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Flower - visiting insect pollinators of okra [*Abelmoschus esculentus* (L.) Moench] in Bengaluru region

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Abstract

An experiment was conducted at Indian Institute of Horticultural Research, Bengaluru during 2016-17 with an objective to study the flower-visiting insect pollinators of okra in Bengaluru region, Karnataka, India. The okra flowers were frequently visited by insects belongs to Hymenopteran order. Among them *Apis spp* were the most dominant visitors constitute 41.75 % of the total insect pollinators followed by *Lasius niger* and *Solenopsis invicta* with 34.23% and 24.02% respectively. The foraging population of *Apis spp*, *Lasius niger* and *Solenopsis invicta* was positively correlated with maximum temperature whereas, it was negatively correlated with relative humidity during evening hours for *Apis spp* and negatively correlated with relative humidity in the morning hours for *Lasius niger* and *Solenopsis invicta*. This study clearly revealed that all the observed insect pollinators had differences in their response to the recorded weather parameters during flowering period of okra.

Keywords: okra, insect pollinators, foraging activity, weather parameters

Introduction

Okra [*Abelmoschus esculentus* (L.) Moench] is an economically important vegetable crop grown in tropical and sub-tropical parts of the world (Thakur and Arora, 1986) [1]. It belongs to Malvaceae family having chromosome number $2n=130$. The fresh okra fruits have lot of health benefits providing low calories (30 calories per 100 g) besides containing no cholesterol, rich sources of mucilage substance that helps in ease constipation. High iodine content of fresh fruits helps to control goitre. Hence, it is often recommended by nutritionists in cholesterol controlling, weight reduction programs and to develop immunity (Gemedé *et al.*, 2015) [4]. Okra has perfect flowers (both male and female reproductive parts in the same flower) and it is self-pollinating crop. Various levels of cross pollination from 4 to 19 per cent (Purewal and Randhawa, 1947; Choudhury *et al.*, 1970 and Shalaby, 1972) [9, 2, 10] with a maximum of 42.20 per cent (Mitidieri and Vencovsky, 1974) [6] have also been reported. Although it is a self-pollinated crop, selfing in the absence of cross pollination generally reduces seed yield and seed size in subsequent generation (Delaplane and Mayer, 2000) [3]. Insects constitute one among the primary group of pollinating agents, as the relationship between them and flowers are well established. (Bajiya, 2017) [1]. Due to attractive golden yellow flowers and presence of nectaries, it is freely visited by honey bees, bumble bees, ants, butterflies and other insects belonging to different orders during flowering period. Further, Moses (2005) [7] 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 setting per fruit acquired from the spontaneous self-pollination using bagged flowers. Hence, keeping in view the economic importance of this crop, the present investigation was undertaken to study the flower visiting insect pollinators of okra in Bengaluru region.

Materials and Methods**Experimental site**

The field experiment was conducted during 2016-17 at Indian Institute of Horticultural Research, Bengaluru, Karnataka, India. An experimental site was located at an altitude of 890 m above mean sea level with 13° N latitude and 17° 37' E longitude. The soil type was red sandy loam with pH 5.2 to 6.4. An experimental design was randomized complete block design (RCBD) with three replications. The okra seeds (cv. Arka Anamika) were sown at spacing of 60 x 30 cm.

Collection of weather data

The recorded weather parameters during the peak flowering period was shown in Figure 2. The weather parameters like temperature (°C) in (Maximum and Minimum), relative humidity (%) (Morning and Evening hours), wind speed (km/hr) and evaporation (mm) were collected daily from the weather station of IIHR, Bengaluru.

Observation on flower visiting insect pollinators

The relative abundance of pollinators (number of flowers visited by pollinators) was recorded randomly on selected five plants during different times of the day (6.00, 7.00, 8.00, 9.00, 10.00, 11.00, 12.00, 13.00, 14.00, 15.00 and 16.00 hrs) during the peak flowering period. The observations on foraging behavior viz., number of flowers (Number of pollinators/m²/min) visited by insect pollinators at different hours of the day, foraging rate of pollinators (mean number of flowers visited/min) were recorded by using an electronic stopwatch during flowering period.

Statistical analysis

The recorded data were analyzed and correlation coefficient was calculated for flower visiting insect pollinators with meteorological parameters were performed using the statistical software SPSS version 16.0.

Results and Discussion

Diversity of insect pollinators on okra during flowering period

The data pertaining to diversity of insect pollinators during the flowering period in okra has been represented in Table 1 and Figure 1. The data clearly revealed that *Apis* spp were the most dominant flower visitors with 41.75% followed by black ant (*Lasius niger*) with 34.23% and small ant (*Solenopsis invicta*) with 24.02% among total flower visiting insect pollinators. These findings are in close agreement with Hasnat *et al* (2015) [5] who studied the relative abundance of pollinators, foraging activity of bee species in okra and stated that Hymenopterans were higher, followed by other insect orders.

Table 1: Dominant insect pollinators and their percentage proportion on okra during flowering period

Order	Family	Species	Percentage composition	Total
Hymenoptera	Apidae	<i>Apis</i> spp	41.75	41.75
	Formicidae	<i>Lasius niger</i>	34.23	34.23
		<i>Solenopsis invicta</i>	24.02	24.02

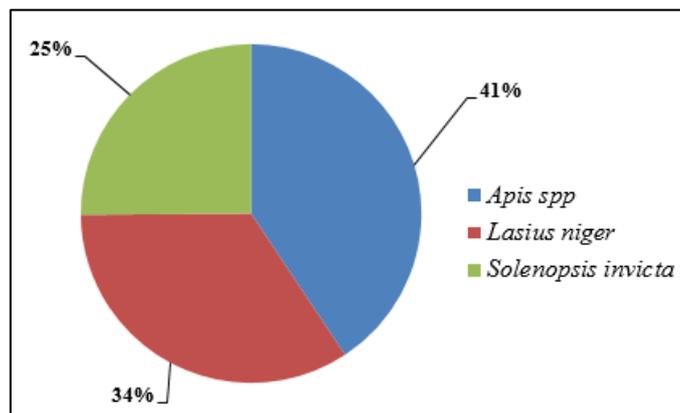


Fig 1: Percentage proportion of insect pollinators visiting okra during flowering period

Seasonal abundance of Pollinators on okra during flowering period

The data regarding the seasonal abundance of pollinators on okra during flowering period have been reported in Figure 2 and 3. The seasonal abundance pattern of *Apis* spp, *Lasius niger* and *Solenopsis invicta* in relation to weather conditions viz., temperature (°C) at maximum and minimum, relative humidity (%) both in the morning and evening hours, evaporation (mm) and wind speed (km/hr). The data reveal the graphical representation of weather parameters with significant increase of insect population on okra during the peak flowering period. There is a tremendous increase in population of *Apis* spp at a temperature of 29°C - 30°C followed by *Lasius niger* and *Solenopsis invicta*. The findings of the present study were in agreement with Winston (1987) [12] who reported that the flight activity of *Apis* spp begins at temperatures between 12°C - 14°C and decreased with increasing wind speed in blue berry.

In correlation with weather parameters if the relative humidity is 50 per cent during morning hours *Solenopsis invicta* may occur in low numbers. In contrast, Porter (1987) [8] reported that the foraging activity of *Solenopsis invicta* is higher when the air temperature lies between 22°C - 36°C, whereas, the relative humidity and wind has no relation with foraging activity. The graph clearly reveals that the number of pollinators may be visiting the okra at an optimum temperature and low humidity during morning and evening hours. Further, number of honey bee visiting the flowers that may aid in pollination and increase the flowering period of okra during peak season. When wind speed is higher the insect pollinators' does not visits the flowers and thus reduces the flowering period.

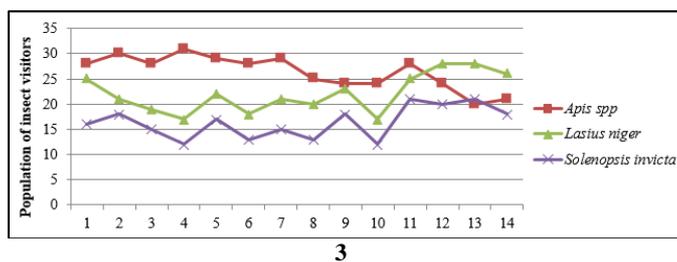
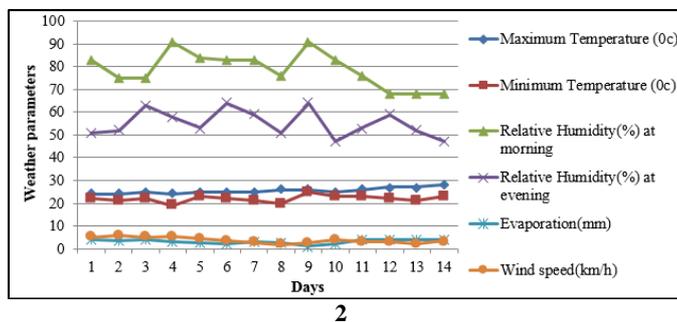


Fig 2 & 3: Seasonal effect of Pollinators on okra during peak flowering period in relation to weather parameters

Correlation coefficient (r) between activity of insect pollinators and weather parameters

The data regarding correlation coefficient (r) between insect pollinators and weather parameters have been represented in table 2. It clearly revealed that the foraging population of *Apis* spp was highly significant and positively correlated with maximum temperature (r=0.85). Whereas it was significant and positively correlated to relative humidity during morning hours (r=0.55) and wind speed (r=0.66). Foraging population

of *Lasius niger* and *Solenopsis invicta* were significantly and positively correlated with maximum temperature ($r=0.66$ and $r=0.55$) whereas it was significant and negatively correlated with relative humidity in the morning hours ($r= -0.62$ and $r= -0.57$). The Correlation coefficient was found to be null when insect visited flowers at minimum temperature, relative humidity during evening hours and evaporation.

Table 2: Correlation coefficient (r) between pollinators and weather parameters

Name of the parameters	Correlation coefficient (r)		
	<i>Apis</i> spp	<i>Lasius niger</i>	<i>Solenopsis invicta</i>
Maximum temperature (°C)	0.85**	0.66*	0.55*
Minimum temperature (°C)	-0.33	0.27	0.37
Relative humidity morning (%)	0.55*	-0.62*	-0.57*
Relative humidity evening (%)	0.32	-0.22	-0.10
Evaporation (mm)	-0.09	0.53	0.47
Wind speed (km/hr)	0.66*	-0.39	-0.27

*Correlation is significant at 0.05 level (2-tailed)

**Correlation is significant at 0.01 level (2-tailed)



Apis spp



Lasius niger

Fig 4: Flower visiting insect pollinators of okra

Conclusion

The study concluded that okra flowers were attracted by a various insect species belongs to different orders. Due to the presence of bright yellow colored flowers with abundant pollen grains in okra attracts the various flower visiting insect pollinators. Among them the most abundant insect visiting pollinators belonged to the Hymenoptera order during the entire flowering period. Among hymenopterans *Apis spp* were the dominant flower visitors followed by *Lasius niger* and *Solenopsis invicta*. The data on seasonal abundance revealed that the foraging activity of *Apis spp* was increased with an increase in temperature and decline in relative humidity. The

foraging population of *Apis* spp, *Lasius niger* and *Solenopsis invicta* were highly significant and positively correlated with maximum temperature, whereas, it was negatively correlated with relative humidity during evening hours for *Apis* spp followed by the negative correlation with relative humidity during morning hours for *Lasius niger* and *Solenopsis invicta*. This study clearly reveals that all the observed flower visiting insect pollinators had differences in their response to the various weather parameters recorded during the peak flowering period of okra.

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