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SEASONAL INCIDENCE OF MAJOR INSECT PESTS AND NATURAL ENEMIES OF MUSTARD (*Brassica juncea* L.) IN RELATION TO WEATHER PARAMETERS

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ABSTRACT

A field study was conducted during the *Rabi* seasons of 2023–24 and 2024–25 at the Experimental Farm, Department of Agricultural Entomology, Vasantrao Naik Marathwada Krishi Vidyapeeth (VNMKV), Parbhani, Maharashtra to investigate the seasonal incidence of major insect pests and their natural enemies in mustard and their relationship with weather parameters. Mustard aphid (*Lipaphis erysimi*), mustard sawfly (*Athalia lugens proxima*), painted bug (*Bagrada hilaris*), coccinellid beetles, syrphid larvae and spiders were recorded weekly along with meteorological observations. Mustard aphid first appeared during the 52nd SMW and reached peak populations of 153.60 and 156.40 aphids per top 10 cm shoot during the 3rd SMW in 2023–24 and 2024–25, respectively. Sawfly and painted bug attained peak populations during the 4th and 5th SMWs, while coccinellids, syrphids and spiders reached maximum abundance during the 3rd SMW. Correlation analysis revealed that aphid and sawfly populations were negatively associated with temperature, rainfall and wind speed, but positively associated with relative humidity. Maximum temperature showed significant negative correlations with aphid ($r = -0.627$), sawfly ($r = -0.664$) and spider ($r = -0.608$) populations, whereas evening relative humidity exhibited significant positive correlations with aphids, sawfly, syrphids and spiders. Multiple regression analysis indicated that weather parameters explained 37–82% of the variation in pest and natural enemy populations. The study highlights the importance of weather factors and natural enemies in regulating mustard pest dynamics and provides useful information for pest forecasting and eco-friendly integrated pest management.

***Keywords*:** Mustard, *Lipaphis erysimi*, *Athalia lugens proxima*, *Bagrada hilaris*, coccinellid beetles, syrphid flies, spiders, seasonal incidence, weather parameters, correlation, integrated pest management.

Introduction

Mustard (*Brassica juncea* L. Czern. & Coss.) is one of the most important oilseed crops cultivated during the *Rabi* season in India and several other countries. It is an important source of edible oil and protein-rich meal, contributing significantly to nutritional security and the agricultural economy. India occupies the largest acreage under rapeseed–mustard cultivation globally and is the third-largest producer after Canada and China. However, productivity remains considerably lower than the global average due to several biotic and abiotic constraints, among which insect pests are one of the major limiting factors (Directorate of Rapeseed–Mustard Research, 2023; FAOSTAT, 2024).

More than 50 insect species have been reported to infest mustard during different crop growth stages, although only a few attain economic importance. Among them, mustard aphid (*Lipaphis erysimi* Kalt.), mustard sawfly (*Athalia lugens proxima* Klug) and painted bug (*Bagrada hilaris* Burmeister) are considered the major pests causing substantial yield losses (Bakhetia and Sekhon, 1989; Singh and Sachan, 1994). Mustard aphid is regarded as the most

destructive insect pest, causing direct damage through continuous sap feeding and indirect losses by excreting honeydew, which encourages the development of sooty mould and interferes with photosynthesis. Under severe infestation, aphid damage may reduce seed yield by 35–96%**,** depending on crop stage, environmental conditions and the duration of infestation (Ahuja, 1990; Khokhar and Singh, 2000). Similarly, mustard sawfly causes severe defoliation during the vegetative stage, whereas painted bug damages developing siliquae and seeds, resulting in poor seed quality and reduced oil content (Rai, 1976).

The seasonal abundance and population dynamics of insect pests are strongly influenced by prevailing weather conditions, crop phenology and the activity of natural enemies. Temperature, relative humidity, rainfall and wind speed play important roles in determining pest incidence and population build-up, thereby influencing the severity of infestations. Understanding the relationship between pest populations and weather parameters is therefore essential for developing reliable forecasting models and implementing timely integrated pest management (IPM) strategies.

Natural enemies, particularly coccinellid beetles, syrphid flies and spiders, constitute important biological control agents in mustard ecosystems. These predators naturally suppress aphid populations and contribute significantly to ecological balance by reducing pest outbreaks and minimizing reliance on chemical insecticides (Omkar and Bind, 2004; Dwivedi and Singh, 2022). Conservation of these beneficial organisms has become increasingly important under sustainable crop protection programmes.

Several researchers have investigated the seasonal incidence of mustard insect pests under different agro-climatic conditions. Tamang *et al.* (2017) reported that mustard aphid populations generally attain peak abundance during January under eastern Indian conditions, whereas Patel *et al.* (2020) observed that fluctuations in temperature and relative humidity significantly influenced aphid population dynamics. More recently Darji *et al.* (2026) demonstrated that effective management of mustard aphid through newer insecticides significantly enhanced seed yield while emphasizing the importance of understanding pest occurrence for timely interventions.

Although information is available on individual insect pests of mustard, comprehensive studies on the seasonal incidence of major insect pests and their associated natural enemies in relation to weather parameters under the agro-climatic conditions of the Marathwada region of Maharashtra are limited. Therefore, the present investigation was undertaken to study the seasonal incidence of major insect pests and natural enemies of mustard in relation to prevailing weather parameters and to generate baseline information for forecasting pest outbreaks and strengthening integrated pest management strategies.

Materials and Methods

Experimental site

The field experiment was conducted during the *Rabi* seasons of 2024–25 and 2025–26 at the Experimental Farm, Department of Agricultural Entomology, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth (VNMKV), Parbhani, Maharashtra, India. The experimental farm is situated at 19°16′ N latitude and 76°47′ E longitude**,** with an altitude of approximately 409 m above mean sea level. The region experiences a semi-arid tropical climate with hot summers, mild winters, and erratic rainfall.

Crop establishment and experimental details

The mustard variety TAM 108-1 was grown during the Rabi seasons of 2024–25 and 2025–26 under irrigated conditions at VNMKV, Parbhani. The crop was sown during the 48th and 47th Standard Meteorological Weeks (SMWs), respectively, following the recommended agronomic practices with a spacing of 45 × 15 cm. No insecticides were applied to allow the natural build-up of insect pests and their associated natural enemies. Observations on the seasonal incidence of major insect pests and natural enemies were recorded weekly from crop emergence to harvest and expressed in terms of Standard Meteorological Weeks (SMWs). The population of mustard aphid (*Lipaphis erysimi*) was recorded as the number of aphids on the top 10 cm central shoot of ten randomly selected plants. Populations of mustard sawfly (*Athalia lugens proxima*), painted bug (*Bagrada hilaris*) and natural enemies (coccinellid beetles, syrphid flies and spiders) were recorded from the same plants and expressed as the number of individuals per plant.

Weather parameters

Weekly meteorological data on maximum temperature (°C), minimum temperature (°C), rainfall (mm), morning relative humidity (RH-I, %), afternoon relative humidity (RH-II, %) and wind speed (km h^{-1}) corresponding to each Standard Meteorological Week were obtained from the Agrometeorological Observatory, VNMKV, Parbhani**.** These weather variables were used to study their influence on the seasonal incidence of insect pests and natural enemies.

Statistical analysis

The seasonal incidence data were analysed using Pearson's correlation analysis to determine the relationship between insect pest populations, natural enemies, and weather parameters. Multiple linear regression analysis was performed to quantify the combined influence of weather variables on pest incidence and the coefficient of determination ($\mathbf{R^2}$) was used to explain the proportion of variation accounted for by the regression models.

Results and Discussion

Seasonal incidence of major insect pests and natural enemies of mustard

Seasonal incidence and weather relationship of mustard aphid (*Lipaphis erysimi*)

The mustard aphid (*Lipaphis erysimi*) first appeared during the 52nd Standard Meteorological Week (SMW) and attained peak populations during the 3rd SMW, recording 153.60 and 156.40 aphids per top 10 cm central shoot during the *Rabi* seasons 2023–24 and 2024–25, respectively (Table 1 & 3; Fig 1 & 2). Thereafter, the population declined gradually and disappeared by the 11th SMW. Similar seasonal trends have been reported by Hasan and Singh (2011), Pawar *et al*. (2010) and Lal *et al*. (2018). Correlation analysis indicated that aphid population was negatively associated with maximum and minimum temperatures, rainfall and wind speed, while relative humidity exhibited a positive association. During 2024–25, maximum temperature showed a significant negative correlation ($r = -0.627$), whereas evening relative humidity exhibited a significant positive correlation ($r = 0.614$). Aphid population also showed highly significant positive correlations with coccinellid beetles, syrphids and spiders during both seasons, indicating a close predator–prey relationship. The multiple regression models explained 56% and 57% of the variation in aphid population during 2023–24 and 2024–25, respectively, suggesting that weather parameters played a major role in determining seasonal aphid abundance (Table 2 & 4).

Seasonal incidence and weather relationship of mustard sawfly (*Athalia lugens proxima*)

The mustard sawfly (*Athalia lugens proxima*) first appeared during the 50th and 52nd SMWs and reached peak populations of 9.80 and 10.20 larvae per plant during the 4th SMW in the *Rabi* seasons 2023–24 and 2024–25, respectively (Table 1 & 3; Fig 1 & 2). Thereafter, the population declined gradually and disappeared by the 10th–11th SMW. Similar seasonal incidence has been reported by Hasan and Singh (2011), Shaila *et al*. (2022), Kashyap *et al*. (2018), Pratihar *et al*. (2024) and Sahoo (2013). Correlation analysis indicated that sawfly population was negatively associated with maximum and minimum temperatures, rainfall and wind speed, while relative humidity showed a positive association. During 2024–25, maximum temperature exhibited a significant negative correlation ($r = -0.664$) and evening relative humidity showed a significant positive correlation ($r = 0.702$). The sawfly population also exhibited highly significant positive correlations with coccinellid beetles, syrphids and spiders during both seasons, reflecting the simultaneous occurrence of insect pests and natural enemies in the mustard ecosystem rather than a direct predator–prey relationship. The multiple regression models explained 57% and 70% of the variation in sawfly population during the *Rabi* seasons 2023–24 and 2024–25, respectively, indicating that weather parameters substantially influenced seasonal population fluctuations (Table 2 & 4).

Seasonal incidence and weather relationship of painted bug (*Bagrada hilaris*)

The painted bug (*Bagrada hilaris*) first appeared during the 52nd Standard Meteorological Week (SMW) and attained peak populations of 7.40 and 7.60 bugs per plant during the 5th SMW in the *Rabi* seasons 2023–24 and 2024–25, respectively (Table 1 & 3; Fig 1 & 2). Thereafter, the population declined gradually towards crop maturity. Similar seasonal trends have been reported by Hasan and Singh (2011) Divya *et al*. (2015), Shaila *et al*. (2022), Kashyap *et al*. (2018), Pratihar *et al*. (2024) and Yadav *et al*. (2026). Correlation analysis indicated that painted bug population was generally positively associated with temperature and negatively associated with rainfall and relative humidity, although most relationships were non-significant. During 2023–24, wind speed exhibited a significant negative correlation ($r = -0.619$), whereas none of the weather parameters showed significant effects during 2024–25. Positive associations were also observed between painted bug population and coccinellid beetles, syrphids and spiders, suggesting a concurrent seasonal occurrence of insect pests and natural enemies in the mustard ecosystem rather than a direct predator–prey interaction. The multiple regression models explained 67% and 82% of the variation in painted bug population during the *Rabi* seasons 2023–24 and 2024–25, respectively, indicating that the combined weather variables considerably influenced seasonal population fluctuations (Table 2 & 4).

Seasonal incidence of natural enemies

Coccinellid beetles

The coccinellid beetles first appeared during the 1st SMW (1.80 beetles per plant) in *Rabi* 2023–24 and during the 52nd SMW **(**0.20 beetles per plant) in *Rabi* 2024–25 (Table 1 & 3; Fig 1 & 2). The population reached its peak during the 3rd SMW, recording 16.40 and 18.40 beetles per plant during 2023–24 and 2024–25, respectively, and thereafter declined gradually until crop maturity. The population dynamics of coccinellid beetles closely synchronized with aphid abundance, indicating a strong predator–prey relationship. Similar observations have been reported by Lal *et al*. (2018), Kashyap *et al*. (2018), Shaila *et al*. (2022), Pratihar *et al*. (2024) and Yadav *et al*. (2026), who observed that coccinellid populations increased concurrently with aphid infestation and reached maximum abundance during the flowering stage of mustard. The study revealed varying correlations between coccinellid beetle populations and weather parameters during the *Rabi* seasons of 2023–24 and 2024–25. Coccinellid beetle populations showed predominantly non-significant negative correlations with maximum temperature, rainfall and wind speed, while relative humidity exhibited positive but non-significant associations. Overall, weather parameters had no significant influence on coccinellid abundance during either season.The multiple regression models explained 44% and 37% of the variation in coccinellid beetle population during the *Rabi* seasons 2023–24 and 2024–25, respectively, suggesting that weather parameters had a moderate influence on predator abundance, while prey availability and other ecological factors also contributed substantially to seasonal population fluctuations (Table 2 & 4).

Syrphids

Syrphid larvae first appeared during the 1st Standard Meteorological Week (SMW) in both *Rabi* 2023–24 and 2024–25, reaching peak populations of 1.10 and 1.80 larvae per plant, respectively during the 3rd SMW (Table 1 & 3; Fig 1 & 2). Thereafter, the population declined gradually with the reduction in aphid abundance, indicating a close dependence on prey availability. Similar observations were reported by Lal *et al*. (2018), Kashyap *et al*. (2018), Shaila *et al*. (2022), Pratihar *et al*. (2024) and Yadav *et al*. (2026), who observed that syrphid populations increased concurrently with mustard aphid infestation and declined as aphid density decreased. The study revealed varying correlations between syrphid populations and weather parameters during the Rabi seasons of 2023–24 and 2024–25. Syrphid population showed negative, non-significant correlations with maximum temperature, minimum temperature, rainfall and wind speed during both seasons. Morning relative humidity exhibited a positive but non-significant association in both years, whereas evening relative humidity showed a significant positive correlation (r = 0.589) during 2024–25. The multiple regression models explained 45% and 48% of the variation in syrphid population during the *Rabi* seasons 2023–24 and 2024–25, respectively, indicating that weather parameters moderately influenced syrphid abundance, while prey availability remained the major determinant of their seasonal occurrence (Table 2 & 4).

Spiders

Spider populations were first recorded during the 52nd SMW in both *Rabi* seasons and attained peak populations of 2.50 and 2.40 spiders per plant during the 3rd SMW in 2023–24 and 2024–25, respectively (Table 1 & 3; Fig1 & 2). Thereafter, spider abundance declined gradually with decreasing prey density and crop maturity. Similar trends have been reported by Lal et al. (2018), Kashyap *et al*. (2018), Shaila *et al*. (2022), Pratihar *et al*. (2024) and Yadav *et al*. (2026), who observed that spider populations closely followed the build-up of aphid populations and played an important role in the natural regulation of mustard insect pests. The study revealed varying correlations between spider populations and weather parameters during the Rabi seasons of 2023–24 and 2024–25. During 2023–24**,** spider population exhibited non-significant positive correlations with maximum temperature (r = 0.002NS), morning relative humidity (r = 0.301NS) and evening relative humidity (r = 0.002NS), while minimum temperature (r = −0.040NS), rainfall (r = −0.173NS) and wind speed (r = −0.090NS) showed non-significant negative correlations. During 2024–25, spider population exhibited a significant negative correlation with maximum temperature (r = −0.608*), whereas minimum temperature (r = −0.356NS), rainfall (r = −0.201NS) and wind speed (r = −0.470NS) remained negatively but non-significantly correlated. Morning relative humidity (r = 0.563NS) showed a positive non-significant association, while evening relative humidity exhibited a significant positive correlation (r = 0.622). The multiple regression models explained 50% and 44% of the variation in spider population during the *Rabi* seasons 2023–24 and 2024–25, respectively, suggesting that weather factors had a moderate influence on spider abundance, whereas prey density and crop phenology also contributed significantly to their seasonal dynamics (Table 2 & 4).

Conclusion

The present study demonstrated that mustard aphid (*Lipaphis erysimi*) was the predominant insect pest of mustard, with peak infestation occurring during the 3rd Standard Meteorological Week (SMW), while mustard sawfly (*Athalia lugens proxima*) and painted bug (*Bagrada hilaris*) attained peak populations during the 4th and 5th SMWs, respectively. The abundance of these pests was influenced by prevailing weather conditions with maximum temperature showing a generally negative effect and relative humidity exerting a positive influence on population build-up. The populations of natural enemies, namely coccinellid beetles, syrphid larvae and spiders, closely followed aphid abundance indicating their important role in the natural regulation of mustard pests. Multiple regression analysis further confirmed that weather parameters explained a substantial proportion of the seasonal variation in pest and natural enemy populations, although other ecological factors also contributed. These findings provide valuable information on the seasonal occurrence of major insect pests and their natural enemies, which can be utilized for forecasting pest outbreaks and developing timely, eco-friendly integrated pest management (IPM) strategies in mustard cultivation.

Table 1: Seasonal incidence of major insect pest and natural enemies occurring in mustard and their weather data during *Rabi*, 2023-24

SMW	Insect pest and natural enemy population per plant						Weekly weather data					
	Aphids	Sawfly	Painted bug	Coccinellid beetle	Syrphids	spider	Temperature (^{0}C)		Rain fall (mm)	Relative humidity (%)		Wind speed (km/hr)
							Max temp	Min temp		R.H.1 (%)	R.H.2 (%)	
48	0.00	0.00	0.00	0.00	0.00	0.00	28.29	11.96	0.00	78.71	35.86	4.31
49	0.00	0.00	0.00	0.00	0.00	0.00	30.99	18.84	1.20	89.43	50.29	2.70
50	0.00	0.60	0.00	0.00	0.00	0.00	27.70	8.11	0.00	85.86	25.29	2.83
51	0.00	1.00	0.00	0.00	0.00	0.00	29.17	10.49	0.00	83.14	33.29	2.14
52	10.60	1.40	0.20	0.00	0.00	0.10	30.11	16.34	0.00	89.63	43.00	2.56
1	45.80	2.80	0.60	1.80	0.40	0.30	29.64	9.34	0.00	88.29	27.00	2.04
2	84.80	5.40	1.80	3.00	0.80	0.50	28.17	12.06	0.00	86.14	38.00	2.66
3	153.60	7.50	2.40	16.40	1.10	2.50	29.40	11.56	0.00	89.86	29.43	3.13
4	108.00	9.80	3.50	9.00	0.80	1.10	32.71	11.13	0.00	86.57	24.00	1.16
5	85.90	3.80	7.40	7.40	0.60	0.70	34.24	13.90	0.00	81.57	25.86	0.00
6	61.70	2.40	5.80	6.50	0.70	2.10	33.86	15.86	0.00	77.43	27.71	0.00
7	24.60	1.60	3.80	6.40	0.50	0.40	34.03	12.13	0.00	66.86	18.00	0.00
8	11.50	1.00	2.40	5.20	0.30	0.20	34.46	13.27	0.00	67.43	20.71	0.00
9	6.60	0.40	1.60	4.80	0.20	0.10	31.20	13.00	0.00	59.00	16.25	0.00
10	3.60	0.00	0.60	3.60	0.00	0.00	35.73	13.17	0.00	57.43	12.29	0.00
11	0.00	0.00	0.00	1.40	0.00	0.00	38.49	18.54	0.00	52.86	13.71	2.04

Table 2: Correlation coefficient and multiple regression of major insect pests and natural enemies on mustard during *Rabi*, 2023-24

Insect pests/ Natural enemies	Correlation coefficient									Multiple regression with weather parameters	
	Temperature (^{0}C)		Rain fall (X3)	Relative humidity (%)		Wind speed Km/hr. (X6)	Coccinellids	Syriphids	Spiders	R^2	Multiple regression equation
	Max ^{0}C) (X1	Min ^{0}C) (X2		R.H. 1 %) (X4	R.H. 2. %) (X5						
Aphids	-0.107^{NS}	-0.213^{NS}	-0.208^{NS}	0.440^{NS}	0.047^{NS}	-0.001^{NS}	0.840**	0.947**	0.838**	0.56	$Y = -296.888+(-3.956)T_{Max} + (12.020)\ T_{Min} +(-33.007)_{Rainfall} + (6.225)_{RH.1}+(-6.342)_{Rh.2} + (-1.924)_{wind\ speed}$
Sawfly	-0.150^{NS}	-0.303^{NS}	-0.215^{NS}	0.481^{NS}	0.060^{NS}	0.033^{NS}	0.715**	0.860**	0.680**	0.57	$Y = -23.424+(0.084)T_{Max} + (0.336)\ T_{Min} +(-1.710)_{Rainfall} + (0.342)_{RH.1}+(-0.280)_{Rh.2} + (0.002)_{wind\ speed}$
Painted	0.346^{NS}	0.042^{NS}	-0.222^{NS}	0.021^{NS}	-0.216^{NS}	-0.619*	0.618*	0.669**	0.590*	0.67	$Y= -13.313+(0.099)T_{Max} +$

bug											$(0.245)\ T_{Min} + (-2.357)_{Rainfall} + (0.158)_{RH.1} + (-0.049)_{Rh.2} + (-1.204)_{wind\ speed}$
Coccinellid beetle	0.176^{NS}	-0.136^{NS}	-0.245^{NS}	0.050^{NS}	-0.293^{NS}	-0.297^{NS}	-	-	-	0.44	$Y = -6.417 + (-0.741)T_{Max} + (1.296)\ T_{Min} + (-0.462)_{Rainfall} + (0.495)_{RH.1} + (-0.739)_{Rh.2} + (-0.616)_{wind\ speed}$
Syrphids	-0.045^{NS}	-0.219^{NS}	-0.243^{NS}	0.318^{NS}	-0.044^{NS}	-0.165^{NS}	-	-	-	0.45	$Y = -1.340 + (-0.037)T_{Max} + (0.076)\ T_{Min} + (-0.271)_{Rainfall} + (0.0396)_{RH.1} + (-0.0390)_{Rh.2} + (-0.075)_{wind\ speed}$
Spider	0.002^{NS}	-0.040^{NS}	-0.173^{NS}	0.301^{NS}	0.002^{NS}	-0.090^{NS}	-	-	-	0.50	$Y = -2.292 + (-0.171)T_{Max} + (0.315)\ T_{Min} + (-0.592)_{Rainfall} + (0.100)_{RH.1} + (-0.126)_{Rh.2} + (-0.092)_{wind\ speed}$

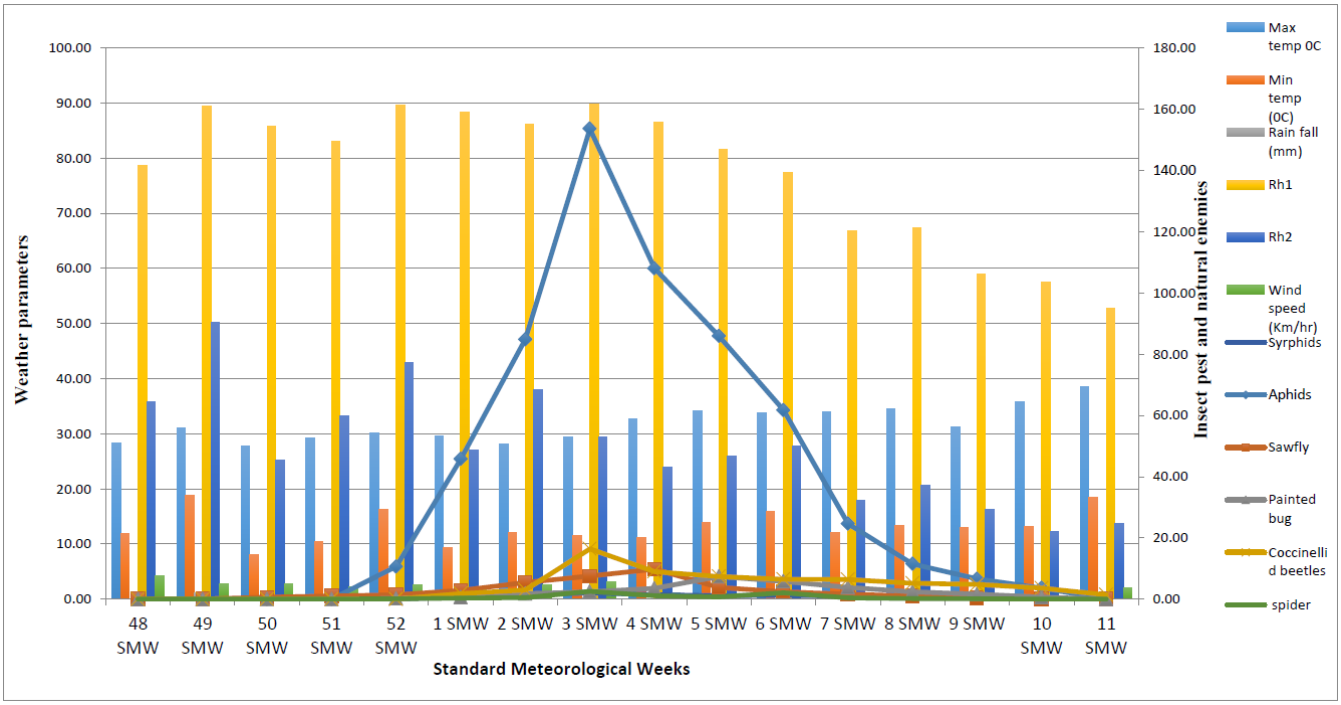

Fig. 1 : Seasonal incidence of major insect pests and natural enemies with weather parameters on mustard during *Rabi*, 2023-24

Table 3: Seasonal incidence of major insect pest and natural enemies occurring in mustard and their weather data during *Rabi*, 2024-25

SMW	Aphids	Sawfly	Painted bug	Coccinellid beetle	Syrphids	spider	Temperature (^{0}C)		Rain fall (mm)	Relative humidity (%)		Wind speed (km /hr)
							Max temp	Min temp		R.H.1 (%)	R.H.2 (%)	
48	0.00	0.00	0.00	0.00	0.00	0.00	28.70	10.80	0.00	89.43	31.86	2.79
49	0.00	0.00	0.00	0.00	0.00	0.00	28.60	8.76	0.00	90.00	26.29	2.94
50	0.00	0.00	0.00	0.00	0.00	0.00	28.27	6.41	0.00	89.29	23.14	2.43
51	0.00	0.00	0.00	0.00	0.00	0.00	28.07	6.40	0.00	89.00	26.86	2.43
52	12.40	2.40	0.50	0.20	0.00	0.40	27.68	6.95	0.00	90.25	27.75	2.13
1	48.80	3.60	0.80	1.80	0.50	0.80	28.26	11.07	0.00	91.14	36.71	1.99
2	125.80	6.00	2.20	3.40	1.20	1.20	28.50	9.53	0.00	83.43	27.86	3.00
3	156.40	8.80	2.80	18.40	1.80	2.40	29.64	11.73	0.00	88.29	32.14	2.33
4	96.80	10.20	3.70	10.00	1.00	1.20	29.44	14.29	0.00	82.43	33.57	2.69

5	84.50	4.60	7.60	7.00	0.80	0.60	29.70	13.20	0.00	87.00	33.29	3.09
6	51.60	2.80	5.80	5.50	0.50	0.50	30.69	10.97	1.10	85.00	25.00	2.61
7	22.60	1.40	3.80	4.40	0.40	0.30	32.40	12.66	0.00	80.29	23.57	2.69
8	8.10	1.20	3.00	2.60	0.10	0.20	33.20	16.41	0.00	79.14	28.00	3.37
9	3.00	0.60	1.80	4.80	0.00	0.10	34.83	15.49	0.00	72.57	23.43	3.13
10	2.00	0.20	0.80	3.60	0.00	0.00	37.21	13.77	0.00	65.43	13.86	3.47
11	0.00	0.00	0.00	1.40	0.00	0.00	37.96	17.26	0.00	56.57	16.86	3.00

Table 4 : Correlation coefficient and multiple regression of major insect pests and natural enemies on mustard during *Rabi*, 2024-25

Insect pests/ Natural enemies	Correlation coefficient									Multiple regression with weather parameters	
	Temperature (^{0}C)		Rain fall (X3)	Relative humidity (%)		Wind speed (Km/hr.) (X6)	Coccinellids	Syriphids	Spiders	Multiple regression equation	R^2
	Max (^{0}C) (X1)	Min (^{0}C) (X2)		R.H. 1 (%) (X4)	R.H. 2. (%) (X5)						
Aphids	-0.627*	-0.347^{NS}	-0.253^{NS}	0.545^{NS}	0.614*	-0.299^{NS}	0.750**	0.987**	0.934**	$Y = 436.689+(-16.885)T_{Max} + (5.90)\ T_{Min} +(-71.264)_{Rainfall} + (-0.999)_{RH.1}+(1.48)_{Rh.2} + (42.700)_{wind\ speed}$	0.57
Sawfly	-0.664*	-0.280^{NS}	-0.215^{NS}	0.559^{NS}	0.702*	-0.379^{NS}	0.730**	0.885**	0.882**	$Y = 64.946+(-2.036)T_{Max} + (1.194)\ T_{Min} +(-3.951)_{Rainfall} + (-0.102)_{RH.1}+(-0.280)_{Rh.2} + (0.576)_{wind\ speed}$	0.70
Painted bug	-0.314^{NS}	0.001^{NS}	0.037^{NS}	0.404^{NS}	0.374^{NS}	0.131^{NS}	0.378^{NS}	0.372^{NS}	0.173^{NS}	$Y= -6.58+(-1.35)T_{Max} + (1.910)\ T_{Min} +(-4.811)_{Rainfall} + (0.533)_{RH.1}+(-0.778)_{Rh.2} + (2.227)_{wind\ speed}$	0.82
Coccinellid beetle	-0.226^{NS}	0.034^{NS}	-0.171^{NS}	0.278^{NS}	0.362^{NS}	-0.153^{NS}	-	-	-	$Y= -42.788+(-0.617)T_{Max} + (2.231)\ T_{Min} +(-9.433)_{Rainfall} + (0.662)_{RH.1}+(-0.509)_{Rh.2} + (0.156)_{wind\ speed}$	0.37
Syrphids	-0.572^{NS}	-0.286^{NS}	-0.231^{NS}	0.515^{NS}	0.589*	-0.307^{NS}	-	-	-	$Y = 3.520+(-0.177)T_{Max} + (0.116)\ T_{Min} +(-0.794)_{Rainfall} + (0.006)_{RH.1}+(-0.005)_{Rh.2} + (0.294)_{wind\ speed}$	0.48
spider	-0.608*	-0.356^{NS}	-0.201^{NS}	0.563^{NS}	0.622*	-0.470^{NS}	-	-	-	$Y = 2.58+(-0.086)T_{Max} + (0.032)\ T_{Min} +(-0.491)_{Rainfall}\ 0+ (-0.\ 006)_{RH.1}+(0.037)_{Rh.2} + (-0.038)_{wind\ speed}$	0.44

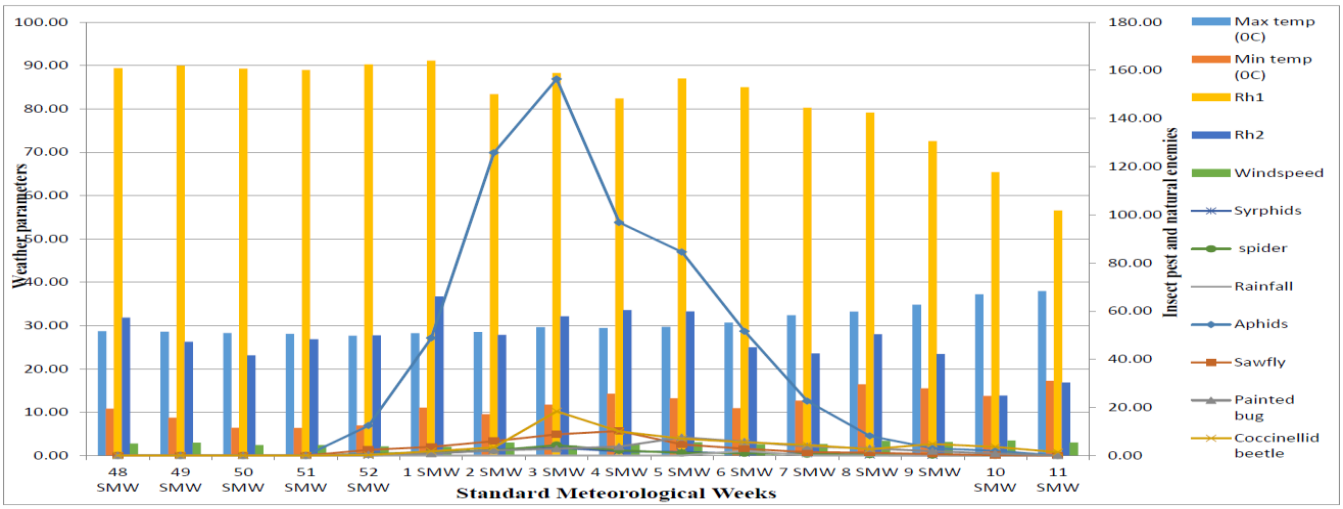

Fig. 2 : Seasonal incidence of major insect pests and natural enemies with weather parameters on mustard during *Rabi*, 2024-25

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