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First report of mungbean insect pests and their seasonal abundances under climatic influence in Southern Bangladesh

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ABSTRACT

Mungbean (*Vigna radiata* L.) is an important pulse crop in Bangladesh, yet its productivity is frequently hampered by insect infestation. Ecological information on pest diversity, seasonal incidence, and climatic influence remains limited for the southern region, a major mungbean-growing area. A field investigation was conducted in Barishal during the *late rabi* season of 2022 to document the insect pest complex, assessing stage-wise population trends, and evaluates relationships between pest abundance and weather variables. Seventeen insect species belonging to five Orders namely Hemiptera, Lepidoptera, Coleoptera, Diptera, and Thysanoptera were recorded. Flower thrips (*Megalurothrips usitatus*), legume pod borer (*Maruca vitrata*), flea beetles (*Phyllotreta striolata* and *Phyllotreta cruciferae*), and common cutworm (*Spodoptera litura*) exceeded economic threshold levels and were identified as major pests. Sap-sucking insects, including whitefly (*Bemisia tabaci*), aphid (*Aphis craccivora*), jassid (*Empoasca kerri*) and bean bug (*Riptortus pedestris*) persisted throughout the growing season, whereas leaf miner (*Liriomyza brassicae*), leaf roller (*Lamprosema indicata*), hairy caterpillar (*Spilosoma obliqua*), and epilachna beetle (*Epilachna dodecastigma*) occurred intermittently. *Spodoptera litura* was observed on mungbean for the first time in Bangladesh, while *R. pedestris* was newly confirmed in this region. Insect pest's abundance varied across crop growth stages, with flea beetles dominating at early vegetative stage, while thrips and pod borers peaking during flowering and pod formation. Temperature and solar radiation were positively correlated with populations of *S. litura*, *M. usitatus*, and *R. pedestris,* whereas relative humidity was negatively associated with whitefly, aphid, and leaf roller densities. The findings provide the first comprehensive baseline on pest community structure and climate-pest interactions in southern Bangladesh, supporting climate-responsive, stage-specific pest management strategies for sustainable mungbean production.

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Introduction

Mungbean (*Vigna radiata* L.) is a short duration, protein rich pulse crop that plays a crucial role in human nutrition and soil fertility enhancement through biological nitrogen fixation. In Bangladesh, it is a vital pulse crop primarily cultivated during the summer season in the north western, south western, and winter (late *rabi*) seasons in the southern coastal belt. Farmers are increasingly adopting mungbean cultivation after harvesting *T aman* rice in the southern region (late *rabi*) and following *rabi* crops in the north western and south western regions. The availability of short duration, high yielding varieties coupled with strong market demand has positioned mungbean an attractive crop for intensifying production system and income diversification (Rahman and Miah, 1987; Kamal *et al*., 2020; Islam *et al*., 2021; Ahmed *et al*., 2023; Ahmed *et al*., 2025).

National agricultural statistics reveal a steady expansion of mungbean cultivation, particularly during the late *rabi* season in the southern coastal districts where favorable weather conditions, and innovative production systems such as floating bed and raised bed cultivation are prevalent (BBS, 2023; Ullah *et al*., 2022). Despite its growing importance, the average national yield remains far below its potential. This yield gap is attributed to multiple biotic and abiotic constraints. Among which, insect pests represent the most serious limiting factors, inflicting serious damage at various crop growth stages (Singh *et al*. 2020; Tanzum *et al*., 2021; Hossain *et al*. 2009).

A diverse complex of insect pests is challenged with mungbean production in South Asia, including whitefly (*Bemisia tabaci*), aphid (*Aphis craccivora*), jassid (*Empoasca kerri*), stem fly (*Ophiomyia phaseoli*), flower thrips (*Megalurothrips usitatus*), legume pod borer (*Maruca vitrata*), gram and pod borer (*Helicoverpa armigera*) (Hossain *et al*., 2009; Islam *et al*., 2021; Tanzum *et al*., 2021; Hossain *et al*., 2024). These pests cause damage by cell sap sucking, leaf damage and destruction of flowers and pods, as well as through transmission of mungbean yellow mosaic virus (MYMV). Previous studies reported that 25% to 70% yield of mungbean can be reduced due to pest attack but it depends on pest density, crop growth stage-pest association and prevailing climatic conditions (Sehgal and Ujagir, 1988; Duraimurugan and Tyagi, 2014; Islam *et al*., 2021; Hossain *et al*., 2025).

Climatic factors such as temperature, relative humidity, rainfall, and solar radiation strongly influence the seasonal occurrence and outbreak of insect pests (Rahman *et al*., 2024; Ravi *et al*., 2024). Even though, numerous researches on pest diversity and population dynamics in mungbean has been conducted on the western and north central agroecological regions of Bangladesh (Tanzum et al., 2021). In contrast, the southern coastal zone has received comparatively limited scientific attention, although it represents a major mungbean growing area. This coastal ecosystem is characterized by high humidity, salinity intrusion, and rapid shifts between dry and wet periods, conditions that may largely influence pest community, incidence and seasonal occurrence compared with other inland areas. For example, research carried out in the central zone (Gazipur) documented twelve insect species on mungbean, with flea beetle, jassid, and pod borer identified as key pests (Tanzum *et al*., 2021). Similar ecological documentation of mungbean pests for the southern coastal system remains scarce. The lack of region-specific information restricts the formulation of locally adapted integrated pest management (IPM) strategies and climate-based forecasting models. A clear understanding of pest community structure, seasonal succession, and their relationships with environmental variables is essential for predicting population peaks and improving monitoring management decisions.

Thus, the current study aimed to (i) document the insect pest complex associated with mungbean production in southern Bangladesh;(ii) quantify their seasonal occurrences across different crop growth stages; and (iii) assess the relationships between pest population dynamics and prevailing climatic variables.

Materials and Methods

Study site and duration

The study was conducted during the late *rabi* season of 2022 at the Bangladesh Agricultural Research Institute (BARI) research farm in Rahmatpur, Barishal, Bangladesh (22°47′00″ N, 90°17′47″ E).

Crop growing and experimental design

The widely cultivated mungbean variety BARI Mung-6 was selected for the experiment due to its regional adaptability. The crop was sown on 26 January 2022 in uniformly prepared plots measuring 20 m by 20 m. Plant spacing was maintained at 50 cm between rows and 20 cm between plants to ensure adequate aeration and light interception. Three separate fields were selected as replications, each were located by approximately 40 to 50 m apart to minimize pest movement between plots and ensure spatial independence. Agronomic practices such as land preparation, fertilizer application, irrigation and weeding were carried out following BARI recommendations. No pesticides were applied throughout the entire cropping season so that natural pest colonization and population development could occur.

Sampling for data recording

Field monitoring started just after the first appearance of insect pest and continued at weekly intervals until the crop reached maturity and was harvested. During each sampling, ten randomly selected plants were visually examined to record the number insect per plants. Sampling was carried out from 7:00 to 9:00 am, when insects were usually less active and stayed on plants. Data were expressed as the number of individuals per plant or per specific plant part, depending on their feeding behavior.

Sucking pest: The population of whitefly and green jassid were recorded by counting the number of individuals on three leaves per tagged plant, including upper, middle and lower leaves. Aphid density was measured by counting insects present on a 10 cm apical shoot of each selected plant. To assess flower thrips, 60 open flowers were randomly collected from three different parts of each field. Then the collected flowers were opened separately over a white sticky board in the laboratory, and both adult and immature thrips were counted using a hand lens. Thrips infestation was expressed as the number of thrips-infested flowers and the number of thrips per 20 flowers.

Borer complex: Boring insect in mungbean was assessed by counting larvae directly on ten 15 plants from three different parts of each field. Borer infested pods and flowers were also collected and brought to laboratory to confirm larval presence. Species identification, larvae were either reared to adults or identified at the larval stage using standard taxonomic keys and reference specimens.

Other pests: All other insect, excluding sucking pests and borer complex, were counted from the same tagged plants, and their incidence was presented as number of individuals per plants.

Species identification

All the recorded species were identified based on morphological characteristics by comparing specimens with authenticated collections preserved in the Entomology Division of BARI. Identification was further confirmed using standard taxonomic literature, identification keys, and reference manuals relevant to mungbean insect pests. All the recorded pests were categorized based on their feeding habit as root feeders, stem feeders, leaf feeders, leaf rollers, leaf and pod suckers, and pod borers.

Pod damage

At harvest, all pods from ten randomly selected plants per plot were examined to determine infestation percentage. Pod infestation was calculated using the following formal:

$$\%\ \text{Pod infestation} = \frac{\text{Number of infested pods}}{\text{Total number of pods}} \times 100$$

Diversity analysis

The diversity and relative abundance of insect pests were assessed throughout the cropping seasons from seedling to crop maturity. Insect pests that persisted throughout the specific crop growth stages with comparatively higher population densities and caused more than 15% crop damage were categorized as major pests, whereas those occurring intermittently with lower abundance were categorized as minor pests. Relative abundance was calculated using the following formula (Yadav et al., 2025):

$$\text{Relative abundance (\%)} = \frac{\text{Number of individuals of a particular species}}{\text{Total number of individuals of all species}} \times 100$$

Species diversity was quantified using Simpson's diversity index (D) (Simpson, 1949), which considers both species richness and relative abundance. The index was calculated as:

$$D = \sum H(H-1)/ N(N-1)$$

where, H = number of individuals of a particular species, and N = total number of individuals of all recorded species. The Simpson's Index of Diversity (SID) was calculated as 1-D. SID values range from 0 to 1, where values closer to 1 indicate higher species diversity within the ecosystem.

Weather data Collection

Daily data on temperature, relative humidity, rainfall, sunshine duration, cloud cover, and solar radiation were collected from the weather station at the Bangladesh Rice Research Institute (BRRI), Barishal. This station is situated about 13 kilometers away from the study area.

Statistical analysis

To assess the relationship between weather parameters and pest abundance, Pearson correlation analyses were performed. All statistical analyses were done using R software, specifically version 4.1.2.

Results and Discussion

Diversity patterns and new occurrences of mungbean insect pests

The high diversity of insect pests observed in mungbean may be associated with favorable climatic conditions, continuous host availability, diverse surrounding cropping systems, and the absence of insecticide application during the cropping season. During the late *rabi* season of 2022, a total of 17 insect species were recorded infesting mungbean in southern Bangladesh (Table 1). These included five species of Hemiptera: aphid (*Aphis craccivora*), green jassid (*Empoasca kerri*), whitefly (*Bemisia tabaci*), green stink bug (*Nezara viridula*), and bean bug (*Riptortus pedestris*); six species of Lepidoptera: hairy caterpillar (*Spilosoma obliqua*), common cutworm (*Spodoptera litura*), legume pod borer (*Maruca vitrata*), gram pod borer (*Helicoverpa armigera*), pea blue butterfly (*Euchrysops cnejus*), and leaf roller *(Lamprosema indicata)*; three species of Coleoptera: striped flea beetle (*Phyllotreta striolata*), crucifer flea beetle (*Phyllotreta cruciferae*), and epilachna beetle (*Epilachna dodecastigma*); two species of Diptera: leaf miner (*Liriomyza brassicae*) and stem fly (*Ophiomyia phaseoli*); and one species of Thysanoptera: flower thrips (*Megalurothrips usitatus*).

The occurrence of *S. litura* and *R. pedestris* may indicate recent changes in pest composition and agroecological conditions in southern Bangladesh. The common cutworm (*S. litura*) was recorded for the first time on mungbean in Bangladesh, while the bean bug (*R. pedestris*) was newly documented in the southern region during 2019 in our previous study (Rahman *et al*., 2022). These findings enhance and updated the current information of mungbean pest community in Bangladesh, showing both established and emerging pests. Previous studies in Bangladesh and neighboring India reported several insect species associated with mungbean, with thrips, whitefly, gram pod borer, and legume pod borer identified as the main pests across South Asia (Kooner et al., 2006; Singh and Singh, 2015; Kharel et al., 2016; Kumar et al., 2019; Tanzum et al., 2021; Islam et al., 2021). The current study confirms these earlier findings and also records the presence of emerging or previously unnoticed pests, notably *S. litura* and *R. pedestris*, reflecting changes in the agroecological pest scenario.

The relative abundance analysis demonstrated that *S. litura was the most dominant species in the mungbean ecosystem accounting for 574 individuals or 27.11%* of the total insect population recorded (Table 1). Flower thrips (*M. distalis*) and striped flea beetle (*P. striolata*) were the second and third most abundant species, contributing 19.04% and 13.04% of the total population, respectively. In contrast, stem fly, green stink bug, leaf miner, and pea blue butterfly were comparatively less abundant.

Species diversity analysis using Simpson's Diversity Index further explained the structure and stability of the pest community. The calculated Simpson's Index (D) was 0.15, while Simpson's Index of Diversity (SID = 1 − D) was 0.85 (Table 1). A lower value of D and a higher SID value indicate high species diversity and relatively balanced species distribution within the mungbean ecosystem, despite the dominance of a few major pests. The SID value of 0.85 suggests that the mungbean field supported a diverse insect pest assemblage with substantial species richness. Such high diversity may be associated with favorable climatic conditions, continuous host availability, and the absence of insecticide application during the cropping season.

Infestation analysis further showed that flower thrips (45.0% plants infested), common cutworm (34.4%), legume pod borer (21.3%), and flea beetles (18.7%) exceeded the 15% threshold (Rahman *et al*., 2024) and were therefore categorized as major pests. On the other hand, insect species with infestation rates between 2.2% and 11.7% were considered minor pests (Table 2). Although whitefly infestations were low, its role in transmitting mungbean yellow mosaic virus (MYMV) makes it economically significant (Swathi *et al*., 2023). From this study it was clear that sap-sucking insects remain as the dominant group, but increasing abundance of polyphagous species including *S. litura* and flea beetles suggests a gradual alteration in pest dynamics, possibly driven by cropping

Table 1. Species composition, taxonomic classification, feeding habits and relative abundance of insect pests recorded on mungbean in Southern Bangladesh

Sl. No.	Common name	Scientific name	Family	Order	Pest type	Total number of insects observed	Relative abundance (%)
1	Stripped flea beetle	*Phyllotreta striolata*	Chrysomelidae	Coleoptera	Leaf feeder	276.00	13.04
2	Crucifer flea beetle	*Phyllotreta crucifera*	Chrysomelidae	Coleoptera	Leaf feeder	123.00	5.81
3	Whitefly	*Bemisia tabaci*	Aleyrodidae	Hemiptera	Sap sucker	40.00	1.89
4	Green jassid	*Empoasea kerri Purthi*	Cicadellidae	Hemiptera	Sap sucker	32.00	1.51
5	Aphid	*Aphis craccivora Koch*	Aphididae	Hemiptera	Sap sucker	154.00	7.27
6	Hairy caterpillar	*Diacrisia obiliqua*	Noctuidae	Lepidoptera	Leaf feeder	139.00	6.57
7	Stem fly	*Atherigona spp.*	Muscidae	Diptera	Stem borer	8.00	0.38
8	Flower thrips	*Megalurothrips distalis*	Thripidae	Thysanoptera	Sap sucker	403.00	19.04
9	*Common cutworm	*Spodoptera litura* .	Noctuidae	Lepidoptera	Borer and defoliator	574.00	27.11
10	Legume pod borer	*Maruca virtata*	Crambidae	Lepidoptera	Pod borer	135.00	6.38
11	Gram pod borer	*Helicoverpa armigera*	Noctuidae	Lepidoptera	Pod borer	80.00	3.78
12	Pea blue butterfly	*Euchrysops cnejus Fab*	Lycaenidae	Lepidoptera	Pod borer	25.00	1.18
13	Leaf miner	Liriomyza spp.	Agromyzidae	Diptera	Leaf miner	18.00	0.85
14	Leaf roller	*Lamprosema indicata*	Crambidae	Lepidoptera	Leaf feeder	18.00	0.85
15	Green stink bug	*Nezara viridula*	Pentatomidae	Hemiptera	Sap sucker	9.00	0.43
16	Bean bug	*Riptortus pedestris*	Alydidae	Hemiptera	Sap sucker	61.00	2.88
17	Epilachna beetle	*Epilachna vigintioctopunctata*	Coccinellidae	Coleoptera	Leaf feeder	22.00	1.04
	Total no. of insects					2117.00	
	Simpson's Index (D)					0.15	
	Simpson's Index of Diversity (SID)					0.85	

*Previously known on other hosts; first observed on mungbean patterns, variety selection, or climatic variation.

Seasonal abundance and crop growth stage relationship

The mungbean crop growth was divided into four distinct stages following a modified classification of Tanzum *et al*. (2021): seedling (9 to 23 February), flowering (2 March), flowering and fruiting (9 March to 6 April), and fruiting to harvest (13 to 27 April). Results showed that clear differences in pest occurrence were observed among these growth stages (Table 2; Fig. 2, 3 and 4). During seedling stage, flea beetles, whiteflies were predominant, which together caused leaf damage and reduced plant vigor (Fig. 1). The persistent activity of flea beetles, which is unlike in mungbean, may be explained by spillover from neighboring cruciferous crops or specific local cropping sequences. Flower thrips damaged anthers and causing flower dropping and affected nearly 45% of plants during the reproductive phase, highlighting its economic importance.

All borer species attacked floral structures and pod causing serious yield loss (Table 2). The *S. litura* caused substantial leaf, flower and pod damage throughout the season, reflecting its polyphagous feeding habit.

Hemipteran sap sucking insect pests including whiteflies, aphids, green jassid and bean bugs persisted across the growth stages, contributed to continuous plant stress and potential transmission of mungbean yellow mosaic virus (MYMV) diseases (Fig. 1). The stem fly infestation occurred mainly during the seedling stage. Although its incidence was low in the present study, earlier reports documented infestation can reach up to 97% of plants (Rahman *et al*., 1981). The current findings are consistent with previous investigations that whitefly, aphid, and jassid incidence generally increased from vegetative to flowering stages, showing positive relationships with temperature and humidity (Khaire *et al*., 2024). Similarly, flea incidence of beetles and flower thrips were also varied with crop growth stages in southern Bangladesh (Ullah and Khan, 2024).

Abundance patterns of major insect pests

Flea beetles: Two flea beetle species, the striped flea beetle (*P. striolata*) and crucifer flea beetle (*P. cruciferae*), were observed during the early growth stage (Fig. 1). *Phyllotreta striolata* was identified by two amber longitudinal stripes on the elytra, whereas *P. cruciferae* has uniform dark black elytra. *P. striolata* were recorded higher densities with mean 2.0-3.3 individuals per five plants compared with *P. Cruciferae* (0.45 to 1.0 individuals per plants) (Fig. 2). Populations of both species reached their highest levels during the seedling and early flowering stages before declining. This dominance of *P. striolata* aligns with previous reports from other Asian countries where it is considered as most destructive pests of many cruciferous crops Mayoori and Mikunthan, 2009; Raghavendra et al., 2023). Its higher

Table 2. Crop growth stage occurrence, infestations onset, damage severity and pest status of insect species recorded on mungbean

Name of the insect	Crop growth stage of infestation	Initiation of infestation (DAS)	Rate of plant infestation (%)	Status
Stripped flea beetle Crucifer flea beetle	Seedling to flowering Seedling to flowering	14	18.67±1.04	Major
Flower thrips	Flowering and fruiting	42	45.00±1.12	
Common cutworm	Seedling to fruiting	35	34.44±0.84	
Legume pod borer	Flowering to fruiting	56	21.25±0.31	
Whitefly	Seedling to flowering	21	10.56±0.55	Minor
Green jassid	Seedling to fruiting	21	7.50±0.81	
Aphid	Seedling to flowering	21	11.67±1.21	
Hairy caterpillar	Seedling to flowering	28	5.00±0.86	
Stem fly	Seedling to harvesting	28	2.22±0.74	
Gram pod borer	Flowering to fruiting	56	8.33±0.54	
Pea blue butterfly	Flowering to fruiting	63	4.17±0.54	
Leaf miner	Seedling	21	3.89±1.92	
Leaf roller	Seedling to harvesting	28	11.11±0.81	
Green stink bug	Seedling to flowering	28	5.00±1.67	
Bean bug	Seedling to harvesting	49	7.50±0.61	
Epilachna beetle	Seedling to harvesting	21	6.67±0.61	

*Note: DAS:-Days after sowing.

abundance can be explained by its greater adaptability and reproductive potential. Thus, in local mungbean agroecosystems, management approaches should prioritize *P. striolata* during early crop growth stage, while *P. cruciferae* can be secondary threat.

Flower thrips: Flower thrips was among the most destructive pest at reproductive stages of mungbean. Its infestation started immediately after flowering and reached peak one week into flowering (9 March) with 12.7 flowers infested per 20 flowers (Fig. 3). Then, infestation levels were declined to 0.7 flowers per 20 flowers. Thrips population per 20 open flowers, ranged from 1.0 to 12.7 individuals, peaking at 14.7 individuals on 9 March (Fig. 3). These observations align with previous studies identifying thrips as a major pest during the reproductive stage of mungbean (Kumar and Singh, 2020; Hossain et al., 2020; Hossain et al., 2024). Therefore, pest management strategies should target the flowering period to effectively reduce yield losses caused by this species.

Borer complex: Four lepidopteran borers, *S. litura*, *M. vitrata, H. armigera and E. cnejus* were recorded. Among the *S. litura* newly recorded in the study area, emerged as dominant species and persisting from seedling to fruiting stages. Larval densities of *S. litura* range from 1.6 to 5.7 larvae per plant, with a peak in early April (Fig. 4). Its polyphagous nature and ability to damage both vegetative and reproductive plant parts increase its significance in mungbean. Under unmanaged conditions, *S. litura* infestation may approach 100%, indicating its potential as a major threat. In contrast, larvae of *M. vitrata* were moderately abundant with densities 0.4 to 2.3 per plant, whereas *H. armigera and E. cnejus recorded lower densities (<1.0 per plant). Pod damage caused by the all borer complex ranged from 38.2 to 55.1%, which* aligns with reported regional yield losses (25-

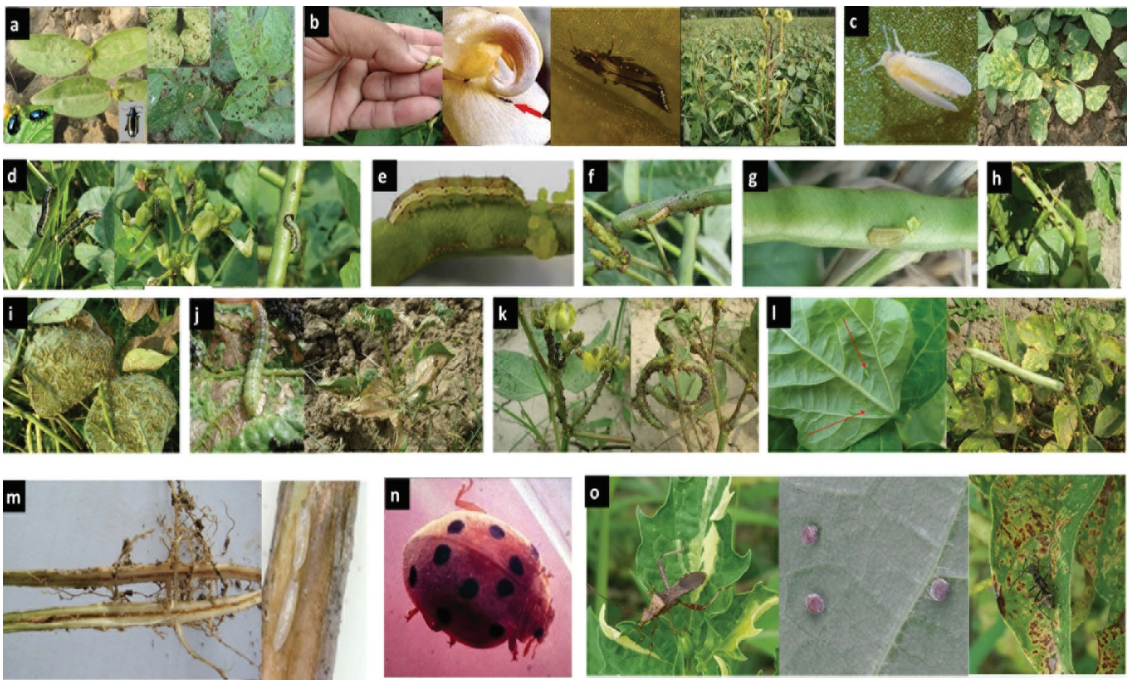

Fig. 1. Insect pests infesting mungbean in southern Bangladesh and their associated damage. (a) Flea beetles (*P. striolata* and *P. cruciferae*) with characteristic leaf damage; (b) Flower thrips (*M. usitatus*) causing flower abortion and loss; (c) Whitefly (*B. tabaci*) with symptoms of mungbean yellow mosaic virus (MYMV) infection; (d) Common cutworm (*S.litura*) feeding on leaves, flowers, and pods; (e) Gram pod borer (*H. armigera*) damaging pods; (f) Legume pod borer (*M. vitrata*) attacking reproductive structures; (g) Larva of pea blue butterfly (*E. cnejus*) feeding on pods; (h) Pod damage caused by borer complex; (i) Hairy caterpillar (*S. obliqua*) leaf damage; (j) Leaf roller (*L. indicata*) with leaf-folding damage; (k) Aphid (*A. craccivora*) infestation on leaves; (l) Green jassid (*E. kerri*) with feeding damage; (m) Stem fly (*O. phaseoli*) larvae inside stem tunnels; (n) Epilachna beetle (*E. dodecastigma*); (o) Bean bug (*R. pedestris*) adult, eggs, and nymphs causing foliage damage.

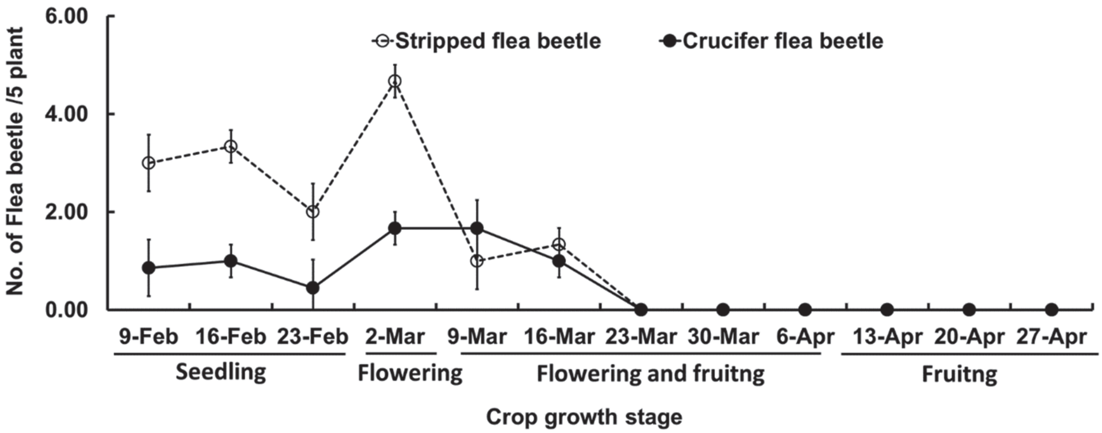

Fig. 2. Seasonal trends of flea beetles (*Phyllotreta spp*.) population on mungbean during 2022 season

30%), underscoring significant economic risk (Duraimurugan and Tyagi, 2014; Bhati et al., 2020). The early appearance and persistent present of *S. litura* suggest a possible shift borer species dominance over *M. vitrata* and *H. armigera* as the major mungbean borers (Islam *et al*., 2021). The extended temporal distribution of *S. litura* emphasizes the need for prolonged monitoring periods and implementing early-season integrated pest management interventions. Furthermore, concurrent flower-stage damage caused by thrips increases the susceptibility of reproductive structures, reinforcing the need for synchronized integrated pest management strategies of both chewing and sap-sucking insect pests.

Abundance patterns of minor insect pests

The abundance and seasonal occurrence of minor insect pests are presented in Table 3. Minor pests included whitefly, aphid, green jassid, hairy caterpillar, stem fly, leaf miner, leaf roller, green stink bug, bean bug, and epilachna beetle. Whitefly was observed throughout the season (0.33-3.67 per six leaves), peaking on 2 March. Aphid and green jassid were present from seedling to early fruiting, peaking at 23 February and 2 March, respectively. Hairy caterpillar was sporadic, with up to 27.7 larvae per leaf, while stem fly occurred at very low densities (0.68 larvae per plant). Leaf miner and leaf roller occurred from seedling to flowering at low densities (0.67-1.36 per plant). Green stink bug was rare (0.3 per plant), and epilachna beetle was occasional (0.56-1.67 per plant). Bean bug were recorded from flowering to fruiting stages and reached a peak at 7.37 per plat in mid-March.

Although these species occurred at lower densities than the major pests, several possess significant agronomic importance. Sap feeding pests such as whitefly, aphid, and green are vectors of mungbean yellow mosaic virus, and their continuous presence

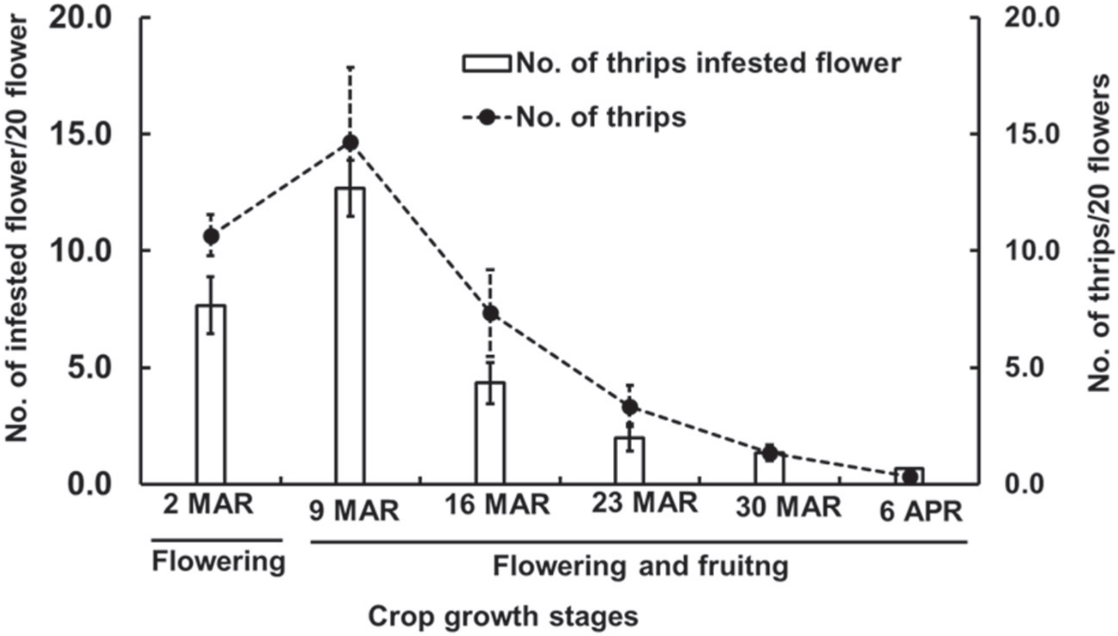

Fig. 3. Seasonal trends of flower thrips population and flower infestation in mungbean during 2022 season

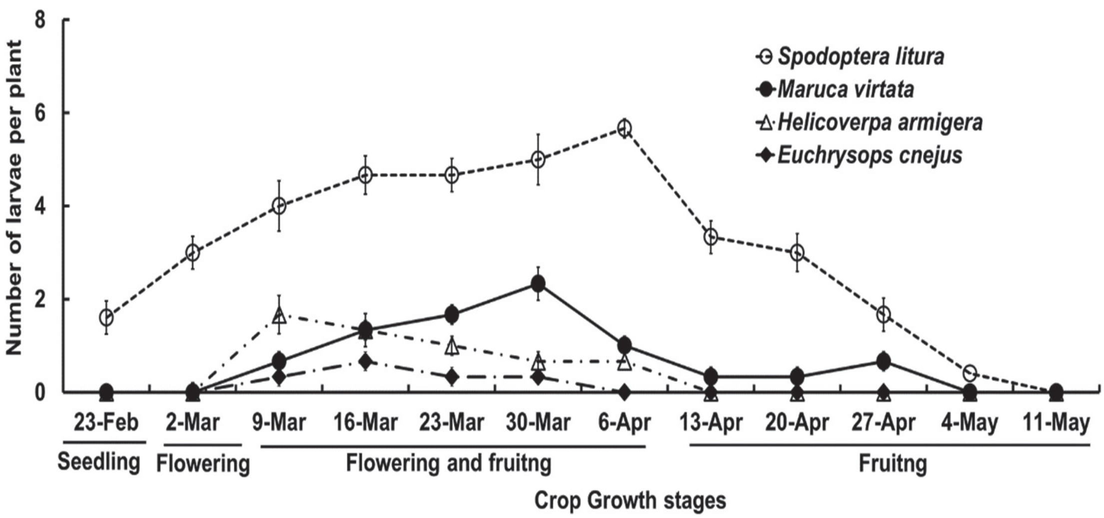

Fig. 4. Seasonal population fluctuation of the borer complex (mean ± SE) in mungbean during the 2022 season

Table 3. Seasonal occurrence, stage wise abundance, and population fluctuations of minor insect pests affecting mungbean in southern Bangladesh

Date of observation	Crop growth stage	Mean population of insect pests ± (SE)									
		whitefly/6 leaves	Green iassid/6 leaves	Aphid/10cm twig	Hairy caterpillar/6 leaves	Stem fly larvae/ plant	Leaf miner infested leaf/plant	Leaf roller/ plant	Green stink bug/ plant	Bean bug/ plant	Epilachna beetle/ plant
09/02/2022		0.67±0.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16/02/2022	Seedling	2.67±1.20	1.34±0.33	7.65 ±0.88	0.00	0.00	0.67±0.67	0.00	0.00	0.00	0.67±0.22
23/02/2022		2.00±0.58	1.65±0.33	16.00±1.15	27.67±14.33	0.68±0.34	1.00±0.58	1.14±0.51	0.36±0.23	0.00	0.62±0.33
02/03/2022	Flowering	3.67±0.67	1.67±0.61	14.63±1.76	18.67±18.67	0.00	1.33±0.33	1.36±0.45	0.33±0.61	0.00	1.67±0.31
09/03/2022		2.67±1.20	0.62±0.66	13.00±1.53	0.00	0.00	0.00	1.23±0.58	0.00	3.33±0.88	0.56±0.32
16/03/2022		1.33±0.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.37±1.20	0.00
23/03/2022	Flowering and fruiting	0.33±0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00±0.58	0.00
30/03/2022		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.33±0.33	0.00
06/04/2022		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.67±0.33	0.00
13/04/2022		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00±0.58	0.00
20/04/2022	Fruiting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.85±0.31	0.00
27/04/2022		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.67±0.32	0.00

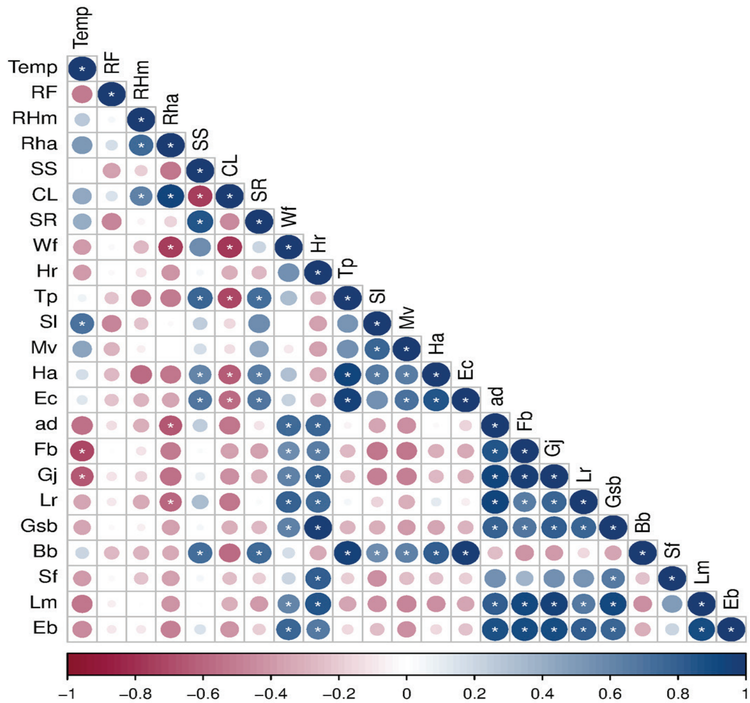

Fig. 5. Correlation of major climatic variables with mungbean insect pest during 2022 season. Positive correlations are shown in blue, negative correlations in red, with darker shades representing stronger relationship.

Notes: Temp: Temperature, RF: Rainfall; RHm: Morning relative humidity, RHa: Afternoon relative humidity, SS: Sunshine hours, CL: Cloudy hours; SR: Solar radiation, WF: Whitefly, Hr: Hairy caterpillar, Tp: Thrips, Sl: *Spodoptera litura,* Mv*: Maruca vitrata*, Ha: *Helicoverpa armigera*, Ec: *Euchrysops cnejus*, Ad: Aphid, Fb: Flea beetle, Gj: Green jassid, Lr: Leaf roller, Gsb: Green stink bug, Sf: Stem fly, Lm: Leaf miner, Eb: Epilachna beetle

may accelerate virus transmission even at low densities (Tanzum *et al*., 2021). Reproductive stage feeders such as bean bug can be an emerging threat to seed formation, emphasizes its inclusion in integrated pest management strategies. Furthermore, the continuous low-level occurrence of leaf miner, leaf roller, and green stink bug may contribute cumulatively to crops stress. These findings indicate the importance of comprehensive monitoring and management strategies for all pest complex rather than on major pests only.

Effect of climatic factors on seasonal occurrence of insect pests in mungbean

The relationships between climatic factors including temperature, relative humidity (RH), rainfall, sunshine, cloudy hours, and solar radiation with pest populations in mungbean were analyzed (Fig. 5). Pearson correlation analysis showed strong positive correlation with *S. litura* but with negatively associated with flea beetle, aphid, and green jassid. Afternoon relative humidity negatively affected whitefly, aphid, and leaf roller, whereas rainfall and morning RH had little effect. However, sunshine hours and solar radiation were positively correlated to flower thrips, *H. armigera*, *E. cnejus* and *R. pedestris,* whereas cloudy hours showed negative relationships with these pests.

These findings highlight that among the climatic variables temperature and solar radiation are the most important factors of pest population abundance particularly for *S. litura* and flower thrips while moderately cool and humid conditions favor sap-sucking pests. The positive response of *S. litura* to temperatures explained its biology as a polyphagous pest adapted to warm environments. Conversely, flea beetle, aphid, and green jassid populations decreased with increasing temperatures, suggesting a preference for cooler, more humid microclimates, consistence with previous observations (Kumar and Singh, 2020; Khaire *et al*. 2024). Rainfall had minimal effect on pest incidence, likely because rainfall was very low during the study period. Increased sunshine hours and higher radiation positively influence the activity and feeding of reproductive-stage pests, including thrips, bean bug, and *H. armigera.* These findings highlight the importance of using climatic data for forecasting pest incidence and implementing adaptive IPM strategies.

Conclusion

This investigation provides the first comprehensive documentation of the insect pest complex associated with mungbean in southern Bangladesh, including first record of common cutworm (*Spodoptera litura)* and the occurrence of bean bug (*Riptortus pedestris)* as an emerging pest. A total of seventeen species belonging to five insect orders were recorded. Seasonal occurrence patterns showed that *S. litura,* flower thrips (*M. distalis),* legume pod borer (*M. virtata)* and flea beetles *(Phyllotreta striolata)* were major pests due to their higher infestation levels and persistence across crop stages. In contrast, whitefly, aphid, green jassid, and bean bug were minor pest but hold significant epidemiological important. Pest incidence showed strong temporal correlations with crop growth stages and climatic factors including temperature, humidity, rainfall and solar radiation. The increasing prevalence of polyphagous pests such as *S. litura* indicates a possible shift in pest ecology driven by climatic variability and modern cropping practices. These findings emphasize the need for climate-adaptive, growth stage-specific pest management strategies and provide a baseline for future ecological and IPM research in in mungbean systems of southern Bangladesh.

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Conflict of Interest

The authors affirm that no financial or commercial relationships that might be construed as a potential conflict of interest existed during the course of the research.

Author Contributions

Conceptualization, Md Mahbubur Rahman; methodology, Md Mahbubur Rahman; software, Sumaiya Akter; validation, Md. Altaf Hossain and Md. Akhtaruzzaman Sarkar; resources, Md Mahbubur Rahman; data curation, Md Mahbubur Rahman and Sumaiya Akter; writing— Md Mahbubur Rahman and Sumaiya Akter; writing, review and editing, Md Mahbubur Rahman and Md. Ahsanul Haque; visualization, Md Mahbubur Rahman and Md. Akhtaruzzaman Sarkar; supervision, Md. Altaf Hossain and Md. Akhtaruzzaman Sarkar; project administration, Md Mahbubur Rahman; revenue acquisition, Md Mahbubur Rahman. All authors have reviewed the manuscript in its current form and given their approval.

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