



# Honeybee Flora for Commercial Beekeeping in Manipur, India

Jenita Thokchom <sup>a</sup>, Rocky Thokchom <sup>a\*</sup>, Romila Akoijam <sup>b</sup>,  
Sanjay Singh Sanasam <sup>b</sup>, Yengkokpam Ranjana Devi <sup>c</sup>  
and Kumar Singh Potsangbam <sup>a</sup>

<sup>a</sup> South Asian Institute of Rural and Agricultural Management, Langjing Achouba,  
Imphal West-795113, Manipur, India.

<sup>b</sup> ICAR, NEH Region, Lamphelpat, Imphal, Manipur, India.

<sup>c</sup> CAU, Lamphelpat, Imphal, Manipur, India.

## Authors' contributions

This work was carried out in collaboration among all authors. Author RA designed the study and under their supervision of authors JT, RT and SSS conducted the investigation and collected possible information. Authors KSP and RT drafted the manuscript and authors RA, JT and SSS revised the manuscript. All authors read and approved the final manuscript.

## Article Information

DOI: 10.9734/IJECC/2023/v13i92204

## Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/101428>

**Original Research Article**

**Received: 14/04/2023**

**Accepted: 16/06/2023**

**Published: 26/06/2023**

## ABSTRACT

Beekeeping, otherwise known as apiculture is a lucrative business providing supplementary or major income to the people in rural areas. Honey has certain health benefits, with its nutritional composition closely similar to fruits and is a natural sweetener. Honeybees are also a good pollinator and gives valued products such as beeswax, propolis, bee venom, etc. However, for commercial beekeeping, selection of bee species is very important and for yearly flow of honey, a beekeeper should know the flora preferred by the bees for every seasons. The present study revealed that, out of the total 161 plant species identified, which is visited by the honeybees (*Apis cerana* and *Apis mellifera*) for nectar and pollen, maximum plant species belong to the horticultural crops (33%) followed by the wild plants and forest trees (29%); and ornamental plants and avenue trees (28%). The least (10%) was recorded in agronomic crops.

\*Corresponding author: E-mail: rockythokchomaa@gmail.com;

**Keywords:** Apiculture; *Apis cerana*; *Apis mellifera*; bee flora.

## 1. INTRODUCTION

The bees (Apoidea) constitute a group of 20000 species constituting from solitary and non-social to community and true social like the modern honeybees, *Apis* [1]. Bees depend on flowering plants for their food in the form of pollen and nectar. Similarly, for pollination plants depend on pollinators like the bees. The mutual interdependence of the flower loving (anthophilous) insects and entomophilous angiosperms hastened their co-evolution [2]. The relationship between the bees and the plants is known to be during the middle cretaceous period, i.e., roughly 100 million years ago [3].

Honeybee, an important primitive social and beneficial insect live in a colony with different caste systems having a queen, drones and workers. Honey bees produce honey which is beneficial in many ways ranging from nutrition to medicine and is used for various purposes. Bees help in pollinating the cross-pollinated plant species for production of fruits and helps in evolving new natural varieties. Honey is used directly in medicines at an estimation of about 80 per cent while about 10 % is used in ayurvedic and pharmaceutical production. Honey bees also have a great impact on agriculture and is known to increase the productivity of any crops at an estimate of about 30-80 % annually through cross pollination.

Honeybee in a lifetime visit thousands of flowers in order to collect nectar and/or pollen as flowers are the main stay of bee's life. This in turn helps in pollinating the flowers and thereby helping to increase fruit and seed-setting both in wild and cultivated plants. The quality of the honey produced depends on the seasons and timing of the bees visiting diverse plant species [4]. Honeybees contribute enormously to the conservation of ecosystems and agricultural production while on the other hand they produce important products such as honey and bee waxes.

Five important species of honey bees such as the rock bee (*Apis dorsata*), the Indian hive bee, (*Apis cerana indica*), the little bee (*Apis florea*), the European or Italian bee (*Apis mellifera*) of the order Apidae and the Dammer bee or stingless bee (*Melipona iridipennis*) of the order Meliporidae are found all over the world.

Rock bee (*Apis dorsata*) are the giant bees found all over India in sub-mountainous regions up to

an altitude of 2700 m. They construct single comb in wild which is about 6 feet long and 3 feet deep. They shift the place of the colony often. Rock bees are known to be vicious and difficult to rear. Each comb yields about 36 Kg honey per comb per year.

Little bee (*Apis florea*) build single vertical combs in open of the size of a palm in branches of bushes, hedges, buildings, caves, empty cases, etc. Honey production is less i.e., about half a kilo of honey per year per hive. Since they change their place frequently, they are not at all rearable. The size of the bees is smallest among four *Apis* species described and smaller than Indian bee. They distribute only in plains and not in hills above 450 m MSL.

Indian hive bee/Asian bee (*Apis cerana indica*) are the domesticated species, which construct multiple parallel combs with an average honey yield of 6-8 kg per colony per year. These bees are larger than *Apis floreae* but smaller than *Apis mellifera*. They are more prone to swarming and absconding. They are native of India/Asia.

European bee / Italian bee (*Apis mellifera*) are also similar in habits to Indian bees, which build parallel combs. They are bigger than all other honeybees except *Apis dorsata*. The average honey production per colony is 25-40 kg. They have been imported from European countries (Italy) for rearing and are less prone to swarming and absconding.

Dammer Bee or stingless bees, viz., *Melipona* and *Trigona* occur in our country in abundance. These bees are much smaller than the true honey bees and build irregular combs of wax and resinous substances in crevices and hollow tree trunks. They are helpful in the pollination of various food crops. They can be domesticated but the honey yield per hive per year is very less (100 g/year).

## 2. MATERIALS AND METHODS

In order to study the honeybee flora of Manipur, proper identification of the species were done by adopting standard methods of identification up to species level. While identifying the honeybee species, the most important part is to identify the plant species, where, these species visited to the flowers of the plant, for their pollen and nectar, so as to get the complete information of the particular honeybee species.

## 2.1 Identification of Plant

The plant specimens were collected and processed into mounted herbarium specimens following standard methods of Jain and Rao [5]. The specimens were identified with the help of different floras [6-9] (Deb 1956, 1957, 1961 a,b; Singh and Arora 1978) [10-18] in the Department of Life Sciences, Manipur University, Canchipur, Imphal and Botanical Survey of India, Eastern Circle, Shillong and were finally matched at ASSAM. The voucher specimens were deposited at the herbarium of Department of Plant Protection, South Asian Institute of Rural and Agricultural Management, Langjing Achouba, Imphal West-795113, Manipur, India. Online data bases like The International Plant Names Index [19] and The Plant Lists [20] was referred for correct nomenclature and author citations.

## 2.2 Identification of Honeybee-flora

The identification of honeybee flora in the area is done visually by observing the foraging nature of the bee. After visual confirmation and collection of food by honey bees, the flower species are then identified as a bee plant by adopting the published literatures [21,22].

## 2.3 Commercial Honey Production

*Apis cerana* and *Apis mellifera* are reared in hives in India. Previously in Manipur, honey were collected from the wild from deep within the forest. But now a days, with the advancement of technology people started rearing honey bees. The richness of bee flora and their unceasing availability is one of the main factors for successful apiary in the state. Beekeeping or apiary is an agri-horticultural and forest based industry which is of great importance for farmers. It can be practiced by investing minute expenses and obtain maximum subsidiary income with other agricultural activities. This practice not only depends on the better strain of honeybees, but, also on the available sources of pollen and nectar within the surrounding area of an apiary [23,24].

Prolong availability of flowers is one of the major factors for apiculture as availability of nectar and pollen in flora required for quantitative and qualitative production of honey depends upon the change in seasons. Foraging intensity decrease during winter, rainy and windy days in Manipur. The intensity is much higher with the onset of spring and post monsoon here in the

state. Foraging behavior of the honey bees also depend on the flora available in the locality. It is important to know the different plant species with an option of abundant nectar and/or pollen to overcome the problem during the dearth period for commercial apiculture.

For commercial purpose, two bee species viz., *Apis cerana* and *Apis mellifera* are reared in Manipur. Several plants, both cultivated and wild have been identified with special reference to apicultural importance. More than 400 plant species are useful to honeybees as food sources. The most important and common bee plant species are show in Table 1. The genera like *Citrus*, *Brassica*, *Tithonia*, *Guizotia*, *Helianthus*, *Cosmos*, *Lagerstroemia*, etc. are some of the important plants considered as good sources for honeybees in Manipur.

Important features which should be considered for apiculture are as follows:

## 2.4 Melissopalynology

It is the study of pollen contained in honey and, in particular, the pollen's source. Following the method of Louveaux *et al.* [25], pollen analysis of honey samples from the bee colonies is carried out. The identified bee flora is further classified as pollen plant, nectar plant, and both pollen and nectar plants. Based on the bee visits and the type of food collected by them.

## 2.5 The Study on Bee-Flora

The study on bee-flora reveals that it consists mostly ornamentals, timber, medicinal, fruits, vegetables and other commercially important plants like spices, pulses, cereals, oil yielding, fiber, fodder, etc. Generally, apiculture is done where economic plants are grown in Manipur and hence, the bee-plants are protected and propagated as well. The economically important bee plants provides considerable quantity of pollen and nectar for honey bees throughout the year during different months, and their number also increased year after year as farmers carried propagation every year. To maintain bee colonies, the flowering plants of an area having good value as bee pasture is necessary [26]. For successful rearing of honeybees, availability and maintenance of bee flora is a prerequisite.

## 2.6 Bee Plants

Bee plants are classified in the following four groups:

1. Agronomic crops
2. Horticultural crops
3. Ornamental Plants
4. Wild plants and Forest Trees

crops are grown in small pockets and hence, contribute minor sources and helps in the development and nourishment of the bee colonies.

These plants are arranged sequentially according to their importance in honey production. The main important agronomic crops in Manipur includes rice and maize; legumes like chick pea, field pea, pigeon pea, ground nut; and oilseed crops like mustard, sunflower, safflower and perilla. Amongst these, mustard is the major source of nectar and continue to the main honey flow in different parts of the state. The rest of the

### 3. RESULTS AND DISCUSSION

An exhaustive survey was performed, accordingly, many information were collected regarding the nature of the crop, visited by the honeybee, nature of foraging, the time of foraging and nature of visit, etc., by the particular honeybee. Some of the important agronomic bee plants are given in Table 1.

**Table 1. Important agronomic crops for bee keeping in Manipur**

Sl. No	Crop	Visited by	Nature of foraging	Time of foraging	Nature of visit
1.	Mustard ( <i>Brassica campestris</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	Dec-Feb	Frequent
2.	Indian mustard ( <i>Brassica juncea</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	February-March	Frequent
3.	Buckwheat ( <i>Fagopyrum esculentum</i> Moench.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	August-September	Frequent
4.	Niger ( <i>Guizotia abyssinica</i> Cass.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	August-September	Frequent
5.	Sunflower ( <i>Helianthus annuus</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	July-September	Frequent
6.	Rice ( <i>Oryza sativa</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Pollen	May-June/September-October	Moderate
7.	Maize ( <i>Zea mays</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Pollen	July-August	Frequent
8.	Perilla ( <i>Perilla frutescens</i> L.) Brit	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar	September-October	Frequent
9.	Safflower ( <i>Carthamus tinctorius</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	March-April	Frequent
10.	Roselle ( <i>Hibiscus sabdariffa</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	October-November	Moderate
11.	Kenaf ( <i>Hibiscus cannabinus</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	September-October	Rare
12.	Pigeon pea ( <i>Cajanus cajan</i> (L.) Millsp.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar	October-November	Frequent
13.	Pea ( <i>Pisum sativum</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar	November-January	Moderate
14.	Rice bean [ <i>Vigna umbellata</i> (Thunb.) Ohwi & H. Ohashi]	<i>Apis cerana</i> and <i>Apis mellifera</i>	Pollen	May-September	Moderate
15.	Soybean [ <i>Glycine max</i> (L.) Merrill]	<i>Apis cerana</i> and <i>Apis mellifera</i>	Pollen	June	Moderate
16.	Groundnut ( <i>Arachis hypogaea</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Pollen	July-September	Moderate

**Table 2. Important horticultural crops for bee keeping in Manipur**

Sl. No	Crop	Visited by	Nature of foraging	Time of foraging	Nature of visit
1.	Cauliflower ( <i>Brassica oleracea</i> var. <i>botrytis</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	February-March	Rare
2.	Cabbage ( <i>Brassica oleracea</i> var. <i>capitata</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	February-March	Rare
3.	Broccoli ( <i>Brassica oleracea</i> var. <i>italica</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	February-March	Rare
4.	Broad bean ( <i>Vicia faba</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	October- November (hills) January-March (Valley)	Moderate
5.	Onion ( <i>Allium cepa</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	April-May	Rare
6.	Chinese chive ( <i>Allium tuberosum</i> Rottler ex Spreng)	<i>Apis cerana</i>	Nectar and Pollen	April	Rare
7.	Hooker chive ( <i>Allium hookeri</i> Thwaites)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	April-May	Rare
8.	Coriander ( <i>Coriandrum sativum</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	March-April	Frequent
9.	Cucumber ( <i>Cucumis sativus</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	May-September	Frequent
10.	Chayote ( <i>Sechium edule</i> (Jacq.) Pers.)	<i>Apis cerana</i>	Nectar and Pollen	July-November	Rare
11.	Sponge gourd ( <i>Luffa cylindrica</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	July-September	Frequent
12.	Great pumpkin ( <i>Cucurbita maxima</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	February to April	Frequent
13.	Field pumpkin ( <i>Cucurbita pepo</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	April-May	Frequent
14.	Bitter gourd ( <i>Momordica charantia</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	June-September	Frequent
15.	Ash gourd [ <i>Benincasa hispida</i> (Thunb.) Cogn.]	<i>Apis cerana</i>	Nectar and Pollen	May-August	Rare
16.	Bottle gourd ( <i>Lagenaria siceraria</i> (Molina) Standl.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	April-June	Rare
17.	Water melon ( <i>Citrullus vulgaris</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	April May	Frequent
18.	Okra ( <i>Abelmoschus esculentus</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	April-September	Frequent
19.	Radish ( <i>Raphanus sativus</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	February March	Frequent
20.	Apple ( <i>Malus domestica</i> Borkh.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	March-April	Frequent

Sl. No	Crop	Visited by	Nature of foraging	Time of foraging	Nature of visit
21.	Apricots ( <i>Prunus armeniaca</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	February-March	Moderate
22.	Plum ( <i>Prunus domestica</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	February-March	Moderate
23.	Peach ( <i>Prunus persica</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	February-March	Moderate
24.	Pear ( <i>Pyrus communis</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	February-March	Rare
25.	Lime [ <i>Citrus aurantifolia</i> (Christm .J Swingle)]	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	March-April	Frequent
26.	Pumelo [ <i>Citrus grandis</i> (L.) Osbeck]	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	March-April	Frequent
27.	Mandarin orange ( <i>Citrus reticulata</i> Blanco)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	March-April	Frequent
28.	Tamenglong orange ( <i>Citrus reticulata</i> Blanco)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	September- October	Frequent
29.	Kachai lemon ( <i>Citrus jambheri</i> Lush.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	March-April	Frequent
30.	Citron ( <i>Citrus medica</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	March-April	Frequent
31.	Lemon [ <i>Citrus limon</i> (L.) Osbeck]	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	Almost throughout the year	Frequent
32.	Strawberry ( <i>Fragaria ananassa</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	Year round (depending upon the varieties)	Frequent
33.	Litchi ( <i>Litchi chinensis</i> Gaertn)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	February-March	Frequent
34.	Mango ( <i>Mangifera indica</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	February-March	Frequent
35.	Banana ( <i>Musa paradisiaca</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	Year round	Frequent
36.	Guava ( <i>Psidium guajava</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	May-June	Frequent
37.	Jamun [ <i>Syzygium cumini</i> (L.) Skeels]	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	April-May	Moderate
38.	Ber ( <i>Ziziphus jujuba</i> Mill.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	July-October	Frequent
39.	Indian jujube ( <i>Ziziphus mauritiana</i> Lam.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar	September- October	Frequent
40.	Pomegranate ( <i>Punica granatum</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	May-June	Rare
41.	Papaya ( <i>Carica payaya</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	May	Frequent
42.	Walnut ( <i>Juglans regia</i> L.)	<i>Apis cerana</i>	Pollen	March-April	Rare
43.	Avocado ( <i>Persea americana</i> Mill.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	March-April	Frequent
44.	Tulsi ( <i>Ocimum tenuiflorum</i> )	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	April-June	Frequent

Sl. No	Crop	Visited by	Nature of foraging	Time of foraging	Nature of visit
45.	Haori basil ( <i>Ocimum canum</i> Sims.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	November- February	Frequent
46.	Thai Basil ( <i>Ocimum basilicum</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	March-April	Frequent
47.	Passion fruit ( <i>Passiflora edulis</i> Sims)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	April-November	Frequent
48.	Aonla ( <i>Phyllanthus emblica</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	March-May	Moderate
49.	Indian olive ( <i>Elaeocarpus serratus</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	October- November	Moderate
50.	Areca nut ( <i>Areca catechu</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Pollen	May-June	Moderate
51.	Coconut ( <i>Cocos nucifera</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	Almost year round	Frequent
52.	Hog plum [ <i>Spondias pinnata</i> (L.f.) Kurz]	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	March-April	Frequent
53.	Dragon fruit [ <i>Selenicereus undatus</i> (Haworth) D.R. Hunt	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	August- September	Frequent

### 3.1 Horticultural Crops

Manipur is blessed with favourable climatic conditions for growing a wide range of horticultural crops. Various kinds of temperate and subtropical fruits and vegetables are grown in different zones of the region. Temperate crops such as apples, cherries, peaches, pears, and plums, are planted in the hilly regions and gives flower during early spring (March-April) producing large quantities of nectar and pollen. However, it is very difficult to obtain pure honey from these crops because of low colony strength in the colder regions. Amount of nectar and pollen harvested are therefore sufficient for brood rearing and developing colony strength during this period. Important nectar and pollen yielding fruit crops of Manipur is given in Table 2.

### 3.2 Ornamental Plants and Avenue Trees

Several ornamental plants and avenue trees are grown for beautification in public and private areas. Most of the flowering ornamentals are foraged by honeybees for pollen and nectar. The yield of honey is very low as compared to agronomic and horticultural crops since a majority of ornamental plants are too scattered for the bees to act as the main source of nectar and pollen. However, during dearth period the ornamental plant species ensure a continuous supply of both nectar for the sustenance of bee

colonies. Some of the important species are *Poinsettia pulcherrima*, *Ageratum*, *Tagetes* and *Salvia splendens* that flower most of the year. Some ornamental plants like *Calliandra calothyrsus* and *Callistemon citrinus*, which are planted as roadside avenue trees, produce large quantities of nectar and pollen during the main season. These plants are very much useful for apiary as they contribute in honey yield. It is, therefore, necessary for beekeepers to plant these important ornamental and avenue plants around their apiaries that facilitate the production of surplus honey and help to sustain bee colonies. Important ornamental and avenue plants for bee keeping in Manipur is given in Table 3.

### 3.3 Wild Plants and Forest Trees

Several wild plant and forest trees are visited by honeybees for collecting nectar and honey. Though the forest trees flowering span is shorter as compared to that of agricultural and horticultural crops, yet they are very much important sources of pollen and nectar and contribute to the main flow of honey. Identification of wild plants is important because during dearth period, honeybees hover around the nearby areas in search of food to maintain the hives. A brief account of some important forest trees and wild plants is given in Table 4.

**Table 3. Important ornamental and avenue plants for bee keeping in Manipur**

Sl. No.	Crop	Visited by	Nature of foraging	Time of foraging	Nature of visit
1.	Cornflower ( <i>Centaurea cyanus</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar	February-April	Frequent
2.	Pride of India ( <i>Lagerstroemia indica</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	June –July	Frequent
3.	Lagerstroemia ( <i>Lagerstroemia parviflora</i> Roxb.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	April-May	Frequent
4.	Salvia ( <i>Salvia splendens</i> Sellow Roemer & ex J.A. Schultes)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar	Year round	Frequent
5.	China rose ( <i>Hibiscus rosa-sinensis</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	March-May	Frequent
6.	Californian poppy ( <i>Eschscholzia californica</i> Cham.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Pollen	March-June	Frequent
7.	Balsam ( <i>Impatiens balsamina</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar	July-August	Frequent
8.	Wax mallow ( <i>Malvaviscus arboreus</i> Cav.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	Year round	Frequent
9.	Trumpet vine ( <i>Campsis grandiflora</i> (Thunb.) K.Schum.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar	May-August	Frequent
10.	Calendula ( <i>Calendula officinalis</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	February-April	Rare
11.	Gulmohar ( <i>Delonix regia</i> Raf.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	May-June	Frequent
12.	Jacaranda ( <i>Jacaranda mimosifolia</i> D.Don)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	May-June	Rare
13.	Red calliandra ( <i>Calliandra surinamensis</i> Meissn)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar	April-August	Frequent
14.	China aster ( <i>Callistephus chinensis</i> (L.) Nees.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	April-May	Rare
15.	Chrysanthemum ( <i>Chrysanthemum morifolium</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	August-September	Rare
16.	Cineraria [ <i>Cineraria hybrida</i> (L.) Bernh.]	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	February-March	Rare
17.	Cosmos ( <i>Cosmos sulphureus</i> Cav.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	October	Frequent
18.	Dahlias ( <i>Dahlia</i> spp)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	Year round	Frequent
19.	Larkspur ( <i>Delphinium roylei</i> Munz.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	March-May	Rare
20.	Carnations ( <i>Dianthus caryophyllus</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	April-June	Frequent
21.	Paper flower ( <i>Helichrysum arenarium</i> (L.) Moench)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar	February-June	Frequent
22.	Zinnia ( <i>Zinnia elegans</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	June-September	Frequent
23.	Rose ( <i>Rosa</i> sp.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	Year round	Frequent



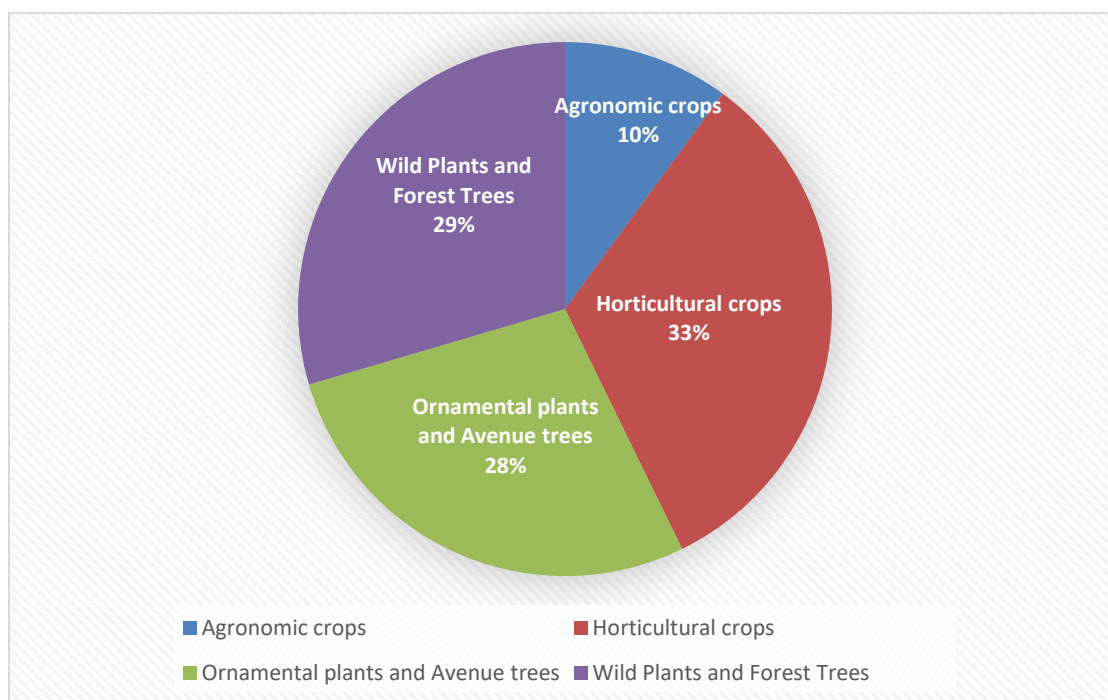
Sl. No.	Crop	Visited by	Nature of foraging	Time of foraging	Nature of visit
24.	Blood Iris ( <i>Iris sanguinea</i> Donn ex Hornem.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Pollen	March-April	Rare
25.	Water iris ( <i>Iris laevigata</i> Fisch)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Pollen	March-April	Rare
26.	Marigod ( <i>Tagetes</i> sp.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar	Year round	Rare
27.	Gladiolus ( <i>Gladiolus hybrida</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	October	Frequent
28.	Common Daisy ( <i>Bellis perennis</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Pollen	February-July	Frequent
29.	Poinsettias ( <i>Euphorbia pulcherrima</i> Willd. ex Klotzsch)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar	December - February	Frequent
30.	Honeysuckle [ <i>Lonicera ciliosa</i> (Pursh) Poir. ex DC.]	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	February-April	Rare
31.	Lotus ( <i>Nelumbo nucifera</i> Gaertn.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Pollen	July-September	Rare
32.	Water lily ( <i>Nymphaea</i> sp.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Pollen	June-September	Rare
33.	Butterfly pea ( <i>Clitoria ternatea</i> L.)	<i>Apis mellifera</i>	Nectar	March-July	Rare
34.	Peruvian lily ( <i>Alstroemeria hybrida</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar	May-June	Moderate
35.	Latana ( <i>Latana camara</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Pollen	Almost round the year	Moderate
36.	Camellia ( <i>Camellia japonica</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Pollen	February-March	Moderate
37.	Ornamental coleus [ <i>Plectranthus scutellarioides</i> (L.) R.Br.]	<i>Apis cerana</i>	Nectar	June-August	Rare
38.	Orange Jasmine ( <i>Murraya exotica</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar	June-July	Frequent
39.	Bakul ( <i>Mimosops elengi</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	May-June	Rare
40.	Rangoon creeper [ <i>Combretum indicum</i> (L.) DeFilipps]	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	May-July	Moderate
41.	Ixora ( <i>Ixora coccinea</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar	May-October	Rare
42.	Lily ( <i>Lilium</i> sp.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	March-April	Moderate
43.	Lily of the Nile [ <i>Agapanthus africanus</i> (L.) Hoffmanns]	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	June-July	Moderate
44.	<i>Magnolia</i> sp.	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	March-April	Moderate
45.	Tricolour chrysanthemum [ <i>Ismelia carinata</i> (Schousb.) Sch.Bip.]	<i>Apis cerana</i>	Pollen	February-April	Moderate

**Table 4. Important wild plants and forest trees for bee keeping in Manipur**

SI No	Crop	Visited by	Nature of foraging	Time of foraging	Nature of visit
1.	Eucalyptus ( <i>Eucalyptus camaldulensis</i> Dehnh.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	May-June	Frequent
2.	Silver oak ( <i>Grevillea robusta</i> A. Cunn. ex_ R. Br.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	April-May	Frequent
3.	Sissoo ( <i>Dalbergia sissoo</i> Roxb.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	March-April	Frequent
4.	Cedrela ( <i>Cedrela toona</i> Roxb.; Syn. <i>Toona ciliata</i> Roem.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	April	Frequent
5.	Silk cotton tree ( <i>Bombax ceiba</i> Lor.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar	February-March	Frequent
6.	Butea [ <i>Butea buteiformis</i> (Voigt) Grierson & D.G.Long]	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar	January-March	Frequent
7.	Drum stick ( <i>Moringa oleifera</i> Lam.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	January-March	Frequent
8.	Yellow myrobalan ( <i>Terminalia chebula</i> Retz.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	April- May	Frequent
9.	Leucosceptum [ <i>Leucosceptum canum</i> Sm. Exot.]	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	February-March	Frequent
10.	Indian privet ( <i>Ligustrum indicum</i> (Lour.) Merr.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	June-July	Rare
11.	Cutch tree [ <i>Acacia catechu</i> (L.f.) Willd.]	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	May-July	Frequent
12.	<i>Elsholtzia rugulosa</i> Hemsl.	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	October-December	Frequent
13.	<i>Elsholtzia densa</i> Benth.	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar	August-September	Frequent
14.	<i>Elsholtzia fruticosa</i> (D. Don) Render	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	September- October	Frequent
15.	<i>Elsholtzia communis</i> (Collett & Hemsl.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar	October-November	Frequent
16.	<i>Verbena officinalis</i> L.	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar	June-July	Frequent
17.	Throughwort ( <i>Eupatorium glandulosum</i> H.B.K. Banerji)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar	March-April	Frequent
18.	<i>Choerospondias axillaris</i> (Roxb.) B.L. Burt & A.W. Hill	<i>Apis cerana</i>	Nectar	April-May	Frequent

SI No	Crop	Visited by	Nature of foraging	Time of foraging	Nature of visit
19.	Vasak ( <i>Adhatoda vasica</i> Nees)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	March-April	Frequent
20.	Geranium tree ( <i>Bauhinia purpurea</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	September-October	Rare
21.	Wild Apple/ Heitup ( <i>Pyrus sylvatica</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	March-April	Rare
22.	Rubber tree ( <i>Hevea brasiliensis</i> Muell. Arg.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Leaf nectar and flower pollen	February-March	Frequent
23.	Camel's foot ( <i>Bauhinia vahlii</i> Wight & Arn.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	May-June	Rare
24.	Kachnan ( <i>Bauhinia variegata</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	March-April	Rare
25.	Curry leaf plant ( <i>Murraya koenigii</i> Spreng)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	March-April	Frequent
26.	Alpine rose ( <i>Rhododendron arboreum</i> Smith)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar	February-March (Hills)	Rare
27.	Sumac ( <i>Rhus javanica</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar	September-October	Frequent
28.	Dandelion ( <i>Taraxacum officinale</i> Weber)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	February-May	Frequent
29.	Polygonum ( <i>Polygonum</i> sp.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	May-September	Frequent
30.	Coral tree ( <i>Erythrina suberosa</i> Roxb.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	April-May	Frequent
31.	Spiny amaranth ( <i>Amaranthus spinulosus</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Pollen	June-August	Frequent
32.	Indian laburnum ( <i>Cassia fistula</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	April-May	Frequent
33.	<i>Colebrookea oppositifolia</i> Sm.	<i>Apis cerana</i> and <i>Apis mellifera</i>	Pollen	December-May	Frequent
34.	<i>Woodfordia fruticosa</i> (L.) Kurz	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	March-April	Rare
35.	Paulownia ( <i>Paulownia elongata</i> S.Y. Hu)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	February-March	Frequent
36.	Jatropha ( <i>Jatropha curcas</i> L.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	April-May	Rare
37.	<i>Leucaena leucocephala</i> (Lam.) De Wit.	<i>Apis cerana</i> and <i>Apis mellifera</i>	Pollen	September-October	Frequent
38.	<i>Tithonia diversifolia</i> (Hemsl.) A.Gray	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	October-November	Frequent

SI No	Crop	Visited by	Nature of foraging	Time of foraging	Nature of visit
39.	Wild okra ( <i>Abelmoschus angulosus</i> Wall. ex Wight & Arn.)	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	September-November	Rare
40.	Bael [ <i>Aegle marmelos</i> (L.) Correa]	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	May	Moderate
41.	Elephant apple ( <i>Dillenia indica</i> Roxb.)	<i>Apis cerana</i>	Pollen	March-April	Moderate
42.	Crown Flower [ <i>Calotropis gigantea</i> (L.) W.T.Aiton]	<i>Apis cerana</i>	Pollen	October-November	Rare
43.	<i>Clerodendrum infortunatum</i> L.	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar	April-May	Moderate
44.	<i>Mallotus philippensis</i> (Lam.) Muell. Arg	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	February-March	Rare
45.	<i>Oxalis</i> sp. L.	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar	May-November	Moderate
46.	<i>Grewia hirsuta</i> Vahl	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	June-July	Rare
47.	<i>Schima wallichii</i> (DC) Korth.	<i>Apis cerana</i> and <i>Apis mellifera</i>	Nectar and Pollen	May-June	Rare



**Fig. 1. Showing the percentage of flora available in the state for honey flow**

Out of 161 plants identified, horticultural crops contributed the maximum (33%) bee flora for the honey flow, followed by the wild plants and forest trees (29%) and ornamental plants and avenue trees (28%). The least was shown in agronomic crops (10%). However, contribution of agronomic crops is more during the peak flowering season as compared to other plants because of lengthy flowering period.

#### 4. CONCLUSION

Study on bee flora for commercial beekeeping is important, so as to nourish the bee colonies throughout the year and get good honey yield. To maintain the colonies, identification and planting of preferable bee plants near and around the hives is vital, most importantly during the dearth period. To know more on bee flora in the state, further investigation is needed to be carried out in near future.

#### ACKNOWLEDGEMENTS

The work was supported by ICAR-NEH Region, Lamphelpat, Imphal, Manipur, India.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

#### REFERENCES

- Hargasim O. Bees as pollinators of entomophilous crops. *Bee World*. 1974;55(4):137-140.
- Suryanarayan MC. Honeybee – flower relationship. *Bulletin of Botanical Survey of India*. 1986;28(1-4): 55 – 62.
- Velthuis HHW. Pollen digestion and the evolution of sociality in bees. *Bee World*. 1992;73(2):77-89.
- Adhikari S, Ranabhat NB. Bee flora in mid hills of Central Nepal. *Botanica Orientalis – Journal of Plant Science*. 2011;8:45–56.
- Jain SK, Rao RR. *A Handbook of Field and Herbarium Methods*. Today and Tomorrow's Printers & publishers, New Delhi; 1977.
- Singh NP, Chauhan AS, Mondal MS.. *Flora of Manipur (Ranunculaceae – Asteraceae)* Vol. 1, Botanical Survey of India, Calcutta; 2000.
- Clarke CB. On the plants of Kohima and Manipur. *J. Zinn. Soc.* 1889;25:1 – 107.
- Kaith DC. Reports on the working of Manipur Forest. Horticulture Department, Govt. of Manipur; 1932.
- Kaith DC. Reports on the working of Manipur Forest. Horticulture Department, Govt. of Manipur; 1936.

10. Sinha SC. Ethnobotanical study of Manipur. Ph. D. Thesis, Manipur University, Imphal 1987a.
11. Sinha SC. Ethno botanical of Manipur – Medicinal plants. *Front. Bot.* 1987b;1:123 – 152.
12. Sinha SC. A study on the wetland vascular plants of the Central valley of Manipur, Manipur Sci. Cong. 2nd Session; 1990a.
13. Sinha SC. Notes on etnomedicinal plants of Manipur, *Curr. Pambiol letters.* 1990b;1(1):3 – 6.
14. Sinha SC. *Medicinal Plants of Manipur.* MASS & Sinha Pub., Imphal, Manipur; 1996a.
15. Sinha SC. Wild Edible Plants of Manipur, India, In: S.K. Jain (Ed.), *Ethnobiology in Human Welfare.* Deep Pub., New Delhi. Pp. 1996b:42 – 47.
16. Singh PK, Singh NI, Singh LJ. Ethno botanical studies of wild edible plants in the markets of Manipur- II. *J. Econ. Taxon. Bot.* 1988;12(1):113 –119.
17. Shyamananda RK. Study of nutrient Enrichment in Loktak Lake with reference to Biological indices. Ph. D. Thesis, Manipur University; 1991.
18. Tombi SH. Study of wetland ecosystem in Manipur valley from management perspectives of fish, wildlife and Environment. Final technical Report, Department of Environment, Government of India; 1992.
19. Available:www.ipni.org
20. Available:www.theplantlist.org
21. Sivaram V. Honeybee flora and beekeeping in Karnataka state, India. Proceedings of the 37<sup>th</sup> International Apicultural Congress, 28 October – 1 November 2001, Durban, South Africa; 2001.
22. Naim N, Phadke RP. Bee flora and seasonal activity of *Apis cerana indica* at Pusa (Bihar). *India Bee Journal.* 1976;38(1-4):13 –19.
23. Free JB. *Insect Pollination of Crops* (Second Edition). London: Academic Press Inc. Ltd. 1993:92.
24. Akranakal P. Beekeeping in Asia. FAO, United Nations. 1987:112.
25. Louveaux T, Maurizio A, Vorwhol G. Methods of melittopalynology. *Bee world.* 1978;51:125–138.
26. Baptist BA, Punchihewa RWK. A preliminary analysis of the principal factors which will affect apiary honey production in Sri Lanka. Proceedings of the 2nd Conference of Apiculture in Tropical Climates, New Delhi. 1980;75-81.

© 2023 Thokchom et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

*Peer-review history:*

*The peer review history for this paper can be accessed here:*  
<https://www.sdiarticle5.com/review-history/101428>