



Diversity of Bee Flora in Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

S.C. Kiran, H.K. Deshmukh, S.S. Harne, Y.B. Taide, V.K. Komal, P.S. Nandanwar
V.G. Ingle and P.R. Palaspagar

Dr. Panjabrao Deshmukh Krishi Vidyapeeth, College of Forestry, Akola (MH)-444 104, India
E-mail: kiranchar2019@gmail.com

Abstract: Bees are crucial natural pollinators and their activities depends on availability and abundance of bee flora. The current study involved the study of foraging flora of agriculture, horticultural, forestry crops and wild plants. Here 171 plants were considered as bee flora out of which 13 are Agricultural crops, 49 are Horticulture crops, 70 are forestry crops and 34 are wild crops. All types of plants were available at study site that is nectar and Pollen and both nectar and Pollen providing. Study showed that there is highest abundance of bee flora in April month followed by May.

Keywords: Nectar, Pollen, Bee-forage, Pollination

Pollination is a crucial mechanism in continuation of life process of all angiosperm and gymnosperm. In agriculture, forestry, horticulture and even in weed science pollination plays most important role in obtaining yield. It is a mechanism of continuation of all ecological processes and sustainable agriculture production (Pande and Ramkrushna 2018), where honey bees are most important and superior pollinator of all natural ecosystem as they play vital role in pollination because honey bees colony depends directly on plants ranging from cultivated crop, wild species, ornamental crops, horticulture crops, forest crop, olericulture crops, and even wild grasses, herbs and shrubs etc. In India there are mainly six type of species these Six species bees are of commercial importance in India; *Apis dorsata* (Rock bee), the Himalayan species, *Apis laboriosa*, *Apis cerana indica* (Indian hive bee), *Apis florea* (dwarf bee), *Apis mellifera* (European or Italian bee), and *Tetragonula iridipennis* (Dammer or stingless bee). For commercial apiculture we can go for rearing of *Apis cerana* and *Apis mellifera*, these are practicing in India for honey production. Farmers chose bee keeping as agro-bases rural industry, integrated with farming systems because it can improve livelihood of farmers. The Plant that yield nectar and Pollen are collectively referred as bee flora or bee pasture (Pande and Ramkrushna 2018).

Bee flora differ from one place to another place because of change in climatological, topographical factors and environmental factors that is way it is major prerequisite to study of abundance and availability of flora in campus area for successful beekeeping. For sound management of bee keeping study of flower duration their blooming time, span of

critical darth period, availability of water sources should be studied. Critical darth period is period where there is unavailability of flora that is nectar and pollen which serves as main qualitative and quantitative factor in final product of apiary. Hence for ease of study we created a tabular bee flora calendar which shows available of bee flora in particular month of year.

MATERIAL AND METHODS

Study sites: The present study was conducted in Dr. PDKV campus. Dr. Panjabrao Deshmukh Krishi Vidyapeeth (Agriculture University) is situated at 77°02'42" E longitudes and 20° 42' 0" N latitudes. The university has over a total 3425 hectares of land out of which the total area of the main campus of the University is 1266.03 ha. The average annual rainfall is between 700 to 950 mm and on an average, there are 53 rainy days in a year. The temperature rises rapidly after February till May, which is the hottest month of the year. In May the mean daily maximum temperature is 43.3 C means daily minimum temperature is 29.5 C. The site has predominant of black cotton soil and loamy soil and has altitude of 307.42 from mean sea level. Major crops cultivated crops in this area are cotton, soybean, blackgram, green gram, cowpea, chickpea and some vegetables and fruits.

Identification of bee flora: During surveying for identification of bee-flora we studied the vegetation by classifying plant into different parts or groups, agricultural crops, horticultural crops, vegetable crops, forest crops and forest species, ornamental plants and weeds present at study site.

Flowers are the source of nectar and Pollen variety of plants are forage by bees. Plants are classified into nectariferous (N) polleniferous (P) or both (NP) on bee's activity during forage.

Study includes keen observation of flowers to classify them. A plant is observed for 10 minutes at least three bees should be visited to the flowers then it is called as bee flora. Plants are called as nectariferous when bee sits calmly on flowers and penetrate it's proboscis into flower for the suction of sweet nectar for some time. Plants are called as polleniferous when bees don't sit calmly on flowers but do buzzing around the flower and take pollen bath by collecting pollen on body may be in the pollen basket which is present at hind legs of bees. With the help of entomology professionals, apiary managing people, rural honey collectors and trainer we made a listing of flora species. After being collected, the documented flora was finally recognized with the aid of a plant taxonomist. The entire bee flora was divided into groups

Using the facts of the situation, identify plants that produce nectar, pollen, or both. Then, throughout the study period, plants were identified month by month as a food source, and all groups' percent contributions in each month were made for simple understanding like a floral calendar.

The percentage of abundance of bee flora was calculated by following formula:

$$\text{Percentage of abundance of bee flora} = \frac{\text{No. of bee flora species in particular month}}{\text{Total no. of bee flora species}} \times 100$$

The study of bee flora shows that the presence of total 171 species of 61 different botanical families. Among this recorded families highest number with 21 species belongs to

Fabaceae family followed by 10 species of asteraceae family and 6 species of Malvaceae family and moderate of Lamiaceae, Verbinaceae, Caesalpinaceae, Amaranthaceae, Acanthaceae, Anacardiaceae, Rutaceae, etc. These families include Agricultural crops , Horticultural crops (Ornamental, vegetables, fruits, and medicinal) and Forest tree species (wild plants).

Bee flora classification on the basis of benefits: The plants as well as honeybees are mutually benefited from the pollination. Plants provide nectar, pollen or both to honeybees and honeybees provide better pollination to plants that gives assurity of fruit/seed. Out of total bee-flora species Necteriferous are 13 and Polleniferous are 39 and both pollen and nector providing species are 110. (Table 1, 2, 3).

Accessibility of bee-flora in various months: Bee flora accessibility was counted to find out the critical darth period of bee-flora, highest flowering peak period and scarcity period in the different months. This study will help for better apiculture management and providing best pollination period in all available vegetation. Based on observation, April with 81 species, May with 75 species and March with 68 species found at selection site. The minimum bee flora available in December and January with 51 and 50 species respectively.

As per the data totally 171 plants species belonging to different botanical families, out of 13 agriculture crops highest number of flora recorded in the month of September with 9 bee-flora species followed by August, July, February and March. In May and November month only single bee-flora species is available. Highest floral abundance contribution of September month is 13.85% followed by august with 12.90%. In May month floral abundance was

Table 1. Diversity of agriculture crops in Dr. Panjabrao Deshmukh Krushi Vidyapeeth Akola

Common name	Scientific name	Family	Food source	Flowering period	Intensity of visitation
Wheat	<i>Triticum aestivum</i>	Poaceae	N	Oct-Dec	++
Jawar	<i>Sorghum bicolor</i>	Poaceae	P	Feb-Mar	++
Cotton	<i>Gossipium</i>	Malvaceae		Sep-Dec	
Gram	<i>Cicer arietinum</i>	Fabaceae	N	Dec-Mar	+++
Maize	<i>Zea mays</i>	Poaceae	P	Aug-Sep/Feb-Mar	++
Pigeon pea	<i>Cajanas cajan</i>	Fabaceae	N	July-Sept	+++
Ground nut	<i>Arachishypogaea</i>	Leguminosae	N;P	July-Oct/Apr-June	++
Soyabean	<i>Glycin max</i>	Leguminosae	N	July-Oct	+++
Green gram	<i>Vigna radiata</i>	Fabaceae	N	Aug-Sep	+++
Back gram	<i>Vigna mungo</i>	Fabaceae	N	Aug-Sep	+++
Sesame	<i>Sesamum indicum</i>	Pedaliaceae	N;P	July-Sept	+++
Sunflower	<i>Helianthus annus</i>	Compositae	N;P	Aug-Sep	+++
Safflower	<i>Carthamus tinctoria</i>	Asteraceae	N;P	June-July	++

Table 2. Diversity of Horticulture crops in Dr. Panjabrao Deshmukh Krushi Vidyapeeth Akola

Common name	Scientific Name	Family	Food source	Flowering period	Intensity of visitation
a. Fruits					
Orange	<i>Citrus reticulata</i>	Rutaceae	N;P	Jan- mar/Jun-July	+++
Sapota	<i>Manilkara zapota</i>	Sapotaceae	N;P	Oct-Nov / Feb-March	++
Kaghziinimboo	<i>-Citrus aurantifolia</i>	Rutaceae	N;P	Nov-mar	+++
Papaya	<i>Carica papaya</i>	Caricaceae	N;P	March-april	+++
Tamarind	<i>Tamarind Indica</i>	Fabaceae	P	Apr-May/Dec-jan	+++
Aonla	<i>Phyllanthus emblica</i>	Euphorbiaceae	N;P	Mar-May	++
Dragon fruit		Cactaceae	N	June-Nov	+
Date palm	phonix dactylifera	Arecaceae	N;P	June-Dec	+++
Wood apple	limonia acidissima	Rutaceae	N;P	Feb-march	++
Pomegranate	<i>Punica grantum</i>	Punicaceae	N;P	Mar-june	++
Mango	<i>Mangifera indica</i>	Anacardiaceae	P	Jan-Apr	+
Zizipus	<i>Zizipus jujuba</i>	Ramnaceae	N;P	Jul-Oct	++
Zizipus	<i>Zizipusmauritiana</i>	Ramnaceae	N;P	May-June	++
Custard apple	<i>Annona squamosa</i>	Annonacea	N;P	June-Aug	+++
Bel	<i>Aeglemarmilose</i>	Rutaceae	N;P	May-June	++
Guava	<i>Psidium guajava</i>	Myrtaceae	P	June -Sept	+++
Lemon	<i>Citruslinom</i>	Rutaceae	N;P	Oct- Jan/July-Sept	+++
b. Vegetables					
Garlic	<i>Allium sativum</i>	Liliaceac	N;P	Aug-Sep	++
Curry patta	Murray koenigii	Rutaceae	N	Mar-May	+++
Onion	<i>Alliumsepa</i>	Liliaceac	P	Dec-Feb/Mar-May	++
Chilli:	<i>Capsicum annum</i>	Solanaceae	N;P	Jan-Dec	++
Tomato:	<i>Lycoperesicum esculentum</i>	Solanaceae	N;P	Jan-Dec	+++
c) Ornamental plants					
Tulsi	<i>Ocimum sanctum</i>	Lamiaceae	N;P	July -Sept/Mar-April	+++
Gladiolus		Gladiolaceae	N;P	August	++
Marigold	<i>Tagetuserecta</i>	Asteraceae	N	Sept-Dec	+++
Basil	<i>Ocimumbasilium</i>	Labiatae	N;P	Oct-Feb	++
Zinnia	<i>Zinnia elegans</i>	Asteraceae	N;P	April-Nov	+++
Crisenthemum		Asteraceae	N;P	Oct-Nov	++
Rose	<i>Rosa Indica</i>	Rosaceae	P	Mar-Sept	+++
Gulmohar	<i>Delonixregia</i>	Fabaceae	N;P	Mar-April	+++
Tube Rose	<i>Polianthas tubrosa</i>	Asperagaceae	P	Aug-Sep	+++
Canna	<i>Canna indica</i>	Cannaceae	N;P	July-August	++
d) Medicinal plants					
Bhrami:	Adhatodavasica	Acanthaceae	N	May-Oct	++
Shatavari:	Asparagus racemosus	Asparagaceae	P	May-June	+
Brahmhi:	Bacopa monieriSSS	Scrophulariaceae	P	June -Oct	+
Tulsi	Ocimum sanctum	Lamiaceae	N;P	July -Sept/ Mar-April	+++
Sarpagandha:	Rauvoffia serpentine	Apocunaceae	N;P	March-May	++
Aloevera:	Aloe barbadensis	Asphodelaceae	N;P	March-May	+++
Lavangtulas:	Ocimum gratissimum	Lamiaceae	P	All Year	++
Indian squill:	Urgania indica	Asparagaceae	N;P	April-May	+++
Star grass lilly:	Iphiginnaia stellate	Colchicaceae	N;P	May-july	++
Mint:	Coleus forshkohli	Lamiaceae	N;P	June-Sep	+++
Guggul:	Commiphora mukul	Burseraceae	N;P	Nov-July	
Aromatic grass:	Cymbophogon nardus	Poaceae	N;P	April-june	++
Adhulsa:	Justicia adhatoda	Acanthaceae	N;P	March-June	+++
Bibba;	seacarpus anacardium	Anacardiaceae	N;P	June-july	++
Gambheri	Gmelina arborea	Verbinaceae	N;P	Feb-April	+++
Nirgudi:	Vitex nrgundo	Laminaceae	N;P	June-August	++
Parosa pimpal		Malvaceae	N;P	All Year	+++

Table 3. The diversity of forest trees in Dr. Panjabrao Deshmukh Krishi Vidyapeeth Akola

Common name	Scientific name	Family	Food source	Flowering period	Intensity of visitation
Wild plants					
Touch Me Not	<i>Mimosa pudica</i>	Fabaceae	P	July-May	+++
Indian Catmint	<i>indica Anisomeles</i>	Labiataeae	N:P	Nov-March	+
Rui	<i>Calatropis gigantea</i>	Asclepediaceae	N:P	Nov-Dec	++
Jangalimuli	<i>Blumealacera</i>	Asteraceae	N:P	Dec-Mar	+++
Wild Senna	<i>Cassia tora</i>	Ceaselpineaceae	P	Mar-July	++
Lantana	<i>Lantana camara</i>	Verbenaceae	N	Jan-April, July-Sept	+
Devils's-Horsewhip	<i>Achyranthes aspera</i>	Amaranthaceae	P	Dec-Feb	+
Ekhandi	<i>Tridax procumbens</i>	Asteraceae	N:P	Jan-Dec	+
Broad leaf button	<i>Borreria sp</i>	Rubiaceae	N:P	Aug-Jan	++
Mustard	<i>Brassica sp.</i>	Brassicaceae	N	Oct-Nov	+
Dayflower species	<i>Commelina sp</i>	Commelinaceae	P:N	Aug-Dec	+
Datura sp.	<i>Datura stramonium</i>	Solanaceae	P	April-Dec	+
Wireweed	<i>Sida acuta</i>	Malvaceae	P	Jan-Dec	+
Bhumibala	<i>Sida cordata</i>	Malvaceae	N:P	Oct-Dec	+
Ilima/ flannel weed	<i>Sida cordifolia</i>	Malvaceae	N:P	Jan-Dec	+
Vernonia albicans	<i>Cyanthillium albicans</i>	Asteraceae	P	Aug-Dec	+
Milk weed	<i>Calatropis</i>	Asclepiadaceae	P	Mar-Feb	+
Field bind weed	<i>Convolvulus aevensis</i>	Convolvulus arvensis	P	Mar-Feb	++
Chinese-violet	<i>Asysteasis gangaetic</i>	Acanthaceae	N;P	Feb -March	+++
Kalsarji	<i>Wedelia Chinensis</i>		N;P	Jul-Nov	+++
Suryavarti	<i>Chrozophora rottleris</i>	Euphorbiaceae	N;P	March-May	+
Sessile joywood	<i>Allternanthera Sessile</i>	Amaranthaceae	N;P	Oct-Dec	++++
Lantana	<i>Lantana camera</i>	Verbenas	N;P	Jul-Dec	++
Tridax-daisy	<i>Tridax procumbence</i>	Asteraceae	N;P	Jul-Mar	++
Zoysia	<i>Zoysia spp.</i>	Zoysiaceae	N;P	Mae-Apr	+++
Wild mint	<i>Mentha arvensis</i>	Lamiaceae	N;P	Sept-Oct	++
Cyndrella-weed	<i>Syndrella nodiflora</i>	Asteraceae	N;P	Sept -March	+++
Devil's horsewhip	<i>Achyranthus Aspera</i>	Amaranthaceae	P	Sept-March	+
Chickenweed	<i>Portulaca quadrifida</i>	caryophyllales	N;P	March-April	+++
Fire-weed	<i>Chamaenerion angustifolium</i>	Onagraceae	N;P	June – Sep	++
Trida daisy	<i>Tridaxprocumbence</i>	Compositae	N;P	April-June	+++
Malabr nut	<i>Adhotodavasica</i>	Acanthaceae	N;P	Dec-June	++
Alexandrian-senna	<i>cassia angustifolia</i>	Fabaceae	N;P	All year	+++
Mimosa	<i>Mimosa diplotrica</i>	Mimosaceae	N;P	Apr-June	++
Forest trees					
Eucalyptus	<i>Eucalyptus spp.</i>	Myrtaceae	N;P	Nov-mar	+++
Tamarind	<i>Tamarindus indica</i>	Fabaceae	P	April-May/Dec-Jan	+++
Neem	<i>Azadirachta indica</i>	Meliaceae	N;P	Mar-May	++
Babul	<i>Acacia nilotica</i>	Fabaceae	N;P	July - Sep	+++
Black Siris	<i>Albezialebeek</i>	Mimosaceae	N;P	Apr-May	++
Apta	<i>Bauhiniaracemose</i>	Caesalpinaceae	N;P	Jan-Feb	+++

Cont...

Table 3. The diversity of forest trees in Dr. Panjabrao Deshmukh Krishi Vidyapeeth Akola

Common name	Scientific name	Family	Food source	Flowering period	Intensity of visitation
Semal	<i>Bombax ceiba</i>	Bombaceae	N;P	Jan-may	++
Khair	<i>Bombax ceiba</i>	Caesalpinaceae	N;P	Sept-Dec	+++
Palas	<i>Beutea monosperma</i>	Papilionaceae	N;P	Feb-Apr	+++
Kadamb	<i>Anthrocephalus cadamba</i>	Rubiaceae	N;P	Jan-Apr	+++
Arjun	<i>Terminalia Arjuna</i>	Combretaceae	N;P	Apr-May	++
Nimbara	<i>Melia Azadirach</i>	Meliaceae	P	Feb-May	+++
Bahava	<i>Casia fistula</i>	Caesalpinaceae	P	Apr-May	+++
Kanchan	<i>Bauhinia purpurea</i>	Caesalpinaceae	N;P	Jan-Feb	+++
Karanj	<i>Pongamia pinnata</i>	Fabaceae	N;P	Feb-May	+++
Shami	<i>Prosopis julifera</i>	Fabaceae	P	May-June/Sept-Oct	++
Jamun	<i>Syzigium cumimi</i>	Myrtaceae	N;P	Mar-May	+++
Teak	<i>Tectona grandis</i>	Verbinaceae	P	June-Sept	+
Bel	<i>Aegle Marmelos</i>	Rutaceae	N;P	Dec- Jan	++
Mango	<i>Magnifera indica</i>	Anacardiaceae	P	Jan-April	+
Ashoka	<i>Saracaasoca</i>	Leguminosae	P	Feb-april	+
Bija	<i>Pterocarpus marsupium</i>	Fabaceae	N;P	July- Oct	++
Rain tree	<i>Samanea saman</i>	Leguminosae	P	May-june	+++
Reetha	<i>sapindus indica</i>	Sapindaceae	N;P	Oct- Dec	++
Kusum	<i>Scheleicheraoleosa</i>	Sapindacea	P	Feb-Jul	+++
Biba	<i>Semecarpus anacardium</i>	Anacardiaceae	N;P	May- Sept	+
Simaruba	<i>Simaruba glauca</i>	Simaroubaceae	P	April- Jul	+++
Bitti	<i>Thevetia peruviana</i>	Apocynaceae	N;P	April-June	+++
Nirgundi	<i>Vitex negundo</i>	Lamiaceae	N;P	March-June	++
Hirda	<i>Termanaliachebula</i>	Combretaceae	N;P	April- Oct	+++
Beheda	<i>Terminalia bellerica</i>	Combretaceae	N;P	April- Nov	++
Badam	<i>Terminalia bellerica</i>	Combretaceae	N;P	April	+
Vilayati babul	<i>Prosopis juliflora</i>	Leguminoceae	N;P	April-Jul	+++
Parijatak	<i>Nyctanthesarbortristis</i>	Oleaceae	N	Aug-Jan	+++
Tiwas	<i>Ougeinia dalbergioides</i>	Papilionace	N;P	Feb-Jul	+++
Kunda	<i>Paspalum scrobiculatum</i>	Poaceae	N	Aug-Feb	+++
Shevaga	<i>Moringa oleifera</i>	Moringaceae	N;P	Feb-Mar	+++
Khirni	<i>Mimusopshexandra</i>	Sapotaceae	N;P	Mar-May	++
Mahua	<i>Madhuca indica</i>	Sapotaceae	N;P	Feb- April	+++
Subabul	<i>Leucaena leucocephala</i>	Mimosaceae	N;P	April- Jul	++
Ghaneri	<i>lantana camera</i>	Verbenaceae	N;P	Aug-Nov	+++
Jatropha	<i>Jatrophacurcas</i>	Euphorbiaceae	P	June- Jul	++
Jungle cork tree	<i>Holoptelae integrifolia</i>	Ulmaceae	N;P	June-Jul	+++
Anjan	<i>Hardwickiabinata</i>	Caesalpinaceae	N;P	April- May	+++
Siwan	<i>Gmelina arborea</i>	Verbanaceae	N;P	Feb- Apr	+++
Giripushp	<i>Gliricida maculate</i>	Fabeceae	N;p	Jan-Feb	+++
Dikamali	<i>Gliricida maculate</i>	Rubiaceae	N;P	Feb-Jan	++
Pipal	<i>Ficus religiosa</i>	Moraceae	N;P	Apr-May	+++

Cont...

Table 3. The diversity of forest trees in Dr. Panjabrao Deshmukh Krishi Vidyapeeth Akola

Common name	Scientific name	Family	Food source	Flowering period	Intensity of visitation
Umber	<i>Ficus glomerata</i>	Moraceae	N;P	Jan-July	+++
Nilgiri	<i>Ficus glomerata</i>	Myrtaceae	N;P	May-June	+++
Tendu	<i>Diospyros melanoxylon</i>	Ebenaceae	N;P	April-june	++
Kapok	<i>Ceiba pentandra</i>	Bombaceae	P	Jan-March	+++
Amaltas	<i>Cassia fistula</i>	leguminosae	N;P	March-April	+++
Karonda	<i>Carissa caranthus</i>	Apocinaceae	P	May-Sept	++
Apta	<i>Carissa caranthus</i>	Fabaceae	N	March-June	+
Sagargoti	<i>Caesalpinia crista</i>	Fabaceae	P	April-June	+
Acher	<i>Buchanania lanzan</i>	Anacardiaceae	P	April- June	++
Kanchan	<i>Bahunia variegata</i>	Fabaceae	N;P	April- June	+++
Hingan	<i>Balanites egyptiaca</i>	Simaroubaceae	N;P	April- May	+++
Saptaparni	<i>Alstoni ascholaris</i>	Apocynaceae	P	Oct- Jan	+++
Siris	<i>Albizia lebback</i>	Fabaceae	N;P	Mar-Oct	+++
Maharukh	<i>Albizia lebback</i>	Simarobroubaceae	N;P	May- June	+++
Haldu	<i>Adina cordifolia</i>	Rubiaceae	N;P	June- Oct	+++
Adulsa	<i>Adhatoda vasica</i>	Acanthaceae	P	Oct- Feb	++
Elephant foot tree	<i>Adhatoda vasica</i>	Malvaceae	P	Oct- Dec	++
Chirchiri	<i>Achyranthes aspera</i>	Amranthaceae	P	Oct- Dec	++
Chilati	<i>Acacia pennata</i>	Fabaceae	N;P	Oct-Feb	++
Hiwar	<i>Acacia leucocephala</i>	Mimosaceae	N;P	Jul-Nov	+++
Gunj	<i>Abruspreparatorius</i>	Fabaceae	N;P	Aug-Jan	+++
Spanish cherry	<i>Mimusops elengi</i>	sapotaceae	N;P	April	++

Note: N- Nectariferous P- Polleniferous

1.33%. In November it was 1.89%. In January with 4% , February with 7.14%, March with 5.88% (Table 5).

During the experimental period out of total 17 number of horticultural crops highest number where recorded in June with 8 bee-flora species followed by July, March, and August, with 7,7 and 6 species respectively. The floral abundance of horticultural crops in the June month was 11.94% , March with 10.29%, July 10.45%. Least abundance was found in December month with 2 floral species having percentage abundance 3.5% (Table 5). During study period out of 5 vegetable crops same number of bee-flora available in March, April, May month with 4 bee-flora species availability, with percentage abundance 5.88%, 4.94%, and 5.33%, respectively (Table 5).

Abundance of bee-flora: The presence of plant species with particularly alluring colours was crucial for attracting pollinators and enhancing the number of times they visited. The diversity of plant species, or the amount of blossoms, and the presence of plant species that are appealing to pollinators both help to stabilise the frequency of their visits. During the experimental period out of 10 number of

ornamental crops, in August 6 bee-flora species availability was present followed by September with 5 bee-flora species and 4 bee-flora species in April, July, October and November. Highest bee-flora abundance was 9.68% in August, September 7.69% least floral abundance was obtained in January with 2%, February with 1.79% (Table 6).

During the study period, Out of total 17 medicinal crops, Highest bee-flora found in June with 12 and May with 11, April and July with 10 bee-flora species available. The percentage abundance of June month is 17.91%, May 14.46% and April 12.35% July 14.93%. The least floral abundance of January and February month is 6% and 7.14%, respectively (Table 6).

During the study period, out of total 70 forest trees species, highest bee-flora found in April month with 38 and 35 in May. The least floral availability is obtained in December month with 13 forest trees species. The percentage Abundance of April month is 46.91% and that of May month 46.67% , the floral abundance of January, February, March, and June is 36%,39.29%,32.35%, and 40.30% respectively. The least floral abundance is 22.58% of August month (Table 6).

As per the above Data, out of total 34 wild plant species

Table 4. Bee-flora calender in Dr. Panjabrao Deshmukh Krishi Vidyapeet Akola campus in January 2022 to January 2023

Common name	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Cereals, Pulses												
Wheat	*	*	*	*								
Jawar		*	*									
Cotton									*	*	*	*
Gram	*	*	*									*
Maize		*	*					*	*			
Pigeon pea							*	*	*			
Ground nut				*	*	*	*	*	*	*		
Soyabean							*	*	*	*		
Green gram								*	*			
Back gram								*	*			
Sesame							*	*	*			
Sunflower								*	*			
Safflower						*	*					
Fruits												
Orange	*	*	*			*	*					
Sapota		*	*							*	*	
Kaghiinimboo	*	*	*								*	*
Papaya			*	*								
Tamarind	*			*	*							*
Aonla			*	*	*							
Dragon fruit						*	*	*	*	*	*	
Date palm						*	*	*	*	*	*	
Wood apple	*	*										
Pomegranate			*	*	*	*						
Mango	*	*	*	*								
Zizipus							*	*	*	*		
Zizipus					*	*						
Custard apple						*	*	*				
Bel					*	*						
Guava						*	*	*	*			
Lemon	*						*	*	*	*	*	*
Vegetables												
Garlic								*	*			
Curry patta			*	*	*							
Onion	*	*	*	*	*							*
Chilli	*	*	*	*	*	*	*	*	*	*	*	*
Tomato	*	*	*	*	*	*	*	*	*	*	*	*
ORNAMENTAL PLANTS												
Tulsi			*	*	*		*	*	*			
Gladiolus								*				
Marigold									*	*	*	*
Basil	*	*								*	*	*

Cont...

Table 4. Bee-flora calendar in Dr. Panjabrao Deshmukh Krishi Vidyapeet Akola campus in January 2022 to January 2023

Common name	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Zinnia				*	*	*	*	*	*	*	*	*
Rose:			*	*	*	*	*	*	*			
Gulmohar			*	*								
Tube Rose								*	*			
Canna							*	*				
Medicinal plants												
Bhrami					*	*	*	*	*	*		
Shatavari					*	*						
Brahmhi						*	*	*				
Tulsi			*	*			*	*	*			
Sarpagandha			*	*	*							
Aloevera			*	*	*							
Lavangtulas	*	*	*	*	*	*	*	*	*	*	*	*
Indian squill				*	*							
Star grass lilly					*	*	*					
Mint						*	*	*	*			
Guggul	*	*	*	*	*	*	*				*	*
Aromatic grass				*	*	*						
Adhulsa			*	*	*	*						
Bibba						*	*					
Gambheri		*	*	*								
Nirgudi						*	*	*				
Parosa pimpal	*	*	*	*	*	*	*	*	*	*	*	*
Forest trees												
Eucalyptus	*	*	*								*	*
Tamarind	*			*	*							*
Neem			*	*	*							
Babul							*	*	*			
Black Siris				*	*							
Apta	*	*										
Semal	*	*	*	*	*							
Khair									*	*	*	*
Palas		*	*	*								
Kadamb	*	*	*	*								
Arjun				*	*							
Nimbara		*	*	*	*							
Bahava				*	*							
Kanchan	*	*										
Karanj		*	*	*	*							
Shami					*	*			*	*		
Jamun			*	*	*							
Teak						*	*	*	*			
Bel	*											*
Mango	*	*	*	*								
Ashoka		*	*	*								
Bija							*	*	*	*		
Rain tree					*	*						
Reetha										*	*	*

Cont...

Table 4. Bee-flora calendar in Dr. Panjabrao Deshmukh Krishi Vidyapeet Akola campus in January 2022 to January 2023

Common name	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Kusum		*	*	*	*	*	*					
Biba					*	*	*	*	*			
Simaruba				*	*	*	*					
Bitti				*	*	*						
Nirgundi			*	*	*	*						
Hirda				*	*	*	*	*	*	*		
Beheda				*	*	*	*	*	*	*	*	
Badam				*								
Vilayati babul				*	*	*	*					
Parijatak	*							*	*	*	*	*
Tiwas		*	*	*	*	*	*					
Kunda	*	*						*	*	*	*	*
Shevaga		*	*									
Khirni			*	*	*							
Mahua		*	*	*								
Subabul				*	*	*	*					
Ghaneri								*	*	*	*	
Jatropha						*	*					
Jungle cork tree						*	*					
Anjan				*	*							
Siwan		*	*	*								
Giripushp	*	*										
Dikamali	*	*										
Pipal				*	*							
Umber	*	*	*	*	*	*	*					
Nilgiri					*	*						
Tendu				*	*	*						
Kapok	*	*	*									
Amaltas			*	*								
Karonda					*	*	*	*	*			
Apta			*	*	*	*						
Sagargoti				*	*	*	*					
Acher				*	*	*	*					
Kanchan				*	*	*	*					
Hingan				*	*	*	*					
Saptaparni	*									*	*	*
Siris			*	*	*	*	*	*	*	*		
Maharukh					*	*						
Haldu						*	*	*	*	*		
Adulsa	*	*								*	*	*
Elephant foot tree										*	*	*
Chirchiri										*	*	*
Chilati	*	*								*	*	*
Hiwar							*	*	*	*	*	
Gunj	*							*	*	*	*	*
Spanish cherry				*								
Wild plants												
Touch Me Not	*	*	*	*	*		*	*	*	*	*	*

Cont...

Table 4. Bee-flora calender in Dr. Panjabrao Deshmukh Krishi Vidyapeet Akola campus in January 2022 to January 2023

Indian Catmint	*	*	*							*	*
Rui										*	*
Jangalimuli	*	*	*								*
Wild Senna			*	*	*	*	*				
Lantana	*	*	*	*				*	*		
Devil's Horsewhip	*	*									*
Ekhandi	*	*	*	*	*	*	*	*	*	*	*
Borreria sp.	*							*	*	*	*
Brassica sp.										*	*
Commelina sp.								*	*	*	*
Datura sp.				*	*	*	*	*	*	*	*
Sida acuta	*	*	*	*	*	*	*	*	*	*	*
Sida cordata										*	*
Sida cordifolia	*	*	*	*	*	*	*	*	*	*	*
Vernonia albicans								*	*	*	*
Milk weed	*	*	*	*	*	*	*	*	*	*	*
Field bind weed	*	*	*	*	*	*	*	*	*	*	*
Chinese violet	*	*	*	*	*	*	*	*	*	*	*
Kalsarji							*	*	*	*	*
Suryavarti			*	*	*						
Sessile joywood										*	*
Lantana							*	*	*	*	*
Tridax daisy	*	*	*				*	*	*	*	*
Zoysia	*	*	*	*	*	*	*	*	*	*	*
Wild mint									*	*	
Cyndrella weed	*	*	*						*	*	*
Devil's horsewhip	*	*	*						*	*	*
Chickenweed			*	*							
Fireweed						*	*	*	*		
Trida daisy				*	*	*					
Malabar nut	*	*	*	*	*	*					*
Alexandrian senna	*	*	*	*	*	*	*	*	*	*	*
Mimosa				*	*	*					

Table 5. Bee flora abundance in agricultural and horticultural crops (Fruits & vegetables), in January 2022 to January 2023

Month	Bee flora			Total bee flora	Floral abundance (%)		
	Agriculture crops	Horticulture/ fruits crops	Horticulture/ vegetable		Agriculture crops	Horticulture/ fruits crops	Horticulture/ vegetable
January	2	6	3	50	4.00	12.00	6.00
February	4	5	3	56	7.14	8.93	5.36
March	4	7	4	68	5.88	10.29	5.88
April	2	5	4	81	2.47	6.17	4.94
May	1	4	4	75	1.33	5.33	5.33
June	2	8	2	67	2.99	11.94	2.99
July	5	7	2	67	7.46	10.45	2.99
August	8	6	3	62	12.90	9.68	4.84
September	9	5	3	65	13.85	7.69	4.62
October	3	5	2	57	5.26	8.77	3.51
November	1	5	2	53	1.89	9.43	3.77
December	2	3	3	51	3.92	5.88	5.88
Overall total	13	17	5	171	7.60	9.94	2.92

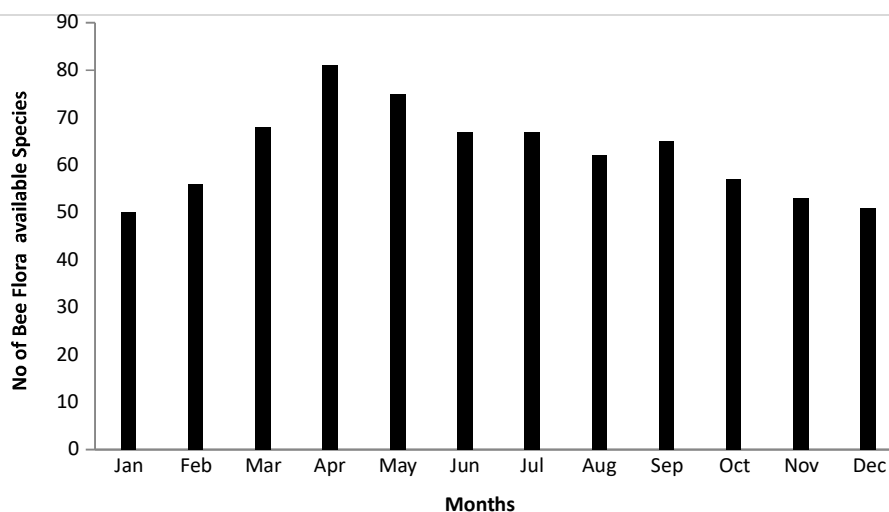


Fig. 1. Floral availability in different months

Table 6. Bee flora abundance in horticultural crops (Ornamental and medicinal crops) and forest tree species & wild plants, in January 2022 to January 2023

Month	Bee flora				Total Bee Flora	Floral abundance (%)			
	Ornamental-crops	Medicinal-crop	Forest-Tree	Wild Trees		Ornamental-crops	Medicinal-crops	Forest tree	Wild trees
January	1	3	18	18	50	2.00	6.00	36.00	36.00
February	1	4	22	17	56	1.79	7.14	39.29	30.36
March	3	8	22	19	68	4.41	11.76	32.35	27.94
April	4	10	38	17	81	4.94	12.35	46.91	20.99
May	3	11	35	15	75	4.00	14.67	46.67	20.00
June	2	12	27	14	67	2.99	17.91	40.30	20.90
July	4	10	22	15	67	5.97	14.93	32.84	22.39
August	6	7	14	15	62	9.68	11.29	22.58	24.19
September	5	5	16	21	65	7.69	7.69	24.62	32.31
October	4	3	18	22	57	7.02	5.26	31.58	38.60
November	4	3	14	25	53	7.55	5.66	26.42	47.17
December	2	3	13	25	51	3.92	5.88	25.49	49.02
Overall total	10	17	70	34	171	5.84	9.94	40.93	19.888

(weeds, shrubs), Highest bee-flora availability found in November and December Month and Least in June Month. The percentage abundance in bee-flora in November-December Month is 47.17% and 49.02%, respectively. The least floral abundance of June Month is 20.90% (Table 6).

In conclusion the bees plays most important role in biodiversity conservation and ecological balance through pollination. It helps in sustainable agriculture development. In the above discussion Out of 171 species there are 13 agricultural crops species, 17 horticultural fruits crops species, 5 vegetable crops species, 10 ornamental plants species, 17 medicinal plants species, 70 forest trees species and 34 wild plant species included (Table 1,2,3).

CONCLUSION

From this research activity, It is proved that the study Area is full of bee-foraging flora with great percentage abundance in different months. This area is most suitable for apiculture that can benefited for farmers as well as campus for study, and honey collection. We can say there is lack of critical darth period in this study area. The bee-flora availability order is forest crops, medicinal crops, wild plants, horticultural crops fruits crops, ornamental crops, vegetables crops and agricultural crops.

REFERENCES

Addi A and Bareke T 2019. Floral resources diversity and vegetation

- types important for honeybees in Ethiopia. *Asian Journal of Forestry* **3**(2): 64-68.
- Arega A, Gemechu T and Debela M 2020. Assessment on honeybee flora species with their time of flowering in East and Horo Guduru Wollega, Oromia
- Behera LK, Mehta AA and Sinha SK 2014. Suitable bee flora availability for commercial apiculture during dearth period in the heavy rainfall zone of South
- Chauhan MS, Farooqi A and Trivedi A 2017. Plants foraged by bees for honey production in northern India: The diverse flora of India and its implications for apiculture. *Acta Palaeobotanica* **57**(1): 119-132.
- Cheng Z, Luo B, Fang Q and Long C 2020. Ethnobotanical study on plants used for traditional beekeeping by Dulong people in Yunnan, China. *Journal of Ethnobiology and Ethnomedicine* **16**(61): 1-13.
- Crane E 1990. Bees and Beekeeping: Science, Practice and World Resources Cornell University Press, 640.
- Debara M, Negash D, Bekele B and Zeleke B 2019. Assessment and Establishment of Honeybee Flora Calendar to Increase Honey Production in Selected Areas of SNNPR State, Ethiopia. *Finance & Economics Review* **1**(1): 77-88.
- El-Kazafy A, Tahaa, Tahac RA and Al-Kahtanib SN 2019. Nectar and pollen sources for honeybees in Kafrelsheikh province of northern Egypt. *Saudi Journal of Biological Sciences* **26**: 890-896.
- Freitas BM and Silva EMS 2006. Potencial Apoicola Da Vegetacao Do Semi- Aridobrasileiro. Santos F.A.R. (Ed.) *Apium Plantae*, pp19-32. Gujarat, *Research Journal of Chemical and Environmental Sciences* **2**(6): 65-68.
- Hussain AB, Jamshed I and Asif A 2021. Charecterization of pollen profile of *Apis mellifera* L. in arid region of Pakistan. *Saudi Journal of Biological Sciences* **28**: 2964-2974.
- Jaiswal R, Chandra U, Gautam MP, Yadav SK, Giri SK and Ramveer 2018. Study on availability of bee flora and foraging activities of honeybee in Eastern Uttar Pradesh. *Journal of Entomology and Zoology Studies* **6**(4): 1633-1636.
- Jawale CS 2020. Bee flora for urban beekeeping in Nasik city. *International Journal of Science and Engineering* **5**(1): 17-19.
- Khalifa AM 2021. Overview of bee pollination and its economic value for crop production. *Journal Insects* **12**(8): 688.
- Moar NT 1985. Pollen analysis of New Zealand honeys. *New Zealand Journal of Agricultural Research* **28**: 39-70.
- Monique D, Da Silva D, Mougua Feretti V, De Sena JC, Warkentin M, Santos AK and Ribeiro CL 2015. Ornamental bee plants as foraging resources for urban bees in Southern Brazil. *Agricultural Sciences* **6**: 365-381.
- Olana T and Demrew Z 2019. Identification of honeybee floras and their flowering times in Wondo Genet, Southern Ethiopia. *Journal of Resources Development and Management* **59**: 1-9.
- Oluwaseyi FO, Mukaila AM and Mustapha MA 2021. Effect of flora diversity on honey production in selected local government areas in Kwara state. *Journal of Research in Forestry, Wildlife & Environment* **13**(3): 29-36.
- Pande R and Ramkrushna GI 2018. Diversification of Honeybee's flora and bee flora calendar for Nagpur and Wardha districts of Maharashtra, India. *J Entomol Zool Stud* **6**(2): 3102-3110.
- Piya V and Raichal A 2018. Diversity of nectariferous and polleniferous honeybee flora found in Chittur Taluk of Palakkad district India for commercial apiculture. *International Journal of Botany Studies* **3**(2): 129-132.
- Rachna P and Ramkrushna GI 2018. Diversification of honey bees' flora and bee flora calendar for Nagpur and Wardha districts of Maharashtra, India. *Journal of Entomology and Zoology Studies* **6**(2): 3102-3110.
- Rijal SP, Thapa RB, Sharma MD, Sah SK and Dhoj Y 2018. Bee flora calendar of cultivated and wild plants available in different agroecosystems of Chitwan, Nepal. *International Journal of Research Granthaalayah* **6**(11): 222-245.
- Sallibartan C 2016. *Characterization of the availability and use of pollen for domesticated honeybees in agricultural landscapes in France*. M.Sc. Thesis Wageningen University (Unpublished).
- Singh D 2007. Apiculture in India. *Current Science Association* **92**(10): 1335-1336.
- Singh ST 2005. *Bee plant diversity in Southern Peninsular India*. Ph.D. thesis, submitted to University of Pune, India.
- Sivaram V 2001. Honeybee flora and beekeeping in Karnataka state, India. Proceedings of the 38th year *International Apicultural Congress*, Apimondia, urban, South Africa.
- Taddesse Z 2020. *Assessing the management of honeybee colonies and major honeybee flora resources in Debark District, Amhara Region, Ethiopia*. M.Sc. Thesis, Bahir Dar University, Ethiopia (Unpublished).
- Teklay A 2011. *Seasonal availability of common bee flora in relation to land use and colony performance in Gergera Watershed Atsbi Wembwrta District, Eastern Zone of Tigray, Ethiopia*. M.Sc. thesis, Hawassa University, Ethiopia (unpublished).
- Thapa RB 2006. Honeybees and other insect pollinators of cultivated plants: A review. *Institute of Agriculture and Animal Sciences* **27**: 1-23.
- VanEngelsdorp D, Hayes J, Underwood R and Pettis JS 2010. A survey of honeybee colony losses in the United States, fall to spring. *Journal of Apicultural Research* **49**(1): 7-14.
- Vidya KC, Kandakoor SB, Prabhu ST and Talekar SC 2020. Study on the diversity of bee flora in university of Agriculture sciences, Dharwad campus, Karnataka, India. *International Journal of Current Microbiology and Applied Sciences* **9**(11): 3365-3376.
- Waykar B and Baviskar RK 2015. Diversity of bee foraging flora and floral calendar of Paithan Taluka of Aurangabad district (Maharashtra), India. *Journal of Applied Horticulture* **17**(2): 155-159.
- Waykar B, Baviskar RK and Nikam BT 2014. Diversity of nectariferous an polleniferous bee flora at Anjaneri and Dugarwadi hills of Western Ghats of Nasik district (M. S.) India. *Journal of Entomology and Zoology Studies* **2**(4): 244-249.