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POPULATION DYNAMICS OF MAJOR INSECT PESTS AND THEIR NATURAL ENEMIES ON MUNGBEAN (*Vigna radiata* L., R. WILCZEK) IN RELATION TO WEATHER PARAMETERS

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ABSTRACT

A field investigation was conducted during *Kharif* 2025 at the Entomological Research Farm, R.A.K. College of Agriculture, Sehore, Madhya Pradesh to characterize the seasonal population dynamics of major insect pests and associated natural enemies on mungbean. The experiment was conducted on mungbean variety AKM 8802 with observations recorded at weekly interval from crop emergence to maturity. Whitefly (*Bemisia tabaci*), jassid (*Empoasca kerri*), thrips (*Megalurothrips usitatus*), Bihar hairy caterpillar (*Spilosoma obliqua*) and spotted pod borer (*Maruca vitrata*) were recorded as major pests, while coccinellids and spiders were observed as natural enemies. Whitefly appeared during the 31st standard meteorological week (SMW), increased progressively and attained a maximum of 6.40 individuals per three leaves during the 35th SMW. Jassid also reached its maximum population of 4.30 individuals per three leaves during the 35th SMW. Thrips appeared during the 32nd SMW and peaked at 1.90 individuals per three leaves during the 34th SMW. Bihar hairy caterpillar was first observed during the 32nd SMW and reached 2.60 larvae per plant in the 35th SMW, whereas spotted pod borer appeared during the 33rd SMW and attained 2.80 larvae per plant in the 37th SMW. Coccinellids and spiders showed maximum populations of 2.60 and 1.60 individuals per plant, respectively, both during the 35th SMW. Correlation analysis indicated significant positive associations of jassid with maximum temperature (r = 0.680), thrips with maximum temperature (r = 0.708) and relative humidity (r = 0.675), Bihar hairy caterpillar with minimum temperature (r = 0.728) and coccinellids with maximum temperature (r = 0.758). The results indicate that pest incidence was concentrated largely during the mid-season and that weather variable, particularly temperature and relative humidity, contributed to the observed population fluctuations. These findings provide a useful basis for timely monitoring and weather-informed integrated pest management in mungbean.

Key words : Mungbean, Insect pests, Population dynamics, Weather parameters, Natural enemies.

Introduction

Mungbean, *Vigna radiata* (L.) R. Wilczek is an important pulse crop of India and is valued for its nutritional quality, short duration and adaptability. The crop contributes substantially to pulse-based food systems and is cultivated widely in the Indian subcontinent. Mungbean seeds contain approximately 25-28% protein together with carbohydrates, minerals and vitamins, making the crop nutritionally important. The crop is also consumed as sprouts and in several processed food products.

Mungbean cultivation has expanded from Asia to parts of Africa and the Americas and is presently grown on about 7.3 million hectares globally, with a production of nearly 5.3 million tonnes and an average productivity of 721 kg ha^{-1}. India and Myanmar together contribute about 30 per cent of global production, while other major producers include China, Indonesia, Thailand, Kenya and Tanzania. In India, mungbean is mainly cultivated in Rajasthan, Karnataka, Maharashtra, Odisha, Madhya Pradesh and Gujarat. Among these, Rajasthan accounts

for the largest share of area under mungbean cultivation, followed by Karnataka, Maharashtra and Odisha, while Madhya Pradesh and Gujarat also contribute significantly to national production. Madhya Pradesh alone contributed significantly with 5.0-5.5 lakh hectares' area, 5.8-6.2 lakh tonnes production and higher productivity of 1050-1150 kg ha{ ¹ highlighting its importance in national mungbean production (Anonymous, 2024).

Numerous insect pests have been reported to infest mungbean and urdbean crops worldwide. Approximately 198 insect species are known to attack these crops globally (Chhabra and Kooner, 1994), whereas under Indian conditions, nearly 64 insect pest species have been recorded on mungbean alone (Lal, 1985). Several studies have documented the occurrence of major sucking and chewing insect-pests on mungbean. The important insect-pests infesting mungbean include jassid (*Empoasca kerri* Pruthi), thrips (*Caliothrips indicus* Bagnall), whitefly (*Bemisia tabaci* Genn.), semilooper (*Plusia orichalcea* Fab.), green stink bug (*Nezara viridula* Linn.), stem fly (*Ophiomyia phaseoli* Tryon), pod borers such as *Helicoverpa armigera* Hubner and *Maruca testulalis* Geyer, tortricid moth (*Cydia ptychora* Meyr), galerucid beetle (*Madurasia obscurella* Jacoby) and cutworm (*Agrotis ipsilon* Hufn.) (Kumar *et al*., 2004; Nitharwal and Kumawat, 2013).

Whitefly (*Bemisia tabaci*), jassid (*Empoasca kerri*) and thrips (*Megaluro thripsusitatus*) suck cell sap from leaves, buds and flowers, causing yellowing, curling, stunted growth, flower drop and reduced pod setting. Whitefly also transmits yellow mosaic virus (Atwal and Dhaliwal, 2008). Spotted pod borer (*Maruca vitrata*) larvae web flowers, buds and pods together and feed inside pods by damaging developing seeds, resulting in flower shedding and poor grain yield (Zahid *et al*., 2008). Hairy caterpillar (*Spilosoma obliqua*) and tobacco caterpillar (*Spodoptera litura*) larvae feed on foliage and cause severe defoliation, reducing photosynthetic area and plant vigour (Kumar *et al*., 2013). It has been estimated that insect pests cause an annual loss of about 2.5 to 3.0 million tonnes of pulses, accounting for nearly 30 per cent reduction in total production (Rabindra *et al*., 2004). Due to such severe damage, insect pests are regarded as one of the major limiting factors in mungbean productivity (Panchabhavi and Kadam, 1990).

The abundance of insect pests and their associated natural enemies is greatly influenced by prevailing weather conditions. Seasonal incidence, population build-up and developmental rates of both pests and beneficial insects are largely governed by abiotic factors. Among the climatic factors, temperature and relative humidity play a crucial role in regulating pest population dynamics, their developmental patterns and the temporal occurrence of pests along with their natural enemies. Information on these relationships is essential for formulating effective integrated pest management strategies that ensure ecological sustainability, while maintaining economic viability. The present study was therefore undertaken to determine the seasonal occurrence and population dynamics of major insect pests and natural enemies on mungbean under the agro-climatic conditions of Sehore, Madhya Pradesh, and to quantify their association with selected weather parameters. The work corresponds specifically to the first objective of the thesis: to study the population dynamics of major insect pests and their natural enemies on mungbean.

Materials and Methods

Experimental site and crop

The experiment was conducted during *Kharif* 2025 at the Entomological Research Farm of R.A.K. College of Agriculture, Sehore (Madhya Pradesh), located in the Malwa Plateau region at approximately 23°18′ N latitude, 77°05′ E longitude and 502 m above mean sea level. Mungbean variety AKM 8802 was sown on 11 July 2025. The experimental plot measured 10 × 10 m, with 45 cm row-to-row and 10 cm plant-to-plant spacing. The crop received fertilizer at 25:50:25 kg N:P:K ha^{-1} and routine intercultural operations as described in the thesis.

Sampling and observations

Observations were recorded at weekly intervals from crop emergence to maturity. Whitefly and jassid populations were counted in the early morning on three leaves (top, middle and bottom canopy) of ten randomly selected plants. Thrips were recorded on three compound leaves of ten randomly selected plants. Larvae of defoliators and pod borer were counted on ten randomly selected plants. Natural enemies, particularly coccinellids and spiders were also recorded on ten randomly selected plants at weekly intervals. The observations covered SMW 31 to 39 for the pest population series.

Weather observations

Weekly maximum and minimum temperature, relative humidity and rainfall were obtained from the meteorological observatory of R.A.K. College of Agriculture, Sehore. Weather observations corresponding to SMW 31-40 were used to describe the crop-season environment; pest and natural-enemy correlations were calculated using the available weekly observations.

Statistical analysis

Simple correlation coefficients (r) between insect populations and weather parameters were calculated following Snedecor and Cochran (1967). Correlations marked with an asterisk were significant at the 5% level.

Results and Discussion

Insect pest complex and seasonal occurrence

Seven arthropod groups were consistently documented in the crop ecosystem: five major insect pests - whitefly (*Bemisia tabaci*), jassid (*Empoasca kerri*), thrips (*Megalurothrips usitatus*), Bihar hairy caterpillar (*Spilosoma obliqua*) and spotted pod borer (*Maruca vitrata*) and two natural-enemy groups, coccinellids and spiders. The observed complex agrees broadly with earlier reports from mungbean-growing regions, although the exact composition and timing of incidence vary with location and season.

Sucking pests

Whitefly appeared first during the 31st SMW at 0.80 individuals per three leaves. Its population increased through the mid-season and attained the highest density of 6.40 individuals per three leaves during the 35th SMW. Overall, the population density varied from 0.8 to 6.4 whiteflies per leaves during the cropping season, when maximum and minimum temperatures were 32.4 and 23.5 °C, relative humidity was 87% and rainfall was 7.7 mm. Thereafter, the population declined to 1.20 by the 38th SMW and was absent in the 39th SMW. The seasonal pattern is comparable with reports of peak whitefly activity around the 35th - 36th SMW in mungbean. Similar observations were reported by Bairwa and Singh (2017), Ojha *et al*. (2022) those observed that the peak population of whitefly and other sucking pests on mungbean occurred around the 35th SMW, which coincides with the peak incidence recorded in the present investigation. Likewise, Mahore and Panday (2023) also reported that whitefly remained active from the vegetative stage to maturity and showed significant association with favourable weather conditions. Correlation analysis indicated that the whitefly population did not show any significant association with the studied abiotic factors. The revealed that the whitefly population exhibited a positive but non-significant correlation with maximum temperature (r = 0.583), minimum temperature (r = 0.561), and relative humidity (r = 0.507). In contrast, rainfall showed a negative and non-significant relationship (r = –0.146) with whitefly population. Similarly, Mohapatra *et al*. (2018) showed significant positive association between maximum temperature and whiteflies population of urdbean. Singh *et al*. (2019) revealed that the significant positive association was found in the whitefly population at the highest temperature, while negative correlations was found in the whitefly population with rainfall. Rajawat *et al*. (2020) population of whitefly showed a positive association with temperature, while rainfall exhibited a negative association with whitefly. Patel *et al*. (2021) maximum temperature had exhibited significantly positive correlation (r = 0.60) with whitefly, while rainfall was expressed non-significant correlation. Chauhan *et al*. (2022) indicated that the population of whitefly adults as significant and negative correlation between the rainfall (r= -0.68). Khaliq *et al*. (2022), who that the maximum temperature had a positive relationship (r = 0.51) with whitefly in mungbean and rainfall showed a highly significant but negative correlation. Ojha *et al*. (2022), Mahore and Panday (2022) revealed that the population of whitefly in mungbean had a significant positive correlation with maximum temperature (r = 0.78).

Table 1 : Weekly meteorological conditions recorded during the Mungbean crop period at Sehore, *Kharif* 2025.

SMW	Date	Max. temp. (°C)	Min. temp. (°C)	RH (%)	Rainfall (mm)
31	02 Aug 2025	30.5	22.3	85	16.4
32	09 Aug 2025	31.7	22.6	87	4.6
33	16 Aug 2025	32.1	23.2	86	4.5
34	23 Aug 2025	31.1	23.3	86	6.4
35	30 Aug 2025	32.4	23.5	87	7.7
36	06 Sep 2025	30.4	22.8	81	6.0
37	13 Sep 2025	31.1	23.4	75	4.1
38	20 Sep 2025	28.9	22.8	72	8.7
39	27 Sep 2025	29.7	23.1	68	3.0

Jassid appeared during the 31st SMW at 0.50 individuals per three leaves and increased to a peak of 4.30 during the 35th SMW. The population then declined to 1.10 by the 37th SMW and was absent thereafter. Throughout the crop period, the jassid population ranged between 0.50 and 4.30 per leaves. Similarly, Yadav *et al*. (2015) reported that jassid infestation on green gram started from the 36th SMW and reached its peak during the 39th SMW, indicating that the pest population generally increases during the mid-crop stage. Further, Singh *et al*. (2019) also observed that the population of jassid and whitefly on mungbean increased gradually and attained peak activity during the 36th SMW under favourable weather conditions, which supports the present findings. The jassid population showed a significant and positive correlation with maximum temperature (r = 0.680*). However, minimum temperature (r = 0.497) and relative humidity (r = 0.649) exhibited positive but non-significant

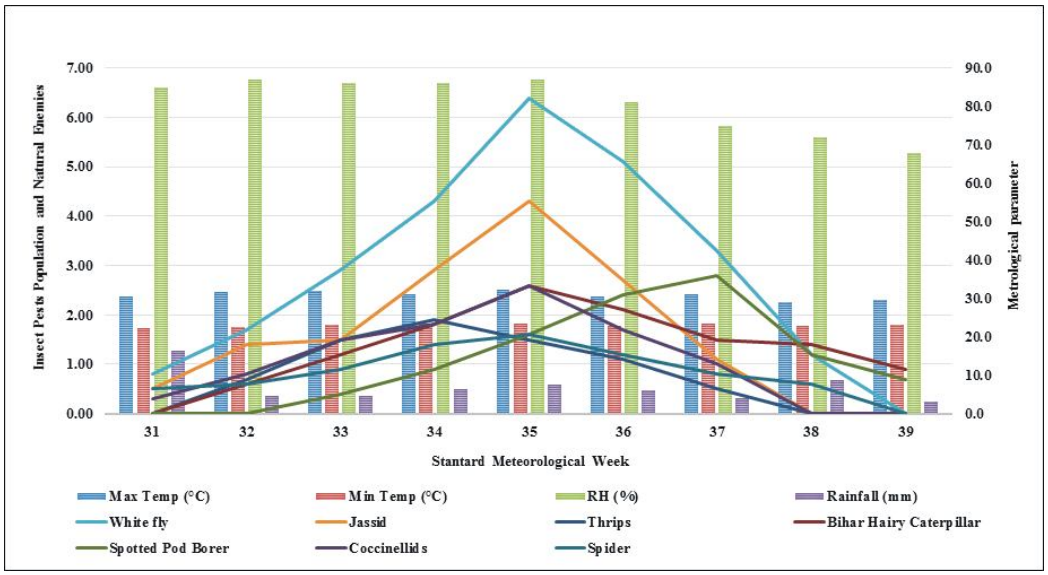


Fig. 1 : Population dynamics of insect pests and their natural enemies on Mungbean.

correlations with jassid population. Rainfall was found to have a negative and non-significant association (r = –0.097) with jassid incidence. Similar observations were reported by Yadav *et al*. (2015) jassid population showed positive correlation with temperature, humidity and rainfall. Bairwa and Singh (2017) showed that the maximum temperature was positive correlation with population of jassid and populations of other insect were negative correlation with rainfall. Mohapatra *et al*. (2018) showed that the significant positive association between maximum temperature and jassid population of urdbean. Patel *et al*. (2021) jassid population was found relative humidity and rainfall had non-significant positive correlation. Singh *et al*. (2022) jassid exhibited a significant positive association with maximum temperature. Similarly, Ojha *et al*. (2022) revealed that the population of jassid was found significant positive correlation with minimum temperature (r= 0.78), while that a significant negative correlation with population of *E. kerri* (r = -0.78).

Thrips appeared during the 32nd SMW at 0.70 individuals per three leaves, increased to a maximum of 1.90 in the 34th SMW and subsequently declined to 0.50 by the 37th SMW. During the entire cropping season, the thrips population fluctuated between 0.50 and 1.90 per leaves. These results are in accordance with Tamang *et al*. (2017), who reported that thrips population on mungbean reached its peak during the middle stage of the crop season. The thrips population exhibited a significant positive correlation with maximum temperature (r = 0.708*) and relative humidity (r = 0.675*). Minimum temperature (r = 0.571) showed a positive but non-significant association with thrips population. Rainfall had a negative and non-significant effect (r = –0.097) on thrips incidence. Similarly, Nadeem *et al*. (2020) reported that thrips population in green gram showed a positive association with temperature but negative association with

Table 2 : Seasonal population dynamics of major insect pests and natural enemies on Mungbean cv. AKM 8802 during *Kharif* 2025.

SMW	Date	Whitefly*	Jassid*	Thrips*	BHC†	SPB†	Coccinellids‡	Spiders‡
31	02 Aug 2025	0.80	0.50	0.0	0.0	0.0	0.30	0.50
32	09 Aug 2025	1.70	1.40	0.70	0.60	0.00	0.80	0.60
33	16 Aug 2025	2.90	1.50	1.50	1.20	0.40	1.50	0.90
34	23 Aug 2025	4.30	2.90	1.90	1.80	0.90	1.80	1.40
35	30 Aug 2025	6.40	4.30	1.50	2.60	1.60	2.60	1.60
36	06 Sep 2025	5.10	2.70	1.10	2.10	2.40	1.70	1.20
37	13 Sep 2025	3.30	1.10	0.50	1.50	2.80	1.00	0.80
38	20 Sep 2025	1.20	0.00	0.00	1.40	1.20	0.00	0.60
39	27 Sep 2025	0.00	0.00	0.00	0.90	0.70	0.00	0.00

* Individuals per three leaves plant^{-1}; † Larvae plant^{-1}; ‡ Individuals plant^{-1}. SMW = Standard Meteorological Week; BHC = Bihar hairy caterpillar; SPB = spotted pod borer.

Table 3 : Correlation coefficients (r) between weather parameters and populations of major insect pests and natural enemies.

Weather parameter	Whitefly	Jassid	Thrips	Bihar hairy caterpillar	Spotted pod borer	Coccinellids	Spider
Maximum temperature (°C)	0.583	0.680*	0.708*	0.255	-0.066	0.758*	0.573
Minimum temperature (°C)	0.561	0.497	0.571	0.728*	0.487	0.575	0.486
Relative humidity (%)	0.507	0.649	0.675*	0.078	-0.317	0.657	0.631
Rainfall (mm)	-0.146	-0.097	-0.288	-0.365	-0.308	-0.174	0.007

* Significant at 5% level. Values reproduced from the thesis correlation table; No additional significance testing was performed.

Table 4 : Summary of first appearance, peak population and peak SMW of the recorded arthropods.

Arthropod group	First appearance	Peak population	Peak SMW	Unit
Whitefly	31st	6.40	35th	Per three leaves plant^{-1}
Jassid	31st	4.30	35th	Per three leaves plant^{-1}
Thrips	32nd	1.90	34th	Per three leaves plant^{-1}
Bihar hairy caterpillar	32nd	2.60	35th	Larvae plant^{-1}
Spotted pod borer	33rd	2.80	37th	Larvae plant^{-1}
Coccinellids	31st	2.60	35th	Individuals plant^{-1}
Spiders	31st	1.60	35th	Individuals plant^{-1}

rainfall and relative humidity. Singh *et al*. (2022) population of thrips showed a significant positive correlation with minimum temperature.

Defoliator and pod borer

Bihar hairy caterpillar was recorded from the 32nd to 39th SMW. Its population increased from 0.60 larvae per plant to a maximum of 2.60 larvae per plant during the 35th SMW and then declined to 0.90 larvae per plant by the 39th SMW. These findings are supported by Mohapatra *et al.* (2018), who reported that Bihar hairy caterpillar along with jassid and whitefly were the major pests infesting pulse crops and their population reached higher levels during later crop stages. Bihar hairy caterpillar population showed a significant positive correlation with minimum temperature (r = 0.728*). Maximum temperature (r = 0.255) and relative humidity (r = 0.078) were positively but non-significantly associated with pest population. Rainfall exhibited a negative and non-significant correlation (r = –0.365) with the population of Bihar hairy caterpillar.

Spotted pod borer appeared slightly later, from the 33rd SMW, and increased steadily to a peak of 2.80 larvae per plant during the 37th SMW before declining to 0.70 larvae per plant at harvest. The delayed peak of *M. vitrata* relative to sucking pests is biologically consistent with its stronger association with the reproductive stage of mungbean and with previous reports of pod borer activity during flowering and pod formation. Similar findings were reported by Yadav and Singh (2013), who recorded the first incidence of spotted pod borer during the 33rd SMW with peak population during the 36th SMW in mungbean crop. Likewise, Meena *et al*. (2021) reported that the population of spotted pod borer on green gram gradually increased and attained peak levels during the 36th SMW, which supports the results of the present investigation. Correlation studies revealed that the spotted pod borer population did not exhibit any significant association with the weather parameters under study. A positive but non-significant correlation was observed with minimum temperature (r = 0.487). In contrast, negative and non-significant correlations were recorded with maximum temperature (r = –0.066), relative humidity (r = –0.317), and rainfall (r = –0.308). Similar findings were reported by Meena *et al*. (2021) showed that the spotted pod borer on green gram was had highly significant correlation with maximum temperature (r= -078), while showed non-significant correlation with minimum temperature. Similarly, Sreedhar *et al*. (2023) spotted pod borer showed a significantly correlation with rainfall. Singh *et al*. (2022) spotted pod borer was found non-significant correlation with most weather parameters.

Natural enemies

Coccinellids were observed from the 31st to 37th SMW, increasing from 0.30 to a maximum of 2.60 beetles per plant during the 35th SMW and subsequently declining. Spider abundance ranged from 0.50 to 1.60 spiders per plant with the maximum population also recorded during the 35th SMW. The concurrent occurrence of natural

enemies with sucking-pest build-up emphasizes the importance of conserving beneficial arthropods as a component of integrated pest management. Similar occurrence of coccinellids and spiders in pulse crop ecosystems has been documented previously. Similar results were reported by Tamang *et al*. (2017), who observed a positive relationship between the population of sucking pests and predatory coccinellids in mungbean ecosystem. The population of coccinellids showed a significant positive correlation with maximum temperature (r = 0.758*). Minimum temperature (r = 0.575) and relative humidity (r = 0.657) were positively but non-significantly correlated with coccinellid population. Rainfall had a negative and non-significant association (r = –0.174) with their population. The results of correlation analysis during *Kharif* 2025 indicated that spider population did not show any significant association with the abiotic factors considered in the study. The spider population exhibited positive but non-significant correlations with maximum temperature (r = 0.573), minimum temperature (r = 0.486), and relative humidity (r = 0.631). Rainfall showed a negligible and non-significant relationship (r = –0.007) with spider population. Similar results were reported by Tamang *et al.* (2017) indicated a positive relationship between the incidence of sucking pests and the population of predatory coccinellids.

Implications for pest monitoring and IPM

The concentration of several pest populations around the 34th - 37th SMW indicates a practical monitoring window for mungbean in the Sehore environment. Regular scouting should begin before the 31st SMW for early detection of whitefly and jassid and continue through the reproductive stage for pod borer surveillance. Because coccinellids and spiders were present during periods of pest abundance, indiscriminate insecticide applications may compromise naturally occurring biological control. Weather-informed surveillance, host plant resistance, cultural practices and conservation of natural enemies should therefore be integrated rather than relying solely on calendar-based chemical control.

Conclusion

The *Kharif* 2025 investigation at Sehore demonstrated distinct seasonal patterns in the major insect-pest complex of mungbean. Whitefly and jassid appeared earliest and attained their maximum populations during the 35th SMW, while thrips peaked slightly earlier in the 34th SMW. Bihar hairy caterpillar also peaked in the 35th SMW, whereas spotted pod borer reached its maximum during the 37th SMW. Coccinellids and spiders were present concurrently, with peak abundance during the mid-season. Maximum temperature was significantly and positively associated with jassid, thrips and coccinellids; relative humidity was significantly associated with thrips; and minimum temperature was significantly associated with Bihar hairy caterpillar. The results support intensified pest surveillance during the mid-season and provide a local evidence base for weather-informed integrated pest management in mungbean under Sehore conditions.

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