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IMPACT OF VARIOUS WEATHER PARAMETERS ON INSECT PESTS COMPLEX OF MUSTARD IN MANDAWAR REGION OF HARIDWAR DISTRICT UTTARAKHAND INDIA

Rakesh Kumar*, Asheesh Malik and Shivani Tyagi

School of Agricultural Studies, Quantum University, Roorkee, Uttarakhand -247662

*Corresponding author e-mail: rakeshpantento26@gmail.com

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ABSTRACT

The present study on mustard crops was conducted at the Agricultural Research Field of Quantum University in Roorkee, Uttarakhand during the year 2023-24. The research identified the presence of insect pests such as flea beetles, mustard sawflies, and aphids affecting mustard plants during the nursery phase as well as at the bloom and pod initiation stages. The initial populations of flea beetles, sawflies, and aphids were noted in the 42nd, 44th, and 46th Standard Meteorological Weeks, respectively. A gradual rise in the flea beetle population was recorded in the 44th SMW, with an average of 2.00 beetles per plant, while the peak population was observed in the 47th SMW, reaching 5.00 beetles per plant. Both larvae and adult stages of sawflies were documented, with the highest number of larvae recorded in the 50th SMW, totaling 3.67 flies per plant. Data on aphid populations were collected from the flower initiation stage through to pod maturation. A significant increase in aphid populations was noted, with the highest count occurring in the 7th SMW under favorable conditions of 23°C and 87% relative humidity. The correlation coefficient between flea beetles and weather parameters indicated a positive relationship with temperature (r_{max} = 0.14 and r_{min} = 0.67), whereas the correlation with sawflies was negative (r_{max} = -0.23 and r_{min} = -0.37). Similarly, a negative correlation was observed for aphids (r_{max} = -0.58**, r_{min} = -0.66**). Among all weather parameters, only rainfall exhibited a negative correlation with all three insect species in the field. The coefficient of determination (R^2) indicated variability in insect populations, with values of 0.32, 0.38, and 0.65 for flea beetles, sawflies, and aphids, respectively. Therefore, weather parameters play a crucial role in the buildup of insect populations under field conditions. By understanding the timing of insect incidence on crops, appropriate and effective management practices can be implemented to maintain insect populations below injury levels without adversely affecting beneficial insects in the field.

***Key words*:** Flea beetle, saw fly, aphids, weather parameters, correlation

Introduction

Mustard, scientifically referred to as *Brassica juncea* (Linn) Czern and Coss, is an important oilseed crop within the cole crops category and is part of the Cruciferae family. In India, the primary states involved in mustard cultivation are Rajasthan, Uttar Pradesh, Madhya Pradesh, West Bengal, Haryana, Punjab, and Assam (Shekhawat *et al.*, 2012). This crop is mainly grown during the *rabi* season (Pal and Debnath, 2020), with oil content varying between 36 to 42% (Srinivasan, 2005). A variety of abiotic and biotic factors significantly affect mustard production, often impeding it and resulting in reduced yields. Among the biotic factors, insect pests and diseases play a crucial role in the decrease of mustard crop yields (Shukla *et al.*, 1990). Insect pests such as the mustard sawfly (*Athalia lugens proxima* Klug.), mustard aphid (*Lipaphis erysimi* Kalt.), flea beetle (*Phyllotreta cruciferae* Geoze), and cabbage butterfly (*Pieris brassicae* Linn.) inflict damage and contribute to the decline in crop yields. Specifically, flea beetles and mustard sawflies target the crop during the seedling phase, while mustard aphids infest the plants from flowering until harvest.

The mustard aphid, *L. erysimi* Kalt, is a prominent

and significant pest, acknowledged as the most damaging pest in rapeseed mustard, with infestations generally occurring from December to February-March. Both adult and nymph stages of aphids affect various parts of the plant, including terminal twigs, leaves, flower buds, flowers, and pods. Damage can be noted from the seedling stage to maturity, with the most critical damage occurring during the flowering period (Ahmed and Jalil, 1993). These pests feed on the sap from the softer plant tissues and produce honeydew, which encourages the development of sooty mold, consequently diminishing the plants' photosynthetic capacity. In instances of severe infestation, the following symptoms may appear on the plant: leaf curling, failure of plants to produce pods, and the inability of young pods to mature, which hinders the generation of healthy seeds. This leads to a decline in the vitality of the plants and inhibited growth (Morzia and Huq, 1991).

Another notable pest is the flea beetle, whose adult form consumes leaves in significant quantities, resulting in considerable damage to the foliage during the seedling phase and potentially leading to crop fatalities. The leaves exhibit symptoms such as small, rounded, irregular perforations, and in extreme cases, the feeding results in a speckled appearance with fine shot holes (Patel *et al*., 2017). The larvae of the mustard sawfly, which bear a resemblance to caterpillars, represent the damaging stage that typically feeds on the tender leaves, beginning at the edges and progressively skeletonizing them (Jayanthi and Ramesha, 2014). It is crucial for farmers to be cognizant of the timing of pest appearances on their crops, which will enable them to apply suitable methods and techniques to keep pest populations below the economic threshold level. Furthermore, comprehending the interplay between various climatic factors and pests will aid in forecasting the occurrence of insect pests on crops. As a result, this study was undertaken to investigate the seasonal occurrence of different insect complexes on mustard and the influence of various meteorological parameters on them at different crop stages in the western Uttar Pradesh (Uttarakhand) Haridwar region.

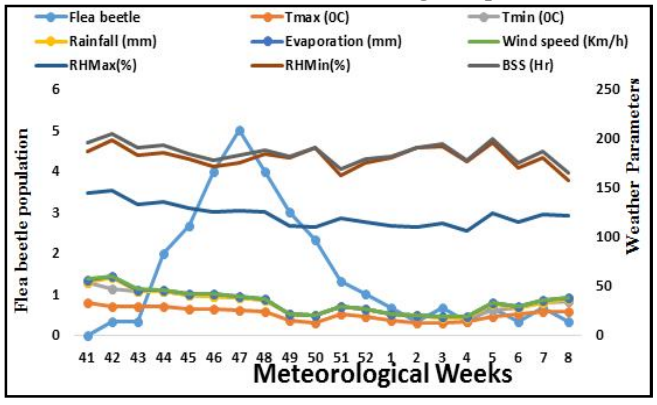

Fig 1: Effect of weather parameters on Flea beetle population.

Material and Method

The present field experiments were carried out during the rabi season of 2023-24 at the Agricultural Research Field, School of Agricultural Studies, Quantum University, Roorkee, with the aim of examining the seasonal prevalence of insect pests on mustard crops in the Mandawar region of Haridwar, Uttarakhand. The experimental design employed was a randomized block design with three replications. Each plot was sized at 3 × 2 square meters, with row and plant spacing established at 30 cm and 10 cm, respectively (Mishra and Kanwat, 2018). The mustard crop was sown in the field on September 30, 2023. Weeds within the experimental plots were removed through weeding and hoeing practices. All agronomic management protocols were followed in accordance with the established package and practices. Observations on flea beetles, sawflies, and aphids were documented at weekly intervals. Data regarding flea beetles and sawflies were gathered during the seedling phase, while aphid population data were recorded shortly after their emergence. Insect populations were evaluated on five randomly selected and tagged plants per plot. Initially, the aphid population was noted for the entire plant as a single entity, but subsequent evaluations concentrated on three leaves—top, middle, and bottom—per plant. From the flowering stage onward, aphids were counted on the upper 10 cm of the central twig per plant, ensuring minimal disturbance, in accordance with the methodology outlined by Pradha *et al*., (1960) and Mathur and Singh (1960). Ultimately, the average pest population per plant was computed. Meteorological data, encompassing maximum and minimum temperatures, maximum and minimum relative humidity, rainfall, evaporation, bright sunshine, and wind speed for the year 2023-24, were sourced from the Meteorological Observatory of the Indian Institute of Technology (IIT), Roorkee, Uttarakhand. The data underwent statistical analysis utilizing IBM SPSS 20.0 software, where

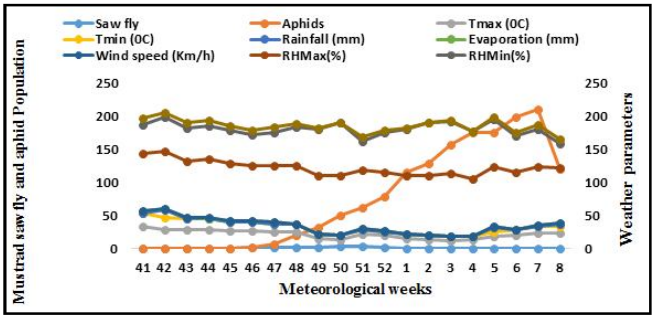

Fig. 2: Effect of weather parameters on mustard sawfly and aphids.

Table 1: Population of insects on mustard and weather parameters.

Metro Week No.	Date	Month	Number of Insects			Temp. (⁰C)		R	E	WS	RH (%)		GSS (Hr.)
			FB	SF	A	Max	Min				Max	Min	
41	**08-14**	Oct	0.00	0.00	0.00	33.14	20.57	0.00	2.86	0.66	87.14	42.86	9.04
42	**15-21**	Oct	0.33	0.00	0.00	28.71	17.93	11.50	1.57	0.76	86.86	51.00	6.49
43	**22-28**	Oct	0.33	0.00	0.00	29.36	15.29	0.00	1.81	0.37	85.86	49.86	8.34
44	**29-04**	Oct-Nov	2.00	0.33	0.00	29.14	15.53	0.00	1.27	0.20	89.43	50.43	7.84
45	**05-11**	Nov	2.67	1.00	0.00	26.64	13.93	0.00	1.19	0.20	86.71	50.14	5.94
46	**12-18**	Nov	4.00	1.33	0.33	26.86	12.79	0.00	1.90	0.20	83.57	45.86	7.26
47	**19-25**	Nov	5.00	1.67	4.67	26.00	11.64	0.00	1.90	0.29	86.29	49.57	7.56
48	**26-02**	Nov-Dec	4.00	2.00	18.33	24.64	11.43	0.00	0.97	0.30	88.00	58.86	4.51
49	**03-09**	Dec	3.00	2.67	30.00	14.86	6.43	0.00	0.00	0.24	89.14	70.29	0.29
50	**10-16**	Dec	2.33	3.67	46.67	13.07	6.61	0.00	0.09	0.24	90.57	79.71	0.17
51	**17-23**	Dec	1.33	3.33	58.33	22.07	6.54	0.00	0.79	0.20	89.29	43.43	6.06
52	**24-31**	Dec	1.00	2.67	75.33	19.50	6.53	0.00	0.41	0.23	88.63	59.75	3.79
1	**01-07**	Jan	0.67	0.33	115.00	14.86	6.43	0.00	0.00	0.24	89.14	70.29	0.29
2	**08-14**	Jan	0.33	0.33	128.33	13.07	6.61	0.00	0.09	0.24	90.57	79.71	0.17
3	**15-21**	Jan	0.67	0.00	156.67	12.13	6.00	0.00	0.23	0.20	94.86	79.00	1.74
4	**22-28**	Jan	0.33	0.00	175.00	13.19	5.11	0.00	0.40	0.23	87.14	70.29	1.19
5	**29-04**	Jan-Feb	0.67	0.00	175.00	18.57	7.29	6.47	0.70	0.34	91.00	71.71	3.27
6	**05-11**	Feb	0.33	0.00	198.67	20.93	7.21	0.00	0.87	0.26	85.57	55.71	5.16
7	**12-18**	Feb	0.67	0.00	210.67	23.71	9.83	0.00	1.73	0.27	87.71	57.71	6.27
8	**19-25**	Feb	0.33	0.00	121.00	24.27	9.59	3.00	1.54	0.07	83.43	36.00	7.10

FB: Flea beetle; **SF:** Saw fly; **A:** Aphids; **R:** Rainfall (mm); **E:** Evaporation (mm); **WS:** Wind speed(KM/h);

correlation and multiple stepwise linear regression analyses were conducted to investigate the relationship between insect populations and weather parameters.

Result and Discussion

Population of flea beetle, mustard saw fly and aphids in the year 2023-24 on mustard crop

The insect population on mustard crops was observed weekly throughout the seedling phase, with particular attention given to flea beetles and saw flies. The results revealed that flea beetles were first detected after the 42nd Meteorological Standard Week (SMW), with a recorded count of 0.33 beetles per plant (Tmax = 28 °C and RHmax = 86%). A consistent rise in the beetle population was noted during the 44th SMW, reaching 2.00 beetles per plant (Tmax = 29 °C and RHmax = 89%), with the peak population recorded in the 47th SMW at 5.00 beetles per plant (Tmax = 26 °C and RHmax = 86%). Following this, a gradual decrease in the beetle population was observed in the 49th SMW, where the count was 3.00 beetles per plant, succeeded by a significant reduction in the 1st SMW of 2024, which documented only 0.67 beetles per plant (Tmax = 14 °C and RHmax = 89%). The data presented in Table 1 and Graph 1 illustrated the presence of mustard saw flies during the seedling stage, with a count of 0.33 saw flies per plant in the 44th SMW (Tmax = 29 °C and RHmax = 89%). It was noted that a gradual decrease in temperature contributed to the increase in the saw fly population, with 1.33 saw flies recorded in the 47th SMW (Tmax = 26 °C and RHmax = 86%). The highest number of saw flies was observed in the 50th SMW, reaching 3.67 saw flies per plant (Tmax = 22 °C and RHmax = 89%). A gradual decline in the saw fly population was noted starting from the 1st SMW of 2024, where the count was 0.33 flies per plant (Tmax = 14 °C and RHmax = 70%), and subsequently, no saw fly larvae were found on mustard leaves from the 3rd SMW onward. In terms of aphids, observations indicated their presence on the plants, with the first occurrence recorded in the 46th SMW at 0.33

Table 2: Correlation of insect population with various weather parameters.

Insect	Weather parameters							
	Temperature (⁰C)		Rainfall (mm)	Evaporation (mm)	Wind speed (KM/h)	Relative Humidity (%)		Bright Sun Shine (Hr)
	Max	Min				Max	Min	
Flea beetle	0.14	0.67	-0.26	0.07	-0.24	-0.16	-0.11	0.92
Saw fly	-0.23	-0.37	-0.29	-0.33	-0.25	0.14	0.09	-0.24
Aphids	-0.58**	-0.66**	-0.22	-0.40	-0.32	0.26	0.43	-0.43

Table 3: Regression equation of insect population with weather parameters.

Regression equation	R^2
$Y_{\text{Flea beetle}} = -11.52 + 0.62\ X_1 - 0.22\ X_2 - 0.004\ X_3 + 1.22\ X_4 - 6.30\ X_5 + 0.04\ X_6 + 0.04\ X_7 - 0.95\ X_8$	0.32
$Y_{\text{Saw fly}} = -12.87 + 0.39\ X_1 - 0.29\ X_2 - 0.13 X_3 - 0.25\ X_4 + 1.58\ X_5 + 0.18\ X_6 - 0.75\ X_7 - 0.70\ X_8$	0.38
$Y_{\text{Aphids}} = 215 - 5.97 X_1 - 18.63\ X_2 + 5.77\ X_3 + 66.28\ X_4 + 24.84\ X_5 - 2.06\ X_6 + 3.35\ X_7 + 18.16\ X_8$	0.65

aphids per plant (Tmax = 26 °C and RHmax = 83%). A notable rise in the aphid population was observed during the 48th SMW, where the count reached 18.33 aphids per plant (Tmax = 24 °C and RHmax = 88%). The highest population was recorded in the 7th SMW, with 210.00 aphids per plant (Tmax = 23 °C and RHmax = 87%), attributed to favorable climatic conditions. However, after rainfall in the 8th SMW (Tmax = 24 °C and RHmax = 83%), a reduction in the aphid population was noted, leading to a count of 121.00 aphids per plant.

Correlation coefficient and determination of coefficient (R^2) between flea beetles, mustard saw fly and aphids and weather parameters

The flea beetle exhibits a positive yet non-significant correlation with temperature (r= 0.14), evaporation (r= 0.07), and bright sunshine (r= 0.92). In contrast, it shows a negative correlation with wind speed (r= -0.24), relative humidity (r= -0.16), and rainfall (r= -0.26). The coefficient of determination indicated a variability of 32 percent within the population. The correlation coefficient for the mustard sawfly demonstrated negative correlations with all given weather parameters, except for relative humidity, which showed a positive and non-significant correlation (r= 0.14). The R^2 value recorded was 0.38, indicating a variability of 38 percent, which is higher than that of flea beetles. A significant negative correlation was noted between the aphid population and temperature (r= -0.58**), while rainfall (r= -0.22), evaporation (r= -0.40), and wind speed (r= -0.32) exhibited negative and non-significant correlations. However, relative humidity was positively and non-significantly correlated with the aphid population (r= 0.26). The coefficient of determination (R2 = 0.65) suggested a 65 percent variability in the aphid population.

These findings align with the observations made by Mishra and Kanwat (2018), who reported that the aphid population on mustard was observed in the last week of December, averaging 31.75 aphids per 5 plants. The peak population was recorded at 404.25 aphids per 5 plants in the last week of January, after which there was a significant decline. They identified a negative significant correlation between the aphid population and maximum temperature (r = -0.4576, -0.7692, and -0.6094). Conversely, a positive and significant correlation was found between the aphid population and relative humidity, with values of r = 0.4196, 0.5059, and -0.4616. Furthermore, a research study by Pal and Debnath (2020) demonstrated that the highest populations of sawfly and aphid were observed in mid-January (coinciding with the bloom and bud formation phase) and in the second week of February (during the silica formation phase), respectively. Pal *et al.*, (2020) identified three key insect species, including the Mustard sawfly, *A. lugens proxima* Klug, which was recorded during the seedling stage. The Mustard aphid, *L. erysimi* Kaltenbach, was found from the flowering to the pod-bearing stages of the mustard crop. The presence of cloudy weather conditions and temperatures between 8 to 32°C contributed to the increase of these insect pests.

The results presented by Purija and BiSMWal (2023) revealed that the peak populations of mustard insects were as follows: aphids (3.7 A.I. per plant at the 50th SMW), whiteflies (25.9 whiteflies per plant at the 50th SMW), painted bugs (13.37 nymphs and adults per plant at the 50th SMW), mustard sawflies (12 larvae per plant at the 48th SMW), and flea beetles (12.45 grubs and adults per plant at the 50th SMW) during the study year 2022-23.

Conclusion

The insect population on mustard was first noted in the second week of October, with peak populations of flea beetles, sawflies, and aphids recorded when weather conditions were favorable for these insects. This indicates a significant positive and negative correlation between weather parameters and the buildup of insect populations. The determination coefficient was highest for aphids, followed by sawflies and flea beetles, suggesting that the greatest variability is observed in aphid populations. This study demonstrated the incidence of insect pests on mustard crops throughout the season and at specific growth stages when environmental conditions are conducive to their development. To maintain pest populations below the economic threshold level, regular monitoring is essential, and appropriate management practices can help control pest populations without adversely affecting non-target organisms and the environment.

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