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FORAGING BEHAVIOUR OF *AMEGILLA ZONATA* (L.) ON *OCIMUM KILIMANDSCHARICUM* GUERKE

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Abstract

Ocimum kilimandscharicum Guerke an important medicinal plant of Jammu and Kashmir, India was found to be pollinated by insects belonging to 4 orders, 8 families and 14 species. The flowers of *O. kilimandscharicum* were visited abundantly by *Amegilla zonata* (L.) followed by *Apis dorsata* and *A. cerana.* The number of bees foraging during different times on the day ranged from 4.7 - 11.30/ 5 plants/5 min; visited 12 - 25 flowers/5 plant and spent 2.3 - 7.9 s/flower. Foraging populations of *A.zonata* responded significantly to environmental factors.

Ocimum kilimandscharicum Guerke (fam.: Lamiaceae, common name Camphor Basil) is an economically important medicinal perennial herb (Dolly *et al*. 2012) of Jammu and Kashmir. In India, it is being cultivated both in plains and in hilly areas of U.P, West Bengal, Dehradun, Maharashtra, Mysore, Kerala, Jammu and Kashmir and Darjeeling (Singh *et al*. 1955). It is a good nectar producing plant. The flowers plenty of insect pollinators. The Blue-banded bee, *Amegilla zonata* (L.) (Hymenoptera: Apidae: Anthophoridae), are medium-large, pubescent, long-tongued, solitary, fossorial bees that nest gregariously in vertical burrows in the ground or horizontally in soil embankments and occasionally in sandstone or artificial substrates (Michener 1960). The *Amegilla* sp. have already been established as well-known pollinators of a wide range of crops (Dollin *et al*. 2000, Gross and Kukuk 2001, Hogendoorn *et al*. 2007).

The pollinator diversity and foraging behaviour of *Amegilla zonata* (L.) were examined in the University research farm, SKUAST-Jammu of Jammu and Kashmir, India. Counts were made throughout the flowering period of *O. kilimandrischium*. The *A. zonata* were followed from their first flower visit to a marked area until the bee moved away. The observations were made during 2 hrs periods and within 3 time periods daily from 0900 - 1000, 1200 - 1300 and 1400–1500 hrs local time. During each count, the 5 marked plants were observed for 5 min. Data were gathered on visit rates (number of bee/plant/minute), number of flowers visited/plant and time spent/flower. The data so obtained was analyzed statistically.

It is showed that insects belong to 4 orders, 8 families, and 14 species forag the *O. kilimandrischium*. The abundance of all the insects foragers was in the order of : *A. zonata* >*A. dorsata* > *A. mellifera* > *A. cerana* > others. The other insect visitors included solitary bees (*Xylocopa fenestrata, Halictus* sp., *Nomia* sp.), butterflies (*Pieris brassicae*, *Danaus chrysippus*), true flies (*Eristalis* sp., *Metasyrphus* sp., *Musca domestica*), and beetles (blue beetle, *Coccinella septempunctata*). Honeybees (*A. mellifera* and *A. cerana*) were reported as worthy foragers of *O. kilimandrischium* (Free 1993, Sajjanar *et al*. 2005). Kuberappa *et al*. (2007) recorded ten species

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of insect pollinators on Vishnu tulsi (*O. sanctum* [*O. tenuiflorum*]), belonging to orders Hymenoptera (*Apis cerana, A. florea, A. dorsata, Trigona iridipennis, Vespa cincta* [*V. tropica*] and unidentified) and Diptera (including *Musca domestica, Lucilia cuprina* and *Philoliche longitorsis*).

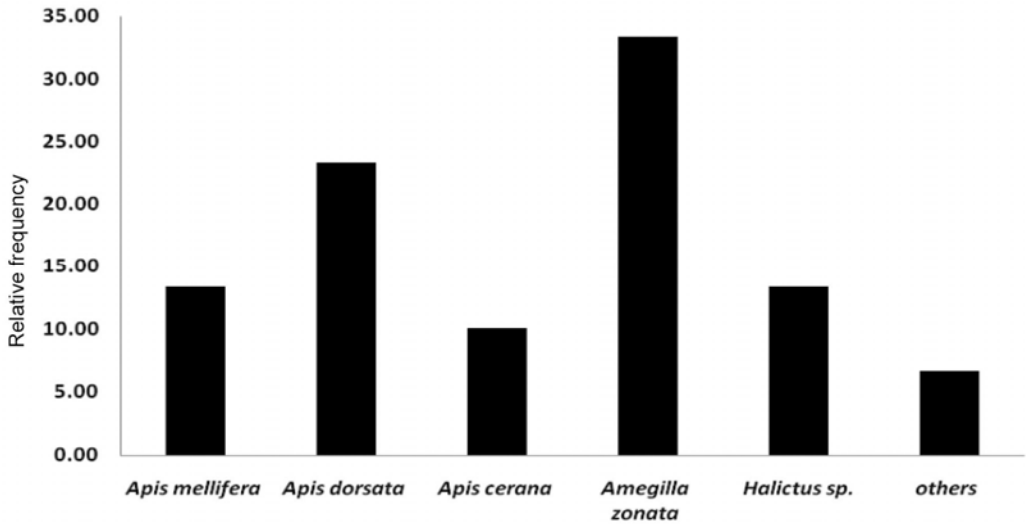

Fig. 1. Abundance of pollinators insects /foraging insects on *O. kilimandrischium.*

The foraging activity of *A. zonata* revealed that the number of bees foraging during different times on the day ranged between 4.7 and 11.30/5 plants/5 min (Fig. 2). The *A. zonata* on an average visited 12 - 25 flowers/5 plant. The amount of time bees take to forage on flower is an important component determining foraging behaviour. The time spent by *A. zonata* on flower ranged between spent 2.3 and 7.9 s/flower. The highest foraging activity was noticed between 12.00 and 13.00 hrs. Darrah (1974) observed that pollination of *O. kilimandscharicum* was mostly by honeybees, which preferentially moved to plants within the same cultivar, but some cross-pollination between cultivars did occur, especially of cultivars that were represented by a few plants only. Some cross-pollination was also found to occur between species but the resultant seed was not viable.

Of the several factors, abiotic factors greatly influence the foraging behaviour. The foraging behavior is greatly affected by the quantity and quality of resources like pollens or vector and and environmental characteristics. The observations on the abundance of *A. zonata* on blooming *O. kilimandrischium* in relation to abiotic variables revealed that temperature (maximum and minimum) and sunshine exerted a positive and significant effect while relative humidity (maximum and minimum), rainfall and wind speed had a negative impact on *A. zonata* foraging. The number of visiting bees and number of flowers visited by *A. zonata* on *O. kilimandrischium* exhibited significant positive correlation with the temperature (maximum) but positive and non-significant with temperature (minimum) and sunshine. The relative humidity, rainfall and wind speed had significant negative effect on the foraging activity of *A. zonata.* The duration of time spent per flower was significantly correlated with temperature (maximum and minimum); positive but non significantly with sunshine (Table 1). The relative humidity (maximum) exerted a significant negative effect while as, relative humidity (maximum), rainfall and wind speed had a

positive but non significant effect on bee activity. The multiple linear regression analysis showed that all the weather parameters ensemble were responsible for 98.10 per cent (R^2 value) of total variation of the foraging activity. The foraging activity of all honeybee species followed the same general pattern as temperature, light intensity, solar radiation, nectar sugar concentration and inversely with relative humidity (Abrol 2012). Each bee pollinator has specific ecological threshold for foraging activity which differ inter and intra specifically depending upon the level of adaptation of a given species in an environment (Burill and Dietz 1981, Abrol and Kapil 1986). Burill and Dietz (1981) reported that the bee activity increased with temperature but was not affected by relative humidity and vapour pressure.

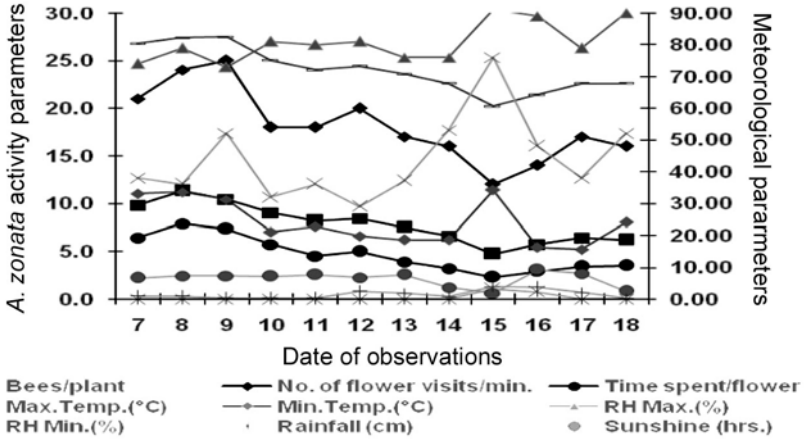

Fig. 2. Effect of abiotic parameters on the foraging activity of *A. zonata.*

Table 1. Correlation coefficient between population dynamics of *A. zonata* and weather parameters on *O . kilimandscharicum.*

Parameters	Temperature (°C)		Relative humidity (%)		Rainfall (cm)	Sunshine (h)	Wind speed
	Max.	Mini.	Max.	Mini.			
Number of bees/ 5 plant	0.986**	0.435	–0.686*	–0.574	–0.621*	0.436	–0.597*
Number of flower visits/5min.	0.967**	0.410	–0.704*	–0.492	–0.643*	0.406	–0.572*
Time spent/flower	0.980**	0.525*	–0.605*	–0.477	–0.537*	0.380	–0.557*

P** > 0.01, p* > 0.05.

An understanding of the mutualistic relationship between flower-visiting insects and crop species, particularly on the diversity of pollinator species, their spatio-temporal variations, foraging behaviour and their pollination efficiency, is important as they are some of the crucial biological predictors of pollination success. Information on the contribution of wild pollinators to the pollination of flowering crops is mostly lacking. In most areas with crop pollination deficits, bee fauna are sufficiently rich to find suitable target species, and the development of native species should be attempted before considering exotic introductions. The genus *Amegilla* illustrates the availability of suitable pollinators in large areas of various crops. Hopefully, the knowledge gained

from these species can be applied to successfully develop other native species and provide improved stability to those crops that rely on insect pollination.

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