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Diversity of Bee Flora in University of Agricultural Sciences, Dharwad Campus, Karnataka, India

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A B S T R A C T

Bees execute a special performance by pollinating several plant species. But the activity of honeybees depends on the bee flora availability and quantity and quality of nectar, pollen present in them. In the present study University of agricultural Sciences, Dharwad campus were surveyed to asses the diversity of bees' flora from July 2019- March 2020 which is covered with Agro- horticultural crops, wild plants and trees. Total 93 plants were considered as a bee flora, out of which 17 were field crops, 16 were horticultural crops, 33 were ornamental plants, 10 were trees and 17 were weeds. These bee flora available in different months supplying pollen, nectar and some both. Among the recorded bee flora, nectar and pollen yielding plants were more followed by nectar yielding and pollen yielding. It was also noticed that March month recorded with highest abundance of bee flora of 45.16 per cent recording 33 plant species.

Introduction

Pollination is a "free ecological service" which plays a vital role in the ecosystem by providing services to crops and wild plants. Pollination is a key part of global diversity. However in recent days, we found decline in both domesticated and wild pollinators due to environmental pollution, fragmentation of land, increased pest and disease, genetic diversity and variation in environmental conditions like rainfall, relative humidity and temperature. Pollinator decline impacting on two broad groups of flowering plants *viz.* crop plants and flowering plants. The plants which require obligate cross pollination by external agents, decline parallely with respective pollinator group (Potts *et al*., 2010). The goal of every organism on this earth including plants, is to reproduce and continue the generation. Plants continue their generation by producing seeds, for which flowers are the tools. Interestingly, many plants flower rely on the external agents to get pollinate; these external agents are called as vectors which helps in pollen movement from one flower to the other flower which results in fertilization followed by seed set. These vectors include

water, wind, birds, insects and other animals which depends on the ecosystem. Among the animals, insects are the major pollinators providing the pollination services. These pollinators uphold the biodiversity and their population indicates healthy ecosytem.

Materials and Methods

During the survey period, in the UAS, Dharwad Campus, the flora was divided into groups consisting of field crops, horticultural crops, ornamental plants, weeds and forest trees. To determine the spectrum of different bee species visiting the blossoms of plants, pollination observations were made between 7 am to 12 noon during flowering period of the respective groups at every fortnight. During the visit, the flora was recorded that supported the bee population either as pollen source or nectar or both pollen and nectar.

For each pollination observation, ten minutes were spent at a particular flower plant and noted any bee that visited on it. After 10 minutes of observation, the bees were collected, killed and stored for identification. Initially the bees visitation data was examined qualitatively to determine whether the bees preferentially visit to particular flower types.

Classification of plant as nectariferous and polleniferous depends on activities performed by honeybees on different flowers. After landing on flower if honey bee sits calmly and extends its proboscis into the flower or collect the nectar from outside nectaries the flora was considered as nectariferous flora and if bees are hyperactive inside the flower carrying pollen on their body or in pollen basket (hind leg) from the flower, the flora were considered as polleniferous flora.

Flowers with honey bees showing both the activities were considered under nectariferous as well as polleniferous flora.

During the survey, the peak time of flowering, duration of flowering and the source of pollen or nectar was noted. Later the data was correlated to the diversity and activity of pollinator fauna and weather parameters. The survey was continued for entire study period at every fortnight on field crops, horticultural crops, ornamental plants, trees and weeds *etc*.

Finally, the recorded flora was collected and with help of plant taxonomist, they were identified. The total bee flora was categorised using available informations as a nectar yielders, pollen yielders and both pollen and nectar yielders. Then plants were identified monthwise in supporting as a food source through out the study period and all groups and their per cent contribution in each month was made for easy understanding like a floral calendar.

$$\text{Per cent abundance of bee flora for a month} = \frac{\text{Number of bee flora species in particular month}}{\text{Total number of bee flora species}} \times 100$$

Results and Discussion

Bee flora recorded at UAS, Dharwad Campus

The documented flora showed the presence of 93 plant species belonging to different botanical families. Among the recorded families, Asteraceae consisted the highest number with 16 species, followed by Fabaceae with 14 species. These families includes field crops, ornamental crops, weeds, horticultural crops and perennial trees (Table 1).

Availability of bee flora in different months

Bee flora availability was recorded to asses the peak period and lean period of flora in the campus in different months of the year. This study will help to focus on the activity of the bees and to think about future prospectus of

enhancing the bees diversity to support the better pollination process in field and horticultural crops. Based on the monthwise observations it was noticed that July and August months supported very less with very few floral availability compare to other months. In July, hardly 11 plants species were recorded as compared to total of 93 bee flora species Nevertheless the availability of flora increased from August and reached peak in the month of September and October with 40 and 37 plant species respectively. Futhermore second peak was observed in the month of March with 42 plant species (Table 2).

Categorization of bee flora on reward basis

The pollinators and plants are mutually benefitted from pollination process. Plants reward pollinators with pollen or nectar or both pollen and nectar and in turn plants get successful pollination service for better seed set. Among 93 plant species recorded in the UAS, Dharwad Campus, 54 plant species are with both pollen and nectar which belongs to the different groups (field crops, horticultural crops, trees and weeds) followed by 22 plant species which are nectar providers and 16 plant species are pollen providers. Garlic vine (*Mansoa alliacea)* neither pollen or nectar source on which *Apis dorsata* and *Xylocopa amethystine* were found (Table 3).

Abundance of bee flora

The existence of plant species with particularly attractive colours were important for the attraction of pollinators and the frequency of their visits. Richness of plant species *i.e*, cover of blossom and the existence of plant species which are attractive to increase the stability in the pollinator visitors frequency. The highest floral abundance was recorded during the month of March with 45.16 per cent followed by September with 43.01 per cent, October with 39.78 per cent. These three months were recorded as a highest floral abundance months which were directly related to the pollinators population and their visits. Similarly, January month recorded with 33.33 per cent, Months of November and February recorded the same per cent of floral abundance of 31.18 per cent and December 26.88 per cent and these four months were considered as a moderate level of floral abundance. August and July month recorded least floral abundance with 16.12 and 11.82 per cent respectively (Fig. 1).

Abundance of field crops and horticultural crops contribution

Out of 17, highest numbers were recorded in the month of September with 9 species. Followed by January and February with 6 species, October, November, December and March with 5 species, August with 3 species. But, July month with no flowering field crops were recorded during the study period. When, it was observed for total floral abundance of field crops with over all bee flora recorded, the September month was found as highest floral abundance contribution with 22.50 per cent followed by February with 20.68 per cent, December with 20 per cent, August with 20 per cent, January with 19.35 per cent, November with 17.24 per cent, October with 13.51 per cent, March with 11.90 per cent, July with zero abundance because of out of 11 flora recorded, none of them were field crops (Table 4 and 5).

During the study period a total of 16 horticultural crops were recorded, of which the highest numbers were recorded in the month of October with 7 horticultural crops. Followed by March with 6 species, September and January with 5 species, February with 4 species, July, August and December with 2 species, November with 1 species respectively. When, it was observed for total floral abundance of horticultural crops with

over all bee flora, October month was found as highest floral abundance with 18.91 per cent followed by July with 18.18 per cent, January with 16.12 per cent, March with 14.28 per cent, February with 13.79 per cent, August with 13.33 per cent, September with 12.50 per cent and December with 8.00 per cent, November found least abundance with 3.57 per cent respectively (Table 5).

Table.1 List of bee flora recorded at UAS, Dharwad Campus, July 2019 to March 2020

Sl. No.	Scientific name	Common name	Family
1	*Cajanus cajan*	Redgram	Fabaceae
2	*Cicer arietinum*	Bengalgram	Fabaceae
3	*Vigna mungo*	Blackgram	Fabaceae
4	*Vigna radiate*	Greengram	Fabaceae
5	*Vigna unguiculata*	Cowpea	Fabaceae
6	*Macrotyloma uniflorum*	Horsegram	Fabaceae
7	*Glycine max*	Soyabean	Fabaceae
8	*Albizia odoratissima*	Black siris	Fabaceae
9	*Mimosa pudica*	Touch me not	Fabaceae
10	*Caesalpinia*	Peacock flower	Fabaceae
11	*Clitoria ternatea*	Butterfly pea	Fabaceae
12	*Tamarindus indica*	Tamarind	Fabaceae
13	*Phanera purpurea*	Camel foot tree	Fabaceae
14	*Samanea saman*	Rain tree	Fabaceae
15	*Helianthus annus*	Sunflower	Asteraceae
16	*Carthamus tinctorius*	Safflower	Asteraceae
17	*Guizotia abyssinica*	Niger	Asteraceae
18	*Tridax procumbens*	Tridax daisy	Asteraceae
19	*Parthenium hysterophorous*	Santa Maria feverfew	Asteraceae
20	*Syndrella nodiflora*	Cyndrella Weed	Asteraceae
21	*Zinnia*	Zinnia	Asteraceae
22	*Tagetus erecta*	Marigold	Asteraceae
23	*Callistephus chinensis*	China aster	Asteraceae
24	*Cosmos*	Cosmos	Asteraceae
25	*Gaillardia*	Blanket flower	Asteraceae
26	*Symphyotrichum oblongifolium*	Aromatic aster	Asteraceae
27	*Pulicaria vulgaris*	False fleabane	Asteraceae
28	*Glebionis coronaria*	Crown daisy	Asteraceae
29	*Ageratum houstonianum*	Floss weed	Asteraceae
30	*Wedelia chinensis*	Kalsarji	Asteraceae
31	*Lycopersicum esculentum*	Tomato	Solanaceae
32	*Solanum melongena*	Brinjal	Solanaceae
33	*Capsicum annum*	Chilli	Solanaceae
34	*Nicandra physalodes*	Apple-of-Peru Shoo-fly plant	Solanaceae

35	*Amaranthus retroflexus*	Amaranth	Amaranthaceae
36	*Alternenthra sessilis*	Sessile joyweed	Amaranthaceae
37	*Celosia argentea*	Cock's comb	Amaranthaceae
38	*Achyranthes aspera*	Devil's horsewhip	Amaranthaceae
39	*Convulvulus arvernsis*	Field bindweed	Convolvulaceae
40	*Stictocardia beraviensis*	Hawaiian Bells	Convolvulaceae
41	*Ipomea tricolor*	Morning glory	Convolvulaceae
42	*Ipomoea horsfalliae*	Cardinal creeper	Convolvulaceae
43	*Duranta erecta*	Pigeon berry	Verbenaceae
44	*Lantana camera*	Lantana	Verbenaceae
45	*Sorghum bicolour*	Sorghum	Poaceae
46	*Zoysia* spp	Zoysia	Poaceae
47	*Zea mays*	Maize	Poaceae
48	*Fagopyrum esculentum*	Buckwheat	Polygonaceae
49	*Antigon leptipus*	Mexican creeper	Polygonaceae
50	*Gossypium*	Cotton	Malvaceae
51	*Abelmoschus esculentus*	Bhendi	Malvaceae
52	*Aleca rosea*	Hollyhock	Malvaceae
53	*Allium cepa*	Onion	Amarylidaceae
54	*Zephyranthes sulphurea*	Rain lily	Amarylidaceae
55	*Hymenocallis littoralis*	Beach spider lilly	Amarylidaceae
56	*Cucumis sativus*	Cucumber	Cucurbitaceae
57	*Coccinia grandis*	Ivy guard	Cucurbitaceae
58	*Chrozophora rottleris*	Suryavarti	Euphorbiaceae
59	*Euphorbia mili*	Christ plant	Euphorbiaceae
60	*Asystasia gangetica*	Chinese violet	Acanthaceae
61	*Thunbergia grandiflora*	White sky vine	Acanthaceae
62	*Thunbergia erecta*	Bush clock vine	Acanthaceae
63	*Tecoma stans*	Yellow bells	Bignoniaceae
64	*Mansoa alliacea*	Garlic vine	Bignoniaceae
65	*Pyrosteiga venusta*	Orange trumpet vine	Bignoniaceae
66	Anacardium occidentale	Cashew nut	Anacardiaceae
67	*Mangifera indica*	Mango	Anacardiaceae
68	*Psidium guajava*	Guava	Myrtaceae
69	Callistemon citrinus	Bottle brush	Myrtaceae
70	*Sesamum indicum*	Sesamum	Pedaliaceae
71	*Linum usitatissimum*	Linseed	Linaceae
72	*Coriandrum sativum*	Coriander	Apiaceae
73	*Punica granatum*	Pomegranate	Puniaceae
74	*Muntingia calabura*	Singapore cherry	Mutingiaceae
75	*Sapindus emarginatus*	Soapnut tree	Sapindaceae
76	*Aegle marmelos*	Stone apple	Rutaceae
77	*Terminalia catappa*	Kadu Badami	Combretacea

78	*Calotropis*	Milk weed	Apocynaceae
79	*Trianthema portulocastrum*	Gaintpig weed	Aizoacea
80	*Portulaca quadrifida*	Chicken weed	Portulacaceae
81	*Turnera subulata*	Damiana	Passifloraceae
82	*Tristellateia australlis*	Shower of gold climber	Malphigiacea
83	*Boughenvillea*	Paper flower	Nyctaginaceae
84	*Polianthes tuberose*	Tuberose	Asparagaceae
85	*Cuphea hyssopifolia*	Mexican heather	Lythraceae
86	*Hamelia patens*	Fire bush	Rubiaceae
87	*Impatiens balsamina*	Balsam	Balsiminaceae
88	*Mentha arvensis*	Wild mint	Lamiaceae
89	*Brassica*	Mustard	Brassicacea
90	Cocos nucifera	Coconut	Arecaceae
91	Moringa oleifera	Drumstick	Moringaceae
92	Phyllanthes acidus	Goosberry	Phyllanthaceae
93	Azadirachta indica	Neem	Meliaceae

Table.2 Bee flora recorded in different months at UAS, Dharwad Campus, July 2019 to April 2020

Common name	Scientific name	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Field Crops										
Sorghum	*Sorghum bicolour*	--	--	**	--	--	**	**	--	--
Maize	*Zea mays*	--	--	**	--	--	--	--	--	**
Buckwheat	*Fagopyrum esculentum*	--	--	--	**	**	**	--	--	**
Cotton	*Gossypium*	--	--	--	**	**		**	**	--
Redgram	*Cajanus cajan*	--	--	--	**	**	**	**	**	--
Bengal gram	*Cicer arietinum*	--	--	--	--	--	--	**	**	--
Black gram	*Vigna mungo*	--	**	**	**	**	--	--	--	--
Green gram	*Vigna radiate*	--	**	**	--	--	--	--	--	**
Cowpea	*Vigna unguiculata*	--	--	**	**	**	--	--	**	--
Horse gram	*Macrotyloma uniflorum*	--	--	--	--	--	--	**	--	--
Mustard	*Brassica nigra*	--	--	--	--	--	**	--	--	--
Sunflower	*Helianthus annuus*	--	--	**	--	--	**	--	**	--
Safflower	*Carthamus tinctorius*	--	--	--	--	--	--	--	**	**
Soyabean	*Glycine max*	--		**	--	--	--	--	--	**
Sesamum	*Sesamum indicum*	--	**	**	--	--	--	--	--	--
Linseed	*Linum usitatissimum*	--	--	--	--	--	--	**	--	--
Niger	*Guizotia abyssinica*	--	--	**	--	--	--	--	--	--
Horticultural crops										
Onion	*Allium cepa*	--	--	--	--	--	--	--	--	**
Cucumber	*Cucumis sativus*	--	**	**	**	--	--	--	--	--

Bhendi	*Abelmoschus esculentus*	--	--	--	**		--	--	--	--
Tomato	*Lycopersicum esculentum*	--	--	--	--	--	--	**	--	--
Brinjal	*Solanum melongena*	--	--	--	**	--	--	--	**	--
Chilli	*Capsicum annum*	--	--	--	**	--	--	--	--	--
Ivy guard	*Coccinia grandis*	--	--	--	--	--	--	--	--	**
Coriander	*Coriandrum sativum*	--	--	**	**	--	--	**	**	--
Amaranth	*Amaranthus retroflexus*	--	--	--	--	--	--	--	--	**
Guava	*Psidium guajava*	**	--	--	--	--	--	--	--	**
Pomegrante	*Punica granatum*	--	--	**	**	--	--	--	--	--
Mango	*Mangifera indica*	--	--	--	--	--	--	**	**	--
Gooseberry	*Phyllanthes acidus*	--	--	--	--	--	--	--	--	**
Coconut	*Cocos nucifera*	**	**	**	**	**	**	**	**	**
Drumstick	*Moringa oleifera*	--	--	**	--	--	--	--	--	--
Cashew	*Anacardium occidentale*	--	--	--	--	--	--	**	**	--
Trees										
Singapore cherry	*Muntingia calabura*	**	**	**	--	--	--	**	**	**
Stone apple	*Aegle marmelos*	--	--	--	--	--	--	--	--	**
Tamarind	*Tamarindus indica*	--	--	--	--	--	**	**	--	--
Indian almond	*Terminalia catappa*	--	--	--	--	--	--	--	**	--
Soapnut tree	*Sapindus emarginatus*	--	--		**	**	**	--	--	--
Yellow bells	*Tacoma stans*	--	--	**	**	**	**	**	**	**
Black siris	*Albizia odoratissima*	--	--	--	--	--	--	**	--	--
Camel foot tree	*Phanera purpurea*	--	--	**	**	**	--	--	--	--
Rain tree	*Samanea saman*	--	--	**	**	**	--	--	**	**
Neem	*Azadirachta indica*	--	--	--	--	--	--	--	--	**
Ornamental crops										
Damiana	*Turnera subulata*	--	--	**	**	**	--	--	--	--
White sky vine	*Thunbergia grandiflora*	**	**	**	**	**	**	**	**	**
Zinnia	*Zinnia* sp.	--	--	**	**	--	--	--	--	--
Mexican creeper	*Antigon leptipus*	--	--	**	**	**	**	--	--	--
Beach spider lilly	*Hymenocallis littoralis*	**	**	--	--	--	--	--	--	--
Marigold	*Tagetus erecta*	--	--	**	**	**	**	**	--	--
Hollyhock	*Aleca rosea*	--	--	--	**	--	--	--	--	--
Peacock flower	*Caesalpinia*	--	--	--	**	**	**	**	--	--
China aster	*Callistephus chinensis*	--	--	--	--	--	**	**	--	--
Shower of gold climber	*Tristellateia australlis*	--	--	--	--	--	--	**	**	**
Cosmos	*Cosmos*	--	--	**	**	**	--	**	**	**
Christ plant	*Euphorbia mili*	--	--	**	**	**	--	--	**	**
Paper flower	*Boughen villea*	--	--	**	--	--	--	--	--	**
Tube rose	*Polianthes tuberose*	--	--	--	--	--	**	**	--	--
Bush clock vine	*Thunbergia erecta*	--	--	**	--	--	--	--	--	--

Garlic vine	*Mansoa alliacea*	--	**	--	**	**	--	--	--	--
Butterfly pea	*Clitoria ternatea*	--	--	--	--	**	--	--	--	--
Apple-of-Peru Shoofly plant	*Nicandra physalodes*	--	--	--	**	--	--	--	--	--
Mexican heather	*Cuphea hyssopifolia*	**	**	**	**	**	**	**	**	**
Morning glory	*Ipomea tricolor*	--	--	**	**	**	**	**	**	**
Blanket flower	*Gaillardia*	--	--	--	--	--	**	**	**	**
Hawaiian Bells	*Stictocardia beraviensis*	--	--	--	--	--	**	**	**	**
Fire bush	*Hamelia patens*	--	--	--	--	**	--	--	`--	--
Bottle brush	Callistemon citrinus	--	--	--	**	**	**	--	--	--
Rain lily	Zephyranthes sulphurea	**	**	--	--	--	--	--	--	--
Aromatic aster	*Symphyotrichum oblongifolium*	--	--	--	--	--	--	--	--	**
Pigeon berry	*Duranta erecta*	--	**	**	--	--	--	--	**	**
Cardinal creeper	*Ipomoea horsfalliae*	--	--	**	**	**	**	**	**	--
Orange trumpet vine	*Pyrosteiga venusta*	--	--	--	--	--	--	**	**	**
Crown daisy	*Glebionis coronaria*	--	--	**	--	--	--	--	**	**
Cockscomb	*Celosia argentea*	--	--	**	**		--	--	--	**
False fleabane	*Pulicaria vulgaris*	--	--	--	--	--	--	**	--	--
Balsam	*Impatiens balsamina*	--	--	**	--	--	--	--	--	--
Weeds										
Milk weed	*Calotropis*	--	--	--	--	--	--	--	**	**
Chinese violet	*Asystasia gangetica*	--	--	--	--	--	**	**	--	--
Field bind weed	*Convulvulus arvernsis*	--	--	--	--	--	--	--	**	**
Suryavarti	*Chrozophora rottleris*	--	--	--	--	--	--	--	--	**
Kalsarji	*Wedelia chinensis*	**	**	**	**	**	--	--	--	--
Touch me not	*Mimosa pudica*	--	--	**	--	**	**	--	--	**
Sessile joyweed	*Alternenthra sessilis*	--	--	**	**	**	**	--	--	**
Lantana	*Lantana camera*	**	**	**	**	**	--	--	**	--
Tridax daisy	*Tridax procumbens*	**	--	--	**	**	--	**	--	**
Wild mint	*Mentha arvensis*	--	--	**	--	--	--	--	--	--
Zoysia	*Zoysia sp.*	--	--	--	--	--	--	--	--	**
Gaint pigweed	*Trianthema portulocastrum*	**	**	--	--	--	--	--	--	**
Cyndrella Weed	*Syndrella nodiflora*	--	--	--	**	--	--	--	--	**
Devil's horsewhip	*Achyranthes aspera*	--	--	--	**	--	--	--	--	--
Chicken weed	*Portulaca quadrifida*	--	--	--	--	--	--	--	--	**
Floss weed	*Ageratum houstonianum*	--	--	--	--	--	--	--	--	**
Santa Maria feverfew	*Parthenium Hysterophorous*	--	--	**	--	--	--	--	--	**

** Presence of bee flora -- Absence of bee flora

Table.3 Bee flora and their reward in UAS, Dharwad Campus, July 2019 to March 2020

Sl. No.	Pollen yielding plants	Nectar yielding plants	Pollen and nectar yielding plants
1	*Sorghum bicolor*	*Fagopyrum esculentum*	*Gossypium*
2	*Zea mays*	*Cajanus cajan*	*Macrotyloma uniflorum*
3	*Lycopersicum esculentum*	*Cicer arietinum*	*Brassica*
4	*Solanum melongena*	*Vigna mungo*	*Helianthus annus*
5	*Psidium guajava*	*Vigna radiate*	*Carthamus tinctorius*
6	*Zinnia sp.*	*Vigna unguiculata*	*Sesamum indicum*
7	*Antigon leptipus*	*Glycine max*	*Linum usitatissimum*
8	*Aleca rosea*	*Phanera purpurea*	*Guizotia abyssinica*
9	*Nicandra physalodes*	*Turnera subulata*	*Allium cepa*
10	*Ipomea tricolor*	*Thunbergia grandiflora*	*Cucumis sativus*
11	*Convulvulus arvernsis*	*Hymenocallis littoralis*	*Abelmoschus esculentus*
12	*Mimosa pudica*	*Tagetus erecta*	*Capsicum annum*
13	*Achyranthes aspera*	*Stictocardia beraviensis*	*Coccinia gramdis*
14	*Portulaca quadrifida*	*Zephyranthes sulphurea*	*Coriandrum sativum*
15	*Mangifera indica*	*Ipomoea horsfalliae*	*Amaranthus retroflexus*
16	*Samanea saman*	*Pyrosteiga venusta*	*Punica granatum*
17		*Chrozophora rottleris*	*Tamarindus indica*
18		*Alternenthra sessilis*	*Muntingia calabura*
19		*Lantana camera*	*Aegle marmelos*
20		*Mentha arvensis*	*Terminalia catappa*

Table.4 Bee flora contribution (Abundance) in field crops and horticultural crops, July 2019 to March 2020

Month	Bee flora		Total bee flora	Floral Abundance of field crops (%)	
	FC	HC		FC	HC
July	0	2	11	0.00	18.18
Aug	3	2	15	20.00	13.33
Sept	9	5	40	22.50	12.50
Oct	5	7	37	13.51	18.91
Nov	5	1	29	17.24	3.44
Dec	5	2	25	20.00	8.00
Jan	6	5	31	19.35	16.12
Feb	6	4	29	20.68	13.79
Mar	5	6	42	11.90	14.28
Overall	**17**	**16**	**93**	**18.27**	**17.20**

Table.5 Bee flora contribution (Abundance) in ornamental plants, trees and weeds, July 2019 to March 2020

Month	Bee flora			Total bee flora	Floral Abundance (%)		
	OP	T	W		OP	T	W
July	4	1	4	11	36.36	9.09	36.36
Aug	6	1	3	15	40.00	6.66	20.00
Sept	16	4	6	40	40.00	10.00	15.00
Oct	16	4	5	37	43.24	10.81	13.51
Nov	14	4	5	29	48.27	13.79	17.24
Dec	12	3	3	25	48.00	12.00	12.00
Jan	14	4	2	31	45.16	12.90	6.45
Feb	12	4	3	29	41.37	13.79	10.34
Mar	14	4	12	42	33.33	9.52	28.57
Overall	**33**	**10**	**17**	**93**	**35.48**	**10.75**	**18.27**

Abundance of total bee flora recorded from July 2019 to March 2020

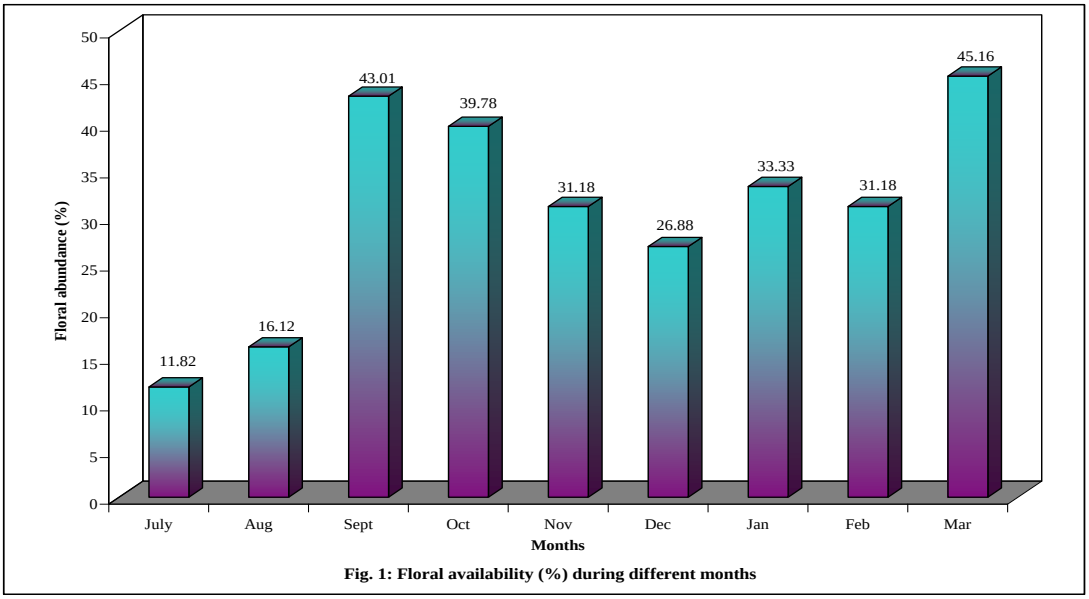

Fig. 1: Floral availability (%) during different months

Abundance of ornamental plants, trees and weeds contribution

During the study period, a total of 33 ornamental plants were recorded as a bee flora. Out of 33, highest numbers were recorded in the month of September and October with 16 ornamental plants. Followed by November, January and March each with 14 species, December and February with 12 species, August with 6 species and July with 4 species. When, it was observed for total floral abundance of ornamental plants with over all flora, the November month were to be found highest floral abundance with 48.27 per cent followed by December with 48 per cent, January with 45.16 per cent, October with 43.24 per cent, February with 41.37, September and August each with 40 per cent, July with 36.36 per cent, March month

reported least floral abundance of ornamental plants of 33.33 per cent (Table 6).

In total, during the study period, 10 trees were recorded as a bee flora. Out of 10, highest numbers were recorded in the month of September, October, November, January, February and March, all with 4 tree species, Followed by December with 3 tree species, July and August were recorded with only one tree species each. When it was observed for total floral abundance of trees with over all bee flora recorded, the November and February month found to be highest floral abundance each with 13.79 per cent followed by January with 12.90 per cent, December with 12 per cent, October with 10.81 per cent, September with 10 per cent, March with 9.52 per cent, July with 9.09 per cent, least floral abundance of trees reported during August month with only 6.66 per cent (Table 6).

In total, during the study period, 17 weeds were recorded as a bee flora. Out of 17, highest numbers were found in the month of March with 12 weeds. Followed by September with 6 weed species, October and November with 5 weed species, July with 4 weed species, August, December and February each with 3 weed species, January with 2 weed species. When, it was observed for total floral abundance of weeds with over all bee flora recorded, the highest abundance was noticed with 36.36 per cent observed in July, followed by March with 28.57 per cent, August with 20 per cent, November with 17.24 per cent, September with 15 per cent and January found least abundance with 6.45 per cent (Table 6).

Among the total bee flora which were catagorised into field crops, horticultural crops, ornamental plants, trees and weeds and out of these 93 plant species recorded, the ornamental plants contributed highest per cent of 35.48 floral abundance, followed by field crops and weeds with 18.27 per cent, followed by horticultural crops with 17.20 per cent and least in case of tree species which contributed only 10.75 per cent (Table 5).

As per the data, totally 93 plant species belonging to different botanical families were recorded, this study was compararble with the study of Pande and Ramkrushna (2018) in Nagpur and Wardha districts of Maharashtra where they recorded 92 plant species belongs to different families. When bee flora was observed month wise, it clearly showed that July and August supports very less with very few floral availability; March, September, October encouraged with high floral availability compare to other months, similar investigation done by Shiva *et al*. (2018), who also reported the maximum bee flora during March month (45) followed by September, February, April with 39 species, August with 36 species, May with 34 species, July with 32 species, January with 31 species, December with 30 species, October with 28 species, June with 27 species and November recorded with least number of bee flora with 25 species. Among the recorded 93 bee floral species, 54 plant species were both pollen and nectar yielders which belongs to the different groups (field crops, horticultural crops, trees and weeds) followed by 22 plant species which are nectar providers and 16 plant species are pollen providers. Bhalchandra *et al*., 2014 grouped identified flora into nectar, pollen and combination of both pollen and nectar. Total bee flora which were catagorised into field crops, horticultural crops, ornamental plants, trees, weeds and out of these 93 plant species recorded, the ornamental plants contributed highest per cent of 35.48 floral abundance with 33 bee flora. Followed by, field crops and Weeds with 18.27 per cent with 17 bee flora each, followed by horticultural crops with 17.20 per cent with 16 plants and least in case of tree species which contributed only 10.75 per cent

with 10 species. Pande and Ramkrushna (2018) reported 69.4 per cent contribution from the cultivated plant species during August, 66.6 per cent in September, 60.7 per cent in October, 56.2 per cent in July, 51.6 per cent in January, 51.2 per cent in February, 51.1 per cent in March, 48.0 per cent in November, 46.6 per cent in December, 41.0 per cent in April and found lowest during May with 35.2%. related to wild plants, it found reverse to the abundance of cultivated plants *viz*, highest during may month with 64.8 per cent and lowest during August with 30.6 per cent.

In conclusion the bees are necessarily important component in cropping system by pollinating wide variety of crops. This investigation represents 93 bee flora out of which 17 were field crops; 16 were horticultural crops; 33 were ornamental plants; 10 were trees and 17 were weeds. These groups were the provider of pollen, nectar and both pollen and nectar. Contribution from the source of Ornamental plants recorded highest with 35.48 per cent, field crops and weeds equally contribute to the bee source with 18.27 per cent, horticultural crops with 17.20 per cent and trees with 10.75 per cent recorded with least contribution. It can be concluded that UAS, Dharwad, Campus can be considered as rich bee floral area, where scientific bee keeping should be undertaken to improve the farmers livelihood. The record of wild bee flora during the study encourages their conservation for sustainable bee keeping in future as well.

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