



Diversity and pollination probability of insect pollinators of *Tagetes Erecta* L. in the Chomu Tehsil, Rajasthan, India

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Abstract

Pollination is an essential process for the success of sexual reproduction in cross-breeding plants that is intended by different methods, including air, water and animals. The probability of entomophilous pollination depends upon the diversity of insects. A total of 18 insect species were reported for *Tagetes erecta* (Mexican Marigold) from nine families and two orders (Hymenoptera and Diptera). Hymenoptera was found to be the most abundant order followed by Diptera. Apidae was found to be the most abundant family followed by Scoliididae, Muscidae, Megachilidae, Colletidae, Syrphidae, Halictidae, Calliphoridae and Vespidae. The *Apis dorsata* bee in the study area was revealed as a major pollinator. *Apis dorsata* was reported as the most effective pollinator carrying loose pollen grains with the highest pollination index (123402.60) sticking to the body 17235. The Simpson index was estimated 0.2859, indicating high diversity in the study area and the Simpson diversity index was estimated to be 0.7141, indicating that when randomly selected from a sample; there is a more than 71 per cent probability of the two distinct species. The Shannon index was estimated at 1.525, which reflects the dominance of a sample group.

Keywords: diversity, insects, pollination, Shannon index, Simpson index

1. Introduction

Biodiversity is the variability of ecosystem biotic factors that reflect variations at the level of the species, genetics or ecosystem. For sustainable development, diversity is very relevant. The variety of insects plays an important role in maintaining the environment through the provision of pollination services. The transfer of pollen grains from an anther to the stigma of a pistil is referred to as pollination [15]. Pollination has been reported to be important for growing crop production. Only 5 percent of plants are able to self-pollinate and 95 percent of plants are cross-pollinated by animals [16]. In the absence of natural pollination, crop production has decreased [3]. Of all insect pollinators, bees are the most successful pollinators. In most aspects of human custom, economy, and society, bees are closely linked [2]. Bees, along with pollination, are found to be the main service provider for human society [8]. The plant is very useful for attracting insect pollinators for enhancing crop production. Plants are pollinated by wind (anemophilous) as well as by insects called entomophilous pollination [11]. Insects dislodged the pollen grains from the anther by the vibration in wing muscles to produce Buzz sound [1]. These pollen loads attached to the pollinators are transported from an anther to the stigma. To estimate the index of pollination, pollen loads attached to the body of insect pollinators are used. The probability of pollination is determined by the pollination index analysis [12]. Cultivation of flowers and ornamental plants for the gardening and floristry for the development of floral industry has been defined as Floriculture [4]. It has socio-economic importance in term of income generation, employment and empowerment, so considered as a boon for the farmers [13]. *Tagetes erecta* L. or Mexican Marigold is the native plant of Mexico and also found in Africa and Asia. It is a perennial plant which attains an averages height about 25 cm to 85 cm and commercially cultivated for making garlands in India.

The extract of flowers and leaves are used in the Ayurvedic treatment. Its natural oil is used in perfumery and in the treatment of fungal infection [7]. *Tagetes erecta* is cross-pollinated by various insect pollinators. *Tagetes erecta* has the pollen grains of a monad and tri-colporate type with a polar diameter of around 39 μm and equatorial diameter around 45.5 μm which seems circular in polar view and prolate to spheroidal in equatorial view with P/E ratio of 0.85 [10].

2. Material and Methods

The experiments were carried out in the private agricultural farms at the Gadero ki Dhani in the Chomu tehsil of Jaipur district, Rajasthan. The experimental site was regularly visited and Samples were collected by using hand sweeping net from 6 am to 6 pm on every field visit day. Samples were preserved in the killing bottles with ethyl acetate and brought into the laboratory for the spreading, identification and photography. For the study of pollen load, samples were collected separately very carefully to avoid unnecessary loss of pollen grains, in the glass vials contains ethanol. Pollen grains were counted with the help of the hemocytometer technique as followed by Kumar (1990) [9] with slight required modifications.

The number of loose pollens = Count of pollens \times dilution/number of 1mm square counted in Neubauer chamber.

Pollination index

Pollination efficiency of bees was determined by the pollination index which is the product of the mean proportion of loose pollen grains attached on the body of bees and the relative abundance. The abundance of insect pollinators was estimated in term of number of pollinators/m²/5 minutes

Pollination index = Abundance of pollinators × Loose pollen grains on insect body

Calculation of biodiversity

Biodiversity is a mathematical measure of species/family diversity in a given community that was calculated as Shannon Index (H) and Simpson index (D).

Shannon Index (H) = $-\sum_{i=1}^s p_i \ln p_i$

Here p= is the proportion (n/N) of individual, S= Total number of species.

N= Total number of individuals, ln = is the natural log
n= total number of individuals in a species/family

Simpson Index (D) = $\sum_{i=1}^s p_i^2$

Simpson Index of biodiversity (1-D) = $1 - \sum_{i=1}^s p_i^2$

Simpson Reciprocal Index (1/D) = $1 / \sum_{i=1}^s p_i^2$

Here p= is the proportion (n/N) of individual, S= Total number of species

N= Total number of individuals, ln = is the natural log
n= total number of individuals in a species/family

The Shannon index is the statistical index of knowledge

which assumes that every species is present and randomly selected in a sample. The Simpson index is the index that emphasizes the most commonly used species.

3. Result

The study area as shown in table 1 was occupied by a total of 18 species of insects from nine families (Apidae, Halictidae, Syrphidae, Calliphoridae, Muscidae, Scoliidae, Megachilidae, Colletidae, and Vespidae). Apidae family was observed as most abundant family on *Tagetes erecta* (Fig 1). *Apis dorsata* is the most abundant pollinator on *Tagetes erecta* followed by *Apis florea*, *Campsomeriella collaris*, *Campsomeriella annulata* and other pollinators as given in table 2. Maximum levels of loose pollen grains attached to *Apis dorsata* (approximately 17,235) were estimated, followed by *Apis mellifera*, *Amegilla cingulata* and *Nomia spp.* The maximum pollination index was recorded for *Apis dorsata* (1, 23,402.60) (Fig 2). Biodiversity of insect pollinators was calculated in term of Shannon index (H) and Simpson index (D). Shannon index (H) was estimated 1.525, Simpson index (D): 0.2859, Simpson index of biodiversity (1-D): 0.7141 and Simpson reciprocal index (1/D): 3.4977 as given in table 3. Some most common insect pollinators are shown in Fig.3.

Table 1: Insect pollinators on *Tagetes erecta*

Sr. No.	Scientific name of pollinators	Order	Family	Foraging purpose
1	<i>Apis florea</i>	Hymenoptera	Apidae	Pollen & Nectar
2	<i>Apis dorsata</i>	Hymenoptera	Apidae	Pollen & Nectar
3	<i>Apis mellifera</i>	Hymenoptera	Apidae	Pollen & Nectar
4	<i>Apis cerana</i>	Hymenoptera	Apidae	Pollen & Nectar
5	<i>Thyreus minuta</i>	Hymenoptera	Apidae	Pollen & Nectar
6	<i>Amegilla zonata</i>	Hymenoptera	Apidae	Pollen & Nectar
7	<i>Amegilla comberi</i>	Hymenoptera	Apidae	Pollen & Nectar
8	<i>Nomia spp.</i>	Hymenoptera	Halictidae	Pollen & Nectar
9	<i>Eristalis tenax</i>	Diptera	Syrphidae	Nectar
10	<i>Lucilia sericata</i>	Diptera	Calliphoridae	Nectar
11	<i>Halophilus spp.</i>	Diptera	Syrphidae	Nectar
12	<i>Musca domestica</i>	Diptera	Muscidae	Nectar
13	<i>Canipsomeriella collaris</i>	Hymenoptera	Scoliidae	Pollen
14	<i>Canipsomeriella cmulata</i>	Hymenoptera	Scoliidae	Pollen
15	<i>Micromeriella spp.</i>	Hymenoptera	Scoliidae	Pollen & Nectar
16	<i>Megachile gathela</i>	Hymenoptera	Megachilidae	Pollen & Nectar
17	<i>Colletes minutes</i>	Hymenoptera	Colletidae	Pollen & Nectar
18	<i>Vespa orientalis</i>	Hymenoptera	Vespidae	Nectar

Table 2: Pollination index of various insect pollinators on *Tagetes Erecta*.

Sr. No.	Pollinators	Abundance (bees/m ² /5 minutes)	Number of loose pollen grains Sticking on the body of a bee	Pollination index Abundance x loose pollen grains
1	<i>Apis florea</i>	6.30	13385	84325.50
2	<i>Apis dorsata</i>	7.16	17235	123402.60
3	<i>Apis mel4fera</i>	4.73	16807	79497.11
4	<i>Apis cerana</i>	3.23	15124	48850.52
5	<i>Thymus minuta</i>	4.76	12295	58524.20
6	<i>Amegilla zonata</i>	4.42	14356	63453.52
7	<i>Amegilla comberi</i>	3.01	16418	49418.18
8	<i>Nomia spp.</i>	2.82	16101	45404.82
9	<i>Eristalis tenor</i>	2.24	6427	14396.48
10	<i>Lucilia sericata</i>	1.59	3099	4927.41
11	<i>Halophilus spp.</i>	1.33	5492	7304.36
12	<i>Musca domestica</i>	4.71	4331	20399.01
13	<i>Campsomeriella collaris</i>	5.98	9218	55123.64
14	<i>Campsomeriella cmulata</i>	5.16	9115	47033.40
15	<i>Mcromeriella spp.</i>	5.50	8497	46733.50
16	<i>Megachile gathela</i>	4.07	13917	56642.19

17	<i>Colletes minutes</i>	3.81	12111	46142.91
18	<i>Vespa orientalis</i>	1.14	5241	5974.74

Table 3: Shannon / Simpson biodiversity index

Sr. No.	Families on <i>Tagetes erecta</i>	Abundance n	n/N	Pi	Pi ²	ln pi	Pi ln pi
1	Apidae	33.61	33.61/71.96	0.4670	0.2180	-0.7614	-0.3555
2	Halictidae	02.82	02.82/71.96	0.0391	0.0015	-0.9390	-0.0367
3	Megachilidae	04.07	04.07/71.96	0.0565	0.0031	-2.8735	-0.1623
4	Colletidae	03.81	03.81/71.96	0.0529	0.0027	-2.9393	-0.1554
5	Syrphidae	03.57	03.57/71.96	0.0496	0.0024	-3.0037	-0.1489
6	Calliphoridae	01.59	01.59/71.96	0.0220	0.0004	-3.8167	-0.0839
7	Muscidae	04.71	04.71/71.96	0.0654	0.0042	-2.7272	-0.1783
8	Scoliidae	16.64	16.64/71.96	0.2312	0.0534	-1.4644	-0.3385
9	Vespidae	01.14	01.14/71.96	0.0158	0.0002	-4.1477	-0.0655
S (Number of families) = 09		N (Total number of individuals) = 71.96					
Sum of pi ² (n/N) = 0.2859		Sum of Pi ln pi = -1.525					
H = Shannon Biodiversity Index		D = Simpson Biodiversity Index = 0.2859					
H = - (-1.525) = 1.525		1/D = 1/0.2859 = 3.4977					
		1-D = 1- 0.2859 = 0.7141					

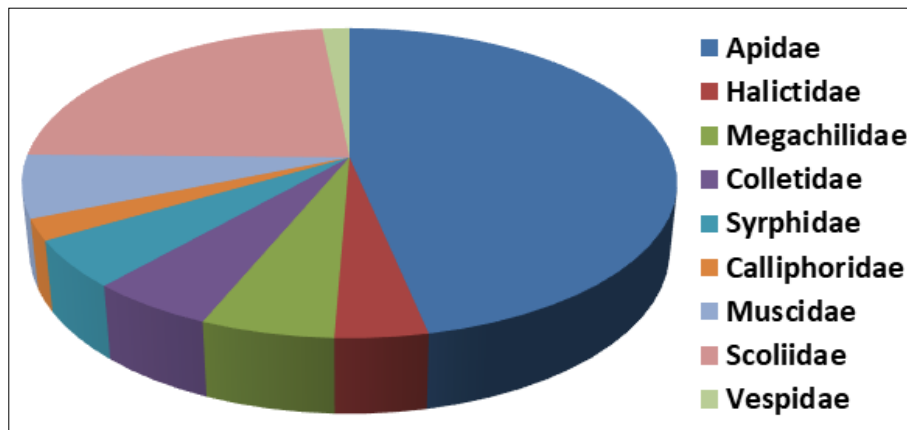


Fig 1: Abundance of families of insect pollinators (Insects/m²/minutes)

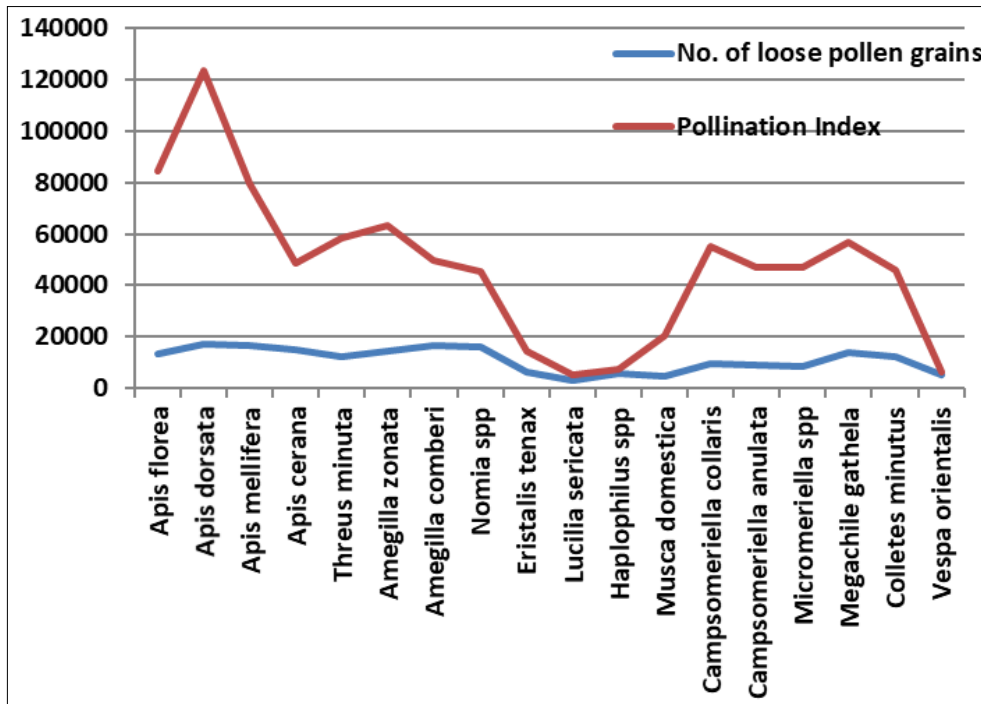


Fig 2: Pollination probability



Fig 3: insect pollinators on *Tagetes erecta* from the research area

4. Discussion

Results represent that insects from Hymenoptera are the major pollinators on *Tagetes erecta* and family Apidae is the most abundant family in the pollination service. Pollination index represents that Honey bees have high pollination probability and actively engaged in cross-pollination service. It has been found that intensive foraging behaviour of honey bee makes them able to sense the availability of food within a large territory^[6]. Pollination probability of *Apis dorsata* was estimated highest in the sample group of pollinators because of its large size while *Lucilia sericata* has lowest pollination index. Size of insect pollinators and morphological features greatly influenced the pollination probability^[17]. *Vespa orientalis* has a large size relative to *Apis florea*, but due to morphological features and pollination adaptability, its probability of pollination is lower. The probability of pollination has been significantly affected by morphological features^[5, 14]. The Simpson Diversity Index (D) was calculated to be 0.2859, suggesting greater diversity in the region of the study. The value of D varies from 0-1. With D's declining value, diversity increases. Range of Simpson index is 0-1, indicating the range of diversity in the study area. In the experimental field, zero value shows infinite diversity while 1 index shows no diversity. The Simpson index (D) was calculated at 0.2859, indicating high diversity in the study area, and it means that if randomly selected from an experimental population, there is more than 28 percent probability of the same species. The Simpson diversity index (1-D) was calculated at 0.7141, reflecting that two distinct species are more than 71 percent likely to be selected randomly from the study. Shannon index represents the abundance and evenness of the group in the sample was determined to be 1.525, reflecting the dominance of a group in the sample that was Apidae family in the sample.

5. Conclusion

Tagetes erecta attracts more insect pollinators, so it is important to cultivate such flowering plants close to agricultural farms in order to increase the yield for better commercial production and economic development. The size of bees and pollen carrying ability increase the probability of pollination. Apis bees are more effective

pollinators than others, while in the field, dipterans are less effective pollinators. It was proposed that farmers actively participate in bee farming in their respective field because without the presence of insect pollinators, agricultural work cannot be sustained.

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7. References

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