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Seasonal incidence of mustard aphid, *Lipaphis erysimi* (Kalt) and its major predator on mustard and their correlation with abiotic factors

SK Mishra and PM Kanwat

Abstract
Field experiment was conducted during *Rabi* 2000-2001 and 2001-2002 at Agronomy Farm of S.K.N. College of Agriculture, Jobner (Rajasthan) to ascertain the pest incidence in mustard variety 'Varuna'. The incidence of aphid started in the last week of December (31.75 aphids/5 plants). The aphid population reached to its peak (404.25 aphids/5 plants) in the last week of January. Thereafter, the population declined abruptly. Negative significant correlation was found between aphid population and maximum temperature (r = -0.4576, -0.7692 and -0.6094) for the years of 2000-2001, 2001-2002 and pooled data, respectively and minimum temperature (r = -0.6047, -0.4944 and -0.5491) for the years of 2000-2001, 2001-2002 and pooled data, respectively. Positive significant correlation was found between aphid population and relative humidity (r = 0.4196, 0.5059 and -0.4616) for the years of 2000-2001, 2001-2002 and pooled data, respectively. Five species of predator were found predating on mustard aphid. *C. septempunctata* and *M. sexmaculatus* appeared in the first week of January and population reached to its peak in the last week of January and coincided with the peak of aphid population. C. *transversalis* and *A. variegata* were noticed during second and third week of February, respectively and remained in the field for a short period of time. The maggot of syrphid fly, *X scutellarae* appeared in the second week of January and its population reached to peak (13 larvae/ 5 plants) during fourth week of January.

Keywords: Mustard aphid, *Lipaphis erysimi*, abiotic factors, Predators, coccinellids, syrphids

Introduction
Mustard, *Brassica juncea* (L.) Czern and Coss is important oilseed crops of Cruciferae family. The important mustard growing states in India are Rajasthan, Uttar Pradesh, Madhya Pradesh, West Bengal, Haryana, Punjab and Assam [19]. The average productivity of rapeseed and mustard crops is quite low in India due to a number of abiotic and biotic stresses, e.g. non-adoption of improved technology and cultivation in rainfed and marginal lands having low fertility. In addition, the insect-pests and diseases also cause heavy damage to the yield potential of these crops [20] and [3]. The mustard crop is damaged at various stages of plant growth by a number of insect pests *viz;* mustard sawfly (*Athalia lugens proxima* Klug.), painted bug (*Bagrada cruciferarum* Kirk.), mustard aphid (*Lipaphis erysimi* Kalt.), cabbage leaf webber (*Crocidolomia binotalis Z*eller), flea beetle (*Phyllotreta cruciferae* Geoze) and leaf miner (*Phytomyza horticola* Meign). Among these, mustard aphid (*Lipaphis erysimi* Kalt.) is of prime significance, which tolls up to 91.30 percent seed yield [21]. This pest alone can devastate the entire mustard crop. Both nymph and adult cause damage by sucking the cell sap from leaves, petioles, tender stems, inflorescence and pods. Due to continuous desaping by large aphid population, yellowing, curling and subsequent drying of leaves takes place, which ultimately leads to formation of weak pods and undersized grains. The aphids also secrete the honey dew which provides suitable medium for the development of sooty mould which ultimately hampers the process of photosynthesis. On the basis of economic importance, mustard aphid is considered to be a key pest [2]. During severe outbreak of insect-pest, the farmers want immediate relief, which is achieved through use of insecticides means. [13]. However, the extensive use of these chemicals has led to the development of insecticidal resistant insect strains and contributed to the problems of ecological imbalance and various direct and indirect health hazards. The aphid population fluctuates at various stages of the crop growth. The knowledge of seasonal incidence is necessary for adopting sustainable management practices against the pest.

Indiscriminate and repeated use of pesticides has resulted in plethora of problems, e.g., resurgence of minor insect-pest, insecticidal resistance in insects, mortality of natural enemies and insecticidal resistance leading to various health hazards, and the increased cost of cultivation per unit area. [22]. To overcome these problems, it has now become imperative to minimize the use of insecticides for controlling the pest by way of adoption of other methods like cultural and biological tactics in a compatible manner, so as to keep the pest population below economic injury level. The bio-control agents like Coccinellids, chrysopids and syrphids have been reported to be effective for controlling the aphid, *Lipaphis erysinri* (Kalt.) [6] and [19]. The ecological approach to the pest management suggests using pesticides only when and where necessary. Therefore, for ensuring an effective and economical management of this serious pest, the present study was undertaken to study the mustard aphid population and its predators fluctuations in relation to weather parameter.

Materials and Methods

Field experiment was conducted during *Rabi* 2000-2001 and 2001-2002 at Agronomy Farm of S.K.N. College of Agriculture, Jobner (Rajasthan) to ascertain the pest incidence in mustard variety 'Varuna'. The experiment was laid out in a randomized block design. The plot size was 3 x 3 metres with row to row and plant to plant distances were 30 and 10 cm, respectively. The crop was sown on 25th October, 2000 and 2001. Half of the recommended dose of nitrogenous fertilizer (60 Kg N/ha) and full dose of phosphatic fertilizer (60 Kg P_2O_5/ha) and potasic fertilizer (40 Kg K_2O/ha) were applied at the time of last ploughing and rest of the nitrogenous fertilizer were applied through top dressing at the time of flowering. The experimental plots were kept free from weeds by weeding and hoeing. All the agronomic management practices were followed from time to time as per package and practices booklet of the region. Observations on aphid population were recorded soon after the appearance of the aphids. The population of aphid was recorded on five randomly selected and tagged plants per plot. Initially the population of aphid was recorded on whole plant as a one single unit but later on three leaves, i.e. top, middle and bottom per plant. From flowering stage, the aphids were counted per 10 c.m. long top portion of central twig per plant causing least possible disturbances as per technique described by [16] and [12]. The population of different predators was recorded on whole plant simultaneously with the population of aphids on leaves and flowers at weekly intervals. The population of maggots of syrphids was recorded on three leaves/twig as mentioned for mustard aphid.

Results and Discussions

Incidence of aphid

The data presented in Table 1 and 2 indicates that mustard aphid, *L. erysimi* appeared in 52 (SMW) during 2000-2001 and 2001-2002. The infestation of aphid during 2000-2001 started in the last week of December (31.75 aphids/5 plants). The population increased gradually and reached to its peak (404.25 aphids/5 plants) in the last week of January. During 2001-2002 the infestation of aphid started in the end of December (44.65 aphids/5 plants) and attained its peak (448.65 aphids/ 5 plants) in the last week of January. Thereafter, the population declined abruptly. Average maximum (23.1 °C) and minimum (1.4 °C) temperature coupled with average relative humidity (53 percent) during 2000-2001 and temperature (maximum) 21.4 °C and (minimum) 3.7 °C coupled with 59 percent relative humidity during 2001- 2002 favored the faster multiplication of mustard aphid. The present investigation corroborates with those of [14] and [15] who reported the first appearance of mustard aphid in month of December. Gour (2001) [5] reported 20-25 °C temperature most favorable for the multiplication of the pest and above 25 °C adversely affected the multiplication.

Correlation between mustard aphid and abiotic factors

Negative significant correlation was found between aphid population and maximum temperature (r = -0.4576, -0.7692 and -0.6094) for the years of 2000-2001, 2001-2002 and pooled data, respectively and minimum temperature (r = -0.6047, -0.4944 and -0.5491) for the years of 2000-2001, 2001-2002 and pooled data, respectively (Table-3). The data pertaining to relative humidity presented in Table-1 and 2 revealed that R.H. favored the population build-up of mustard aphid. At the peak of aphid population the relative humidity were 53 and 59 percent during 2000-2001 and 2001-2002, respectively. Positive significant correlation was found between aphid population and relative humidity (r = 0.4196, 0.5059 and - 0.4616) for the years of 2000-2001, 2001-2002 and pooled data, respectively (Table-3). The present results are in conformity with those of [7] [5] [9] and [10] who reported significant negative correlation between maximum and minimum temperature and aphid population buildup but positive correlation between mustard aphid population and relative humidity.

Incidence of predators of mustard aphid

The quantitative survey of predators showed that four species of Coccinellids viz; *Coccinella septempunctata* (Linn.), *Menochilus sexmaculalus* (Fabr.), *Coccinella transversalis* (Fabr.) and *Adonia variegate* (Goeze) and syrphid fly, *Xanthogramma scutellare* were found predating on mustard aphid during 2000-2001 and 2001-2002 (Table-1 and 2).

Coccinella septempunctata

During the year 2000-2001, *C. septempunctata* appeared in the first week of January with 2 beetle/ 5 plants, thereafter, population gradually increased and reached to its peak in the last week of January with 17 beetles/5 plants when maximum and minimum temperature were 23.1 °C and 1.4 °C, respectively and relative humidity of 53 percent (Table-1). The population of beetles disappeared in the field when the maximum and minimum temperatures recorded were 27.4 °C and 7.5 °C, respectively. During 2001-2002, the population of *C. septempunctata* appeared with 2 beetles/5 plants with aphid population of 44.65 aphids. The population of beetles increased gradually and attained its peak in the last week of January reaching the maximum and minimum temperatures were 21.4 °C and 3.7 °C, respectively, and relative humidity of 59 percent. The data presented in Table 1 and 2 revealed that the population of *C. septempunctata* was influenced by the host insect as both were at peak the same time (17 beetles/404.25 aphids). The present findings are in agreement with that of Lakhanpal and Deshraj (1998) [11] who reported maximum population of *C. septempunctata* at 21.7 °C maximum and 10.2 °C minimum temperature with 59 percent relative humidity.

Menochilus sexmaculatus

During 2000-2001, *M sexmaculatus* appeared in the first week of January with 2 beetles/5 plants and population continued to increase gradually reaching to its peak during last week of January with 7 beetles/5 plants. With regards to weather

parameters, the maximum and minimum temperatures were 23. 1 °C and 1.4 °C, respectively and mean relative humidity during this week was 53 percent (Table-1). The population then declined gradually and was observed up to fourth week of February in less numbers (1 beetle/5 plants). The maximum and minimum temperature during this period was 29.62 °C and 11.2 °C, respectively and relative humidity of 44.5 percent. Same trend was noticed during 2001-2002 as the appearance of the beetle was observed in first week of January with 2 beetles/5 plants and at the same time the aphid population was 131 aphids/5 plants (Table-2). The population of the beetle increased gradually and reached to its peak of 8 beetles/10 plants (448.65 aphids/5 plants) in the fourth week of January when maximum and minimum temperatures were 21.4 °C and 3.7 °C, respectively and relative humidity of 59 percent. The population of beetle disappeared completely in the fourth week of February when the aphid population in field was 59.50 aphids/5 plants. The maximum and minimum temperatures during this period were 26.7 °C and 7.5 °C, respectively and relative humidity was 52 percent. The present findings are in agreement with that of Gour (2001) [5] who reported the appearance of of *M sexmaculatus* in the fourth week of November with 12 beetles / 15 plants and reached to its peak and reached to its peak in the fourth week of January with 68 beetle / 15 plants. [5] recorded peak population of *M sexmaculatus* at 21 - 23.1 °C maximum temperature, 1.2 – 2.7 °C minimum temperature and relative humidity 88 – 91 percent in the morning and 36 – 37 percent in evening.

Coccinella transversalis

The appearance of *C. transversalis* was observed during second week of February and remained in the field for a short period in both the years (Table-1 and 2). The population' of of this beetle varied from I to 2 beetles /5 plants with aphid population of 77.75 to 193.50/5 plants and 59.50 to 206.75 / 5 plants during 2000-2001 and 2001-2002, respectively. Not much work is available on the incidence of this predator therefore; it could not be compared and discussed in detail.

Adonia variegata

The appearance of *A. variegata* was observed during third and fourth week of February in both the years (Table-1 and 2). The population was meagre (1 beetles/5 plants) whereas, the aphid population varied from 77.75 to 132.40/5 plants and 59.50 to 169.60/5 plants during 2000-2001 and 2001-2002, respectively. Sureja (1991) [23] observed *A. variegata* during fourth week of December with 11 beetles/50 plants which increased gradually and reached to its maximum of 63 beetles/50 plants in first week of March.

Xanthogramma scutellarae

During the year 2000-2001, the population of *X. scutellarae* larvae appeared with 2 larvae/5 plants with aphid population of 239.50 aphids. The population of syrphid fly increased gradually and reached its peak in the last week of January, reaching to 13 larvae with 404.25 aphids per five plants when the maximum and minimum temperature were 23.1 °C and 1.4 °C, respectively, and relative humidity of 53 percent. The population then declined gradually and was observed up to fourth week of February in less number (1 larvae/5 plants). The maximum and minimum temperature during this period was 29.6 °C and 11. 2 °C, respectively, and of relative humidity of 44.5 percent (Table-1). During 2001-2002, the activity of syrphid larvae was same as in the previous year. The syrphid larvae started its activity during the second week of January (3 larvae/5 plants) with aphid populations of 212.75 aphids per five plants. The population of syrphid larvae increased gradually and attained its peak in the fourth week of January, reaching to 14 larvae with 448.65 aphids per five plants when the maximum and minimum temperature were 21.4 °C and 3.7 °C, respectively, and relative humidity of 59 percent. The maximum and minimum temperature during this week were 26.7 °C and 7.5 °C, respectively, and of relative humidity of 52 percent (Table-2). The results confirm the findings of Raghvani (1991) [17], Vekaria [24] and Kulkarni & Patel (2001) [8].

Correlation between aphid predator and abiotic factors

The data presented in Table-4 indicated that maximum temperature (r = -0.2550, -0.6346 and -0.4503) for the years of 2000-2001., 2001-2002 and pooled data, respectively, and minimum temperature (r = - 0.3981, -0.4258 and -0.4077) for the years of 2000-2001, 2001-2002 and pooled data, respectively had significant negative correlation with the population of *C. septempunctata.* Positive significant correlation was found between *C. septempunctata* population and relative humidity (r = -0.2092, 0.4104 and 0.3127) for the years of 2000-2001, 2001-2002 and pooled data, respectively. In case *of Msexmaculatus* maximum (r - 0.3949, -0.7091 and -0.5556 for 2000-2001, 2001-2002 and pooled data) and minimum (r = -0.5473, -0.3946 and -0.4650 for 2000-2001, 2001-2002 and pooled data) temperature had significant negative correlation with the population. Relative humidity showed positive correlation (r= 0.3196, 0.4868 and 0.4048) for 2000-2001, 2001-2002 and pooled data, respectively. Perusal of the data presented in Table-4 indicated that maximum (r = -0.2048, -0.6055 and -0.4022 for 2000-2001, 2001-2002 and pooled data) and minimum (r= -0.4886, -0.4508 and -0.4672 for 2000-2001, 2001-2002 and pooled data) temperature had significant negative correlation with the population of *X. scutellarae.* Relative humidity showed significant positive correlation (r = 0.2781 and 0.1708) for 2001-2002 and pooled data. The data recorded in relative abundance of different aphidophagous coccinellids and syrphid fly during *Rabi* seasons of 2000-2001 and 2001-2002 revealed the presence of four species of Coccinellids, i.e. *C. septempunctata, M sexmaculatus, A. variegata* and *C. transversalis* and syrphid fly, *Xanthogramma scutellarae.* The relative abundance of predators was found maximum in case of *C. septempunctata* (48.41, 46.71 and 47.57% in 2000-2001, 2001-2002 and pooled data) followed by *X. scutullarae* (29.36, 29.92 and 29.64%) in 2000-2001, 2001-2002 and pooled data). The relative abundance of *M. sexmaculatus* (17.46, 18.97 and 18.22%), *C. transversalis* (3.17, 2.91 and 3. 04%) and *A. variegata* (1.58, 1.45 and 1.51%) in 2000-2001, 2001-2002 and pooled data, respectively. The relative abundance of aphid predators followed same order of occurrence with little variation during both the years of observation. Further, it is evident from the Table-1 and 2 that the maximum relative abundance was in the last week of January in case of *C. septempunctata, M. sexmaculatus* and *X. scutellarae* in both the years. The abundance of *C. transversalis* and *A. variegata* was for very short period in both the years. The present results are in conformity with that of Gour (2001) [5] who reported significant negative correlation between maximum and minimum temperature and *C. septempunctata* and significant positive correlation between morning relative humidity and *C. septempunctata* population.

Correlation between aphid predators and aphid

The data presented in Table-5 indicated that the association between the population of mustard aphid and population of predators, *C. septempunctata*, *M. sexmaculatus* and *X. scutellarae* had significant positive correlation. The correlation coefficients (r) value of *C. septempunctata* (*r 0.9219*, 0.8199 and 0.8640), M. *sexmaculatus* (*r* = 0.9410, 0.9646 and 0.9519) and *X. scutellarae* (r = 0.9101, 0.8988 and 0.9037) for the years of 2000-2001. 2001- 2002 and pooled data, respectively. It showed that population of predator increased with increasing aphid population. The present result confirms the findings of Kalra (1988) [6], Gour (2001) [5], Ali and Rizvi (2012) [1] and Gauns *et al.* (2014) [4] who observed a strong positive correlation between coccinellid and *L. erysimi* population. The present findings are not in agreement with that of Nathuram *et al.* [15] who reported that both *C. septempunctata* and *L. erysimi* were inversely related with each other and at a time the population of one increased, while the other decreased resulting in asynchronization.

Table 1: Incidence of mustard aphid and subsequent appearance of its predator during Rabi 2000-2001

Date of Observation	Meteorological Week	Meterological conditions			Mean* population of aphids per 5 plants	Mean* population of predator per 5 plants				
		Temperature (°C)								
		Max.	Min.	Aveg. Relative humidity (%)		*C. septempunctata*	*M. sexmaculatus*	*C. transversalis*	*A. variegata*	*X. scutellarae*
31.12.2000	52	22.4	2.3	53.0	31.75	-	-	-	-	-
07.01.2001	1	20.4	2.5	65.5	111.00	2	2	-	-	-
14.01.2001	2	19.1	1.1	71.0	239.50	5	2	-	-	2
21.01.2001	3	23.1	2.7	63.5	297.00	8	4	-	-	6
28.01.2001	4	23.1	1.4	53.0	404.25	17	7	-	-	13
04.02.2001	5	24.6	2.9	53.0	280.25	10	3	-	-	9
11.02.2001	6	25.3	2.9	45.0	193.50	8	2	1	-	5
18.02.2001	7	27.2	8.5	53.5	132.40	8	1	2	1	1
25.02.2001	8	29.6	11.2	44.5	77.75	3	1	1	1	1
04.03.2001	9	27.4	7.5	48.5	36.00	-	-	-	-	-
11.03.2001	10	29.2	7.8	40.0	11.25	-	-	-	-	-
				Total	1814.75	61	22	4	2	37
				Percent of total		48.41	17.46	3.17	1.58	29.36

*Mean of four replication

Table 2: Incidence of mustard aphid and subsequent appearance of its predator during Rabi 2001-2002

Date of Observation	Meteorological Week	Meterological conditions			Mean* population of aphids per 5 plants	Mean* population of predator per 5 plants				
		Temperature (°C)								
		Max.	Min.	Aveg. Relative humidity (%)		*C. septempunctata*	*M. sexmaculatus*	*C. transversalis*	*A. variegata*	*X. scutellarae*
31.12.2001	52	23.8	3.6	61	44.65	-	-	-	-	-
07.01.2002	1	22.5	3.0	61	131.00	2	2	-	-	-
14.01.2002	2	24.1	5.0	59	212.75	5	2	-	-	3
21.01.2002	3	20.5	7.9	77	274.40	9	5	-	-	6
28.01.2002	4	21.4	3.7	59	448.65	16	8	-	-	14
04.02.2002	5	21.7	1.9	57	245.35	12	4	-	-	11
11.02.2002	6	22.2	3.6	57	206.75	9	2	1	-	4
18.02.2002	7	23.0	5.8	61	169.60	8	2	2	1	2
25.02.2002	8	26.7	7.5	52	59.50	3	1	1	1	1
04.03.2002	9	30.5	11.8	54	22.50	-	-	-	-	-
11.03.2002	10	28.8	8.9	39	10.00	-	-	-	-	-
				Total	1814.75	64	26	4	2	41
				Percent of total		46.71	18.97	2.91	1.45	29.92
				Pooled average		95.12	36.43	6.08	3.03	59.28
				Pooled Percent total		47.57	18.22	3.04	1.51	29.64

*Mean of four replication

Table 3: Correlation coefficients (r) between mustard aphid and weather parameters during Rabi 2000-2001 and 2001-2002

Abiotic components	2000-2001	2001-2002	Pooled
Temperature (°C)			
(a) Maximum	-0.4576*	-0.7692*	-0.6094*
(b) Minimum	-0.6047*	-0.4944*	-0.5491*
Relative humidity (%)	0.4196*	0.5059*	0.4616*

*Significant at 5% level

Table 4: Correlation coefficients (r) between mustard aphid predators and weather parameters during Rabi 2000-2001 and 2001-2002

Abiotic components	Years	Predators		
		Coccinella septempunctata	***Menochilus sexmaculatus***	***Xanthogramma scutellarae***
1. Temperature (°C)				
(a) Maximum	2000-2001	-0,2550*	-0.3949*	-0.2048*
	2001-2002	-0.6346*	-0.7091*	-0.6055*
	Pooled	-0,4503*	-0.5556*	-0.4022*
(b) Minimum	2000-2001	-0.3981*	-0.5473*	-0.4886*
	2001-2002	-0.4258*	-0.3946*	-0.4508v
	Pooled	-0.4077*	-0.4650*	-0.4672
2. Relative humidity (%)	2000-2001	0.2092*	0.3196*	0.0615 NS
	2001-2002	0.4104*	0.4868*	0.2781*
	Pooled	0.3127*	0.4048*	0.1708*

*Significant at 5% level
NS Non - significant

Table 5: Correlation coefficients (r) between mustard aphid predators and its predator during Rabi 2000-2001 and 2001-2002

	Years	Predators		
		C. septempunctata **r value**	***M. sexmaculatus*** **r value**	***X. scutellarae*** **r value**
Mustard aphid, *L.erysimi*	2000-2001	0.9219*	0.9410*	0.9101*
	2001-2002	0.8199*	0.9646*	0.8988*
	Pooled	0.8640*	0.9519*	0.9037*

*Significant at 5% level

Conclusion

From the findings of present study, it could be concluded that the seasonal incidence of *Lipaphis erysimi* Kalt. on mustard crop found to be from December last week onwards and later infestation of aphid reached peak at 4th standard week during years of 2000-2001 and 2001-2002. So, by manipulating the calendar of sowing of mustard, we can protect crop from the peak aphid population infestation. Aphid population on mustard is greatly influenced by both abiotic and biotic factors. Negative correlation was found between aphid population and maximum and minimum temperature. Positive significant correlation was found between aphid population and relative humidity. Positive correlation was found between mustard aphid and its predator *C. septempunctata*, *M. sexmaculatus* and *X. scutullarae*.

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