Journal Crop and Weed, 11(2):34-37(2015)

Relative abundance of pollinators, foraging activity of bee species and yield performance of okra at Dhaka (Bangladesh)

M. A. HASNAT, S. SARKAR, [1]M. S. HOSSAIN,
[2]I. F. CHOWDHURY, [2]M. A. MATIN

Department of Agricultural Botany, [1]Department of Entomology, [2]Department of Agronomy
Sher-e-Bangla Agricultural University, Dhaka-1207

Received : 23.10.2014, Revised : 01.11.2015, Accepted : 30.11.2015

ABSTRACT

A field experiment was conducted at the experimental field of Sher-e-Bangla Agricultural University (SAU), during kharif season of May, 2011 to September, 2011 with a view to find out the abundance of pollinators, foraging activity and yield of different varieties of okra in a Randomized Complete Block design with three replications where experimental treatments included four okra varieties (T_1 = Metal, T_2 = BARI Dherosh 2, T_3 = Munmun 45, T_4 = Sarosh 2). Major pollinators namely Apis cerana (hymenoptera), Papilio demolius (Lepidoptera), Desmocerus californicus dimorphus (coleoptera) and Ceria dimidiatipennis (dipteral) of insect orders were found during the flowering period. Hymenoptera and Lepidoptera were the major pollinators visiting okra flowers and peak of foraging activity during 9-11 am. Among the tested varieties, Munmun45 (T_3) was superior in case of yield performance by producing the highest number of fruits per plant (41) and fruit yield (11.23 t ha^{-1}) while Sarosh2 (T_4) produced the lowest number of fruits per plant (29.33) resulted in lowest fruit yield (6.8 t ha^{-1}).

Keywords: Forage, okra, pollinators, pollination, yield

Okra [*Abelmoschus esculentus* (L.) Moench.] is one of the important and popular vegetable crops grown especially in tropic and sub-tropic regions of the world (Thakur and Arora, 1986). The global production of okra was listed at 6 million tons per year. In Bangladesh, it was calculated at 4.2 million tons per year (BBS, 2011). The production of okra is increasing day by day in Bangladesh. Several studies regarding the weather conditions suitable for better yield of okra show that when the temperature reaches 18ºC (minimum) and 35ºC (maximum), respectively, in the tropic region, okra performs best (Ezeakunne, 1984). A temperature range of 35º-40ºC is optimum for better growth and yield of okra (Grubben, 1997). On the other hand okra requires a critical day length of 12.5 hr for better initiation of flowers and ultimately higher fruit yield (Oyolu, 1997). However, According to Thamburaj (1972), short day lengths of 5.2-5.7 hrs and maximum temperature of 28º-29ºC and minimum temperature of 17.9-19.8ºC attributed higher formation of flowers. The reproductive system of okra consists of a combination of cross-and self-pollination. Insect play the major and important role in the fertilization of flowers but the use of pesticides in an indiscriminate way reduced the number of various pollinators tremendously, which is a common phenomena around the world now a days. Pollination is an important step in fertilization, a complex process resulting in the production of vegetables, seeds, and seeds of flowering crops. Pollination by insects is called entomophily. In this process, insects particularly from hymenoptera (bees), lepidoptera (*e.g.* butterflies and moths), diptera (flies) and coleoptera (beetles) order distribute pollen. Al-Ghzawi (2003) reported that the number of seeds per plant, number of seeds per fruit, seed weight per plant, and fruit weight of okra was greater in plants pollinated by various insects than self pollinated plants. Insect pollinated plants produced a greater number of young fruits and mature fruits due to higher transformation of flowers into tender fruits. Moses (2005) mentioned that pollination of okra flowers done by hand and insect received seed setting around 73-84% per fruit which was higher compared to the 57% seed settings per fruit acquired from the spontaneous self pollination using bagged flowers. As a result, cross pollination received 10.3% higher seed setting compared to forced-self pollination and forced-self pollination was increased by 16% than spontaneous-self pollinated flowers.

Under the above circumstances, the study was undertaken to investigate the abundance of different pollinators, foraging activity and yield of okra varieties.

MATERIALS AND METHODS

The experiment was carried out in medium fertile soil at the experimental field of Sher-e-Bangla Agricultural University (90º33´ E longitude and 23º77´ N latitude), Dhaka-1207, Bangladesh during the period from May to September, 2011 in *kharif*

Email: pallab_sau@yahoo.com

season. The pH value of the soil was 5.60. Four okra varieties such as Metal, BARI Dherosh 2, Munmun 45 and Sarosh 2 were used as the test crop, collected from Kushtia Seed Store, Dhaka. The experimentation was done in a Randomized Complete Block Design with three replications. There were 12 treatment combinations. The plot size was 9 m^2. The distances between plot to plot, plant to plant were 50 and 40 × 55 cm, respectively. The experimental plots were fertilized with 220, 65, 220, 20, 10, 5 kg ha^{-1} urea, triple super phosphate (TSP), muriate of potash (MOP), gypsum, zinc sulphate and boron, respectively. TSP, gypsum, zinc sulphate and boron were given as basal during final land preparation. Split application of urea and MoP were done at 20, 40 and 60 days after sowing. In each period, observations were made for ten minutes. Pollinators were collected by taking twenty sweeps per plot. Then the collected insects were killed using a killing bottle and transferred immediately to the laboratory for identification. Data regarding pollinators representing different insect orders were collected carefully. For controlling shoot and fruit borer before fruit setting Diazinone 60 EC @ 3.5 ml L^{-1} water in thrice was sprayed in an interval of 10 days started soon after the appearance of infestation. After fruit setting Nogos @ 0.02% was sprayed four times in an interval of 7 days for controlling Jassid. Randomly ten plants from each plot were selected for recording yield data. The yield and yield contributing characters were considered in this study were days to first flowering, fruit length (cm), number of fruits $plant^{-1}$, yield of green fruits (t ha^{-1}). The data collected on different parameters were statistically analyzed using the MSTAT-C software to find out the significance of variation resulting from the experimental treatments. The mean values for all the treatments were calculated and the analysis of variance for most of the characters was accomplished by 'F'variance test. The significance of difference between pair of means was tested at 5% level of probability (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Days to first anthesis

Cultivars showed no significant variation in respect of days to anthesis. The variety Munmun 45 (T_3) required 41 days to first flowering. But other varieties required 40 days to first flowering (Table 1). This finding is in agreement with Rai *et al.* (2012) who observed the same phenomena as days to first flowering depends mainly on genetic makeup of the crop.

Days to edible maturity

In case of days to edible maturity, no significant relation was observed among the cultivars. The variety Sharosh2 required 6-7 days to maturity. BARI Dherosh 2 (T_2), Metal (T_1) and Munmun 45 (T_3) were ready to harvest at 6.2, 6.26 and 6.46 days, respectively (Table 1).

Table 1: Effect of varieties of okra on days to first anthesis and edible maturity

Treatments	Days to first anthesis	Days to edible maturity
T_1	40.00	6.26
T_2	40.50	6.20
T_3	41.66	6.46
T_4	40.00	6.70
LSD (0.05)	**NS**	**NS**
CV (%)	**2.05**	**4.42**

Relative abundance of pollinators

Experiments were carried out to identify the relative abundance of major insect orders visiting okra field during the flowering period. It revealed that *Apis cerana* (hymenoptera), *Papilio demolius* (lepidoptera), *Desmocerus californicus dimorphus* (coleoptera) and *Ceria dimidiatipennis* (diptera) were the most dominant types of pollinators found to visit the experimental area during the flowering period (Fig. 1). Among the insect orders, hymenoptera was found major, followed by lepidoptera. Coleoptera and diptera were identified as minor insect orders. The results prove that during flowering period hymenopterans and lepidopterans are the major pollinators visiting okra fields. These findings are in close agreement with Mahfouz *et al.* (2012) who studied the pollinators visiting sesame seed crop and stated that Hymenopterans were higher, followed by lepidopterans and then both of coleopterans and dipterans. Viraktmath *et al.* (2001) who studied the relative abundance of pollinator fauna of sesame during two successive seasons and stated that hymenopterans insects were higher, followed dipterans and lepidopterans.

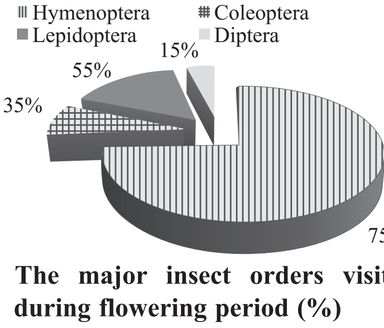

Fig. 1: The major insect orders visiting okra during flowering period (%)

Time span of visiting pollinators

Not only types and also the number of insect visitors changed with time during the flowering period of the okra. Results revealed that insects belonging to hymenopteran order increased along with increase in flowering (Fig. 2). When the number of flowers per plant was maximum (at the fourth week of flowering), bees were recorded maximum. Bee population decreased with decrease of flowers per plant due to advancement of crop age (at seventh week of flowering).

Time of foraging activity

Data in fig.- 3 revealed the foraging activity of the major insect orders visiting okra during flowering period. Major foraging activity of hymenoptera insects was observed and the peak time was during 9-11 am and lowest during 3-5 pm in this study. By applying pesticides late in the afternoon pollinators can be saved and by protecting the pollinators high yields can be ensured in a sustainable way. Bee pollination not only ensures the increase in yields of okra but also improves its quality, uniform maturity and early harvest of crop which ultimately ensures better quality and yield.

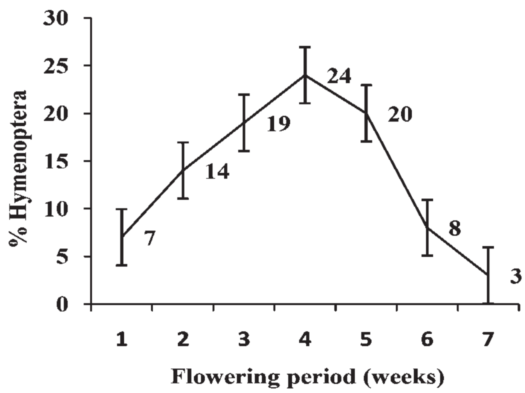

Fig. 2: Fluctuation percent of hymenopterous population during flowering period

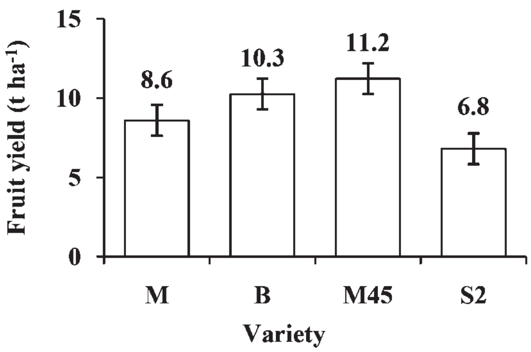

Fig. 3: Foraging activity of the major insect orders visiting okra during flowering period

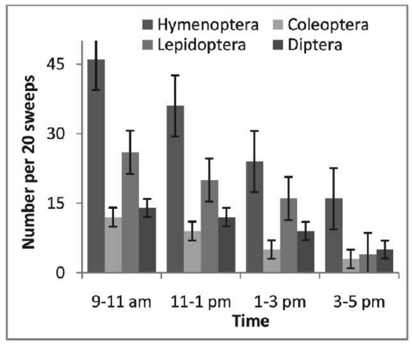

Fig. 4: Effect of varieties on fruit length of okra

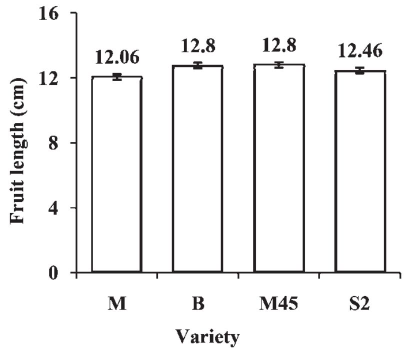

Fig. 5: Effect of varieties on number of fruits plant^{-1}

Yield performance of okra

Fruit length and number of fruits per plant are the most important parameters as maximum number of fruits per plant ensures higher fruit yield of okra. However another important factor is fruit size which can change the situation in many cases. In this experiment, there was no significant variation observed in case of the fruit length of different cultivars of okra (Fig. 4). On the other hand, Varieties respond differently in case of number of fruits per plant as it is the general consent. Among the four cultivars, Munmun 45 (T_3) produced maximum fruits per plant (41) and statistically *at par* with BARI Dherosh 2 (T_2). Fruits per plant (29.33) were minimum in case of Metal (T_1) (Fig. 5). Several studies indicate that number of fruits per plant varied due to varietal differences of okra. These findings are in agreement with Jordan-Molero (1986), Gondane and Bhattia (1995) and Shri-Dhar and Dhar (1995). Okra yield had a significant relation with varietal difference and is demonstrated in fig.- 3. The maximum yield (11.23 t ha^{-1}) was obtained from Munmun 45 (T_3) which was statistically *at par* with BARI Dherosh 2 (T_2). While, yield of Sharosh 2 (T_4) was extremely low (6.80t ha^{-1}). Different okra cultivars having variation in yield has also been confirmed by other researchers (Shaikh *et al.*, 1987; Baloch *et al*., 1990; Arora *et al.*, 1991 and Somkuwar *et al.*, 1997).

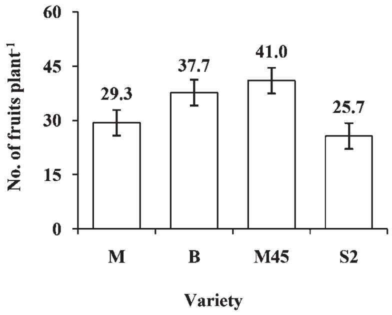

Fig. 6: Effect of varieties on fruit yield of okra

Depending on the experimental results, it may be outlined that no significant variation was observed in case of anthesis period, edible maturity and fruit length. Among the tested okra varieties, maximum number of fruits per plant (41) and fruit yield (11.23 t ha^{-1}) was obtained from Munmun 45 (T_3). The results also revealed that insects from both Hymenoptera and Lepidoptera orders are the primary types of pollinators of okra and peak time for foraging activity done by Hymenoptera order insects at 9-11 am and lowest during 3-5 pm.

ACKNOWLEDGEMENT

The authors thank the academic staff members of the Department of Agricultural Botany, Department of Entomology and Department of Agronomy of Sher-e-Bangla Agricultural University for all their regardless contribution and support during the experimentation period.

REFERENCES

Al-Ghzawi, M.M.A., Shahera, T.Z., Ibrahim, M. and Abdel, R.M. 2003. The impact of wild bees on the pollination of eight okra genotypes under semi-arid mediterranian conditions. *Int. J. Agric. Biol*., **5**:408-10.

Arora, S.K., Kumar, N. and Sharma, B.R. 1991. Effect of nitrogen and phosphorus fertilization on growth and yield components in okra (*Abelmoschus esculentus* L Moench). *Haryana J. Hort. Sci.,* **20**: 261-66.

Baloch, A.F., Qayyum, S.M. and Baloch, M.A. 1990. Growth and yield performance of okra (*Abelmoschus esculentus* L) cultivars. *Gomal Univ. J. Res*., **10**: 91-94.

BBS (Bangladesh Bureau of Statistics) 2011. *Statistical Year Book of Bangladesh*. pp. 151-63.

Ezeakunne, C.O. 1984. *Large scale Fruit and Vegetable Production in Nigeria*. Department of Agronomy, Ahmadu Bello University, Zaria, pp. 8.

Gomez, K.A. and Gomez, A.A. 1984. *Statistical Procedure for Agricultural Research*. John Wiley and Sons. Inc. New York, pp. 215.

Gondane, S.U. and Bhattia, G.L. 1995. Response of okra genotypes to different environments. *PKV Res. J*., **19**:143-46.

Grubben, G.H. 1997. Directory of institutions involved with vegetable germplasm resources. Tropical Vegetable and their Genetic Recourses (Eds.), FAO, Rome, Italy. pp. 137.

Jordan-Molero, F.L. 1986. Behaviour of six okra cultivars as vegetable and as agrain. *J. Agric. Univ. Puerto Rico***.** **70**: 57-61.

Mahfouz, H.M., Kamel, S.M., Belal, A.H. and Said, M. 2012. Pollinators visiting sesame (sesamum indicum L.) seed with reference to foraging activity of some bee species. *Cercetari Agron. in Moldova*. **2**:150.

Moses, T.N., Witlmann, D. and Schindler, M. 2005. Effect of bee pollination on seed set and nutrition on okra (*Abelmoschus esculentus*) in Cameroon. Deutscher Tropentag in Stuttgart Hohenheim, The global food and product chain-dynamies innovation, conflicts, strategies.

Oyolu, C. 1977. Variability in photoperiodic response of okra. *Acta Hort*., **52**: 207-15.

Shaikh, M.A., Ansari, A.H., Qayyum, S.M. and Baloch, M.A. 1987. Okra cultivars: Tandojam experts' study of vegetable behavior in okra. *Pak. Agri*, **9**: 40-42.

Shri-Dhar and Dhar, S. 1995. Performance of okra cultivars in South Andaman. *Curr. Res*., **9**: 169-71.

Somkuwar, R.G., Mahakal, K.G. and Kale, P.G. 1997. Effect of different levels of nitrogen on growth and yield of okra cultivars. *PKV Res. J*., **21**: 22-24.

Thakur, M.R. and Arora, S.K. 1986. Okra. In. Vegetable Crops in India (Ed), Naya Prokash, Calcutta, pp. 610-18.

Thamburaj, S. 1972. Response of okra to thermo and photoperiods. *Madras Agric. J*. **59** : 339-46.

Viraktmath, S.A., Patil, B., Murasing, S. and Guruprasad, G.S. 2001. Relative abundance of pollinator fauna of cross-pollinated oilseed crops at Dharwad in Karnataka (India). *Indian Bee J*., **63**: 64-67.