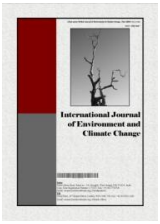

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Role of Non-cultivated Flowering Plants in Conservation of Pollinators

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

A study was conducted to emphasize the importance of non-cultivated plants/weeds in North Bangalore, Karnataka from October 2014 to March 2015 in three locations. The pollinators were collected using sweep net method on cultivated and non-cultivated flowering plants. A total of 22 non-cultivated plant species and 11 cultivated plant species were observed on which 85 and 56 pollinator species were collected respectively belonging to the four families (Apidae, Halictidae, Megachilidae and Scoliidae) of Hymenoptera and two families (Syrphidae and Bombyliidae) of Diptera. It is found that association of pollinators were more towards non-cultivated plants than cultivated plants. Among cultivated flowering plants, *Ocimum americanum* was highly attractive followed by Field bean and *Lavandula angustifolia*. Among non-cultivated flowering plants, *Alternanthera sessilis* was highly attractive on which majority were Dipterans followed by *Leucas aspera* and *Hyptis suaveolens* indicating the importance of non-cultivated flowering plants/weeds in conservation of pollinators.

Keywords: Non-cultivated; cultivated; pollinator; conservation.

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1. INTRODUCTION

Pollinator provides an importance ecosystem service. Leading 87 global food crops are entirely or partly dependent on animal pollination and that these crops make up 35 per cent of the global food production [1]. Insects that visit flower provide an important ecosystem function to global crop production through their pollination services [2]. Potential risk to crop production has emerged as pollinator declining globally due to agricultural intensification [3] and habitat fragmentation [4]. A plant and its pollinator have a mutualistic relationship. Pollinators depend on floral resources for their food, on either mass flowering crops or weeds. It has been established that pollinators are essential for survival and reproduction of several wild plant species also. The mass flowering of crops reduces the time for pollinator visits in contrast weeds has less flowers but present constantly and timely to pollinators. In conflict to farmers, weeds may reduce the yield of crops, but weeds also maintain pollinators and provide the ecosystem services, therefore presence of weeds in the farm also benefits the farmer. As pollinators enhance the crop yield, at least for some annual crop [5] and many plant species, mainly weeds, found in natural and semi-natural habitats are food resources for honeybees [6] as well as wild, solitary bees, the loss of such natural habitats therefore, regarded as the primary cause for decline of wild pollinators with both a decrease in nesting and foraging sites [7,8]. Therefore, this study emphasis on importance of non-cultivated plants/weeds for the conservation of pollinators.

2. MATERIALS AND METHODS

2.1 Study Area

The study was conducted at North Bangalore in Karnataka. Accordingly, three locations viz., Sadahalli, Gandhi Krishi Vigyan Kendra campus and Hebbal were selected for the collection of pollinators.

2.2 Methodology

Sweep net method of sampling was followed. Sampling was done at monthly intervals from October, 2014 till March 2015. In each month three samples were taken at each location with a total of 54 samples.

2.3 Sweep-net Sampling

Flower visitors were collected by direct netting on flowering plants using an insect sweep net. The net consisted of 75 cm long handle with a 30 cm dia hoop fitted with a mesh bag of 60 cm depth. Sweep net samples were made approximately 300 m away from the site where bee bowls were placed in the selected location. A total of six hours of active sampling was done on each sampling day at each site of sampling. Sampling was done on consecutive days in the three locations. Three samples per month with an interval of ten days were taken. The sampling effort in terms of time spent was constant for each location. Sweeps were made randomly on the flowering plants to collect all insects visiting flowers or hovering near flowers of any flowering plant in the area irrespective of whether the plant was a weed or a cultivated species. The collected insects were transferred to a killing jar containing ethyl acetate. The specimens were brought to the laboratory, pinned, labelled and dried for further identification. All specimens have been deposited in the department of Entomology, UAS, GKVK, Bangalore.

2.4 Record of Bee Flora

In order to gain insight into the pollination habits of the pollinators and to determine the spectrum of different pollinator species visiting the blossom of plant. All the flowering plants (cultivated and non-cultivated plants) visited by pollinators were recorded along with the pollinator species visited in rural, peri-urban and urban area. The pollinator flora was identified with the help of experts in the Botanical Garden, UAS, GKVK, Bangalore. The floral resources were divided in to three categories based on number of species attracted:

Highly Attractive : > 10 species
Attractive : 6-10 species
Less Attractive : 1-5 species

3. RESULTS AND DISCUSSION

This study describes the importance of weeds/non-cultivated flowering plants, which helps to harbor the pollinators and help the crop for better pollination and fruit set. A total of 33 plant species were observed of which 22 species were non-cultivated plants and 11 species were cultivated plants on which pollinators were collected. In total 85 and 56 pollinator species were collected from non-cultivated and cultivated flowering plants respectively belonging to the

four families (Apidae, Halictidae, Megachilidae and Scoliidae) of Hymenoptera and two families (Syrphidae and Bombyliidae) of Diptera (Table 1).

3.1 Association of Pollinators with Non-cultivated and Cultivated Flowering Plants

It was evident that the rich diversity of pollinators were related to the availability of floral plant but due to Agricultural intensification, landscape biodiversity for pollinators decreased [9] making weeds a significant part of the remaining floral diversity. The overall association of pollinators were found to be more towards non-cultivated flowering plants than cultivated flowering plants. The members of family Bombyliidae were observed only on non-cultivated flowering pants, similarly species of Halictidae, Scoliidae and Syrphidae were found to be higher towards non-cultivated flowering plants. In contrast if these non-cultivated flowering plants/weeds are removed from the agroecosystem that may lead to the decline of native pollinators [10,11]. Species of Apidae were found to be associate similar on cultivated and non-cultivated flowering plants due to more attractive nature of cultivated crops like, Field bean and *Ocimum americanum* (Fig. 1).

3.2 Number of Pollinators Attracted to Non-cultivated and Cultivated Flowering Plants

One pollinator to one plant species relationship are very rare in plant-pollinator interaction. More often plants have pollination syndrome directed towards broader pollinator groups. In the study flowering plant were broadly classified in to highly attractive (> 10 species), attractive (6-10 species), less attractive (1-5 species). Among cultivated flowering plants, *Ocimum americanum* found to be highly attractive with 43 species which majorly include 18 species of Apidae and 15 species of Megachilidae as it is evident,

Table 1. Pollinator species collected on non-cultivated/weeds and cultivated flowering plants from October 2014 to March 2015

Order	Family	Pollinator species	
		Collected on non-cultivated Plants	Collected on cultivated Plants
Hymenoptera	Apidae	18	25
	Halictidae	15	8
	Megachilidae	17	17
	Scoliidae	8	2
Diptera	Syrphidae	16	4
	Bombyliidae	11	0
Total		85	56

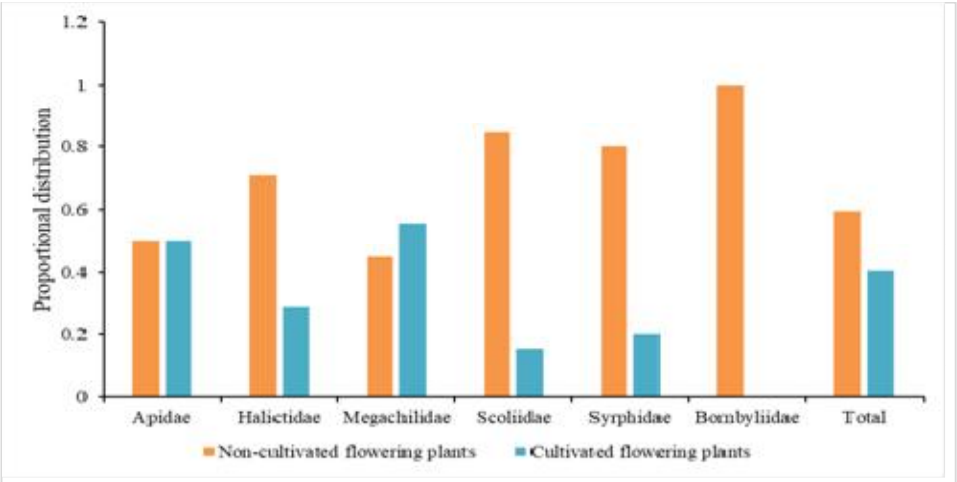

Fig. 1. Proportional distribution of pollinator families on non-cultivated and cultivated flowering plants

Table 2. Number of pollinators attracted to non-cultivated and cultivated flowering plants. Highly attractive (> 10 species), attractive (6-10 species), less attractive (1-5 species)

Host	Apidae	Halictidae	Megachilidae	Scolidae	Syrphidae	Bombyliidae	Total
Bitter gourd (*Momordica charantia*)	3	0	0	0	1	0	4
Cucumber (*Cucumis sativus*)	5	0	0	0	0	0	5
Field bean (*Vicia faba*)	18	3	2	0	0	0	23
Lavandula angustifolia	7	0	13	0	2	0	22
Muskmelon (*Cucumis melo*)	3	1	0	0	1	0	5
Ocimum americanum	18	7	15	2	1	0	43
Redgram (*Cajanus cajan*)	9	1	5	0	0	0	15
Ricebean (*Vigna umbellata*)	5	1	6	0	0	0	12
Sponge gourd (*Luffa aegyptiaca*)	5	1	0	0	0	0	6
Watermelon (*Citrullus lanatus*)	5	3	0	0	4	0	12
Jasminum officinale	3	0	0	0	0	0	3

Table 3. Number of pollinators attracted to non-cultivated and cultivated flowering plants. Highly attractive (> 10 species), attractive (6-10 species), less attractive (1-5 species)

Host	Apidae	Halictidae	Megachilidae	Scolidae	Syrphidae	Bombyliidae	Total
Alternanthera sessilis	4	9	0	0	16	5	34
Cassia hirsuta	5	0	1	0	0	0	6
Crotolina pallidas	4	0	2	0	0	0	6
Dactyloctenium aegyptium	2	0	0	0	0	0	2
Hyptis suaveolens	12	0	12	3	0	6	33
Lagascea mollis	1	1	0	0	0	0	2
Lantana camara	4	0	0	1	0	0	5
Leucas aspera	15	7	8	0	3	0	33
Mimosa pudica	3	2	0	0	0	3	8
Oxalis acetocella	0	3	0	0	5	0	8
Oxygonum sinuatum	4	0	0	0	0	0	4
Paspalum sp.	1	0	0	0	1	0	2
Richardia scabra	3	8	0	1	2	3	17
Sida cordifolia	1	0	0	0	0	0	1
Stylosanthes fruticosa	4	4	1	6	0	0	15
Synedrella vialis	1	0	0	0	0	0	1
Tecoma stans	3	3	0	0	0	0	6
Tephrosia purpurea	4	3	9	0	2	0	18
Trichodesma indicum	3	1	0	0	0	0	4
Tridax procumbens	3	0	0	0	7	0	10
Triumfetta rhomboidea	1	0	0	0	0	0	1
Waltheria indica	3	1	0	0	0	0	4

genus *Ocimum* known to support many pollinators of wild plants when these plants are not in flowering [12]. These were followed by Field bean and *Lavandula angustifolia* (Table 2). Among non-cultivated flowering plants 34 species were found on *Alternanthera sessilis* which was highly attractive to Dipterans with 21 species as flowers of *A. sessilis* are morphologically adapted to cross pollination to attract the insects like, Hoverflies and Honeybees by producing nectar and emitting scent [13]. Similarly, *Leucas aspera* and *Hyptis suaveolens* were present in two different locations as weed found highly attractive with 33 species of pollinators majorly include Apidae and Megachilidae (Table 3). There is a strong correlation between plant diversity and wild bee diversity [14,15]. With importance of non-cultivated flowering plants/weeds, which are highly attractive to pollinators is an emerging tactic by agroecologist to sustain pollinators and pollinators can use weeds as alternate source of resources before, during and after the flowering crop, there by increases the yield [16]. Carvalheiro et al. [5] showed for instance that, when or when weeds are growing sufficiently close to crops or weeds are present in sufficient numbers, the wild bee community is more abundant, pushing honeybees away to pollinate crop flowers which in turn increase crop production. Growing of such specific weeds in crop fields may improve the abundance diversity of pollinators [17]. This can be achieved by planting non-cultivated flowering plants/weeds in strips or along border in the farming ecosystem of majorly monoculture that enhances the pollinators [18].

4. CONCLUSION

There is clear evidence of recent declines in both wild and domesticated pollinators maybe due to habitat loss and fragmentation. Maintaining non-cultivated plants/weeds in and around the field without competing with crop, provide floral resources and maintain flagship species particular pollinating insects and provide the bulk of pollination services.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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