Impact of Pollinator Insects Associated with Cucumber Fruit Set

Md. Ruhul Amin, S. Nahid¹, Sang Jae Suh²

ABSTRACT

Background: Cucumber is one of the popular vegetables of the cultivated cucurbits. Different insect species harbored with cucumber plant and they influence on its production, but little have been studied in Bangladesh. This study investigated the abundance of the insect species and the impact of insect pollinators on cucumber yield.

Methods: Investigation was conducted in summer and rainy seasons at Gazipur, Bangladesh. Insects were collected and categorized as pest, predator, pollinator and casual visitor. Occurrence of the insects at different hours of the day and impact of supplemented insect pollinators on fruit and seed set compared to natural and hand pollination were studied.

Result: In total thirty species of insects were found with cucumber plants and their relative abundances ranged from 0.4 to 13.7%. We found ten species of insects as pest, ten species as predator, four species as pollinator and six species as casual visitor. The red pumpkin beetle, epilachna beetle and fruit fly were found as the major pests. The red pumpkin beetle revealed the top ranks among the insects and the highest abundance of the insects occurred at 09:00 h of the day. Supplemented insect pollinators revealed higher yield, which indicated the significant for conserving insect pollinators.

Key words: Cucumis sativus, Pest, Predator, Pollinator, Yield.

INTRODUCTION

Cucumber Cucumis sativus L. is an important vegetable crop of the family Cucurbitaceae, which has 118 genera and 825 species (Khan et al., 2015). In Bangladesh, cucumber is widely cultivated throughout the year and the average yield is 7.5 t ha⁻¹ (BBS 2017), which is very low compared to other cucumber-growing countries of the world. The subtropical monsoon climate of Bangladesh is suitable for cultivation of various crops and favorable for population buildups of insect pests, predators and pollinators. Marina et al. (2018) studied entomofauna in a cucumber field in Côte d'Ivoire (Ivory Coast) and reported 46 species of insects, which were grouped into 29 families and 11 orders. Fomekong et al. (2008) reported 37 species of insects grouped into 36 families and 9 orders in cucumber field in Cameroon.

Cucumbers are being subjected to damage by a wide array of insect pests such as the pumpkin beetle, epilachna beetle, fruit fly, thrips, aphid, white fly, leaf roller, leaf miner and green semilooper (Barma and Jha, 2013). Among the destructive pests of cucumber, fruit fly and red pumpkin beetle infestation may cause 73.8% and 70% damage, respectively (Krishna et al., 2006; Khan et al., 2012). The predator insects play a critical role in the natural control of insect pests and most of them are coccinellids, chrysopids, syrphids and mantids (Satti and Bilal, 2012).

Cucumber flowers require pollination on the day of opening and the insects are their major group of pollinators. Supplemented honeybees Apis mellifera as pollinators increase fruit set, size, weight and the number of seeds per fruit of cucumber (Vidal et al. 2010). There is limited information on the abundance of the foraging insect pests, predators and pollinators of the cucumber fields in Bangladesh and little research has been conducted on the role of the pollinators. The objective of this study is to identify the insect species prevalent in cucumber fields, their categories of occurrence and to know the impact of insect pollinators on fruit set.

MATERIALS AND METHODS

Study area

The study was conducted in the field of the Department of Entomology, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh, from March to May and July to September of 2017. The study site has a subtropical climate with an annual mean maximum temperature of 36.0°C, a minimum temperature of 12.7°C, relative humidity of 65.8%, rainfall of 237.6 cm and has a dry season, rainy season and a short winter which exists from February to May, June to September and December and January, respectively (Rahman et al., 2018).

Cultivation of cucumber

Cucumber C. sativus seeds were purchased from a Gazipur local market and cultivated in an 8 × 8 m plot to observe the
abundance of the insects. In this plot, seeds were sown in 10 rows and each row contained 10 plants. To investigate the impact of pollinators on fruit set, cucumbers were cultivated in another nine plots each of 80 × 80 cm. Each plot contained five plants. Fertilizers were applied according to the fertilizer recommendation guide (FRG 2012) (N: 70 kg ha⁻¹, P: 22 kg ha⁻¹, K: 100 kg ha⁻¹). Both of the experiments were conducted two times and seeds were sown on March 3 and June 2, 2017. Intercultural operations were done whenever necessary. At the onset of flowering, 80 cm × 80 cm experimental plots were categorized into three types and each type had three plots. The types were (i) open plot (natural pollination), (ii) enclosed plot (covered with white mosquito net) having five supplemented insect pollinators (honey bee: carpenter bee: sulphur butter fly = 2:1:2) per week and (iii) hand pollination (covered with white mosquito net).

Collection and categorization of harbored insects
To identify and quantify the abundance of the insects, a collection was conducted from the 8.0 × 8.0 m plot during the blooming stage of the plants using a sweep net. Sweeping was done at one day intervals at 07:00, 09:00, 11:00 and 13:00 h of the day and each sample consisted of 30 sweeps. The total number of collections in the summer and rainy seasons were 4 days and 3 days, respectively. The collected insects were kept in polythene bags and brought to the Entomology Laboratory for identification, counting and categorization. Insects were categorized as pest, predator, pollinator, or casual visitor group (not detected) on the basis of their behavior and feeding.

Impact of insect pollinators
Newly emerged fruits in each of the 80 cm × 80 cm experimental plots were tagged and the number of fruits plant⁻¹ was counted. Fruits were harvested at the ripening stage and were weighed using a balance. To calculate yields, the amount of fruit plot⁻¹ was converted into t ha⁻¹. To count the number of seed fruit⁻¹, five harvested fruits from each pollination condition were cut into pieces.

Data analysis
We used Whittaker abundance-rank curve to compare the abundances of the insect species and to compare the abundances of the categories of pest, predator, pollinator and casual visitor insects. A one-way analysis of variance (ANOVA) followed by a Tukey HSD post hoc test was used for analyzing the hourly distribution of insects and the number of fruit plant⁻¹, number of seed fruit⁻¹ and yield ha⁻¹ among the pollination conditions. All the analyses were performed using IBM SPSS 19.0.

RESULTS AND DISCUSSION
Cucumber plants harbored a total of thirty species of insects which belonged to twenty families in ten orders and their relative abundances ranged from 0.4 to 13.7% (Table 1). In total ten species of insects were found harmful to cucumber plants of which three species were categorized as major pest. The major pests were red pumpkin beetle Aulacophora foveicola, epilachna beetle Epilachna duodecastigma and fruit fly Bactrocera cucurbitae. The red pumpkin beetle A. foveicola occupied the top rank among the associated insect species (Fig 1). We observed ten species of insects as predator, four species as pollinator and six species as casual visitor (Table 1). The lady bird beetle Coccinella septempunctata, honey bee Apis sp. and ant Camponotus compressus revealed the top ranks among the insect species of the predator, pollinator and casual visitor categories, respectively (Fig 2). The findings showed that the pest and predator categories of insects revealed higher number of species compared to the other two categories. Amin et al. (2015) studied the abundance, richness and diversity of pest, predator, pollinator and other categories of insects in an agroforestry system in Bangladesh and found significant variations among them.

In our study, the abundance of the red pumpkin beetle depicted the top rank among the harbored insect species of cucumber, which confirmed the findings of Nancy et al. (2018), who reported the highest abundance of red pumpkin beetle in a sweet gourd field of Bangladesh. Cucurbits are favorable hosts of red pumpkin beetle and the crops are cultivated round the year in Bangladesh, which is why the pest continues its reproduction and attains the highest abundance in a subtropical climate. We observed the top rank of the abundance of ant C. compressus in the casual visitor category, which concurred with the findings of Nancy et al. (2019).

The abundance of insects in the cucumber field at different hours of the day in the summer and rainy seasons varied from 5.5±0.9 to 17.1±0.9 and 4.7±0.7 to 9.4±0.8, respectively, which differed significantly (Fig 3; summer: 𝐹₁,₂₄ = 41.7, 𝑃 < 0.001; rainy: 𝐹₂,₂₄ = 9.3, 𝑃 < 0.001). Insects showed the highest and lowest abundances at 09:00 and 13:00 h of the day, respectively. The highest abundance of insects was found at 09:00 h of the day when the plants had bloomed, thus pollinator insects were attracted and foraged in the field Ahmad and Aslam (2002) studied the foraging behavior of some Hymenoptera, Diptera, Coleoptera and Lepidoptera pollinators on blooming carrot and found peak foraging from 8:00 to 9:00. Amin et al. (2015) observed higher abundances of insects during the flowering season of mango and it was observed to peak at 11:00. Our findings contrast with Amin et al. (2015) because the crops were different. Dorjay et al. (2017) found that cucumber flowers attracted 21 species of insects and honey bee was the most abundant, which showed peak foraging at 09:00-10:00 h of the day.

The number of fruits setting in the summer and rainy seasons among the pollination conditions ranged from 4.7±0.2 to 5.8±0.1 and 4.2±0.2 to 5.3±0.2 plant⁻¹, respectively, which differed significantly (Fig 4; summer: 𝐹₁,₂₄ = 10.4, 𝑃 < 0.001; rainy: 𝐹₂,₇₂ = 10.4, 𝑃 < 0.001). The number of seeds produced among the pollination conditions ranged
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Table 1: Encountered insect species, their relative abundance and harbored categories on cucumber plant at Gazipur in Bangladesh.

| Insect species                  | Relative abundance (%) | Harbored category |
|---------------------------------|------------------------|-------------------|
| Red pumpkin beetle *Aulacophora foveicollis* (Coleoptera : Chrysomelidae) | 13.7 | + + + + + |
| Epilachna beetle *Epilachna duodecastigma* (Coleoptera : Coccinellidae) | 8.5 | + + + + + |
| Fruit fly *Bactrocera cucurbitae* (Diptera : Tephritidae) | 5.6 | + + + + + |
| Thrips *Scirtothrips dorsalis* (Thysanoptera : Thripidae) | 1.7 | + + + + + |
| Whitefly *Bemisia tabaci* (Hemiptera : Aleyrodidae) | 1.3 | + + + + + |
| Squash bug *Anasa tristis* (Hemiptera : Coriedae) | 3.0 | + + + + + |
| Aphid *Aphis gossypii* (Hemiptera : Aphididae) | 5.6 | + + + + + |
| Jassid *Amrasca biguttula* (Hemiptera : Cicadellidae) | 3.4 | + + + + + |
| Green sting bug *Nezara viridula* (Hemiptera : Pentatomiidae) | 1.7 | + + + + + |
| Stripped cucumber beetle *Acalymma vittatum* (Coleoptera : Chrysomelidae) | 1.7 | + + + + + |
| Preying mantid *Mantis religiosa* (Dictyoptera : Mantidae) | 2.6 | + + + + |
| Dragon fly *Orthetrum glaucum* (Odonata : Libellulidae) | 3.4 | + + + + |
| Damselfly *Coenagrion resolutum* (Odonata : Coenagrionidae) | 2.1 | + + + + |
| Pirate bug *Orius sp*. (Hemiptera : Anthocoridae) | 1.3 | + + + + |
| Tiger beetle *Cicindela sp.* (Coleoptera : Cicindellidae) | 2.1 | + + + + |
| Lady bird beetle *Coccinella septempunctata* (Coleoptera : Coccinellidae) | 7.7 | + + + |
| Robber fly *Zosteria sp.* (Diptera : Asilidae) | 0.9 | + + + |
| Hover fly *Eristalis sp.* (Diptera : Syrphidae) | 0.4 | + + + |
| Syrphid fly *Eristalis sp.* (Diptera : Syrphidae) | 0.9 | + + + |
| Green lace wing *Chrysoperla carnea* (Neuroptera : Chrysopidae) | 0.9 | + + + |
| Swallow tail butterfly *Papilio demoleus* (Lepidoptera : Papilionidae) | 1.7 | + + + |
| Sulphur butterfly *Phoebis sennae* (Lepidoptera : Pieridae) | 3.8 | + + + |
| Honey bee *Apis sp.* (Hymenoptera : Apidae) | 5.1 | + + + |
| Carpenter bees *Xylocopa violacea* (Hymenoptera : Apidae) | 2.1 | + + + |
| Grasshopper *Hieroglyphus banian* (Orthoptera : Acrididae) | 1.3 | + + + |
| Rice bug *Leptocorisa acuta* (Hemiptera : Coriedae) | 1.7 | + + + |
| Flea beetle *Phyllotreta cruciferae* (Coleoptera : Chrysomelidae) | 2.1 | + + + |
| Cabbage butterfly *Pieris brassicae* (Lepidoptera : Pieridae) | 1.7 | + + + |
| Ant *Camponotus compressus* (Hymenoptera : Formicidae) | 9.0 | + + + |
| House fly *Musca domestica* (Diptera : Muscidae) | 3.0 | + + + |

Major pest: +++++, Minor pest: +++, Predator: ++, Pollinator: +, Casual visitor: +.

Fig 1: Rank abundance curve of the encountered insect species associated with cucumber plant.

Fig 2: Comparison of the abundance of pest, predator, pollinator and casual visitor insect species associated with cucumber plant.
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seasons. Gemmill-Herren and Ochieng, (2008) reported that many horticultural crops are dependent on animal pollinators and without pollinator fruit and seed set, yields reduced. Hossain et al. (2018) reported a significantly lower number of healthy fruits, seed fruit¹ and fruits being a smaller size and weight without honeybee pollination in cucumber.

![Graph](image)

Fig 3: Distribution of insect counts (mean ± SE) on fruiting cucumbers during the summer and rainy seasons of 2017. Bars with common letter(s) are not significantly different according to Tukey HSD posthoc statistics at P < 0.05.

![Graph](image)

Fig 4: Effects of different types of pollination on fruit set of cucumber. Data are expressed as mean ± SE number plant⁻¹. Bars with common letter(s) are not significantly different according to Tukey HSD posthoc statistics at p < 0.05.

![Graph](image)

Fig 5: Effect of different types of pollination on the seed set of cucumber. Data are expressed as mean ± SE seed fruit⁻¹. Bars with common letter(s) are not significantly different according to Tukey HSD posthoc statistics at p < 0.05.

Cucumber plants produced the highest number of fruits and seeds, as well as the highest yields under supplemented insect pollination conditions because the flowers were pollinated during the fully functional phase of the generative organs. On the contrary, some flowers may not have been pollinated or injured under hand pollination conditions. In open pollination conditions, plants produced a significantly lower number of fruits and seeds because of the infestation of red pumpkin beetle and fruit fly. The most preferable foraging time of the pollinator insects in the cucumber field was at 9:00 h of the day and they contributed to producing higher yields and seeds in cucumber. Therefore, insect pest management in cucumber fields should not be applied in the morning and public awareness should be created for the conservation of native insect pollinators.

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