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SEASONAL DYNAMICS OF INSECT PESTS OF BLACK GRAM (*Vigna mungo* L.) IN A COASTAL AGROECOSYSTEM

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ABSTRACT
In this study, the seasonal population dynamics of insect pests of black gram (*Vigna mungo* L.) and their relationships with meteorological parameters were studied. The field experiments were done in the summer and *kharif* seasons of 2024 at Pandit Jawaharlal Nehru College of Agriculture and Research Institute (PAJANCOA & RI), Karaikal, Puducherry, India. The monitored insect pest complex comprised of defoliators (*Phyllotreta striolata* Fabricius and *Omiodes indicata* Fabricius) and pod borers (*Maruca vitrata* Geyer and *Lampides boeticus* Linnaeus). During summer, peak pest populations were observed during 13th and 14th Standard Meteorological Weeks (SMW). Correlation analysis revealed significant positive associations between maximum and minimum temperature and the populations of *M. vitrata* and *L. boeticus*, whereas morning relative humidity (RH) exhibited significant negative associations with their populations. During the *kharif* season, peak pest populations were generally observed during the 33rd and 34th SMW. During this season, morning and evening RH showed strong positive correlations with *M. vitrata* and *L. boeticus* populations and the maximum temperature had a negative correlation with *M. vitrata* and *L. boeticus* populations. Multiple linear regression models showed that the meteorological variables explained 60-79% of the variation in pest populations (R^2 = 0.60-0.79). These findings highlight the seasonality of insect pests and their relationship with weather parameters, providing a better reference for understanding insect pest dynamics and developing weather-based IPM strategies for black gram.

KEYWORDS: Black gram; *Lampides boeticus*; *Maruca vitrata*; *Omiodes indicata*; *Phyllotreta striolata*; weather parameters.

1. INTRODUCTION

Black gram [*Vigna mungo* (L.) Hepper], also known as urdbean, is a prominent pulse crop widely cultivated across the Indian subcontinent during both the *kharif* and spring seasons (Kanth *et al*., 2021). It is highly valued for its important agronomic characteristics, particularly its short growth duration, which makes it suitable for cultivation in various cropping systems, including mixed cropping and intercropping, as well as in association with cereals and commercial crops such as cotton and sugarcane. Black gram is also a good source of nutrients for human consumption and is an efficient crop for biological nitrogen fixation. Its seeds contain high proportions of carbohydrates (59.6%), proteins (24%), minerals and dietary fibre (Nene, 2006; Tiwari and Shivhare, 2016).

Although black gram is widely cultivated, its actual yield often remains below its genetic potential. Biotic stresses and changing climatic conditions are among the major factors contributing to this yield gap. Climate change, characterised by rising average temperature and erratic rainfall, is altering agricultural climatic conditions and influencing crop-pest interactions. Such changes can affect the distribution, development, survival and persistence of insect pests, thereby increasing the likelihood of pest outbreaks (Alotaibi, 2023). The development, reproductive rate and survival of insects are strongly influenced by environmental factors because they are poikilothermic organisms. A relatively small increase in temperature can accelerate insect development, potentially promote overlapping generations and pest population build-up within a cropping season (Kumar *et al*., 2023).

Several insect pests target black gram at various phases of crop development. Defoliators like flea beetles and leaf folders consume foliage during the vegetative stage. The production of photosynthates necessary for ideal plant growth and reproductive development is impacted by their feeding activity, which decreases the functional leaf area available for photosynthesis. Pod-feeding insects can result in significant financial losses during the reproductive period. The pea blue butterfly and the spotted pod borer are two significant pests. Their larvae feed on floral parts and developing pods, damaging reproductive tissues and developing seeds. Such feeding damage can result in flower and pod loss, thereby reducing both the quantity and quality of the harvested produce (Sharma *et al*., 1999; Shejulpatil *et al*., 2020; Sreedhar *et al*., 2024).

Farmers have frequently resorted to repeated applications of broad-spectrum synthetic insecticides to minimise losses caused by insect pests. However, the indiscriminate and blanket use of insecticides is recognised as an ineffective approach to sustainable pest management. Excessive use of chemical insecticides can lead to the development of insecticide resistance in pest populations, secondary pest outbreaks and the loss of natural enemies, including predators and parasitoids. Therefore, more scientifically sound and environmental friendly pest management practices are required. An important prerequisite for developing such strategies is an understanding of the relationships between meteorological parameters and fluctuations in insect pest populations. Under field conditions, the development, survival, reproduction and population dynamics of insects may be influenced by weather variables such as maximum and minimum temperature, morning and evening relative humidity and rainfall (Kumar *et al*., 2023; Sreedhar *et al*., 2024).

Establishing statistical relationships between weather parameters and changes in pest populations can help develop reliable weather-based pest forecasting models. Such models can help predict the likelihood of pest occurrence and population build-up under prevailing weather conditions, thereby supporting timely pest management interventions. Weather forecasting is an important factor in Integrated Pest Management (IPM), as it can help implement management practices at the right time and place, before pest populations exceed economic threshold levels. This approach can also help minimise the unnecessary use of insecticides. The present study was conducted to investigate the incidence of major defoliators and pod borers of black gram and their statistical associations with meteorological parameters during the summer and *kharif* seasons under field conditions. Further, the study aimed to find out the location-specific information in terms of the nature of pest incidence and their reactions to agroclimatic factors prevailing in the region.

2. MATERIALS AND METHODS

Field investigations were undertaken to assess the seasonal abundance and population fluctuations of major insect pests associated with black gram *V. mungo* at the Eastern Farm of Pandit Jawaharlal Nehru College of Agriculture and Research Institute (PAJANCOA & RI), Karaikal, Puducherry, India, during the summer and *kharif* seasons of 2024. The crop was raised using the variety VBN (Bg) 11, maintaining a spacing of 30 cm between rows and 10 cm between plants. Standard crop production practices were adopted throughout the crop growth period, from sowing until harvest. Major defoliating and pod-boring insect pests were surveyed at weekly intervals. Observations on pest abundance were made at six sampling locations within the untreated experimental plots, with 10 plants examined at each location. Weekly records of pest incidence were statistically analysed in relation to maximum and minimum temperatures, morning and evening relative humidity (RH), and rainfall for both cropping seasons to determine their association with fluctuations in pest populations. Weather observations were obtained from the Agrometeorological Observatory of PAJANCOA & RI, Karaikal. No insecticides were applied to the experimental plots throughout the crop season, thereby permitting natural pest occurrence and population fluctuations to be assessed under field conditions.

3. RESULTS AND DISCUSSION

3.1 Weather-Associated Incidence of *P. striolata*

The flea beetle *P. striolata* was first recorded during the 8th Standard Meteorological Week (SMW) (13 numbers / 60 plants) and peaked during 13th SMW (124 numbers / 60 plants). Subsequently, the population decreased to its minimum count in the 17th SMW (32 numbers / 60 plants) during summer 2024 (Table 1). During *kharif* 2024, the incidence of beetle appeared from 28th SMW (28 numbers / 60 plants), peaked during 33rd SMW (206 numbers / 60 plants) and reached its lowest level at 37th SMW (48 numbers / 60 plants) (Table 2). It was concluded that the incidence of *P. striolata* was highest during the month of March (12th-13th SMW) in summer 2024 (Figure 1) and during August (31st - 33rd SMW) in *kharif* 2024 (Figure 2). Tanzum *et al*. (2021) observed a higher infestation by *P. striolata* on green gram, *Vigna radiata* (L.) in May and early August. Similarly, peak incidence was found during the 11th SMW (3rd week of March) in Indian bean, *Lablab purpureus* (L.) (Kannan *et al*., 2022). Dawar *et al*. (2022) reported that flea beetle, *Phyllotreta vittula* (Redtenbacher), appeared in cluster bean, *Cyamopsis tetragonoloba* (L.) Taub., from 37th to 43rd SMW (September to October) and peaked during 39th SMW (3rd week of September). These findings are consistent with the current study.

In summer 2024, the population of *P. striolata* exhibited positive correlation with the maximum (r = 0.43) and minimum temperature (r = 0.26) and rainfall (r = 0.07), and was negatively correlated with morning (r = -0.74) and evening (r = -0.52) RH (Table 3). The multiple linear regression model yielded an R^2 value of 0.60 (Table 4). During *kharif* 2024, the population exhibited a positive correlation with morning (r = 0.45) and evening (r = 0.71) RH, and rainfall (r = 0.41), while it was negatively correlated with maximum (r = -0.53) and minimum (r = -0.24) temperature (Table 3). The regression model explained 68% of the variability (R^2 = 0.68) (Table 4). Dawar *et al.* (2022) also reported a significant positive correlation between flea beetle *P. vittula* and morning relative humidity, along with a non-significant negative correlation with the minimum temperature in cluster bean *C. tetragonoloba*. These findings provide a basis for comparison with the present observations.

3.2. Weather-Associated Incidence of *O. indicata*

The infestation of *O. indicata* was first recorded during the 8th SMW (8 larvae / 60 plants) , followed by an increase to a peak during the 14th SMW (38 larvae / 60 plants). Subsequently, the population decreased during the 17th SMW (13 larvae / 60 plants) in summer 2024 (Table 1). During *kharif* 2024, the larval incidence appeared from 28th SMW (10 larvae / 60 plants), peaked during 33rd SMW (52 larvae / 60 plants) and reached its lowest level during the 37th SMW (6 larvae / 60 plants) (Table 2). The incidence of *O. indicata* was highest during
April (13th - 14th SMW) during summer 2024 (Figure 1) and in August (32nd - 34th SMW) during *kharif* 2024 (Figure 2). Kannan *et al.* (2022) observed the leaf folder *Nacoleia* spp. in Indian bean *L. purpureus* from January to May with peak incidence in early April. In black gram *V. mungo*, it was recorded from 36th to 43rd SMW (September to October) and peaked during 39th SMW (early October) (Faiz, 2023a). These results align with the present findings.
During summer 2024, the *O. indicata* population showed a positive correlation with maximum (r = 0.62) and minimum (r = 0.31) temperature and rainfall (r = 0.005), but a negative correlation with morning (r = -0.70) and evening (r = -0.80) RH (Table 3). The regression analysis resulted R^2 value of 0.72 (Table 4). During *kharif* 2024, the population showed a positive association with morning (r = 0.33) and evening (r = 0.66) RH and rainfall (r = 0.45) and a negative association with maximum (r = -0.50) and minimum (r = -0.21) temperature (Table 3). The multiple linear regression exhibited an R^2 value of 0.79 (Table 4). Kannan *et al*. (2022) also noted that leaf folder *Nacoleia* spp. exhibited a significant positive correlation with minimum temperature and a negative correlation with relative humidity in Indian bean *L. purpureus*, aligning with results for *O. indicata* in black gram *V. mungo* (Faiz, 2023b). These results align with the present findings.

3.3. Weather-Associated Incidence of *M. vitrata*

The larval incidence of spotted pod borer *M. vitrata* appeared from 12th SMW (13 larvae / 60 plants) and peaked during 14th SMW (29 larvae / 60 plants). Thereafter, the population declined and reached its lowest level during 17th SMW (7 larvae / 60 plants) during summer 2024 (Table 1). During *kharif* 2024, the larval incidence appeared from 31st SMW (5 larvae / 60 plants), peaked during 34th SMW (46 larvae / 60 plants) and reached its lowest level during the 37th SMW (11 larvae / 60 plants) (Table 2). The maximum incidence of *M. vitrata* was recorded during April (13th -14th SMW) in summer 2024 (Figure 1) and August (34th SMW) in *kharif* 2024 (Figure 2). Patel *et al.* (2010) reported that *M. vitrata* incidence began in the 2nd week of March and peaked in the 4th week of March in cowpea *V. unguiculata*. In pigeon pea *Cajanus cajan*, it appeared from 45th SMW at the early flowering stage until 4th SMW with peak incidence during 51st SMW (Kumar and Rao, 2015) In Indian bean *L. purpureus*, higher incidence occurred from January to May, with a peak at the 18th SMW while in green gram *V. radiata*, it occurred from the 17th to 22nd SMW with the highest level in the 19th SMW (Kannan *et al.*, 2022). These findings were found to support the current study.
During summer 2024, the *M. vitrata* population showed a positive correlation with maximum (r = 0.67) and minimum temperature (r = 0.64) and rainfall (r = 0.25), and a negative correlation with morning (r = -0.71) and evening (r = -0.43) RH (Table 3). The multiple linear regression model produced an R^2 value of 0.64 (Table 4). During *kharif* 2024, the population showed a positive correlation with morning (r = 0.61) and evening (r = 0.70) RH and rainfall (r = 0.37), while exhibiting a negative correlation with maximum (r = -0.60) and minimum (r = -0.47) temperature (Table 3). The R^2 value was 0.74 (Table 4). Kishor *et al*. (2019) reported that temperature and rainfall positively influenced *M. vitrata*, while relative humidity had a negative effect in lentil *Lens culinaris* (L.) and Indian bean *L. purpureus* (Kannan *et al*., 2022). These findings were found to support the current study.

3.4. Weather-Associated Incidence of *L. boeticus*

The larval incidence of pea blue butterfly *L. boeticus* appeared from 11th SMW (5 larvae / 60 plants) and peaked during 14th SMW (33 larvae / 60 plants). The population exhibited a downward trend thereafter, with the lowest count (9 larvae/60 plants) recorded during the 17th SMW of summer 2024 (Table 1). During *kharif* 2024, it appeared from 31st SMW (3 larvae / 60 plants), peaked during 34th SMW (41 larvae / 60 plants) and reached its lowest level during at 37th SMW (8 larvae / 60 plants) (Table 2). It was found that the incidence of *L. boeticus* was highest in April (13th-14th SMW) during summer 2024 (Figure 1) and in August (34th SMW) during *kharif* 2024 (Figure 2). In Indian bean *L. purpureus*, it occurred from January to May with peak incidence during 18th SMW (Kannan *et al.*, 2022) and from 11th to 16th SMW to a higher level in the 12th SMW (Devi *et al.*, 2024). It was also observed from the 35th to 46th SMW with the peak population during the 39th SMW in black gram *V. mungo* (Faiz, 2023b). These reports are consistent with the present findings.
During summer 2024, the *L. boeticus* population showed a positive correlation with maximum (r = 0.76) and minimum (r = 0.69) temperature and rainfall (r=0.23), and a negative correlation with morning (r = -0.76) and evening (r = -0.54) RH (Table 3). The results of the regression were $R^2 = 0.71$ (Table 4). During *kharif* 2024, the population exhibited a positive correlation with morning (r = 0.61) and evening (r = 0.71) RH and rainfall (r = 0.38), whereas it had a negative correlation with maximum (r = -0.63) and minimum (r = -0.50) temperature (Table 3). The regression analysis yielded a coefficient of determination (R^2) of 0.78 (Table 4). Rathore *et al*. (2017) reported a positive correlation between the population and mean temperature in pigeon pea *C. cajan*, while Mahore and Pandey (2023) observed a positive correlation with maximum temperature in green gram *V. radiata*. Faiz (2023b) noted a significant positive correlation with minimum temperature and a significant negative correlation with maximum relative humidity in black gram *V. mungo*. These reports are consistent with the present findings.

4. CONCLUSION

Findings from the current investigation suggest that the occurrence of major insect pests of black gram, namely, *Phyllotreta striolata*, *Omiodes indicata*, *Maruca vitrata* and *Lampides boeticus*, is linked to the prevailing agroclimatic conditions. The incidence of these pests was first recorded between 8th-12th SMW and continued till 17th SMW during summer 2024. During *kharif* 2024, the incidence of pests commenced from 28th-31st SMW and continued up to 37th SMW. In summer 2024, *P. striolata* and *O. indicata* populations were positively correlated with maximum temperature, minimum temperature and rainfall, but negatively correlated with morning and evening RH. The regression models yielded R^2 values of 0.60 and 0.72, respectively. Similarly, the populations of *M. vitrata* and *L. boeticus* showed positive correlations with maximum and minimum temperature and rainfall, whereas negative correlations were observed with morning and evening RH. Their corresponding R^2 values were 0.64 and 0.71, respectively.

During *kharif* 2024, the populations of *P. striolata* and *O. indicata* exhibited positive correlation with morning and evening RH, and rainfall, whereas negative correlations were observed with maximum and minimum temperature. The regression models showed R^2 values of 0.68 and 0.79, respectively. Similarly, the populations of *M. vitrata* and *L. boeticus* exhibited positive correlations with morning and evening RH and rainfall, but negative correlations with maximum and minimum temperature. The corresponding R^2 values were 0.74 and 0.78, respectively. The presence of pests was noted to be high in *kharif* as compared to summer 2024. The observed associations between pest populations and climatic factors may contribute to the formulation of reliable forecasting systems for major insect pests of black gram. Integrating meteorological observations with regular pest monitoring may facilitate timely and targeted implementation of IPM strategies. However, the predictive models developed in the present study need to be validated across different locations and growing seasons to establish their reliability and wider applicability.

Table 1. Seasonal incidence of insect pests of black gram *V. mungo* during summer 2024

Standard Meteorological week (SMW)	Total pest population of 60 plants			
	Pod borers (No. of larvae)		Defoliators (No. of larvae/adults)	
	Spotted pod borer (*Maruca vitrata*)	Pea blue butterfly (*Lampides boeticus*)	Striped flea beetle (*Phyllotreta striolata*)	Leaf folder (*Omiodes indicata*)
7	-	-	-	-
8	-	-	13	8
9	-	-	23	12
10	-	-	47	19
11	-	5	54	29
12	13	11	98	24
13	22	24	124	31
14	29	33	87	38
15	19	21	68	21
16	11	15	43	18
17	7	9	32	13

Table 2. Seasonal incidence of insect pests of black gram *V. mungo* during *kharif* 2024

Standard Meteorological week (SMW)	Total pest population of 60 plants			
	Pod borers (No. of larvae)		Defoliators (No. of larvae/adults)	
	Spotted pod borer (*Maruca vitrata*)	Pea blue butterfly (*Lampides boeticus*)	Striped flea beetle (*Phyllotreta striolata*)	Leaf folder (*Omiodes indicata*)
27	-	-	-	-
28	-	-	28	10
29	-	-	43	17
30	-	-	64	26

31	5	3	112	32
32	27	25	138	39
33	23	20	206	52
34	46	41	154	39
35	24	26	106	21
36	17	15	76	18
37	11	8	48	6

Table 3. Correlation between meteorological parameters and pest populations of black gram *V. mungo* during summer and *kharif* 2024

Insects	Temperature (°C)				Relative humidity (%)				Rainfall (mm)	
	Maximum		Minimum		Morning		Evening			
	summer	*kharif*	summer	*kharif*	summer	*kharif*	summer	*kharif*	summer	*kharif*
P. striolata	0.43	-0.53	0.26	-0.24	-0.74**	0.45	-0.52	0.71*	0.07	0.41
O. indicata	0.62*	-0.50	0.31	-0.21	-0.70*	0.33	-0.80**	0.66*	0.005	0.45
M. vitrata	0.67*	-0.60*	0.64*	-0.47	-0.71*	0.61*	-0.43	0.70*	0.25	0.37
L. boeticus	0.76**	-0.63*	0.69*	-0.50	-0.76**	0.61*	-0.54	0.71*	0.23	0.38

* Significance at 5 per cent level ** Significance at 1 per cent level

Table 4. Multiple linear regression between meteorological parameters and pest populations of black gram *V. mungo* during summer and *kharif* 2024

Variables(Y)	Season	Regression equation	R^2 Value
P. striolata	**summer**	$Y=170.12+0.83X_1-0.72X_2-0.29X_3-0.26X_4+0.10X_5$	0.60*
	kharif	$Y= -1025.99+0.42X_1 +0.07X_2 -0.65X_3 +1.51X_4 +0.34X_5$	0.68*
O. indicata	**summer**	$Y=270.21+0.84X_1-0.71X_2-0.39X_3-0.17X_4+0.10X_5$	0.72**
	kharif	$Y= -308.80+0.24X_1 +0.42X_2 -0.85X_3 +1.43X_4 +0.74X_5$	0.79**
M. vitrata	**summer**	$Y=15.41+0.90X_1-0.34X_2-0.57X_3+0.51X_4+0.23X_5$	0.64*
	kharif	$Y= 244.21+0.93X_1 -1.44X_2 -0.45X_3 +1.83X_4 -1.06X_5$	0.74**
L. boeticus	**summer**	$Y=-14.12+0.96X_1-0.33X_2-0.47X_3+0.37X_4+0.22X_5$	0.71**
	kharif	$Y= 282.57+0.89X_1 -1.51X_2 -0.47X_3 +1.82X_4 -1.11X_5$	0.78**

* Significance at 5 per cent level ** Significance at 1 per cent level

X_1-Maximum temperature (°C); X_2-Minimum temperature (°C)
X_3-Morning relative humidity (%); X_4-Evening relative humidity (%); X_5-Rainfall (mm)

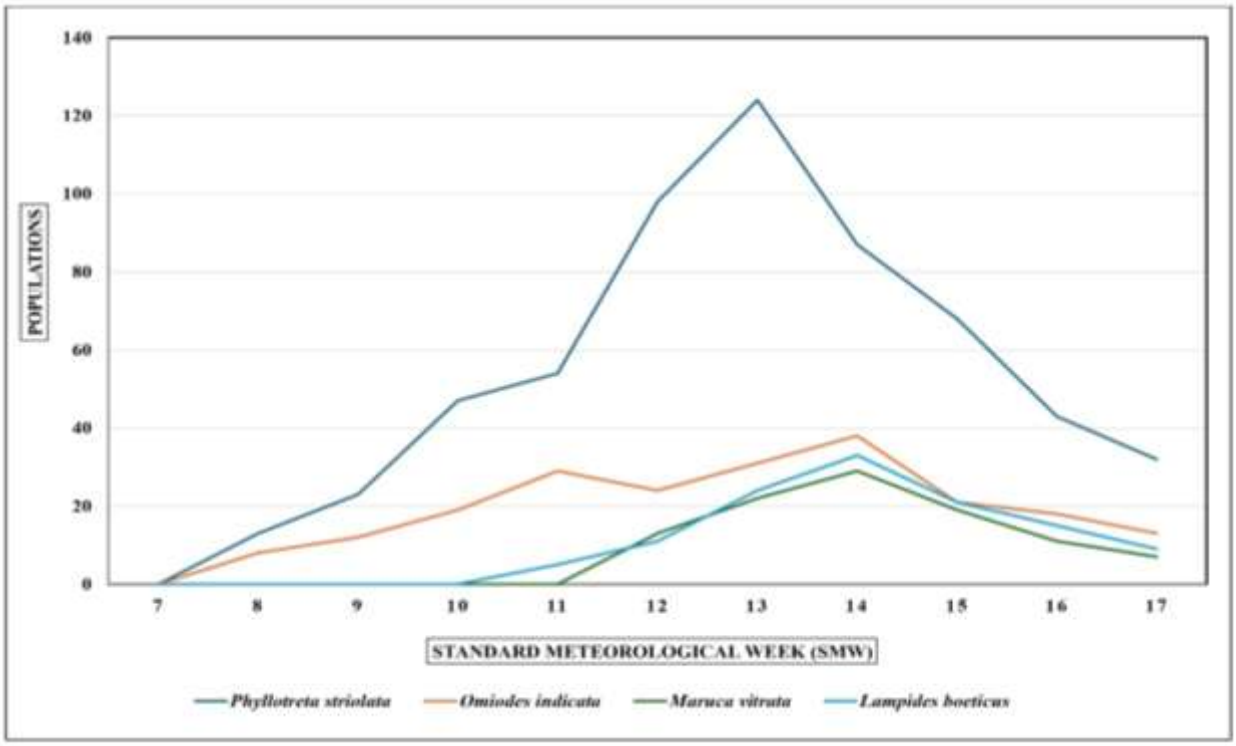


Figure 1. Seasonal incidence of major pests of black gram during summer 2024

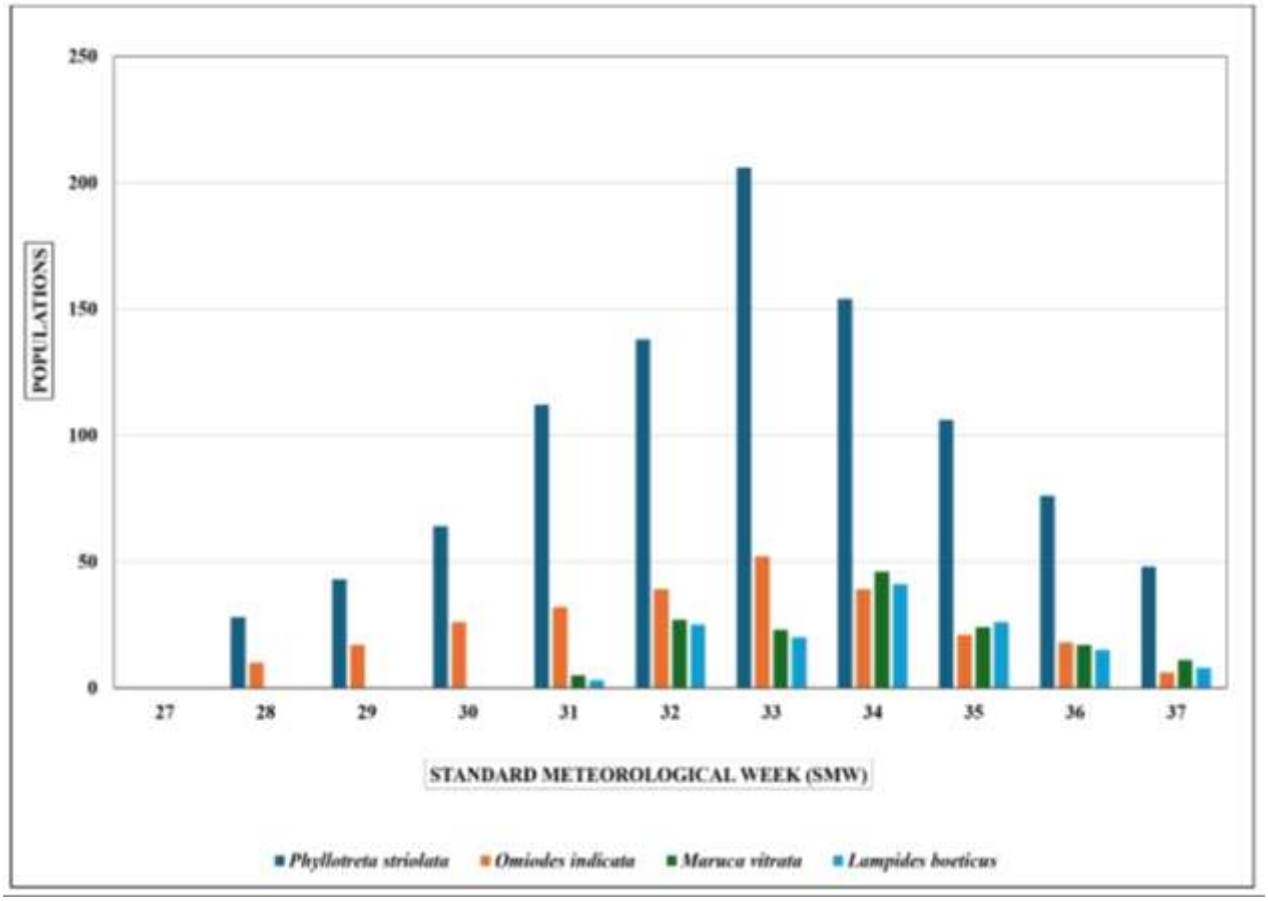


Figure 2. Seasonal incidence of major pests of black gram during *kharif* 2024

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