



## FORAGING DYNAMICS OF WESTERN HONEY BEE *APIS MELLIFERA* L. ON LITCHI

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### ABSTRACT

Honey bee *Apis mellifera* L. is one of the most important pollinating insect of litchi. Foraging behaviour of pollinators is greatly influenced by many environmental factors including temperature, relative humidity, wind speed, rainfall etc. Variation in the foraging behaviour of *A. mellifera* in relation to environmental factors has been studied during March-April 2022 on nectar rich litchi flora. Temperature > 30°C had negative impact on bee activity with correlation coefficient of -0.71, -0.41 and -0.21 for outgoing, pollen collecting and nectar collecting bees, respectively. The temperature, > 15°C and upto 30°C, on other hand exhibited positive impact on outgoing bees ( $r = 0.66$ ), nectar collecting bees ( $r = 0.76$ ) and pollen collecting bees ( $r = 0.77$ ). Distinct correlation had also been found between the foraging activity and relative humidity, rainfall and diurnal variation.

**Key words:** *Apis mellifera* L., foraging activity, temperature, litchi, nectar, out going and incoming bees, seasonal variations, diurnal variations, pollen basket

The Litchi flower is self-sterile and requires different groups of insects for pollination (Pandey and Yadav, 1970; Phadke and Naim, 1974). Among various insect visitor, honeybees have been reported as the most advantageous pollinator insect on litchi trees (Groff, 1943). Honey bees collect nectar and pollen from the flowers and play an important role in promoting pollination in a mutualistic manner (Dalio, 2015; Kumar, 2016). *Apis mellifera* is popular for commercial beekeeping in the northern state of India whereas *A. cerana* is common across Asia (Oldroyd and Nanork, 2009). The successful viability of honeybee colonies depends directly on the foraging efficiency of worker bees. The activity of a colony is determined by the number of bees going out for foraging per unit of time. Foraging activity, itself, is influenced both by factors within the colony and those outside it. Apart from the availability of ample flora, honeybees activity is also influenced by abiotic factors. Foraging activity of *A. mellifera* varies along with changes in season and weather conditions (Alghamdi, 2002; Corbet et al., 1993). The foraging and pollen-gathering activities of honeybee colonies are controlled by environmental conditions (Dukku et al., 2013; Abou-Shara, 2014), including temperature (Roman and Weryszko, 2006; Ali et al., 2019), relative humidity (Joshi and Joshi, 2010) wind speed etc. (Omoloye and Akinsol, 2006). The rates of foraging and pollen gathering reflect the performance and productivity of honeybee colonies

under certain conditions. Keeping these repercussions in mind, this study, concerned with the different aspects of the foraging behaviour of *A. mellifera* on litchi, had been carried out, to investigate into details of (i) impact of weather variables and (ii) diurnal variation on the foraging activity of *A. mellifera* in respect to weather conditions.

### MATERIALS AND METHODS

The experiments were carried out in local shahi litchi orchards at Muzaffarpur, Bihar, India (26°05'48"N, 85°26'18"E). The blooming of litchi flowers started in the first week of March. Ninety% flowers faded by start of April in Bihar. Foraging activities of *A. mellifera* on litchi flower were observed. Three colonies of nearly equal strength (nine frames) were selected. Triplicates of a colony was taken into account to validate the data. Weather data such as temperature (°C), % relative humidity (%RH), wind speed (km/ hr) and rainfall (mm) were recorded from Rajendra Prasad Central Agriculture University, Pusa, Bihar. Bees going out from hives, coming into hives with pollen in their pollen baskets present on their legs and coming into hives without pollen with distended abdomen were called out going forager, pollen gatherer and nectar gatherer, respectively. Foraging activities were determined by counting the total number of bees going out/ 5 min (outgoing foragers), bees coming in/ 5 min (pollen gatherer) and bees coming without pollen load/ 5

min (nectar gatherer) using a hand tally counter and stopwatch. Data were recorded hourly from 6:00 to 17:00 hr for 5 min, between 9 to 30 March, 2022 (litchi blooming period) at 3-day intervals from each hive. Statistical analysis was done with Microsoft Excel 2016. The mean values of data of were correlated with weather data. To test the significance of the mean difference ANOVA ( $p=0.05$ ) was used.

## RESULTS AND DISCUSSION

Temperature is the most important abiotic factor, which influences honey bee activities (Corbet et al., 1993). During the study period, maximum temperature ranged between 30 - 37°C and the mean number of forager bees going out/ 5 min were 105.33 to 49.00, nectar forager, 65.42- 45.08 and pollen forager, coming in/ 5 min were 19.33- 8.67 (Fig. 1). With increase in temperature, there was a decrease in the number of worker bees going out. Correlation coefficient ( $r$ ) value -0.57 of outgoing bees show that maximum temperature negatively affects their foraging activity. Upon more pronounced temperature rise, beyond 30 °C 49 bees went out/ 5 min. Maximum temperature also exhibited a significant adverse impact on incoming pollen and nectar gatherer honey bees with correlation coefficient ( $r$ ) value -0.58 and -0.68, respectively. Foraging activity is adversely affected by rising temperature. Significant correlation ( $r = -0.09$ ) was reported between temperature and foraging activity (Abou – Shaara et al., 2013). During the observational period, minimum temperature ranged from 15-23°C and the mean number of forager bees going out/ 5 min were 144.08-285.92, 105.33-153.33 nectar foragers came in 5 min and the number of pollen foragers coming in 5 min were 24.00 -66.75 (Fig. 2). *A. mellifera* activity was significantly influenced by minimum temperature. Contrast to maximum temperature, minimum temperature positively affects the bees going

out for foraging ( $r = 0.71$ ), in coming bees with pollen ( $r = 0.41$ ) and nectar ( $r = 0.21$ ), but only up to 15°C because foraging activity commenced in *A. mellifera* only at 15°C. This result matches with that of Joshi and Joshi (2010) who found that *A. mellifera* started foraging at 16°C but it varies with the findings of Tan et al. (2012), who reported commencement of foraging activity at 6.57°C. In present study highest foraging activity was recorded at mean temperature 28.88°C; Tan et al. (2012) recorded highest foraging activity at ambient temperature of about 20°C.

During the observational period relative humidity ranged between 21-92% and there was a significant positive correlation ( $r = 0.66$ ), pollen gatherers ( $r = 0.76$ ) and pollen gatherer ( $r = 0.77$ ). Joshi and Joshi (2010) reported relative humidity alone had less effect on flight activities whereas high relative humidity along with low temperature reduces activities. Correlation with relative humidity ( $r = -0.59$ ). However, pollen gatherer had negative correlation ( $-0.72$ ) with temperature and positive correlation with humidity ( $r = 0.62$ ). Alqerni (2006) found that rising temperature and low humidity negatively affect foraging activity. During the study period wind speed varied from 1.60-7.64 km/h. Present study show a negative correlation between wind speed and outgoing, incoming with nectar and pollen gatherers with coefficient of correlation values -0.56, -0.63, -0.65, respectively. A speed of more than 12 km/h has been documented to impair foraging because strong wind cause bee to fly less frequently as they can't carry load upward at speed s of >15 kmph (Reddy et al., 2015). In present study, rainfall ceased the foraging activity of *A. mellifera*, so a strongly negative correlation could be establish between rainfalls and foraging activity. When it rains, *A. cerana* and *A. mellifera* stop flying because they prefer to stay within their hives (Joshi and Joshi, 2010).

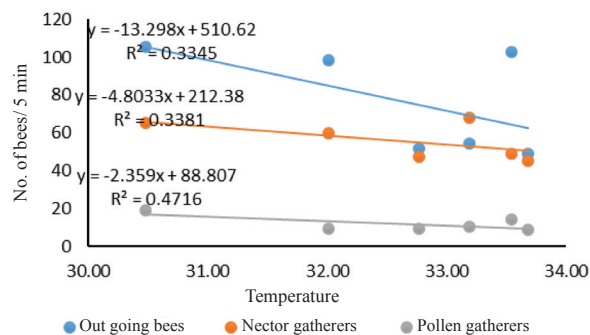


Fig. 1. Effect of temperature > 30°C on foraging activity of *A. mellifera*

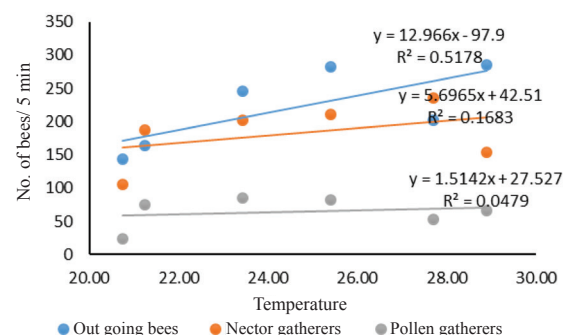


Fig. 2. Effect of temperature from 15°C to upto 30°C on foraging activity of *A. mellifera*

Diurnal variation in foraging pattern of *A. mellifera* was also recorded. Foraging activities were maximum during the first half of a day i.e. 6:00 to 11:00 hr. (Fig. 3). The maximum number of bees going out were recorded between 9:00 to 11:00 hr with mean 282.33 to 285.92 forager going out/ 5 min. In case of nectar gatherer, maximum number recorded between 8:00-10:00 with mean 201.33-235.08 forager/ 5 min entering into hive without pollen load. Whereas in case of pollen gatherer maximum recorded between 7:00-9:00 hr with mean 75.25-82.92 forager/ 5 min entering into hives. After 12:00 hr, the number of outgoing and incoming bees with nectar and pollen declined considerably and the trend continued till 5:00 hr. with mean value coming to a minimum of 49.00 forager going out /5 min, 45.08 forager entering into hives without pollen/ 5 min and 8.67 forager entering into hives with pollen load/ 5 min. Morning hours were ideal for the highest foraging activity. Another significant factor for the high foraging activity in the morning is due to high amount of nectar secreted by litchi flower and also maximum availability of pollen as most flower bloom at this hours. The preference for foraging in the morning could be an evolutionary adaption to increase their efficiency in collecting resources (Reddy et al., 2012). Environmental factors influence honey bee foraging activities (Hemalatha et al., 2018; Paray et al., 2019). The foraging pattern of an *A. mellifera* varies during entire litchi blooming period not only due to change in weather condition but also availability of nectar rich flora at different day timings. It was further noticed that foraging activities picked up as the blooming process progressed.

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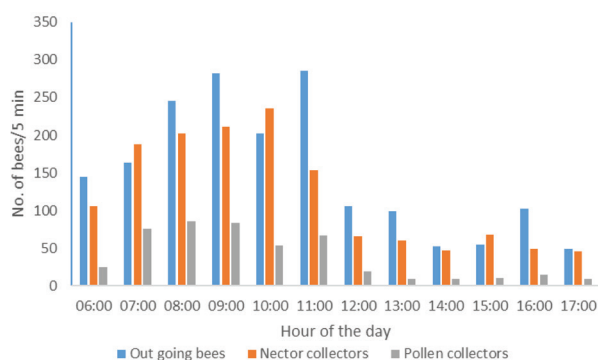


Fig. 3. Effect of diurnal variation on foraging activity of *A. mellifera*

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#### AUTHOR CONTRIBUTION STATEMENT

BKPS: designed the experiment; FW: collection of data, statistical analysis and manuscript writing; BKPS: reviewing and editing manuscript.

#### CONFLICT OF INTEREST

No conflict of interest.

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