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Floral calendar of bee floral resources in sujanpur and adjoining region of Hamirpur Hills, Himachal Pradesh, India

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Abstract
Establishment of floral calendar for a particular area is very important to enhance economy of agrarian people by paving the way for beekeepers and farmers to increase the honey production, manage their bee colonies and helps in selecting the most suitable places for the bees. The study was carried out to identify the floral sources for honeybees in the given area. A total of 73 plant species belonging to different families was reported with 22 plant species as major source of nectar and pollen; 14 as medium source, 19 as minor source and rest were 3 medium nectar and minor pollen 3 major nectar and medium pollen; 3 medium nectar and major pollen; 1 major nectar source and minor pollen; 1 minor nectar and major pollen source and rest either nectar or pollen source. The main floral sources for the study area includes *Taraxacum officinale*, *Brassica campestris*, *Eruca sativa*, *Cucurbita pepo*, *Cucurbita maxima*, *Raphanus sativus*, *Carica Papaya*, *Acacia catechu*, *Dalbergia sissoo*, *Trifolium repens*, *Woodfordia fruticosa*, *Moringa oleifera*, *Callistemon citrinus*, *Eucalyptus camaldulensis*, *Psidium guajava*, *Syzygium cumini*, *Grevillea robusta*, *Sesamum indicum*, *Eriobotrya japonic*, *Citrus grandis*, *Sapindus mukorosii*, *Grewia optiva Dumm.* Whereas Medium nectar and pollen sources reported were *Adhatoda vasica* Nees, *Carissa caranda* L, *Dahlia pinnata*, *Berberis balsamina* L, *Cannabis sativa* L, *Sechium edule*, *Emblica officinalis* Gaertn. *Cassia fistula* L, *Erythrina suberosa* Roxb, *Salvia* spp., *Hibiscus Rosa sinensis* L., *Malvaviscus arboreus etc.*

Keywords: bee flora, floral calendar, honeybee, nectar, pollen

Introduction
Indian sub-continent, this part of earth belongs to tropical region and it is one of the world's mega-diversity area with tremendous biodiversity which includes at genetic, species as well as level of ecosystem which is about 7% of world biodiversity. (Basavarajaih, 2018) Beekeeping in this area is an interesting activity, where honeybee too fulfil their requirement of pollen and nectar acts as an important pollinators, which helps the human to fulfill their desire of having high yield of food crops including fruits, nuts, fibres etc. (Hein, 2009) [6]. Thus the majority of agricultural and horticultural crops benefitted by the pollination services of bees and it accounts for one third of total human diet (Raijal *et al*., 2018).

In beekeeping, the honey production and the type of honey depend on the vegetal species available in different regions of working area, so the success of beekeeping depends on health of colony, which further depends on the availability of food i.e. availability and abundance of rich floral resources, time duration of floral resources and knowledge about important bee floral resources is prime requirement (Baum *et al*., 2011) [2]. Therefore information on utility of plant species, their distribution, abundance, preference for any climate or soil types is great importance to beekeepers for sustaining the maximum number of bee colonies that can increase the honey production manifolds. Thus, Proper documentation of bee flora in some ready reckoner form helps the beekeeper and beginners of that particular area.

A floral calendar is a time table that indicates approximate date and duration of blossoming period of the honey or the pollen plants in an area. It also includes density, distribution and honey potential of the regional bee flora. Preparation of a floral calendar for any specific area needs detailed studies of seasonal changes in vegetation pattern or agro-ecosystems of the area, the foraging tendencies of the bees and the manner in which the honeybee colonies interact with their floral environment. So, an accurate and detailed calendar often require several years of repeated recording and refinement of information (Lakshmi and Suryanarayana, 1997 c; Kumari *et al*., 2003., Tiwari *et al*., 2010; Sekine *et al*., 2013., Harugade and Chaphalkar, 2013., Pande and Ramkrushna., 2018) [10, 9, 22, 16, 5, 11]. Keeping in view, the importance of the floral calendar for honeybee, this study is an attempt to identified the bee floral resources in Sujanpur and adjoining localities of Hamirpur hills as separate floral calendars are required for different regions in beekeeping practiced areas.

Materials and Methods
For the present bee botanical investigation work of honey yielding plants was carried out in Sujanpur and adjoining localities of Hamirpur hills during 2014. The study area falls under the subtropical zone with altitude varying from 350 to 1000 metres and have annual rainfall between 600 to 1000mm. The climate is not a typical hilly and chilly but varied throughout the year with hot summer and cold winter due to its location on the bank of river Beas. The people of the region are mainly involved in agricultural and horticultural activities. Flowering plants (wild and cultivated) which were visited by honeybees to collect pollen and nectar were observed at fortnight intervals and sample of those plants were collected from the studied area, during different season. While doing this Honey bees were observed for 10 minutes on flowering plants during their

visit for pollen and nectar (Silveira, 2004) [20]. A Plant was considered as the nectar source if honeybees pierce the flower by its proboscis and a pollen source, if it carries pollen load of a particular flowering plant on their hind legs (Bista and Shivakoti, 2001) [3]. Honey potentiality with respect to nectar and pollen were also categorized accordingly (Sharma, 1989; Partap, 1997) [13, 12] for the pollen load analysis slides were prepared according to the method of Erdtman (1960) [4] and Sharma (1970 a, b) [15]. The plants collected were identified with the help of a local floras and texonomists from department of Biosciences, Himachal Pradesh University, Shimla; Punjabi University, Patiala; Forest Research Institute, Dehradun and National Botanical Research Institute, Lucknow.

Results

In this study, a total of 73 plant's species belonging to different families were identified and recorded with their common and botanical names, distribution in the area, flowering season and sources of nectar or pollen. All bee floral resources were summarized in the Table 1.

Table 1: Major, medium and minor Bee floral resources of Sujanpur and adjoining region of Hamirpur hills.

Plant species	Common name	Family	Type/Nature (Wild/Cultinated)	Honey Potentiality	Flowering period	Distribution	Significance
1	2	3	4	5	6	7	8
Adhatoda vasica Nees	Basuti	Acanthaceae	Shurb(w)	N2P2	Apr-Nov	Throughout	Medicinal
Allium cepa L.	Onion	Amaryllidaceae	Herb(c)	N3P3	May-Jun	Throughout	Vegetable
Mangifera indica L.	Mango	Anacardiaceae	Tree(c)	N3P3	Mar-Apr	Valley & low hills	Fuel & Timber
Coriandrum sativum L.	Corriander	Apiaceae	Herb(c)	N3P3	May-Jun	Throughout	Herb, Condiment
Carissa caranda L.	Karandas	Apocynaceae	Shrub(w/c)	N2P2	Apr-May	Throughout	Preservation
Ageratum conyzoides L.	Ageratum or Goat weed	Asteraceae	Herb(w/c)	N3P3	Jul-Sept	Throughout	Ornamental
Bidens pilosa L.	Badi-gumbri	Asteraceae	Herb(w	N3P3	Jun-Sept	Throughout	Weeds
Calendula officinalis L.	Marigold	Asteraceae	Herb(w/c	N3P3	May-Jul	Valley, low & mid hills	Ornamental
Chrysanthemum spp.	Chrysanthemum	Asteraceae	Herb(w/c)	N3P3	May-Sept	Throughout	Ornamental
Sonchus spp.	Sow thistle	Asteraceae	Herb(w)	N3P3	Jun-Oct	Throughout	Weed
Dahlia pinnata	Dahlia	Asteraceae	Herb(c)	N2P2	July- Jan	Throughout	Ornamental
Taraxacum officinale Weber.	Dandelion	Asteraceae	Herb(w)	N1P1	Mar-Sept	Throughout	Juicy weed
Berberis balsamina L.	Berberry	Berberidaceae	Shrub(w)	N2P2	Apr-Jun	Throughout	Fruit, Dye,Medicinal
Jacaranda mimosifolia D. Don	Jacaranda	Bignoniaceae	Tree(w/c)	N3P3	May-Jun	Valley, low & mid hills	Ornamental
Brassica campestris L.	Mustard	Brassicaceae	Herb(c)	N1P1	Dec-May	Throughout	Oilseed
Eruca sativa Mill	Rocket Salad	Brassicaceae	Herb(c)	N1P1	Dec-Mar	Throughout	Oilseed, Fodder.
Raphanus sativus L.	Radish	Brassicaceae	Herb(c)	N1P1	Feb-Mar	Throughout	Vegetable.
Cannabis sativa L.	Hemp	Cannabinaceae	Herb(w/c)	N2P2	Jun-sept	Throughout	Alkaloid fibre.
Dianthus caryophyllus L.	Carnation	Caprifoliaceae	Herb(c)	N3P3	Apr-Jun	Throughout	Ornamental.
Carica papaya L.	Papaya	Caricaceae	Tree(c)	N1P1	May	Valley & low hills	Fruit, Edible.
Chenopodium album L.	White goose foot	Chenopodiaceae	Herb(w/c)	N3P3	Mar-May & Aug-Oct	Throughout	Weed, Fodder.
Terminalia bellirica (Gaertn.) Roxb.	Bahera	Combretaceae	Tree(c)	N1	Mar-june	Valley, low & mid hills	Timber, Fuel, Medicine.
Ipomoea batatas Lam.	Sweet Potato	Convolvulaceae	Herb(c)	N2P3	Aug-Nov	Throughout	Vegetable.
Sechium edule	Chayote	Cucurbitaceae	Climber(c)	N2P2	Jun-sept	Valley, low & mid hills	Vegetable.
Cucurbita pepo L.	Pumpkin	Cucurbitaceae	Climber(c)	N1P1	Apr-May	Throughout	Vegetable
Cucurbita maxima L.	Great Pumpkin	Cucurbitaceae	Climber (c)	N1P1	Feb-Apr	Throughout	Vegetable.
Luffa cylindrica L.	Ridged Gourd	Cucurbitaceae	Climber (c)	N3P3	Jul-sept	Throughout	Vegetable.
Momordica charantia L.	Bitter Gourd	Cucurbitaceae	Climber (c)	N3P3	Jun-sept	Throughout	Vegetable.
Emblica officinalis Gaertn.	Indian Gooseberry	Euphorbiaceae	Tree(c)	N2P2	Mar-May	Valley, low & mid hills	Medicinal
Jatropha curcas L.	Jatropha	Euphorbiaceae	Shrub(w)	N3P3	April-Aug	Valley, low & mid hills	Biofuel.
Acacia catechu (L.f.) Willd.	Acacia	Fabaceae	Tree(w/c)	N1P1	Apr-Jul	Valley, low & mid hills	Timber, Fodder, Fuel.
Albizzia stipulate Roxb.	Oai	Fabaceae	Tree(w/c)	N3P3	May-June	Valley, low & mid hills	Timber, Fodder, Fuel.

Albizzia lebbek Benth.	Siris	Fabaceae	Tree(w/c)	N3P3	Apr-May	Valley, low & mid hills	Timber, Fodder, Fuel.
Bauhinia variegata L.	Kachnar	Fabaceae	Tree(w/c)	N2P3	Feb-Apr	Throughout	Fodder, Fuel, Vegetable.
Bauhinia vahlii Wight & Arn.	Camel's foot	Fabaceae	Tree(w/c)	N2P3	Mar-Mau	Throughout	Fodder, Fuel, Vegetable.
Butea monosperma (Lam.) Kuntze	Palas	Fabaceae	Tree(w/c)	N3P3	May-Sept	Valley, low & mid hills	Fodder, Fuel, Food for lac insect, Medicinal.
Cassia fistula L.	Indian laburnum	Fabaceae	Avenue tree (w)	N2P2	Apr-Jul	Valley, low & mid hills	Avenue tree.
Dalbergia sissoo Roxb.	Sissoo	Fabaceae	Tree(w)	N1P1	Mar-May	Valley, low & mid hills	Tree Timber, Fodder, Fuel.
Erythrina suberosa Roxb.	Coral tree	Fabaceae	Tree (w/c)	N2P2	May-Jun	Valley, low & mid hills	Tree (w/c)
Medicago sativa L.	Alfalfa	Fabaceae	Herb(w/c)	N1P2	May-Aug	Throughout	Fodder.
Trifolium repens L.	White clover	Fabaceae	Herb(w/c)	N1P1	Apr-Jul	Throughout	Fodder, Cover crop.
Ocimum sanctum L.	Tulsi	Lamiaceae	herb (w/c)	N2	Apr-Nov	Throughout	Aromatic.
Salvia spp.	Red Sage	Lamiaceae	herb(w)	N2P2	Jul-Oct	Throughout	Medicinal.
Lilium spp.	Lilium	Liliaceae	Herb(c)	P3	May-Jun	Valley, low & mid hills	Ornamental.
Woodfordia fruticosa (L.) Kurz	Dhawi	Lytheraceae	Shrub(w)	N1P1	Mar-Apr	Throughout	Dye, Medicinal, Fodder, Fuel.
Hibiscus rosa sinensis L.	Chinese Rose	Malvaceae	Shrub(c)	N2P2	Mar-Apr	Valley, low & mid hills	Ornamental.
Malvaviscus arboreus	Malvaviscus	Malvaceae	Shrub(c)	N2P2	Whole Year	Valley, low & mid hills	Ornamental.
Cedrela toona Roxb. Ex Rottl. & Willd	Cedrela	Meliaceae	Tree(w)	N1P2	Mar-Jun	Valley, low & mid hills	Woody, Furniture
Melia azaderach L.	Chinaberry	Meliaceae	Tree(w)	P2	Feb-May	Valley, low & mid hills	Wood (w).
Moringa oleifera Lam.	Drumstick tree	Moringaceae	Tree(w/c)	N1P1	Jan-Mar	Low & mid hills	Perfumes & Lubricants, Fertilizer, Gum, Fodder, Vegetable
Musa sapientum L.	Banana	Musaceae	Herb(c)	N2P3	Mar-Dec	Valley, low & mid hills	Fruit.
Callistemon citrinus (Curt) Skeels	Bottle Brush	Myrtaceae	Tree (c)	N1P1	Mar-Oct	Valley & low hills	Ornamental.
Eucalyptus camaldulensis Dehn.	Eucalyptus	Myrtaceae	Avenue tree(w/c)	N1P1	May-Jun	Valley & low hills	Fuel wood, Charcoal,Paper pulp, Termite resistant timber, Medicinal.
Psidium guajava L.	Guava	Myrtaceae	Tree (c)	N1P1	May-Jun	Valley, low & mid hills	Fruit.
Syzygium cumini (L.) Alston	Jambolan	Myrtaceae	Tree (w/c)	N1P1	Apr-Jun	Valley, low & mid hills	Avenue tree, Fruit.
Sesamum indicum L.	Sesamum	Pedaliaceae	Herb(c)	N1P1	Jul-Sept	Throughout	Crop, Oilseed.
Pinus roxburghii Sarg.	Pinus	Pinaceae	Tree(w)	P3	Mar-April	Throughout	Timber.
Zea mays L.	Maize	Poaceae	Herb(c)	P1	Jul-Aug	Throughout	Grain, Fodder.
Rumex hastatus D. Don	Almor	Polygonaceae	Herb (w)	N3P3	Jun-Oct	Throughout	Medicinal.
Grevillea robusta A. Cunn. Ex. R.Br.	Silky Oak	Proteaceae	Tree (c)	N1P1	Apr-May	Valley, low & mid hills	Avenue tree, Timber, Ornamental.
Punica granatum L.	Pomegranate	Punicaceae	Shrub (c)	N2P1	Apr-May	Valley, low & mid hills	Fruit (c)
Zizyphus jujuba Mill.	Chinese date	Rhamnaceae	Tree	N1P3	Jul-Sept	Valley, low & mid hills	Fruit,Fodder, Oilseed.
Eriobotrya japonica Thunb. Lindley	Loquat	Rosaceae	Tree (c)	N1P1	Feb-Mar & Sept-Oct	Valley, low & mid hills	Fruit.
Prunus domestica L.	Plum	Rosaceae	Tree (c)	N2P1	Feb-Mar	Mid & high hills	Fruit.
Pyrus communis L.	Pear	Rosaceae	Tree (c)	N2P1	Feb-Apr	Mid & high hills	Fruit.
Rosa indica L.		Rosaceae	Shrub(c)	N3P1	Mar-Apr	Throughout	Ornamental.
Rubus spp.	Berries	Rosaceae	Shrub(c)	N2P2	Apr-Jun	Throughout	Climber, Hedges, Fruit.

Aegle marmelos L. Correa	Bel	Rutaceae	Tree (W)	N2P2	Mar-June	low & mid hills	Edible, Medicinal.
Citrus grandis (L.) Osbeck	Pumelo	Rutaceae	Tree (C)	N1P1	Mar-Apr	Throughout	Fruit tree.
Murraya koenigii Spreng	Curry leaf plant	Rutaceae	Shrub(w/c)	N2P2	Mar-Apr	Valley, low & mid hills	Ornamental, Medicinal.
Sapindus mukorosii Gaertn.	Soap nut	Sapindaceae	Tree (W/C)	N1P1	May-Jun	Valley, low & mid hills	Avenue tree, Fruit used as Soap, Timber
Grewia optiva Dumm. Ex Burret	Beol or Bhemal	Tiliaceae	Tree (w/c).	N1P1	May- July	Throughout	Fruit, Fodder, Timber.
Vitex negundo L.	Indian privet	Verbenaceae	Shrub(w)	N1P2	May-Jun	Throughout	Insect repellent, Medicinal.

N1: Major nectar source P1: Major pollen source
N2: Medium nectar source P2: Medium pollen source
N3: Minor nectar source P3: Minor pollen source Throughout: Valley, low, mid & high hills

Discussion

In present study, 22 plant species were recognized as major source of nectar and pollen (N1P1), 14 were medium source (N2P2), 19 minor source (N3P3), 3 Medium nectar and minor pollen (N2P3), 3 Major nectar and medium pollen (N1P2), 3 Medium nectar and major pollen (N2P1), 1 Major nectar source and minor pollen (N1P3), 1 Minor nectar and Major Pollen source (N3P1) and rest were either nectar or pollen source (Table. 1) Major nectar and pollen sources of the area includes *Taraxacum officinale, Brassica campestris, Eruca sativa, Cucurbita pepo, Cucurbita maxima, Raphanus sativus, Carica Papaya, Acacia catechu, Dalbergia sissoo, Trifolium repens, Woodfordia fruticosa, Moringa oleifera, Callistemon citrinus, Eucalyptus camaldulensis, Psidium guajava, Syzygium cumini, Grevillea robusta, Sesamum indicum, Eriobotrya japonica, Citrus grandis, Sapindus mukorosii, Grewia optiva.* Whereas Medium nectar and pollen sources reported were *Adhatoda vasica, Carissa caranda, Dahlia pinnata, Berberis balsamina, Cannabis sativa, Sechium edule, Emblica officinalis, Cassia fistula, Erythrina suberosa, Salvia* spp., *Hibiscus rosa sinensis, Malvaviscus arboreus, Murraya koenigii*. These plant species are also reported by major and medium source of pollen and nectar by other workers in their studies from different region (Partap, 1997; Tiwari *et al*., 2012; Rijal *et al*., 2018; Hoshamani *et al*., 2018) [12, 22]. Sources like *Allium cepa, Mangifera indica, Coriandrum sativum, Ageratum conyzoides, Bidens pilosa, Calendula officinalis, Chrysanthemum* spp, *Sonchus* spp, *Jacaranda mimosifolia, Dianthus caryophyllus, Chenopodium album, Luffa cylindrical, Momordica charantia, Albizzia lebbek, Bauhinia vahlii., Jatropha curcas, Albizzia stipulate, Butea monosperma, Rumex hastatus* were minor source of nectar and pollen and honey potentialities of rest were varies with respect to nectar and pollen i.e. some are medium nectar source and major pollen source; Major nectar source and medium pollen source; medium nectar source minor pollen source etc and some are either nectar source or pollen source only. Minor sources of nectar and pollen support the honeybee colonies during the time when major source of nectar and pollen are in less availability (Hoshamani *et al*., 2018). The study indicated that, blooming period of most the flowering plants were extends from the March to June which is the main honey flow period of this region. The majority of the reported flora were tree (31) followed by herbs (25) shrubs (12) and others (5). The present finding is concurrence with the finding of Shubharani *et al*., 2012 [12]; Kebede and Gebrechirstos (2016) [8] and Saklani and Mattu (2017) [14] which reported the trees as major source followed by herbs and shrubs however this finding is in contrast to the study of Alemtsehay Teklay (2011) who reported herb as major sources for honeybees. The variation may be due to the distribution and abundance of floral sources within flight range of honeybee, soil type and climate condition (Suryanarayana, 1978; Kebede and Gebrechirstos, 2016) [8].

Conclusion

Present study will improve honey production, augmentation of income resources and also support livelihood of large population in rural and hilly areas. Beside this it can be useful in conserving the important sources of nectar and pollen with natural vegetation and can also be helpful in production of organically produced and unpolluted insecticide free honey. Moreover, floral calendar information can be useful in taking new beekeeping projects in new areas.

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