



Weather-mediated Population Dynamics of Major Insect Pests Infesting Chickpea (*Cicer arietinum* L.)

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ABSTRACT

Background: Chickpea (*Cicer arietinum* L.) is one of the most important pulses crops cultivated widely for its high nutrition value and soil fertility improvement through biological nitrogen fixation. However, its productivity is significantly affected by several insect pests, particularly pod borers.

Methods: A field experiment was conducted during the *rabi* season of 2022-23 and 2023-24 for which “Udai” variety of chick pea was sown during the last week of October and the observations on insect pest population were recorded weekly using standard sampling methods. The population of major pests was correlated with abiotic factors such as temperature, relative humidity and rainfall to determine their influence on the pest incidence.

Result: The major insect pests observed in the chickpea ecosystem were *Helicoverpa armigera*, *Aphis craccivora*, *Spodoptera litura* and *Empoasca kerri*, which appeared after December and gradually increased up to February. The peak population was recorded during the 6th-7th SMW with 2.60 larvae m⁻¹ row of *H. armigera*, 10.73 aphids plant⁻¹ of *A. craccivora*, 1.50 larvae m⁻¹ row of *S. litura* and 2.50 hoppers plant⁻¹ of *E. kerri*. Correlation analysis revealed that maximum temperature showed a positive relationship with *H. armigera* ($r = 0.52$), *A. craccivora* ($r = 0.24$), *S. litura* ($r = 0.34$) and *E. kerri* ($r = 0.35$), while relative humidity exhibited a negative association with pest population. Rainfall showed a weak positive correlation with the incidence of major insect pests.

Key words: Abiotic factors, Chickpea, Correlation, Insects pest complex, Seasonal Incidence.

INTRODUCTION

India is one of the leading producers, consumer and exporter of pulses globally. The major pulses cultivated in the country are chick pea, mung bean, pigeon pea, black gram, field pea and pea (Kumar *et al.*, 2026). Among them, chickpea (*Cicer arietinum* L.) is one of the most import pulses crops cultivated in the semi-arid tropics and subtropics of the of the world. It serves as a rich source of dietary protein, carbohydrates, minerals, vitamins and therefore play a crucial role in ensuring nutritional security, particularly in developing countries where a larger proportion of population depend on plant-based protein. In to its nutritional significance, chickpea contributes substantially to sustainable agriculture due to its ability to fix atmospheric nitrogen symbiotic association with *rhizobium*, thereby improving soil fertility and reducing the requirement for synthetic fertilizers. Globally chickpea is cultivated on more than 15 million hectares with annual production exceeding 16 million ton and India accounts for nearly 65 to 70 per cent of total global production (FAOSTAT, 2024).

Despite its economic and nutritional importance, chickpea productivity is considerably affected by several biotic and abiotic stresses. Among the biotic constraints, insect pests have been reported to infest chickpea during different growth stages, damaging foliage, flower and developing pods (Sharma *et al.*, 2014 and Ahmad *et al.*, 2021). Among these, the pod borer is considered as the most destructive pest and has been reported to cause

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yield losses ranging from 20 to 80 per cent depending upon the level of infestation and environmental conditions. The larvae feed voraciously on flowers, buds and pods, leading to direct reduction in grain yield and quality

(Fitt, 2020; Sharma and Pampapathy, 2021). Besides the pod borer, sucking insect pests that damages plant by extracting sap and transmitting viral disease, leading to reduced plant vigour and productivity. The tobacco caterpillar feeds on foliage and reproductive structures, often causing severe defoliation during outbreak condition while the leaf hopper injures plants by sap feeding, resulting in yellowing, curling and reduced photosynthetic activity. Other pests such as *Agrotis ipsilon*, *Maruca vitrata* and *Ophiomya phaseoli* may also occur in chickpea fields and collectively form a complex affecting crop growth and yield (Kambrekar *et al.*, 2020 and Singh *et al.*, 2022). The incidence and population dynamics of these pests are strongly influenced by abiotic factors such as temperature, relative humidity and rainfall which regulate insect development, survival and reproduction (Kumar *et al.*, 2026). Understanding pest-weather relationships is therefore essential for forecasting pest outbreaks and implementing timely integrated pest management strategies (Prasad *et al.*, 2022; Yadav *et al.*, 2023; Balikai *et al.*, 2019).

For the aforesaid reasons, the present investigation was undertaken to study the seasonal incidence of major insect pests of chickpea and their relationship with important abiotic factors such as temperature, relative humidity and rainfall under field conditions in Kanpur, Uttar Pradesh. The findings will provide useful insights into pest population dynamics and help in developing effective pest management strategies for chickpea cultivation.

MATERIALS AND METHODS

The experiment was conducted at individuals research field located at Indira Nagar, under the supervision of CSAUAT, Kanpur, Uttar Pradesh during the *Rabi* season of 2022-23 and 2023-2024. The experimental site was situated at 26.5159° N latitude and 80.2673° E longitude at an altitude of 132 m above mean sea level (MSL). The experiment was laid out in a 100 m² plot using the chickpea variety Uдай. The crop was sown manually at depth of 5-7 cm in soil.

Spacing of 30 cm between rows and 10 cm between plants was maintained. Sowing was carried out in the last week of October in both the years. No plant protection measures were applied during the experiments.

Observations were recorded from the 15 randomly selected plants at weekly intervals starting from the vegetative stage when the initial insect population appeared. The population of *E. kerri* was recorded using split cage methods while aphid population were counted from the upper and lower surface of the first three trifoliate leaf of the plants. The average population was calculated for each observations. The larval population of *Helicoverpa* and *Spodoptera* was recorded through direct visual count per meter row length.

Meteorological data were obtained from the Department of Agronomy at Chandra Shekhar Azad University of Agriculture and Technology Kanpur (Table 1). The Impact of weather parameters on the population fluctuation of insects was analyzed using simple correlation analysis following the procedure described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Insects pest complex observed in chickpea ecosystem during the crop season

Table 2 presents the insect pest complex observed in chickpea ecosystem during the different months of the crop season. The pest population levels were categorized as absent, low, moderate and high based on the classification scale present in Table 2.1. The observation revealed that several insect pests were associated with chickpea during the crop growth, although their incidents varied with crop stage and environmental conditions. Among the pest recorded, Gram Pod Borer (*Helicoverpa armigera*), Aphid (*Aphis craccivora*), Tobacco cutworm (*Spodoptera litura*) and Leaf hopper (*Empoasca kerri*) were the most prominent species. These pests were absent during November indicating that early vegetative stage of the crop remained relatively free from insect infestation. The incidence started

Table 1: Weekly meteorological data recorded during the experimental period (2022-23 and 2023-2024).

S.M.W	2023					2024				
	Temperature (°C)		Relative humidity (%)		Rainfall (mm)	Temperature (°C)		Relative humidity (%)		Rainfall (mm)
	Max.	Min.	Max.	Min.		Max.	Min.	Max.	Min.	
1	20.60	7.60	93	60	0.00	16.80	10.00	95	81	11.20
2	13.90	5.40	96	73	0.00	16.40	6.20	96	72	0.00
3	17.80	6.30	95	68	0.00	12.50	5.30	94	77	0.00
4	20.40	4.40	93	46	0.00	17.70	5.10	95	63	0.00
5	22.30	10.80	93	71	10.20	23.10	9.00	92	55	0.00
6	22.70	9.70	91	59	1.00	21.50	9.30	88	54	26.80
7	28.10	10.90	90	51	0.00	26.00	10.10	92	48	0.00
8	26.70	11.10	83	50	0.00	26.50	11.60	87	45	0.60
9	31.00	11.80	92	47	0.00	25.70	14.10	82	53	32.20
10	31.20	14.40	90	50	0.00	25.70	10.80	73	40	0.00

appearing from the last week of December at very low level, suggesting the initiation of pest colonization with the advancement of crop growth. The pest population gradually increased to moderate level during the January coinciding favourable environmental condition and the development of tender plant parts. The infestation reached its peak during the February where most of major pests such as pod borer, aphids, tobacco cutworm and leafhopper were categorized under the different levels indicating that flowering and pod formation stage of chickpea are highly vulnerable to insect pest attack. During March the pest population declined to moderate or low level, possibly due to crop maturity and changing weather conditions. Other insect pests such as stem fly (*Ophiomyia phaseoli*), black cutworm (*Agrotis ipsilon*), spotted pod borer (*Maruca vitrata*) and pulse beetle (*Callosobruchus chinensis*) were also recorded but their occurrence remained sporadic and comparatively less severe. Overall the results indicate that the maximum pest activity occurred during February highlighting this as a critical stage for implementing effective insect pest management strategy in chickpea cultivation.

The dominance of gram pod borer, aphids, tobacco cutworm and leafhopper during the reproductive stage

agrees with Reynolds *et al.* (2019), who reported that flowering and pod formation favour the rapid multiplication. The gradual increase in pest population from December to February is supported by Tripathy *et al.* (2017) and Singh and Singh (2020) who emphasized the role of rising temperature and declining humidity in accelerating pest development. The decline in March may be due to crop senescence, as observed by Chakraborty *et al.* (2018). The sporadic occurrence of minor pests is in line with Sarwar (2016) who reported their low population under field conditions.

Weather-mediated population dynamics of major insect pest in chickpea

Table 3 depicts pooled data of seasonal incidence of major insect pests of chickpea during 2022-23 and 2023-24, expressed as mean population per unit area/plant across the different standard meteorological weeks. The data reveals a clear pattern of gradual increase, peak and subsequential decline in the pest population during the crop growth.

The population of initiated at a very low level (0.23 larvae m⁻¹ row) during the 1st SMW and showed a

Table 2: Insects pest complex observed in chickpea ecosystem during the crop season.

Insect pest	November	December	January	February	March
<i>Helicoverpa armigera</i>	Absent	Low	Moderate	High	Moderate
<i>Aphis craccivora</i>	Absent	Low	Moderate	High	Low
<i>Spodoptera litura</i>	Absent	Low	Moderate	High	Low
<i>Empoasca kerri</i>	Absent	Low	Low	High	Low
<i>Ophiomyia phaseoli</i>	Absent	Moderate	Low	Low	Absent
<i>Agrotis ipsilon</i>	Absent	Moderate	Low	Low	Absent
<i>Maruca vitrata</i>	Absent	Low	Low	Moderate	Low
<i>Callosobruchus chinensis</i>	Absent	Absent	Absent	Low	Moderate

Table 2.1: Pest population classification.

Category	Absent	Low	Moderate	High
Approximate population	No noticeable pest population	Initial infestation, below ETL	Increasing population, near ETL	Economic damage causes

Table 3: Seasonal incidence of major insect pests of chickpea-2023 and 2024 (Pooled).

S.M.W	<i>Helicoverpa</i> (larvae/m row)	<i>Aphid</i> (Aphids/plant)	<i>S. litura</i> (larvae/m row)	<i>E. kerri</i> (Hoppers/plant)
1	0.23	2.67	0.33	0.57
2	0.53	3.80	0.60	0.70
3	0.77	5.73	0.67	1.53
4	1.30	7.80	0.97	1.70
5	1.60	9.73	1.20	2.07
6	2.30	10.73	1.50	2.50
7	2.60	9.80	1.50	2.37
8	2.30	7.73	1.33	2.33
9	1.40	5.60	0.73	1.67
10	0.67	3.47	0.50	0.73

Table 4: Correlation coefficient (r) between insect pest population and abiotic factors 2023 and 2024.

Insect pest	Tmax	Tmin	RHmax	RHmin	Rainfall
<i>Helicoverpa armigera</i>	+ 0.52*	+ 0.33	-0.35	-0.53	+ 0.15
<i>Aphid</i>	+ 0.24	+ 0.05	-0.07	-0.29	+ 0.26
<i>Spodoptera litura</i>	+ 0.34	+ 0.16	-0.20	-0.38	+ 0.16
<i>Empoasca kerri</i>	+ 0.35	+ 0.19	-0.22	-0.39	+ 0.22

*Significant at $p = 0.05$.

continuous increase, reaching its peak (2.60 larvae m^{-1} row) during the 7th SMW. Thereafter, the population declined progressively towards crop maturity. Similarly, the aphid population started with 2.67 aphid/plant during the 1st SMW and increased steadily, attaining a maximum population of 10.73 aphids/plant during 6th SMW. A declining trend was observed in subsequent weeks, possibly due to changes in weather conditions and crops maturity. The population of tobacco cutworm also followed a similar trend, increasing from 0.33 larvae m^{-1} row during the 6th and 7th SMWs, followed by a gradual decline. In case of leafhopper, the population ranged from 0.57 to 2.50 hopper/plant, with the highest record during the 6th SMW. Population trends indicated a gradual build up during early crop growth stages, followed a decline towards the later stages.

Overall, the result indicates that the population of major insect pests increased progressively with crop growth and reached peak levels during the flowering and pod formation stages, which are the most vulnerable stages for the insect pest attack. The subsequent decline in the pest population may be attributed to crop maturity and unfavourable environmental conditions.

The weather-mediated population dynamics observed in the present study showed a characteristics trend of gradual buildup, peak incidence and subsequent decline of major insect pest in chickpea and this study also supported by Sharma *et al.* (2017) who reported maximum incidence during flowering and pod formation under favourable temperatures. The increase in the major insect pest of chickpea is supported by Ali *et al.* (2019), highlighting the role of increasing temperature and low humidity. The decline towards maturity corroborates with Reddy *et al.* (2020), who attributed to host deterioration and adverse condition, as also emphasized by Sharma and Singh (2016).

Impact of abiotic factors on the pest population of insect pest in chickpea ecosystem

Table 4 presents the correlation coefficients (r) depicting the relationship between major insect pests of chickpea and abiotic factors. The analysis revealed that maximum temperature exhibited a positive association with all pests, namely *Helicoverpa armigera* ($r = 0.52$), *Empoasca kerri* ($r = 0.35$), *Spodoptera litura* ($r = 0.34$) and *Aphis craccivora* ($r = 0.24$), indicating a significant role of temperature in enhancing pest proliferation. Minimum temperature also showed a weak positive correlation, suggesting its limited but supportive effect on pest survival.

In contrast, relative humidity exhibited a negative correlation with pest population, with the strongest effect observed in *Helicoverpa armigera* ($r = -0.53$ with R.H. min.), indicating a suppressive influence on pest development. Rainfall showed weak positive correlation ($r = 0.15-0.26$), reflecting its marginal impact. Overall, the findings statistically confirm temperature as a dominant factor governing pest dynamics.

The correlation analysis indicated that temperature had a positive association with pest population, with maximum temperature significantly correlated with *H. armigera*, supporting the findings of Patel *et al.* (2018). In contrast, relative humidity showed a negative correlation, particularly for *H. armigera*, is in line with Jat and Yadav (2020). Rainfall exhibited a weak positive relationship, consistent with Kumar *et al.* (2017), indicating its indirect influence on pest incidence.

CONCLUSION

It is concluded that major insect pests of chickpea namely gram pod borer, aphids, tobacco cutworm and leafhopper showed a distinct seasonal pattern with initial appearance in December, peak infestation during February and decline towards crop maturity. Among abiotic factors max. temperature exhibited a positive influence on pest population while relative humidity showed a negative correlation. Rainfall had only marginal effect. The findings highlight that flowering and pod formation stages are most vulnerable and weather parameters, particularly temperature play a crucial role in pest buildup, aiding in timely forecasting and effective pest management strategies.

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Conflict of interest

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