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EFFECT OF DIFFERENT BENEFICIAL INSECT POLLINATORS ON FRUIT SETTING OF LITCHI

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Abstract

An experiment was carried out at the BAU Germplasm Centre (GPC), Bangladesh Agricultural University, Mymensingh during February to May, 2021 to study the effect of beneficial insects on litchi flower pollination and fruit setting. The experiment was laid out in a Randomized Complete Block Design with three replications of four litchi varieties viz. Mongolbari, China-3, Bombai, Mozzafforpuri. In each replication same number of blooming flower was considered for the study. The data were recorded on the number of flower per inflorescence, beneficial insects per inflorescence, fruit set per inflorescence and fruit dropping record. It was found that most of the beneficial insects were hymenopteran and dipteran insects which covered 89 percent of total beneficial insects. Honey bee and syrphid fly were found as better pollinator. In this experiment maximum number of fruit set per inflorescence was found in the Bombai variety, where the highest number of beneficial insects (2.49) was found. On the other hand, lowest number of beneficial insects (1.37) and lowest fruit set was found in China-3 variety (6.33) where harmful insects were higher (1.72). After pollination when fruit set was at marble stage, number of fruit set and fruit dropping per inflorescence were recorded. So, it can be concluded that beneficial insect pollinators play a direct role in litchi flower pollination and fruit set. It could be concluded that timely establishment of colonies in sufficient number and conservation of the pollinators in litchi orchard is essential to ensure better pollination and fruit set of litchi.

Key Words: Pollinators, Insect Abundance, Insect Foraging Behavior, Fruit Setting.

Introduction

Litchi (*Litchi chinensis* Sonn.) is an important subtropical evergreen fruit crop belongs to family Sapindeace. It is known as queen of the fruit due to its attractive deep pink/red color and flavored juicy aril (Singh *et al*., 2012). Pollination of crops by insects is an essential feature for the agriculture. Litchi is a cross pollinated plant and its flower requires sufficient pollinating agents for pollination and fruit set. Nectar and pollen presence in huge amount in the self-sterile flowers attracts various insects. It is estimated that one-third of the total human food supply relies on insect pollination (Said *et al*., 2015). It was observed two hundred female flowers to determine the mode of pollination in litchi (Chaturvedi, 1965). During flowering, installation of honey bee boxes in litchi orchard increases the yield up to 30-40 per cent. Flowering in litchi occurs during the month of

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March-April, which attracts and invites a number of insects for pollination (Rai *et al*., 2017). Pollination of entomophilous crops by honeybees is regarded as one of the effective and cheapest methods for improving the qualitative and quantitative yield of crops (King *et al*., 1989). Litchi flowers are visited by varieties of insects including, Hymenopteran, Dipteran, Coleopteran, Hemipteran, Homopteran and Lepidopteran insect orders (Ali *et al*., 2013). Most common insect pollinators are the honeybees *Apis cerana* F., *Apis dorsata* F., *Apis mellifera* L. and *Apis florea* F., and the syrphi flies. *Apis dorsata* Fab., *Apis mellifera* L. and *Apis cerana* indica are the most important and efficient pollinators of litchi (Abrol *et al.,* 1998). It was observed that oilseed plants caged with bees produced 25 percent more fruits than plants caged without bees (Free *et al.,* 1968). Singh *et al.,* (2012) reported that anthesis of litchi flowers occurred both during day and night, with peak opening in the early morning (6.00 hr.) and dehiscence began about one day after floral anthesis and continued upto three days. *Apis* sp. and *Mellipona* sp. comprised 98-99% of the total insect visitors to the litchi flowers (Pandey *et al.,* 1970). Most visits were made during morning hours between 6:30 to 11 am. This indicates synchronization with foraging rate and time of honey bees. Owing to the increasing population, research works related to the reduction of fruit setting problem of available litchi varieties of Bangladesh are unnoticeable despite its great importance. So, the study was conducted to study the behaviour of different beneficial insects on litchi inflorescence and the different varietal response on fruit setting due to beneficial insects.

Materials and Methods

The present experiment was conducted at the 'BAU Germplasm Centre' (GPC) of Fruit Tree Improvement Program (FTIP), Bangladesh Agricultural University (BAU), Mymensingh during the period from February to May 2021. About ten to twelve years old twelve indigenous, exotic and hybrid litchi plants were selected for the study. Four germplasms of litchi viz. Mongolbari, China-3, Bombai, Mozzafforpuri were considered as the experimental treatment. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Here replication number is represented by number of plants observed per variety. In the study each replication with four litchi varieties, nine litchi inflorescences per plant were selected randomly and after pollination initial number of litchi fruits at marble stage were counted. In each tree, number of beneficial insects per inflorescence were recorder approximately 3 minutes observing during the blooming period. The insect pollinators visiting the litchi flowers were identified by visual inspection and collected with the help of tools of Entomology Laboratory, BAU. The number of insect pollinators visiting the flowers were studied on four litchi variety during morning to afternoon (9 am to 5 pm) hour at one day interval. The following parameters were studied.
Beneficial insects: different types of beneficial insects were collected, identified and recorded per inflorescence of randomly selected five inflorescence per plant during blooming period at different day times (morning, noon, afternoon). Fruit setting: number of fruit setting per inflorescence were calculated. Fruit dropping: number of fruits dropping

due to harmful insects, bird damage, unfavourable climatic condition per inflorescence of tested varieties were calculated. Fruit number: number of undamaged fruits per inflorescence were counted.

The data obtained during experiments were statistically analysed by using MSTAT software in a computer. The means of different parameters were separated by Duncan's Multiple Range Test (DMRT).

Results and Discussion

The insect pollinators visiting the litchi flowers were identified and listed in Table 1 along with their systematic position.

Table 1. Number of insect pollinators per inflorescence of litchi

Insect Visitors	Order	Family	Pollinators/ inflorescence (no.)	Percent value (%)
Honey bee *(Apis melifera)*	Hymenoptera	Aphididae	5	25
Syrphid fly *(Episyrphus balteatus)*	Diptera	Syrphidae	3	16
Blue bottle fly *(Calliphora vomitoria)*	Diptera	Calliphoridae	3	16
House fly *(Musca domestica)*	Diptera	Muscidae	2	11
Horse fly *(Tabanus sp)*	Diptera	Tabanidae	1	5
Wasp *(Vespula germanica)*	Hymenoptera	Vespidae	2	11
Bumble bee *(Bombus pensylvanicus)*	Hymenoptera	Apidae	1	5
Butterfly *(Danaus plexippus)*	Nymphalidae	Lepidoptera	2	11

From the above Table 1, it was found that most of the beneficial insects visited were as pollinator from hymenopteran and dipteran insects. Honey bee, syrphid fly and blue bottle fly had higher abundance in litchi inflorescence.

Foraging behavior of different beneficial insects at different day times are shown in Table 2. During observation, seven families of different insect species were recorded in the blooming period of litchi inflorescence in three heads viz. Morning, Noon, Afternoon from 9 am to 5 pm. It is evident that more insect visitors were in morning than noon or afternoon.

In case of morning, honey bee was the most dominant insect visitors found in Bombai (8.62), Mongolbari (5.9), China-3 (4.37) and Mozafforpuri (4.11) variety. The second dominant insect visitors was remained in between blue fly and syrphid fly (Photo-1) where bule fly was dominant in Bombai (3.87) and China-3 (2.87) but syrphid fly was dominant in Mongolbari (2.91) and Mozaffarpuri (2.45) litchi variety which are statistically significant at 1% level of significance to the dominant insect species honey bee. The lowest magnitude of insect visitors were wasp (0.62) in mongolbari and bumble bee (0.49) in China-3 (Photo-1) variety during morning. During noon, horse fly (0.87) and house fly (0.41) were the dominant insect visitors found in Bombai (Photo-1) which were not statistically significant. In case of honey bee the highest number was present in Bombai (0.20) and the lowest in China-3 (0.12). The lowest magnitude of insect visitors was bumble bee (0.04) in China-3 variety at noon.

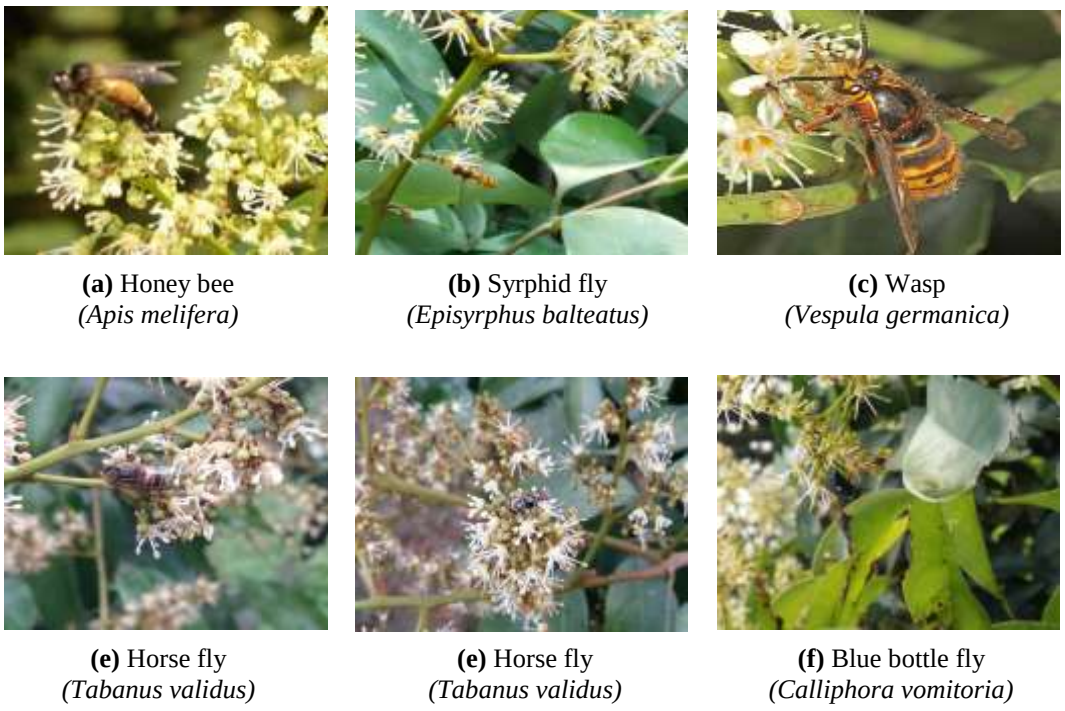
Table 2. Beneficial insect pollinators foraging behavior on litchi varieties at different day times

Insects	Morning				Noon				Afternoon			
	Bombai	Mongolbari	China-3	Mozaffarpuri	Bombai	Mongolbari	China-3	Mozaffarpuri	Bombai	Mongolbari	China-3	Mozaffarpuri
Honey Bee	8.62a	5.9a	4.37a	4.41a	0.20b	0.16b	0.12bc	0.16b	0.33bc	0.20abc	0.16ab	0.25ab
Blue fly	3.87b	2.58b	2.87b	2.37b	0.20b	0.08b	0.08bc	0.16b	0.20cd	0.37a	0.08b	0.12b
Syrphid fly	3.37b	2.91b	2.25c	2.45b	0.12b	0.08b	0.08bc	0.12b	0.16cd	0.12bc	0.08b	0.20ab
House fly	1.62cd	1.04cd	0.83d	1.04c	0.41ab	0.20ab	0.20ab	0.37a	0.58a	0.20abc	0.25a	0.25ab
Wasp	1.00d	0.62d	0.54de	0.54c	0.37b	0.16b	0.12bc	0.20ab	0.29cd	0.25ab	0.08b	0.25ab
Horse fly	2.16c	1.50c	0.66de	1.04c	0.87a	0.33a	0.29a	0.37a	0.50ab	0.16bc	0.29a	0.33a
Bumble bee	1.18d	0.78cd	0.49e	0.70c	0.12b	0.08b	0.04c	0.08b	0.12d	0.04c	0.04b	0.08b
$LSD_{(0.05)}$	0.82	0.76	0.33	0.51	0.47	0.16	0.16	0.18	0.17	0.18	0.14	0.18
SE(±)	0.37	0.34	0.15	0.23	0.21	0.07	0.07	0.09	0.8	0.08	0.06	0.08
Level of significance	**	**	**	**	**	**	**	**	**	**	**	**
CV(%)	14.83	19.51	11.00	16.12	8.11	7.97	9.08	9.57	13.67	14.08	8.85	9.30

In a column, means of similar letter (s) do not differ significantly.
** = Significant at 1% level, CV = Co-efficient of Variation

In afternoon, house fly was the most dominant insect visitors found in Bombai (0.58) and blue fly in Mongolbari (0.37) varieties. The dominant insect visitor was house fly (0.58) and the lowest was bumble bee (0.12) in Bombai variety (Photo-1) which were statistically significant at 1% level of significance to the insect visitors in Bombai. The dominant insect visitors was blue fly (0.37) and the lowest was bumble bee (0.04) in Mongolbari variety (Photo-1) which were statistically significant at 1% level of significance. The lowest magnitude of insect visitor was bumble bee (0.04) in China-3 variety at afternoon.

The above observations in different day times shows that the foraging activity of honey bee started nearly 8.00 am - 9.00 am in the morning (8.62) then gradually declined towards the succeeding time of the day and less activity was found after 5.00 pm (0.16). In terms of blue fly, syrphid fly, house fly, horse fly their foraging activities were more in morning but during noon their activities were less and in the afternoon their activities were more than noon. It may be due to the floral biology of litchi inflorescence, as the anthesis and dehiscence of litchi flowers mostly occurs at early period of the day, facilitate the availability of pollens to the foragers.



(a) Honey bee *(Apis melifera)*
(b) Syrphid fly *(Episyrphus balteatus)*
(c) Wasp *(Vespula germanica)*
(e) Horse fly *(Tabanus validus)*
(e) Horse fly *(Tabanus validus)*
(f) Blue bottle fly *(Calliphora vomitoria)*

Photo 1. Different beneficial insects in litchi inflorescence at BAU Germplasm centre.

Table 3. Beneficial insect abundance at different day times in different litchi varieties

Variety	Beneficial insects		
	Morning	Noon	Afternoon
Bombai	2.49a	1.35a	1.18a
Mongolbari	1.75b	0.80b	0.74b
China-3	1.37c	0.51c	0.45c
Mozafforpuri	1.43c	0.76bc	0.72b
$LSD_{(0.05)}$	0.24	0.25	0.26
SE(±)	0.10	0.11	0.11
Level of significance	**	**	**
CV (%)	7.20	6.00	7.63

In a column, means of similar letter (s) do not differ significantly. ** = Significant at 1% level,
CV = Co-efficient of Variation

The abundance of the beneficial insects at different day times in different litchi varieties is presented in Table 3. In the morning, pollinators were dominant in four litchi varieties viz. Bombai (2.49), Mongolbari (1.75), Mozafforpuri (1.43), China-3 (1.37) whereas in afternoon, pollinators were less abundant in four litchi varieties viz. Bombai (1.18), Mongolbari (0.74), Mozafforpuri (0.72), China-3 (0.45). In Bombai, maximum (2.49) beneficial insects were present in morning where noon (1.35) and minimum (1.18) were in afternoon. In China-3 variety maximum (1.37) beneficial insects were present in the morning where noon (0.51) and minimum (0.45) beneficial insects were in the afternoon. A significant negative correlation ($r = -0.09$) was found by Abou-Shaara *et al*. (2013) between foraging activity and temperature. It is also noted that all the bees spent more time in flowers during the early time of day period, while less in later period. This is due to the flower biology, as the anthesis and dehiscence of litchi flowers mostly occur in early period of the day, facilitate the availability of pollens to the foragers. Results revealed in Table 3 that significant variation was observed in respect of insects abundance per inflorescence in same variety at different day times.

Table 4. Number of fruit set and dropping per inflorescence of different litchi varieties

Variety	Fruit set (no.)	Fruit dropping (no.)
Bombai	12.33a	2.66c
Mongolbari	9.66b	5.33b
China-3	6.33c	8.666a
Mozaffarpuri	7.33c	7.66a
$LSD_{(0.05)}$	1.76	1.76
CV (%)	14.43	9.92

Number of fruit set per inflorescence was higher in Bombai than China-3 variety (Table 4). It was also found that fruit dropping per inflorescence (8.66) was significantly highest in China-3 and minimum fruit dropping (2.66) in Bombai, respectively, that was significant among other varieties in fruit retention.

Conclusion

In this study, foraging behavior of litchi pollinator on four litchi varieties viz. Bombai, Mongolbari, China-3, and Mozzafforpuri in the Germplasm Centre, BAU was found a total number of seven families from different orders. Most of the beneficial or pollinatory insects were hymenopteran and dipteran order which covered 89 percent of total insects. Honey bee and syrphid fly were found as dominant pollinator. After pollination, maximum number of fruit set per inflorescence was in Bombai variety (12.33), whereas minimum number of fruit set was in China-3 variety (6.33). Based on the study it can be concluded that beneficial insect visitors have direct effect on litchi flower pollination and fruit setting.

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