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Population Dynamics of Insect Pests in Mustard and Eco-friendly Management of *Lipaphis erysimi* (Kaltenbach) in Uttrakhand

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A B S T R A C T

The peak population of mustard aphid on yellow sticky traps was recorded with 35.4±2.9 aphids/trap from 7th SW and it was active from 45th SW to 14th SW, where it was on peak with 712.4±16.4 aphids/plant under the field condition from untreated plots at 3rd SW. *Coccinella septempunctata*s active from 50th SW to 13th SW of the season and peak population noticed from 5th SW with 14±0.4 grubs and adults/plant. Incidence of mustard sawfly was noticed at early stage of crop from 46th SW to 4th SW and population range was 0.3±0.2 to 7.3±0.6 larvae/plant. Painted bug active two times in a season from 45th – 52nd SW with peak population was 7.5±0.5 nymphs and adults/plant and 6th – 12th SW, where peak population was 8.9±0.5 nymphs and adults/plant. Imidacloprid 17.8%SL was most effective against mustard aphid where yield increased 881.38kg/ha and cost benefit ratio was 1:18.06 rupees.

Introduction

Mustard (*Brassica jumnica* (L.) is an important oilseed crop which is damaged by a number of insect-pests *viz*., sawfly (*Athalia lugens proxima*), aphid (*Lipaphis erysimi*), painted bug (*Bagrada cruciferarum*) and leaf miner (*Phytomyza horticola*). Thirty eight insect pests are known to be associated with rapeseed-mustard crop in India (Bakhetia and Sekhon 1989). Among them mustard aphid, *Lipaphis erysimi* (Kalt.) is the key pest in all the mustard growing regions of the country mustard aphid, *L. erysimi* (Kaltenbach) (Homoptera: Aphididae) is the key pest of rape seed mustard crop in India responsible for yield losses ranging from 11.6 to 99% and oil reduction up to 15% and also responsible to transmit single-stranded RNA luteo-viruses disease in the crop. In the past, a number of chemical insecticides were evaluated by many workers against this dreaded pest and some of them were effective. These chemical insecticides were found more or less toxic to a number of parasitoids, predators and also to pollinators (Singh and Singh, 2009; Singh *et al.*, 2009). Keot *et al.*, (2002) recorded ten insect pests infesting the brassica vegetables

right from the seedling stage to the harvest of the crop. The present investigation was undertaken to study the seasonal abundance of aphid on mustard and its eco-friendly management through insecticides and bio-pesticides.

Materials and Methods

The field experiment was carried out at DBS College of Agriculture and Allied Science, Dehradun, Uttrakhand, India during 2016-17 and 2017-18. The seeds of local mustard variety sowed in randomized block design (RBD) under three replications (plot size 4.2 x 3 m2) on second week of November 2016 and 2017. Observation recorded on winged aphid, from 10 yellow sticky traps, installed around the experimental field. Chrome painted with smeared transparent greasy material 1.0 kg oil round tin boxes was installed at ten locations in the experimental farm at 1.5 m above ground. Population was recorded daily by taking care of cardinal direction throughout the study period. For mustard sawfly, number of larvae/10 plants, for painted bug as number of bugs (adult + nymph)/10 plants and for Coccinella as adult and grub/10 plants at weekly intervals. Observation recorded from treated and untreated plots as the aphid population recorded form top 10 cm apical twigs of 10 randomly selected from each plot were counted at 3, 7 and 10 days after spray of insecticides, separately. The aphids were removed from the plants with the help of a soft brush and placed on a piece of white paper. Their number was counted with the help of a magnifying glass and tally counter. The numbers of aphids per plant were converted into per cent reduction of aphid population over the control. The observations on damage and mortality were first converted into percentage and then were transformed into angular transformation for statistical analysis to work out the standard error and significant differences among the treatments. The formula used for the calculation of percentage reduction of pest population over control is as follows:

Population reduction over=100 [1-(Ta x Cb)/(Tb x Ca)] control (%)

Where,
Ta=Population in treatment after spray
Tb=Population in treatment before spray
Ca=Population in control after spray
Cb=Population in control before spray.
The meteorological data were also considered during the period of study for correlation calculation.

Results and Discussion

Population of winged aphid, *Lipaphis erysimi* attracted on yellow sticky traps

The population of aphid was fluctuating throughout the season. First observation noticed in 45th WS of the season and numbers of winged aphid attracted on yellow sticky trap was 0.1±0.1 aphid/plant. The population was continuing increased to 52nd WS with 13.7±0.9 aphids/plant. After that it was decreases on 1st SW and population was 9.7±0.4 aphids/plant. This population was again continuing increased to 7th SW than decreased. The two peak populations of aphid were recorded from 52nd SW (13.7±0.9 aphids/plant) and second from 7th SW (35.4±2.9 aphids/plant) in table 1. The population was not break in the seasons. The population was positive correlate with RH but negative with rainfall (%). Pal *et al.,* (2015) recorded a population of aphid was noticed from last week of December and population was reach in second week of February. Population of winged aphid was very low at the beginning i. e. (0.2 aphid/trap) at the 52nd SW, but attained its maximum density (243.4 aphids/trap) at the 8th SW. Similar peak period was also observed by Kumar *et al.,* (2009).

Population of aphid, *Lipaphis erysimi* from plants

The aphid population was noticed from untreated but separated in field from field experiment. The population level was buildup 51.8±5.9, 244.9±8.1, 430.6±8.8, 533.9±8.0, 679.9±14.1 and 712.4±16.4 aphids/plant from 50th, 51st, 52nd, 1st, 2nd and 3rd WS, respectively. First noticed of aphid population from 48th WS with 1.2±0.3 aphids/plant and it was continue increased to 3rd SW with peak population (712.4 aphids/plant) than it was continue decreased in table 1. The population was positive correlate with RH but negative with rainfall (%). Pal *et al.,* (2015) recorded winged form aphid population from yellow sticky trap 151 aphids/5 traps.

Population of *Coccinella septempunctata*s

Predatory population mean of *Coccinella* was 0.2±0.2- 14.0±0.4 grubs and adults/plant. The maximum population of predator was 14.0±0.4 grubs and adults/plant from 5th SW where it was peak point of the season (Table 1). The population of predator was fluctuating according to his prey population in the season. Population of predator was positive correlation with pray population. Singh *et al.,* (2011) was foundund maximum activity of this coccinellid was recorded in the second week of march during 'Rabi' seasons. Bilashini and Singh (2011) observed numerical density of the predator was observed to increase in response to increase in density of aphid prey in the field and the correlation analysis showed highly significant positive correlationship between predator and aphid species.

Population of mustard sawfly, *Athalia lugens proxima*

Mustard sawfly population was recorded from 46th to 4th SW. Fly population was first time recorded from 46th WS with 2.0±0.3 larvae/plant. The population range of mustard sawfly was 0.3±0.2-7.3±0.6 larvae/plant in season (Table 1). The peak population of mustard sawfly was 7.3 larvae/plant recorded from 49th SW.

Pal *et al.,* (2015) recorded mustard sawfly population at early stage where peak population recorded with 2.9 larvae/10 plants. It was non-significant and negative with minimum temperature and RH but significantly positive with sunshine.

Population of painted bug, *Bagrada hilaris*

The population of painted bug was observed two times in a season. First population was recorded from 45th SW to 52nd SW and second population observed from 6th SW to 12th SW. The population range was 0.3±0.2-7.5±0.5 larvae/plant in first population and in second population it was 1.9±0.2-8.9±0.5 larvae/plant. The peak population was 7.5±0.5 larvae/plant at 50th SW in first population and 8.9±0.5 larvae/plant at 11th SW in second population of season in table 1.

Divya *et al.,* (2015) recorded on incidence of painted bug started in 3 week of December in both years and attained first peak reported during the 1st week of January with 6.75 bugs/plant, whereas, second peak i.e. 7.05 bugs/plant was noticed during the 3rd week of January during 2012-13.

In case of 2013-14, the population of painted bug nd attained a first peak i.e. 6.95 bugs/plant during 2 week of January and second peak i.e. 5.92 bugs/plant rd during 3 week of February. Pal *et al.*,(2015) recorded the population of painted bug was recorded during 44th to 51st SW and 5th to 11th SW but it was absent from 52nd to 4th SW. The maximum population was recorded 6.1 bugs/10 plants.

Table.1 Insect pest's incidence in mustard, *Brassica species* during 2016-17 and 2017-18

Standard Week	Mean population of insect-pests/10 plants				
	Lipaphis erysimi		***Coccinella* spp.**	***Athalia lugens proxima* Klug.**	***Bagrada hilaris***
	Mean/10 traps	**Untreated plot**			
44	-	-	-	-	-
45	0.1±0.1	-	-	-	0.3±0.2
46	0.4±0.2	-	-	2.0±0.3	1.1±0.2
47	1.7±0.3	-	-	2.9±0.4	2.7±0.3
48	5.3±0.4	1.2±0.3	-	5.0±0.5	3.2±0.5
49	7.0±0.6	7.4±3.1	-	7.3±0.6	5±0.5
50	7.4±0.4	51.8±5.9	0.2±0.1	4.6±0.4	7.5±0.5
51	12.1±0.6	244.9±8.1	0.4±0.2	3.6±0.5	1.3±0.2
52	13.7±0.9	430.6±8.8	1.1±0.3	1.8±0.2	0.3±0.2
01	9.7±0.4	533.9±8.0	1.2±0.3	1.8±0.5	-
02	9.0±0.5	679.7±14.1	6.7±0.7	0.6±0.2	-
03	6.7±0.6	712.4±16.4	8.1±0.7	0.5±0.2	-
04	18.7±1.2	566.5±10.9	11.9±0.5	0.3±0.2	-
05	18.7±1.2	436.2±9.8	14±0.4	-	-
06	29.9±1.4	354.6±8.8	9.2±0.4	-	1.9±0.2
07	35.4±2.9	230.6±5.8	6.6±0.6	-	2.8±0.2
08	15.4±1.3	192.3±6.0	4.6±0.4	-	6.4±0.3
09	13.3±0.7	78.7±4.0	2.6±0.5	-	7.0±0.5
10	7.7±0.5	41.3±4.7	1.3±0.4	-	8.5±0.5
11	3.7±0.6	23.6±2.2	0.7±0.3	-	8.9±0.5
12	1.6±0.5	10±1.1	0.4±0.2	-	2.1±0.2
13	1.0±0.3	3.6±0.6	0.2±0.2	-	-
14	0.1±0.1	0.9±0.3	-	-	-
15	-	-	-	-	-

Table.2 Pooled efficacies of insecticides against mustard aphid (*Lipaphis erysimi* Kalt.) 2016-17 and 2017-18

Treatments	Aphid Av. Population in number before spray	Mean aphid population after insecticides application/plants									
		1st Day		3rd Day		5th Day		7th Day		10th Day	
		Population	% mortality	Population	% mortality	Population	% mortality	Population	% mortality	Population	% mortality
Acephate 75%SP	116.00 (11.27)	98.33 (10.42*)	15.23 (22.95**)	83.33 (9.63)	28.16 (32.01)	62.33 (8.39)	46.27 (42.82)	47.67 (7.40)	58.91 (50.13)	21.67 (5.16)	81.32 (64.38)
Azadirectin 5SL	120.33 (11.47)	110.00 (10.99)	8.58 (16.95)	90.33 (10.00)	23.23 (28.79)	78.67 (9.37)	34.62 (36.03)	57.33 (8.07)	52.36 (46.32)	28.00 (5.79)	76.73 (61.14)
Carbofuran 3G	117.67 (11.35)	104.00 (10.70)	11.62 (19.91)	87.33 (9.85)	24.28 (29.47)	72.67 (9.02)	38.24 (38.17)	54.00 (7.85)	54.11 (47.35)	24.00 (5.40)	79.60 (63.15)
Coccinella Spp.	115.33 (11.24)	100.67 (10.53)	12.71 (20.88)	90.67 (10.02)	24.65 (29.73)	70.00 (8.87)	39.30 (38.82)	51.33 (7.66)	55.49 (48.10)	22.00 (5.19)	80.92 (64.08)
Dimethoate 30%EC	112.67 (11.11)	94.00 (10.20)	16.57 (23.97)	76.00 (9.22)	32.55 (34.76)	59.33 (8.20)	47.34 (43.45)	38.67 (6.72)	65.68 (54.09)	18.33 (4.78)	83.73 (66.19)
Imidacloprid 17.8%SL	132.33 (12.00)	108.00 (10.89)	18.39 (25.33)	62.67 (8.42)	52.64 (46.49)	43.33 (7.08)	67.26 (55.06)	24.00 (5.40)	81.86 (64.75)	15.00 (4.37)	88.66 (70.27)
Control	128.00 (11.81)	124.33 (11.65)	2.87 (9.63)	123.33 (11.61)	3.65 (10.94)	121.33 (11.51)	5.21 (13.18)	123.67 (11.62)	3.38 (10.47)	125.00 (11.68)	2.34 (8.72)
CD at 5% tab.vl.	0.20	0.22	1.23	0.49	0.94	0.23	0.31	0.42	0.56	0.24	0.66

*Figure in parentheses $\sqrt{x+0.5}$ are transferred values. **Figure in parentheses $\sin.^{-1}\sqrt{(P/100)}$ are transferred values.

Table.3 Pooled cost benefit ratio of insecticides against mustard aphid (*Lipaphis erysimi* Kalt.)

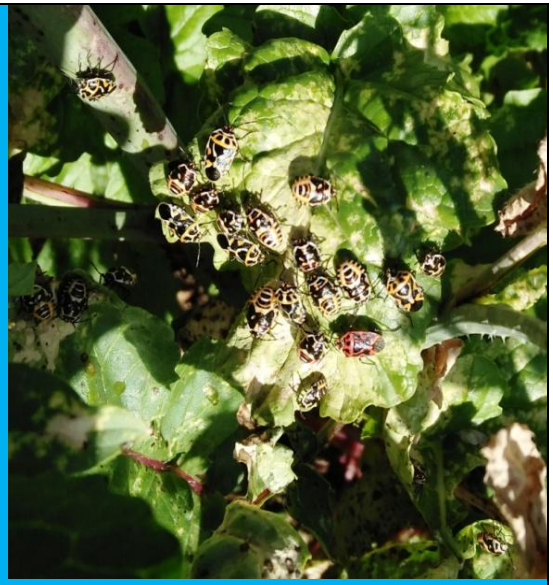
	Dose of	Rate of	Total cost	Yield	Increase	Value of	Net	
Acephate 75%SP	350g/ha	350.00	1850.00	1605.39	528.36	21134.40	19284.40	1 : 10.42
Azadirectin 5SL	5ml/L	1527.00	3027.00	1512.51	435.48	17419.20	14392.20	1 : 04.75
Carbofuran 3G	12g/plot	290.15	1790.15	1544.32	467.29	18691.60	16901.45	1 : 09.44
Coccinella Spp.	5000grub/ha	305.00	1805.00	1722.22	645.19	25807.60	24002.60	1 : 13.30
Dimethoate 30%EC	300g/ha	386.56	1886.56	1894.05	817.02	32680.80	30794.24	1 : 16.32
Imidacloprid 17.8%SL	20g/ha	349.58	1849.58	1958.41	881.38	35255.20	33405.62	1 : 18.06
Control	-	-	-	1077.03	-	-	-	-

*Labour charges=Rs. 300/labour (four labours)=1200. Rent charges=Rs. 75/machine/day (Two machines and two days)=300. Total cost =Rs. 1500. Marketing price of mustard= Rs. 40.00/kg.

Plate-1st

Larvae of mustard sawfly

Aphid infectation of mustard plant



Gregarious form of painted bugs

Grub of *Coccinella septumpunctata*

Field trial-1st stage

Field trial-2nd stage

Management of mustard aphid, *Lipaphis erysimi*

The population of mustard aphid was non-significantly difference before spray. Population of aphid was decreased just after spray and data recorded first day after chemicals application. The mortality recorded after chemical application as 94.00, 98.33, 100.67, 104.00, 108.00, 110 and 124.33 aphids/plant followed by before application as 112.67, 116.00, 115.33, 117.67, 132.33, 120.33 and 128.00 aphids/plant, from dimethoate, acephate, *Coccinella septumpunctata*, carbofuan, imidacloprid, azadirectin (treated) and control plots, respectively, in table 2. The mortality per cent was recorded in ascending order, 8.58, 11.62, 12.71, 15.23, 16.57 and 18.39% from azadirectin, carbofuan, *Coccinella septumpunctata*, acephate, dimethoate and imidacloprid, respectively, followed by control. Imidacloprid was best followed by other treatments, but there was no significant difference between carbofuran and *Coccinella septumpunctata* and acephate and dimethoat. Data recorded on 3rd DAA (Day After Application) the mortality range was 23.23-52.64 per cent followed by control. The maximum mortality was recorded from imidacloprid treated plots. The minimum mortality per cent was recorded from azadirectin treated plots. This mortality was superior followed by 1st DAA. There was no significant difference in mortality per cent between azadirectin, carbofuran and *Coccinella septumpunctata*. Men *et al.*, (2002) recorded seed extract 5% while dimethoate 0.03% proved toxic to the parasitoid. Observation was noticed at 5th DAA on mortality per cent in descending order 67.26, 47.34, 46.27, 39.30, 38.24 and 34.62 from imidacloprid, dimethoate, acephate, *Coccinella septumpunctata*, carbofuan and azadirectin, treated plots, respectively. The population was continue decreased at 7th DAA and observation was recorded 24.00, 38.67, 47.67, 51.33, 54.00 and 57.33 aphids/plant from imidaclopride, dimethoate, acephate, *Coccinella septumpunctata*, carbofuran and azadirectin treated plots followed by before spray. James (2003) and Xue (2002) were founded dimethoate and imidacloprid were most toxic against sucking insect pests. The maximum mortality per cent (81.86) was recorded from imodaclopride treated plots followed by control. Boquel *et al.*, (2015) was found most effective 1-4 days after application, contact insecticides strongly modified aphid behavior and intoxicated them. Pal *et al.*, (2015) recorded that the Imidacloprid controlled most effectively followed by oxydemeton methyl, thiamethoxam, dimethoate, fipronil, acephate and acetamiprid. Mortality was continuing at 10th DAA and mortality range was 15.00-28.00 aphids/plant where mortality per cent range was noticed 76.73-88.66. The effiancy of treatment for mortality per cent was imidacloprid > dimethoate > acephate > *Coccinella septumpunctata* > carbofuran > azadirectin followed by control.

The efficacy of treatment in mustard was imidacloprid > dimethaote > *Coccinella septumpunctata* > acephate > carbofuran > azadirectin where net return ₹ 33405.62 > 30794.24 > 24002.6 > 19284.4 > 16901.45 > 14392.20, respectively, in table 3. Pal *et al.*, (2015) recorded that the cost : benefit ratio was highest in imidacloprid with a record of maximum monetary benefit of Rs. 29973.36. The cost benefit was ₹ 18.06 > 16.32 > 13.30 > 10.42 > 9.44 > 4.75 after per rupee investment from imidacloprid > dimethaote > *Coccinella septumpunctata* > acephate > carbofuran > azadirectin, respectively. The maximum yield (881.38 kg/ha) was recorded from imidacloprid treated plots. The additional yield of 18.51 q/ha was also recorded by imidacloprid 17.8 EC (0.008%) treated plots over the control (Mishra *et al.*, 2012).

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