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## Bee Flora and floral calendar of honey bees in dry land regions of northern Karnataka

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### Abstract

The present investigation was conducted to study the diversity of bee flora which includes both nectariferous and polleniferous plants and also to develop a floral calendar for Haveri districts. The study revealed that in Haveri district, 75 plant species were useful to honeybees. Out of which nineteen species vegetables, fruits (13), field crops (15) and plantation, flower and ornamental crops and other plants constituted fifteen species and medicinal plants (13). The identified flora was further grouped into pollen, nectar and both pollen and nectar yielding plants. Out of 75 crops, there were 16 species of nectar yielding plants, pollen (12) and both pollen and nectar were 44 species. The peak periods of honeybee foraging activity (honey flow period) were recorded during June– October of winter season and January to March of summer season of the year. During the honey flow period (June– October), abundant bee floral plants were found blossoming and plants species were recorded as source of food for honeybees. Based on the availability, utility status and flowering duration of flora, floral calendar was developed for the study area.

**Keywords:** Bee flora, beekeeping, honey flow period, dearth period, floral calendar

### Introduction

The bees are dependent on flowering plants as they provide food in the form of pollen and nectar. Similarly, plants are also depending on bees for pollination. This mutual interdependence of insects and plants increased their coevolution<sup>[1]</sup>. The flowering plants of many plant families are blooming at different time periods and seasons of the year. Pollen and nectar availability to foraging bees varied with time of the season and flowering periods of different plants species. The blooming period does not commence simultaneously in all the bee flora attending in the main honey-flow season. Climatic factors, soil parameters, habitat of vegetation, the time of blooming may change even in the same nectar plant<sup>[2]</sup>. The types of honey harvest not similar in all the ecosystems and regions of a country because honey plants are not similar in all the ecosystems as they are restricted to particular climatic conditions. Flowers are main resources for successful apiculture and bee's life. Flower period and major blooming time the information is very prime important for successful apiculture. Since beekeeping includes multi approach as it includes agri-horticultural and forest based industry and nowadays it is of great importance for farmers with respect to their pollination services in improving the Agri-Horticultural productivity and other useful bee products. By spending little investment beekeeping can be practiced to get maximum subsidiary income along with other routine agricultural activities. Successful Beekeeping is not only depends on the good strain of honeybees but it also depends on be floral availability i.e., pollen and nectar sources within the surrounding area of an apiary<sup>[3]</sup>. The present study has been undertaken to study the bee-flora in dry land region of northern Karnataka in particularly Haveri district for determining the honey and pollen flow seasons and also develop floral calendar of the different plants existing in and around the study area

### Materials and Methods

The study area of Haveri (14°47'36" N, Lat: 75°24'16" E Long, 576 m aslm) is selected for studying bee-flora and floral calendar during 2009-2011. The average annual rainfall of Haveri districts was 625mm. For the purpose of collection of data,

25 km radius area was marked in which 20 study sites were selected. Observations were recorded during flowering periods of principal crops of that are visited by worker bees of different plant groups viz., vegetable crops, fruit crops, field crops, plantation, flower, medicinal and ornamental plants.

**Identification of bee-flora:** Field data were collected through monthly visits to the study sites, during 2010-2011. Each study visit served as pseudo replicates for the site and all observations were observed between 0700-1730 hours. The study included observations of activities of bees on flowers of different plant species whenever bees were found on the flowers of such plants, their foraging behavior was observed for a period of 10 minutes. If the success of any foraging attempt was ascertained, the plant was scored as bee foraging species if at least three (3) honeybees visited the flowers simultaneously within 10 minutes of the observations. The observations on nectar and pollen source were based on activities performed by honeybees on different flowers observed by using Binoculars (Nikon 8x42 Aculon Camo). Honey bees with activity of extending their proboscis into the flowers was considered as nectar source and bees carrying pollen on their hind legs were determined as pollen source. Honey bees with activity of extending their proboscis into the flowers and also collecting pollen on their hind legs were determined as nectar and pollen yielding plants. Based on frequency visitation of worker bees to a flower, forage value was established as low and high nectar and pollen rich plant. Such plants were identified using the books *in situ*. If the plants were recorded as bee foraging species at particular site and later encountered in subsequent surveys on the other sites; it was only scored for presence of bees. Plants that could not be identified in the field their portion or twig of a branch with necessary botanical features like leaves, flowers and portion of stem were cut and arranged in herbarium, identified with the help of Botanist from UAS, Dharwad and compared with the published reports. The observations were recorded for three seasons during 2009- 2011. A complete chronological record of flowering periods of plant species was made during the survey. The data recorded in field's notebooks was compiled into annual floral calendar and was also used to prepare honey flow and dearth periods (Methodology used as followed by Wayker *et. al.*, 2014)<sup>[4]</sup>.

## Results and Discussion

Bee flora and floral calendar were documented under field conditions at Haveri districts. The field observations were recorded during 2009-2011. This basic information is required to time the pesticide application without causing any inimical effects on the pollinators. A complete chronological record of flowering periods of all plant species was made. The results are presented in Tables 1-4 and the floral calendar has considerably facilitated the standardization of routine management practices in apiaries. The districts has number of Agricultural, Horticultural, forest and weed plants and their distribution, blooming period, honey flow time in the confined area is very essential and important tool in predicting the pollen and nectar flow periods for successful beekeeping. The thorough knowledge of flowering season and time duration are important factors for sustainable management of bee colonies and for good honey harvest. The flowering duration of any particular locality will also helps the beekeeper in migratory beekeeping practice also.

The present findings revealed that, in Haveri district, 62 plant species were useful to honeybees, out of which vegetables

(19), fruits (13), field crops (15) and plantation, flower and ornamental crops and other plants (15) and medicinal plants (13) identified and found in the study area. The identified flora was further grouped into pollen, nectar and both pollen and nectar yielding plants (Tables 1-4) out of 55 crops, nectar (16), pollen (12) and both pollen and nectar (34) yielding plants

Among the 19 vegetables there were few plants viz., Bhendi, Bottle guard and Pumpkin those served as both nectar and pollen sources. Similarly among the fruit crops (13) majority viz., citrus, ber, custard apple, banana, guava etc served as both nectar and pollen source where as rose apple, guava, banana, coronda, sweet lime, ber, custard apple are the source low pollen yielders. Among field crops (15) sunflower, blackgram, chickpea, groundnut, maize, niger and castor served as both nectar and pollen source. Similarly in plantation, flower and ornamental crops (15), antigonum served as both nectar and pollen sources. And medicinal plants (10) both served as pollen and nectar sources (Table 1 to 4).

## Honey flow and dearth period

In Haveri district the honey-flow and dearth periods were determined and results are summarized in Tables 1-4. The peak periods of honeybee foraging activity (honey-flow period) were recorded during June– October of winter season and January to March of summer season of the year. During the honey-flow period (June– October), abundant bee floral plants were found blossoming and plants species were recorded as source of food for honeybees.

Major nectar-rich plants included viz., Beans *Phaseolus vulgaris*, Mung bean *Vigna radiate*, Cluster bean *Cyamopsis tetragonolobus*, Bitter gourd *Momordica charantia*, Mango *Mangifera indica*, Black gram *Vigna mungo*, Chickpea *Cicer arietinum*, Pigeon pea *Cajanus cajan*, Mustard *Brassica rapa*, Beans *Dolichus lab lab*, Cow pea *Vigna spp*, Pongamia *Pongamia pinnata*, Bajra *Pennisetum typhoides*

Pollen rich plants viz., Brinjal *Solanum melongena*, Tomato *Lycopersicon esculentum*, Chilli *Capsicum sp.*, Cucumber *Cucumis sativus*, Musk melon *Cucumis melo*, Water melon *Citrullus lanatus*, Rajgiri/ Amaranthus *Amaranthus gracilis*, Groundnut *Arachis hypogaea*, Maize *Zea mays*, Mesta *Hibiscus sutrattensis* and Coconut *Cocos nucifera*.

Both nectar and pollen rich plants viz., Bhendi *Abelmoschus esculentus*, Bottle gourd *Lagenaria siceraria*, Pumpkin *Cucurbita pepo*, Onion *Allium cepa*, Drumstick *Moringa oleifera*, Ridge gourd *Luffa acutangula*, Pea *Pisum sativum*, Snake gourd *Trichosanthes anguina*, Citrus *Citrus limon*, Ber *Ziziphus jujube*, Custard apple *Annona squamosa*, Papaya *Carica papaya*, Caronda (Kavale) *Carissa carandas*, Banana *Musa sp.*, Guava *Psidium guajava*, Rose apple *Syzygium jambos*, Sunflower *Helianthus annuus*, Sesame *Sesamum indicum*, Niger *Guizotia abyssinica*, Paddy *Oryza sativa*, Castor *Ricinus comunis*, Cotton *Gossypium spp*. Tamarind *Tamarindus indicus*, Neem *Azardirhacta indica*, Antigonum *Antigonum leptopes* and other bee-flora plants of the region supported honey production. The flowering plants of an area having good value as bee pasture are necessary to maintain bee colonies. Honey bees foraged on these plants extensively for honey production.

Both nectar and pollen Medicinal plants identified were, *Moringa oleifera*, *Ricinus comunis*, *Tamarindus indicus*, *Azardirhacta indica*, *Ocimum sp.* *Butea monosperma*, *Murraya koeinigi*, *Melia dubia*, *Mimosa pudica*, *Solanum nigrum*, *Echinops echinatus*, *Tylophora asthematica*, *Mesua*

*furea*, *Butea monosperma*, and other bee floras of the region supported honey production. The flowering plants of an area having good value as bee pasture are necessary to maintain bee colonies. Honeybees visited these plants extensively for honey production and colony multiplication. (Table. 1-4)

Summer season was critical dearth period with high temperature (over 35 °C), scarcity of water and very few species are in blooming. The few cultivated plants like *Moringa oleifera*, *Cucumis melo*, *Psidium guajava*, *Phyllanthus nirori*, *Coriandrum sativum*, *Vigna aconitifolia*, *Arachis hypogaea*, *Punica granatum*, *Pennisetum tyhoides* and wild plants like *Azardirhacta indica*, *Cassia tora*, *Tridax procumbens*, *Antigonum leptopes* (creeper) were in bloom during the season. However, their numbers per unit area was less or having lesser quantity of pollen or nectar. Hence they provide minor nutritional requirements to the bee colony. these minor food sources are utilized by bees during the scarcity of major bee flora. Because of high temperature and scarcity of water resources in dry lands for flowering plants, this period was found unfavorable for foraging of honeybees and large-scale management of apiary.

The present findings supported by (Dalio, 2012) [5] and Kumar. *et.al.*, (2013) [6] during dearth period when agro-horticultural crops are not in blooming, then weeds and wild flowering plants were observed as alternate food source for honeybees and higher temperature and scarcity of water resources for flowering plants unfavorable for bee foraging. The present findings are also supported by Bisht and Pant (1968) [7] reported that *A.cerana* gathered pollen throughout the year under Delhi conditions. The higher pollen gathering activity was recorded during January-March where as May and June was the period of lesser activity. Similarly Venkatachalapathi *et al.*, (2013) [8] documented 66 species of medicinal plants which are potential forages of honey bees in Walayar Valley of Coimbatore district in Western Ghats, Present findings also in conformity with the records of Sivaram, (2001) [9] recorded 192 plant species in southern Karnataka during 1993-1999. These plant species includes medicinal, fruit, ornamental, vegetable, pulses and spice crops and also documented that flowering duration of bee plant provided to know the peak blooming period by the beekeeper

**Table 1:** Nectariferous / polleniferous bee flora and floral calendar in vegetable crops at Haveri district

Sl. No.	Common name	Botanical name	Family	Flowering period	Bee forage value		
					Nectar	Pollen	Nectar + Pollen
<b>Vegetables</b>							
1.	Brinjal	<i>Solanum melongena</i>	Solanaceae	Jan to March, June to July.	-	P2	-
2.	Tomato	<i>Lycopersicon esculentum</i>	Solanaceae	Jul-Sep	-	P1	-
3.	Chilli	<i>Capsicum sp.</i>	Solanaceae	Jul-Feb	-	P2	-
4.	Bhendi	<i>Abelmoschus esculentus</i>	Malvaceae	Aug – Nov	-	-	P1N2
5.	Beans	<i>Phaseolus vulgaris</i>	Fabaceae	Dec-Feb	N2	-	-
6.	Bottle gourd	<i>Lagenaria siceraria</i>	Cucurbitaceae	Oct – Feb.	-	-	N2P2
7.	Cucumber	<i>Cucumis sativus</i>	Cucurbitaceae	Aug – Oct.	-	P1	-
8.	Musk melon	<i>Cucumis melo</i>	Cucurbitaceae	March – May.	-	P1	-
9.	Pumpkin	<i>Cucurbita pepo</i>	Cucurbitaceae	Aug – Oct.	-	-	N2P2
10.	Water melon	<i>Citrullus lanatus</i>	Cucurbitaceae	July – Aug.	-	P1	-
11.	Onion	<i>Allium cepa</i>	Liliaceae	Jun– Aug.	-	-	P1N2
12.	Drumstick	<i>Moringa oleifera</i>	Moringaceae	Nov – Feb.	-	-	N1P2
13.	Ridge gourd	<i>Luffa acutangula</i>	Cucurbitaceae,	July – Oct.	-	-	N1P1
14.	Mung bean	<i>Vigna radiata</i>	Fabaceae	Aug – Sep.	N2	-	-
15.	Pea	<i>Pisum sativum</i>	Fabaceae	Aug- Sep.	-	-	N1P1
16.	Cluster bean	<i>Cyamopsis tetragonolobus</i>	Leguminosae	Jun - Aug.	N2	-	-
17.	Rajgiri/ Amaranthus	<i>Amaranthus gracilis</i>	Amaranthaceae	Feb-Mar	-	P1	-
18.	Bitter gourd	<i>Momordica charantia</i>	Cucurbitaceae	Aug-Oct	N2	-	-
19.	Snake gourd	<i>Trichosanthes anguina</i>	Cucurbitaceae	Jan-Mar	-	-	P2N2

N1 = Low nectar yield N2 = High nectar yield “-“ = absent

P1 =Low pollen yield P2 = High pollen yield

**Table 2:** Nectariferous / polleniferous bee flora and floral calendar in fruit crops at Haveri district

Sl. No.	Common name	Botanical name	Family	Flowering period	Bee forage value		
					Nectar	Pollen	Nectar + Pollen
<b>Fruit crops</b>							
1.	Citrus	<i>Citrus limon</i>	Rutaceae	Oct – Jan, July – Sep.	-	-	N2P1
2.	Mango	<i>Mangifera indica</i>	Anacardiaceae	Dec- Jan	N2	-	-
3.	Ber	<i>Ziziphus jujuba</i>	Rhamnaceae	July – Oct.	-	-	N2P2
4.	Custard apple	<i>Annona squamosa</i>	Annonaceae	Aug – Oct.	-	-	N1P2
5.	Papaya	<i>Carica papaya</i>		May-June	-	-	N2P1
6.	Caronda (Kavale)	<i>Carissa carandas</i>	Apocynaceae	Mar-Apr	-	-	P2N2
7.	Water melon	<i>Citrullus lanatus</i>	Cucurbitaceae	Sep-Oct	-	P1	-
8.	Banana	<i>Musa sp.</i>	Musaceae	Jan-Dec	-	-	P2N2
9.	Gauva	<i>Psidium guajava</i>	Myrtaceae	Mar-Jun	-	-	P2N1
10.	Rose apple	<i>Syzygium jambos</i>	Myrtaceae	Mar-Jun	-	-	P2N1
11.	Sapota	<i>Manilkera achras L.</i>	Sapotaceae	Mar-Jun	N1	P1	
12.	Amla	<i>Phyllanthus nirori</i>	phyllanthaceae	April-may	-	-	P2N2

N1 = Low nectar yield N2 = High nectar yield “-“ = absent

P1 =Low pollen yield P2 = High pollen yield

**Table 3:** Nectariferous / polleniferous bee flora and floral calendar in field crops at Haveri district

Sl. No.	Common name	Botanical name	Family	Flowering period	Bee forage value		
					Nectar	Pollen	Nectar + Pollen
<b>Field crops</b>							
1.	Sunflower	<i>Helianthus annuus</i>	Compositae	March – April.	-	-	N2P1
2.	Black gram	<i>Vigna mungo</i>	Fabaceae	Aug – Sep.	N2	-	-
3.	Chickpea	<i>Cicer arietinum</i>	Fabaceae	Dec – March.	N2	-	-
4.	Ground nut	<i>Arachis hypogaea</i>	Fabaceae	July - Oct, April – June.	-	P2	-
5.	Pigeon pea	<i>Cajanus cajan</i>	Fabaceae	July – Sep.	N2	-	-
6.	Sesame	<i>Sesamum indicum</i>	Pedaliaceae	July – Aug.	-	-	N1P2
7.	Maize	<i>Zea mays</i>	Poaceae	Aug – Sep, Feb – March.	-	P2	-
8.	Mustard	<i>Brassica rapa</i>	Brassicaceae	Jan – March.	N1	-	-
9.	Mesta	<i>Hibiscus sutrattensis</i>	Malvaceae	Aug-Nov	-	P2	-
10.	Niger	<i>Guizotia abyssinica</i>	Asteraceae	Sep-Nov	-	-	P1N1
11.	Paddy	<i>Oryza sativa</i>	Poaceae	Aug-Sep	-	-	P2N1
12.	Castor	<i>Ricinus comunis</i>	Euphorbiaceae	Feb-Apr	-	-	P2N2
13.	Lab lab		Fabaceae	Jan-Dec	N1	-	-
14.	Cotton	<i>Gossipium spp.</i>	Malvaceae	Sept-Jan	-	-	P2N2
15.	Cow pea	<i>Vigna spp</i>	Leguminiaceae	Jan-Dec	N2	-	-

N1 = Low nectar yield N2 = High nectar yield “-“ = absent

P1 =Low pollen yield P2 = High pollen yield

**Table 4:** Nectariferous / polleniferous bee flora and floral calendar in plantation, flower, ornamental and medicinal crops at Haveri district

<b>Plantation crops</b>							
1.	Coconut	<i>Cocos nucifera</i>	Arecaceae	Jan-Dec	-	P1	-
2.	Tamarind	<i>Tamarindus indicus</i>	Fabaceae	Apr-Jun	-	-	P2N1
3.	Pongamia	<i>Pongamia pinnata</i>	Fabaceae	Feb-Apr	N1	-	-
4.	Neem	<i>Azadirachta indica</i>	Meliaceae	Mar-Apr	-	-	P1N1
5.	Oil palm	<i>Elaeis guineensis</i>	Aracaceae				P2N2
<b>Flower and ornamental plants</b>							
1.	Antigonum	<i>Antigonum leptopus</i>	Polygonaceae	Apr- May	-	-	P1N2
2.	Marigold	<i>Tagitis spp</i>					
<b>Medicinal plants</b>							
1.	Tulasi	<i>Ocimum sp.</i>	Lamiaceae	Jan-Dec	-	-	P3N1
2.	caster	<i>Ricinus communis</i>	Euphorbiaceae	Feb-Apr	-	-	P2N2
3.	Neem	<i>Azadirachta indica</i>	Meliaceae	Mar-Apr	-	-	P1N1
4.	Drumstick	<i>Murraya koenigii</i>	Rutaceae	Apr-Jun	-	-	P2N1
5.	Tamarind	<i>Tamarindus indica</i>	Fabaceae	Apr-Jun			P1N1
6.	Tulasi	<i>Ocimum sp.</i>	Lamiaceae	Jan-Dec	-	-	P3N1
7.	Brahma Dande	<i>Echinops echinatus</i>	Asteraceae	Throught Year	-	-	N2P1
8.	Aadumuttada balli	<i>Tylophora asthematica</i>	Apocynaceae	March-Jul	-	-	P2N1
9.	Nagalinga	<i>Mesua furea</i>	Calophyllaceae	March-May	-	-	P1N1
10.	Bael	<i>Aegle marmilose</i>	Rutaceae	Nov-Dec	N1	P2	-
11.	Muttuga	<i>Butea monosperma</i>	Papilionaceae	Jan March	-	-	P1N1
12.	Doddagono soppu	<i>Portulaca oleraceae</i>	Portulacaceae	Jan-Feb			P2
13.	Womans tongue tree	<i>Albija lebeck</i>	Fabaceae	April -May	-	P2	-

N1 = Low nectar yield N2 = High nectar yield “-“ = absent

P1 =Low pollen yield P2 = High pollen yield

**Conclusion:** Bee flora and floral calendar was documented under field conditions at Haveri districts. This basic information is required to time the pesticide application without causing any inimical effects on the pollinators. The results revealed that in Haveri district, 62 plant species were useful to honeybees, of which vegetables (19), fruits (13), field crops (15) and plantation, flower and ornamental crops and other plants (15) identified and found in the study area. The identified flora was further grouped into pollen, nectar and both pollen and nectar yielding plants out of 62 crops, nectar (16), pollen (12) and both pollen and nectar yielding plants (34).

#### Honey flow and dearth period

In Haveri districts the honey flow and dearth period was determined and the peak periods of honeybee foraging activity (honey flow period) were recorded during June–October of winter season and January to March of summer

season of the year. During the honey flow period (June–October), abundant bee floral plants were found blossoming and plants species were recorded as source of food for honeybees. Summer season was critical dearth period with high temperature (over 35 °C), scarcity of water and few flowering plants during this period weeds and wild flowering plants were served as alternate food source for honeybees.

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