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NATIVE INSECT POLLINATORS AND THEIR EFFECT ON SWEET GOURD PRODUCTION

N. P. Nancy[1], M. R. Amin[1*], M. R. U. Miah[1] and M. G. Miah[2]

Abstract

The study was conducted in the field laboratory of the Department of Entomology, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh during September 2016 to June 2017 to know the insect pollinators of sweet gourd, their behavior and their role on sweet gourd yield and seed quality. The study showed that ten species of insects belong to seven families in three orders (Lepidoptera, Diptera and Hymenoptera) were found as pollinator. The abundance of the pollinator species ranged from 0.1±0.1 to 2.2±0.3 per 30 sweeps. The cabbage butter fly and ant showed statistically similar and higher abundance compared to other insect pollinators. The foraging durations of the frequently abundant pollinators ranged from 16.8 ± 2.2 to 36.6 ± 4.4 S per flower and ant spent the longest duration. Insect pollination showed the highest number of fruit plant^{-1}, yield ha^{-1} and seed fruit^{-1} both in winter and summer season compared to natural and hand pollination. Production of fruit, seed set and yield of insect pollinating plot in winter and summer seasons were 6.4 ± 0.3 and 4.8 ± 0.2 plant^{-1}, 84.8 ± 2.7 and 62.6 ± 1.0 fruit^{-1}, and 18.5 ± 0.8 and 16.7 ± 0.7 t ha^{-1}, respectively. The findings indicated that the native insect pollinators increased the production of fruit, seed and yield of sweet gourd. Conserving and enhancing native insect pollinators may boost sweet gourd production in Bangladesh.

Keywords: *Cucurbita moschata,* pollinator species, abundance, seed quality, fruit yield.

Introduction

Sweet gourd (*Cucurbita moschata* Duch.) is also called pumpkin, which belongs to the family Cucurbitaceae. The Cucurbitaceae is a fairly large family containing about 100 genera and 800 species, which are distributed in tropical and subtropical regions (Rahman, 2013). Sweet gourd is one of the most important and popular vegetables in Bangladesh. It grows all over the country throughout the year. The total cultivation area and average yield of sweet gourd in Bangladesh is 28.3 thousand ha and 9.8 t ha^{-1}, respectively (BBS, 2016). The production areas in summer and winter in Bangladesh are 11.1 and 17.2 thousand ha and the respective yields are 100.5 and 177.9 thousand tons (BBS, 2016).

Sweet gourd attracts a wide array of insect visitors due to its large, monoecious and showy flowers that open before sunrise and wilt or close by early afternoon. The insect visitors in sweet gourd field may be categorized as pest, predator and pollinator. The high incidence of insect pests reduces yield and fruit quality of the crops. On the contrary, insects act as the key driver in the maintenance of biodiversity

[1]Department of Entomology, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur 1706, [2]Department of Agroforestry and Environment, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh.
*Corresponding author: mramin.bsmrau@gmail.com

and ecosystem, and help in transferring pollen. Delaplane and Mayer (2000) reported that cucurbit vegetables require pollinatorsto transfer pollen from staminate to pistillate of the flowers.

Insects pollinate about 80% of flowering plants and assisted pollination is necessary when natural pollination is insufficient (Klein *et al.,* 2007). Honey bees are important pollinators of sweet gourd (Vidal *et al*., 2010). Walters and Taylor (2006) reported increased fruit set, fruit size and weight, and higher number of seeds fruit^{-1} in pumpkin in the presence of managed honey bee *Apis mellifera* pollination.

Despite information on the beneficial effects of pollinating insects on crops, pest management is running through indiscriminate use of insecticides. That is why the abundance and diversity of pollinating insects are declining day by day. On the contrary, continuous breeding process resulting in an ever-increasing number of new cultivars which are successively implemented in cultivation practices. The currently grown cultivar necessitates sufficient pollination for optimizing yield. Therefore, it is necessary to identify and conserve native pollinating insects to achieve higher yield. The objective of this study was to identify the insects involved in pollination of sweet gourd and to know their behavior and role on fruit and seed set.

Materials and Methods

The study was conducted in the field laboratory of the Department of Entomology, Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur, Bangladesh during September 2016 to February 2017 and March 2017 to June 2017 which were considered as winter and summer seasons, respectively. The study site is located at 25°25′ North latitude and 89°5′ East longitude, which is in the middle of Bangladesh. The study area has a sub-tropical climate having annual mean maximum and minimum temperatures, relative humidity and rainfall were 36.0 and 12.7 ^{o}C, 65.8% and 237.6 cm, respectively (Amin *et al*., 2015).

Experimental design and cultivation of sweet gourd

The sweet gourd plants were cultivated in 3.0 × 3.0 m plots following randomized block design with three replications for each treatment. Each plot contained 5 rows and each row had 5 pits apart from 60 cm. The spacing between plot to plot was 1.0 m. Fertilizers were applied according to Fertilizer Recommendation Guide (FRG, 2012) (N- 120 kg, P- 70 kg, K- 40 kg, S- 20 kg per hectare). The subsequent two sowing dates in winter and summer were 02 November 2016 and 15 March 2017, respectively and in each season, sweet gourd was cultivated in four plots. After emergence of seedlings the plants were supported by bamboo scaffold to facilitate creeping. The plots were separated by cultivation of maize. Among the four plots, three were considered for observation of the effect of native pollinators on fruit set and another one was used for collection and identification of pollinating insects.

Effect of pollinators on fruit set

To determine the effect of wind and insect pollinators on fruit set, three types of treatments were adopted on the experimental plots. The adopted treatments were (i) open plot (wind and native insect pollination), (ii) enclosed plot (covered with mosquito net) having 20-25 supplemented native insect pollinators (black ant, honeybee and house fly) per week, and (iii) hand pollination (covered with mosquito net). The number of flower was counted in each plot for making comparison among the treatments and to quantify fruit set.

Collection, identification and determination of abundance of insect pollinators

Free-living insects were collected from the open plot during blooming stage. Insect collection was done by using a 30 cm diameter sweep net having 1.5 mm mesh and attached with a 2 m long rod. Every week sweeping was done in between 09:00 to 11:00 h of the day, and each sample was consisted of 30 sweeps. The collected insects were brought to the Entomology Laboratory for identification and counting. They were killed by storage in a freezer for a few hours, mounted on points, dried and morphotyped. Insects were identified to genus or species level following morphological characters and compared to the museum specimens. On the basis of the collection dates, the pollinator species were separated and their abundance (number 30 sweeps^{-1}) was recorded.

Observation of foraging duration of insect pollinators

The foraging duration (length of time of foraging on a flower) of the pollinator insects were observed during full blooming stage. Foraging durations of the pollinator insects on flowers were measured using a stop watch.

Data analysis

Data were analyzed by one way analysis of variance (ANOVA) and the mean values were separated by Tukey posthoc test. All the analyses were performed using IBM SPSS 19.0.

Results and Discussion

In total 409 insects were collected of which 130 were in winter and 279 were in summer. Of the total collected insects, ten species belong to 7 families of 3 orders (Lepidoptera, Diptera and Hymenoptera) were found as pollinators (Table 1). The abundance of the pollinator species ranged from 0.1±0.1 to 2.2±0.3 per 30 sweeps and the results differed significantly ($F_{8, 180}$ =17.2, $p < 0.001$) (Table 1). Among the insect pollinators, cabbage butter fly and ant showed statistically similar and higher abundance compared to others. Figure 1 showed that the visiting durations of the frequently abundant pollinators ranged from 16.8 ± 2.2 to 36.6 ± 4.4 S flower^{-1} and the results differed significantly ($F_{6, 42}$= 7.3, $P < 0.001$). Ant spent significantly longer duration compared to other insects.

The insect pollinator species differed in their foraging duration on different crop flowers and their activity led to higher levels of fruit set. The present study showed that the duration of flower visitation by different insect pollinator species varied significantly and the ant foraged the longest duration. It indicated that the other pollinator insect species are rapid flier. Saeed *et al.* (2008) reported that the syrphid flies were rapid visitors of loquat flowers. Amin *et al*. (2015) studied the foraging duration of different pollinator insects and reported that horse fly and sulphur butterfly spent longest duration on mango flower.

The effect of natural pollination, supplemented insect pollination and hand pollination on

Table 1. Insect pollinator along with their abundance in sweet gourd field during November 2016 to February 2017 and March to June 2017

Pollinator	Taxonomic profile	Abundance
Honey bee	*Apismellifera* (Hymenoptera:Apidae)	0.8±0.2 bc
Wasp	*Vespa vulgaris* (Hymenoptera:Vespidae)	0.6±0.3 bc
Sulphur butterfly	*Coliaseurytheme* (Lepidoptera:Pieridae)	0.6±0.2 bc
Ant	*Formica rubra* (Hymenoptera: Formicidae)	2.2±0.3 a
	Camponotuscompressus(Hymenoptera: Formicidae)	-
Cabbage butterfly	*Pierisrapae* (Lepidoptera: Pieridae)	2.2±0.3 a
Carpenter bee	*Xylocopapubescens* (Hymenoptera: Apidae)	0.2±0.1 c
Blow fly	*Calliphoraerythrocephala*(Diptera: Calliphoridae)	0.1±0.1 c
Syrphid fly	*Syrphid*sp. (Diptera : Syrphidae)	0.1±0.1 c
House fly	*Musca domestica* (Diptera: Muscidae)	1.2±0.2 b

Data expressed as mean ± SE. Mean of each insect was taken from 30 sweeps per total collection. Means in the column followed by same letter(s) are not significantly different by Tukey posthoc statistic at < 0.05.

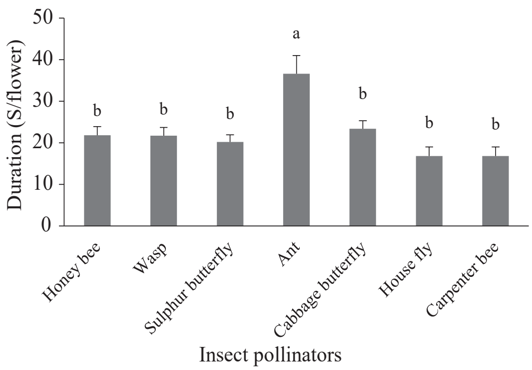

Fig. 1. Foraging duration (mean ± SE second) of different insect pollinators associated with sweet gourd flowers. Bars with common letter(s) are not significantly different by Tukey posthoc statistic at *P < 0.05*.

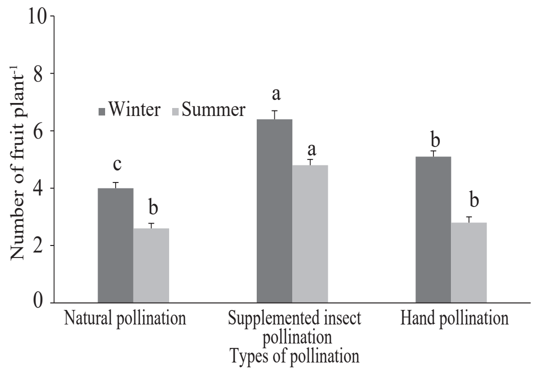

Fig. 2. Effect of different types of pollination on fruit set of sweet gourd. Data expressed as mean ± SE. Bars with common letter(s) are not significantly different by Tukey posthoc statistic at *P < 0.05*.

fruit set is presented in fig. 2. The fruit set in the supplemented insect pollination was significantly higher both in winter ($F_{2,\ 51}$= 25.7, $p<0.001$) and summer ($F_{2,\ 51}$= 44.8, $p <0.001$) seasons compared to natural and hand pollination. Fruit sets in supplemented insect pollination in winter and summer seasons were 6.4 ± 0.3 and 4.8 ± 0.2 plant^{-1}. Fruit set was found lowest in natural pollination both in winter and summer and the results were 4.0±0.2 and 2.6± 0.1 plant^{-1}, respectively.

Occurrence of different insect species in significant numbers in the field could influence on the productivity of the crop. The present study revealed that the percentage of fruit set in supplemented insect pollination was significantly higher than natural and hand pollination which indicated that supplemented insect pollination played an effective role on fruit set. Stanghellini *et al.* (1997) reported that the increased number of bee visit resulted higher fruit set in cucumber and water melon.

In the present study, significant differences were observed in the effect of natural pollination, supplemented insect pollination and hand pollination on seed set of sweet gourd both in winter and summer seasons Figure 3; winter: $F_{2,\ 12} = 62.4$, <0.001; summer: $F_{2,\ 12} = 125.4$, <0.001). The seed set in supplemented insect pollination was significantly higher both in winter and summer seasons compared to natural and hand pollination. Seed set in supplemented insect pollination in winter and summer seasons were 84.4 ± 2.7 and 62.6 ± 1.0 fruit^{-1}, respectively. Seed set was found lowest in natural pollination both in winter and summer seasons and the results were 38.8±3.9 and 30.4±2.1 seeds fruit^{-1}, respectively.

Figure 4 showed the effect of natural pollination, supplemented insect pollination

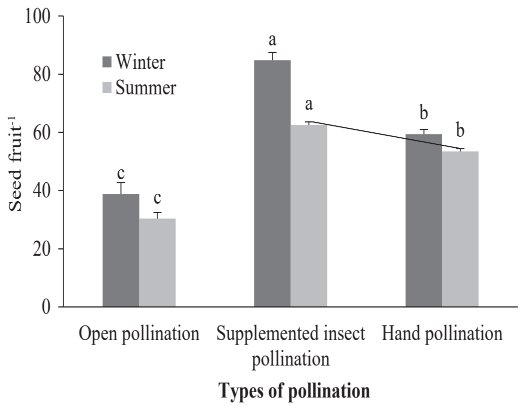

Fig. 3. **Effect of different types of pollination on seed set of sweet gourd. Data expressed as mean ± SE. Bars with common letter(s) are not significantly different by Tukey posthoc statistic at *P < 0.05.***

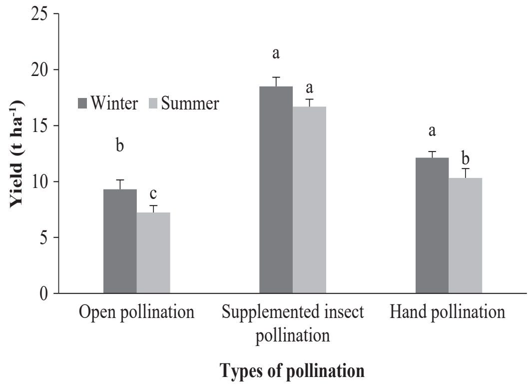

Fig. 4. Effect of different types of pollination on yield of sweet gourd. Data expressed as mean ± SE. Bars with common letter(s) are not significantly different by Tukey posthoc statistic at *P < 0.05.*

and hand pollination on the yield of sweet gourd. The yield obtained in the winter and summer seasons ranged from 9.3 ± 0.8 to 18.5 ± 0.8 and 7.2 ± 0.6 to 16.7 ± 0.7 t ha^{-1}, respectively and the results differed significantly (Fig. 4; winter: $F_{2,\ 28} = 34.5$, $p < 0.001$; summer: $F_{2,\ 22} = 41.5$, $p<0.001$). Among the conditions, supplemented insect pollination provided the highest yield both in winter and summer seasons (18.5 ± 0.8 and 16.7 ± 0.7 tha^{-1}, respectively). This finding was in agreement with the report of Delaplane and Mayer (2000) who indicated that the number of pollen grains deposited on the stigma by pollinators is directly related to seed formation, which determines fruit size and yield.

The present study showed that sweet gourd cultivated in open condition provided lowest yield and lowest number of seed fruit^{-1}. In this condition, flowers get opportunity for pollination by insects but the plants suffer from the attack of fruit fly, red pumpkin beetle and epilachna beetle. In hand pollination, fruit set may be sufferedfrom insufficient amount of pollen deposited on the stigma thus provided lower number of seed fruit^{-1}, smaller fruit and lower fruit weight. The present findings indicated that the supplemented insect pollination increased the number of fruit plant^{-1}, seed fruit^{-1} and yield ha^{-1} of sweet gourd. Conserving and enhancing native insect pollinators may boost sweet gourd and other cucurbit production.

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