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D PadhyAICRP on Honeybees and
Pollinators, Department of
Entomology, College of
Agriculture, OUAT,
Bhubaneswar, Odisha, India**CR Satapathy**AICRP on Honeybees and
Pollinators, Department of
Entomology, College of
Agriculture, OUAT,
Bhubaneswar, Odisha, India**RN Mohapatra**AICRP on Honeybees and
Pollinators, Department of
Entomology, College of
Agriculture, OUAT,
Bhubaneswar, Odisha, India

Diversity of Insect pollinators on Pigeon pea, *Cajanus cajan* L. in Odisha

D Padhy, CR Satapathy and RN Mohapatra
Abstract

A field experiment was conducted to study the “Diversity of insect pollinators on Pigeon pea (*Cajanus cajan* L.) in Odisha” during *Kharif*, 2017-2018 at the Entomology block in Central Research Station of Orissa University of Agriculture and Technology, Bhubaneswar, Odisha. The Pigeon pea crop attracted eleven species of pollinators represented by 3 families viz., Apidae (45.5%), Megachilidae (36.4%) and Vespidae (18.2%) of order Hymenoptera. Species wise diversity indicated that *Megachile lanata* Fab. was the most dominant one (29.1%) followed by *Megachile disjuncta* Fab. (20.5%), *Tetragonula iridipennis* Smith (14.2%), *Apis cerana indica* Fab. (10.95%), *Megachile bicolor* Fab. (10.7%), *Xylocopa latipes* Drury (8.5%), *Megachile hera* Bingham (2.1%), *Eumenes* spp. (1.7%), *Xylocopa aestuans* Lin. (1.2%), *Vespa tropica* Lin. (0.8%) and *Apis dorsata* Fab. (0.2%). All the pollinators were active during early and mid-flowering stage except *X. latipes* which was more active on the late flowering stage. During various flowering stages (69-159 DAS) of the crop the number of species varied from 5-11 with the Simpson's diversity index of 0.602-0.897. In general the diversity was almost uniform because of the evenness of the species.

Keywords: Pollinators, Diversity, Simpson's diversity index, Pigeon pea
Introduction

Pigeon pea (*Cajanus cajan* L.), commonly known as red gram, tur or arhar is an important perennial legume crop of India belonging to the family Fabaceae. India produces 2.46 million tons of arhar from an area of 3.75 million hectares and it is also one of the most important pulse crops of Odisha, cultivated over an area of 0.14 million hectares with a production of 0.12 million tons as per Agricultural Statistics at a glance (2016) ^[1]. Pigeon pea possesses cleistogamous flowers which favour self pollination. However, 14-20 per cent natural out crossing has been reported to occur in Pigeon pea as per Sharma and Green (1980) ^[12] and Howard *et al.* (1919) ^[16]. Pollination service rendered by entomophilous is one of the important factors in increasing productivity of pigeon pea crop. Flowering followed by peak period of pollen availability occur between 12.00 noon to 03.00 p.m. (Somerville, 2002) ^[17]. Rashmi *et al.* 2010 ^[10] recorded thirty species of insect pollinators during flowering period of which twenty one species belong to order Hymenoptera, four species to Lepidoptera, two species to Diptera and one species each to Coleoptera, Hemiptera and Thysanoptera. Singh (2016) ^[14] reported 7 species of pollinators belonging to three families of Hymenoptera order. Under Odisha conditions the crop is grown as *Kharif* or pre -*Rabi* season crop and the duration vary greatly starting from as low as 110 -115 days (Extra early cv. ICPL -87 and ICPL -151) to as long as over 200 days duration (HYV cv. Basant and Bahar) which are visited by a large number of insects. The present investigation was undertaken with an intention to record the important pollinators on this important legume crop with their diversity under agro-climatic conditions of Odisha.

Materials and Methods

In order to record the insect pollinators associated with Pigeon pea crop, studies were conducted during *Kharif*, 2017-18 in the Experimental Station of Entomology located in the upland area of Central Research Station, Orissa University of Agriculture and Technology, Bhubaneswar. The seeds of HYV Pigeon pea cv. Asha were sown during 9th September of *Kharif*, 2017. The crop was raised in 40 plots of 4.0m² (2m×2m.) size with inter and intra row spacing of 50 cm and 30 cm respectively. The recommended dose of N₂: P₂O₅: K₂O at 20:40:20 kg/ha was applied and necessary agronomic practices were followed to maintain

Correspondence**CR Satapathy**AICRP on Honeybees and
Pollinators, Department of
Entomology, College of
Agriculture, OUAT,
Bhubaneswar, Odisha, India

proper plant population and normal growth of plants. Ten such plots were kept away and free from insecticidal treatment to study on pollinators' diversity. Observations on diverse insect pollinators visiting Pigeon pea flowers were recorded during the early flowering (69 -99 days after sowing (DAS)) mid flowering (109 -129 DAS), late flowering (139 DAS-159 DAS) at different day intervals i.e. 07.00 a.m.-08.00 a.m., 10.00 a.m.-11.00 a.m., 13.00 p.m.-14.00 p.m., 16.00 p.m.-17.00 p.m.

The observations were taken based on the number of pollinators visiting pigeon pea flowers per 1 m² in 5 minute at randomly selected 10 spots within the field and the mean data was recorded for the final result and collection was done at 10 days interval in thirty sweeps per day at 07:00 a.m., 10:00 a.m., 01:00 p.m. and 05:00 p.m. by using a sweeping net of 40cm radius. After collection of the pollinators they were killed by using the Ethyl acetate solution and dry preserved as per Borror and De Long's 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).

The data obtained were subjected to computation for assessing the relative dominance status of various taxa of the pollinators on the basis of relative abundance which determines the percentage of specimens of a given species in the total number of organisms collected and the index of dominance was ascribed following classes of domination as suggested by Slawinska and Jauekiew (2005).

- <1 % = Subrecedent; 1-9% = Recedent
- 10-20 % = Sub-dominant; 21-30% = Dominant
- 31-60 % = Eudominant; > 60 % = Superdominant

The diversity index to measure the species diversity in a community like Simpson's Index of Diversity and Simpson's Reciprocal Index were worked out based on the methods suggests by Simpson (1949) [13]. The Simpson's Diversity Indices were calculated as per the following:

Simpson's Index (D).

$$D = \frac{\sum n(n-1)}{N(N-1)}$$

Where

n = the total number of organisms of a particular species.

N = the total number of organism of all species

Simpson's Index of Diversity (SID): 1-D

Simpson's Reciprocal Index: 1/D

Equitability or Evenness (E₀) was calculated by taking

Simpson's Index (D) and expressing it as a proportion of the maximum value D.

$$D = \frac{1}{\sum_{i=1}^s P_i^2}$$

$$\text{Evenness (E}_D) = \frac{D}{D_{max}} = \frac{1}{\sum_{i=1}^s P_i^2} \times \frac{1}{s}$$

Where

D = Simpson's Diversity Index

P_i = Proportion of S made up of the ith species

S = total number of species in the community (richness)

Results and Discussion

The results of the present investigation revealed that the Pigeon pea is visited by 11 species of pollinators (Table 1 and Fig. 1) belonging to three families viz., Apidae, Megachilidae and Vespidae under single order Hymenoptera. Besides, stray population of butterflies and true flies were also observed visiting the Pigeon pea flower mostly for meeting their dietary requirement. Activity of different pollinators commenced from 10 per cent flowering stages coinciding with 69 (DAS) and the activity continued till the late flowering stage i.e. 159 DAS. Majority of Pigeon pea plants flowered between 89 DAS to 129 DAS.

Among the pollinators, family Apidae with 45.5 per cent share was the most dominant followed by Megachilidae (36.36 %) and Vespidae (18.18%). Pigeon pea crop is 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., *Megachile lanata* Fab., *Megachile disjuncta* Fab., *Xylocopa latipes* Drury, *Xylocopa aestuans* Lin. and *Megachile bicolor* Fab. also visited the crop frequently.

Singh (2017) [15] reported that diurnal abundance of six species of bee pollinators. Singh (2016) [14] reported 7 species of true insect pollinators, More *et al.* (2015) [9] reported 24 species of insect pollinators while Rashmi *et al.* (2010) [11] observed 30 species of insect pollinators on pigeon pea. Apidae and megachilid were reported as the common pollinators by all the above researchers.

Dominance status of pollinators on pigeon pea

Assessment of relative abundance of different pollinators in the experimental Pigeon pea field was done following the method suggested by Jakiewicz (2003) [8]. The observations revealed that eleven different categories of pollinators were collected from the field which can be categorized in to five out of six classes of dominance.

Table 1: Pollinator's species occurring on Pigeon pea during *kharif*, 2017-2018

S.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.	Leaf cutting bee	<i>Megachile lanata</i> Fabricius	Megachilidae	Hymenoptera
4.	Leaf cutting bee	<i>Megachile disjuncta</i> Fabricius	Megachilidae	Hymenoptera
5.	Leaf cutting bee	<i>Megachile bicolor</i> Fabricius	Megachilidae	Hymenoptera
6.	Leaf cutting bee	<i>Megachile hera</i> Bingham	Megachilidae	Hymenoptera
7.	Stingless bee	<i>Tetragonula iridipennis</i> Smith	Apidae	Hymenoptera
8.	Carpenter bee	<i>Xylocopa latipes</i> Drury	Apidae	Hymenoptera
9.	Carpenter bee	<i>Xylocopa aestuans</i> Linnaeus	Apidae	Hymenoptera
10.	Wasp	<i>Eumenes</i> spp.	Vespidae	Hymenoptera
11.	Wasp	<i>Vespa tropica</i> Linnaeus	Vespidae	Hymenoptera

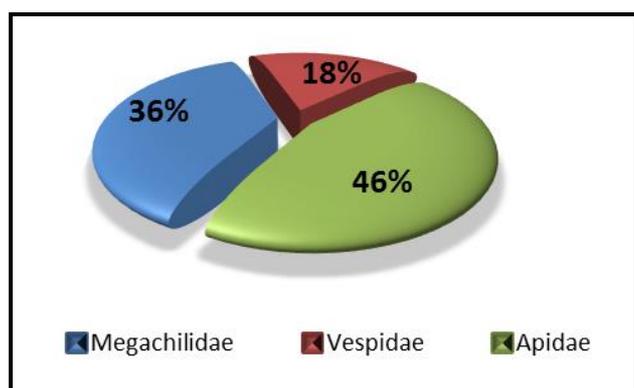
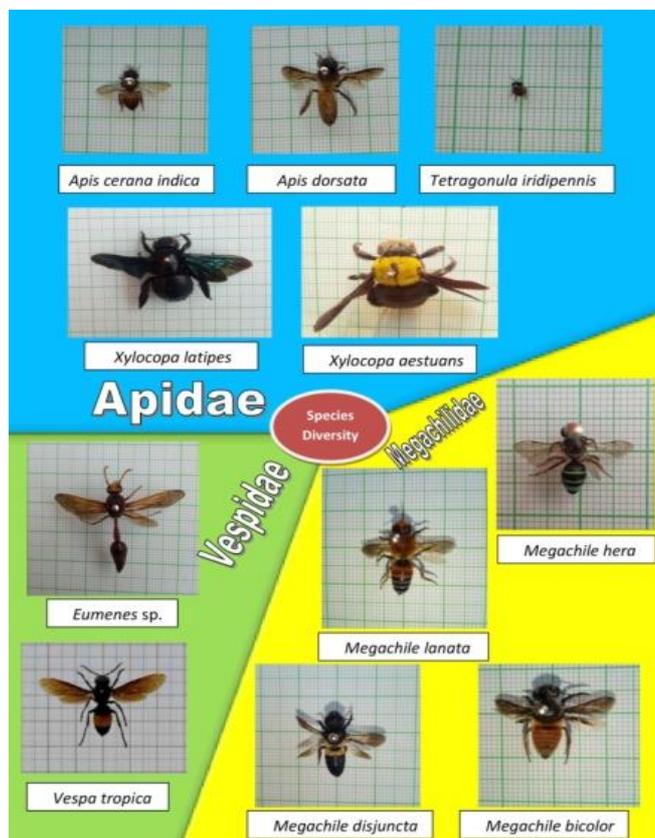


Fig 1: Different species of pollinators on Pigeon pea flower

During early flowering stage *Megachile lanata* with 31.53% share appear as Eudominant species followed by *Megachile disjuncta*, *Tetragonula iridipennis* and *Apis cerana indica* as Sub dominant. Other 4 species occupied the recedent status while 3 species with less than 9.0 per cent share assumed the

sub recedent status (Table 2)

During mid flowering stage *Megachile lanata* with 30.78% share continued to appear as the Eudominant species followed by *Megachile disjuncta* as the dominant one. *Tetragonula iridipennis*, along with *Megachile bicolor* and *Apis cerana indica* positioned under Subrecedent class while 5 other species came under recedent status. (Table 2)

During late flowering stage the scenario was observed to be different. *Xylocopa latipes* with 40.85 % share appear as the Eudominant species followed by *Megachile lanata* and *Megachile disjuncta* as the sub dominant species. During this stage majority of the pollinators species(5 numbers) classed under recedent and 3 species under sub recedent (Table 2).

Overall status revealed that all the eleven species of pollinators recorded could be placed covering four classes of dominance. Two (2) numbers of species occupied the dominant status, three (3) subdominant, four (4) recedent and two (2) sub recedent status. Among the pollinators *Megachile lanata* constitute 29.01 per cent of the total foragers and it remained the most dominant among the bee species visiting pigeon pea flowers followed by *Megachile disjuncta* (20.84%), *Tetragonula iridipennis* (14.06%), *Megachile bicolor* (10.78%), *Apis cerana indica* (10.33%) *Xylocopa latipes* (8.80%), *Megachile hera* (2.20%), *Eumenes spp.* (1.75%), *Xylocopa aestuans* (1.19%), *Vespa tropica* (0.82%) and *Apis dorsata* (0.22%) were also observed visiting on Pigeon pea (Table 2).

Singh (2016) [14] reported that *Megachile lanata* was the most dominant bee species followed by other *Megachile sp.* of Pigeon pea crop. Similar results have been reported by Brar *et al.* (1992) at Punjab, that the most abundant species was *Megachile lanata* (28%) followed by *A. dorsata* (23%) and *A. mellifera* (22%). Similar observations were also made by Ahmad and Srivastava (2002) [2] and Azevedo *et al.* (2007) [3] in Pigeon pea. Similarly Chaudhary and Jain (1978) [6] reported the predominant occurrence of *Megachile lanata*.

Pollinators’ diversity on Pigeon pea

The diversity of the pollinators are estimated through the Simpson’s index of diversity during various flowering stages (69-159 DAS) of the crop revealed that the number of species varies between 5-11 with the diversity index of 0.602-0.897. In general the diversity was almost uniform because of the evenness of the species. At 149 DAS and 159 DAS the diversity indices reduced to 0.74 and 0.60 due to reduced evenness i.e. 0.37 and 0.43 respectively as presented in Table 3. Similarly the diversity at all early, mid and late flowering (0.82-0.84) didn’t vary very much (Table 4).

Table 2: Relative populations of Pollinator’s species on Pigeon pea during Kharif, 2017-18

S. No.	Name of the Species	Number of pollinators							
		Early flowering	Dominant class	Mid flowering	Dominant class	Late flowering	Dominant class	Overall	Dominant class
1	<i>Apis cerana indica</i>	3.13(12.33)	Subdominant	4.40(10.41)	Subdominant	0.77(6.05)	Recedent	2.77(10.33)	Sub-dominant
2	<i>Apis dorsata</i>	0.13(0.51)	Subrecedent	0.03(0.07)	Subrecedent	0(0.00)	Subrecedent	0.06(0.22)	Subrecedent
3	<i>Megachile lanata</i>	8.07(31.78)	Eudominant	12.90(30.53)	Eudominant	2.37(18.62)	Subdominant	7.78(29.01)	Dominant
4	<i>Megachile disjuncta</i>	4.93(19.42)	Subdominant	9.90(23.43)	Dominant	1.93(15.16)	Subdominant	5.59(20.84)	Dominant
5	<i>Megachile hera</i>	0.87(3.43)	Recedent	0.80(1.89)	Recedent	0.10(0.79)	Subrecedent	0.59(2.20)	Recedent
6	<i>Xylocopa latipes</i>	0.50(1.97)	Recedent	1.37(3.24)	Recedent	5.20(40.85)	Eudominant	2.36(8.80)	Recedent
7	<i>Tetragonula iridipennis</i>	4.73(18.63)	Subdominant	5.80(13.72)	Subdominant	0.77(6.05)	Recedent	3.77(14.06)	Sub-dominant
8	<i>Megachile bicolor</i>	2.10(8.27)	Recedent	5.53(13.09)	Subdominant	1.03(8.09)	Recedent	2.89(10.78)	Sub-dominant
9	<i>Eumenes spp.</i>	0.70(2.76)	Recedent	0.57(1.35)	Recedent	0.13(1.02)	Recedent	0.47(1.75)	Recedent
10	<i>Vespa tropica</i>	0.10(0.39)	Subrecedent	0.53(1.25)	Recedent	0.03(0.24)	Subrecedent	0.2(0.82)	Subrecedent
11	<i>Xylocopa aestuans</i>	0.1(0.51)	Subrecedent	0.43(1.02)	Recedent	0.40(3.14)	Recedent	0.32(1.19)	Recedent

Table 3: Diversity and evenness of pollinator's species of Pigeon pea during different days after sowing (DAS)

Days after Sowing	No of species recorded	Simpsons index D	Simpsons index of diversity (SID)	Simpson's reciprocal index (I/D)	Evenness (E ₀)
69 DAS	5	0.132	0.868	7.58	0.79
79 DAS	8	0.109	0.891	9.21	0.72
89 DAS	10	0.199	0.801	5.03	0.44
99 DAS	11	0.173	0.827	5.78	0.46
109 DAS	10	0.175	0.825	5.71	0.51
119 DAS	10	0.193	0.807	5.18	0.48
129 DAS	11	0.177	0.823	5.65	0.46
139 DAS	9	0.103	0.897	9.71	0.68
149 DAS	9	0.259	0.741	3.86	0.36
159 DAS	5	0.398	0.602	2.51	0.43

Table 4: Diversity and evenness of pollinators species of Pigeon pea during different stages of flowering

Flowering Stage	No of species	Simpsons index D	Simpsons index of diversity (SID)	Simpson's reciprocal index (I/D)	Evenness (E ₀)
Early Flowering	11	0.16	0.84	6.07	0.460
Mid Flowering	11	0.18	0.82	5.64	0.462
Late Flowering	11	0.17	0.83	5.73	0.418

Conclusion

Pigeon pea crop in Odisha is visited by eleven different species of pollinators. Though family wise Apidae comprising five species was the dominant one followed by Megachilidae but population wise the megachillids, *Megachile lanata* was the most dominant followed by *Megachile disjuncta*.

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