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Pollination Potentiality of Indian Honey Bee in Production of Sesame (*Sesamum indicum* L.)

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ABSTRACT

Bee pollination studies in relation to sesamum crop production was carried out during 2017-18 with three treatments in four replications viz., T1: Untreated Check (pollinator exclusion), T2: Open pollination and T3: Plot caged with honeybee pollination. Insect pollinators of Sesame (*Sesamum indicum* L.) and their foraging activity in open pollinated plot were recorded during flowering period. A total of 14 insect species were found visited the sesame flower, out of 14 insect species, 10 species belongs to Hymenoptera and 4 were belongs to Dipterans. Among Hymenopterans, the 4 species of honeybees viz., *Apis dorsata, Apis cerana, Apis florea* and *Trigona iridipennis* were recorded during flowering period. The foraging activity of honey bees and other pollinators were recorded from 6 AM to 6 PM at an hourly interval during the flowering period. The number of pollinators visiting the sesame flowers were found maximum during 9 to 11 hrs. The highest number of pollen foragers were recorded during mid morning hours. The quantitative yield parameters like number of pods per plant, number of seeds/pod, 1000 seed weight (g), yield (q/ha), similarly qualitative yield parameter, oil content (%) was found significantly maximum in plots caged with honey bees followed by open pollination and lowest in untreated check.

Keywords Sesame, Pollinators, Foraging activiy, Yield parameters.

INTRODUCTION

Sesame (*Sesamum indicum* L.) which originated in Africa, is probably the most ancient oil seed plant cultivated in many parts of the world. Currently, China, India and Myanmar (Burma) are the world's largest producers of sesame, followed by Sudan, Nigeria, Pakistan, Bangaldesh, Ethiopia, Thialand, Turkey and Mexico (Desai 2004).

Sesamum is one of the important oil seed crop of Southern and Central India. Among the nine oil seed crops grown in India, Sesamum ranks third

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after Groundnut and Mustard. Sesamum believed to have originated in Indian sub continent and the crop is grown extensively in Uttar Pradesh, Rajasthan, Madhya Pradesh, Orissa, Tamil Nadu, Gujarat, Karnataka and West Bengal. Among these Uttar Pradesh, Madhya Pradesh, Rajasthan and Orissa account for 65% of the cultivated area and 55% of the production respectively.The Sesamum occupies the fourth place in area and production next to Groundnut, Sunflower and Safflower in Karnataka and is being cultivated over an area of 113.30 thousand hectares with the production of 46.60 thousand tones (Anon 2000).

Cross pollination of entomophilous crops by honeybees is considered as one of the effective and cheapest method for triggering the crop yield both qualitatively and quantitatively (Mohapatra *et al.* 2010). Since most of the oil seed crops are cross pollinated still adequate pollination is vital for any significant increase in seed production by the utilization of honeybee as effective pollinators.

The flower structure of Sesamum facilitates cross pollination although it is considered to be self pollinated. The extent of natural crossing ranges from 0.5 to 65%. *Apis florea, Apis dorsata, Megachile umbripennis, Andrenai lereda, Ceratina sexmaculata* and *Trichometallepollinosa* were reported to be common pollinators on Seasamum (Rashad *et al.* 1980).

Besides honey bees, other pollinators such as flies, butterflies and wasps were also recorded on sesamum flowers in open pollination. However, their frequency of visit was very less compared to honeybees. The honey bees visited more numbers of sesamum flowers per minute compared to other pollinators. Thus the need of keeping sufficient number of bee colonies in the vicinity of the crops during flowering period was envisaged (Panda *et al.* 1989).

Flowers of several plant species occur within the foraging range of 1 to 2 km form bee colony and bee exercise their instinct to compare and select a particular plant species which yield nectar with relatively higher sugar concentration or pollen with better nutritive value (Deodikar and Suryanarayan 1977). Usually bees collect pollen and nectar which incidentally facilitates cross pollination. The present investigation was carried out to assess the insect fauna, their abundance on sesamum flowers with special reference to the foraging activity of honey bees and qualitative and quantitative of sesamum.

MATERIALS AND METHODS

The sesamum crop was raised in plots of 10 × 9 m with all the recommended package of practices at the Agricultural Research Station, Siruguppa during crop season 2017-18. Which is located at an altitude of 380 m, latitude and longitude of 15° 38 ' N and 76° 54' E respectively. The observations on various insect pollinators visiting sesamum flowers and their abundance with special reference to foraging activity of honey bees were recorded from initiation of flowering up to cessation of flowering.

The different species of insects visiting the flower of tagged one sesamum plant was observed and recorded from 0600 to 1800 hrs at an hourly interval for 5 minutes. Pollinators visiting the crop were collected and identified using taxonomic keys.

The relative abundance of different insect pollinators visiting sesame were recorded from 0600 to 1800 hrs for 5 min at hourly interval during flowering period per plant and are expressed as mean number of pollinators or bee visited per plant per 5 minutes.

The pollen and nectar foraging activity of different honey bee species were recorded by observing flower of tagged one sesamum plant canopy plant during flowering period for 5 min. The forager bees with pollen pellets in their corbicula (even small loads) were classified as pollen forager. Similarly, the forager bee without pollen loads in their corbicula were classified as nectar forager and were recorded throughout the study period from morning 0600 to 1800 hrs of the day at an hourly interval for one month and were expressed as number of pollen or nectar foragers per plant per 5 minutes.

To study the effect of bee pollination on quantitative and qualitative yield parameters. The three treatments viz., T1: Check, T2: Open pollination, T3: Crop caged with Indian honey bee colony was taken in seven replications laid out in completely Randomized Block design.

The treatment T_1 is completely covered with 1 mm nylon mesh to prevent visit of bees and other pollinators. In the treatment T_2, all the pollinators were allowed to visit the crop, where as in the treatment T3 a colony of *Apis cerana* was placed inside the mesh during peak flowering period.

The pods from randomly tagged plants in each treatment were harvested as and when they attained maturity and the mean number of pods per plant was calculated by total number of pods divided by total number of plants.

Twenty five harvested pods from each treatment were randomly taken and seeds were separated from the pods. The mean number of seeds per pods were calculated by total number of seeds divided by total number of pods.

Seeds from all the treatments were collected and counted manually and weighed immediately using electronic digital balance. The mean 1000 seed weight was expressed in term of grams.

In ten square meter area, total number of plants were counted in all the treatments, later seed yield/ha was calculated by multiplication of No. of plants, 10000, seed weight and divided by 10 square meter.

Seeds from all the treatments were collected and oil content was analyzed using Nuclear Magnetic Resonance (NMR) technique and oil content was expressed in terms of percentage.

All the observations recorded in four replications and the data from filed experiment was subjected to $\sqrt{x+1}$ transformation and analyzed statistically for comparing treatments using Fischer's Method of "Analysis of Variance" (ANOVA) technique as outlined by Panse and Sukhatme (1967) for completely Randomized Block Design and results were interpreted at 5% level of significance. Duncan's Multiple Range Test (DMRT) was used to know the difference between the treatments.

RESULTS AND DISCUSSION

There are 14 number of different species of insects were found visited the sesamum during (Feb-March 2018) flowering period. Among different insect pollinators, ten species were belongs to Hymenopterans and four species belongs to Dipterans. Among Hymenopterans four species of honey bees belongs to Apidae and one species each belongs to Anthophoridae, Chrysididae, Formicidae, Megachilidae, Scolidae and Vespidae. Similar results on various species of insect pollinators belongs to Diptera, Lepidoptera and Hymenoptera particularly *Apis cerana* Fab, *Apis florea* Fab and *Trigona iridipennis* Smith were found collecting the nectar and pollen from sesamum flowers in Northern India (Ali and Alam, 1933, Sikka and Gupta, 1949; Mohana Rao *et al*.1984; Panda *et al.* 1989).

Table 1. Species of insects visiting sesamum flowers.

Order	Family	Species
Hymenoptera	Apidae	*Apis dorsata* Fab.
		Apis cerana Fab.
		Apis florea Fab.
		Trigonai ridipennis Smith
	Anthophoridae	Pithitis sp.
	Chrysididae	*Stilbum cyanurum* Forst
	Formicidae	*Camponotuss ericius* Fab.
	Megachilidae	*Megachile* sp.
	Scolidae	*Scolia* sp.
	Vespidae	*Ropalidia marginata* Van dervecht
Diptera	Calliphoridae	*Chrysomya bezziana* Villaneuve
	Muscidae	*Musca domestica* Linn.
	Syrphidae	*Eristalis* sp.
	Tephritidae	*Dacus cruciferae* Hendel

The other insect pollinators under Diptera, one species each belongs to Calliphoridae, Muscidae, Syrphidae and Tephritidae (Table 1). Similar results on other insect pollinators such as *Pithitis* sp., *Stilbumcyanurum* Forst, *Camponotus sericus* Fab., *Megachile* sp., *Scolia* sp. and *Ropalidia marginata* Van der vecht were also recorded on sesamum flowers in smaller numbers from Northern India (Sikka and Gupta 1949, Panda *et al.* 1989).

Observations on the relative abundance of different pollinators visiting sesamum flowers revealed maximum intensity of *A. cerana* (6.28 bees/plant/5 min) followed by *A. dorsata* (6.21 bees/plant/5 min), *Apis florea* (3.64 bees/plant/5min) and stingless bee *Trigona iridipennis* (2.26 bees/plant/5min). In addi-

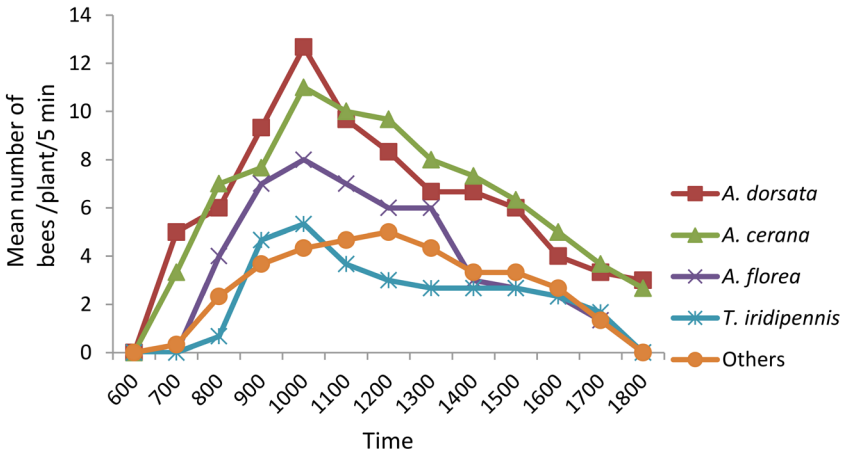


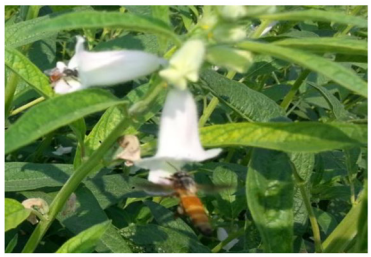
Fig. 1. Relative abundance of pollinators visiting sesamum flowers.

tion, the Dipterans were recorded 2.72 pollinators/ plant/5min (Fig.1). These findings were in accordance

Apis dorsata –Nectar forager

Apis florea- Nectar forager

Apis cerana- Nectar forager



Apis dorsata- pollen forager

Apis florea- pollen forager

Pithitis sp.

Fig. 2. Pollinators visiting sesame (*Sesamum indicum* L.) flowers.

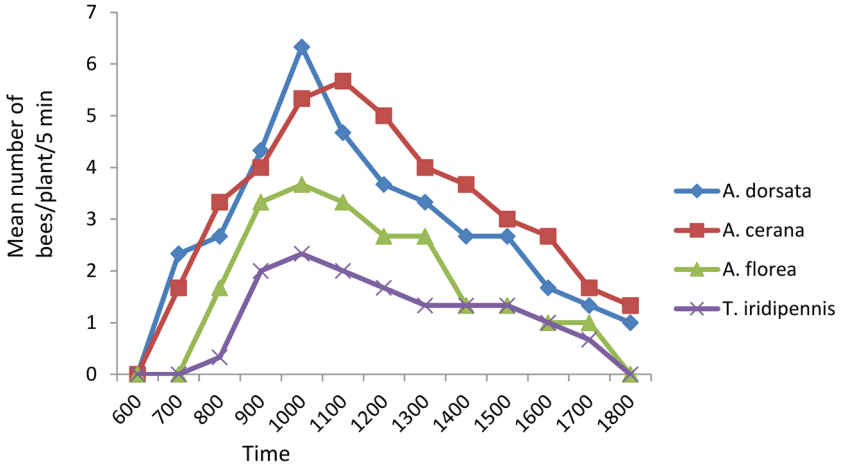


Fig. 3. Pollen foraging activity of different species of honey bees.

with the findings of Mohan Rao *et al.* (1981) who observed a similar activity of *Apis cerana indica, Apis dorsata* and *Apisflorea* on Sesamum cultivars and reported *Apis ceranaindica* was the most frequent visitor of Sesamum followed by *Apis florea* and *Apisdorsata*.

The foraging activity different species of honeybees reveals that the *A. dorsata* and *A. cerana* was found forage from 0700 to 1800 hrs, whereas *A. florea* and *Trigona iridipennis* found to start forage one hour later than *Apis dorsata* and *A. cerana* and continued up to 1700 hrs.The foraging activity all the species were found maximum during morning (1000 hrs). Among the honeybees, *A. dorsata* were visiting the flowers in maximum numbers (12.67 bees/plant/5min) followed by *A. cerana* (11 bees/plant/5min), *A. florea* (8 bees/plant/5min) and lowest (5.33 bees/plant/5min) recorded with *Trigona iridipennis.*The foraging activity of non *Apis* pollinators of Hymenoptera and Dipterans were also recorded and were found maximum (5/plant/5 min) at 1200 hrs (Fig.1).

The pollen foragers of *A. dorsata* (6.33bees/plant/5min), *A. florea* (3.67bees/plant/5min) and *Trigona iridipennis* (2.33 bees/plant/5min) were found peak at 1000 hrs. Whereas pollen foragers of

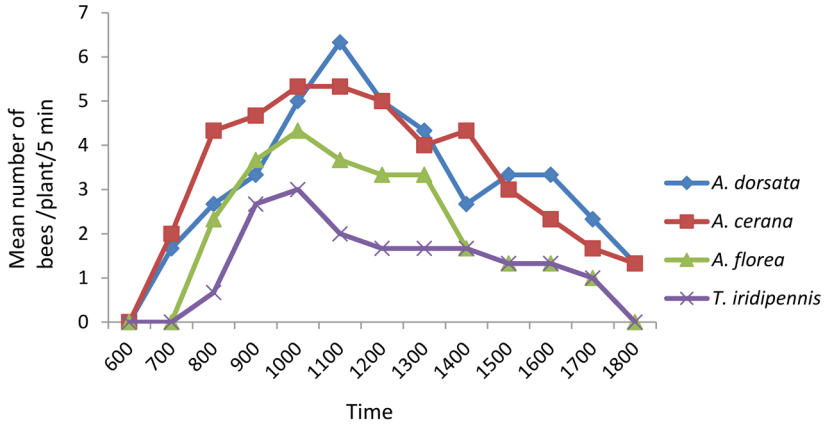


Fig. 4. Nectar foraging activity of different species of honey bees.

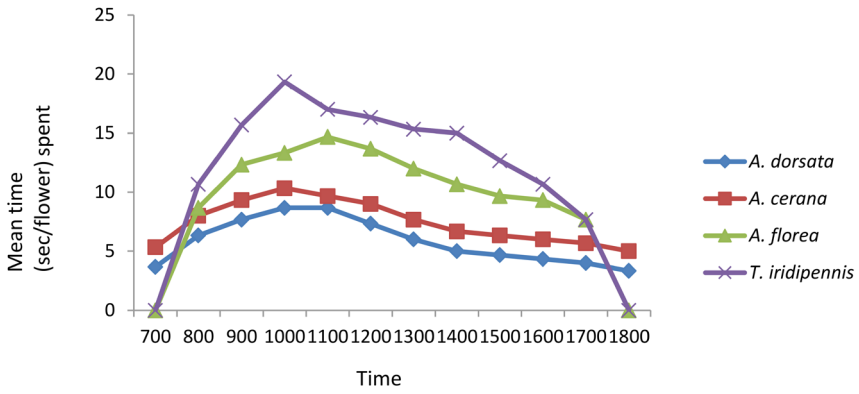


Fig. 5. Time spent by different species of honey bees for collection of pollen.

A. cerana (5.67bees/plant/5min) were found peak at 1100 hrs (Fig. 3).The significant variations were recorded in foraging activity of all species of honey bees at different hours of the day. This might be perhaps due to the complexity of various factors embracing the bee species and the floral rewards in terms of quality and quantity at different hours of the day.

The nectar foragers of *A. cerana* (5.33 bees/plant/5min), *A. florea* (4.33 bees/plant/5min) and Trigona iridipennis (3.0 bees/plant/5min) were recorded at 1000 hrs. Whereas the nectar foragers of *A. dorsata* (6.33bees/plant/5min) were found peak at 1100 hrs (Fig. 4). The mean numbers of nectar foragers of all the species of honey bees were found when compare to pollen foragers during morning hours indicates the presentations good quantity of nectar from the flowers. These findings are in conformity with the observations made by Verma (1983), who reported that the foragers were active throughout the year.

All the species of honeybee showed greater variation in time taken for collection of pollen from the flowers at different hours of the day (Fig. 5). All the bees viz., *A. dorsata* (8.67 Sec /flower), *A. cerana* (10.33 Sec /flower), *A. florea* (14.67Sec / flower) and *Trigona iridipennis* (19.33 Sec /flower) were taken longer duration for collection of pollen from the flowers between 1000 and 1100 hrs of the day. Whereas lesser duration for the collection of pollen from flowers by *A. dorsata* (3.33 Sec /flower), *A. cerana* (5 Sec /flower) were recorded at 1800 hrs of the day, but the bees of *A. florea* and *Trigona iridipennis* were not noticed in collection of pollen from flowers at 1800 hrs of the day. The difference in duration taken for the collection of pollen by all the species of honey bees might be corroborated with quantity of pollen that will be presented by flowers during different hours of the day.

The importance of honeybee pollination in relation to qualitative and quantitative yield characters of sesamum are presented in below Table 2.

Table 2. Effect of bee pollination on yield parameters in sesamum. (Means followed by the same letter in a column do not differ significantly by DMRT).

Treatments	No. of pods/plant	No. of seeds /pod	1000 seed weight	Oil content (%)	Yield (q/ha)
Check	29.14^{c}	39.86^{c}	2.70^{c}	42.96^{c}	4.66^{c}
Open pollination	36.43^{b}	52.57^{b}	3.29^{b}	49.46^{b}	6.26^{b}
Plot caged with honeybee colony	40.43^{a}	56.43^{a}	3.47^{a}	52.84^{a}	6.93^{a}
Mean	35.33	49.62	3.15	48.42	5.95

The pods per plant was significantly higher in the plots caged with honey bee colony (40.43) followed by open pollination (36.43) and the lowest was recorded in untreated check (29.14). The significant increase in number of pods per plant were also recorded from mustard due to bee pollination (Singh and Singh 1997).

Significantly maximum number of seeds per pod was recorded in plots caged with honey bees colony (56.43) followed by open pollination (52.57) and the lowest was recorded in untreated check (39.86). Bee pollination resulted in 4 times increased seeds/pod in mustard (Singh and Singh 1997). Panchabhavi *et al.* (1976) also reported an increased seed set of 27% in sunflower crop where bee colonies were placed in the open cultivated crop.

The 1000 seed weight and yield per hectare was significantly maximum in plots caged with honeybees (3.47g and 6.93 q/ha) compared to open pollination (3.29 g and 6.26 q/ha) and untreated check (2.70 g and 4.66 q/ha). The seed weight and yield in plot caged with colony of *Apis cerana* was highest due to bee pollination, where in open pollination it may be due to pollination of bees along with non *Apis* pollinators, lowest seed weight and yield in check plot due to exclusion of pollinators. Similar results has been reported in Niger (Panda *et al.* 1989, Choudhary and Kumar 1998), mustard (Panigrahi and Maiti, 1996), Sunflower (Roy *et al.* 1998) and Sesamum (Viraktamath and Patil 1998).

The qualitative parameters like oil percent was recorded significantly higher in honey bee pollination (52.84) followed by open pollination (49.46) and lowest in untreated check (42.96). Prasad *et al*. (1989), Kulkarni and Dhanorkar (1998) also reported significant increase of oil content in mustard (20.91%) and niger seeds (9.09). Mahmoud (2012) reported quantitative parameters like pod weight, number of seeds/pod, weight of 1000 seeds, seed yield per plant and qualitative parameters like germination percentage, seedling vigour and oil content was significantly higher in insect pollinated sesame crop.

CONCLUSION

Apis and non *Apis* species were found as an insect pollinators of sesamum during the study period, however conservation of these pollinators by rationale pest management tactics, i.e., pesticide application, if needed should be done in the late afternoon to protect the pollinators for high seed yield or spray at a time of the day when crop flowers are closed.

The present findings confirmed that the quantitative and qualitative yield parameters can be improved by effective bee pollination as these flowers are very much attracted not only honeybee species but also to wide variety of other insect pollinators.

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