International Journal of Advanced Research in Biological Sciences
ISSN: 2348-8069
www.ijarbs.com
(A Peer Reviewed, Referred, Indexed and Open Access Journal)
DOI: 10.22192/ijarbs Coden: IJARQG (USA) Volume 10, Issue 6 -2023

Research Article

DOI: http://dx.doi.org/10.22192/ijarbs.2023.10.06.007

Establishing Honey Bee Floral Calendar in East Wollega Zone, Western Oromia, Ethiopia

Amsalu Arega[*1], Tusa Gemechu[1]
[1]Bako Agricultural Research Center, Oromia Agricultural Research Institute
Email address:
amsaluarega04@gmail.com (Amsalu Arega)
[*]Corresponding author

Abstract

East Wollega, Ethiopia contains important coverage of natural forest and one of the potential areas for beekeeping. Identification of the flowering calendar of honey plants is critical for improving honey yield. The study was carried out to assess the bee flora that produce more honey in plant flowering cycle and develop a floral calendar in East Wollega Zone of the Oromia Region. Semi-structured surveys, participatory Rural Appraisal methods, and field observation were used for data collection, and honey samples were collected from 159 beekeepers. Pollen analysis was done to determine the botanical composition of honey. Based on the interview with beekeepers, honey pollen analysis, pollen load collection, and field observations 53 plant species belonging to 26 families were identified. It was also indicated that some of honey bee flora species identified by the respondent were similar with honey bee plant identified through honey pollen analysis. Assessments of the flowering period of the honey bee flora indicated that the majority of plant species flower from September to November and December to February in all districts. The honey pollen analysis revealed that two mono-floral honey types were identified which include *Guizotia scabra* and *Eucalyptus camaludensis*. Therefore beekeepers can do the essential management practice such as transferring, adding super, control swarming and honey harvesting following the established floral calendar.

Keywords: Pollen, Honey Bee, Floral Calendar, Absconding, Honey Flow

1. Introduction

Beekeeping in Ethiopia is accomplished in many ways, starting from traditional beekeeping in hives made from locally available materials and without moveable frames to transitional hives (top bar hives) and modern hives (often Zander, Langstroth, or Dadant). The country hosts an estimated 6 million managed colonies and nearly 10 million feral colonies. The success of beekeeping depends upon many factors, among which availability of abundant bee flora within the surrounding area of the apiary[1, 2]. Honeybee forages provide honeybees with nectar and pollen to fulfill their dietary requirements and adequate knowledge of nectar and pollen-producing plants is the prerequisite to undertaking beekeeping production [3].

Bees fed almost entirely on nectar and pollen obtained from the blooming flowers and honey comes from the flower nectar. It is probable that honey taken from a hive is never composed absolutely of one kind of flower nectar. Honeybees collect nectar from a diverse range of plants. Not all plants contribute to the production of honey, but are important for the wellbeing of the colony.

Most of the approaches for obtaining evidence about plants utilized by honeybees in an area are based on direct field observation. The analysis of pollen loads and palynological analysis of honey samples can provide reliable information on floral sources along with a relative preference of the bees among the diverse assemblage of plant species [3, 4]. Thus identification of nectar and pollen source plants and the establishment of a flowering calendar of honey plants concerning the seasonal honeybee colony cycle is critical in improving yields of honey production.

A calendar of bee forage is a timetable that indicates the approximate date and duration of the blooming periods of the important nectar and pollen source plants to the beekeepers in their respective areas [4]. Establishing a floral calendar of the area requires complete observation of the seasonal dynamics in the vegetation patterns and how the honeybee colonies interact with their floral environment [5, 6]. The accuracy of a floral calendar, and hence its practical value, depend solely on the careful recording of the beginning and end of the flowering season of the plants and how they affect the bees.

Ethiopia has various climatic conditions, topography and a wide range of altitudes supporting the presence of 6000-7000 flowering plants and most of them are bee plants which include forest trees, bushes, herbs, weeds, and undergrowth [7, 8]. For the exploitation of untapped beekeeping resources of the region identification and documentation, of major bee forages and preparing their flowering calendar are important to increase honey production.

The analysis of bee plant pollen loads and palynological analysis of honey samples can provide a true picture of honeybee flora of the area that provides food for honeybees and other pollinators in the ecosystem [9, 10]. Due to high content of proteins, amino acids and minerals, pollen has many applications as basic nutrition for honeybees and as a nutritional complement for humans [11].

Documentation of bee plants and establishment of the flora calendar helps to indicate the approximate date and duration of the flowering of important bee plant species in the area [12, 13] and it has paramount importance for practical beekeeping. Knowledge of bee flora help in theeffective management of bee colonies during different season of the year including active and dearth periods [14]. The honey flow period and dearth period vary from one location to another depending on altitudes [14, 16]. Thus the extensive knowledge of bee flora, flowering duration, density, and quality of nectar and pollen is a prerequisite for enhancing the efficiency of the beekeeping industry. Such information enables beekeepers to utilize them at the maximum level so that they can harvest a good yield of honey [17, 8].

There is a limitation of information floral calendar of bee forages that relates to the flowering of the duration of honeybee forage plants, honey flow, and harvesting seasons in the East Wollega zone of Oromia.Considering all these facts, this study aimed to identify existing bee flora and establish a floral calendar and recommend the management intervention in each agro-ecology of the East Wollega zone.

2. Materials and Methods

2.1. Description of the Study Area

The study was conducted in East Wollega Zone, Oromia Regional State, Ethiopia. The zone is located at 36 0 30'00" to 36 0 45'00"longitude and 9 0 05'00" to 9 0 15'00" latitude with elevations ranging from 1000 m to 3207m. The annual rainfall of the zone ranged from 1500mm to

2200mm with a mean annual temperature of 15-200 [18]. The study districts covered in this study were; Diga, Gida Ayana, Gobu Sayyo and Wayu Tuka.

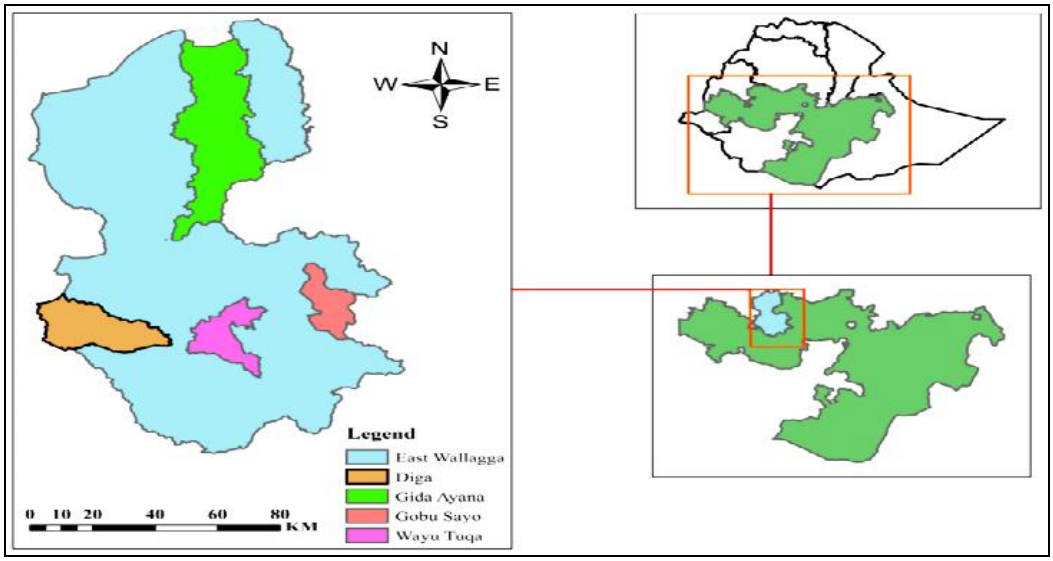


Figure 1. *Map of the study area.*

2.2. Methods of Collection

In this study, both principal and secondary sources of data were used. The primary data was collected from sample household beekeepers through a semi-structured questionnaire, focus group discussion and transect walks around the sample household.

2.3. Sampling Technique and Sample Size Determination

A multistage stage sampling was conducted to select beekeepers. In the first stage, four districts; Diga, Wayu Tuka, Gida Ayana, and Gobo Seyo were selected using purposive sampling based on their potential for beekeeping. In the second stage, three peasant villages were selected from each district purposively based on their relative beekeeping potential. In the third stage, 36 beekeepers from all districts were selected and thee zander bee hives were distributed for pollen collection. In the fourth stage, 159 beekeepers from all districts were interviewed for the bee flora information of the study area.

2.4. Field Observation

Field observation was made on bee floras of the forest to identify the plant and the food source provided for bees during the flowering period. During field observations, the types of food sources offered by plants and the behavior of the honeybees while collecting nectar and pollen were studied. The flowering periods of bee forage, date of blooming, and shedding were also recorded.

In addition to field observation; pollen grains were collected from flower buds to identify botanical sources of the pollen loads, for this purpose a sample of ripe pollen grains was collected from live flower buds. The fat content was washed out using ether to enhance the clearness of pollen grains. The slides were covered with a coverslip and examined under a light microscope having X400 magnifications.

2.5. Pollen Load Collection

Thirty-six movable frame box hives were placed in each representative site of the area and honeybee colonies were transferred to the hives. Pollen trappers having 16% pollen trapping efficiency were fitted at the entrance of beehives and pollen loads were collected then dried and sorted by color and pollen grains identified to genus or species level using the pollen atlas of Ethiopia [15]

2.6. Honey Pollen Analysis

The honey samples were collected from beekeeping peasant associations during the honey harvesting period (April-May). From each locality 3kg of honey, samples were collected. To determine the botanical origin of honey, pollen slides of honey samples were prepared using the method of [19, 4]. The pollen grains extracted from honey samples were identified and compared with the reference slides collected during field observation. The percentages of pollen types in each honey sample were calculated based on the total number of different types of pollen grains counted for each honey sample.

3. Results and Discussion

3.1. Household Information

Of 159 sample households, about *96.2%* were male with occupation (98.1% farmer) which indicates the beekeeping activity in the study area was practiced dominantly by the male. Beekeeping is more of a male's occupation due to traditional beehives is hung on tall tree branches that females could not access and manage. About 37.7% of respondents were in 31-42 age categories with elementary education (39.6%) background.

Table 1.*Household information.*

Character of Respondents	Category	Frequency N=159	Percent (%)
Sex	Female	6	3.8
	Male	153	96.2
Age	31-42	60	37.7
	43-45	26	16.4
	56-68	10	6.3
	>69	7	4.4
Occupation	Farmer	156	98.1
	Merchant	2	1.3
	Student	1	0.6
Educational Status	Illitrus	58	36.5
	Elementary	63	39.6
	Secondary	32	20.1

3.2 The trend of honeybee colony numbers

The number of colonies in three types of bee hives in the study areas were presented by beekeepers in five years during the study periods. Beekeepers mentioned that honey bee colony numbers in traditional bee hives were declining from year to year in the area (Figure 2). However, the number of honeybee colonies kept in transitional and frame box bee hives were increasing in past five years. This indicate the use of frame box and transitional hives is increasing, that is, beekeepers are shifting from traditional beekeeping to transitional and frame box beekeeping due to increased awareness in improved honeybee management system in the area.

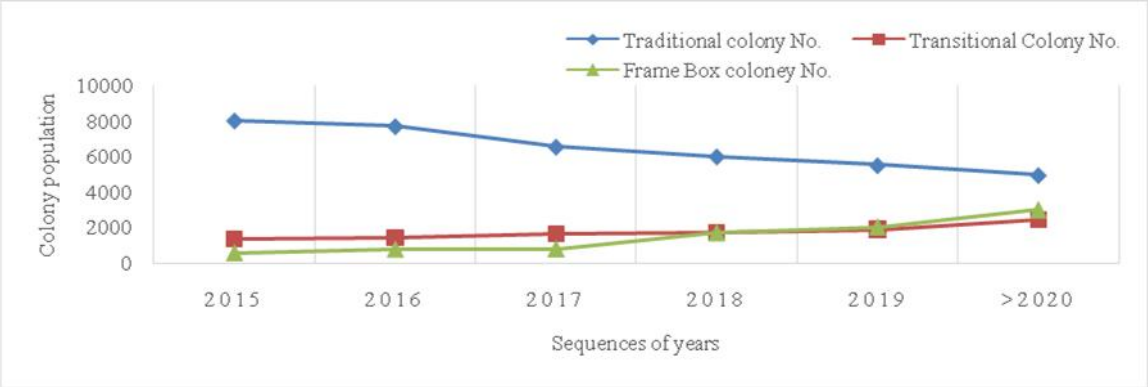
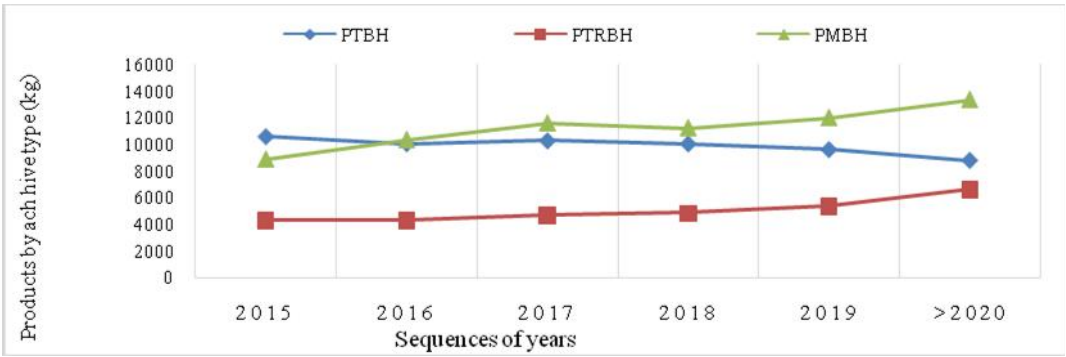


Figure 2. Trend of honey Colony population per Hive type over five years in the past

3.3. Trend of honey production by Hive type

The number of colonies and volumes of honey and beeswax produced were presented in past five years during our study period. Beekeepers mentioned that honey production in traditional bee hives were decreased from year to year in the area. Honey production by transitional and frame box bee hives were increasing in past five years. The use of frame box hives and transitional hives is increasing, that is, beekeepers were shifting from traditional beekeeping to transitional and frame box beekeeping due to increased awareness in improved honeybee management system in the area.



PTBH=products from traditional hive, PTRBH=products from transitional hives, PMBH=products from movable frame box hive

Figure 3. Trend of honey production per hive type over certain years in the past

3.4. Honeybee Plant Inventory

53 plant species were identified belonging to 26 families during plant inventory. Among the plant families Fabaceae. Asteraceae, Acanthaceae, Rosaceae and Poaceae. Regarding the growth habit of the plant about 40.4%, 30.2%, and 28.8% are trees, herbs, and shrubs respectively a graph). The dominancy of trees in the study area is due to the protection and conservation of forest trees, and hanging beehives for traditional beekeeping which might have contributed to the availability of a higher number of trees in the area.

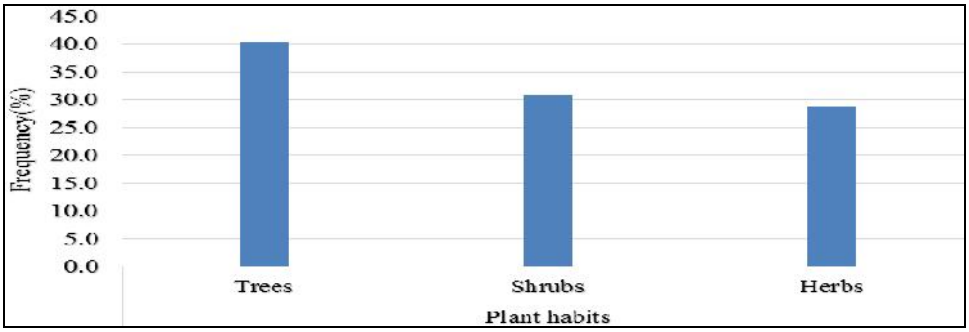


Figure 3. *Honeybee plant inventory.*

3.5. Honey Pollen Analysis

Fresh honey samples were collected for laboratory analysis. A total of 1 kg/farmer honey samples were collected per site of the study area from 36 beekeepers across the actual surveyed farmers. The pollen analysis was made following the methods adopted by [20] for the determination of botanical composition and frequency of pollen grains in the honey at Holleta Bee research center Laboratory. During the present investigation, 102 honey samples were collected from 4 study districts.

Table 2. Honey pollen analysis.

Districts	Honey samples	Kebele/Village	Major Pollen/flora type	Minor type
Diga	1	Geme1	Gamachis	vernonia sp, Trifolium spp, Guizotia spp, Eucalyptus spp	Coffee Arrabica, Maize,Lipidium,Vernonia
	2	Geme2	Gamachis	Trifolium spp, Guizotia spp, Vernonia spp, Eucalyptus globules.Brassica spp	Accacia spp., Grass spp.
	3	Geme3	Gamachis	Trifolium spp, Guizotia spp, Vernonia spp, Eucalyptus globules	Coffee arabica, Albizia schimperiana
	4	Firom1	Firomsa	Brassica spp, GuizotiaVernonia spp	Brassica spp, Croton macrostachyus
	5	Firom2	Firomsa	Eucalyptus spp, Guizotia, Vernonia spp.	Carissa edulis
	6	Firom3	Firomsa	Eucalyptus spp.Guizotia Vernonia spp	Guizotia,Syzygivm guineese
	7	Damak1	Damaksa	Guizotia spps, Guizotia spp	Eucalyptus,Guizotia,Syzygivm guineese
	8	Damak2	Damaksa	Vernonia spp, Guizotia spp, Trifollium spp	Sorghum bicolor,Syzygivm guineese
	9	Damak3	Damaksa	Vernonia spp eucalyptus,Trifollium spp	Accacia,daturaarborea,Syzygivm guineese
Gida Ayana	1	Kon1	Konneji	vernonia sp, Trifolium spp, Guizotia spp,	Accacia spp.
	2	Kon2	Konneji	Trifolium spp, Guizotia spp,	Grass spp, Brassica spp

				Vernonia spp, Eucalyptus sp.	
	3	Kon3	Konneji	Trifolium spp, Guizotia spp, Vernonia spp, Eucalyptus globules	unknown
	4	hrbkan1	Harbu Kane	Brassica spp, GuizotiaVernonia spp	Vernonia
	5	hrbkan2	Harbu Kane	Croton macrostachyus, Eucalyptus spp, Guizotia, Vernonia spp.	Coffee Arabica
	6	hrbkan3	Harbu Kane	Eucalyptus spp.Guizotia Vernonia spp	Vernnia spp. Justicia shimperiana)
	7	gati1	Gatira	Guizotia, DaturaArborea, Guizotia	Trifolium
	8	gati2	Gatira	Vernonia spp Accacia spp.,	Triffolium
	9	gati3	Gatira	Vernonia spp eucalyptus Coffee Arrabica	Romex
	1	Sokej1	Sombo Kejo	vernonia sp, Trifolium spp, Guizotia spp, Coffee Arrabica	Vernonia
	2	Sokej2	Sombo Kejo	Trifolium spp, Guizotia spp, Vernonia spp, Combretum paniculatum.Brassica spp	Eucalyptus spp.
	3	Sokej3	Sombo Kejo	Trifolium spp, Guizotia spp, Vernonia spp, Eucalyptus globules	Trifollium spp.
Gobu Sayo	4	ongob1	Ongobo	Brassica spp, GuizotiaVernonia spp	Coffee arabica
	5	ongob2	Ongobo	Eucalyptus spp, Guizotia, Vernonia spp.	Pissamsativum
	6	ongob3	Ongobo	Eucalyptus spp.Guizotia Vernonia spp	Guizotia, Millettia ferruginea
	7	Gambt1	Gambela Tare	Guizotia, DaturaArborea, Guizotia	Vernonia spp.
	8	Gambt2	Gambela Tare	Vernonia spp Accacia spp.,	Guizotia, Apodytes dimidata
	9	gambt3	Gambela Tare	Vernonia spp eucalyptus Coffee Arrabica	Pterolobium stellatum
	1	warbab1	Wara babu minya	vernonia sp, Trifolium spp, Guizotia spp, Coffee Arrabica	Schefflera abyssinica
	2	warbab2	Wara babu minya	Trifolium spp, Guizotia spp, Vernonia spp,	Sorghum bicolor,Syzygivm guineese,Schefflera abyssinica
	3	warbab3	Wara babu minya	Trifolium spp, Guizotia spp, Vernonia spp, Eucalyptus globules	Accacia,daturaarborea
Wayu tuka	4	mikur1	Migna Kura	Brassica spp, GuizotiaVernonia spp	Guizotia,Syzygivm guineese
	5	mikur2	Migna Kura	Eucalyptus spp, Guizotia, Vernonia spp.	Guizotia,
	6	mikur3	Migna Kura	Eucalyptus spp.Guizotia Vernonia spp	Unidentified, Vicia faba
	7	Dalko1	Dalo Komto	Guizotia, DaturaArborea, Guizotia	Crassoephalumvitellinum
	8	Dalko2	Dalo Komto	Vernonia spp Accacia spp.,	Coriadrumsativum
	9	Dalko3	Dalo Komto	Vernonia spp eucalyptus Coffee Arrabica	Hypoestestrifolia, Ekbergia capensis

Table 1.*Checklist of bee flora species from east Welega zone.*

Plant species	Local name	Family	Habit	Plant source	flowering period
Acacia spp	lafto	Fabaceae	Tree	P&N	Mar-May
Albiziaschimperina	Mukarbaa	Fabaceae	Tree	P&N	Mar-May
Albizia grandibracteata	Mukarba	Fabaceae	Tree	P&N	Mar-August
Albizia gummifera	Sootalloo	Fabaceae	Tree	P&N	Sep-Dec
Apodytes dimidata	Wandaboo	Icaniaceae	Tree	P&N	Sept-Nov
Biden spp	Habaaboo masqalaa	Asteraceae	herb	P&N	Sep-Feb
Borassus aethiopium	Meexxii	Aricaceae	shrub	N	Mar-May
Brassica carinata	Goommanzara	Brassicaceae	herb	P&N	Aug-Nov
Capsicum annum	Hotpepper	Solanaceae	herb	P&N	Sep-Nov
Carisa edulis	Agamsa	Apocynaceae	shrub	P&N	Dec-May
Citrus sinensis	Burtukana	Rutaceae	shrub	P&N	Sep-Nov
Climatis hisrsuta	Hidda fitii	Ranuculaceae	shrub	P&N	Dec-May
Coffea arabica	Buna	Rubiaceae	shrub	P&N	Mar-May
Combretum molle	Dhandhansa	Combretaceae	Tree	P&N	Dec-May
Combretum Paniculatum	Hidda bagi	Combretaceae	Tree	P&N	Dec-May
Cordia africana	Wadeessa	Boraginaceae	Tree	P&N	Sept-Feb
Croton macrostachyus	Bakkanniisa	Euphorbiaceae	Tree	P&N	Mar-Augest
Cucuerbita pepo	Dabaaqula	Cucubritceae	herb	P&N	Dec-Febr
Ekbergia capensis	Somboo	Meliaceae	Tree	P&N	Sep-Nov
Eucalyptus spp	bargamo	Myrtaceae	Tree	P&N	Dec-May
Grewia spp	Dhoqini	Tiliaceae	shrub	P&N	Jun-Aug
Guizota abysinica	Nuugii	Asteraceae	herb	P&N	Sep-Nov
Guizota scabra	Tufo	Asteraceae	herb	P&N	Sept-Nov
Helianthus annus	sufi	Asteraceae	herb	P&N	Sept-Nov
Hypoestes triflora	Dergu	Acanthacae	Tree	P&N	Mar-May
Justice schmperiana	dhummugaa	Acanthacae	shrub	P&N	Sep-Nov
Mangifira indica	Mango	Ancaridiaceae	Tree	P&N	June-Nov
Millettia ferruginea	Birbirraa	Fabaceae	Tree	P&N	Mar-May
Musa paradisca	muuzii	Musaceae	herb	P&N	Through year
Nigella sativa	Abasuuda adii	Ranuculaceae	herb	N	Sep-Nov
Ocimum sanctum	Mosobila	Lamiaceae	herb	P&N	Sep-Nov
Phytolacca dodecandra	Andode	Phytolacceae	shrub	P&N	Mar-May
Pisum sativum	Atara	Fabaceae	herb	P&N	Sep-Nov
Plantago lanceolata	Qorxobbii	Plantaginaceae	herb	P	Sep-May
Prunus africana	Hoomii	Roseaceae	Tree	P&N	Sept-Nov
Pterolobium stellatum	Harangamaa	Fabaceae	shrub	P&N	Dec-May
Rhus glutinosa	Xaaxessaa	Anacaridaceae	Tree	P&N	Dec-Aug
Rosa abyssinica	Qaqawwii	Roseacaceae	shrub	P	Dec-Aug
Rubus apetalus	Gora	Roseacaceae	Tree	P&N	Dec-Febr
Schefflera abyssinica	Gatamaa	Araliaceae	Tree	N	Mar-May
Sesbania sesban	Sasbaaniyaa	Fabaceae	shrub	N	Jun-Aug
Agave sisalana	sisal	Agavaceae	herb	P&N	Dec-Febr
Solanum tubersum	Dinnicha	Solanceae	herb	P&N	Sep-Feb

Plant species	Local name	Family	Habit	Plant source	flowering period
Sorghum bicolor	Bisinga	Poaceae	herb	P&N	Sep-Feb
Stereospermum kunthianum	Botoro	Bignoniaceae	Tree	P&N	Dec-May
Syzygium guineese,	Baaddeessaa	Myrtaceae	Tree	P&N	Dec-May
Trifolium burchellianum	Siddisa	Fabaceae	herb	P	Sept-Nov
Vernonia amygdalina	eebicha	Asteraceae	shrub	P&N	Dec-May
Vernonian auriculifera	Reejjii	Asteraceae	shrub	P&N	Dec-Febr
Vicia faba	Baaqalaa	Fabaceae	herb	P&N	Aug-Nov
Zea mays	Boqqolloo	Poaceae	herb	P	Jun-Nov

3.6. Floral Calendar of Bee Forages

Preparation of a floral calendar enables the beekeeper, to know the dates and duration of the blooming period of the important nectar and pollen plants which can provide information on the honey flow period of the area. According to field records of the flowering period, the majority of bee plant species flowered 40% (September-November), 32% (December-February, 15% (March-April), and 13% (June-August). It is remarkable to note that although the majority of plant species flowered during September-October The presence of a higher percentage of flowering species during Sept–Nov, and Dec-Feb due to summer rain which starts in the middle of June and extends up to December (Figure 2). Based on the flowering calendar of honey bee flora species of the area, two main honey flow periods and one minor honey flow period were identified. These are October –November, December to February, and March to May.

The first two flowering seasons are considered major honey flow seasons and the third one is a minor honey flow period in the area. Following this calendar of bee flora beekeepers should manage their colonies for better honey production which agrees with [20] who stated that the Preparation of honeybee flowers is based on the duration of flowering of hon eybee plants is very important for the management of honeybee colonies.

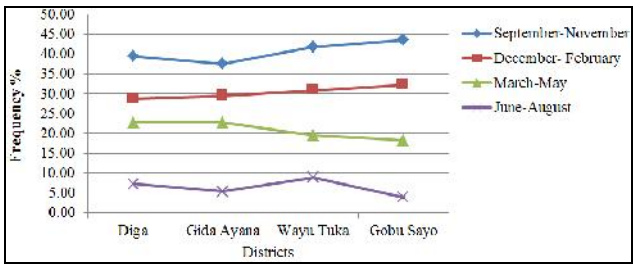


Figure 4. *Bee floral Calendar.*

The result was current with **[**21, 22] The number of plant species flowering during December to January is small, but December-January is one of the minor honey flow periods in the area 94 due to the availability of a few plant species which are able to provide abundant nectar that can be converted to honey by bees.

3.7. Seasonal Honeybee Colony Dynamic of the Area

According to the result, the maximum brood-rearing occurred during September, and the minor was in January and February. The honey flow months were January to February. The dearth period occurs in March and April while June and July were wet and the second dearth period for the area. The maximum colony absconding occurred during March, June, and July Figure 5. Thus using the identified bee plants and calendar of bee flora, beekeepers can perform bee management practices like, transfer colony, suppering hive, colony multiplication, and honey harvesting in their respective areas.

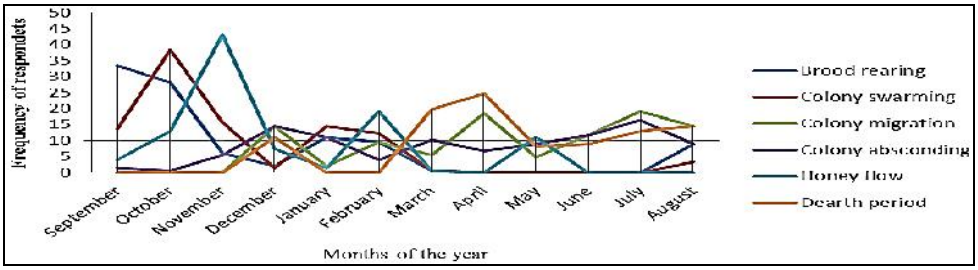


Figure 5. *Major dynamic of the Year.*

4. Conclusion and Recommendation

The botanical inventory of bee plants and melissopalynological is very significant for beekeeping. Both pollen load collection and field observation showed, 53 bee plant species were identified. The greatest honey flow season is from September to November. This is because most areas of the locality are covered with herbaceous flora of weeds, cultivated d crops, forest trees and shrubs as comparable. Medium flowering period occurred from December to February and this is due to most of the study areas are covered with natural forest trees and shrubs.Based on the flowering season two major and one minor honey flow period was identified in all districts, and the beekeeper can select an apiary site, transfer bee colonies, multiply colony, add supers, and take action on swarm control measures and harvest honey. Beekeeper must provide artificial feeding during the dearth period. It is therefore awareness creation should be made to farmers about the flowering calendar of the area, to manage their honeybee colony to increase honey production.

Appendix

Appendix 1 Bee flora species of the east Wollega

Table x. *Xxxxx.*

Districts	Scientific Name	Common Name	Plant Habit	Food source	Flowering Season
				P&N	
Diga	*Syzygivm guineese*	Baaddeessaa	Tree	P&N	Dec-May
	Brassica carinata	Goommanzara	herb	P&N	Aug-Nov
	Accasia spp	Laaftoo	Tree	P&N	Mar-May
	Albizia schimperiana	Mukarbaa	Tree	P&N	Mar-May
	Biden spp	Habaaboo masqalaa	herb	P&N	Sep-Feb
	Borassus aethiopum	Meexxii	shrub	N	Mar-May
	Capsicum spp.	Mixmixa	herb	P&N	Aug-Nov
	Carissa edulis	Agamsa	shrub	P&N	Dec-May
	Citrus spp	Burtukana	shrub	P&N	Sep-Nov
	Coffea arabica	Buna	shrub	P&N	Mar-May
	Cordia africana	Wadeessa	Tree	P&N	Sept-Feb
	Croton macrostachyus	Bakkanniisa	Tree	P&N	Mar-Augest
	Cucurbita pepo	Dabaaqula	herb	P&N	Dec-Febr
	Ekbergia capensis	Somboo	Tree	P&N	Sep-Nov
	Euculyptus spp	Baargamoo	Tree	P&N	Dec-May
	Guizota abysinica	Nuugii	herb	P&N	Sep-Nov
	Guizotia scabra	Tufo	herb	P&N	Sep-Feb

Districts	Scientific Name	Common Name	Plant Habit	Food source	Flowering Season
				P&N	
	Helianthus annus	sufi	herb	P&N	Sept-Nov
	Combretum paniculatum	Hidda bagi	shrub	P&N	Dec-Aug
	Clematis hirsuta	Hidda fitii	shrub	N	Sep-Feb
	Justicia shimperiana)	Dhumuugaa	shrub	P&N	Sep-Nov
	Musa paradisca	muuzii	herb	P&N	Through year
	Nigella sativa	Abasuuda adii	herb	N	Sep-Nov
	Ocimum basilicum	misobilaa	herb	P&N	Sep-Nov
	Phytolaccadodecandra a	Andode	shrub	P&N	Mar-May
	Pisum sativum	Atara	herb	P&N	Sep-Nov
	Plantago lanceolata	Qorxobbii	herb	P	Sep-May
	Prunus africana	Hoomii	Tree	P&N	Sept-Nov
	Pterolobium stellatum	Harangamaa	shrub	P&N	Dec-May
	Schefflera abyssinica	Gatamaa	Tree	N	Mar-May
	Sesbania sesban	Sasbaaniyaa	shrub	N	Jun-Aug
	Solanum tubersum	Dinnicha	herb	P&N	Sep-Feb
	Sorghum bicolor	Bisinga	herb	P&N	Sep-Feb
	Trifolium burchellianum	Siddisa	herb	P	Sept-Nov
	Vernonia amygdalina	Eebicha	shrub	P&N	Dec-May
	Vernonian auriculifera	Reejjii	shrub	P&N	Dec-Febr
	Vicia faba	Baaqalaa	herb	P&N	Aug-Nov
	Zea mays	Boqqolloo	herb	P	Jun-Nov
	Apodytes dimidata	Wandaboo	Tree	P&N	Sept-Nov
	Millettia ferruginea	Birbirraa	Tree	P&N	Mar-May
	Combretum molle	Dadamsa	Tree	P&N	Dec-May
	Galinsoga quadriradiata	Abbadabo	shrub	P&N	Mar-Augest
	Grewia spp	Dhoqini	shrub	P&N	Jun-Aug
	Acacia spp	lafto	Tree	P&N	Mar-May
	Albizia schimperian	Mukarba	Tree	P&N	Mar-May
	Bidens spp	Kelloo	herb	P&N	Sept-Nov
	Brassica carinata	Goomanzara	herb	P&N	June-Nov
	Capsicum spp.	Hotpepper	herb	P&N	Sep-Nov
	Carissa edulis	Agamsa	shrub	P&N	Dec-Febr
	Climatis hirsuta	Hidda fitii	shrub	P&N	Dec-May
	Coffea arabica	Coffee	shrub	P&N	Mar-Aug
	Combretum Paniculatum	Hidda bagi	Tree	P&N	Dec-May
	Cordia africana	Waddeessa	Tree	P&N	June-Nov
	Croton macrostachyus	Bakkanisa	Tree	P&N	June-Dec
Gida Ayana	*Eucalyptus spp*	bargamo	Tree	P&N	Dec-May
	Guizotia scabra	Tufo	herb	P&N	Sept-Nov
	Hypostes spp.	dereku	Tree	P&N	Mar-May
	Linum usitatissimum	Talba	herb	P&N	June-Nov
	Millettia ferruginea	Sotalloo	Tree	P&N	Mar-May
	Ocimum sanctum	Mosobila	herb	P&N	Sep-Nov
	Justicia shimperiana	dhummugaa	shrub	P&N	Sep-Nov
	Pisum sativum	Pea	herb	P&N	Sep-Nov
	Pterolobium stellatum	Harangama	shrub	P&N	Sept-May
	Rhus glutinosa	Xaaxessaa	Tree	P&N	Dec-Augest
	Rubus apetalus	Gora	Tree	P&N	Dec-Febr
	Sterospermum Kunthianum	Botoro	Tree	P&N	Dec-May

Districts	Scientific Name	Common Name	Plant Habit	Food source	Flowering Season
				P&N	
	Syzygium guineese	Baddesssa	Tree	P&N	Dec-May
	Trifolium burchellianum	Siddisa	herb	P&N	Sept-Nov
	Vernonia amygdalina	eebicha	Tree	P&N	Dec-Febr
	Vicia faba	Bean	herb	P&N	Sep-Nov
	Zea mays	Maize	herb	P&N	June-Nov
	Rosa abyssinica	Qaqawwii	shrub	mesophytes	21.1
	Croton macrostachyus	Bakkanisa	Tree	P&N	Mar-Augest
	Cordia africana	Waddeessa	Tree	P&N	Sept-Nov
	Vernonia amygdalina	eebicha	shrub	P&N	Dec-May
	Eucalyptus *spp*	bargamo	Tree	P&N	Sept-may
	Albizia grandibracteata	Mukarba	Tree	P&N	Mar-Augest
	Albizia gummifera	Sootalloo	Tree	P&N	Sep-Dec
	Acacia spp	lafto	Tree	P&N	Mar-Augest
	Vernonian auriculifera	Rejii	shrub	P&N	Mar-May
	Trifolium burchellianum	Siddisa	herb	P	Sept-Nov
Gobu Sayo	*Rosa abyssinica*	Qaqawwii	shrub	P&N	Dec-May
	Bidens spp.	Kelloo	herb	P&N	Sept-Nov
	Guizotia scabra	Tufo	herb	P&N	Sept-Nov
	Mangifera indica	Mango	Tree	P&N	June-Nov
	Syzygium guineense	Baddesssa	Tree	P&N	Mar-May
	Millettia ferruginea	birbirraa	Tree	P&N	Dec-May
	Helianthus annus	sufi	herb	P&N	Sept-Nov
	Ocimum sanctum	Mosobila	herb	P&N	Dec-Febr
	Nigella sativum	Nechasmud	herb	P&N	Dec-Febr
	Agava sisalina	sisal	herb	P&N	Dec-Febr
	Justicia scimperiana	Dhumugaa	shrub	P&N	Through year
	Acacia spp	Laaftoo	Tree	P&N	Mar-May
	Albizia schimperiana	Mukarbaa	Tree	P&N	Mar-May
	Bidens prestinaria	Habaaboo masqalaa	herb	P&N	Sep-Feb
	Bidens spp.	Bidens spp.	herb	P&N	Sept-May
	Brassica carinata	Goommanzara	herb	N	Aug-Nov
	Borassus aethiopum	Meexxii	shrub	P&N	Mar-May
	Capsicum spp	Mixmixa	herb	P&N	Aug-Nov
	Carissa edulis	Agamsa	shrub	P&N	Dec-May
	Citrus spp	Burtukana	shrub	P&N	Sep-Nov
	Coffea arabica	Buna	shrub	P&N	Mar-May
	Cordia africana	Wadeessa	Tree	P&N	Sept-Feb
Wayu Tuka	*Croton macrostachyus*	Bakkanniisa	Tree	P&N	Mar-Augest
	Cucurbita *pepo*	Dabaaqula	herb	P	Dec-Febr
	Ekbergia capensis	Somboo	Tree	P&N	Sep-Nov
	Eucalyptus spp	Baargamoo	Tree	P&N	Dec-May
	Guizota abysinica	Nuugii	herb	P&N	Sep-Nov
	Guizota scabra	Tufo	herb	P&N	Sep-Feb
	Helianthus annus	sufi	herb	P&N	Sept-Nov
	Combretum paniculatum	Hidda bagi	shrub	P&N	Dec-Aug
	Climatis spp	Hidda fitii	shrub	P&N	Sep-Feb
	Justitia schimperana	Dhumuugaa	shrub	P&N	Sep-Nov
	Musa paradisca	muuzii	herb	P&N	Through year
	Ocimum basilicum	misobilaa	herb	P&N	Sep-Nov

Districts	Scientific Name	Common Name	Plant Habit	Food source	Flowering Season
				P&N	
	Phytolacca dodecandra	Andode	shrub	P&N	Mar-May
	Pisum sativum	Atara	herb	P&N	Sep-Nov
	Plantago lanceolata	Qorxobbii	herb	P	Sep-May
	Prunus africana	Hoomii	Tree	P&N	Sept-Nov
	Pterolobium stellatum	Harangamaa	shrub	P&N	Dec-May
	Schefflera abyssinica	Gatamaa	Tree	P&N	Mar-May
	Sesbania seban	Sasbaaniyaa	shrub	P&N	Jun-Aug
	Solanum tubersum	Dinnicha	herb	P&N	Sep-Feb
	Sorghum bicolor	Bisinga	herb	P	Sep-Feb
	Syzygium guineense	Baaddeessaa	Tree	P&N	Dec-May
	Trifolium burchellianum	Siddisa	herb	P&N	Sept-Nov
	Vernonia amygdlina	Eebicha	shrub	P&N	Dec-May
	Vernonia auriculifera	Reejjii	shrub	P&N	Dec-Febr
	Vicia faba	Baaqalaa	herb	P&N	Aug-Nov
	Zea mays	Boqqolloo	herb	P	Jun-Nov
	Apodytes dimidata	Wandaboo	Tree	P&N	Sept-Nov
	Combretum molle	Dhandhansa	Tree	P&N	Dec-May
	Galinosoga parviflora	Abbagabo	shrub	P&N	Mar-Augest
	Grewia spp	Dhoqini	shrub	P&N	Jun-Aug

Appendix 2

Table 2.*Pollen source plants from pollen tarp.*

Gem=Gemechis, From= Fromsa, Dam=Damaksa, Dalko=Dalo Komto, Mikur=migna Kura, Warbab=Warraa Baabbuu Miinyaa, Kon=Konnejjii, hrbk=Harbu Kane, gati=Gatira, gambt=Gambela Tare, ongob=Ongobo, sikej=Sombo Kejo

Districts	No.	Honey samples	Kebele/Village	*Major Pollen/flora type*	*Minor flora type*
Diga	1	Geme1	Gamachis	*vernonia sp, Trifolium spp, Guizotia spp, Coffee Arrabica,Syzygivm guineese, Vernonia spp.*	*Brassica carinata, Eucalyptus spp, Maize*
	2	Geme2	Gamachis	*Trifolium spp, Guizotia spp, Trifollium spp, Eucalyptus globules, Vernonia spp.*	*Accasia spp*
	3	Geme3	Gamachis	*Vernonia spp.,Trifolium spp, Guizotia spp, Eucalyptus globules, Albezy shyflera*	*Coffee arabica*
	4	Firom1	Firomsa	*Brassica spp, Guizotia,. Biden spp*	*Zea maize*
	5	Firom2	Firomsa	*Eucalyptus spp, Guizotia, Vernonia spp.*	*Borassus aethiopum*
	6	Firom3	Firomsa	*Guizotia, Brassica spp, Guizotia,. Biden spp*	*Capsium spp. Eucalyptus spp*
	7	Damak 1	Damaksa	*Guizotia spp, Guizotia, Guizotia*	*Eucalyptus, carisa edulis*
	8	Damak 2	Damaksa	*Accacia spp., Brassica spp, Guizotia,. Biden spp*	*Sorghum bicolor, Citrus*
	9	Damak 3	Damaksa	*eucalyptus Coffee Arrabica, Brassica spp, Guizotia,. Biden spp*	*Accacia, Coffe Arabica, Cordia*

Districts	No.	Honey samples	Kebele/Village	*Major Pollen/flora type*	*Minor flora type*
Gida Ayana	1	Kon1	Konneji	*Brassica spp, Trifoliu spp, Ekbergia capensis, Vernonia spp, Accacia spp, Croton macrostachys*	*Africana . Justitia schimperana*
	2	Kon2	Konneji	*Accacia spp. Brassica spp, Trifoliu spp, Ekbergia capensis, Vernonia spp, Accacia spp, Croton macrostachys*	*Grass spp.*
	3	Kon3	Konneji	*Eucalyptus, Brassica spp, Trifoliu spp, Ekbergia capensis, Vernonia spp, Accacia spp, Croton macrostachys*	*unknown*
	4	hrbkan1	Harbu Kane	*Triffolium, Lipidium, Brassica spp, Trifoliu spp, Ekbergia capensis, Vernonia spp, Accacia spp, Croton macrostachys*	*Vernonia Euculptus spp*
	5	hrbkan2	Harbu Kane	*Brassica spp, Trifoliu spp, Ekbergia capensis, Vernonia spp, Accacia spp, Croton macrostachys*	*Coffee Arabica Guizota abysinica*
	6	hrbkan3	Harbu Kane	*Coffee Arabica Brassica spp, Trifoliu spp, Ekbergia capensis, Vernonia spp, Accacia spp, Croton macrostachys*	*Vernnia spp. Guizota scapra*
	7	gati1	Gatira	*Coffee Arabica, Brassica spp, Trifoliu spp, Ekbergia capensis, Vernonia spp, Accacia spp, Croton macrostachys*	*Trifolium Helianthus annus*
	8	gati2	Gatira	*Coffee Arabica, Brassica spp, Trifoliu spp, Ekbergia capensis, Vernonia spp, Accacia spp, Croton macrostachys*	*Triffolium Hidda bagi*
	9	gati3	Gatira	*Lipidium, Brassica spp, Trifoliu spp, Ekbergia capensis, Vernonia spp, Accacia spp, Croton macrostachys*	*Romex clamates sp*
Gobu Sayo	1	Sokej1	Sombo Kejo	*Acacia, Brassica spp, Trifoliu spp, Ekbergia capensis, Vernonia spp, Accacia spp, Croton macrostachys*	*Syzygivm guineese, musa paradisca*
	2	Sokej2	Sombo Kejo	*Guizotia spp, Coffee Arrabica Vernonia spp, Accacia spp, Eucalyptus globules*	*Eucalyptus spp, Ekbergia capensis, Nechasmud, mangifera Indica*
	3	Sokej3	Sombo Kejo	*Brassica spp, Trifoliu spp, Ekbergia capensis, Vernonia spp, Accacia spp, Croton macrostachys Eucalyptus globules*	*Ocimum santum Eucalyptus spp, mangifera Indica*
	4	ongob1	Ongobo	*Eucalyptus, camcldulensis, Brassica spp, Trifoliu spp, Ekbergia capensis, Vernonia spp, Accacia spp, Croton macrostachys, Eucalyptus globules*	*Coffee arabica Phytolacca dedecandra*
	5	ongob2	Ongobo	*Brassica spp, Trifoliu spp, Ekbergia capensis, Vernonia spp, Accacia spp, Croton macrostachys Guizotia*	*Eucalyptus spp, mangifera Indica*
	6	ongob3	Ongobo	*Brassica spp. Guizotia, Trifoliu spp,*	*Plantago*

Districts	No.	Honey samples	Kebele/Village	*Major Pollen/flora type*	*Minor flora type*
				Ekbergia capensis, Vernonia spp, Accacia spp, Croton macrostachys Eucalyptus spp.	*lanceolatum Eucalyptus spp, mangifera Indica*
	7	Gambt1	Gambela Tare	*Brassica spp, Trifoliu spp, Ekbergia capensis, Vernonia spp, Accacia spp, Croton macrostachys Eucalyptus spp.*	*Vernonia spp. Prunus africana*
	8	Gambt2	Gambela Tare	*Brassica spp, Trifoliu spp, Ekbergia capensis, Vernonia spp, Accacia spp, Croton macrostachys Eucalyptus spp.*	*Guizotia Pterolobium stellatum*
	9	gambt3	Gambela Tare	*Guizotia spp, Eucalyptus spp, Brassica spp, Trifoliu spp, Ekbergia capensis, Vernonia spp, Accacia spp, Croton macrostachys*	*Vernonia spp. Schefflera abyssinica*
				Brassica spp, Trifoliu spp, Ekbergia capensis, Vernonia spp, Accacia spp, Croton macrostachys Guizotia, DaturaArborea	*Eucalyptus,Guizotia sesbania*
	1	warbab1	Wara babu minya	*Vernonia spp, Trifoliu spp, Ekbergia capensis,, Accacia spp, Croton macrostachys Eucalyptus spp.*	*Unidentified solanumtubersum*
	2	warbab2	Wara babu minya	*Brassica spp, Trifoliu spp, Ekbergia capensis, Vernonia spp, Accacia spp, Croton macrostachys Accacia spp., Brassica spp, Trifoliu spp, Ekbergia capensis, Vernonia spp, Accacia spp, Croton macrostachys*	*Sorghum bicolor Eucalyptus spp, mangifera Indica*
	3	warbab3	Wara babu minya	*eucalyptus Coffee Arrabica Brassica spp, Trifoliu spp, Ekbergia capensis,Vernonia spp, Accacia spp, Croton macrostachys Accacia spp., Coffee Arrabica*	*Accacia, Daturaarborea Burchellianum*
Wayu tuka	4	mikur1	Migna Kura	*Brassica spp, Trifoliu spp, Ekbergia capensis, Vernonia spp, Accacia spp, Croton macrostachys*	*Guizotia,vernonia amygdlina*
	5	mikur2	Migna Kura	*Brassica spp. Brassica spp, Trifoliu spp, Ekbergia capensis, Vernonia spp, Accacia spp, Croton macrostachys*	*Guizotia Vernonian auriculifera*
	6	mikur3	Migna Kura	*Bidens spp, Eucalyptus Brassica spp, Trifoliu spp, Ekbergia capensis, Vernonia spp, Accacia spp, Croton macrostachys*	*Unidentified Vicia faba*
	7	Dalko1	Dalo Komto	*Bidens sp, sprestinaria Brassica spp, Trifoliu spp, Ekbergia capensis, Vernonia spp, Accacia spp, Croton macrostachys*	*Crassoephalumvitellinum Zea mays*
	8	Dalko2	Dalo Komto	*Bidens spp, Brassica spp, Trifoliu spp, Ekbergia capensis, Vernonia spp, Accacia spp, Eucalyptus, Coffee*	*Brassica carinata, Coriadrumsativum, Croton*

Districts	No.	Honey samples	Kebele/Village	*Major Pollen/flora type*	*Minor flora type*
	9	Dalko3	Dalo Komto	*Arrabica* *Cordia Africana, Bidens sp, Albizia schimperian, Acacia spp, Croton macrostachys*	*macrostachys Hypoestestrifolia Millettia ferruginea, EucalyptusCoffee Arrabica*

References

[1] Crane E.1990. Bees and beekeeping. Heinemann, Oxford, Uk

[2] Priya Kumari, Jacob Solomon Raju Aluri and Tatiparthy Byragi Reddy (2003). Floral calendar of honeybees in Visakhapatnam. 39(2003): 175-189.

[3] Admasu, A. and Nuru, A. (1999). Effect of honeybee pollination and seed yield. First.

[4] Louveaux J., Maurizio A., Vorwohl A., 1978. Methods of Melisso Planology. Bee world, Vol.51, 125- 138.

[5] Desalegn, B. (2004). Origin and classification of honeybee pollen source. The Netherlands. MSc. thesis Utrecht University Faculty of Biology, Department of social insect unit.

[6] Suryanarayana MC 1986. Honeybee flower relationship. Bulletin of Botanical Survey of India. 28(1-4):55- 62.

[7] Hodges D. 1978. A calendar of bee plants. Bee World 59:97-100.In proceeding of third international Conference in Tropical Climate, Nairobi, Kenya

[8] AmssaluB. 2005. Nature and phenology of honeybee plants in the central highlands of Ethiopia. Participatory Innovation and Research: Lessons for Livestock Development.12th Annual conference of theEthiopian Society of Animal Production (ESAP) 410.pp.

[9] Kafle, GP. 1984. A general survey of bee forage in and around Kathmandu valley. Nep. J. Agric.15:89-99.

[10] Hepburn, H.R. and Radloff, S.E. 1998. **Honeybees of Africa.** Springer, New York, 35 pp.

[11] Admassu Addi and Debissa Lamessa, 2009. Bee plant inventory and the pollen potentiality of Menagesha Suba state forest for beekeeping utilization. E*thiop. j. biol. sci.*, 8(2): 85-97.

[12] Amssalu B. 1997. Preliminary study on honey plants around Holetta. Proceedings of 5th National Conference of Ethiopia Society of Animal Production.

[13] Mardan M. and Kiew R., 1984. Flowering periods of plants visited by honeybees in two areas of Malaysia. pp.209 – 216.

[14] Rajan, B. K. (1980). Apiculture and farm forestry in semi-arid tracts of Karnataka. Proceedings of second international conference on apiculture in tropicalclimates. New Delhi. India. Pp.187-189.

[15] Debara, M., Negash, D., Bekele, B., and Zeleke, B.(2019). Assessment and Establishment of Honey Bee Flora Calendar to Increase Honey Production in Selected Areas of SNNPR State, Ethiopia.Finance & Economics Review, 1(1), 77-88.

[16] Rajan, B. K. (1980). Apiculture and farm forestry in semi-arid tracts of Karnataka. *Proceedings of second international conference on apiculture in tropical climates*. New Delhi. India. Pp.187-189.

[17] Nuru A. and Admasu A. 2002. The Pollen spectrum and floral calendar in West Showa zone. In: Second Proceeding of Ethiopian Beekeepers association pp.209 – 216.

[18] CSA, (2007). *Population and Housing Census of Ethiopia*

[19] Garga,A.(2006). Bee botany of Bhimtal in western Himalyas; melissopalynological analysis.

[20] Amsalu Arega, Tusa gemechu and Megersa Debela, 2020. Assessment on honeybee flora species with their time of flowering in East and Horo Guduru Wollega, Oromia Regional state, Ethiopia. International Journal of Fauna and Biological Studies 2020; 7(4): 156-163.

[21] Amssalu B. 1999. Identification of major pollen source honey plants around Holeta Bee Research Centre. Proceedings of 7th National Conference of Ethiopian Society of Animal Production.
[22] Debissa L and Amsalu B. 2006. Botanical inventory and phenology of bee plants in rift valley regionsof East Showa Zone. The Role of Agricultural Universities/Colleges in Transforming Animal Agriculture in Education, Research and Development in Ethiopia: Challenges & Opportunities. Proceedings of the 13th annual conference of the Ethiopian Society of Animal Production (ESAP) held in Addis Ababa, Ethiopia, August 25-27, 2004.

Access this Article in Online	
Quick Response Code	Website: www.ijarbs.com
	Subject: Apiculture
DOI:10.22192/ijarbs.2023.10.06.007	

How to cite this article:
Amsalu Arega, Tusa Gemechu. (2023). Establishing Honey Bee Floral Calendar in East Wollega Zone, Western Oromia, Ethiopia. Int. J. Adv. Res. Biol. Sci. 10(6): 72-88.
DOI: http://dx.doi.org/10.22192/ijarbs.2023.10.06.007