

## Foraging behavior of *Apis* species on the bloom of *Ziziphus mauritiana* L.

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### ABSTRACT

Management of bee forage to increase beekeeping potential of any area is of considerable importance. It is necessary to maintain, strong and healthy colonies of domesticated and wild honeybees, as natural areas are shrinking and crop diversification is not practiced by the farmers. Therefore, bee fauna remains in nutritional stress which causes weak and diseased colonies. The present study revealed that *Zizyphus mauritiana* L. was an excellent floral resource for *Apis* species. It has the ability to provide special honey flow period in September and October if grown in large number for reforestation and improved cultivars for horticultural purposes. Outcome of this study will enhance knowledge regarding bee management techniques, bee forage management, floral calendar, making beekeeping more profitable and conservation of wild bee fauna.

### Introduction

Research on bee forage plants in a given area is of primary importance for development of beekeeping industry and conservation of wild honeybees. All plants are not equally important for bees as they show preference to particular type of vegetation. Nectar and pollen are offered as a reward by different species of plants, for insect pollinators (Reddy et al. 1992). Such rewards differ in their quality, quantity and accessibility, as well as they are also associated with particular type of insects (Fenster et al. 2006).

Nectar is an important incentive provided by animal pollinated plants to their pollinator partner (Simpson et al. 1983). In order to survive, prosper and be productive; honeybee colonies require continuous and adequate supply of both nectar and pollen. Some plants produce abundant amount of nectar but little or no pollen, are called honey plants and are the best suited for honey production. A good beekeeping area is one in which honey and pollen plants grow abundantly with a long blooming period, but such areas are not always available under Punjab conditions due to unsustainable as well as non-diversified crop pattern, shrinking natural areas and removal of trees for road widening.

Among many factors, availability of potential flowering plants is considered important for honey production (Adebabay et al. 2008). Vegetation characteristics of an area are considered as important indicators, of its

potential for beekeeping. Identification of honeybee plants, knowing their value to bees, time of blooming and flowering duration has a paramount importance for apiculture (Nuru et al., 2001; Amssalu, 2004). Study of floral resources and foraging behavior of honeybees on them would be useful across a range of research areas. The success of beekeeping industry depends not only on using better strains of bees but also on the abundance and richness of nectar and pollen around the apiary (Mattu et al. 1989).

*Zizyphus mauritiana* L. (Rhamnaceae) is a medium sized tree which provides large amount of nectar (Abrol, 2009). Many varieties of this tree are found commonly in fields, villages and on roadsides but improved cultivars are used for horticulture. Tree may be erect or wide-spreading with drooping thorny branches. Flowers are tiny, white or greenish white in color, protandrous, disciflorous and rich with nectar. Fruit set takes place with cross pollination by honeybees and other insects attracted by the fragrance and nectar.

The main aim of the study was to reveal foraging behavior of honeybees on *Z. mauritiana* L. to assess its status as bee flora. The expected outcome may help to enhance the knowledge regarding honeybee management techniques, development of the apiculture, and conservation of wild bee fauna which is facing nutritional stress. Such information will provide guide lines to identify bee flora, time of blooming and formation of local floral calendar.

## Materials and Methods

The present research work was carried out in Mansa district of Punjab, which is situated at latitude 29°-59'-00" N, 75°-24'-00" E and elevation above the sea level is 210 meters. Experiments were performed in months of September and October during 2015 and 2016 on trees of *Ziziphus mauritiana* L. which were already growing for horticultural purposes in the vicinity of an apiary (*Apis mellifera*). *A. florea* and *A. cerana* were visiting the bloom of the experimental trees from their natural habitats.

Time of commencement and cessation of foraging activity of different types of bees on the bloom was noted. Relative abundance of *Apis* species per unit area per unit time was also recorded at various fixed day hours with the help of meter rod and stop clock. Foraging frequency (number of flowers visited per minute) was also noticed. Observations of nectar and honey stored in *A. mellifera* colonies were done for aroma, flavor and pollen identification to confirm floral sources.

To identify the pollen, samples of the nectar and honey from hives was examined under microscope. The slides of pollen grains, collected directly from bloom of concerned trees, were also prepared to confirm source of pollen and nectar. Data collected were consolidated, analyzed statistically, results were calculated and conclusions were drawn.

## Results and Discussion

All species of the honeybees commenced their foraging activity on the bloom of *Z. mauritiana* L. at about 730 hours and cessation of such activity took place at 1500 hours in case of *A. mellifera* and *A. cerana*, while such time was 1700 hours in case of *A. florea*. On an average 8.08 (Standard Error 1.18), 3.5 (SE 0.81) and 2.4 (SE 0.51) bees  $m^{-2} min^{-1}$  of *A. florea*, *A. mellifera* and *A. cerana* were present on bloom, respectively. The foragers of all the three species of *Apis* could be seen foraging on the

experimental bloom from morning till evening (Fig.1, 2 & 3)

Maximum abundance of bees  $m^{-2} min^{-1}$  (average 10.8 (SE 1.21) was noted at 900-1330 hours in case of *A. florea*, while it was 6.51 (SE1.34) and 5.00 (SE1.31) bees  $m^{-2} min^{-1}$  in case of *A. mellifera* and *A. cerana* respectively at 930-1030 hours (for both the species). Relative abundance of *A. florea* was significantly more followed by *A. mellifera* and *A. cerana* however, there was no significant difference in abundance of *A. mellifera* and *A. cerana* (Fig.4, Table 1.).

Average number of foragers of all the three bee species per unit area per unit time was 13.42 (SE 2.51). Peak foraging activity seemed to depend upon many factors like time related floral physiology of plant, environmental factors, and adjustment of bee species with prevailing environmental conditions and innate characteristics of insect visitors. Bees regulate their foraging activity according to the time at which floral rewards are available in plenty (Atwal, 2000). Foraging activity is also effected by needs of colony (Synge, 1947; Ribbands, 1953; Percival, 1965).

Number of flowers visited per minute (Foraging frequency) was maximum, 20 (SE 1.22) in case of *A. cerana* followed by *A. mellifera*, 19 (SE 1.26) and *A. florea*, 15 (SE 1.31). However, there was no statistical difference in the foraging frequency of *A. mellifera* and *A. cerana*. Foraging frequency depends upon number of factors including floral morphology (Free, 1970; Gilbert, 1980), environmental factors (Wilson, 1926; 1929; Abrol, 1997), instinctive foraging behavior of insects, density of flowers, type of floral incentive quantity and quality of floral rewards.

Most of the foragers of all bee species were nectar gatherers. Nectar or honey stored in *A. mellifera* hives and combs of *A. florea* provided special aroma and flavor of *Z. mauritiana* L. Pollen grains detected in the honey and the nectar samples under microscope were of experimental tree. Study confirmed special honey flow period was provided by these trees.



Figure 1. *Apis mellifera* forager on *Z. mauritiana* bloom



Figure 2. *Apis florea* forager on *Z. mauritiana* bloom.



Figure 3. *Apis cerana* forager on *Z. mauritiana* bloom.

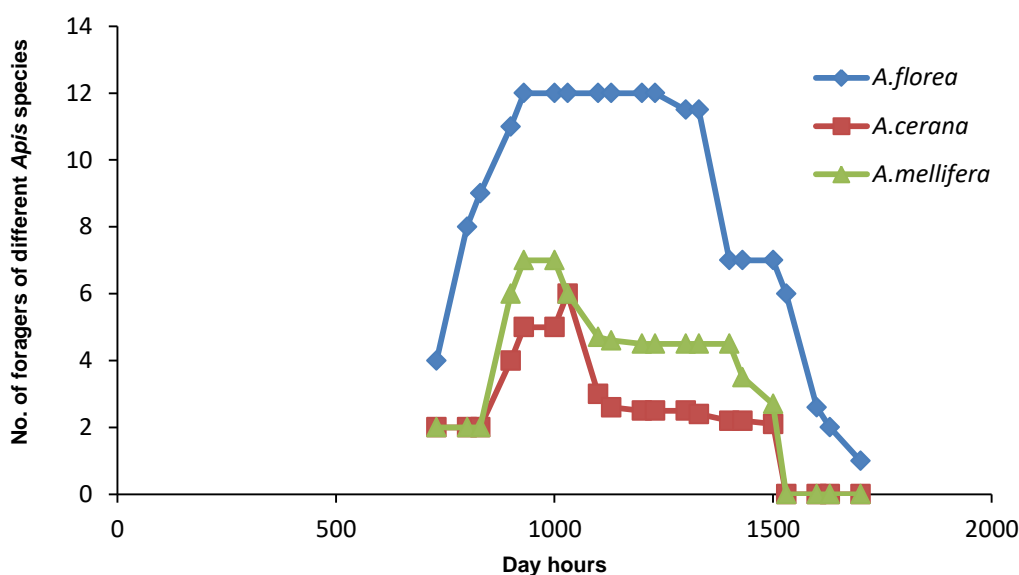


Figure 4. Relative abundance of *Apis* species on *Z. mauritiana* bloom at different day hours

Table 1. Comparative abundance of *Apis* species on bloom of *Z. mauritiana*.

Hours of Day	Number of foragers of honeybees on bloom/m <sup>2</sup> /minute		
	No. of <i>A. florea</i> foragers	No. of <i>A. cerana</i> foragers	No. of <i>A. mellifera</i> foragers
0730	4.0 (1.01)	2.0 (0.50)	2.0 (0.50)
0800	8.0 (1.20)	2.0 (0.45)	2.0 (0.40)
0830	9.0 (1.02)	2.0 (0.43)	2.0 (0.30)
0900	11.0 (1.02)	4.0 (1.21)	6.0 (1.36)
0930	12.0 (1.21)	5.0 (1.31)	7.0 (1.40)
1000	12.0 (1.20)	5.0 (1.30)	7.0 (1.40)
1030	12.0 (1.17)	6.0 (1.29)	6.0 (1.26)
1100	12.0 (1.16)	3.0 (0.40)	4.7 (0.80)
1130	12.0 (1.13)	2.6 (0.50)	4.6 (0.60)
1200	12.0 (1.31)	2.5 (0.50)	4.5 (0.30)
1230	12.0 (1.40)	2.5 (0.50)	4.5 (0.12)
1300	11.5 (1.30)	2.5 (0.41)	4.5 (0.25)
1330	11.5 (1.20)	2.4 (0.30)	4.5 (0.20)
1400	7.0 (1.01)	2.2 (0.50)	4.5 (0.38)
1430	7.0 (1.00)	2.2 (0.20)	3.5 (0.41)
1500	7.0 (0.50)	2.1 (0.21)	2.7 (0.50)
1530	6.0 (0.80)	0 ----	0 ----
1600	2.6 (0.60)	0 ----	0 ----
1630	2.0 (0.30)	0 ----	0 ----
1700	1.0 (0.20)	0 ----	0 ----

Note: The figures in the parenthesis are standard errors.

## Conclusion

It may be concluded that *Ziziphus* species especially *Z. mauritiana* L. was an excellent honey plant. Growing of this tree species is recommended on common land, road sides and other areas under forest department of Punjab. This drought resistant tree grows vigorously and needs less care and improved cultivars are also profitable for horticultural purposes. Tree under investigation if grown in large number would provide special honey flow period during its blooming season in case of *A. mellifera* and may help in sustenance of wild bee fauna. Study will help to add new concepts to existing knowledge regarding management of bee flora, foraging behavior of honeybees, migratory beekeeping and to modify floral calendar. Recommendations if followed would help to manage bee forage system, making beekeeping more profitable, maintain bee populations, make breeding season of *A. mellifera* more successful in September and conservation of wild honeybees like *A. florea* and *A. cerana* as these wild honeybee species are well known and excellent pollinators of the most of the crops grown in the district.

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