Cross Current International Journal of Agriculture and Veterinary Sciences
Abbreviated Key Title: Cross Current Int J Agri Vet Sci
ISSN: 2663-2454 (Print) & Open Access
DOI: 10.36344/ccijavs.2022.v04i03.002

Volume-4 | Issue-3| May-Jun, 2022 |

Original Research Article

Establishing Honey Bee Floral Calendar in West Arsi and East Shewa Zones of Oromia, Ethiopia

Mekonnen Wolditsadik[1*], Taye Beyene, Desta Abi[1]

[1]Oromia Agricultural Research Institute, Adami Tulu Agricultural Research Center

***Corresponding author:** Mekonnen Wolditsadik

| **Received:** 17.05.2022 | **Accepted:** 25.06.2022 | **Published:** 29.06.2022 |

Abstract: Adequate knowledge about honey bee flora is important for beekeeping this study was under taken to identify and document honeybee plants in West Arsi and East Shoa Zone using melissopalynological analysis of honey samples, pollen collection, plant inventory, structured questionnaires and field observation. Eighteen honey samples were collected from different parts of the zones. Out of 18 samples, 14 were identified as monofloral honeys and 4 as multifloral honeys. This indicated that there is high diversity of honeybee plant species in 4 honey samples that give flowers in the same season contributing for production of multifloral honey and 14 samples were dominated by few major honeybee plants due to their abundance in addition to their quality for honey production. Fifty eight (58) plants species were identified as honey source plants based on melissopalynological analysis of honey. Of 58 species, Guizotia scarba (89.7%). Eucalyptus (69.2%) Eucalyptus camadulensis (66.2%) Acacia tortolis (60.9%) Schefflera Abyssinia (70.2%) and Croton macronstachys (57.2%) provided mono-floral honey. The flowering calendar of the zone indicated two major honey flow periods from April to June and September to November. The scarcity of honeybee forages were observed in July to mid of August and January to February and mid of March. In many districts of the zone, herbaceous honeybee forage species were the dominant honey source plants in September to November. While, in March to May majority of honey source plants were trees and shrubs due to the phonological patterns of plants. To apply seasonal honeybee colony management, beekeepers should manage honeybee colonies following phonological pattern of honeybee plants. Beekeeping based agro forestry practices on cultivated rain fed land, and selection of plant species that can resist drought and bear (set) flower for a long season should be introduced in all land use types.

Keywords: Beekeeping, Monoflora, Pollen.

INTRODUCTION

Ethiopia is endowed with natural and cultivated flora and diverse agro-ecological and climatic condition that are well-suited for beekeeping [1]. Oromia is one of the regional states in Federal Republic of Ethiopia rich in natural resources and favorable climatic condition for improved beekeeping development.

In order to boost the production obtained from this huge resource of the region, identification and documentation of economic bee forages and their flowering calendar is critical for the sub-sector development endeavors. Though description of flower producing plants in the region cannot pretend to be exhaustive, it is possible to produce a certain type of identification and characterization of major bee forage plants and establish their flowering calendar which can make it easier to plan various beekeeping management operations. Establishing floral calendar is a critical tool for planning various beekeeping management operations such as hive super adding and to predict the frequency and period of honey flow in a given area.

Despite the richness of the bee flora, suitable climatic condition and its accessibility to market, the knowledge of the bee flora in the region is incomplete. Thus identification of bee plants and establishment of the floral calendar (time table to indicate the approximate date and duration ofthe flowering of important bee plant species in specific area has paramount important for practical beekeeping [10]. Because it is important tool that inform the availability of certain bee forage in particular area, to predict time of honey flow period and their values to bees. Therefore preparation of flowering calendar in the rift valley

Quick Response Code

Journal homepage:
https://www.easpublisher.com/

Citation: Mekonnen Wolditsadik & Taye Beyene, Desta Abi (2022). Establishing Honey Bee Floral Calendar in West Arsi and East Shewa Zones of Oromia, Ethiopia. *Cross Current Int J Agri Vet Sci*, *4*(3), 25-33.

region would be important for better honey production and managements of honeybee colonies. And hence, the study was aimed to provide valuable information on major and minor bee plants that grow in the area &, to prepare honey floral calendar for the region, to assess the frequency distribution of the major bee plants for honey production in area.

However bee forages of the region is not adequately documented and their correlations with seasonal colony management calendar are not established to the required level. As a result areas with unique production opportunities are not identified and hence beekeeping an environmentally friendly and non-farm business activity with immense contribution to the economies of participant beekeepers, region and nation couldn't commensurate with the existing potential in the region. Therefore, assessing the different agro-ecological zones of east shewa and West Arsi for determining the availability of bee forage and establishing flowering calendar of honey plants that enable effective seasonal colony management is paramount important.

General Objective

- To characterize and document major bee forages contributing for honey production and to establish appropriate floral calendar that is suitable for effective bee management in different agro-ecological condition of East Shewa and West Arsi Zones.

Specific Objectives

- To identify, document, and prepare flowering calendar of nectar and pollen sources bee forages to recommended the necessary seasonal colony management practices in different agro- ecologies of the region.
- To establish pollen data base of bee plants of West Arsi and East Shoa Zones
- To map the major mono and multi-floral honey source bee forage in different agro-ecological zone of West Arsi and East Shoa

MATERIALS AND METHODS

Study Area

The study was conducted in west Arsi and East Shewa zones of Oromia. From each zones three districts was selected based on potentiality of beekeeping and agro-ecology.

Honey Sample Collection and Laboratory Analysis

Fresh honey samples from different agro-ecologies at different seasons were collected for laboratory analysis. Honey samples were collected from the different sites of the study area. The pollen analysis was made following the methods adopted by Louvuex for determination of botanical composition and frequency of pollen grains in the honey. Wash out the anthers, or whole flowers, or inflorescences, in a watch-glass filled with ether. Decant the ether, and rinse the pollen with fresh ether; decant this also. After drying, transfer the pollen to a slide and spread it out. A drop of fructose solution makes transfer easier, and accelerates the swelling of the pollen grains. Dry the preparation, preferably by slight warming (not above 40°C), and mount it with glycerine gelatine. If the pollen grains are slow to swell, keep the preparation warm until appropriate swelling has occurred. If the pollens have a tendency to burst, remove the fat from them with ether, directly on the slide. Mount the pollen quickly, with minimal warming. Strip the pollen from the flowers or anthers with a microscope slide, or empty ripe anthers on to a slide with needles. Spread out the pollen and remove any remains of anthers and dirt particles. Then mount the preparation with glycerine gelatine.

Colony Establishment for Pollen Collection and Seasonal Dynamics of Honeybee Population

24 honeybees' colonies were established in 18 sites of 6 districts of the 2 study zones. For each site 4 honeybee colonies were established (two for pollen trapping and two for honey harvesting) for pollen and honey sample analysis. For pollen collection honeybee colonies were fitted with pollen trap and pollen loads were collected every seven days interval and pollen samples were weighed and frozen in the refrigerator until analysis was made using the prepared reference data base, and identified to the generic or species level. Descriptive statistics were used to analysis both survey and laboratory data

RESULTS AND DISCUSSIONS

Melissopalynological Analysis

On the basis of the honey pollen analysis totally 58 plant species (17 in East Shewa and 41 in West Arsi) were identified as honey source plants. The most predominant pollen types (> 45%) were recorded for *Eucalyptus camaldulensis, Acacia tortolis, Guizotia scabra, Eucalyptus globulus, Hypoestes forskaolii*. The secondary pollen source plants (16-45%) recorded were *Vernonia spp , Biden spp, plantago lanceolata, Justicia scmhperina, schefflera abyssinica, Guizotia abyssinica*, and *Dovyalis abyssinica* and finally the minor important pollen source plantspecies (3-15%) were *Trifolium quartinianum, Zea mays, Olea europia and crisium schimperia* and the rest of the species were rare (<3%), (Table 1). The diversity of secondary and important minor honey source plant species were higher than predominant species.

In many districts of the zones, herbaceous honeybee forage species were the dominant honey source plants in September to November due to disturbances and expansion of agricultural crops. Some of those herbaceous honeybee forage plants include *Guizotia* species, *Bidens* species, *Trifolium* species and *Hypoestes* species which grow in farm land and edge of the forest. However, in March to May majority of honey source plants were trees and shrubs in

comparison to herbaceous. For example: The tree species such as *Schefflera abyssinica, Acacia tortolis, Croton macrostachyus and Eucalyptus spp* are flowered in this season [1] also stated that *Schefflera abyssinica, Acacia spp and Croton macrostachyus* are the most important honey producing trees and flowered from April to May. The high scarcity of honeybee forage was observed in July to mid of August and January to February and mid of March. When honeybee plant identification is conducted as major and minor honeybee plants in honey pollen analysis, the main problem was that a given honeybee plant is major in one district and minor in the other districts. This is due to variation in the abundance of the species. For example in Kofale *Guizotia scabra* was not widely distributed and considered as the minor honeybee plants (1.5% in honey sample pollen analysis) and 87.6% in Gimbichu District which is major honeybee plants. This indicated that the abundance of a given honeybee plant species has great impact on honey production potential and mislead to consider the plant as best honeybee forage plant. Adjusting a number of honeybee colonies with available resource is used to increase the productivities of honeybee colonies by overcoming the problem of colony overstocking [1]. Niguse & Haftom also reported that a good beekeeping area is the one in which honeybee plants grow abundantly and with a relatively long blooming season. Hence, beekeepers should select appropriate site that have enough supply of honeybee forage plants within the flight range of honeybees for honey production [6].

Predominant pollen types

During the major and minor honey flow periods *Guizotia* species, *Eucalyptus species, Justicia heterocarpa, Croton macrostachys, Acaiacia* species were predominant honey source plants (45%) due to their massive flowering in the area.

Secondary pollen source

The secondary pollen source plants (16- 45%) identified were *Plantago lanceolata, Vernonia spp, Justicia scmhperina, Dovyalis abyssinica, Zea mays, Trifolium* species and *Mangifera indica.*

Minor pollen source

The minor pollen source (3-15%) was *Ocimum* species, *Echinopes* species, *Gravillea robusta*, Acacia *spp*, Ricinus *communis*. The honey pollen analysis showed that a number of anemophilous (wind pollinated) pollen grains from *Plantago lanceolatum, Andropogon abyssnica, Zea mays, Cyperus species* and *Sporobolus consimilis*. Some of the plant species were found more frequent in sample plots *Achyranthes aspera, Tagtes minuta, Balanite egyptica*, Leucas *spp* but did not appear in honey samples. This might be due to less potential for Honeybees to forage nectar and pollen from these trees or the tree density per plots is very low to attract honeybees.

Table 1: Predominant, Secondary, important minor and minor honey source plants in districts of east shoa and west Arsi Zone based

District	*Predominant pollen source (>45%)*	*Secondary pollen source (16-45)*	*Important minor pollen source (3-15)*	*Minor pollen source (< 3%)*
Dugda	*Guizotia scabra*		*Eucalyptus camaldulensis*	*Plantago lanceolata*
			Trifolium quartinianum	*Lepidium*
	Hypoestes forskaolii		*Zea mays*	
				Phyllanthus
				Olea europea
				Vernonia amygdalina
				Crisium schimperia
				Acacia saligna
				Acacia tortilis
			Acacia tortolis	
Gimbichu	*Guizotia scabra*		*Eucalyptus camaldulensis*	*Plantago lanceolata*
		Justicia scmhperina	*Vernonia amygdalina*	*Lepidium*
			Crisium schimperia	*Olea europea*
			Eucalyptus globulus	*Maesa lanceolata*
				Hypoestes forskaolii
				Datura arborea
Ada'a	*Guizotia scarba*		*Eucalyptus camaldulensis*	*Sesamum indicum*
			Phyllanthus	*Rubus steudreri*
			Plantago lanceolata	*Vernonia amygdalina*
			Olea europia	*Trifolium*
			Lepidum	*Acacia*
			Plantago lanceolata	*Olea europea*
				Plantago lanceolata
				Trifolium
				Vernonia amygdalina

				Acacia abyssinica
				Acacia oarfeta
				Acacia seyal
Wando	*Eucalyptus camaldulensis*	*Guizotia*	*Plantago lanceolata*	*Crambe hispanica*
		Plantago lanceolata	*Lepiolum*	*Olea europia*
		Mangifera indica L		*Bidens*
				Ocium basilicum
				Trifolium
				Phoenix abyssinica
Kofale	*Guizotia scabra*	*Vernonia amygdalina*	*Schefflera abyssinica*	*Apodytesdimidiatavar.acutifolia*
	Acacia tortolis	*Eucalyptus Camaldulensis*	*Guizotia abyssinica*	
		Eucalyptus globolus	*Vernonia auriculifera*	*Pterolobium stellatum*
			Rumex nervosus	*Carissa spinarum L*
			Trifolium quartinianum	*Croton macrostachyus*
			Ricinus communis	*Brassica carinata*
			Erythrina abyssinica	*Medicago polymorpha* L.
			Acacia abyssinica	*Euphorbia nubica*
				Dichrostachys cinera
				Acacia saligna
				Dovyalis abyssinica
				Phytolacca dodecandra
				Hagenia abyssinica
				Maytenus obscura
				Cicer arietinum L.
				Lens culiaris
				Cynodon dactylon
Nagele Arsi	*Croton macrostachyus*	*Vernonia auriculifera*	*Vernonia amygdalina*	*Vicia faba L.*
	Guizotia scarab	*Hypoestes forskaolii*	*Eucalyptus globolus*	*Mangifera indica L.*
	Eucalyptus globulus	*Eucalyptus Camaldulensis*	*Cordia africana*	*Euphorbia abyssinica*
		Guizotia abyssinica	*Buddleia polystachya*	*Prunus Africana*
		Dovyalis abyssinica	*Trifoliumquartinianum*	*Ficus vasta*
		Schefflera abyssinica	*Dombeya torrida*	*Solanumin canum L.*
			Olea europea	*Calpurnia aurea*
			Acacia tortilis	*Milletia ferruginea*
				Acacia seyal
				Persea America
				Schinus molle L.
				Phytolacca Dodecandra
				Erythrina abyssinica Lam.
				Pterolobium stellatum
				Justicia schimperiana
				Acacia oarfeta
				Ekebergia capensis
				Hagenia abyssinica
				Albizia schimperiana

Regarding inventory of beeforages Plant species like *Bidens spp ,Andropogon abyssinica, Acacia tortilis, Acacia negri, Balanites aegyptiaca ,Acacia albida, Croton macrostachys, Eucalyptus Camaldulensis, , Hypoestes forskali, Plantago lanceolata , Croton macrostachyus ,Guizotia scarba, Eucalyptus globolus , Albizia schimperiana, Andropogon abyssinica* species,were more frequent in most sample plots (Figure 1).

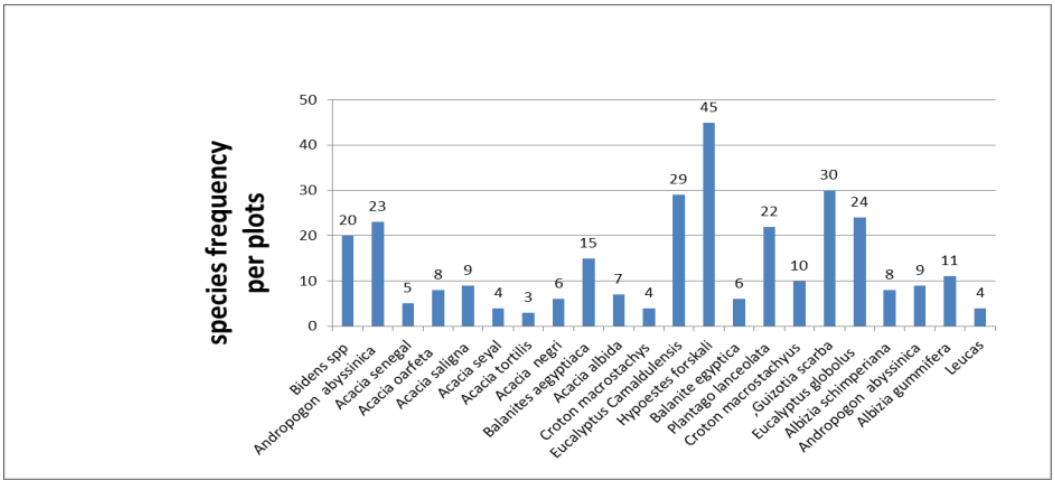

Figure 1: The frequency distribution of honey bee plant species in semple plots

This is due to an adaptation of the plant species to local climate and soil condition suggesting that higher frequencies of the plants is the best indicator of adaptation to the area. For instance *Hypoestes forskali* is the most frequent species in sample quadrate due to its growing habit under shade of different *Acacia* species. The density and cover value of the plant species per plots were higher for herbaceous plants species (*Hypoestes forskali*, Achyranthes *aspera*, *Andropogon abyssinica*, *Tagetes minuta*, *Leucas* species & *Solanum* species) (Figure 2).

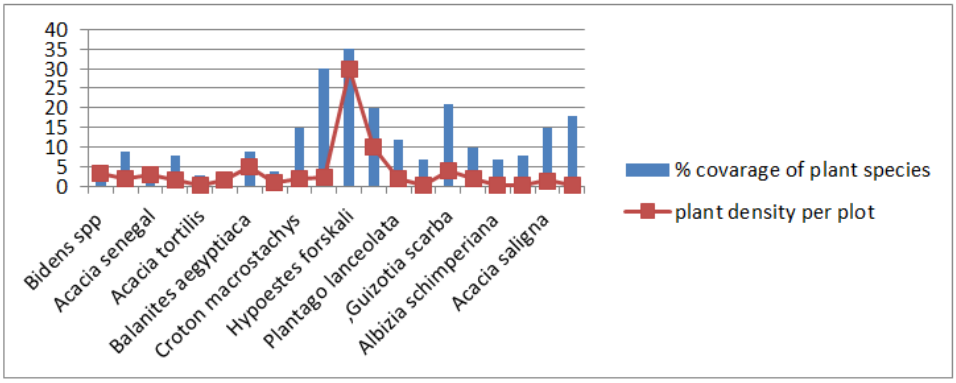

Figure 2: The relationship between plant density and cover abundance of plant specis in sample plots for the major species

This is due to smaller seed size, which occupies large areas of the plots. The trees and shrubs density was lower due to deforestation. However the cover values of trees were higher due to large canopy, which is advantageous for more flower production to be foraged by honeybees. The species diversity in sample plots were generally higher at the lower altitudes of the rift valley (Dugda, Ada'a & wando) and decreasing towards higher altitudes (Negale-Arsi Gumbichu & Kofale), (Figure 3).

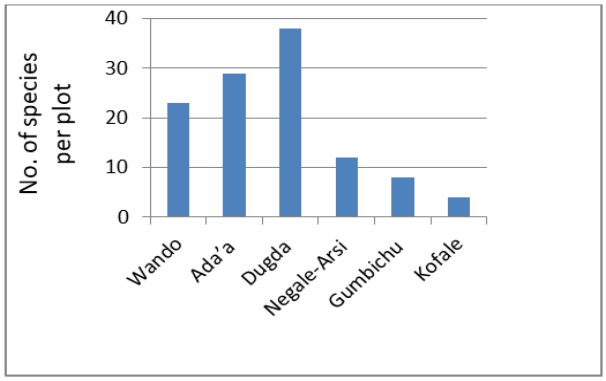

Figure 3: The species richness at different districts of the East Shewa & West Arsi Zones

This may be associated with geology, intensive cultivation, clearing of vegetation and climate.

The flowering period of the plants is very short at lower altitudes of the rift valley due to high

Temperature, insufficient moisture and erratic rainfall while the flowering periods of the plants in the higher altitudes extends up to end of November. In lower altitudes of the area the major

Honey flow seasons is during October as compared to higher altitudes, which is during October, and minor flow during May-June due to availability of field crops and protected forests of the area

Monofloral Honey Based on Melissopalynological Analysis

Based on the number of pollen source plant species and the share of each species in the total pollen count, 14 out of 18 analyzed samples were identified as mono floral honeys and 4 samples were identified as multifloral honeys. This indicated that there is high diversity of honeybee plant species in 4 honey samples that give flowers in the same season contributing for production of multifloral honey. Whereas 14 honey samples are dominated by few major honeybee plants and this is due to their abundance in addition to their quality for honey production. Microscopic analysis revealed that plant species variability is greatest in the minor pollen group (less than 3%), followed by the important minor pollen, secondary, and dominant groups [11] also reported that variability is always small among pollen species in the dominant groups, while greater among minor pollen (less than 3%), important minor pollen and secondary pollen groups. Analysis of the pollen content of honey is used to investigate the provenance and provide a quantitative measure of floral origin (pollen percentage) for use in market. It is very effective to determine and control the geographical origin of honeys and it also provides information about other important quality aspects. Five dominant plant species are identified based on honey pollen analysis. These are *Guizotia scarab Eucalyptus camadulensis, Acacia tortolis, Schefflera abyssinica and Croton macronstachys.* The dominancy of these plant species in honey samples due to their abundance, nectar and pollen potentiality. *Eucalyptus camaldulensis* is major honey source plants that provided monofloral honey in wando District of west Arsi Zone. Gemechis (2013) also mentioned that *Eucalyptus* mono-honey comes mainly from *E.globulus* though there are other important species like *E. camaldulensis and* E. *citrodora* that serve as sources of honey. *Guizotia scabra* is major honey source plants in Gimbichu Dugda,Wando and Ada'a Districts of East Shewa and West Arsi Zones that provide mono floral honey [7]. Also reported that *Guizotia mono* honey mostly comes from *G.scabra* and along with this plant *G. abyssinica* and other weeds which flower in the same period and partly contribute to this honey [1].

From the above identified honeybee plants based on the honey pollen analysis revealed that the honey samples belonged to 14 mono-floral honeys originating from 6 plant types that are produced in different parts ofthe zones. Mono-floral honey of *Guzizotia scarba* produced in Dugda, and Ada'a districts from September to October, in Wando,Gimbichu and Nagelle Arsi September to November. Monofloral honeys of *Schefflera abyssinica* was also produced in kofale districts (Table 2). Due to their wide distribution, *Guizotia scabra and Acacia tortolis* are predominant plant species in mid and lowlands of the zone.

Table 2: Monofloral Honey collected from districts of east shoa and west Arsi with its botanical origin and honey harvesting Season

No. of sample	District	Plant species	Pollen frequency in (%)	Harvesting season
01	Dugda	*Guzizotia scarba*	89.7	September-october
02	Wando	*Eucalyptus*	69.2	December-january
03	Gimbichu	*Guzizotia scarba*	81.4	September-november
04	Ada'a	*Guzizotia scarba*	76.9	September-october
05	Dugda	*Guzizotia scarba*	89.3	September-october
06	Nagele Arsi	*Guzizotia scarba*	88.9	September-november
07	Ada'a	*Guzizotia scarba*	81.95	September-october
08	Gimbichu	*Guzizotia scarba*	87.6	September-november
09	Ada'a	*Guzizotia scarba*	82	September-october
10	Wando	*Eucalyptus camadulensis*	66.2	May-june
11	Wando	*Eucalyptus camadulensis*	54.9	May-june
12	Dugda	*Acacia tortolis*	60.9	March –may
13	Kofale	*Schefflera abyssinica*	70.2	April-june
14	Nagele Arsi	*Croton macronstachys*	57.2	May-june

Figure 1 the pollen grains of some species identified from honey pollen analysis

Majority (50.6%) of major honey source plants identified from honey pollen analysis are flowered from September to November followed by March to May (29.6%) and finally 19.8% flowered in April to june. As a result these two seasons are considered as major honey harvesting season in in East shewa and West Arsi Zones. The high scarcity of honeybee forage was observed in July to mid of August and january to February and mid of march in West Arsi and in East Shoa.

Table 3: Flowering seasons of major honeybee plants in East Shewa Zone

Scientific name of plant	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Acacia abyssinica												
Acacia albida												
Acacia bussei												
Acacia												
Acacia lahai												
Acacia oarfeta												
Acacia pilispina												
Acacia saligna												
Acacia Senegal												
Acacia seyal												
Acacia tortolis												
Balanites aegyptiaca												
Bidens macroptera												
Brassica carinata												
Carthamustinctorius												
Cordia atrtcana												
Croton macrostachyus												
Dovyalis abyssinica												
Ekebergia capensis.												
Eucalyptus Camaldulensis												
Eucalyptus globolus												
Euphorbia abyssinica												
Guizotia scabra												
Helianthus annus												
Hypoestes forskaolii												
Maytenus gracilipes. arguta(Loes.) Sebsebe												
Ocium sanctum												
Olea europea												
Papaya carica												
Rhus natalensis												
Schinus molle												
Trichilia emetic												
Vernonia amygdalina												
Zea mays												
Ziziphus mucronata												

Table 5 Flowering seasons of major honeybee plants in West Arsi Zone

Scientific Name of plant	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Acacia abyssinica												
Acacia oarfeta												
Acacia seyal												
Acacia tortilis												
Acaciasaligna saligna												
Balanites aegyptiaca												
Brassica carinata												
Callistemon citrinus												
Carica papaya												
Carissa spinarum												
Coffea arabica												
Cordia africana												
Coriandrum satium												
Croton macrostachyus												
Datura stramonium												
Dovyalis abyssinica												
Ekebergiacapensis												
Erythrina abyssinica												
Eucalyptus Camaldulensis												
Eucalyptus globolus												
Euphorbia abyssinica												
Euphorbia nubica												
Guizotia abyssinica												
Guizotia scarab												
Hypoestes forskaolii												
Justicia schimperiana												
Mangifera indica												
Maytenus obscura												
Nigella sativa												
Olea europaea												
Persea America												
Prunus Africana												
Psidium guajava												
Schefflera abyssinica												
Schinus molle												
Vernonia amygdalina												
Vernonia auriculifera												
Zea mays												

CONCLUSION AND RECCOMMENDATIONS

In conclusion, based on honey samples pollen analysis Different plant species were identified as honey source plants. The mono-floral honeys were produced from *Guzizotia scarba, Eucalyptus camadulensis,Acacia tortolis ,Schefflera abyssinica and Croton macronstachys.* In many districts of the zone, herbaceous honeybee forage plant species are the dominant honey source plants from September to November. However, in March to May majority of honey source plants are trees and shrubs species. The high scarcity of honeybee forage was observed in July to mid of August and mid of January to mid of March. Therefore, beekeepers should manage their honeybee colonies following phonological pattern of honeybee plants. Beekeeping based agro forestry practices on cultivated rain fed land, and selection of plant species

that can resist drought and bear (set) flower for a long season should be introduced in all land use types.

ACKNOWLEDGEMENTS

The authors are thankful to Adami Tulu Agricultural Research Center, Holota Bee Research Center and Oromia Agricultural Research Institute for providing required facilities and logistics.

REFERENCES

1. Admassu, A., Kibebew, W., Amssalu, B., & Ensermu, K. (2014). Honeybee forages of Ethiopia. *Addis Ababa: United Printers*.
2. Albuquerque, U., Cunha, L., Lucena, R., & Alves, R. (2014). Methods and Techniques in Ethnobiology and ethnoecology.London. Springer New York Heidelberg Dordrecht.
3. Teklay, A. (2011). *Seasonal availability of common bee flora in relation to land use and colony performance in Gergera Watershed Atsbi Wemberta District, Eastern Zone of Tigray, Ethiopia* (Doctoral dissertation, Hawassa University).
4. Assemu, T., Kerealem, E., & Adebabay, K. (2013). Assessment of current beekeeping management practice and honey bee floras of Western Amhara, Ethiopia. *International Journal of Agriculture and Biosciences*, *2*(5), 196-201.
5. Chauhan, M. S., & Trivedi, A. N. J. A. L. I. (2011). Pollen analysis of honey from Lucknow district, Uttar Pradesh. *Journal of Applied Bioscience*, *37*(1), 48-51.
6. Crane, E. (1990). *Bees and beekeeping: science, practice and world resources*. Heinemann Newnes.
7. Gemechis, L. (2013). Identification and characterization of major mono-floral honeys in Ethiopia. In Proceedings of the 20th Annual Conference of the Ethiopian Society of Animal Production (p. 274). Addis Ababa, Ethiopia.
8. Gebru, N., Gebretsadik, H., & Welderufael, S. (2015). Assessment of Honey Bee Flora in Eastern Zone of Tigray, North Ethiopia. *Assessment*, *5*(1). 53-57.
9. Nicola, B. (2009). Bees and their role in forest livelihoods. A guide to the services provided by bees and the sustainable harvesting, processing and marketing oftheir products. No-wood Forest Products.
10. Adgaba, N., Al-Ghamdi, A., Tadesse, Y., Getachew, A., Awad, A. M., Ansari, M. J., ... & Alqarni, A. S. (2017). Nectar secretion dynamics and honey production potentials of some major honey plants in Saudi Arabia. *Saudi Journal of Biological Sciences*, *24*(1), 180-191.
11. SABo, M., Potocnjak, M., Banjari, I., & Petrovic, D. (2011). Pollen analysis of honeys from Varaždin County, Croatia. *Turkish Journal of Botany*, *35*(5), 581-587.