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OFF-SEASON WEED FLORA - A PROSPEROUS FORAGING SOURCE FOR MELIPONICULTURE IN HIGH RAINFALL AGRO-CLIMATIC ZONE OF TAMILNADU, INDIA

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Abstract

A phytosociological survey was carried out in two blocks (Killiyoor and Thuckaly) of high rainfall agro-climatic zone of Tamilnadu, to identify the bee-forage weed flora, its density, frequency and importance value index (IVI). During the critical dearth period (April to June), a total of 42 different pollen and nectar yielding weed flora belonging to 38 genera and 24 families have been recorded. Among the 24 families, Asteraceae was the largest weed flora family representing 8 weed species, followed by Leguminosae (4) and Commelinaceae and Malvaceae (each three). The highest IVI value was recorded on *Abutilon indicum* followed by *Cyanodon dactylon, Commelina benghalensis, Cyanotis axillaris, Trianthema portulacastrum, Mimosa pudica, Cyperus rotundus, Chromolaena odorata, Tridax procumbens, Leucas aspera, Commelina diffusa, Euphorbia hirta, Amaranthus viridis, Parthenium hysterophorus, Sida acuta, Lantana camara, Ageratum conyzoides, Croton sparsiflorus, etc.* and considered as most abundant among the observed weed floras. These weed floras may serve as a good foraging source for Meliponiculture during dearth period.

Keywords : Bee-forage, dammer bee, phytosociology, spatial distribution, stingless bee.

Introduction

Meliponiculture is the art and science of rearing stingless bees for honey, pollen, resin and ecological services. It provides new opportunities to increase household income, especially of rural folks, through the sale of honey and other bee products. Honey derived from stingless bees is of high quality and having therapeutic to many ailments. On the other hand, stingless bees are effective pollinators of many of our economic crops of the families like compositae, cruciferae and leguminoceae etc. where honeybees fail to pollinate (Rahman *et al.,* 2015).

Stingless bee colonies are naturally long-lived and these bees lack functional sting, making them suitable pollinators for crops cultivated in inhabited areas. Many people who have opted out of beekeeping because of their highly defensive behaviour of honey bees may be persuaded to take up Meliponiculture, particularly if floral resources are abundant.

Stingless bees are found throughout the tropical and subtropical regions of the world. There are at least 600 species of stingless bees in the world classified under about 60 genera, as compared with only 11 species of honeybees in a single genus Apis (Bradbear, 2009; Rasmussen *et al*., 2010). *Trigona* spp. (Hymenoptera: Apidae) was the most common stingless bee species found in the southern region of Western Ghats.

Nests of stingless bee are mostly found on subterranean cavities, inside the termite mound, cavities of the tree trunk, old walls, *etc*. These bees build an interesting type of comb made of propolis, mud. In general, under natural conditions, species of stingless bees produce around 200-500 g of honey per season. These stingless bee colonies are managed in artificial hives by bee keepers to produce honey based products such as honey, pollen, cerumen and propolis (Vijayakumar *et al*., 2013). The *Kani* tribes of Western Ghats have used hives made of bamboo poles to domesticate stingless bees and harvest about 600-700 g of honey per year per hive (Suresh Kumar *et al*., 2012). Because of their rich medicinal value, honey of stingless bee collected from wild is sold at a rate of more than Rs.3000/Kg.

Most species of stingless bees have a foraging range lesser than that of honeybee. In general, most of the stingless bees forage at a distance of less than 500 meters. Hence, it constructs its nest nearer to the source. It can be effectively utilized in home gardens for pollination of crops because of their easy accessibility with limited foraging distance. Maximum foraging activity is observed in late morning, while early morning showed the lowest (Bisui *et al*., 2019).

Flowering plants are the foundation of bee's survival. From flowers, they obtain pollen, the protein rich food used principally to feed the brood and nectar. The abundance of bee-flora and their continuous availability is the major pre-requisites for successful survival of bees. Depending upon the climatic and edaphic factors, the habitat of the vegetation and the time of the blooming may change even for the same plants. However, every region has its own nectar flow and critical floral dearth periods. In dearth period when crops are not in blooming, weeds and wild flowering plants are observed as alternate food source for honeybees. Most weeds are of high therapeutic value for human beings and hence the nectar and pollen obtained have rich medicinal properties (Rex Immanuel and Lyla Elizabeth., 2009; Rex Immanuel, 2020). The present study was initiated during the critical dearth period to investigate suitable weed flora for stingless bees of High Rainfall zone of Tamilnadu.

Materials and Methods

Site Description

The study area, Kanyakumari district was situated at the southernmost tip of the Indian peninsula. The district lies

between 77° 15' and 77° 36' Eastern Longitudes and 8° 03' and 8° 35' Northern Latitudes. Kanyakumari district comes under Agro-Climatic Region of West Coast Plains and Ghats Region (XII) (Planning Commission), Agro Ecological Region / Sub Region of Eastern Ghats and Tamil Nadu Uplands and Dry Region (ICAR) (8.1) and High Rainfall Zone of Tamilnadu (TN-6) (NARP). The proximity of equator, its topography and widespread climate factors favour the growth of diversified vegetation.

The Western region of Kanyakumari district (Vilavancode Taluk) is characterized by a bimodal distribution of rainfall with an annual average of >180 cm and a growing period of > 210 days. The first rains start at late of March or the beginning of April and end in August popularly called as '*Kannipoo'* season. The second season starts in early September and ends in early December popularly known as '*Kumbapoo*' season. Other Taluks receive an annual rainfall between 130 and 180 cm with a growing period of 150–180 days. The rainfall trend is unimodal and lasts for approximately 6 months (June – November). Minimum temperature prevailing is 24°C and maximum temperature is 34°C.

The forests (32.39 %) in Kanyakumari District are verdant and virgin forests and believed to be of 75 million years old. The district is purely agriculture oriented (net area sown 46 %) and its economy solely depends on agricultural production. The cropping pattern varies with the effect of climate, topography, soil and irrigation facilities.

Identification of bee-foraging weed flora

Based on the opinion of the elder bee keepers, the critical floral dearth period occurred between April – June. Field data were collected through standard weekly visit to the study sites during April to June, 2016–2018. Each study visit served as pseudo replicates for the site and all observations were taken between 07 00-09 00 hours. The intensity of visit by the foraging stingless bee was visually monitored by recording the number of times a particular foraging source was visited. Number of bees visiting flowers/ plant/ 10 minutes was counted. On the basis of frequency of visit by these bees, the plant species were categorized as frequently visited, moderately visited and poorly visited and indicated by '***', '**' and '*' respectively.

Weed flora survey

The study was based on extensive and intensive field surveys during the dearth period (May month of 2016–2018). A systematic phytosociological survey is necessary to build target oriented research programs such as documentation of weed flora. The study was done in two blocks (Killiyoor and Thuckaly). Agro-ecosystems were selected for data collection and total of 50 quadrates (1 x 1 m) per block were used. From the centre of the block, four directions viz., north, south, east and west and in each direction, at five km distance were surveyed. Importance Value Index (IVI) is a significant quantitative analytical parameter of weed species. It reflects the degree of overall spreading of individual species in a particular ecosystem and usually calculated with the help of following equations (Curtis and McIntosh, 1950).

Importance Value Index (IVI) was computed by summing up by the per cent relative frequency, per cent relative density and per cent relative abundance in each cropping /ecosystem.

Frequency (%) = (Total number of quadrates in which the species occurred / Total number of quadrates studied) x 100

Density = (Total number of individuals of a species in all quadrates / Total number of quadrates studies)

Abundance = (Total number of individuals of a species in all quadrates / Total number of quadrates in which the species occurred)

Relative frequency (%) = (Frequency of individuals of a species / Total frequency of all species) x 100

Relative density (%) = (Density of individuals of a species / Total density of all species) x 100

Relative abundance (%) = (Abundance of individuals of a species / Total abundance of all species) x 100

IVI = Relative frequency + Relative density + Relative abundance

Results and Discussion

The present investigation revealed that 42 species of pollen and nectar providing weedy plants distributed in 38 genera belonging to 24 families flourished during dearth period (Table 1). Asteraceae was the most dominant family with eight species, followed by Leguminosae four species and Commelinaceae and Malvaceae each three species. The weed species such as *Abutilon indicum, Blumea lacera, Commelina benghalensis, Commelina diffusa, Cyanotis axillaris, Cynodon dactylon, Cyperus rotundus, Lantana camara, Leucas aspera, Mimosa pudica, Sida acuta, Trianthema portulacastrum* and *Tridax procumbens* were frequently visited by the stingless bees. The other weeds such as *Ageratum conyzoides, Amaranthus viridis, Cassia occidentalis, Chromolaena odorata, Cleome gynandra, Cleome viscose, Clitoria ternata, Croton sparsiflorus, Digera arvensis, Dipteracanthus prostrates, Euphorbia hirta, Parthenium hysterophorus, Physalis minima, Sida cordifolia, Stachytarpheta indica, Tribulus terrestris, Trichodesma indicum, etc*. were moderately visited by the stingless bees. The other weeds were less frequently visited by stingless bees.

Table 1 : Stingless bee visiting weedy plants during dearth period

S. No	Scientific name	Common name	Family	Frequency of visit
1.	*Abutilon indicum*	Country mallow	Malvaceae	***
2.	*Acmella paniculata*	Panicled Spot Flower	Asteraceae	*
3.	*Ageratum conyzoides*	Goat weed	Asteraceae	**
4.	*Amaranthus viridis*	Slender amaranth	Amaranthaceae	**
5.	*Biophytum sensitivum*	Little Tree Plant	Oxalidaceae	*
6.	*Blumea lacera*	Blumea	Asteraceae	***
7.	*Boerhavia diffusa*	Mukkurattai	Nytaginaceae	*

8.	*Calotropis gigantea*	Giant milkweed	Apocynaceae	*
9.	*Cassia occidentalis*	Coffee weed	Caesalpiniaceae	**
10.	*Chromolaena odorata*	Devilweed	Asteraceae	**
11.	*Cleome gynandra*	Spider Flower	Cleomaceae	**
12.	*Cleome viscosa*	Asian spider flower	Leguminosae	**
13.	*Clitoria ternata*	Butterfly Pea	Leguminosae	**
14.	*Commelina benghalensis*	Tropical spiderwort	Commelinaceae	***
15.	*Commelina diffusa*	Spreading dayflower	Commelinaceae	***
16.	*Convolvulus arvensis*	Field bindweed	Convolvulaceae	*
17.	*Corchorus trilocularis*	Wild jute	Tiliaceae	*
18.	*Croton sparsiflorus*	Ban tulsi	Euphorbiaceae	**
19.	*Cynodon dactylon*	Bermuda grass	Poaceae	***
20.	*Cyanotis axillaris*	Creeping Cradle	Commelinaceae	***
21.	*Cyperus rotundus*	Nut sedge	Cyperaceae	***
22.	*Digera arvensis*	False Amaranth	Amaranthaceae	**
23.	*Dipteracanthus prostratus*	Wild Petunia	Acanthaceae	**
24.	*Eclipta alba*	False daisy	Asteraceae	*
25.	*Euphorbia hirta*	Common spurge	Euphorbiaceae	**
26.	*Heliotropium indicum*	Indian heliotrope	Boraginaceae	*
27.	*Hybanthus enneaspermus*	Spade Flower	Violaceae	*
28.	*Lantana camara*	Lantana	Verbenaceae	***
29.	*Leucas aspera*	Thumbai	Lamiaceae	***
30.	*Mimosa pudica*	Touch-me-not	Mimosaceae	***
31.	*Parthenium hysterophorus*	Congress grass	Asteraceae	**
32.	*Physalis minima*	Ground Cherry	Solanaceae	**
33.	*Rhynchosia minima*	Burn-Mouth Vine	Fabaceae	*
34.	*Sida acuta*	Morning mallow	Malvaceae	***
35.	*Sida cordifolia*	Heart-Leaf Sida	Malvaceae	**
36.	*Stachytarpheta indica*	Indian Snakeweed	Verbenaceae	**
37.	*Stemodia viscosa*	Sticky Blue Rod	Scrophulariaceae	*
38.	*Trianthema portulacastrum*	Horse Purslane	Aizoaceae	***
39.	*Trichodesma indicum*	Indian Borage	Boraginaceae	**
40.	*Tribulus terrestris*	Puncture Vine	*Zygophyllaceae*	**
41.	*Tridax procumbens*	Coat buttons	Asteraceae	***
42.	*Vernonia cinerea*	Iron weed	Asteraceae	*

Weed species act as suitable bee forage during critical dearth period, because of its early flowering and shorter lifecycle compared to crop plants. Even weeds serve as small suppliers of bee forage, its availability can be enough for stingless bees. The foraging activity by bees on weeds during summer dearth period has already been reported by Dalio, (2008), Dalio (2013) and (Kumari and Kumar, 2017). However, weed floral availability depends on the ecological situation of the particular location. The study region received considerable amount of rainfall through summer showers especially during dearth period.

Data presented in Table 2 reveals the overall frequency distribution of the weed flora studied in different ecosystems of the study area. The frequency value ranged between 1-72 per cent. Weed flora such as *Cynodon dactylon* (72%), *Commelina benghalensis* (68%), *Cyperus rotundus* (58%), *Abutilon indicum* (54%), *Tridax procumbens* (54%), *Cyanotis axillaris* (54%), *Leucas aspera* (46 %), *Commelina diffusa* (45%), *Trianthema portulacastrum* (43%), *Croton sparsiflorus* (43%), *Mimosa pudica* (41%), *Lantana camara* (39%), *Chromolaena odorata* (37%), *Corchorus trilocularis* (36%), *Sida acuta* (35%), *Cleome viscose* (34%), *Parthenium hysterophorus* (32%), *etc*. were more frequently occurred. The rarest occurrence was noticed by *Acmella paniculata* and *Biophytum sensitivum* representing only one per cent of frequency values among the various studied weed flora.

Table 2 : Frequency, density, abundance and IVI of different weed flora.

S. No	Scientific name	Frequency (%)	Density	Abundance	IVI
1.	*Abutilon indicum*	54	4.24	3.75	38.47
2.	*Acmella paniculata*	01	1.56	2.16	8.20
3.	*Ageratum conyzoides*	12	0.05	2.40	21.37
4.	*Amaranthus viridis*	09	1.24	3.27	24.00
5.	*Biophytum sensitivum*	01	0.56	2.45	8.75
6.	*Blumea lacera*	26	0.15	1.86	3.45
7.	*Boerhavia diffusa*	21	0.34	2.10	5.76
8.	*Calotropis gigantea*	18	0.05	2.15	15.87
9.	*Cassia occidentalis*	13	0.08	2.37	18.15

10.	*Chromolaena odorata*	37	3.15	3.52	29.00
11.	*Cleome gynandra*	19	2.46	2.35	15.15
12.	*Cleome viscosa*	34	2.40	3.42	16.12
13.	*Clitoria ternata*	18	1.25	2.18	12.15
14.	*Commelina benghalensis*	68	3.54	3.54	35.16
15.	*Commelina diffusa*	45	3.12	2.18	24.80
16.	*Convolvulus arvensis*	17	0.40	1.95	8.67
17.	*Corchorus trilocularis*	36	0.13	1.71	13.43
18.	*Croton sparsiflorus*	43	1.08	2.67	20.93
19.	*Cynodon dactylon*	72	4.07	3.91	32.74
20.	*Cyanotis axillaris*	47	3.46	3.16	36.15
21.	*Cyperus rotundus*	58	3.94	3.56	30.48
22.	*Digera arvensis*	24	1.20	2.10	9.43
23.	*Dipteracanthus prostratus*	16	0.15	1.68	12.68
24.	*Eclipta alba*	12	0.24	1.92	14.19
25.	*Euphorbia hirta*	28	0.23	1.52	24.32
26.	*Heliotropium indicum*	23	0.87	2.18	19.15
27.	*Hybanthus enneaspermus*	27	0.09	1.70	6.14
28.	*Lantana camara*	39	1.90	2.56	21.78
29.	*Leucas aspera*	46	3.26	2.87	27.00
30.	*Mimosa pudica*	41	3.57	3.15	31.62
31.	*Parthenium hysterophorus*	32	2.05	2.36	23.15
32.	*Physalis minima*	12	0.07	1.47	6.37
33.	*Rhynchosia minima*	21	1.23	1.56	18.67
34.	*Sida acuta*	35	2.96	2.85	22.43
35.	*Sida cordifolia*	03	0.05	1.10	5.20
36.	*Stachytarpheta indica*	14	0.27	2.37	2.32
37.	*Stemodia viscosa*	23	1.53	1.72	7.15
38.	*Trianthema portulacastrum*	43	3.15	3.52	32.67
39.	*Trichodesma indicum*	18	3.67	2.00	10.83
40.	*Tribulus terrestris*	09	1.04	1.80	17.16
41.	*Tridax procumbens*	54	4.12	3.71	28.34
42.	*Vernonia cinerea*	26	0.18	1.28	13.51

The density value ranges from 0.05 to 4.24. *Abutilon indicun, Tridax procumbens, Cynodon dactylon, Cyperus rotundus, Trichodesma indicum, Mimosa pudica, Commelina benghalensis, Cyanotis axillaris, Leucas aspera, Trianthema portulacastrum, Chromolaena odorata, Commelina diffusa, etc*. recorded the highest density values. Most of the plant species reflecting lower density values indicate single plant dominated community structure of the weed flora.

The abundance usually referred to as evenness or equitability and measures the extent to which species are equally represented in a community. The abundance values ranged from 1.10 to 3.91. The higher abundance values were recorded in *Cynodon dactylon* (3.91), *Abutilon indicum* (3.75), *Tridax procumbens* (3.71), *Cyperus rotundus* (3.56), *Commelina benghalensis* (3.54), *Trianthema portulacastrum* (3.52), *Chromolaena odorata* (3.2), *Cleome viscose* (3.42), *Amaranthus viridis* (3.27), *Cyanotis axillaris* (3.16), *Mimosa pudica* (3.15), *etc.*

Importance Value Index (IVI) is used to express the overall dominance and ecological success of a given weed species over others.The IVI value ranged between 2.32 to 38.47. The highest IVI value of more than 20 was recorded in *Abutilon indicum, Cynodon dactylon, Commelina benghalensis, Cyanotis axillaris, Trianthema portulacastrum, Mimosa pudica, Cyperus rotundus, Chromolaena odorata, Tridax procumbens, Leucas aspera, Commelina diffusa, Euphorbia hirta, Amaranthus viridis, Parthenium hysterophorus, Sida acuta, Lantana camara, Ageratum conyzoides, Croton sparsiflorus, etc.* and considered as most important among the observed weed floras.

Capability to survive under diverse growing conditions is one of the characteristic futures responsible for the biological success of any weed flora. These plants produces huge amount of seeds that are easily dispersed and stored in the soil as seed bank. When optimum climatic factors triggers immediately its lifecycle begins. Multiple ecosystem services depend on the diversity and maintenance of these weed flora (Tscharntke *et al*., 2005). They provide food sources for biodiversity at higher trophic levels (Marshall *et al*., 2003; Edesi *et al*., 2012) and promote large and rich populations of pollinators necessary to the cultivation of arthropod pollinated crops (Barberi *et al*., 2010).

Conclusion

From the present investigations, it could be concluded that presence of 42 weed flora during off season served as good bee-forage for stingless bees. The diversity of weed flora reported in the study was relatively high. The maximum IVI value was recorded in *Abutilon indicum* followed by *Cynodon dactylon, Commelina benghalensis, Cyanotis axillaris, Trianthema portulacastrum, Mimosa pudica, Cyperus rotundus, Chromolaena odorata, Tridax procumbens, Leucas aspera, Commelina diffusa, Euphorbia hirta, Amaranthus viridis, Parthenium hysterophorus, Sida acuta, Lantana camara, Ageratum conyzoides, Croton sparsiflorus, etc.* and considered as most abundant among the

observed weed floras. This necessary information will be useful as a foraging source for Meliponiculture during the dearth period in High Rainfall agro-climatic zone of Tamilnadu.

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