -9.13 -1.75*T_{Min.} + 1.38*T_{Max.}$	0.23
	Mid late sown	$Y= 0.43 + 7.32*T_{Min.} + 3.76*T_{Max.} -0.42*RH_{Min.} + 1.98*RH_{Max.} -94.22*WS + 11.41*RF$	0.87
		$Y= -161.93 -15.24*T_{Min.} + 15.79*T_{Max.}$	0.37
	Late sown	$Y= 378.18 -27.97*T_{Min.} + 20.78*T_{Max.} +1.73*RH_{Min.} -7.54* RH_{Max.} +19.58*WS+ 0.72*RF$	0.52
		$Y= -261.19 -11.95*T_{Min.} + 18.33*T_{Max.}$	0.45
Predators population	Timely sown	$Y= 1.08 + 8.42*X_1 -9.99*X_2$	0.48
	Mid late sown	$Y= 15.74 -56.26*X_1 + 179.15*X_2$	0.81
	Late sown	$Y= 0.88 -27.39*X_1 + 140*X_2$	0.83

Note: $T_{Min.}$= Minimum Temperature (oC); $T_{Max.}$= Maximum temperature (oC); $RH_{Min.}$= Minimum RH (%); RH_{Max}= Maximum RH (%) and WS= Wind Speed (kmph); RF= Rainfall (mm), X_1= Coccinellids and X_2=Syrphid

where a variability in correlation between *L. erysimi* population and whether parameters among three dates of sown crop was observed.

Regression analysis: Based on pooled data of two cropping seasons, the combined influence of all the weather parameters had more influence on population fluctuation of mustard aphid as R^2 value was 0.89, 0.87 and 0.52 (Table 3). Das et al (2019) also observed weather parameters contributed 72- 87% variation in aphid population. Mandal et al (2018) also reported the combined effect of temperature, light intensity and relative humidity depicted 81.7 per cent abundance of *L. erysimi*. The R^2 value of temperature (minimum & maximum) only were 0.23, 0.37 and 0.45 at timely, mid late and late sown crops, respectively. Soni et al (2021) also observed maximum, minimum temperature and sunshine hours contributed only 41 per cent variation in aphid population and was depicted in predictive model. In case of predators, it was evident from the data that predators influenced with aphid population significantly at mid-late and late sown crops and contributed to the extent of 81 and 83 per cent, respectively, as compared to timely sown crops, where variation was 48 per cent. It is evident from the stepwise regression equations that weather parameters greatly influenced the aphid population at timely and mid late sown mustard crops, however, the predators were more influenced at mid-late and late sown mustard crops and both abiotic and biotic factors played a vital role in growth multiplication, development and distribution of mustard aphid.

AUTHORS CONTRIBUTION

AK conducted experiments and collect the data from field. MKM devised and designed, supervised the research and wrote the manuscript, RP writing-review and edited the manuscript, AKS worked out data curation and formal analysis, BKS and SKS were provided the facilities and edited the manuscript. All the authors read and approved the manuscript.

CONCLUSIONS

The population of mustard aphid *L. erysimi* was quite low at timely sown crops by 15th October as compared to mid-late (05th November) and late sown (25th November) mustard crop in Bundelkhand region of Uttar Pradesh. Among weather parameters, maximum temperature, relative humidity (minimum & maximum) exhibited significant correlation with *L. erysimi* only at late sown crop. Coccinellids and syrphid fly both exhibited strong positive correlation with mustard aphid population at variable dates of sown crops. The multiple linear regression analysis showed that the weather factors and predators both played a vital role in growth multiplication, development and distribution of mustard aphid. Based on the present study sowing of mustard crops up to the third week of October is the best time to avoid the aphid infestation.

Received 27 September, 2023; Accepted 11 February, 2024

REFERENCES

Ali A and Rizvi PQ 2012. Influence of abiotic and biotic factors on the population dynamics of mustard aphid, *Lipaphis erysimi* (Kalt.) on Indian mustard, *Brassica juncea* with respect to

sowing dates. *Academic Journal of Plant Sciences* **5**(4): 123-127.

Anonymous 2019. AMAFW Annual report 2018-19 by Ministry of Agriculture and Farmers Welfare, Government of India. *Annual report 2018-19*. Retrieved from http://agricoop.nic.in/sites/default/files/AR_2018-19_Final_for_Print.pdf

Das S, Tejani DN, Patel JC, Desai AG, Desai AI and Gangwar GP 2019. Effect of Weather Parameters on Population Dynamics of Mustard Aphid. *Intonational Journal of Current Microbiology and Applied Science* **8**(4): 1648-1653.

Devi YR, Kalita J and Singh TK 2011. Biological control potential of an aphidophagous syrphid, *Episyrphus balteatus*, De-Geer (Diptera: Syrphidae) on mustard aphid, *Lipaphis erysimi* (Kalt.) (Homoptera: Aphididae) on cabbage ecosystem in Manipur. *Journal of Experimental Sciences* **2**(12): 13-16.

Dwivedi SA, Singh RS and Gharde SK 2018. Populations buildup of mustard aphid and their natural enemies in relation to biotic and abiotic factors. *Plant Archives* **18**(2): 2495-2500.

Mandal E, Amin MR, Rahman H and Akanda AM 2018. Infestation level and population dynamics of aphid on mustard. *Bangladesh Journal of Agriculture Research* **43**(4): 611-618.

Meena RK, Meena RK, Gurjar H and Kumar S 2019. Recent trends of mustard aphid (*Lipaphis erysimi*) infestation in rapeseed mustard in eastern Rajasthan. *Journal of Oilseed Brassica*, **10**(2): 134-139.

Mehnaj TA, Singh YP, Basant KK, Singh KK and Pandey AC 2017. Forewarning model development for mustard aphid (*Lipaphis erysimi* Kalt.) at Bharatpur and Hisar. *Journal of Agrometeorology* **19**: 334-341.

Mishra SK and Kanwat PM 2018. Seasonal incidence of mustard aphid, *Lipaphis erysimi* (Kalt) and its major predator on mustard and their correlation with abiotic factors. *Journal of Entomology & Zoology Studies* **6**(3): 831-836.

Shylesha AN, Azad Thakur NS, Pathak KA, Rao KR, Saikia K, Surose S, Kodandaram NH and Kalaishekar A 2006. Integrated management of insect pest of crops in north eastern hill region. *Technical Bulletin No. 19*. ICAR RC for NEH Region, Umiam, pp. 50.

Singh SS and Lal MN 1999. Seasonal incidence of mustard aphid, *Lipaphis erysimi* (Kalt.) on mustard crop. *Journal of Entomological Research* **23**(2): 165-67.

Singh VV, Agarwal N, Sathish BN, Kumar S, Kumar S and Pal K 2018. Studies on insect diversity in mustard (*Brassica campestris* L.) ecosystem. *Journal of Entomology & Zoology Studies* **6**(5): 698-702.

Soni S, Kumar S, Sood AK and Rana RS 2021. Modeling of aphid complex and its associated natural enemies in rapeseed-mustard in relation to climatic factors. *Journal of Agrometeorology* **23:** 207-212.

Srivastava AK and Prajapati AK 2012. Validation of degree day based forewarning model of mustard aphid in Bundelkhand agro-climatic zone of Madhya Pradesh. *Journal of Agrometeorology* **14:** 70-73.

Zia A and Haseeb M 2019. Population dynamics of mustard aphid (*Lipaphis erysimi* (Kalt.) In relation to weather parameters. *Journal of Entomology & Zoology Studies* **7**(2): 274-276.