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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

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Abstract: The correlation and regression analysis of mustard aphid, *Lipaphis erysimi* vis-à-vis abiotic as well as biotic factors on Indian mustard, *Brassica juncea* were studied with respect to three different sowing dates. The impact of abiotic factors *i.e.* maximum and minimum temperature and sunshine were acted in reducing *L. erysimi* population to an extent of 35.63, 15.14 and 4.83 %, respectively on early shown *B. juncea* (October 25). Whereas, on late (November 10 and 25) seeded cultivars, the maximum temperature, maximum relative humidity and evaporation are the key factors responsible in reducing the population of 3.06, 5.00 and 1.74 %, respectively. On evaluation of biotic factors, *L. erysimi* population exhibited a positive correlation with *C. septempunctata*, *C. transversalis*, *M. sexmaculatus* and *I. scutellaris*. The information congregated on correlation and regression analysis could be useful to predict the population of *Lipaphis erysimi* at any given time and also to develop effective control measures to avoid the high yield loss Indian mustard.

Key words: *Coccinella septempunctata* · *Coccinella transversalis* · *Ischiodon scutellaris* · *Lipaphis erysimi* · *Menochilus sexmaculatus*

INTRODUCTION

The rapeseed-mustard crops are gaining wide acceptance among farmers mainly because of their adaptability in both irrigated and rainfed areas of the world. It is chiefly grown in Europe, Africa, North America, South America, Oceania and Asia. Rapeseed-mustard is one of the important sources of edible oil for human consumption and cake for animals. This crop needs special attention because there is a lot of gap between the yield potential and the present actual yields. Besides a number of factors are responsible for its low productivity, insect-pests cause moderate to heavy losses in the yield. Bakhetia and Sekhon documented about 40 insect-pests harbored on the rapeseed-mustard, where about half a dozen are serious threats to cultivation of these crops [1]. Among them, mustard aphid, *Lipaphis erysimi* is the key pest [2]. The infestation of this pest varies with place to place and also depends upon the environmental factors. The attack is severe in those areas where the numbers of cloudy days are more during the pest activity period [3].

The manipulation of planting dates takes advantage for absence of the pest or avoids susceptible stage of the crop [4]. It should synchronize with the most inactive period or lowest pest population [5]. On the other hand, natural enemies also play a key role in reducing the population of insect below invasive pest and therefore, their conservation and augmentation are of great importance [6, 7]. The mustard aphid is known to be preyed upon or parasitized by a large number of predators/parasites like coccinellids, syrphids and braconids. The present investigation was, therefore, design on the correlation and regression analysis between abiotic as well as biotic factors and *Lipaphis erysimi* infestation with respect to different sowing dates of mustard.

MATERIALS AND METHODS

Indian mustard, *Brassica juncea* was sown in a randomised block design in experimental field of Faculty of Agricultural Sciences, Aligarh Muslim University, Aligarh during *rabi* season of 2004-05 and 2005-06. To ensure good germination, ploughing of the

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experimental field was done with the help of soil turning plough followed by two cross ploughing with harrow. Farmyard manure @ 1.5 tones/ha and recommended level of fertilizers [N (60 kg) + P_2O_5 (40 kg) and K_2O (40 kg)] were properly mixed into soil. The seeds of Indian mustard were sown in a micro plot (4 x 2 m) with spacing of 15 cm and 45 cm plant-to-plant and row-to-row, respectively. The micro plots were replicated thrice and three different sowing dates, October 25 (First sowing), November 10 (Second sowing) and November 25 (Third sowing) were selected for raising the crop.

To determine the correlation-regression analysis of *L. erysimi* population vis-à-vis biotic and abiotic factors, meteorological data (minimum and maximum temperature and relative humidity, wind velocity, sunshine, rainfall and evaporation) was recorded daily for each sets of experiment. The population count of predator species (*Coccinella septempunctata*, *Coccinella transversalis*, *Menochilus sexmaculatus* and *Ischiodon scutellaris*) synchronize with aphid population was also recorded at weekly interval on Indian mustard, from germination to harvest of crop.

RESULTS

First Sowing (October 25): The correlation and regression analysis of abiotic factors and mustard aphid revealed a positive and significant relation of *L. erysimi* with maximum and minimum relative humidity (r=0.59530 and 0.32321), wind velocity (r =0.72112), rainfall (r=0.04423) and evaporation (r = 0.12318). However, it was found negatively correlated with maximum (r=-0.5969), minimum (r=-0.3891) temperature and sunshine (r= -0.2198) (Table 1). While evaluated against biotic factors, *L. erysimi* population exhibit a positive correlation with coccinellids: *C. septempunctata* (r=0.80226), *C. transversalis* (r = 0.88197), *M. sexmaculatus* (r = 0.80193) and syrphid: *I. scutellaris* (r = 0.93130).

When the effect of maximum and minimum temperature and sunshine were analyzed, these factors acted upon in reducing *L. erysimi* population to an extent of 35.63, 15.14 and 4.83 %, respectively. The regression equations of abiotic and biotic factors and corresponding values responsible for increase and decrease of aphid populations were computed in Table 1.

Second sowing (November 10): On November 10 sown rapeseed-mustard crop, the relationship between *L. erysimi* population and abiotic factors represent a strong positive correlation with minimum temperature (r= 0.03355), maximum and minimum relative humidity (r=0.28847 and 0.21044), wind velocity (r=0.59516), sunshine (r = 0.03041) and rainfall (r = 0.48434). However the negative correlation was seen with maximum temperature (r = -0.1749) and evaporation (r = -0.1318). As far as biotic factors (*C. septempunctata, C. transversalis, M. sexmaculatus* and *I. scutellaris*) were concerned, they exhibited a significant positive correlation (r = 0.927394, 0.891404, 0.915587 and 0.948115, respectively) with *L. erysimi* population (Table 2).

All the abiotic as well as biotic factors showed a significant impact on aphid population (0.09 to 89.89 %). The maximum temperature and evaporation were the key factors responsible in reducing *L. erysimi* population to an extent of 3.06 and 1.74 %, respectively. Though, other factors were found positively correlated with the multiplication of *L. erysimi* (Table 2).

Table 1: The correlation and regression analysis between abiotic as well as biotic factors and *Lipaphis erysimi* population on *Brassica juncea* during first sowing (October 25)

	Parameters	Regression equation	Correlation coefficient	% Aphid increase/ decrease
		Abiotic Factors		
1.	Maximum Temp.	y = -12.273x + 292.56	r = -0.5969	-35.63
2.	Minimum Temp.	y = -7.6247x + 122.58	r = -0.3891	-15.14
3.	Maximum RH	y = 4.3439x - 320.940	r = 0.59530	35.43
4.	Minimum RH	y = 3.0092x - 108.350	r = 0.32321	10.44
5.	Wind velocity	y = 20.5370x - 3.0384	r = 0.72112	52.00
6.	Sunshine	y = -4.8906x + 75.062	r = -0.2198	-4.83
7.	Rainfall	y = 0.1177x + 51.155	r = 0.04423	0.20
8.	Evaporation	y = 9.2718x + 29.452	r = 0.12318	1.52
		Biotic Factors		
1.	*C. septempunctata*	y = 19.541x - 26.763	r = 0.80226	64.36
2.	*C. transversalis*	y = 20.939x - 2.1605	r = 0.88197	77.79
3.	*M. sexmaculatus*	y = 31.056x + 2.1884	r = 0.80193	64.31
4.	*I. scutellaris*	y = 26.580x - 5.2477	r = 0.93130	86.76

The aphid population could thus be predicted by substituting corresponding value of x (abiotic and biotic parameters) at any given point
The data presented in table are pooled analysis of two successive cropping seasons (2004-05 and 2005-06)

Table 2: The correlation and regression analysis between abiotic as well as biotic factors and *Lipaphis erysimi* population on *Brassica juncea* during second sowing (November 10)

	Parameters	Regression equation	Correlation coefficient	% Aphid increase/ decrease
		Abiotic Factors		
1.	Maximum Temp.	y = -4.7021x + 177.1	r = -0.1749	-3.06
2.	Minimum Temp.	y = 0.9295x + 74.02	r = 0.03355	0.11
3.	Maximum RH	y = 3.4431x - 212.22	r = 0.28847	8.32
4.	Minimum RH	y = 5.4687x - 207.43	r = 0.21044	4.43
5.	Wind velocity	y = 29.356x - 1.1012	r = 0.59516	35.42
6.	Sunshine	y = 1.1007x + 77.898	r = 0.03041	0.09
7.	Rainfall	y = 2.1765x + 47.648	r = 0.48434	23.45
8.	Evaporation	y = -12.098x + 117.03	r = -0.1318	-1.74
		Biotic Factors		
1.	*C. septempunctata*	y = 29.917x - 60.551	r = 0.927394	86.01
2.	*C. transversalis*	y = 38.509x - 36.754	r = 0.891404	79.46
3.	*M. sexmaculatus*	y = 63.228x - 46.987	r = 0.915587	83.83
4.	*I. scutellaris*	y = 45.325x - 31.581	r = 0.948115	89.89

So, the population of *L. erysimi* could easily be predicted by substituting corresponding value of x (abiotic and biotic parameters) at any given point
The data presented in table are pooled analysis of two successive cropping seasons (2004-05 and 2005-06)

Table 3: The correlation and regression analysis between abiotic as well as biotic factors and *Lipaphis erysimi* population on *Brassica juncea* during third sowing (November 25)

	Parameters	Regression equation	Correlation coefficient	% Aphid increase/ decrease
		Abiotic Factors		
1.	Maximum Temp.	y = 4.0869x + 14.234	r = 0.14244	2.03
2.	Minimum Temp.	y = 12.1950x - 25.900	r = 0.39248	15.40
3.	Maximum RH	y = -2.8367x + 339.33	r = -0.2235	-5.00
4.	Minimum RH	y = 1.9160x - 4.5259	r = 0.11868	1.41
5.	Wind velocity	y = 15.341x + 49.934	r = 0.27960	7.82
6.	Sunshine	y = 11.466x + 42.279	r = 0.29795	8.88
7.	Rainfall	y = 3.0519x + 42.219	r = 0.61926	38.35
8.	Evaporation	y = -1.2426x + 99.935	r = -0.0125	-0.02
		Biotic Factors		
1.	*C. septempunctata*	y = 26.585x - 69.271	r = 0.91662	84.02
2.	*C. transversalis*	y = 42.036x - 60.914	r = 0.94623	89.54
3.	*M. sexmaculatus*	y = 30.848x + 19.257	r = 0.52135	27.18
4.	*I. scutellaris*	y = 45.291x - 43.656	r = 0.81189	65.92

Substituting corresponding value of x (abiotic and biotic parameters), we can predict *L. erysimi* population at any given time
The data presented in table are pooled analysis of two successive cropping seasons (2004-05 and 2005-06)

Third sowing (November 25): When rapeseed-mustard seeded late, *L. erysimi* exhibited a strong positive correlation with maximum and minimum temperature (r = 0.14244 and 0.39248), minimum relative humidity (r = 0.11868), wind velocity (r = 0.27960), sunshine (r = 0.29795) and rainfall (r = 0.61926), whereas, it was negatively correlated with maximum relative humidity (r = -0.2235) and evaporation (r = -0.0125). Nevertheless, with biotic factors, it showed positive correlation with *C. septempunctata* (r = 0.91662), *C. transversalis* (r = 0.94623), *M. sexmaculatus* (r = 0.52135) and also with *I. scutellaris* (r = 0.81189).

Of all abiotic and biotic factors, evaporation and maximum relative humidity were inversely proportional with the aphid population on late seeded cultivars. These factors reduced the population of *L. erysimi* by 0.02 and 5.00 %, respectively. The other factors (biotic and abiotic) exhibited a positive correlation with *L. erysimi* population (Table 3).

DISCUSSION

The abiotic and biotic factors showed a significant impact on the population dynamics of *L. erysimi* on Indian mustard, *B. juncea*. On October 25 (first sowing) sown crop, both maximum and minimum temperature were found negatively correlated with aphid population. When *B. juncea* seeded in November 10 (second sowing), maximum temperature was again showed negatively correlation with *L. erysimi*, whereas, at third sowing (November 25), both (maximum and minimum) temperatures were positively correlated and favor the multiplication of aphid. The abiotic factors such as sunshine (during first sowing), evaporation (during second sowing and third sowing) and maximum relative humidity (during third sowing) were also exhibited a negatively correlation with aphid multiplication. The reason for this negative correlation could possibly be due to the fact that population of aphid did not synchronize with respective parameters. These findings are in agreement to those reported by others [8-11]. They also observed that the abiotic factors seem to influence the aphid infestation, owing to the large variation in sowing dates. The cloudiness, evaporation, western disturbance and wind velocity also played an important role in build up of aphid population. There is likelihood of increase in cloudiness initially leading to multiplication of aphid on rapeseed-mustard plants. On the other hand, the western disturbances stay over the region with north-westernly winds and when it got cleared, there was a sharp increase in temperature gradient, resulting into fast multiplication of *L. erysimi* on rapeseed-mustard plants. So, frequent occurrence of western disturbances during the cropping season resulted in rapid fluctuation in air temperature, cloudiness and relative humidity, which supported the multiplication of aphid.

With regard to biotic factors, *C. septempunctata*, *C. transversalis*, *M. sexmaculatus* and *I. scutellaris* exhibited a strong and positive correlation with *L. erysimi*, resulting into reduction of aphid population from 27.18 to 89.89 %. Similar observations were also recorded in earlier reports [12, 13], where they suggested that the biotic factors (natural enemies) are responsible for continuous decrease infestation of aphid on rapeseed-mustard cultivars. With late seeded crop (November 25), aphid population, however, increased abruptly due to higher parasitization of pre-imaginal (larvae and pupae) stages of *I. scutellaris* as well as coccinellids.

The information so gathered could be useful to predict the population of *Lipaphis erysimi* at any given time and we can develop effective control practice to avoid the high yield loss. This study also suggested that early sown Indian mustard crop (October, 25) escapes aphid infestation because of un-synchronization of most active period of aphid and susceptible stage of the crop.

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