



Diversity of insect pollinators and their effect on yield parameters of Sesamum, *Sesamum indicum* L.in Gajapati district of Odisha

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ABSTRACT

The study entitled "Diversity of Insect pollinators and their effect on yield parameters of Sesamum, *Sesamum indicum* L. in Gajapati District of Odisha" was carried out during Rabi, 2018-19 and Summer, 2019 at Research field of Department of Entomology, MSSoA, CUTM, Paralakhemundi, Odisha. The Sesamum crop attracted thirteen species of pollinators, out of which species belonging to family Apidae were the maximum (72.7%) and the rest three families i.e. Megachilidae, Halictidae and Vespidae, each one contributing around 9% of the total population, all belonging to single order hymenoptera. Species wise diversity indicated that *Apis cerana indica* was the most dominant one constituting 29 per cent of the total foragers followed by *Ceratina smaragdula* (14%), *Thyreus ramosus* (11%), *Xylocopa latipes* (10%), *Megachile lanata* (8%), *Tetragonula iridipennis* (7%), *Amegilla zonata* (5%). All the pollinators were active during early and mid flowering stage except *X. latipes* which was more active on the late flowering stage. The time spent by the bees on Sesamum crop was more during 11:00 A.M. (7.00 sec) followed by 9:00 AM. (6.5 sec) and 16:00 P.M. (5.7 sec). This study proved that pollination service significantly increased the yield of the crop as open pollination plot recorded with highest yield (226 kg/ha) followed by bee pollination (209.6 kg/ha) and the least was recorded in pollination exclusion plot (169.8 kg/ha). Along with the yield, other parameters like effect of pollinators on plant height, capsules per plant, thousand seed weight (g), yield (kg/ha) and oil content was proved to be significant and indicated a per cent increase of 15.4, 32.4, 12.8, 35.3 and 23.7 respectively in case of open pollination and 2.9, 23.06, 10.04, 23.4 and 21.4 respectively in bee pollination over pollination exclusion plot.

Key words: Sesamum, Pollinators, Foraging activity, Pollination service and Crop improvement Program.

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INTRODUCTION

Sesamum (*Sesamum indicum* L., Family- Pedaliaceae), also called as "til" is one of the most important oil seed crop, native to Asia. Sesamum seed is a rich source of edible oil with high oil content (46-64 %) and a dietary energy of 559 K.cal/ 100g [5]. It is one of the important oil seed crops of Odisha too with an area of 0.23 lakh hectares and production and productivity of 0.05 lakh tonnes and 217 kg/ha which is considerably low compared to the National average productivity of 456 kg/ha [11].

Although it is a self-pollinated crop but as the gynoeceum is superior to androeceum, external agents are necessary to transfer the pollen from anther to stigma which is required for proper seed setting, qualitative and quantitative improvement of the seeds. Differing rates of cross pollination have been also reported by Yermanos [16] and Ashri [1]. Mostly flowers attract bees for their nectar source and thereby enhance pollination. Honeybees are the primary visitors to sesame flowers (Joshi, 1961 and Deodikar, 1977). By considering cumulative mean abundance *Apis cerana indica* (16.4 bees/ m² /5 minute) was considered as the most frequent visitor followed by *Apis dorsata* (7.2 bees/ m² /5 minute) and *Apis florea* (2.9 bees/ m² /5 minute) on Sesamum under Odisha conditions [12]. The crop is considered as self-pollinated crop but the amount of cross pollination due to the activity of bees to the extent of 18.69% has been reported [2]. As far as the diversity is concerned, Sesamum is visited predominantly by bees of Apidae family (69.4per cent) followed by Halictidae (10.6per cent) and Megachilidae (7.1per cent) [15].

The role of insect pollinators in enhancing the crop yield helps the farmers to exploit for better pollination service and honey production [7]. Bees are the best pollinators which contribute nearly 80% of the total insect pollination [11]. Bee pollination enhances the yield of Sesamum when compared to that of pollination exclusion [13, 14].

Gajapati is a district of Odisha, India. The district headquarters at Paralakhemundi, formerly a princely estate, has been clustered within a radius of approximately 5 kilometers around the geometric centre of Paralakhemundi. The District is a part of the Red Corridor. Gajapati district located at the south-east of Odisha between longitude 84° 32'E and 83° 47'E and latitude 18° 44'N and 19° 39'N. This district is a store house of diversified flora and fauna. To utilize this diversified ecological natural locality, this experiment has been carried out in the M. S. Swaminathan School of Agriculture.

In view of the above facts the following investigation had been carried out to know the present situation of the pollinators, their role in pollination and their effect on yield and yield attributing characters of Sesamum in Gajapati District of Odisha.

MATERIAL AND METHODS

In order to record the insect pollinators associated with Sesamum crop, studies were conducted during Rabi, 2018-19 and Summer, 2019 at research field of Department of Entomology, MSSSoA, CUTM, Paralakhemundi, Odisha. Prachi, a popular variety of Sesamum in Odisha was taken. The plot size was 5m × 5m and the inter and intra-row spacing were maintained at 30cm × 10cm. A recommended dose of N: P₂O₅: K₂O at 30:15:15 kg/ha was applied and a spray of urea was given at 45 days after planting. The experiment was conducted in RBD design with 7 replications and three treatments.

Observations on the foraging activity of the pollinators visiting on the flowers of Sesamum in open pollination plot were made during the early flowering i.e. at 10 per cent flowering stage coinciding with 35-40 DAS, followed by mid flowering i.e. at 50 per cent flowering stage i.e. 40-45 DAS, Late flowering stage i.e. at 30 per cent flowering and 20 per cent pod set stage and the last recording at the pod setting stage i.e. at 90 per cent pod set and 10 per cent flowering stages during different day intervals i.e. 8AM-9AM, 10AM-11AM and 16.00PM-17.00PM hours.

The observations were taken based on the number of pollinators visiting Sesamum flowers per m² at 5 minutes interval in randomly selected ten spots within the field and the mean data was recorded for the final result. The same procedure was repeated during both the cropping seasons of Rabi, 2018-19 and summer, 2019. The data were computed for the study of the activity of pollinators during both the seasons by using a sweeping net of 40cm radius. After collection of the pollinators they were killed by using the Ethyl acetate solution, dried and preserved as per Borror and DeLong's method. Identification of the pollinators was done by matching with previously identified fauna of pollinators (Identified by the Division of Entomology, I.A.R.I., New Delhi and maintained by the AICRP on Honeybees and Pollinators).

During the onset of flowering i.e. at 10 per cent flowering stage the crop was covered with Nylon net over a selected areas of 5m² for the bee pollination treatment. Inside the nylon net one bee hive of *Apis cerena indica* F. with three frames of Honey bees and two empty frames were placed and the hive should have two entrances, one hive entrance placed inside the Nylon net and the other entrance to the outside for the entry and exit of bees. Other pollinators entry should be prevented other than the *Apis cerena indica*.

The experiment was designed in such a way that, the Pollination exclusion plots (each of 1m² area) were randomly selected within the plots at seven locations and were covered with nylon net to prevent the entry of any foraging insect. The open pollinated plot placed for the natural cross pollination were not covered with nylon net and was arranged with two bee hives to encourage more amount of cross pollination. During the time of harvest ten plants were randomly selected from each replications of Open pollinated, Bee pollinated and Pollination exclusion plots and various biometric observations i.e., qualitative and quantitative parameters of the Sesamum plant such as given below to be recorded.

Besides different parameters like Number of plants per m², Plant height (cm), Number of branches per plant, Number of capsules per plant, Number of seeds per pod, 1000 grain weight (g), Seed weight (g) were recorded per 10 plants. Along with this Total yield (kg/ha), Oil content (%) were also estimated and compared by using the Cold percolation method [10].

RESULTS AND DISCUSSION

The results of the present investigation revealed that the Sesamum is visited by eleven species of pollinators (Table 1 and Fig. 1) belonging to four families viz., Apidae, Megachillidae, Vespidae and Halictidae under single order Hymenoptera. Besides, stray population of butterflies and true flies were also observed visiting the Sesamum flower mostly for meeting their dietary requirement. The activity of different pollinators commenced at 10 per cent flowering stage i.e. 35-40 DAS and the cessation of activity

was observed after the 90 per cent pod set i.e. 55-60 DAS. A great majority of Sesamum flowers flowered between fifth and seventh week and the diversified activities of pollinators mostly observed during that period.

Table 1: Diverse species of pollinators occurring on Sesamum during the cropping seasons of Rabi, 2018-19 and Summer, 2019

Sl. No	Common Name	Scientific Name	Family	Order
1.	Indian hive bee	<i>Apis cerana indica</i> Fabricius	Apidae	Hymenoptera
2.	Rock bee	<i>Apis dorsata</i> Fabricius	Apidae	Hymenoptera
3.	Stingless bee	<i>Tetragonula iridipennis</i> Smith	Apidae	Hymenoptera
4.	Carpenter bee	<i>Xylocopa latipes</i> Drury	Apidae	Hymenoptera
5.	Carpenter bee	<i>Xylocopa aestuans</i> Linnaeus	Apidae	Hymenoptera
6.	Green metallic bees	<i>Ceratina smaragdula</i> Fabricius	Apidae	Hymenoptera
7.	Cuckoo bee	<i>Thyreus ramosus</i> Lepeltier	Apidae	Hymenoptera
8.	Digger bee	<i>Amegilla zonata</i> Linn.	Apidae	Hymenoptera
9.	Leaf cutter bee	<i>Megachile lanata</i>	Megachilidae	Hymenoptera
10.	Potter Wasp	<i>Eumenes</i> spp.	Vespidae	Hymenoptera
11.	Sweat bee	<i>Lasioglossum</i> sp.	Halictidae	Hymenoptera

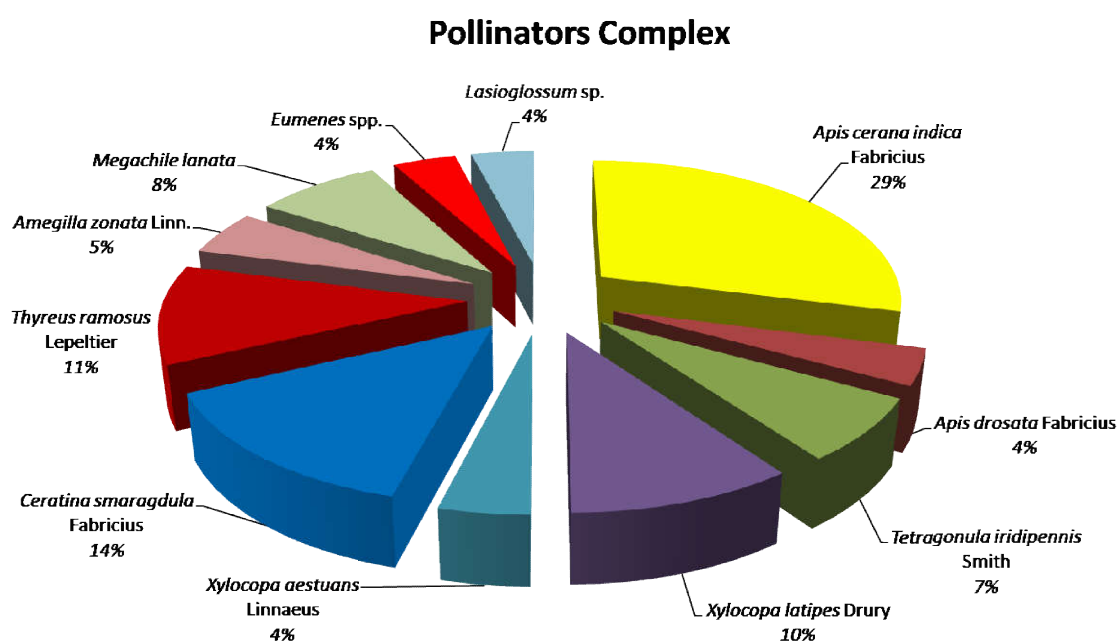


Fig. 1: Species wise pollinator diversity on Sesamum during Rabi, 2018-19 and Summer, 2019

Among the pollinators, family Apidae (72.7 per cent share) was the most dominant followed by all other three families i.e. Megachilidae, Vespidae and Halictidae (each contributing around 9.1%) (Fig. 2). Sesamum flowers are visited by three species of honeybees i.e. *Apis dorsata* Fab., *Apis cerana indica* Fab. and *Tetragonula iridipennis* Smith. Along with the honeybee species, the other pollinators viz., *Xylocopa latipes* Drury, *Xylocopa aestuans* Linnaeus, *Ceratina smaragdula* Fabricius, *Thyreus ramosus* Lepeltier, *Amegilla zonata* Linn., *Megachile lanata*, *Eumenes* spp. and *Lasioglossum* sp. were also recorded.

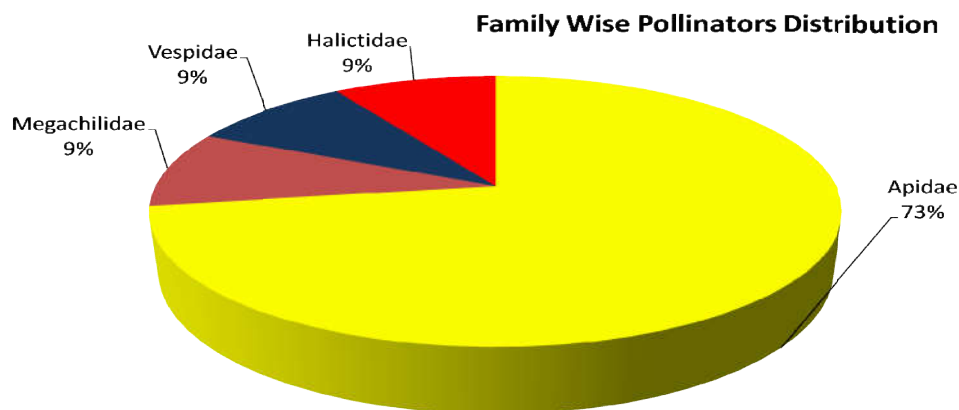


Fig. 2: Family wise composition of diverse pollinators on Sesamum (Rabi, 2018-19 and Summer, 2019)

Garapati [8] has reported 12 numbers of pollinators in her studies from the single order Hymenoptera. Similarly Sanganna, Sajjanar and Eshwarappa [14] reported 14 different species of insects visiting the Sesamum belonging to Hymenoptera and Diptera.

Among the pollinators *Apis cerana indica* constituted 29 per cent of the total foragers and it remained the most dominant among the bee species visiting Sesamum flower followed by *Ceratina smaragdula* (14%), *Thyreus ramosus* (11%), *Xylocopa latipes* (10%), *Megachile lanata* (8%), *Tetragonula iridipennis* (7%), *Amegilla zonata* (5%) and some other pollinators were frequently observed on Sesamum. The relative proportion of different foragers on Sesamum crop is presented in Fig.1.

Observations on diurnal abundance of different insect pollinators indicated that during the first season i.e. Rabi, 2018-19, the activity of pollinators started from 35-40 DAS at 10 per cent flowering and lasted up to 55-60 DAS when there was 90 per cent pod set and 10 per cent flowering. The data on the foraging activity of different pollinators revealed that at peak activity population of *Apis cerana indica* (5.9 bee/m²/5 min) observed to be the maximum followed by *Ceratina smaragdula* (3.33 pollinators/m²/5 min) and *Tetragonula iridipennis* (1.33 bees/m²/5 min). Population of *Apis dorsata* (0.47 bees/m²/5 min) was the least and other hymenopterans (4.93 pollinators/m²/5 min) during the peak activity. Similar was the findings of [12] who reported that peak foraging activity of *Apis cerana indica* (5.8 bees/m²/5 min) was observed at 50% flowering stage. Patnaik et al., 2004 also reported that among different insect foragers on Sesamum, *Apis cerana indica* (5.8 bees/m²/5 min) was predominant and activity of *Apis mellifera* (3.8 bees/m²/5 min) was low at 50 per cent flowering, which collaborates with the present finding.

Data on foraging speed i.e. time spent by different insect pollinators on Sesamum flower were recorded and presented in the Table 2. Results indicated that there is a marked variation in the time spent by different pollinators on each flower. The mean time spent on each flower varied between 5.4-6.4 sec in case of *Apis cerana indica*, 5.1-6.5 sec in case of *Ceratina smaragdula* and 6.5-8.1 sec in case of *Xylocopa latipes*. The mean maximum time spent was recorded to be highest in *Xylocopa latipes* (7.33 sec) followed by the *Apis cerana indica* (5.97 sec) and *Ceratina smaragdula* (5.83 sec). The time spent by the bees was more during the 11.00 A.M. (7.00 sec) followed by at 9.00 a.m. (6.5 sec) and 4.00 p.m. (5.7 sec).

Table 2: Time spent by different bee species on Sesamum flower

SL.N o	Bee Species	Mean time spent on flower (seconds)			
		Time of the day			Overall Mean
		9.00	11.00	16.00	
1	<i>Apis cerana indica</i>	6.1	6.4	5.4	5.97
2	<i>Ceratina smaragdula</i>	5.9	6.5	5.1	5.83
3	<i>Xylocopa latipes</i>	7.4	8.1	6.5	7.33
	MEAN	6.5	7.0	5.7	

*Mean of 10 Observations during each time of observation.

Studies made on effect of pollinators on yield attributes revealed that the open pollination plot was recorded with highest yield of 226 kg/ha followed by bee pollination with an yield of 209.6 kg/ha and the least recorded in pollination exclusion plot with 169.8 kg/ha. Overall per cent increase of 35.3 per cent in open pollination and 23.4 per cent in bee pollination was recorded over pollination exclusion plot.

Out of the above yield parameters, effect on plant height, capsules per plant, thousand seed weight (g), yield (kg/ha) and oil content was proved to be significant and indicated a per cent increase of 15.4, 32.4, 12.8, 35.3 and 23.7 in case of open pollination and 2.9, 23.06, 10.04, 23.4 and 21.4 in bee pollination over pollination exclusion plots.

Similar findings has been observed by Sreenija [8] where open pollination plot was recorded with highest yield of 226 kg/ha followed by bee pollination with an yield of 209 kg/ha and the least recorded in pollination exclusion plot with 170 kg/ha. Overall per cent increase of 32.7 per cent in open pollination and 22.6 per cent in bee pollination was recorded over pollination exclusion plot. The effect on plant height, Number of branches, Number of pods, total seeds per ten plants, thousand seed weight (g), seed yield per ten plants, yield (kg/ha) and oil content has recorded a per cent increase of 16.1, 2.3, 31.1, 31, 14, 22.9, 32.7 and 23.5 in case of open pollination and 2.6, 13.4, 22, 20.4, 13.5, 16.8, 22.6 and 19.6 in bee pollination over pollination exclusion plot was observed.

Thus, It is concluded that the open pollination and the bee pollination with *Apis cerana indica* colony contributed to increase in the yield and yield attributing characters of Sesamum when compared to that of the plants under pollination exclusion plot in Gajapati District of Odisha conditions even though Sesamum crop by default is a self-pollinated crop which is precisely depicted in Table 3.

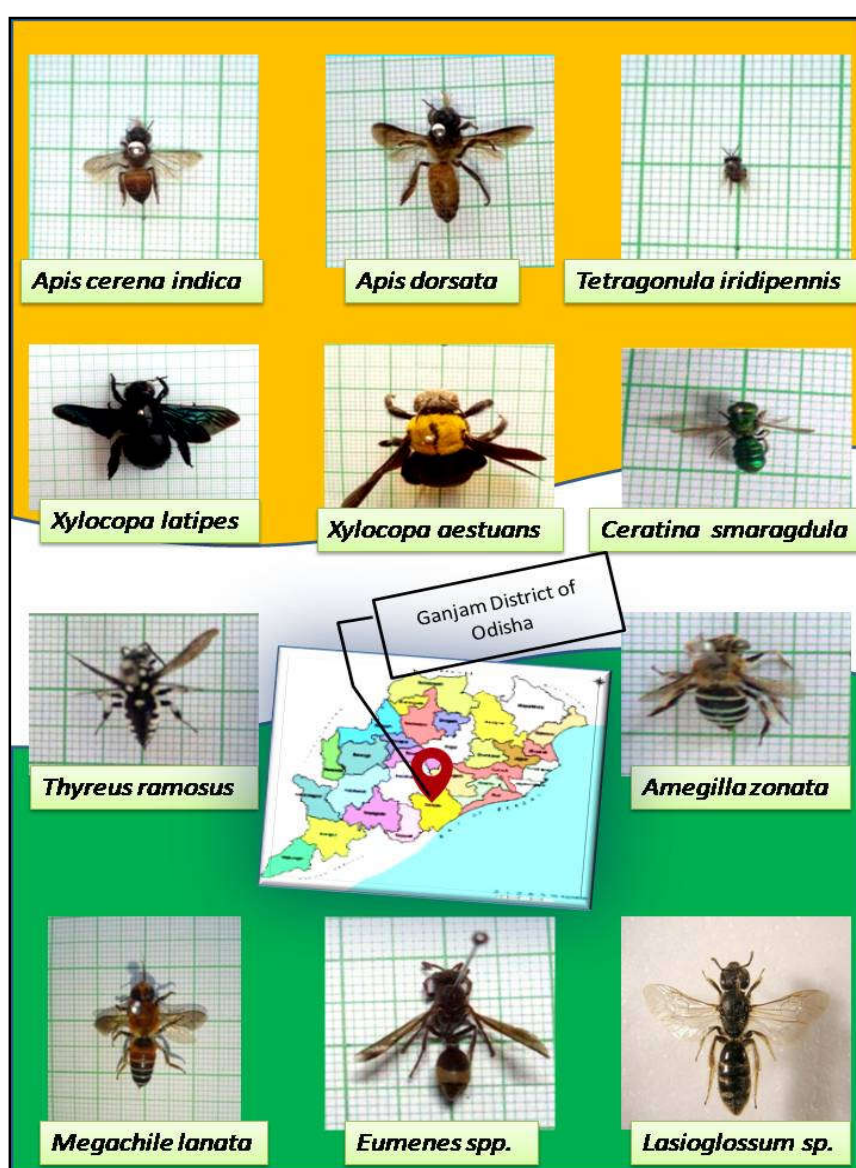


Fig. 3: Pollinator's Diversity of Sesamum in Gajapati District

Table 3: Effect of pollinators on yield and yield attributing characters of Sesamum

	Open Pollination	Bee Pollinated	Pollination Exclusion	SE _{m±}	CD _(0.05)	CV (%)	Increase over Pollination Exclusion (%)	
							Open Pollinated	Bee Pollinated
Plant Height (cm)								
Rabi	61.26	52.89	52.13	2.35	7.11	11.12	15.4	2.9
Summer	58.13	53.60	51.29	1.58	4.74	7.59		
Pulled Mean	59.69	53.24	51.71	1.37	3.89	4.67		
Capsules per Plant								
Rabi	11.48	11.87	9.65	0.41	1.48	11.21	32.4	23.06
Summer	12.47	10.38	8.43	0.47	1.51	12.31		
Pulled Mean	11.975	11.125	9.04	0.31	1.09	6.41		
1,000 seed weight (g)								
Rabi	2.39	2.34	2.10	0.05	0.17	7.02	12.8	10.4
Summer	2.36	2.31	2.11	0.08	0.24	9.46		
Pulled Mean	2.38	2.33	2.1	0.05	0.17	3.39		
Yield (kg/ha)								
Rabi	226.3	221	172.9	9.89	30.2	12.49	35.3	23.4
Summer	225.7	198.3	166.8	9.1	28.4	12.39		
Pulled Mean	226	209.6	169.8	6.7	19.7	6.28		
Oil Content								
Rabi	31.19	30.59	25.9	0.79	2.69	8.03	23.7	21.4
Summer	33.89	32.36	26.71	0.89	2.85	8.09		
Pulled Mean	32.54	31.47	26.3	0.62	1.83	3.91		

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