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Population dynamics of major insect pests of blackgram (*Vigna mungo*) in relation to abiotic factors

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ABSTRACT

Blackgram: (*Vigna mungo* L. Hepper) is an important short-duration pulse crop in India, but its productivity is severely constrained by a complex of insect pests. A field experiment was conducted at the Research Farm of Lovely Professional University (LPU), Phagwara, Punjab, India during the summer season of 2021 to study the population dynamics of major insect pests of blackgram and their relationship with prevailing abiotic factors. Seven insect pests were recorded: whitefly (*Bemisia tabaci*), gram pod borer (*Helicoverpa armigera*), tobacco caterpillar (*Spodoptera litura*), blue butterfly (*Lampides boeticus*), green stink bug (*Nezara viridula*), Bihar hairy caterpillar (*Spilosoma obliqua*), and white-spotted leaf beetle. Pest populations were monitored at weekly intervals from the 13th to 21st Standard Meteorological Week (SMW). Whitefly was the dominant pest, peaking at 27.33 insects/3 leaves/5 plants during the 21st SMW. Correlation analysis revealed highly significant positive correlations of whitefly population with maximum temperature ($r = 0.975^{**}$), minimum temperature ($r = 0.971^{**}$), and wind velocity ($r = 0.954^{**}$), and a highly significant negative correlation with minimum relative humidity ($r = -0.926^{**}$). *S. litura* showed a significant positive correlation with rainfall ($r = 0.749^{*}$), while blue butterfly and green stink bug populations were significantly positively correlated with maximum temperature and wind velocity. The study demonstrates that temperature and wind velocity are the primary drivers of pest population build-up in blackgram during summer, and these findings can guide development of weather-based pest forecasting and integrated pest management strategies.

Keywords: Population dynamics, Insect pests, Abiotic factors

Introduction

Blackgram (*Vigna mungo* L. Hepper), commonly known as urdbean, mash, or mashkalai, belongs to the family Leguminosae (sub-family Papilionaceae). It is the fourth most important short-duration pulse crop in India, contributing approximately 10% of national pulse production and providing a rich source of protein (24%), minerals (3.2%), and carbohydrates (59.6%) (Bakr *et al.*, 2004; Seetha Ramu *et al.*, 2018) [1, 2]. It is extensively cultivated across several Indian states, including Andhra Pradesh, Maharashtra, Karnataka, Tamil Nadu, Madhya Pradesh, and West Bengal, both as a kharif crop and as a rice-fallow rabi crop (Chitti Babu *et al.*, 2009) [3].

Blackgram is attacked by 40 to 64 species of insects at different stages of crop growth (Lal, 1985; Seetha Ramu *et al.*, 2018) [4, 2]. On an average, 2.5 to 3.0 million tonnes of pulses are lost annually due to pest problems in India, with yield losses in blackgram estimated at 30 to 54.3 per cent (Justin *et al.*, 2015; Seetha Ramu *et al.*, 2018) [5, 2]. Among the important pest species, whitefly (*Bemisia tabaci* Genn.) is particularly damaging, both as a direct sap-feeding pest and as the primary vector of Mungbean Yellow Mosaic Virus (MYMV), which can cause yield losses ranging from 5 to 100 per cent depending upon the age of the crop and susceptibility of the variety (Marabi *et al.*, 2017; Swathi *et al.*, 2019) [6, 7]. Gram pod borer (*Helicoverpa armigera* Hubner), spotted pod borer (*Maruca vitrata* Geyer), tobacco caterpillar (*Spodoptera litura* Fabricius), blue butterfly (*Lampides boeticus* L.), green stink bug (*Nezara viridula*), Bihar hairy caterpillar (*Spilosoma obliqua*), and leaf beetles are among the other major pests attacking the crop at different phenological stages (Biswas *et al.*, 2019; Kumar *et al.*, 2016) [8, 9].

The seasonal incidence and population dynamics of insect pests are strongly governed by prevailing abiotic factors, particularly temperature, relative humidity, wind velocity, and rainfall (Kapoor *et al.*, 2019; Swathi *et al.*, 2019) [10, 7]. Temperature plays a key role in the development, reproduction, and survival of insects, while relative humidity and rainfall influence population build-up either directly or indirectly through their effects on host plant physiology and natural enemy activity (Chitti Babu *et al.*, 2009; Marabi *et al.*, 2017) [3, 6]. Understanding these relationships is crucial for developing weather-based pest forecasting models and devising timely, effective integrated pest management (IPM) strategies.

In the Punjab region, blackgram is cultivated during the summer season under semi-arid agroclimatic conditions characterised by high temperatures and moderate to low humidity. However, systematic information on

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the population dynamics of insect pests and their relationship with abiotic factors under summer Punjab conditions is limited. With this background, the present investigation was undertaken at Lovely Professional University, Phagwara, Punjab during summer 2021 to study the population dynamics of major insect pests of blackgram and their correlation with prevailing abiotic weather parameters.

Materials and Methods

The experiment was conducted at the Research Farm of Lovely Professional University (LPU), Phagwara, Punjab, India (31.224°N, 75.771°E) during the summer season of 2021. Blackgram variety MASH-1008 was sown on 11th March 2021 in a Randomized Block Design (RBD) with 3 replications and 10 treatments, with row-to-row spacing of 30 cm and plant-to-plant spacing of 10 cm. Each plot measured 5 m × 3 m, with a total experimental area of 510 m². Whitefly populations were counted from randomly selected five plants of each plot by examining three trifoliate leaves per plant (lower, middle, and

upper leaves). Populations of gram pod borer (*H. armigera*), tobacco caterpillar (*S. litura*), blue butterfly, green stink bug, Bihar hairy caterpillar, and leaf beetle were counted from entire plants by visual observation and the knockdown method. Data collection began three weeks after sowing, from 7:00–9:00 AM. Meteorological data—including maximum and minimum temperature, morning and evening relative humidity, wind velocity, and rainfall—were obtained weekly from the agrometeorological laboratory of LPU.

Statistical analysis

Correlation analysis was performed to determine the relationship between insect pest populations and abiotic weather parameters. Correlation coefficients (*r*) were calculated for each insect pest population against maximum temperature, minimum temperature, maximum relative humidity, minimum relative humidity, wind velocity, and rainfall. Statistical significance was determined at $p \leq 0.05$ (*) and $p \leq 0.01$ (**) probability levels. All statistical analyses were performed using standard statistical methods.

Table 1. Mean population dynamics of insect pests of blackgram (per 5 plants) in relation to abiotic factors (Summer 2021)

S.W.	Whitefly	<i>H. armigera</i>	<i>S. litura</i>	Blue butterfly	Green stink bug	B.H.C	Leaf Beetle	Temp Max. (°C)	Temp Min. (°C)	R.H. Max (%)	R.H. Min (%)	Wind Vel. (km/hr)	Rainfall (mm)
13	0.27	0	0	0	0	0	0	32.5	14.4	49.4	31.4	3.4	0
14	1.83	0.8	0	0	0	0	0	31	12.2	41.6	29.25	5	0.6
15	1.20	0.7	0	0	0	0	0.3	32	17.7	39.1	29.1	2	0.02
16	0.23	0.6	0	0	0	0	0.33	29.1	17.5	46.7	28	4	2.6
17	7.13	0.4	0	0.27	0	0	0.33	32.6	19.5	40.6	27	7.3	0.5
18	23.78	2.8	0	0.53	0.9	0	0.93	39	27.2	38.7	16.7	10.7	0
19	19.33	1.67	0.33	1.33	3.33	0	0.67	37.8	25.7	45.5	19.7	13.5	0
20	21.67	1.67	1.33	1	4	3	0.67	38.1	26.2	49.8	24.1	12.2	6.8
21	27.33	0.67	0.67	0.33	2.33	3.33	0.33	41.7	29.1	34.2	12.1	16.4	0

WF = Whitefly (insects/3 leaves/5 plants); H. arm. = *Helicoverpa armigera*; S. lit. = *Spodoptera litura*; Blue But. = Blue butterfly; G.S.B. = Green stink bug (all as mean insects/5 plants); T = Temperature; RH = Relative Humidity

Results and Discussion

Whitefly (*Bemisia tabaci*)

Whitefly was the first pest to appear on blackgram, with an initial mean population of 0.27 insects/3 leaves/5 plants during the 13th SMW, when maximum temperature was 32.5 °C, minimum temperature 14.4 °C, maximum relative humidity 49.4%, minimum relative humidity 31.4%, wind velocity 3.4 km/hr, and rainfall 0 mm. The population showed a progressive increase throughout the crop season, coinciding with rising temperatures and wind velocity. The peak population of 27.33 insects/3 leaves/5 plants was recorded during the 21st SMW, when maximum temperature reached 41.7 °C, minimum temperature 29.1 °C, maximum relative humidity 34.2%, minimum rela-

tive humidity 12.1%, wind velocity 16.4 km/hr, and rainfall 0 mm. A transient decline was observed in the 16th SMW (0.23 insects/5 plants), associated with relatively lower temperatures and increased wind velocity that may have dispersed the population. Correlation analysis revealed that whitefly population had a highly significant positive correlation with maximum temperature ($r = 0.975^{**}$) and minimum temperature ($r = 0.971^{**}$), and a highly significant positive correlation with wind velocity ($r = 0.954^{**}$). A highly significant negative correlation was observed with minimum relative humidity ($r = -0.926^{**}$), while maximum relative humidity and rainfall showed non-significant correlations. These results clearly indicate that warm, dry, and windy conditions favour whitefly build-up on blackgram under Punjab summer conditions.

Table 2. Correlation coefficients of insect pest populations of blackgram with abiotic factors (Summer 2021)

Insect Pest	Max. Temp.	Min. Temp.	Max. RH	Min. RH	Wind Vel.	Rainfall
Whitefly	0.975**	0.971**	-0.316NS	-0.926**	0.954**	0.157NS
<i>H. armigera</i>	0.662NS	0.572NS	-0.097NS	-0.564NS	0.501NS	0.175NS
<i>S. litura</i>	0.617NS	0.612NS	0.220NS	-0.393NS	0.654NS	0.749*
Blue butterfly	0.711*	0.649NS	0.233NS	-0.511NS	0.733*	0.326NS
Green stink bug	0.774*	0.756*	0.186NS	-0.585NS	0.822**	0.505NS
Bihar hairy cat.	NS+	Sig+	NS-	NS-	Sig+	NS+
Leaf beetle	Sig+	NS+	NS-	NS+	NS+	NS+

** Significant at $p \leq 0.01$; * Significant at $p \leq 0.05$; NS = non-significant; + = positive; - = negative; RH = Relative Humidity

The significant positive correlation of whitefly with maximum and minimum temperature is consistent with the findings of Marabi *et al.*

(2017) [6], who reported a significant positive correlation between maximum temperature ($r = 0.659^{*}$) and whitefly population on black

gram during *kharif* season. Similarly, Swathi *et al.* (2019) [7] and Kumar *et al.* (2016) [9] noted positive correlations between temperature and whitefly populations. The negative correlation with relative humidity in the present study corroborates the findings of Kharia *et al.* (2018) [11] and Mani *et al.* (2007) [12], who observed that drier conditions favour whitefly multiplication. The strong positive correlation with wind velocity observed in the present study is in agreement with Marabi *et al.* (2017) [6], who reported significant negative association between wind speed and whitefly (wind apparently enhancing dispersal in their system), though the direction of correlation can vary with the scale and nature of wind movements.

Gram pod borer (*Helicoverpa armigera*)

The mean population of *H. armigera* was first recorded in the 14th SMW (0.8 larva/5 plants) at maximum temperature 31 °C, minimum temperature 12.2 °C, maximum relative humidity 41.6%, minimum relative humidity 29.25%, wind velocity 5 km/hr, and rainfall 0.6 mm. The larval population increased gradually, reaching a peak of 2.8 larva/5 plants during the 18th SMW when maximum temperature was 39 °C, minimum temperature 27.2 °C, maximum relative humidity 38.7%, minimum relative humidity 16.7%, wind velocity 10.7 km/hr, and rainfall 0 mm. Following the peak, the population declined to 0.67 larva/5 plants by the 21st SMW. Correlation analysis showed positive but non-significant correlations of *H. armigera* population with maximum temperature ($r = 0.662$ NS), minimum temperature ($r = 0.572$ NS), and wind velocity ($r = 0.501$ NS), while maximum relative humidity ($r = -0.097$ NS), minimum relative humidity ($r = -0.564$ NS), and rainfall ($r = 0.175$ NS) also showed non-significant correlations.

The non-significant positive correlations with temperature are in agreement with the findings of Ojha *et al.* (2017) [13] and Kapoor *et al.* (2019) [10], who reported similar trends in pod borer incidence in relation to temperature on blackgram. Rathore *et al.* (2017) [14] also noted positive though non-significant correlations of *H. armigera* with temperature in pigeonpea, which is in conformity with the present findings.

Tobacco caterpillar (*Spodoptera litura*)

S. litura was first recorded in the 19th SMW with a mean population of 0.33 larva/5 plants when maximum temperature was 37.8 °C, minimum temperature 25.7 °C, maximum relative humidity 45.5%, minimum relative humidity 19.7%, wind velocity 13.5 km/hr, and rainfall 0 mm. Its population peaked at 1.33 larva/5 plants during the 20th SMW, coinciding with high temperatures (max. 38.1 °C, min. 26.2 °C) and moderate rainfall of 6.8 mm. Late-season appearance of *S. litura* is consistent with its polyphagous nature and preference for warm humid conditions during pod-filling stage. Among the abiotic factors, *S. litura* population showed a significant positive correlation with rainfall ($r = 0.749^*$), while correlations with temperature ($r = 0.617$ NS, 0.612 NS) and wind velocity ($r = 0.654$ NS) were positive but non-significant.

The significant positive association with rainfall corroborates the findings of Bhamare *et al.* (2018) [15] and Bhavasar *et al.* (2019) [16], who also documented positive correlation of *S. litura* with rainfall. Rainfall may favour *S. litura* population by increasing canopy humidity and lush foliage that serves as larval food and shelter.

Blue butterfly (*Lampides boeticus*)

Blue butterfly was first observed in the 17th SMW with a mean population of 0.27 larva/5 plants at maximum temperature 32.6 °C and minimum temperature 19.5 °C. Population peaked at 1.33 larva/5 plants during the 19th SMW at maximum temperature 37.8 °C and declined by the 21st SMW. Correlation analysis showed a significant positive correlation with maximum temperature ($r = 0.711^*$) and wind

velocity ($r = 0.733^*$), while correlations with minimum temperature, relative humidity parameters, and rainfall were non-significant.

The significant positive association with maximum temperature indicates that the warm summer season is conducive for population build-up of this species on blackgram, consistent with observations reported by Biswas *et al.* (2019) [8] and Ajay *et al.* (2018) [17].

Green stink bug (*Nezara viridula*)

Green stink bug was first recorded in the 18th SMW (0.9 insects/5 plants) under high temperature conditions (max. 39 °C, min. 27.2 °C) and no rainfall, and reached its peak population of 4 insects/5 plants during the 20th SMW. Correlation analysis showed significant positive correlations with maximum temperature ($r = 0.774^*$), minimum temperature ($r = 0.756^*$), and wind velocity ($r = 0.822^{**}$), while other abiotic factors were non-significant. The strong association with both temperature parameters and wind velocity indicates that this pest thrives best during warm, dry weather, which prevails during the latter part of the summer season in Punjab.

These findings are in agreement with Ajay *et al.* (2018) [17] and Kumar *et al.* (2019), who reported positive correlations of green stink bug population with temperature on legume crops.

Bihar hairy caterpillar and leaf beetle

Bihar hairy caterpillar was first recorded in the 20th SMW (3 larva/5 plants) and peaked in the 21st SMW (3.33 larva/5 plants), corresponding to the highest maximum temperature (41.7 °C) and wind velocity (16.4 km/hr) recorded during the study. It showed significant positive correlations with temperature and wind velocity, supporting the view that late-season heat favours this pest. Leaf beetle appeared earliest, from the 15th SMW (0.3 beetles/5 plants), and peaked during the 18th SMW (0.93 beetles/5 plants) with a significant positive association with temperature. Both species demonstrated that rising temperatures during crop reproductive stages triggered population escalation.

These findings are broadly consistent with Biswas *et al.* (2019) [8], who reported positive correlation of hairy caterpillar populations with temperature and sunshine hours.

Conclusion

The present investigation revealed that seven insect pest species infested blackgram during the summer season of 2021 at LPU, Phagwara, Punjab. Whitefly (*Bemisia tabaci*) was the dominant and most consistent pest throughout the crop season, peaking at 27.33 insects/3 leaves/5 plants during the 21st SMW. Rising maximum temperature, minimum temperature, and wind velocity were the primary drivers of whitefly population build-up, as evidenced by highly significant positive correlations ($r = 0.975^{**}$, 0.971^{**} , and 0.954^{**} , respectively), while high relative humidity was suppressive ($r = -0.926^{**}$). Among pod borers, *H. armigera* peaked in the 18th SMW; *S. litura* appeared late in the season and showed a significant positive correlation with rainfall ($r = 0.749^*$). Blue butterfly and green stink bug populations were significantly positively correlated with temperature and wind velocity, confirming that warm, dry, windy summer conditions favour the build-up of multiple pest species on blackgram. These findings establish that temperature and wind velocity are key meteorological drivers of insect pest dynamics in blackgram during summer in Punjab. The weather pest relationships identified in this study can be utilized to develop predictive pest outbreak models and calendar-based spray schedules for whitefly and pod borer management. Given that whitefly also vectors MYMV, early-season monitoring when temperatures start exceeding 32 °C is strongly recommended. Future studies should integrate multi-year data and natural enemy populations to refine the pest forecasting models for this region.

Insect Pests Of Blackgram



Figure 1. Fig. 2 Fig. 3 Fig. 4



Figure 5. Fig. 6 Fig. 7 Fig. 8

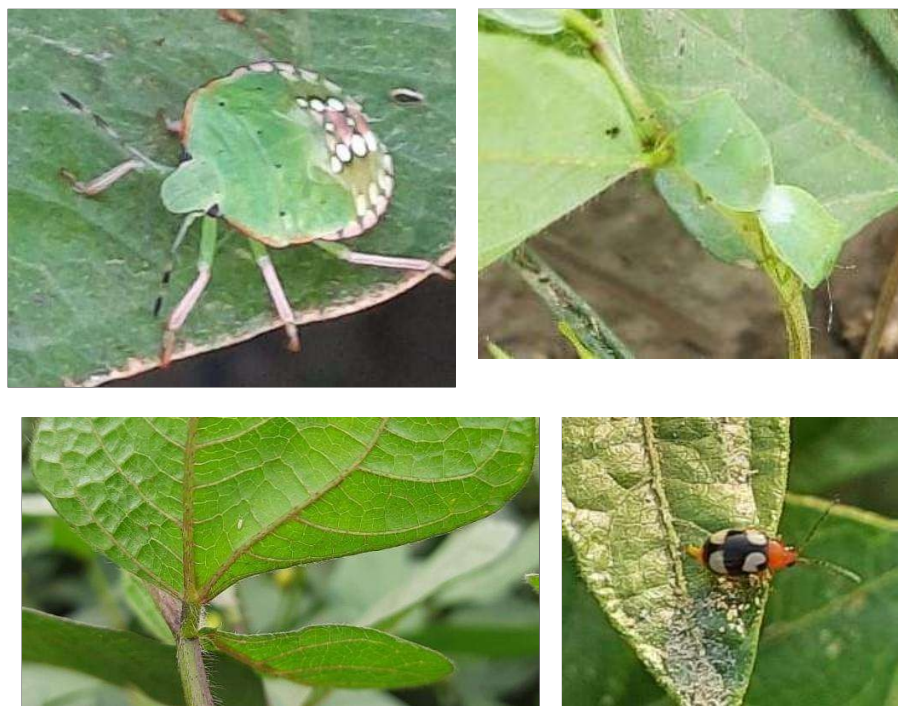


Figure 9. Fig. 10 Fig. 11 Fig. 12

Figure 13. Fig. 14

Figure 1. Larva of *Helicoverpa armigera* Fig. 2 Adult of *Helicoverpa armigera*

Figure 3. Adults of *Helicoverpa armigera* in Insect collection box
Fig. 4 Pod damage by larva of *Helicoverpa armigera*

Figure 5. Egg mass of *Spodoptera litura* Fig. 6 Adult of *Spodoptera litura*

Figure 7. Larva of *Spodoptera litura* Fig. 8 Larva of Buhar hairy caterpillar

Figure 9. Larva of Blue Butterfly Fig. 10 Adult of Blue Butterfly
Figure 11. Nymph of Green Stink Bug Fig. 12 Adult of Green Stink Bug

Figure 13. Adult of White Spotted Leaf Beetle Fig. 14 Adult of Whitefly

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