ABUNDANCE OF EGGPLANT (*Solanum melongena* L.) FLOWER VISITORS IN LALITPUR, NEPAL

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ABSTRACT

In order to determine the abundance of insect flower visitors in growing crop of eggplant, *Solanum melongena* L., a field experiment was conducted in Khumaltar, Laliptur during summer-rainy season of 2012 to 2014. The insect flower visitors were monitored weekly by end-to-end walk method using sweep net at different time of the day, viz. 7-8 am, 12-1 pm and 4-5 pm. Then collected insects were identified using the reference insects/books available in Insect Museum of Entomology Division, NARC, Khumaltar. This study revealed that Hymenopteran were found to be the most dominant (90.75%) flower visitors; followed by Lepidopteran insects (9.25%). Among the identified insect species, *Bombus* sp. (60.22%) was the most frequently collected bees as flower visitor of eggplant followed by *Apis mellifera* L., *A. cerana* F., *Syntomis* sp. in all three years of field study. Other flower visitors, such as *Anthophora* sp., *Andrena* sp. and *Halictus* sp. were also found visiting the eggplant flower but their occurrence was minimal. Significantly ($p<0.05$) higher number of insects visited the eggplant flowers at 7-8 am (58.48%) followed by those visiting during 4-5 pm (28.97%) and 12-1 pm (12.54%), respectively. For adequate pollination and healthy production of eggplant, conservation and utilization of flower visitors and their role in pollination is imperative.

Key words: monitoring, *Bombus* sp., eggplant, flower visitors

INTRODUCTION

Pollination is an essential service for the reproduction of most species of flowering plants and ultimately to the foods (Nunes-Silva *et al.,* 2010). Fruit, vegetable or seed production from 87 of the leading global food crops is dependent upon animal pollination (Klein *et al.,* 2007). An over 80 percent pollination activity is performed by insects and moreover insects including bee group are vital for the pollination of many cultivated and wild plants (Thapa, 2006).

The increasing demand for food and the "Pollination crisis" have emphasized the importance of better understanding the potential of pollinators for pollinating crops (Patricio *et al.,* 2012). In eggplant, quality and quantity of fruit and seed was enhanced by insect visitation (Miyamoto *et al.,* 2006; Gemmill-Herren and Ochieng, 2008; Patricio *et al.,* 2012) and pollen complementation (Patricio *et al.,* 2012). Even in cover cultivation, the highest yield in eggplant was achieved when applying insects as natural pollinators (Kowalska, 2008).

The farmers of Nepal now-a-days are doing offseason vegetable production in protective structure where pollinators have no access to visit flowers frequently. Even in natural condition, the diversity and abundance of pollinators are highly affected by indiscriminate use of pesticides by human. In such conditions to get sustainable yield, pollinators either should be conserved or effective one should be reared and introduced in to the field. But, only sparsely literatures are available in these aspects in the context of Nepal. Long-term systematic monitoring is required for the creation of data on local pollinators for future endeavor. Therefore, this monitoring was carried out for the determination of the diversity and abundance of eggplant flower visitors as well as appropriate foraging time as a baseline study for future advance study.

MATERIALS AND METHODS

The study was carried out in the research field of Entomology Division, NARC, Khumaltar by growing eggplant in 0.2 acres of land. The research field lies in valley of mid hills under central development region of Nepal, having sub-tropical climate, with an average annual rainfall of 1122 mm distributed all over the year. The average temperature and relative humidity range from -1.37 to 32.79^0 C and 35.37 to 100 percent over the year, respectively.

The monitoring on abundance of flower visitors was done after the flowering of 50 percent eggplants during summer-rainy season (second fortnight of April to second fortnight of August) of 2012, 2013 and 2014 AD. The insect flower visitors were collected weekly at different hours of the day, viz. 7-8 am, 12-1 pm and 4-5 pm by end-to-end walk method using sweep net with very low constant speed. For each day hour, 4 end to end walks, each of 20 meter was allocated. It was adjusted in such a way that each walk received 20 sweeps. These collected insects were killed in jars charged with ethyl acetate and taken to Insect Museum of Entomology Division, Khumaltar. The eggplant flower visitors were identified with the help of reference insects and books related to taxonomy those were available in the museum.

The data obtained were entered into the Microsoft Office Excel, analyzed and interpreted. The Analysis of Variance (ANOVA) was conducted to calculate the difference in the flower visitation over time as treatment using GEN-STAT, Discovery Edition. For significant differences among the treatments, Duncan Multiple Range Test (DMRT) was used to differentiate treatments effect at $p<0.05$ as described by Duncan (1951).

RESULTS AND DISCUSSION

In total, 397, 452 and 284 flower visitors were recorded in 2012, 2013 and 2014, respectively. Over the period of three years field studies, a total of two Orders, four Families and seven species were recorded as flower visitors of eggplants (Table 1). Ninety percent insects visiting eggplant flowers were from Order Hymenoptera and most of them from Family Apidae. Bodlah and Waqar (2013) reported that Hymenopteran insects were more diverse and found to be foraging eggplant flowers efficiently. They also reported that the family Apidae was the most dominant flower visitors of eggplant, bitter gourd and ridge gourd.

The bumble bee, *Bombus* sp. was the most dominant visitor (60.22%) of eggplant flower in all three year of field study, which was followed by domestic bees and others (Table 1, Figure 1). Similar results are reported by Montemor and Souza (2009) and Patricio *et al.* (2012), where they identified *Bombus* sp. as potential and important pollinators of eggplants. *Bombus* is known to provide effective fruit setting in eggplant cultivation (Abak *et al.,* 1995).

After bumble bees, the domesticated bees were found to be visiting flower of eggplant more frequently. Patricio *et al.* (2012) also reported *Apis mellifera* L. as pollinators of eggplant. Bodlah and Waqar (2013) observed three species of pollinators visiting eggplant including *Bombus* sp. *Halictus* sp. and an un-identified species from Halictidae family.

All types of flower visitors visited eggplant flower significantly higher in number during morning time than in the evening and day time (Table 2). Over half of recorded insects (58.48%) visited eggplant flower at morning hour 7-8 am, around one-fourth (28.97%) visited at evening hour 4-5 pm and very low number of insects (12.54%) visited at noon hour 12-1 pm. Bodlah and Waqar (2013) reported the peak foraging time for pollinators in hot weather is early morning hour. The pollinator's activity depends on environmental factors, such as temperature and humidity (Ahmad and Aslam, 2002). This could have influenced in this study too.

Table 1. Relative abundance of eggplants flower visitors at Khumaltar, Lalitpur, 2012-2014

Insect species	Order	Family	Abundance frequency (%)	Ranking
Andrena sp.	Hymenoptera	Andrenidae	2.77 (n =32)	VI
Anthophora sp.	Hymenoptera	Apidae	3.26 (n =40)	V
Apis cerana F.	Hymenoptera	Apidae	11.36 (n =126)	III
Apis mellifera L.	Hymenoptera	Apidae	11.95 (n =138)	II
Bombus sp.	Hymenoptera	Apidae	60.22 (n =683)	I
Halictus sp.	Hymenoptera	Halictidae	1.19 (n =12)	VII
Syntomis sp.	Lepidoptera	Syntomidae	9.25 (n =102)	IV

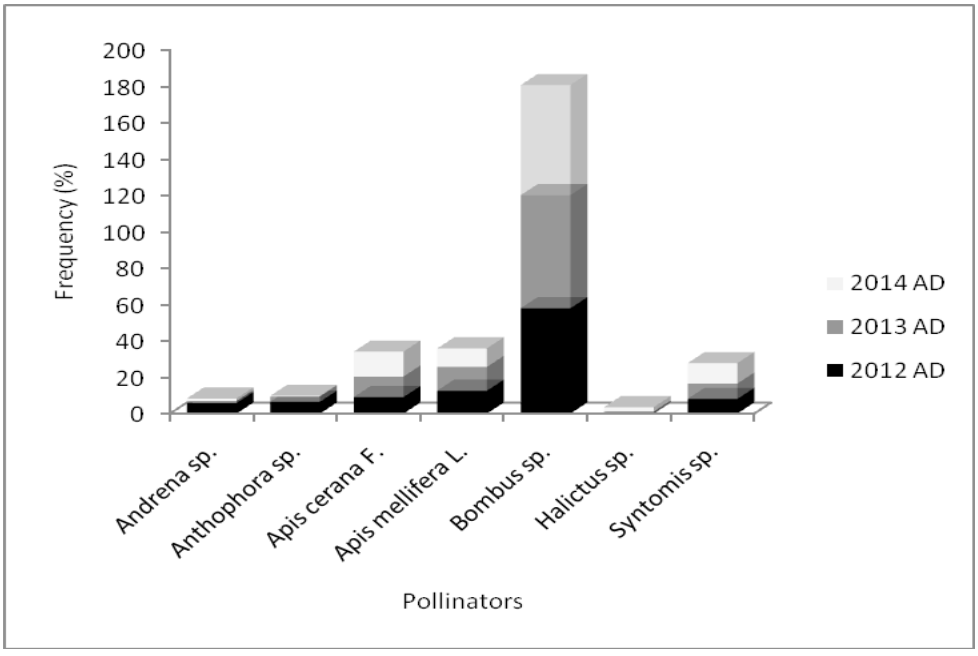

Figure 1. Abundance of eggplant flower visitors at Khumaltar, Lalitpur, 2012-2014

Table 2. Number of insects visiting eggplant flower at different time interval in Khumaltar, Lalitpur, 2012-2014

Insect species	Mean flower visitors observed at indicated times of day ± SE			F-test
	7-8 am	12-1 pm	3-4 pm	
Andrena sp.	0.35 ^{a} ±0.032	0.13 ^{b} ±0.023	0.17 ^{b} ±0.025	*
Anthophora sp.	0.44 ^{a} ±0.012	0.14 ^{c} ±0.035	0.26 ^{bc} ±0.110	*
Apis cerana F.	1.44 ^{a} ±0.042	0.40 ^{c} ±0.033	0.79 ^{b} ±0.024	**
Apis mellifera L.	1.65 ^{a} ±0.057	0.29 ^{c} ±0.027	0.94 ^{b} ±0.039	**
Bombus sp.	8.81 ^{a} ±0.482	1.46 ^{c} ±0.133	3.96 ^{b} ±0.254	**
Halictus sp.	0.15 ^{a} ±0.016	0.06 ^{b} ±0.013	0.04 ^{b} ±0.011	**
Syntomis sp.	0.96 ^{a} ±0.016	0.48 ^{c} ±0.014	0.69 ^{b} ±0.017	*

Means followed by same alphabet do not differ significantly by DMRT at $p<0.05$; * = significant at $p<0.05$; ** = significant at $p<0.01$; SE = Standard error

CONCLUSION

Seven insect species from four families visited eggplant flowers under field condition of Khumaltar, among which Hymenopteran insects were found to be the most dominant. *Bombus* species visited the eggplant flower most frequently followed by domesticated bees and other insects. Insects most frequently foraged on eggplant flower at morning hour, i.e. 7-8 am than noon and evening hours. This might have favored by the cool temperature as majority of the pollinators are said to prefer cool and calm weather. The monitoring of flower visitors and their best time of foraging have to be continued in order to have good understanding of flower visitors and pollinators of eggplant, rearing and utilization of efficient pollinators and determination of diversity and abundance, which will support to sustainable agriculture production without disturbing the natural balance.

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