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Pest status, abundance and diversity of insect pests harboring on soybean

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ABSTRACT

Check lists of insect pests of soybean and their succession in relation to crop stages are scanty in Bangladesh. A study was conducted during January to April 2023 at the Department of Entomology, Gazipur Agricultural University (GAU), Gazipur to know the prevalence of the insect pests and their status on soybean. According to rate of plant infestation, flea beetle (35.7%), jassid (34.4%), whitefly (27.5%), soybean looper (33.6%) and pod borer (36.9%) were categorized as the major pests while leaf miner (15.5%), leaf beetle(15.2%), epilachna beetle (15.8%), grasshopper (17.6%), aphid (11.8%), green stink bug (11.2%), hairy caterpillar (16.7%), leaf roller (17.0%), stem fly (19.5%), thrips (13.1%) and weevil (13.9%) were categorized as the minor pests. The pest insects were most abundant in mid-March (24.7±5.3) when the plant was pod initiation stage. The richness (2.5±0.1), diversity (2.6±0.1) and evenness (0.94±0.2) of insect pests were also the highest in mid-March. The rank abundance of the harbored arthropods showed that the pod borer occupied the top rank (19.0%) in soybean field.

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Introduction

Soybean (*Glycine max* L.) is a dominant oil-producing crop cultivated both in the *Rabi* and *Kharif* seasons in Bangladesh. This crop is used not only as an oil seed crop and feed for livestock and aquaculture, but also as a good source of protein for the human diet and as a biofuel feedstock (Masuda & Goldsmith, 2009). It is an exceptional source of oil, protein, vitamins, minerals, and some functional elements of the human body for instance isoflavones, lecithin and polysaccharide (Islam, 2019). Soybean can contribute significantly to meet the production of edible oil and protein requirement of the people in Bangladesh (Biswas, 2001).

In Bangladesh, soybean occupies 0.041 million ha of land and its production is 0.064 million tones (BBS, 2020). The production of soybean is very low compared to the demand and a huge amount of foreign exchange is spent every year by importing soybean meal and oil. Increasing the production of soybean may be one of the ways to minimize demand and supply gap of soybean in the country. In Bangladesh, soybean is playing an important role in augmenting both the production of edible oil and protein simultaneously. Soybean meal is used as protein supplement in human diet, cattle and poultry feed (Khanzada *et al*., 2013). Additionally, soy-based food products, such as tofu, soy milk, soy sauce, soy paste, tempeh, miso, have gained popularity as healthy alternatives in Asian cultures.

A few decades ago, the hairy caterpillar, leaf roller, common cutworm, pod borer, stem fly, bugs, and whitefly were identified as the most damaging pests during the vegetative, flowering, and pod formation stages of soybean (Biswas *et al*., 2001). Rahman *et al*. (2010) reported the presence of three species of natural enemies (ladybird beetles, carabid beetles, and spiders) and thirteen species of insect pests in the experimental field. Another study included soybean semiloopers, soybean hairy caterpillars, soybean leaf rollers, soybean flies, jassid, soybean pod borer, soybean leaf hoppers, stink bugs, and black leaf beetles as the insect pests of soybean (Singh, 1999). Tobacco caterpillar (*Spodoptera litura*), and green semilooper (*Chrysodeixis acuta*), are the two principal soybean defoliators. The immature stages (larvae or caterpillars) of both the pests damage the crop at vegetative stage, sometimes causing complete defoliation and significant yield loss (Singh & Singh, 1990). These insects are responsible to transmit viral diseases and also affect crop yield through the reduction of photosynthesis by the development of sooty mold (Jones, 2003).

In order to evolve economically feasible, ecologically sound and socially acceptable pest management strategies, detailed information on the pest complex, their status and sequence of appearance during the crop period, losses and type of damage are of great importance (Jayanthi *et al*., 1993). The knowledge of seasonal incidence of insect pests at different growth stages of soybean crop will be helpful in evolving proper management schedule.

Climatic changes may lead to increase the severity of these pests in many regions of the country (Dhaliwal *et al.*, 2010).

However, no recent study has been conducted on the current status of insect pests affecting soybean in Bangladesh. There is a pressing need for up-to-date and comprehensive information on the species richness, their diversity, and seasonal abundance to support in designing effective pest management strategies. Therefore, investigating the status, abundance and diversity of insect pests in soybean is critically important.

Materials and Methods

Study site

The study was set in the field of Department of Entomology, Gazipur Agricultural University, Gazipur. The experiment was laid out in a randomized complete block design (RCBD) with three replications. A total of 18 plots was made and the unit plot size was 3 m × 2 m. The study was carried out during January to April 2023. The seeds were sown in a well-prepared seedbed. The soybean seeds as BU soybean 2 were sown in continuous lines at a depth of approximately 5 cm below the soil surface, maintaining a spacing of 30 cm between the rows. Manures and fertilizers were applied following the recommended dosage for soybean cultivation as per FRG (2012). Intercultural operations were carried out as needed.

Observation of insect pests

The observations on the abundance of insect pests were made visually with the help of magnifying lens at 15 days interval recorded from their appearance on plants and continued until final harvest. The leaves of a plant having the squiggly line symptom of leaf miner infestation were considered as the presence of single leaf miner. For pod borers, both the larvae and adults were counted, while the larvae were identified by dissecting infested soybean pods. The samples were randomly collected from one row out of six in each plot, and the number of healthy and infested plants for each pest species was recorded. These data were then converted to a per-plot basis to calculate infestation rates and arthropod pest numbers. The insect pests were identified through comparing to museum specimens as well as by relevant literature and photographs. Curating and preparation of specimens was followed after Kwon's method (Kwon, 1988). The arthropod pests were categorized as major (>25%) and minor (<25%) according to the rate of infestation (Hasan *et al*., 2021).

Calculation of diversity indices

Shannon-Weaver diversity index (Shannon and Weaver, 1963) and Margalef's richness index (Margalef, l958) were calculated for the insect pests recorded in different observation days.

The indices were determined using the following formulas:

Shannon-Weaver diversity index (H):

$$H' = -\sum_{i=1}^{S} (Pi)\,(ln\ Pi)$$

Where, *S* represents the total number of species, also known as species richness; *Pi* denotes the relative abundance of each species; *P* is the proportion of (n/N) individuals of a specific species (n) relative to the total number of individuals observed (N); *ln* refers to the natural logarithm; and Σ indicates the summation of all the calculated values.

Margalef's species richness index (Dmg):

$$D^{mg} = \frac{S-1}{\ln N} \quad \text{or} \quad D^{mg} = \frac{S-1}{\log_e (N)}$$

Where, S = Total number of species, N = Total number of individuals in the sample, ln = Natural logarithm.

Pielou's evenness index (J′) is:

$$J' = \frac{H'}{\ln(S)}$$

Where, H′ = Diversity, S = Total number of species within the community.

The data were then analyzed statistically by analysis of variance and the means were separated by using Tukey HSD posthoc statistic using IBM SPSS 20.0 software.

Results and Discussion

Pest occurance

A total of 16 insect pests was recorded in the soybean field during *Rabi* season (Table 1). Among them, four insect pests were recorded from Hemiptera order, namely aphid (*Aphis craccivora*, Aphididae), jassid (*Amrasca biguttula,* Cicadellidae), whitefly (*Bemisia tabaci,* Aleyrodidae), green stink bug (*Nezara viridula,* Pentatomidae); two insect pests were recorded from Diptera order such as leaf miner (*Liriomyza brassicae,* Agromyzidae), stem fly (*Ophiomyia phaseoli,* Agromyzidae); four insects were recorded from Coleoptera order, namely flea beetle (*Phyllotreta striolata* , Chrysomelidae), leaf beetle (*Cerotoma trifurcata*, Chrysomelidae), Epilachna beetle (*Epilachna dodecastigma,* Coccinellidae) and weevil (*Tanymecus indicus*, Curculionidae); one insect was recorded from Thysanoptera order, namely thrips (*Frankliniella schultzei*, Thripidae); four insects were found from Lepidoptera order, namely hairy caterpillar (*Spilosoma obliqua,* Arctiidae), pod borer (*Helicoverpa armigera,* Noctuidae), soybean looper (*Chrysodeixis includens,* Noctuidae), leaf roller (*Omiodes indicate,* Pyralidae); one insect from Orthoptera order, namely grasshopper (*Atractomorpha crenulate,* Acrididae).

Several studies have documented insect pests affecting soybean in Bangladesh. A survey conducted by Ali (1988) in northern Bangladesh identified 47 insect pest species at various growth stages of the soybean crop in that region, with 12 species categorized as the major or serious pests. In another study conducted in the Noakhali region by Biswas (2013), 39 insect species from 7 orders and 22 families were found to attack soybean in

the field. Among these, six species—hairy caterpillar (*Spilarctia obliqua*), leaf roller (*Lamprosema indicata*), common cutworm (*Spodoptera litura*), pod borer (*Helicoverpa armigera*), stem fly (*Ophiomyia phaseoli*), and whitefly (*Bemisia tabaci*) were considered the major pests.

Leaf miner was found to infest the crop from seedling stage. Flea beetle and leaf beetle were found from seedling to pod formation stage. Epilachna beetle, grasshopper, jassid and soybean looper were found from vegetative to pod formation stage. Aphid, green stink bug, hairy caterpillar and stem fly were found from seedling to flowering stage. Leaf roller and whitefly was found from vegetative to flowering stage. Pod borer and weevil were found from flowering to pod maturity stage of soybean growing season. Based on the plant infestation rates, flea beetle (35.7%), jassid (34.4%), whitefly (27.5%), soybean looper (33.6%), and pod borer (36.9%) were classified as the major pests. Leaf miner (15.5%), leaf beetle (15.2%), epilachna beetle (15.8%), grasshopper (17.6%), aphid (11.8%), green stink (11.2%), hairy caterpillar (16.7%), leaf roller (17.0%), stem fly (19.5%), thrips (13.1%) and weevil (13.9%) were categorized as the minor pests (Table 2).

Approximately 57 insect species were reported earlier to infest soybean crops at various growth stages in Bangladesh. Among them, 6

Table 1. Insect pests prevailed in the soybean field during Rabi season, 2023 at Gazipur, Bangladesh

Common name	Scientific name	Family	Order
Leaf miner	*Liriomyza brassicae* (Riley, 1885)	Agromyzidae	Diptera
Stem fly	*Ophiomyia phaseoli* (Tryon, 1895)	Agromyzidae	Diptera
Flea beetle	*Phyllotreta striolata* (Fabricius, 1803)	Chrysomelidae	Coleoptera
Leaf beetle	*Cerotoma trifurcata* (Forster, 1771)	Chrysomelidae	Coleoptera
Epilachna beetle	*Epilachna dodecastigma* Mulsant, 1977	Coccinellidae	Coleoptera
Weevil	*Tanymecus indicus* (Faust, 1895)	Curculionidae	Coleoptera
Jassid	*Amrasca biguttula* (Ishida, 1912)	Cicadellidae	Hemiptera
Whitefly	*Bemisia tabaci* (Gennadius, 1889)	Aleyrodidae	Hemiptera
Green stink bug	*Nezara viridula* (Linnaeus, 1758)	Pentatomidae	Hemiptera
Aphid	*Aphis craccivora* (Koch, 1854)	Aphididae	Hemiptera
Hairy caterpillar	*Spilosoma obliqua* (Walker, 1855)	Arctiidae	Lepidoptera
Soybean looper	*Chrysodeixis includens* (Walker, 1858)	Noctuidae	Lepidoptera
Leaf roller	*Omiodes indicata* (Fabricius, 1775)	Pyralidae	Lepidoptera
Pod borer	*Helicoverpa armigera* (Hubner,1808)	Noctuidae	Lepidoptera
Grasshopper	*Atractomorpha crenulate* (Fabricius, 1793)	Acrididae	Orthoptera
Thrips	*Frankliniella schultzei* (Trybom, 1910)	Thripidae	Thysanoptera

species namely, hairy caterpillar, leaf roller, common cutworm, pod borer, stem fly, and white fly are considered as the major pests. About 15-20% of the total soybean production is lost directly or indirectly by the attack of insect pests every year (Biswas, 2008). Begum (1995) listed 9 species of insects in soybean, Das (1998) recorded two major pests namely, hairy caterpillar and stem fly in soybean field.

Seasonal abundance

Table 3 shows the relative seasonal abundance of insect pests in soybean (BU soybean-2). Among the insect pests leaf miner, leaf beetle, epilachna beetle, grasshopper and aphid were found from mid-February to mid-March, but remained absent during the rest of the cropping season In case of flea beetle, it was found from mid- February to early April.

Hairy caterpillar and leaf roller were found from early March to mid-March only. Jassid, white fly, green stink bug, stem fly and soybean looper were found during the month of March and stayed in the field up to the first week of April. Thrips was found from the mid-March to early April. Pod borer and weevil were found from mid-March to mid-April. The mean number of leaf miner, flea beetle, leaf beetle, epilachna beetle, grasshopper, aphid, jassid, whitefly, green stink bug, hairy caterpillar, leaf roller, stem fly, soybean looper, thrips,

Table 2. Prevalence and status of insect pests in soybean field during Rabi season, 2023

Common name	Stage of infestation	Initiation of infestation (DAS)	Rate of plant infestation (%)	Status
Leaf miner	Seedling to pre-flowering	7	15.5	Minor
Flea beetle	Seedling to pod formation	10	35.7	Major
Leaf beetle	Seedling to pod formation	10	15.2	Minor
Epilachna beetle	Vegetative to pod formation	10	15.8	Minor
Grasshopper	Vegetative to pod formation	12	17.6	Minor
Aphid	Seedling to flowering	15	11.8	Minor
Jassid	Vegetative to pod formation	20	34.4	Major
Whitefly	Vegetative to flowering	20	27.5	Major
Green stink bug	Seedling to flowering	25	11.2	Minor
Hairy caterpillar	Seedling to flowering	25	16.7	Minor
Leaf roller	Vegetative to flowering	30	17.0	Minor
Stem fly	Seedling to flowering	30	19.5	Minor
Soybean looper	Vegetative to pod formation	30	33.6	Major
Thrips	Vegetative to pre-flowering	35	13.1	Minor
Pod borer	Flowering to pod maturity	40	36.9	Major
Weevil	Flowering to pod maturity	45	13.9	Minor

*DAS= Days after Sowing

pod borer and weevil were 18.3, 11.6, 7.6, 9.1, 11.9, 10.7, 16.7, 9.9, 8.6, 16.1, 6.1, 10.0, 13.1, 16.9, 40.4 and 8.0 per plot, respectively in five observations during February to April.

The succession of appearances of the insect pests on soybean showed that the population of different pest species occurred in an overlapping manner and the crop was under the continuous attack of one or more pests. Most major and minor pests were detected between the vegetative and flowering stages (30–50 days after sowing), with the highest infestation levels occurring during the flowering and pod formation stages in both the study years. While the majority of insects identified during the study were classified as the minor pests, it is possible that any of these could become major pests under favorable environmental conditions or due to shifts in cropping patterns (Biswas, 2013).

Diversity indices

The abundance, richness and diversity of the insect pests of soybean in untreated control plot are presented in Table 4. The abundance of insect pests was the maximum (24.7±5.3) during the mid-March, followed by early April (16.9±4.2) and early March (4.3±4.1). The lowest abundance occurred in mid-February (4.7±1.5) at early growth stage, followed by mid-April (6.4±4.2). Pest species richness peaked in mid-March (2.5±0.1), with early

Table 3. Seasonal abundance of insect pests per plot in soybean field during Rabi season, 2023

Insect pests	Cropping season					
	15 February	01 March	15 March	01 April	15 April	Mean
Leaf miner	21.0	30.7	40.0	0.0	0.0	18.3
Flea beetle	8.33	17.0	26.0	6.7	0.0	11.6
Leaf beetle	5.8	11.5	21.0	0.0	0.0	7.6
Epilachna beetle	6.7	14.7	24.0	0.0	0.0	9.1
Grasshopper	11.0	20.0	28.3	0.0	0.0	11.9
Aphid	22.7	17	14	0.0	0.0	10.7
Jassid	0.0	18.3	26.7	38.3	0.0	16.7
Whitefly	0.0	11	15.5	23	0.0	9.9
Green stink bug	0.0	9.3	13.8	19.7	0.0	8.6
Hairy caterpillar	0.0	45	35.3	0.0	0.0	16.1
Leaf roller	0.0	11.3	19.3	0.0	0.0	6.1
Stem fly	0.0	9.0	16.0	25.0	0.0	10.0
Soybean looper	0.0	15.5	20.3	29.7	0.0	13.1
Thrips	0.0	0.0	34.3	50.6	0.0	16.9
Pod borer	0.0	0.0	54	65.3	82.7	40.4
Weevil	0.0	0.0	6.7	13.3	20.0	8.0

Table 4. Abundance, richness and diversity of insect pests in soybean field during Rabi season, 2023

Observation dates	Abundance	Richness	Diversity	Evenness
15 February	4.7±1.5c	1.1±0.0b	1.6±0.0b	0.58±0.1b
01 March	14.3±4.1b	2.2±0.0a	2.4±0.1a	0.87±0.2a
15 March	24.7±5.3a	2.5±0.1a	2.6±0.1a	0.94±0.2a
01 April	16.9±4.2b	1.4±0.0ab	2.0±0.0ab	0.72±0.1ab
15 April	6.4±4.7c	0.2±0.0c	0.4±0.0c	0.14±0.0c

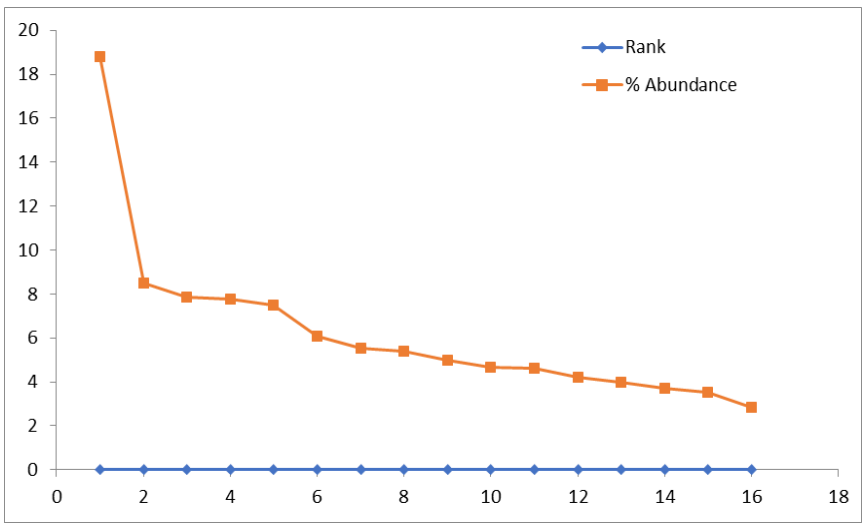

Fig. 1. Rank **and** abundance of the insect pests observed in the soybean field during *Rabi* season, 2023

March (2.2±0.0) showing the next highest value. The lowest richness of the insect pests was found at the beginning of growing season during the mid-April (0.2±0.0) followed by mid-February (1.1±0.0) and early April (1.4±0.0). The diversity of the insects was the maximum during mid-March (2.6±0.1) and early March (2.4±0.1), followed by early April (2.0±0.0), while the lowest diversity was found during the mid-April (0.4±0.0) followed by mid-February (1.6±0.0).

A study conducted by Tanzum *et al*. (2021) about the occurrence and diversity of mung bean insect pests in Gazipur of Bangladesh and reported the pest insects were most abundant in middle April when the plants were at seedling to pre-flowering. They also recorded the highest levels of species richness and diversity in early May.

Data expressed as mean ± SE. Means of the pests are taken from five observation dates.

Data expressed as mean ±SE. Means within a row followed by same letter(s) are not significantly different according to Tukey HSD posthoc statistic at < 0.05.

The rank abundance of the harbored arthropods showed that the major pest namely pod borer occupied the highest rank with 19.0% abundance. The other insect pests *viz*, leaf miner, thrips, jassid, hairy caterpillar, soybean looper, grasshopper and flea beetle showed 8.5, 8.0, 8.0, 7.8, 6.2, 5.8 and 5.8% abundances, respectively (Figure 1). Aphid, stem fly, whitefly, epilachna beetle, green stink bug, weevil, leaf beetle and leaf roller depicted 5.6, 5.5, 5.0, 5.0, 4.2, 4.0, 3.8 and 3.0% abundance individually.

According to Biswas *et al*. (2001), leaf roller (*Lamprosema indicata*) and hairy caterpillar (*Spilarctia obliqua*) were identified as the major soybean pests, infesting approximately 80% of plants and around 60% of leaves. However, in the present study, the infestation levels of these two pests were relatively lower.

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