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Population dynamics of mung bean insect pests correlating to weather parameters

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Abstract

Mungbean (*Vigna radiata*), a vital pulse crop globally recognized as moong or green gram, holds a significant position in India's agriculture. This study explores the seasonal dynamics of key insect pests affecting *kharif* mungbean in 2022 and their correlation with weather parameters. Notable pests include aphids, whiteflies, thrips, leafhoppers, *H. armigera*, *M. vitrata*, and the defoliator green semilooper. The experiment sum up the incidence patterns of these pests & their interactions with meteorological conditions. Aphids' population shows positive correlation with max. temp. and evening relative humidity, while whiteflies showed a non-significant positive association with max. temperature. Leafhoppers showed a non-significant positive correlate with maximum temperature, but thrips showed a positive correlation with both morning relative humidity and maximum temperature. It is crucial to comprehend the unfavourable correlations between *H. armigera* and spotted pod borer and different meteorological conditions. Green semilooper exhibited both positive and negative correlation with different weather factors.

Keywords: Mungbean, insect pests, population dynamics, weather parameters, pest management

Introduction

After pigeon pea and chickpea, greengram (*Vigna radiata*), sometimes referred to as mungbean or moong, is the third most important pulse crop. Belonging to the Leguminosae or Fabaceae family, it's crucial pulse crop in India, contributing to 54% of global production and 65% of total acreage (Singh and Singh, 2014) [13]. Renowned for its nutritional value, mungbean plays a vital role in human nutrition and enhances soil fertility through N fixation. Originating in India, it is cultivated primarily in East of Asia and is valued for its seed's desirability, nutritional content, easy digestibility, and non-flatulent nature. Mungbean stands out because of its wide geographical distribution, minimal water requirements, and its It is an important pulse crop in India, accounting for 54% of worldwide output and 65% of total acreage. It belongs to Leguminosae or Fabaceae family (Singh and Singh, 2014) [13]. It is recognized for its great nutritional value of mungbean is essential to human nutrition and improves soil fertility by fixing nitrogen. It comes from India and is grown mostly in East Asia. It is prized for the nutritious value, easy digestion, and non-flatulent character of its seeds. Mungbean is unique because to its extensive geographic range, low water needs, and application as green gram manure for soil enrichment via nitrogen fixation (Tamang *et al.*, 2017) [14]. Application as green gram manure for soil improvement via nitrogen fixation (Tamang *et al.*, 2017) [14]. Even though India leads the world in greengram production, its output has increased to about 40.38 lakh hectares, or 11% of the overall pulse production in 2021–2022.

Insect pests poses a significant threat to mungbean, with aphids, leafhoppers, whiteflies, thrips, pod borers, and spotted pod borers being major concerns Islam *et al.*, 2008 [3]. The impact of these pests is influenced by meteorological factors such as the degree of humidity, temperature, and precipitation. The pod borer, *M. vitrata*, poses a particular threat during the reproductive stages of green gram, leading to lower yields. Spotted pod borer outbreaks are a common occurrence, contributing to reduced yields. Mungbean is greatly impacted by sucking insect pests, such as thrips, jassids, aphids, and leafhoppers (Dietz, 1914) [2].

Notably, yield decreases of up to 70% have been reported as a result of whitefly harm.

This research intends to explore the population dynamics of important insect pests in mungbean (greengram) in connection to meteorological conditions, given the significance of these pests and their influence on mungbean output. The study tackles the urgent need to comprehend how insect pests and weather interact effectively manage pests in the production of mungbean (greengram).

Methodology

The study conducted at the Agricultural Research Station in Badnapur during the 2021-22 *kharif* season. Tillage operations performed to enhance soil health. Mung bean, a leguminous crop, received half the nitrogen and full P2O5 before sowing. Recommended agronomic practices followed, including thinning, gap filling, irrigation, hand weeding, and hoeing. The greengram crop (BM2013-2 variety) sown in early July 2022, with a plot size of 10 x 10 m and 30 cm row-to-row and 10 cm plant-to-plant spacing. Weekly observations of whiteflies, aphids, thrips, and leafhoppers—sucking pests—from the top, middle, and bottom trifoliate leaves of 10 randomly chosen plants were made. Information displayed as the average frequency of sucking insects on each trifoliate leaf. This data and meteorological characteristics have been linked by statistical analysis. Pod borers (*Maruca vitrata* and *Helicoverpa armigera*) were observed in populations from the time of their emergence till the harvesting of crops. Weekly counts of larval populations on 10 randomly chosen tagged plants are conducted. Ten randomly chosen tagged plants were used to measure the incidence by calculating the mean pod damage and total number of damaged pods.

Results & Discussion

Aphids (*Aphis craccivora*)

First discovered in the 31st SMW, aphids (*Aphis craccivora*) ranged in population size from 5.1 to 9.2 aphids/trifoliate leaf (Table1). From the 31st to the 33rd SMW, the population grew progressively, reaching a high of 9.2 aphids/trifoliate leaf in the 33rd SMW. The findings were consistent with the findings of Kumar *et al.* (2022) [4], who reported that *Aphis craccivora* was first observed on the crop in the 32nd SMW with an average of 1.20 aphids per plant. The presence of *A. craccivora* continued until the 38th SMW, with the peak population reaching 8.70 aphids per plant during the 36th SMW. Table 2 showcases the association between environmental conditions and aphid activity. While there was a positive correlation between maximum temperature ($r=0.478$) and evening relative humidity

($r=0.512$) with aphid population, the effects were not deemed statistically significant. On the other hand, morning relative humidity ($r=-0.420$), rainfall ($r=-0.231$), and minimum temperature ($r=-0.201$) all had a negative impact on aphid population, but these relationships were also found to be non-significant. According to the results of Prince Mahore (2023) [7], there is evidence that the minimum temperatures in the morning and evening, wind speed, rainfall, and relative humidity do not significantly affect aphid population levels. Additionally, their study found a non-significant positive relationship between daylight hours and aphid population. This conclusion is in line with the findings of Bairwa and Singh (2017) [1], who also reported a lack of significant correlation between morning and evening minimum temperatures, wind speed, rainfall, and relative humidity, and aphid population. Furthermore, their study also revealed a non-significant positive correlation between daylight hours and aphid population.

Whitefly (*Bemisia tabaci*)

Whitefly damage, ranging from 1.6 to 2.1, occurred from the 31st to the 36th SMW. The 36th SMW had the lowermost occurrence (1.4 whiteflies/trifoliate leaves), whereas the 33rd SMW had the greatest incidence (2.1 whiteflies/trifoliate leaves). After that, the incidence of whiteflies steadily dropped from the 34th to the 36th SMW till harvesting, with the last observation showing 1.41 whitefly/trifoliate leaves. Present investigation was similar with Nitharwal and Kumawat (2009) [9], who noted that whiteflies began to arrive in the 35th week of the meteorological calendar and peaked in the 39th. The whitefly population began to increase in the first week of August (32 SMW), according to Singh *et al.* (2019) [12]. It peaked in the beginning week of September (36 SMW) with 14.20 whiteflies per three leaves. The highest temperature and the number of whiteflies have a non-significant positive connection ($r=0.061$) according to Table 2. The whitefly population was positively impacted by the lowest temperature and night time relative humidity ($r=0.355$ and $r=0.07$, respectively), this effect was not statistically significant. There were non-significant negative relationships found with morning relative humidity ($r=-0.575$) and rainfall ($r=-0.040$). These results show a substantial negative relationship with rainfall and a significant positive association with the number of whiteflies, which is in line with Prince Mahore's (2021) [7] findings the. Whitefly and highest temperature were also found a positive significant correlation by Bairwa and Singh (2017) [1], while rainfall and relative humidity (maximum and minimum) were found to have non-significant negative correlations. Other factors, on the other hand, showed positive non-significant relationships with abiotic factors.

Table 1: Population dynamics of major insect pests in Mungbean

SMW	Sucking pest/trifoliate leaf				Pod borer		Defoliator
	Aphid\ Trifoliate leaves	Whitefly\ trifoliate leaves	Thrips\ trifoliate leaves	Leafhopper\ trifoliate leaves	<i>H. armigera</i>	<i>M. vitrata</i>	<i>Green Semilooper</i>
31	8.8	1.6	1.7	1.2	0	0	2.6
32	8.5	1.7	1.9	1.4	0.7	0.6	2.9
33	9.2	2.1	2.6	1.7	0.9	0.8	3.8
34	5.6	1.6	3.4	1.2	1.3	1.1	3.2
35	5.4	1.5	1.9	1.5	1.4	1.3	2.8
36	5.1	1.4	2.3	1.4	1.3	0.9	2.9

Table 2: Correlation of insect pest population with weather parameters

Weather Factors	Aphid	Whitefly	Thrips	Leafhopper	<i>H. armigera</i>	<i>M. vitreata</i>	Green Semilooper
Max T	0.478	0.061	0.235	0.121	-0.173	-0.371	0.277
Min T	-0.201	0.355	0.014	0.201	0.239	0.612*	-0.005
Rainfall	-0.231	-0.040	-0.086	-0.127	-0.112	0.120	-0.189
RHm	-0.420	-0.575	-0.765**	0.635*	-0.820**	-0.478	-0.654*
RHe	0.512	0.071	0.103	0.166	-0.209	-0.380	0.271

*Significance level $P = 0.05$ Max T: Maximum temperature, Min T: Minimum temperature, Rainfall (mm), Rhm: Relative humidity at morning, RHe: Relative humidity

Thrips (*Thrips tabaci*)

Thrips population initially observed in the 31st SMW and increased from the 31st to the 34th SMW (1.7 to 3.4 thrips/trifoliolate leaf) before decreasing. The highest population recorded in 34th SMW at 3.4 thrips/trifoliolate leaves, aligning with Kumar *et al.* (2022) [4] findings of *Thrips tabaci* appearing on the crop in the 32nd SMW (2.10 thrips/plant) and infesting until the 38th SMW, with a peak population of 7.00 thrips/plant in the 35th SMW. Table 2 displays the relationship between thrips and meteorological parameters, indicating a moderate effect. Maximum temperature ($r=0.253$), minimum temperature ($r=0.014$), and relative humidity at morning ($r=0.103$) positively influenced thrips population but were non-significant. Rainfall had a non-significant negative correlation ($r=-0.086$) with thrips population, like Sarkar *et al.* (2019) [11] findings that thrips were unaffected by rainfall.

Pod borer (*Helicoverpa armigera*)

Helicoverpa armigera occurrence followed a similar pattern, initially seen around the 32nd SMW and ranging from 0.7 to 1.4 larvae/plant. From the 32nd to the 35th SMW, the population grew; in the 36th SMW, it peaked at 8.50 larvae/ten plants. Pal *et al.* (2021) [10] findings supported this, with *H. armigera* appearing in the 31st SMW (0.50 larvae/ten plants) and reaching a peak of 8.50 larvae/ten plants in the 36th SMW. Table 2 presents the association between *H. armigera* and weather parameters, showing little impact. Highest temperature ($r=-0.173$), rainfall ($r=-0.112$), and evening R. humidity ($r=-0.209$) had non-significant negative correlation with *H. armigera* populations. Minimum temperature ($r=0.239$) found a positive non-significant correlation. As stated by Pal *et al.* (2021) [10], who also found no statistically significant associations with minimum temperature, relative humidity, and rainfall, morning relative humidity ($r=-0.820$) associated strongly and adversely with the *H. armigera* population. The maximum temperature and gram pod borer infection were shown to be significantly inversely correlated.

Maruca vitrata (Spotted pod borer)

The initial *Maruca vitrata* population showed up during the 32nd SMW, ranging from 0.6 to 1.3 larvae/plant. The population gradually increased from the 32nd to the 36th SMW, peaking at 1.3 larvae/plant in the 35th SMW. Kumar *et al.* (2022) [4] findings supported this, with *M. vitrata* appearing on the crop in the 34th SMW (0.90 larvae/plant) and infesting until the 38th SMW, reaching a peak of 2.30 larvae/plant in the 36th SMW. Pal *et al.* (2021) [10] reported the spotted pod borer *M. testulalis* appearing in the 31st SMW (0.66 larvae/ten plants) and reaching a peak of 9.66 larvae/ten plants in the 36th SMW. Table 2 illustrates the correlation coefficients between *M. vitrata* and weather parameters. There were non-significant negative correlations ($r=-0.371$, $r=-0.478$, and $r=-0.380$) between the highest temperature, relative humidity in the morning and evening, and rainfall, however there were significant positive correlations

($r=0.612$ and $r=0.120$) between rainfall and minimum temperature. Umbarkar *et al.* (2010) [15] supported these findings, noting non-significant negative effects of relative humidity (maximum and minimum) and rainfall, with positive non-significant impacts of temperature (maximum and minimum), wind speed, sunshine hours, and evaporation on *M. vitrata* population fluctuation.

Leafhopper (*Empoasca kerri*)

Leafhopper incidence began in the 31st SMW at 1.2 leafhoppers/trifoliolate leaf, persisting until the 36th SMW. The range observed was 1.2 to 1.7 leafhoppers/trifoliolate leaf, with the peak population (1.7 leafhoppers/trifoliolate leaf) occurring in the 33rd SMW. Kumar *et al.* (2022) [4] reported similar results, with *Empoasca kerri* appearing on the crop in the 32nd SMW (3.50 jassids/plant) and infesting until the 38th SMW, reaching a peak population of 7.50 jassids/plant in the 35th SMW. Mohapatra *et al.* (2018) [8] noted *E. kerri* as a significant pest of black gram, appearing in the 35th SMW and reaching a peak population of 36.80 jassids/cage in the 39th SMW. In Table 2 observed that correlations between leafhoppers and weather parameters. There was a non-significant negative relationship ($r=-0.127$) with rainfall, and non-significant positive relationships ($r=0.121$, $r=0.201$, and evening relative humidity, $r=0.166$) with the leafhopper population. Similarly Mohapatra *et al.* (2018) [8], who reported non-significant positive correlations between the leafhopper population and the maximum temperature, minimum temperature, and rainfall, showed a non-significant negative correlation with relative humidity. Bairwa and Singh (2017) [1] also reported a non-significant positive correlation between maximum temperature, and a positive but non-significant correlation between the minimum temperature and the population of jassids.

Green semilooper (*Chrysodeixis acuta*)

The green semilooper first showed up on the crop in the 31st SMW at 2.6 semiloopers/trifoliolate leaf. It continued to show up in the crop until the 36th SMW, when its numbers varied from 1.2 to 1.7 semiloopers/trifoliolate leaf. The maximum population (1.3 semiloopers/trifoliolate leaf) was observed on the 33rd SMW. Kurly and Singh (2021) [6] reported similar findings, with the pest first observed in the 29th SMW at 1.05 larvae/10 plants in 2016 and 1.28 larvae/10 plants in 2017. The highest population was noticed on the 33rd SMW in 2016 (3.90 larvae/10 plants) and on the 32nd SMW in 2017 (4.26 larvae/10 plants). Table 2 illustrates the correlation coefficients between semilooper and weather parameters. Semilooper actions were impacted by all factors. Maximum temperature ($r=0.277$) and evening relative humidity ($r=0.271$) showed non-significant positive correlations, whereas minimum temperature ($r=-0.005$) and morning relative humidity ($r=-0.654$) showed non-significant negative correlations. It was a noteworthy inverse relationship ($r=-0.654$) seen between semilooper populations and morning relative humidity. Kurly and Singh (2021) [6] discovered a positive and

substantial link between green semilooper and meteorological factors. Specifically, they recorded strong correlations with maximum temperature (0.454**) and minimum relative humidity (0.495**).

Conclusion

In conclusion, the study on the cyclic occurrence of pests in *kharif* mung bean during the 2022 season revealed the presence of whiteflies, aphids, thrips, leafhoppers and two borers, *H. armigera* and *M. vitrata*, and the defoliator green semilooper. The peak populations of whiteflies, aphids, and leafhoppers were observed in the 33rd (SMW). Thrips exhibited a significant negative correlation with relative humidity at morning (R_{hm}), while leaf hoppers showed a significant negative association with morning humidity. Morning relative humidity and *H. armigera* showed a negative, non-significant connection. There was a substantial positive association between the minimum temperature and the spotted pod borer. The green semilooper and Rh had a substantial inverse relationship in the morning.

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