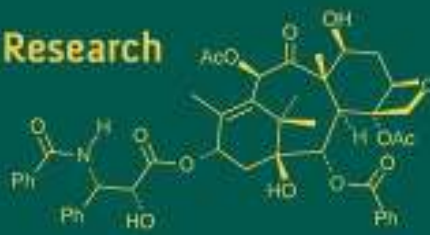
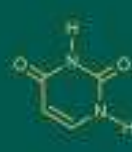
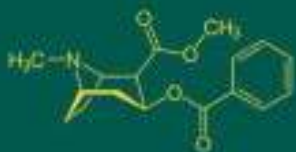


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Seasonal incidence of major insect-pests on mustard (*Brassica juncea* L.) and their correlation with weather parameters

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Abstract

Investigations on seasonal incidence of major insect-pests on mustard (*Brassica juncea* L.) “(*Brassica juncea* L.)” were conducted at research farm of Department of Entomology, V.N.M.K.V., Parbhani during Rabi 2022-23. Mustard aphid *Lipaphis erysimi* appeared from 17-23 December (51st SMW) to 19-25 March (12th SMW) in the range of 22.12 to 90.25 aphids/10 cm twig with the peak activity on 29 January-04 Feb (5th MW). Meanwhile Leaf webber *Crociodolomia binotalis* had shown its presence from 24 Dec -31 Dec (52nd SMW) to 05-11 March (10th SMW) in the scale of 1.35 to 6.45 larvae/plant and it found that 19 Feb-25 Feb (9th MW) was a preferable pace for the pursuit of leaf webber. Mustard Sawfly *Athalia lugens proxima* (Klug) infestation was initiated from 24-31 Dec (52nd SMW) and continued till 19-25 Feb (8th SMW) in the range 2.90 to 7.45 larvae/plant and the peak incidence was observed on 12-18 Feb (7th MW). In natural enemies, lady bird beetles were recorded in the range of 1.20 to 7.34 grubs and adults/plant and Syrphid flies in the scale of 1.00 to 2.60 maggots/plant. Lady bird beetles, Green lacewing in the scale of 0.20 to 2.20 larvae/plant. Ladybird beetle Syrphid fly and Green lacewing had their peak activity during the 5th SMW. Aphids showed negatively significant correlation with rainfall ($r=-0.60^*$), minimum temperature ($r=-0.61^*$), wind speed ($r=-0.55^*$) and EVP ($r=-0.73^*$). Leaf webber showed negatively significant correlation with minimum temperature ($r=-0.55^*$), rainfall ($r=-0.52^*$) and EVP ($r=-0.80^*$). Mustard sawfly had positively significant correlation with morning relative humidity ($r=0.72^*$) and negatively significant correlation with EVP ($r=-0.69^*$).

Keywords: *Brassica juncea*, major insect-pests, seasonal incidence, weather parameters

1. Introduction

Indian mustard (*Brassica juncea* L.) belongs to the family Brassicaceae or Cruciferae originated from Asia or Egypt. Various varieties of mustard and rapeseed are cultivated around the nation. Mohori (Marathi) is a commonly produced oilseed crop in India, also known as Rai or Sarson in Hindi. A vital component of the human diet is mustard. Since allyl isothiocyanates and related chemicals give mustard oil its distinct flavour and pungency, it is highly valued for frying vegetables and fish. Mustard oil is also frequently used for food purposes. (Anonymous., 2019) ^[1] Protein (28-36 percent), oil (28- 32 percent), and essential amino acids (oleic acid, 20-28 percent), linolenic acid, (10- 20 percent), and erucic acid, 10– 20 percent) are all abundant in mustard seeds (30-40 percent) (Solvane and Pathak 2016) ^[12]. With a volume of 68.87 million tonnes, mustard is the second-largest oilseed in the world and has grown to be a significant component of the Indian economy, ranking second in terms of acreage after peanuts (Anonymous, 2021) ^[2]. India made up 13.14 percent of global production with a total area of 6.23 m ha, an output of 8.57 MT, and a productivity of 14.99 q ha-1. Rajasthan contributes 38.07 percent of the country's land and 43.69 percent of its production. Rajasthan, Haryana, Uttar Pradesh, Madhya Pradesh, Gujarat, Assam, West Bengal, Punjab, and Maharashtra are the primary mustard and rapeseed producing states in India (Anonymous, 2019) ^[1]. About 43 insect species have been recorded infesting this crop (Khanal *et al.*, 2020) ^[6] and among these aphids (*Lipaphis erysimi* L.), saw fly (*Athalia lugens proxima* L.), painted bug (*Bagrada cruciferarum* L.), leaf miner (*Chromatomyia horticola* L.), flea beetle (*Phyllotreta Cruciferae* L.), cabbage webber and pod borer (*Crociodolomia binotalis* L.) and cabbage butterfly (*Pieris brassicae* L.) are the important

insect pests. Besides, insect pests like Bihar hairy caterpillar, *Spilosoma obliqua* L. Walker (Lepidoptera: Arctiidae), Cabbage head borer: *Hellula undalis* L. Fabricius (Lepidoptera: Crambidae) and Diamondback moth: *Plutella xylostella* L. (Lepidoptera: Plutellidae) also infest the crop sporadically. Recently tobacco caterpillar (*Spodoptera litura* L.) has been reported as the major insect pests of mustard in different locations of Orissa. However, with increase in cropping intensity and the changing cropping patterns under different agro climatic conditions, the pest complex of the crop has changed (Divya *et al.*, 2015) [3]. *Brassica* crops suffer from heavy damage in yield due to various biotic and abiotic components. Among abiotic factors, its environmental sensitivity is considered to be for most i.e. Instability of mustard plant under different environmental conditions. Kaur and singh (2023) [15].

2. Materials and Methods

The present experiment was conducted to study the seasonal incidence of major insect pests on mustard. The field experiment was performed at Department of Entomology Research Farm, VNMKV, Parbhani, Maharashtra, during rabi 2022-23. Sowing was done on 01-12-2022 at research field. Variety Kranti was used for sowing. The sowing was done by dibbling method at spacing of 45 x 20 cm. The Seasonal incidence of major insect-pests of mustard: The observations were made on random selected 10 plants from each plot. The observations on *Lipaphis erysimi* kalt., *Athalia lugens proxima* klug. and leaf webber, *Crociodolomia binotalis* were registered. The number of Lady bird beetles (grubs or adults), green lace wings and syrphid fly maggots per plant/plot were recorded in natural enemies.

3. Result and Discussion

3.1 To study the seasonal incidence of major insect-pests on mustard

Seasonal incidence of aphid (*Lipaphis erysimi*) on mustard

Aphid population data is displayed both table. 2. In Rabi 2022–2023, the number of aphids on mustard varied from 22.12 to 90.25 aphids per 10 cm central twig. Beginning on the 51st SMW (17–23 Dec.), the aphid infestation persisted until the 12th SMW (19-25 March) Aphid activity peaked on the fifth SMW, with the following conditions: wind speed, 0.00 mm, evaporation, strong sun shine hours, 3.6 mm, 8.6 hours, 26.7 percent, maximum temperature, minimum temperature, morning relative humidity, evening relative humidity, and prevailing rainfall, respectively. According to Sahoo's (2012) [15] report, the mustard aphid emerged in crops during the 52nd SMW, with an average population of 3 aphids per 10 cm shoot. SK Mishra and PM Kanwat (2018) [7] suggested that the fourth SMW had the highest reported aphid activity. According to Singh *et al.*, (2018) [11], the mustard aphid peaked in the eighth SMW with 225.5 aphids/10 cm shoot/plant, having first arrived in crop in the 51st SMW with a mean population of 2.25 aphids/10 cm shoot/plant. Patel *et al.*, (2019) [10] documented that the mustard aphid population peaked during the 8th SMW with

an aphid index of 5.0, started from the 51st SMW.

Seasonal incidence of leaf webber (*Crociodolomia binotalis*) on mustard

The data on leaf webber larval population is presented in table.2, On the 52nd SMW, the population of leaf webber on mustard during Rabi 2022–2023 was first noted (24 Dec- 31 Dec). Larval infestation varied from 1.35 to 6.45 per plant, and attacks were observed up to the tenth SMW (05-11 March). On February 19–25, the 8th SMW had the highest incidence. At that time, the following conditions were observed: 0.00 mm of precipitation, 30.6 °C of maximum temperature, 12.1 °C of minimum temperature, 88.7 percent, 26.7 percent, 3.6 mm, 8.6 hours, and 3.4 Km/h of wind speed. Nayak *et al.*, (2022) [8] indicated that the leaf webber began infesting the crop in the third or fourth week following sowing, or perhaps the second or third week of December. Following that, the pest population grew until it peaked in the seventh or eighth week following seeding (1st to 2nd week of January). After that, the pest population gradually dropped until it vanished during harvest.

Seasonal incidence of mustard sawfly (*Athalia lugens proxima*)

The data on larval population is represented in table.2. The infestation of sawflies began on the 52nd SMW (24–31 Dec) and lasted until the 8th SMW (19–25 March), with 2.90–7.45 larvae per plant. The maximum temperature, minimum temperature, morning relative humidity, evening relative humidity, evaporation, bright sun shine hours, wind speed, and prevailing rainfall were all recorded at 0.00 mm, 30.6 °C, 12.1 °C, 88.7 percent, 26.7 percent, 3.6 mm, 8.6 hours, and 3.4 Km/h, respectively, on the 7th SMW (19 Feb-25 Feb). Pradhan *et al.*, (2020) [16] indicated that a sawfly infestation with a larval population of 0.27 to 1.01 per plant began during the 51st SMW (17–23 Dec) and lasted until the 9th SMW (26 Feb–04 March). On the fourth SMW, the peak incidence was noted (22 Jan-28 Jan). Pal & Debnath (2020) [9] concluded that sawfly infestation was initiated from 52nd SMW (24-31 Dec) Vinyas *et al.*, (2022) [13, 14] suggested that the peak incidence of mustard sawfly appeared at the 7th SMW.

Seasonal incidence of natural enemies

The natural enemies played an important role in minimizing the pest population. In the present study, the population of lady bird beetle, Syrphid fly and Green lace wing were recorded. The data is given in table.2, The lady bird beetle was seen to be active during the aphid infestation. The range was 1.20 to 7.34 adults and grubs per plant. The fifth SMW was the day of peak activity. Conversely, the Syrphid fly was seen to be between 1.00 and 2.60 maggots per plant; the maximum number was noted on the fifth SMW. Mishra & Kanwat (2018) [7] concluded that the final week of January saw the pinnacle of coccinellid activity. The second week of January saw the first appearance of syrphid fly maggots, and by the fourth week, their population had peaked. Pal *et al.*, (2018) [9] documented that the 5th SMW was the location of the lady bird beetle's peak activity.

Table 1: The data on seasonal incidence of major insect - pests on mustard (*Brassica juncea* L.) during rabi 2022-23

SMW	Duration	Insect pests			Weather parameters							
		No of Aphids/10 cm twig	No of Leaf webber larvae/plant	No of Sawfly (larvae/plant)	Rainfall (mm)	Max. Temp. (°C)	Min. Temp. (°C)	RH 1 (%)	RH 2 (%)	EVP (mm)	BSS (Hrs)	WS (Km hr1)
51	17-23 Dec	22.12	0.00	0.00	0.00	30.6	12.1	88.7	26.7	3.6	8.6	3.4
52	24-31 Dec	41.17	1.35	2.90	0.00	31.6	14.2	88.8	36.3	3.2	8.2	2.1
1	01-07 Jan	45.50	4.41	5.80	0.00	28.8	14.5	90.6	43.9	3.0	4.1	2.3
2	08-14 Jan	50.50	4.76	7.20	0.00	28.7	8.0	88.4	25.7	4.1	8.5	3.2
3	15-21 Jan	63.05	5.26	4.30	0.00	31.2	12.2	85.9	28.1	3.7	8.3	4.2
4	22-28 Jan	70.33	6.40	5.20	0.00	30.7	13.1	84.0	30.7	4.4	8.4	2.4
5	29-04 Feb	90.25	5.76	5.60	0.00	30.4	12.3	78.9	21.7	5.7	8.1	3.7
6	05-11 Feb	88.12	5.0	6.40	0.00	33.3	10.0	77.3	15.9	5.8	9.7	2.2
7	12-18 Feb	85.71	5.30	7.45	0.00	33.2	10.3	64.1	13.3	3.6	8.6	2.4
8	19-25 Feb	82.33	6.45	2.05	0.00	35.0	11.3	68.0	13.1	3.2	8.2	3.4
9	26-04 March	80.05	5.40	0.00	0.00	30.9	12.6	55.9	13.5	5.5	7.6	2.4
10	05-11 March	78.02	4.70	0.00	0.00	33.4	15.9	65.4	21.1	6.4	7.2	3.4
11	12-18 March	49.12	0.00	0.00	0.80	33.4	17.1	65.3	28.0	6.3	6.5	6.4
12	19-25 March	20.0	0.00	0.00	0.00	33.2	16.3	66.6	23.9	6.3	9.4	3.6
13	26-01 April	0.00	0.00	0.00	0.00	36.7	16.9	54.4	15.1	8.5	10.2	3.7
14	02-08 April	0.00	0.00	0.00	4.50	36.9	19.2	49.9	19.4	9.9	9.5	4.3

Table 2: The data on seasonal incidence of natural enemies on mustard during rabi 2022-23

SMW	Duration	Insect-pests			Weather parameters							
		No. of Ladybird beetle (grub & adult/plant)	No. of syrphid fly (maggot/plant)	No. of Green Lacewing (larvae/plant)	Rainfall (mm)	Max. Temp. (°C)	Min. Temp. (°C)	RH 1 (%)	RH- 2 (%)	EVP (mm)	BSS (Hrs)	WS (Km hr1)
51	17-23 Dec	0.00	0.00	0.00	0.00	30.6	12.1	88.7	26.7	3.6	8.6	3.4
52	24-31 Dec	1.20	1.00	0.20	0.00	31.6	14.2	88.8	36.3	3.2	8.2	2.1
1	01-07 Jan	3.20	1.40	0.60	0.00	28.8	14.5	90.6	43.9	3.0	4.1	2.3
2	08-14 Jan	5.38	1.80	0.80	0.00	28.7	8.0	88.4	25.7	4.1	8.5	3.2
3	15-21 Jan	5.40	2.00	2.00	0.00	31.2	12.2	85.9	28.1	3.7	8.3	4.2
4	22-28 Jan	5.56	2.10	2.10	0.00	30.7	13.1	84.0	30.7	4.4	8.4	2.4
5	29-04 Feb	7.34	2.60	2.20	0.00	30.4	12.3	78.9	21.7	5.7	8.1	3.7
6	05-11 Feb	6.50	2.40	2.10	0.00	33.3	10.0	77.3	15.9	5.8	9.7	2.2
7	12-18 Feb	6.38	2.30	2.00	0.00	33.2	10.3	64.1	13.3	3.6	8.6	2.4
8	19-25 Feb	6.20	2.40	1.00	0.00	35.0	11.3	68.0	13.1	3.2	8.2	3.4
9	26-04 March	3.33	1.20	0.80	0.00	30.9	12.6	55.9	13.5	5.5	7.6	2.4
10	05 -11 March	2.30	1.00	0.60	0.00	33.4	15.9	65.4	21.1	6.4	7.2	3.4
11	12-18 March	2.20	2.0	0.40	0.80	33.40	17.1	65.3	28.0	6.3	6.5	6.46
12	19-25 March	1.20	0.00	0.00	0.00	33.20	16.3	66.6	23.9	6.3	9.4	3.67
13	26-01 April	1.00	0.00	0.00	0.00	36.70	16.9	54.4	15.1	8.5	10.2	3.70
14	02-08 April	0.00	0.00	0.00	4.50	36.90	19.2	49.9	19.4	9.9	9.5	4.36

Correlation of major insect-pests on mustard with weather parameters

Correlation of major insect pests and their natural enemies with the weather parameters are presented in the Table 3

Table 3: Correlation of major insect-pests on mustard with weather parameters

	Correlation coefficient (r)							
	Max. Temp (°C)	Min. Temp (°C)	Morning RH (%)	Evening RH (%)	Rainfall (mm)	BSH (hrs)	Wind Speed (Km h-1)	EVP (mm)
Aphid	0.39	-0.61*	0.61	0.24	-0.60*	0.31	-0.55*	-0.73*
Leaf Webber	0.28	-0.55*	0.67	0.28	-0.52*	0.25	-0.09	-0.80*
Saw fly	0.13	-0.43	0.72*	0.39	-0.38	0.21	-0.20	-0.69*

Correlation between aphid and weather parameters

Aphids showed negatively significant correlation with rainfall ($r=-0.60^*$), minimum temperature ($r=-0.61^*$), wind speed ($r=-0.55^*$) and EVP ($r=-0.73^*$). While positively non significant correlation was noted by maximum temperature ($r=0.39$), morning relative humidity ($r=0.61$), evening relative humidity ($r=0.24$) and BSH ($r=0.31$). Kalita *et al.*, (2016) ^[4] suggested that aphids showed negatively significant correlation with minimum temperature ($r=-$

0.68^*) and positively nonsignificant correlation with BSS ($r=0.02$).

Multiple regression of weather parameters with mustard aphid

Coefficient of determination (R Square) = 0.847

Multiple Correlation Coefficient (R) = 0.920

$Y = 138.456 + (-2.366) \times B1 + (-0.038) \times B2 + (-0.225) \times B3 + (2.220) \times B4 + (-4.725) \times B5 + (1.577) \times B6 + (-15.830) \times B7 + (-2.137) \times B8 + 20.182$

Correlation between leaf webber and weather parameters

Leaf webber showed negatively significant correlation with minimum temperature ($r=-0.55^*$), rainfall ($r=-0.52^*$) and EVP ($r=-0.80^*$). While positively non significant correlation was observed with maximum temperature ($r=0.28$), morning relative humidity ($r=0.67$), evening relative humidity ($r=0.28$) and BSH ($r=0.25$).

Multiple regression of weather parameters with leaf webber

Coefficient of determination (R Square) = 0.855 Multiple Correlation Coefficient (R) = 0.925 Standard Error = 1.520

Regression Model

The regression equation worked out was as follows.

$$Y = 11.390 + (0.101) \times B1 + (-0.017) \times B2 + (-0.150) \times B3 + (0.106) \times B4 + (-0.189) \times B5 + (-0.183) \times B6 + (-0.609) \times B7 + (-0.679) \times B8 + 1.52$$

Correlation between mustard sawfly and weather parameters

Mustard sawfly had positively significant correlation with morning relative humidity ($r=0.72^*$) and negatively significant correlation with EVP ($r=-0.69^*$). While positively non significant correlation with maximum temperature ($r=0.13$), evening relative humidity ($r=0.39$)

and BSH (0.21). Vinyas *et al.*, (2022) [13, 14] suggested that sawfly had negatively non significant correlation with minimum temperature ($r=-0.43$) and positively non significant correlation with morning relative humidity ($r=0.14$), evening relative humidity ($r=0.01$) and BSH ($r=0.17$).

Intercept (a) = -0.080

Multiple regression of weather parameters with sawfly

Coefficient of determination (R Square) = 0.829, Multiple Correlation Coefficient (R) = 0.910 Standard Error = 1.864

Regression Model: The regression equation worked out was as follows

$$Y = -0.080 + (0.873) \times B1 + (-0.010) \times B2 + (-0.335) \times B3 + (0.155) \times B4 + (-0.043) \times B5 + (-0.154) \times B6 + (0.095) \times B7 + 0.649 \times B8 + 1.864$$

Correlation studies between major insect-pests on mustard and ladybird beetle:

The correlation coefficient were worked out between ladybird beetle and insect-pests on mustard (*Lipaphis erysimi*, *Crocicidolomia binotalis* and *Athalia lugens*) and presented in table. The ladybird beetle showed positive significant correlation with all the pests i.e. *Lipaphis erysimi* ($r=0.82^*$), *Crocicidolomia binotalis* ($r=0.88^*$) and *Athalia lugens* ($r=0.73^*$)

Table 4: Correlation of natural enemies with major insect-pests on mustard

Pests complex	Correlation coefficient ('r' values)		
	LBB	Syrphid fly	Crysoperla
<i>Liaphis erysimi</i>	0.823*	0.839*	0.523*
<i>Crocicidolomia binotalis</i>	0.885*	0.928*	0.646*
<i>Athalia lugens</i>	0.739*	0.814*	0.741*

Summary and Conclusions

The Aphid, leaf webber and sawfly were in the scale of (22.12 to 90.25 aphids/10 cm) twig, (1.35 -6.45 leaf webber larvae/plant) and (2.90 to 7.45 sawfly larvae/plant) accordingly. Lady bird beetles, Syrphid fly, Green Lace Wing, etc. were the major natural enemies in action during the crop period. Natural enemies on mustard i.e. Ladybird beetle, Green Lacewing, Syrphid fly shows positively significant correlation with major insect-pests on mustard.

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