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Study on insect diversity and their activity in *Punica granatum* var. Bhagwa

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Abstract

The study on floral visitors of pomegranate recorded in Bhagwa variety revealed 20 species of insects. Eight species were belonging to the order Hymenoptera, eleven were Lepidoptera and one was a Hemipteran. Peak abundance of all foragers was observed from 0900 to 1300 h. Among different species of insect foragers, *Apis dorsata* was the most dominant with highest "d" value followed by *Apis cerana indica*. *Apis cerana indica*, *Apis dorsata*, *Apis florea*, and *Tetragonula iridipennis* were discovered to be the primary pollinators in pomegranate, while lepidoptera were frequent visits but poor pollinators. The hymenoptera order had the most pollinators, followed by lepidoptera. Non-*Apis* bees have also been identified as promising pollinators in pomegranate.

Keywords: Bhagwa, abundance, non-APIs, Hymenoptera, lepidopteran

Introduction

Pomegranate (*Punica granatum* L.) belongs to family Lytharaceae (De Candolle, 1967) [1]. Pomegranate plant is a naturally growing shrub that has got several trunks with a bushy appearance. Once domesticated, it grows into a small tree of upto five meters (Levin, 1985) [7]. Pomegranate plants self-pollinate as well as cross-pollinate, with cross-pollination being preferred for increased production (Jambagi and Nandini, 2022; Veereshkumar *et al.*, 2021a, 2021b; Veereshkumar *et al.*, 2020) [4, 12-14]. The flowering of pomegranates is traditionally seen in three separate seasons that is in, January-February, June-July, and September-October, and the three crop seasons are known as Ambe bahar, Mrig bahar, and Hasth bahar, respectively (Prasad *et al.*, 2003) [8]. During the flowering season, it attracts a variety of insects, some of which function as pollinators, some as honey thieves, and still others as passers-by (Wilson and Thomson, 1991) [15].

Compared to other winged pollinators like birds and bats, insects pollinate flowering plants the most frequently and in large numbers. Flowers are visited by other insects (anthophiles), but they are not always pollinated by them. The history of interactions between flowers and insects both pollinators and anthophiles is extensive and diverse. The floral visitor's modern-day importance in ecosystem functioning and agricultural production has made them the subject of numerous scientific studies Kevan (2008). There is less data on the floral visitors of pomegranate henceforth, present study was undertaken. This study will provide information on the species that predominately visit pomegranate flowers, and their frequency of visitation. The results of this study may aid future research into the best pollinators for pollinating pomegranates.

Materials and methods

Different species of flower visitors were recorded by as visual counts and sweep net sampling. Identification of the pollinators were done at Biosystematics Laboratory, Department of Agricultural Entomology, UAS, GKVK, Bengaluru. All voucher specimens have been deposited with the collections of the Department of Apiculture, College of Agriculture, GKVK, Bengaluru.

Shannon Wiener diversity index

Pollinator count data was used to compute Shannon-Wiener index of diversity (H) (Shannon, 1948) by using the following formula:

$$H = -\sum p_i \times \ln p_i$$

Where in:

'H' is the Shannon-Wiener index of diversity.

'pi' is the proportion of the i^{th} species of visitor.

Berger-Parker Index (d) of dominance for species

The Berger-Parker index gives an indication of the most dominant species of pollinators when several species visit the flowers of a particular crop (Southwood, 1988). Based on this, the most potential pollinator could be identified. This index was calculated by using the following formula:

$$d = n_i / NT$$

Wherein

'd' is the index of dominance,

'ni' is the number of individuals of the i^{th} species

'NT' is the total number of individuals in a sample

Results and discussion

The study on pollinator diversity of pomegranate recorded in Bhagwa variety revealed 20 species of insect visitors. Eight species were belonging to the order Hymenoptera, eleven were Lepidopterans and one was a Hemipteran (Table 1) (Plate 8). Derin and Eti (2001)^[2] described honey bees as the major pollinators of pomegranate.

Visual observations were made to record the activity of the floral visitors of pomegranate. Among all flowers visitors of pomegranate *Apis dorsata* foragers were in relatively largest numbers and it constituted 38.40 percent when compared to other species, like as *Apis cerana* (30.4%), *Apis florea* (19.5%) and *Tetragonula iridipennis* (8.80%). Other less abundant species foragers were *Hebomoia glaucippe* (0.90%), *Colotis fausta* (0.45%), *Cepora nerissa* (0.22%), *Ceratina binghamii* (0.45) and *Papilio demoleus* (0.68). Peak abundance of all foragers was observed from 0900 to 1300h (Table 2) (Fig. 4). In cucumber, the hymenopteran, *Trigona laeviceps* (319) was found the most abundant with 27.91 percent abundance followed by *Apis florea* (266) with 23.27 percent and *Apis dorsata* (238) with 20.82 percent abundance as very common bee species (Khambhu *et al.*, 2023)^[6].

Shannon-Wiener diversity index (H) values were ranged between 0.05 to 0.54 with respect to different time periods of the day. The highest Shannon-Wiener index of diversity was observed between 1000 to 1100hrs (H=0.54), and the lowest 'H' index which was recorded in the early morning hrs 0600 to 0800 (H=0.05 to 0.15) and late evening hours 1600 to 1800 h (H= 0.23 to 0.32). Maximum diversity values from 9000 to 1300hrs which coincided with peak anthesis indicated greater diversity of species foraging during this period. (Table 10) (fig.5). Shannon-Wiener diversity Index (H) values ranged between 1.201 to 1.619 with respect to different time periods of the day in mango flower visitor. The peak diversity was observed between 0900 to 1000 hrs. and 1000 to 1100 hrs., with 'H' value of 1.597 and 1.619, respectively. These findings in mango implied that 1000 to 1100 hrs., followed by 0900 to 1000 hrs. attracts maximum diversity of foragers to mango inflorescence, because at that time anthesis was at peak. These reports on mango are similar to the present finding in case of pomegranate with regard to maximum 'H' values and peak anthesis (Joshi., 2018)^[5].

The Berger-Parker dominance index of different species

during the different time periods of the day was variable. Among different species of insect foragers, *Apis dorsata* was the most dominant with highest "d" value (d=0.38), followed by *Apis cerana indica* (d = 0.30), *Apis florea* (d=0.19), *Tetragonula iridipennis* (d=0.08), *Hebomoia glaucippe* (d=0.009), *Colotis fausta* (d=0.006), *Ceratina binghamii* (d=0.0045), *Papilio demoleus* (d=0.0045) and *Cepora nerissa* (d=0.002) in that decreasing order. However, *Apis dorsata*, followed by *Apis cerana*, *Apis florea*, *Tetragonula iridipennis* were the four most pre-dominant species on pomegranate inflorescence (Table 11) (Fig.6). The Similar observation recorded on mango indicated that Berger-Parker dominance of different species during the four different stages of mango flowering was variable among the eight different species of insect foragers, *E. obliquus* was the most dominant with highest 'd' values (d=0.40, 0.40, 0.36 and 0.34), followed by *Chrysomya* sp. at (d = 0.29, 0.27, 0.29 and 0.29), *A. florea* (d = 0.13, 0.16, 0.15 and 0.15), *A. cerana indica* (d = 0.09, 0.09, 0.09 and 0.12), *T. iridipennis* (d = 0.06, 0.04, 0.06 and 0.08), *I. scutellaris* (d=0.03, 0.03, 0.04 and 0.04), *Sarcophaga* sp. (d=0.00, 0.01, 0.01 and 0.01) and *Seladonia* sp. (0.00, 0.01, 0.01 and 0.01) in that decreasing order of corresponding values' at 25, 50, 75 and >90 per cent flowering, respectively. The "d" values for all the insect foragers in mango showed a mixed trend with respect to increase in flowering percentage. However, *E. obliquus*, followed by *Chrysomya* sp. appeared to be the two most dominant species, by virtue of relatively higher 'd' values, irrespective of the flowering stage of the crop (Joshi., 2018)^[5].

Out of all these flower visitors the Hymenopteras such as *Apis cerana indica*, *Apis dorsata*, *Apis florea* and *Tetragonula iridipennis* were found to be major pollinators in pomegranate and the lepidopterans were common visitors noticed in pomegranate but were found to be poor pollinators. Sajjanar *et al.* (2004)^[9] and Eswarappa *et al.* (2005)^[3] also recorded hymenopteran pollinators as predominant visitors of cucumber crop.

Summary and conclusion

The study on pollinator diversity of pomegranate recorded in Bhagwa variety revealed 20 species of insect visitors. The insect species recorded are *Apis cerana indica*, *Apis dorsata*, *Apis florea*, *Tetragonula iridipennis*, *Ceratina binghamii*, *Ceratina smaragdula*, *Amegilla cingulate*, *Hoplonomia spp.*, *Hebomoia glaucippe*, *Colotis fausta*, *Cepora nerissa*, *Colotis amata*, *Cepora nadina*, *Danaus chrysippus*, *Papilio demoleus*, *Junonia hierta*, *Sphinx ligustri*, *Macroglossum sp.*, *Psilogramma* sp. and *Nezara viridula*. Visual observations revealed that *Apis dorsata* foragers were the largest, accounting for 38.40% of all flower visitors. Peak abundance of all foragers was observed from 0900 to 1300h. The highest floral visitors observed between 1000 to 1100hrs and the lowest between early morning and late evening hours. The Berger-Parker dominance index of different species was variable, with *Apis dorsata* being the most dominant with the highest "d" value (d=0.38). Hymenopteras, such as *Apis cerana indica*, *Apis dorsata*, *Apis florea*, and *Tetragonula iridipennis*, were found to be major pollinators in pomegranate, while lepidopterans were common visitors but found to be poor pollinators.

Table 1: Floral visitors to pomegranate inflorescence

Sl. No.	Order	Family	Species	
1	Hymenoptera	Apidae	1. <i>Apis cerana indica</i> (Fabricius)	
2			2. <i>Apis dorsata</i> (Fabricius)	
3			3. <i>Apis florea</i> (Fabricius)	
4			4. <i>Tetragonula iridipennis</i> (Smith)	
5			5. <i>Ceratina binghami</i> (Cockerll)	
6			6. <i>Ceratina smaragdula</i> (Fabricius)	
7			7. <i>Amegilla cingulata</i> (Fabricius)	
8		Halictidae	1. <i>Hoplonomia spp.</i> (Gribodo)	
9	Lepidoptera	Pieridae	1. <i>Hebomoia glaucippe</i> (Linnaeus)	
10			2. <i>Colotis fausta</i> (Olivier)	
11			3. <i>Cepora nerissa</i> (Fabricius)	
12			4. <i>Colotis amata</i> (Fabricius)	
13			5. <i>Cepora nadina</i> (Lucas)	
14		Nymphalidae	1. <i>Danaus chrysippus</i> (Linnaeus)	
15			2. <i>Papilio demoleus</i> (Linnaeus)	
16			3. <i>Junonia hierta</i> (Fabricius)	
17		Sphingidae	1. <i>Sphinx ligustri</i> (Linnaeus)	
18			2. <i>Macroglossum sp.</i> (walker)	
19			3. <i>Psilogramma sp.</i> (walker)	
20		Hemiptera	Pentatomidae	1. <i>Nezara viridula</i> (Linnaeus)

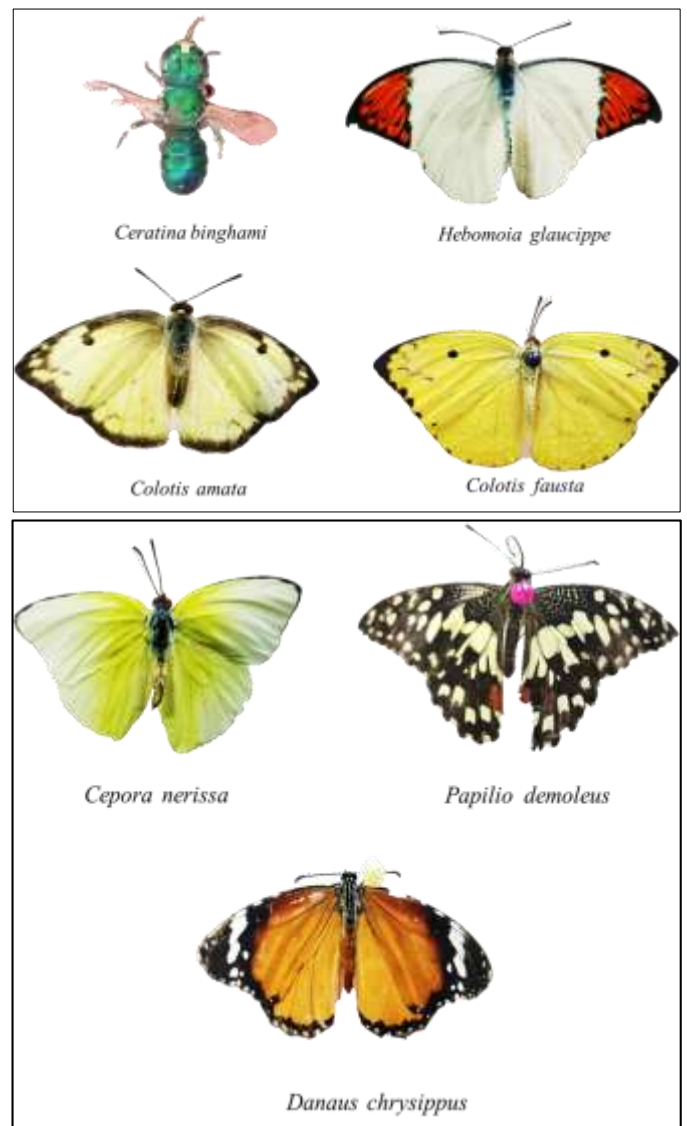
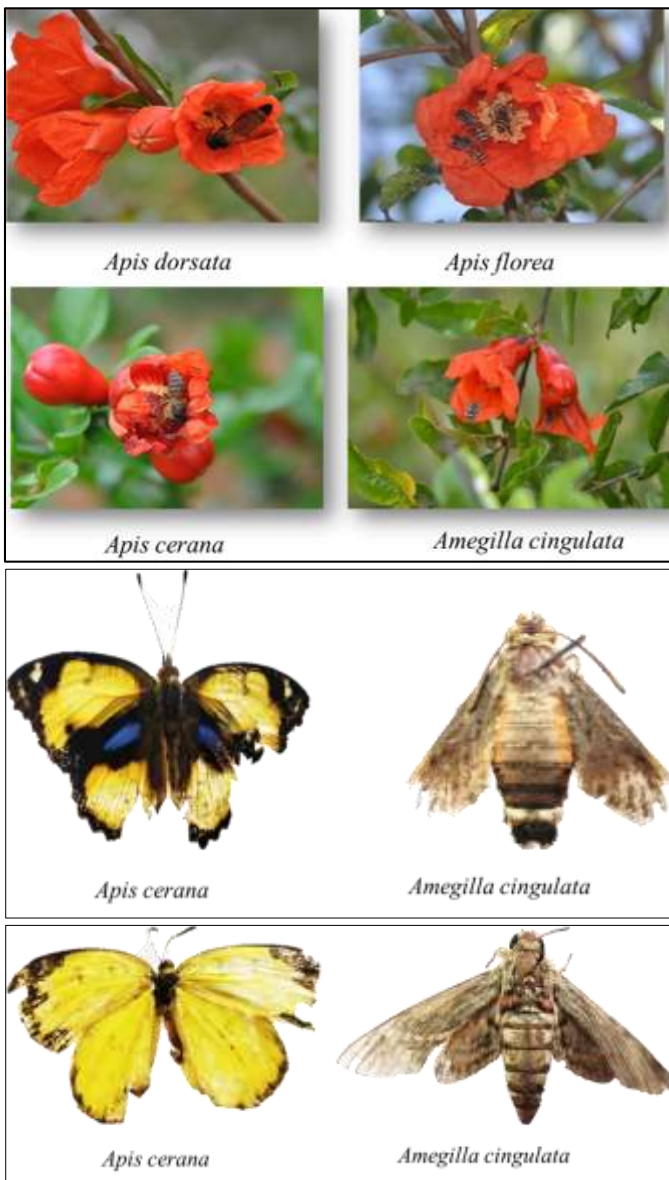


Plate 1: Floral visitors to pomegranate inflorescence

Table 2: Relative abundance of major insect pollinators at full bloom stage of pomegranate during different time periods

Time (Hrs.) Forager Spp.	0600-0700	0700-0800	0800-0900	0900-1000	1000-1100	1100-1200	1200-1300	1300-1400	1400-1500	1500-1600	1600-1700	1700-1800	Total	Mean ± SD	Composition of individual forager species (%)
<i>Apis dorsata</i>	3	7	9	22	25	27	18	10	10	11	15	10	169	13.91±7.52	38.40
<i>Apis cerana</i>	1	5	5	21	22	19	15	12	10	9	8	7	134	11.16 ± 6.76	30.45
<i>Apis florea</i>	2	2	1	10	11	12	16	12	9	8	2	1	86	7.16 ± 5.28	19.54
<i>Tetragonula irridipennis</i>	1	1	2	5	10	10	2	2	2	1	1	1	39	3.16 ± 3.37	8.86
<i>Hebomoia glaucippe</i>	0	0	0	0	1	1	0	0	1	1	0	0	4	0.33 ± 0.49	0.90
<i>Colotis fausta</i>	0	0	0	1	0	0	0	0	1	0	0	0	2	0.16 ± 0.38	0.45
<i>Cepora nerissa</i>	0	0	0	0	0	0	1	0	0	0	0	0	1	0.08 ± 0.28	0.22
<i>Ceratina binghamii</i>	0	0	0	0	0	0	0	0	1	1	0	0	2	0.16 ± 0.38	0.45
<i>Papilio demoleus</i>	0	0	0	0	1	1	0	1	0	0	0	0	3	0.25 ± 0.45	0.68
MEAN	0.77	1.66	2.83	6.55	7.77	7.77	5.77	3.88	3.77	3.44	2.88	2.11	48.88	-	-

Table 3: Shannon – Wiener index of diversity (H) for insect pollinators on pomegranate inflorescence during different time periods of the day

Time (Hrs.) Forager spp.	Number of foragers / 5 mins. per hour									Shannon Weiner Index ("H" value)
	<i>Apis Dorsata</i>	<i>Apis cerana</i>	<i>Apis florea</i>	<i>Tetragonula irridipennis</i>	<i>Hebomoia glaucippe</i>	<i>Colotis Fausta</i>	<i>Cepora nerissa</i>	<i>Ceratina bingham</i>	<i>Papilio demoleus</i>	
0600-0700	3	1	2	1	0	0	0	0	0	0.05
0700-0800	7	5	2	1	0	0	0	0	0	0.15
0800-0900	9	5	1	2	0	0	0	0	0	0.22
0900-1000	22	21	10	5	0	1	0	0	0	0.51
1000-1100	25	22	11	10	1	0	0	0	1	0.54
1100-1200	27	19	12	10	1	0	0	0	1	0.52
1200-1300	18	15	16	2	0	0	1	0	0	0.44
1300-1400	10	12	12	2	0	0	0	0	1	0.37
1400-1500	10	10	9	2	1	1	0	1	0	0.34
1500-1600	11	9	8	1	1	0	0	1	0	0.32
1600-1700	15	8	2	1	0	0	0	0	0	0.28
1700-1800	10	7	1	1	0	0	0	0	0	0.23

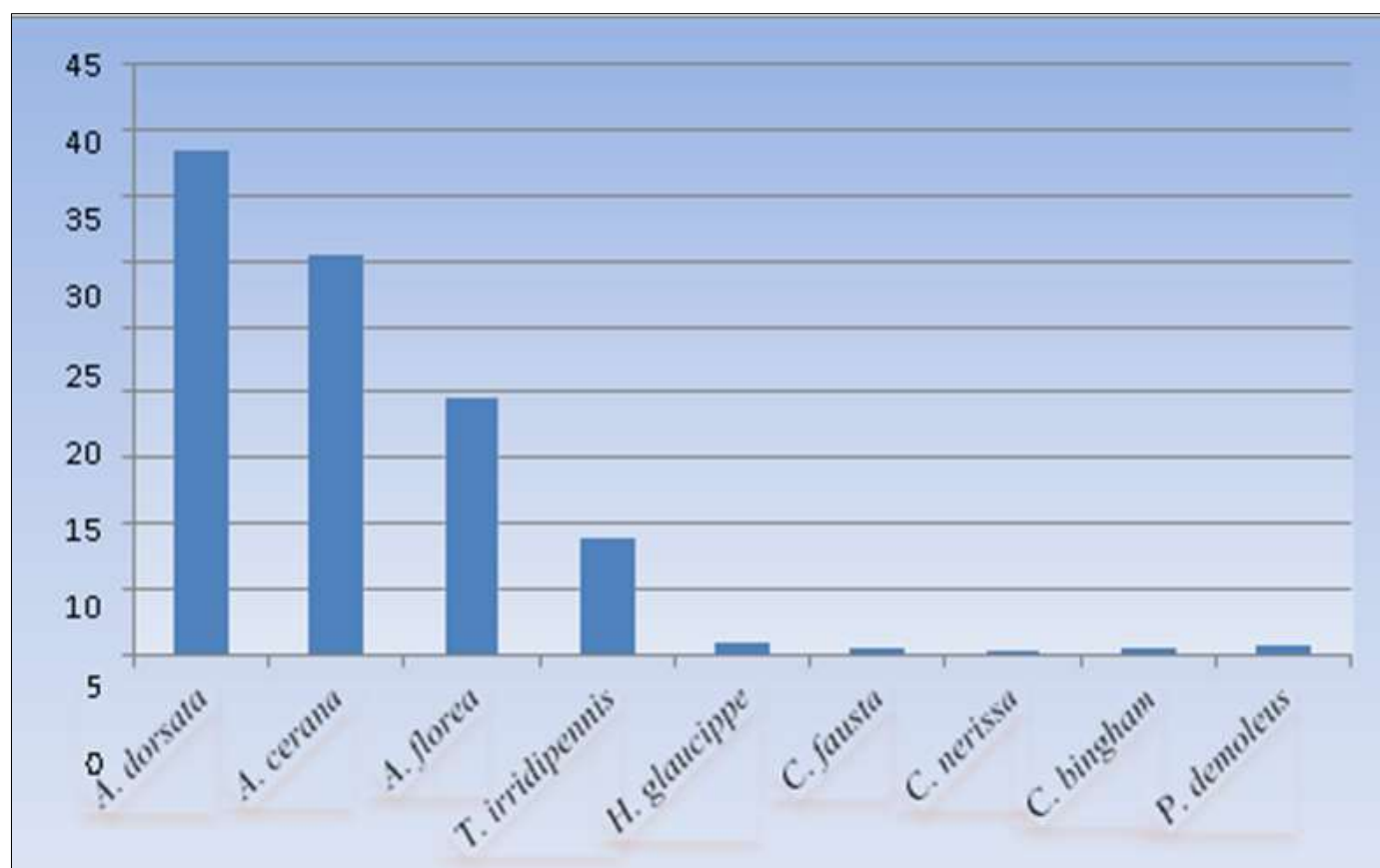


Fig 2: Species wise relative abundance at full bloom stage of pomegranate

Table 4: Berger – Parker dominance index (d) for insect pollinators on pomegranate inflorescence during peak flowering period

“d” value Forager Spp.	“d” value	1/d
<i>Apis dorsata</i>	0.38	2.63
<i>Apis cerana</i>	0.30	3.33
<i>Apis florea</i>	0.19	5.26
<i>Tetragonula iridipennis</i>	0.08	12.5
<i>Hebomoia glaucippe</i>	0.009	111.11
<i>Colotis fausta</i>	0.006	166.66
<i>Cepora nerissa</i>	0.002	500.00
<i>Ceratina binghamii</i>	0.004556	219.49
<i>Papilo demoleus</i>	0.004556	219.49

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