**Effect of seasonal incidence of major insect pests of mustard crop in relation to abiotic factors**

**ABSTRACT**

Rapeseed-mustard is a key oilseed crop in India, contributing 11% to global production, ranking third after Canada and China. ~~The 2023-24 season is expected to yield a record 12 million metric tons due to expanded cultivation across 10 million hectares, primarily in Rajasthan, Haryana, Madhya Pradesh, Uttar Pradesh, and West Bengal~~. However, mustard crops face threats from over ~~43~~ insect pests, including ~~mustard~~ aphids, sawflies, painted bugs, leaf webbers, and leaf miners. ~~Mustard aphids alone can cause yield losses of up to 96% and reduce oil content by 5-15%. The painted bug inflicts severe damage during the seedling stage, while leaf webbers can lead to yield reductions of up to 81.8%.~~ A field study conducted in Kanpur during the 2021-22 and 2022-23 Rabi seasons examined the seasonal incidence of these pests and their correlation with weather ~~conditions~~. Mustard aphid infestations peaked in February, with population fluctuations negatively correlated with temperature. Similarly, the painted bug infestation peaked in December-January, with significant negative correlations with maximum and minimum temperatures. The mustard sawfly and leaf miner also showed seasonal fluctuations influenced by temperature and humidity. Their populations varied seasonally, with correlations to temperature, humidity, and rainfall.

**KEYWORDS: Rapeseed-mustard, Insect pests, aphid, Climatic factors, Temperature, Relative humidity.**

**INTRODUCTION**

Rapeseed-mustard is a major oilseed crop grown in India, which produces good quality oil for cooking purposes and its cake is good feed for animals. India is the third largest producer of rapeseed-mustard after Canada, China and contributing to around 11 % of world's total production. India's mustard production is expected to reach a record 12 million metric tons in the 2023-2024 season. This is due to a record-breaking sown area of 10 million hectares. (Shaila 2024; Kaur 2020) The majority of India's mustard is produced in Rajasthan, Haryana, Madhya Pradesh, Uttar Pradesh, and West Bengal. Mustard yield can be affected by a number of factors, including climate change, weeds, pests, and diseases (Anonymous 2022). In India, Pal *et al. ~~,~~* ~~2018~~ reported in mustard crops to be infested by over 38 ~~various types~~ of insect pests viz., ~~M~~ustard aphid (*Lipaphis erysimi*),~~P~~ainted ~~B~~ug(*~~Bagrada cruciferarum~~*), ~~Mustard Sawfly~~ (*Athalia lugens proxima*), ~~L~~eaf minor (*~~Phytomiza~~ horticola*)*.* Economically, *L. erysimi* is classified as a national pest and is considered a significant obstacle to successful crop cultivation, with potential yield reductions ranging from 35.4% to 96.0% and oil content decreases of 5% to 15% (Bakhetia and Arora, 1986; Bakhetia and Sekhon, 1989; Rana, 2005). Damage from painted bugs is particularly severe during the seedling stage of mustard, resulting in yield losses between 26.8% and 70.8%. In contrast, during the pod formation and maturity stages, losses in yield reach 30.1%, with a 3.4% reduction in oil content (Singh et al., 1980). The leaf minor is another significant pest, leading to yield losses of 13.2% to 81.8% (Ameta et al., 2005; Chauhan and Yadav, 2007).

A correlation study helps identify the positive or negative relationships between pest populations and various abiotic factors. This information enables growers to take prompt and effective measures against insect pests. Consequently, the current investigation was designed to analyze the fluctuations in insect pest populations in relation to weather conditions.

**MATERIAL AND METHODS~~:~~**

To examine the seasonal occurrence of insect pests on mustard, a field experiment was conducted during the third week of December in the Rabi season for the years 2021-2022 and 2022-2023 at the Student Instructional Farm (SIF) of Chandra Shekhar Azad University of Agriculture and Technology in Kanpur, Uttar Pradesh. The farm is situated between 25° 26' and 28° 58' N latitude and 79° 31' and 80° 34' E longitude, at an altitude of 125.9 meters above sea level. The trial utilized a net plot size of 4.5 x 3 m, replicated three times in a Randomized Completely Block Design (RCBD). A crop spacing of 45 x 15 cm was maintained through thinning and gap filling. All agronomic practices were followed except for plant protection measures to evaluate pest incidence and the presence of natural enemies. Observations included counting the number of leaf webber larvae, sawfly grubs, painted bug nymphs and adults, aphids (on the top 10 cm of the apical shoot) per plant, flea beetle larvae per plant, and coccinellid grubs/adults per plant. These counts were taken from 10 randomly selected plants from the onset of pest incidence until the harvest, at weekly intervals (Standard Meteorological Week). Additionally, meteorological data for correlation studies were collected from the meteorological observatory at Chandra Shekhar Azad University of Agriculture and Technology, Kanpur.

**Statistical analysis**: The simple correlation was computed between the population of ~~M~~ustard aphid (*Lipaphis erysimi*~~),~~~~Painted Bug~~(*Bagrada ~~cruciferarum~~*), ~~Mustard Sawfly~~ (*~~A.~~ lugens proxima*), ~~Leaf~~ minor (*~~Phytomiza~~ horticola*)*,* ~~Leady bird~~ beetle (*Coccinella septempunctata*)*,* ~~Zigzag~~ beetle (*~~Menochilus sexmaculatus~~*),~~T~~ransverse ladybird beetle (*Coccinella transversalis*), ~~Skullcaps~~~~fly (~~*~~Coccinella transversalis~~*~~)~~with weather parameters i.e., temperature (°C), relative humidity (%), wind speed and rainfall (mm).

**RESULT AND DISCUSSION**~~:~~

**Mustard aphid (*Lipaphis erysimi* Kalt.)** The study investigated the mustard aphid (*Lipaphis erysimi* Kalt.) infestation on mustard crops during the Rabi seasons of 2021-2022 and 2022-2023, analyzing its population dynamics and correlation with weather conditions. In 2021-2022, aphid infestation occurred from the third week of December to the first week of March, with populations ranging from 15.2 to 73.8 aphids per 10 cm twig. The peak infestation was recorded in the second week of February at 73.8 aphids, with temperatures of 8.1°C (min) and 25.0°C (max), relative humidity of 68.6%, and wind speed of 3.6 km/h. The correlation matrix indicated a significant negative correlation with maximum temperature (r = -0.589) with aphid infestation. However, significant negative correlation was observed with minimum temperature (r = -0.692) and total rainfall (r = 0.281), while non- significant positive correlation was found with average relative humidity (r = 0.430).(Table ~~No 01 & Table No 03~~)

In 2022-2023, aphid infestation started earlier (third week of December) and lasted until the second week of March, with populations ranging from 9.7 to 74.5 aphids per 10 cm twig. The peak infestation occurred in the third week of February at 74.5 aphids, with temperatures of 11.1°C (min) and 26.7°C (max), relative humidity of 66.5%, and wind speed of 5.8 km/h. The study confirmed previous findings that aphid populations peaked at 20-27°C and 5-10°C, with RH between 72-90% (morning) and 53-61% (evening). However, significant negative correlation was observed with minimum temperature (r = -0.330) and total rainfall (r = 0.357), while non-significant positive correlation was found with average relative humidity (r = 0.467). (Table ~~No 02 & Table No 03~~).

The study confirms the seasonal incidence of mustard aphid (*Lipaphis erysimi*) on Indian mustard, influenced by abiotic factors. Jandial and Kumar (2007) reported aphid infestations beginning in late December, peaking in February at 384.15–424.45 aphids per 10 cm shoot. Peak populations occurred at temperatures of 20–27°C (day) and 5–10°C (night), with relative humidity ranging from 72–90% (morning) and 53–61% (evening). Kalita et al. (2016) also found peak aphid populations in the 49th–50th standard week. Correlation analysis showed a significant negative influence of temperature on aphid populations (-0.64 to -0.83). ?

**Painted bug (*Bagrada ~~cruciferarum~~*****~~Burm.~~).** The study analyzed the seasonal incidence of the painted bug ~~(~~*~~Bagrada cruciferarum~~*~~)~~ on mustard crops during the Rabi seasons of 2021–2022 and 2022–2023. In the first year, the bug appeared from the 48th standard week (November) to the 7th standard week (February), with populations ranging from 0.52 to 5.57 bugs per plant. The peak infestation (5.5 bugs/plant) occurred in the 51st week (December) at a minimum temperature of 7.1°C, a maximum of 22.1°C, relative humidity of 64%, and wind speed of 4.1 km/h. The minimum population (0.52 bugs/plant) was observed at a higher temperature of 26.3°C. However, significant negative correlation was observed with minimum temperature (r = -0.459) and total rainfall (r = 0.367), while non- significant positive correlation was found with average relative humidity (r = 0.379). (Table No 01 & Table No 03)

In the second year, infestation patterns were similar, spanning the same weeks, with a population range of 0.21 to 5.74 bugs per plant. The peak occurred in the 1st standard week (January) with 5.74 bugs/plant at a minimum temperature of 5.4°C, a maximum of 13.9°C, relative humidity of 82%, and wind speed of 2.8 km/h. The lowest population (0.21 bugs/plant) was observed at higher temperatures. However, significant negative correlation was observed with minimum temperature (r = -0.854) and total rainfall (r = 0.073), while non- significant positive correlation was found with average relative humidity (r = 0.732). (Table No 02 & Table No 03)

The infestation of the painted bug gradually declined. Divya et al. (2015) reported that the bug appeared in the third week of December, peaking at 6.75 bugs/plant in the first week of January and 7.05 bugs/plant in the third week of January (2012-13). Manzar et al. (1999) observed a maximum population of 78.7 bugs/plant in early March, with another peak of 2.5 bugs/plant. The highest activity of the painted bug was recorded during the 47th standard week.

**Mustard ~~saw fly~~ (*Athalia lugens proxima* Klug):** The study analyzed the seasonal incidence of mustard ~~saw fly~~ ~~(~~*~~Athalia lugens proxima~~* ~~Klug)~~ on mustard crops during the Rabi seasons of 2021–2022 and 2022–2023. In the first year, the pest appeared from the 49th standard week (December) to the 1st standard week (January), with populations ranging from 1.04 to 2.36 grubs per plant. The peak infestation (2.4 grubs/plant) was recorded in the 50th standard week (December) at a minimum temperature of 8.6°C, a maximum of 23.7°C, relative humidity of 69.5%, and wind speed of 1.7 km/h. However, significant negative correlation was observed with minimum temperature (r = -0.244) and total rainfall (r = -0.069), while non- significant positive correlation was found with average relative humidity (r = 0.060). (Table ~~No 01 & Table No 03~~)

In the second year, infestation followed a similar pattern, occurring during the same weeks, with a population range of 0.84 to 1.31 grubs per plant. The peak infestation (2.4 grubs/plant) again occurred in the 50th standard week at a minimum temperature of 10.1°C, a maximum of 25.1°C, relative humidity of 64.5%, and wind speed of 3.8 km/h. The lowest population (0.84 grubs/plant) was recorded in the 1st standard week. The correlation matrix indicated a significant negative correlation with maximum temperature (r = -0.285) with grub infestation. However, significant negative correlation was observed with minimum temperature (r = -0.388) and total rainfall (r = -0.206), while non- significant positive correlation was found with average relative humidity (r = 0.045). Thereafter the infestation of mustard saw fly declined. (Table ~~No 02 & Table No 03~~)

The findings align with Singh et al. (2008), who reported mustard sawfly incidence in mid-November when temperatures ranged from 9.7–13.8°C (minimum) to 28.6°C (maximum), with relative humidity of 82.9–91.6% (morning) and 28–53% (evening). Jat et al. (2006) observed sawfly infestation from the first to the fourth week after sowing, peaking at six grubs per five plants in the second week of November during Rabi 2002–03. Manzar et al. (1999) also recorded peak populations of 2.5 grubs per plant in late November, supporting the present study’s observations.

**Mustard leaf miner (*~~Phytomiza~~ horticola* Goureau):** The study examined the seasonal incidence of mustard leaf miner ~~(~~*~~Athalia lugens proxima~~* ~~Klug)~~ on mustard crops during the Rabi seasons of 2021–2022 and 2022–2023. In the first year, infestation began in the 52nd standard week (December) and lasted until the 10th standard week (March), with populations ranging from 0.15 to 2.4 leaf miners per plant. The peak infestation (2.4 leaf miners/plant) occurred in the 7th standard week (February) at a minimum temperature of 8.1°C, a maximum of 25°C, relative humidity of 68.6%, and wind speed of 3.6 km/h. The lowest population (0.1 leaf miner/plant) was recorded at a higher temperature of 29.2°C. The correlation matrix indicated a significant negative correlation with maximum temperature (r = -0.193) with leaf miner infestation. The correlation matrix indicated a significant negative correlation with maximum temperature (r = -0.193) with leaf miner infestation. However, significant negative correlation was observed with minimum temperature (r = -0.444) and total rainfall (r = -0.046), while non- significant positive correlation was found with average relative humidity (r = 0.051). (Table ~~No 01 & Table No 03~~)

In the second year, mustard leaf miner infestation was observed from the 1st standard week (January) to the 9th standard week (February) of 2023, with populations ranging from 0.2 to 2.3 leaf miners per plant. The peak infestation (2.3 leaf miners/plant) occurred in the 7th standard week (February) at a minimum temperature of 11.1°C, a maximum of 26.7°C, relative humidity of 66.5%, and wind speed of 5.8 km/h. The lowest population (0.2 leaf miners/plant) was recorded in the 1st week at lower temperatures (5.4°C–13.9°C), relative humidity (82.2%) and Wind Speed (km/h) for 2.8 km/hours. The correlation matrix indicated a significant positive correlation with maximum temperature (r = 0.092) with leaf miner infestation. However, significant positive correlation was observed with minimum temperature (r = 0.096) and total rainfall (r = 0.190), while non- significant positive correlation was found with average relative humidity (r = 0.107). (Table ~~No 02 & Table No 03~~)

After the decline of mustard sawfly infestation, Singh and Saravana (2008) reported that pea leaf miner infestation began in the second week of February, peaking at 9.25 miners per plant in the fourth week. The population increased with rising maximum temperature, slight rainfall, and morning humidity but decreased with higher minimum temperature, evening humidity, wind speed, and sunshine. Ahmad et al. (2010) found *~~Chromatomyia horticola~~* infesting brown mustard from March to May in Kashmir, with infestation levels ranging from 4.16% to 100%. *Diglyphus spp.* parasitized the leaf miners, with parasitism rates reaching up to 97.26%.

**CONCLUSION:**

The study highlights the seasonal incidence of key insect pests affecting mustard crops and their correlation with climatic factors. The findings reveal that temperature and humidity significantly influence pest populations, with mustard aphids, painted bugs, sawflies, and leaf miners showing peak infestations under specific temperature ranges. Understanding these relationships is crucial for developing effective pest management strategies. Future research should focus on integrating weather-based forecasting models with biological control methods to enhance sustainable mustard production and minimize yield losses.

**DISCLAIMER (ARTIFICIAL INTELLIGENCE)**

A research paper declaration is a statement affirming the originality of the work, adherence to ethical guidelines, and acknowledgment of sources, ensuring the integrity of the research process.

**COMPETING INTERESTS**

Authors have declared that no competing interests exist.

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**Table No 01: Occurrence and growth of population of *Lipaphis erysimi, Bagrada cruciferarum, A. lugens proxima, Phytomiza horticola,* weather parameters during crop period 2021-2022.**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sr. No.** | **SMW** | **Mean population of insects per 10 plants** | | | | **Temperature (°C)** | | **Relative Humidity (%)** | **Wind Speed (Km/h)** | **Rain Fall (mm)** |
| ***Lipaphis erysimi*** | ***Bagrada cruciferarum*** | ***A. lugens proxima*** | ***Phytomiza horticola*** | **Max** | **Min** |
| **1** | **46** | 0.0 | 0.0 | 0.00 | 0.0 | 27.5 | 11.9 | 69.5 | 1.1 | 0.0 |
| **2** | **47** | 0.0 | 0.0 | 0.00 | 0.0 | 26.9 | 13.3 | 62.5 | 2.5 | 1.2 |
| **3** | **48** | 0.0 | 0.52 | 0.00 | 0.0 | 26.3 | 11.9 | 71.0 | 1.2 | 0.0 |
| **4** | **49** | 0.0 | 1.97 | 1.04 | 0.0 | 26 | 13.5 | 69.5 | 2.4 | 0.0 |
| **5** | **50** | 0.0 | 3.63 | 2.36 | 0.0 | 23.7 | 8.6 | 69.5 | 1.7 | 0.0 |
| **6** | **51** | 15.2 | 5.5 | 2.16 | 0.0 | 22.1 | 7.1 | 64.0 | 4.1 | 0.0 |
| **7** | **52** | 22.87 | 4.73 | 1.42 | 0.15 | 20 | 9.0 | 86.0 | 1.7 | 8.6 |
| **8** | **1** | 31.56 | 3.67 | 0.70 | 0.2 | 20.4 | 8.5 | 83.0 | 3.0 | 23.5 |
| **9** | **2** | 37.93 | 2.31 | 0.00 | 0.3 | 19.4 | 10.3 | 84.0 | 4.1 | 14.6 |
| **10** | **3** | 45.33 | 1.52 | 0.00 | 0.9 | 15.7 | 4.9 | 82.5 | 3.5 | 0.0 |
| **11** | **4** | 59.48 | 1.08 | 0.00 | 1.2 | 17.9 | 7.7 | 80.5 | 4.8 | 3.0 |
| **12** | **5** | 65.82 | 0.83 | 0.00 | 1.7 | 21.2 | 7.5 | 74.5 | 5.9 | 13.0 |
| **13** | **6** | 63.99 | 0.70 | 0.00 | 1.8 | 22.7 | 8.1 | 72.5 | 4.3 | 0.0 |
| **14** | **7** | 73.8 | 0.54 | 0.00 | 2.4 | 25 | 8.1 | 68.6 | 3.6 | 0.0 |
| **15** | **8** | 22.28 | 0.0 | 0.00 | 1.2 | 27.4 | 12.3 | 64.5 | 6.2 | 0.0 |
| **16** | **9** | 10.47 | 0.0 | 0.00 | 0.7 | 27.8 | 11.7 | 68.0 | 3.5 | 0.0 |
| **17** | **10** | 0.0 | 0.0 | 0.00 | 0.1 | 29.2 | 13.9 | 65.5 | 4.8 | 0.0 |

**Fig. 01: Occurrence and growth of population of *Lipaphis erysimi, Bagrada cruciferarum, A. lugens proxima, Phytomiza horticola,* weather parameters during crop period 2021-2022.**

**Table No 02: Occurrence and growth of population of *Lipaphis erysimi, Bagrada cruciferarum, A. lugens proxima, Phytomiza horticola,* weather parameters during crop period 2022-2023.**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sr. No.** | **SMW** | **Mean population of insects per 10 plants** | | | | **Temperature (°C)** | | **Relative Humidity%)** | **Wind Speed (Km/h)** | **Rain Fall (mm)** |
| ***Lipaphis erysimi*** | ***Bagrada cruciferarum*** | ***A. lugens proxima*** | ***Phytomiza horticola*** | **Max** | **Min** |
|  | **46** | 0.0 | 0.0 | 0.0 | 0.0 | 27.8 | 12.9 | 60.0 | 3.3 | 0.0 |
| **1** | **47** | 0.0 | 0.0 | 0.0 | 0.0 | 27 | 9.9 | 62.0 | 2.3 | 0.0 |
| **2** | **48** | 0.0 | 0.41 | 0.0 | 0.0 | 26.8 | 10.3 | 70.0 | 1.2 | 0.0 |
| **3** | **49** | 0.0 | 0.85 | 1.31 | 0.0 | 24.9 | 9.7 | 68.0 | 2.6 | 0.0 |
| **4** | **50** | 12.4 | 1.52 | 2.4 | 0.0 | 25.2 | 10.1 | 64.5 | 3.8 | 0.0 |
| **5** | **51** | 22.46 | 2.46 | 2.01 | 0.0 | 23.3 | 7.5 | 75.0 | 1.8 | 0.0 |
| **6** | **52** | 32.4 | 3.92 | 1.96 | 0.0 | 20.6 | 7.6 | 75.5 | 3.8 | 0.0 |
| **7** | **1** | 39.6 | 5.74 | 0.84 | 0.2 | 13.9 | 5.4 | 82.0 | 2.8 | 0.0 |
| **8** | **2** | 44.7 | 3.89 | 0.0 | 0.4 | 17.8 | 6.3 | 81.5 | 3.0 | 0.0 |
| **9** | **3** | 63.6 | 2.78 | 0.0 | 0.8 | 20.4 | 7.4 | 69.5 | 4.1 | 0.0 |
| **10** | **4** | 69.5 | 2.02 | 0.0 | 1.1 | 22.3 | 10.8 | 81.5 | 4.1 | 18.2 |
| **11** | **5** | 67.4 | 1.2 | 0.0 | 1.8 | 22.7 | 9.7 | 75.0 | 5.9 | 1.0 |
| **12** | **6** | 72.5 | 0.79 | 0.0 | 2 | 28.1 | 10.9 | 70.5 | 4.2 | 0.0 |
| **13** | **7** | 74.5 | 0.21 | 0.0 | 2.3 | 26.7 | 11.1 | 66.5 | 5.8 | 0.0 |
| **14** | **8** | 21.6 | 0.0 | 0.0 | 1.0 | 31 | 11.8 | 69.5 | 2.4 | 0.0 |
| **15** | **9** | 9.7 | 0.0 | 0.0 | 0.4 | 31.2 | 14.4 | 72.5 | 3.2 | 0.0 |
| **16** | **10** | 0.0 | 0.0 | 0.0 | 0.0 | 30.5 | 15.1 | 68.5 | 4.7 | 0.0 |

**Fig. 02: Occurrence and growth of population of *Lipaphis erysimi, Bagrada cruciferarum, A. lugens proxima, Phytomiza horticola,* weather parameters during crop period 2022-2023.**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Table No 03: Correlation analysis between populations of *Lipaphis erysimi, Bagrada cruciferarum, A. lugens proxima, Phytomiza horticola,* and abiotic factor with weather parameters 2021-22 and 2022-23** | | | | | | | | | |
| **Sr. No** | **Weather Parameters** | ***Lipaphis***  ***erysimi*** | | ***Bagrada cruciferarum*** | | 1. ***Lugens proxima*** | | ***Phytomiza horticola*** | |
| **2021-22** | **2022-23** | **2021-22** | **2022-23** | **2021-22** | **2022-23** | **2021-22** | **2022-23** |
| **1** | **Max.**  **Temp(°C)** | -0.589\* | -0.399 | -0.507\* | -0.939\*\* | -0.227 | -0.285 | -0.193 | 0.092 |
| **2** | **Min.**  **Temp(°C)** | -0.692\*\* | -0.330 | -0.459 | -0.854\*\* | -0.244 | -0.388 | -0.444 | 0.096 |
| **3** | **R H (%)** | 0.430 | 0.467 | 0.379 | 0.732\*\* | 0.166 | 0.045 | 0.051 | 0.107 |
| **4** | **W S (Km/h)** | 0.545\* | 0.632\*\* | -0.223 | -0.075 | 0.060 | -0.206 | 0.589\* | 0.675\*\* |
| **5** | **R F (mm)** | 0.281 | 0.357 | 0.367 | 0.073 | -0.069 | -0.159 | -0.046 | 0.190 |

\*\*Correlation is significant at the 0.01 level

\*Correlation is significant at the 0.05 level