



FORAGING DURATION AND INTENSITY OF *APIS MELLIFERA* L.

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ABSTRACT

An experiment was conducted in the apiary of Uttar Banga Krishi Viswavidyalaya, Pundibari during 2019. For study, six strong *Apis mellifera* L. colonies of similar strength were used. A positive and significant correlation of temperature (maximum and minimum) and relative humidity (minimum) with the foraging duration was found. During the cooler months both foraging duration and foraging intensity was minimum and increased later on. Foraging activity was highly affected by rainfall. The mean foraging duration of foragers throughout the year was 11.85 ± 1.79 hrs/ day. The 25th standard week was recorded with maximum foraging duration, viz. 14.22 hrs. Foraging intensity was low during initial hours but increased in later hours. Foraging intensity was very less in initial weeks and very high in 10th to 25th standard weeks at all the three intervals.

Key words: Honey bee, *Apis mellifera* L., foraging activity, duration, intensity, exit, entry, standard week, weather parameters, correlation, terai region, West Bengal

Pollination service is the basic pillar of crop production that can ensure our food security with different wild and hive bees as preeminent mason (Fikadu, 2019; Reilly et al., 2020; Khalifa et al., 2021). Among them the European honey bee, *Apis mellifera* L. provide highly valued pollination services (Calderone, 2012) and as a single species it is the most frequent pollinator for different crops worldwide (Garibaldi et al., 2013). It is their foraging activity which decides the strength and survival of a colony. Foragers start foraging at early morning and continue foraging up to evening hours. Their foraging duration is influenced by various factors prevailing inside and outside of the hive (Abou-shaara, 2014). External factors influencing the foraging activity includes ambient weather parameters viz. rainfall, temperature, relative humidity, sunshine hours etc. At the time of foraging, forager bees faces a wide range of ambient weather parameters having marked effect on their foraging efficiency and alter the foraging time (Kovac and Stabentheiner, 2011). From this perspective the current study was carried out with a view to observe the foraging activity of *A. mellifera* L. round the year along with the impact of weather parameters on their foraging duration under terai region of West Bengal.

MATERIALS AND METHODS

Six strong *A. mellifera* bee hives of almost similar strength (8-9 frames/hive) were maintained in the apiary unit of Uttar Banga Krishi Viswavidyalaya (26°19' N,

89°23' E, 43 masl), Pundibari, Cooch Behar under the terai agro-ecological region of West Bengal during 2019. The apiary was surrounded by several cultivated and natural vegetations that assure availability of floral resources throughout the year. However, during extreme dearth period sugar syrup was provided. This region is characterized by typical perhumid climate with high rainfall (annual average of 3000mm), high relative humidity (65-95%) and average temperatures varied from 24°C–33.2°C. About 80% of total rainfall received from the South-West monsoon during June–September. Average duration of sunshine hours is more than 8 hours. Short spell of winter occur during December–February. The meteorological data were collected from Meteorological Unit located at the Instructional Farm of Viswavidyalaya.

The foraging duration in terms of time between first exit and last entry was recorded according to Singh (2008) and after the last entry half an hour time was given for confirmation. Number of foragers going out and coming in the hive at 5 minute time period was recorded at 09:00 AM, 12:00 noon and 03:00 PM. Both pollen and nectar gatherers were considered. Time was recorded using a stop watch and bees were counted using a hand-tallycounter. Data were recorded thrice/week considering each bee hive as separate replication. The foraging duration was correlated with environmental parameters by correlation coefficient analysis using Microsoft Excel software.

RESULTS AND DISCUSSION

Foraging duration and its relation with weather parameters: Mean foraging duration of *A. mellifera* round the year was 11.85 ± 1.79 hours/day. During study earliest exit and last entry were recorded at 04:29 AM and 06:53 PM respectively. During initial standard weeks (1st to 8th indicating January-February) foraging duration was little less as compared to rest of the standard weeks which may be due to foggy weather and movement was affected thereby. Maximum last entry and higher foraging duration were recorded from 16th to 37th standard week i.e. April-September when day length was comparatively more. In 15th, 24th, 28th and 39th standard weeks, late first exit and less foraging duration were noted due to incidence of heavy rain (Fig. 1). It was also observed that higher foraging duration associated with floral availability for collecting abundant amount of pollen and nectar which was also supported by ambient weather. Singh (2008) recorded 1st exit of Himalayan honey bees at 06.14± 0.004 AM and last entry at 05.28± 0.011 PM with average foraging duration of 9.48± 0.15 hrs. Singh et al. (2018) reported first exit of *A. mellifera* at 9:30 AM and last entry at 04:15 PM. The correlation analysis of foraging duration revealed a significant positive correlation with maximum and minimum temperature (0.700 and 0.739 respectively) and minimum relative humidity (0.433), whereas it showed positive non-significant correlation with maximum relative humidity, rainfall and sunshine hours. Earlier, Puskadija et al. (2007) noticed positive correlation between average and maximum daily temperature and visits, whereas

high humidity, precipitation, stronger wind and low temperature had negative impact. However, Hemalatha et al. (2018) found a negative correlation of maximum temperature with the foraging activity of different honey bee species in Madurai.

Foraging intensity: During initial weeks (1st to 8th) foraging intensity was recorded very less at 09:00 AM (Table 1). But afterwards that significantly increased by many folds during 12.00 noon and 03.00 PM. Increase in later phase may be due to sunny weather. Higher intensity was recorded in all three intervals during 10th to 25th standard weeks when the weather is warm and shiny with availability of different floral resources. Higher activity of *A. mellifera* during midday hours also reported in previous works (Painkra et al., 2021; Nath et al., 2023). In later weeks, the movement declined from average to minimum in all three intervals that may be due to unavailability of flowering plants as well as fluctuation of environmental factors. During 18th, 28th and 39th standard weeks, external activity of worker bees become almost negligible (Table 1) due to continuous rains and huge losses were detected due to attack by ants. In some cases the number of bees exit when enter some time little less as they may be accidentally died or may forget the way back to hive which may in later interval find the way back to hive with its counterparts who exits from the hive and again get back to hive. Aryal et al. (2016) found during 45th (2012) to 8th (2013) standard weeks less number of foragers came out of hive in four time intervals and also enter into hive in a similar way. The findings obtained from our study are somewhat similar and to some extend contradicting

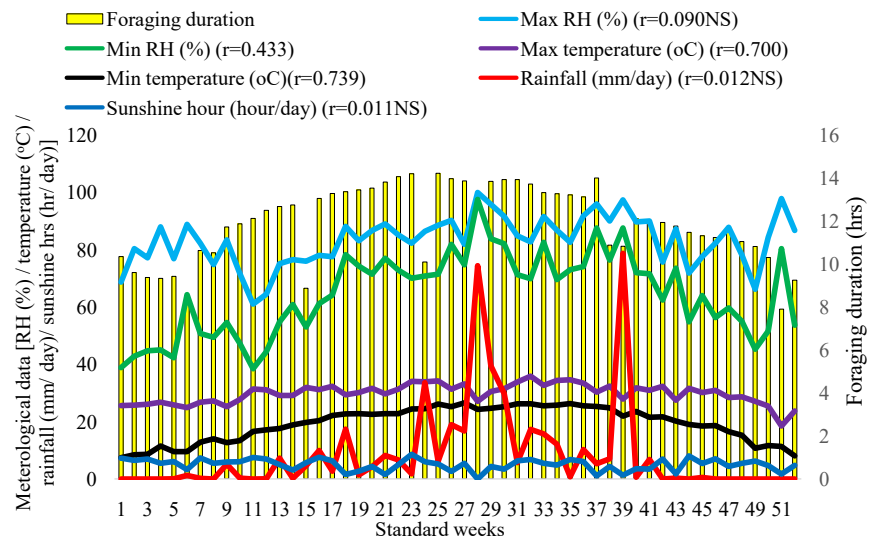


Fig. 1. Foraging duration of *A. mellifera* foragers and its relation with weather parameters (r=Correlation coefficient, NS=Non-significant, p=0.05)

Table 1. Foragers going out and coming in the *A. mellifera* hive (5 min)

Std. week	9:00 hrs		12:00 hrs		15:00 hrs	
	Exit (No.± SD)	Entry (No.± SD)	Exit (No.± SD)	Entry (No.± SD)	Exit (No.± SD)	Entry (No.± SD)
1	33.33± 07.63	28.66± 07.63	153.33± 42.19	155.33± 41.02	98.00± 23.25	104.00± 16.00
2	34.33± 07.23	30.33± 05.85	248.00± 04.58	223.00± 31.48	134.00± 20.07	72.33± 13.27
3	31.33± 07.51	28.00± 11.11	265.00± 39.94	262.67± 56.76	121.33± 30.08	106.33± 23.07
4	29.67± 07.57	25.33± 07.37	307.33± 02.51	309.00± 18.33	137.33± 38.55	115.00± 11.26
5	13.33± 04.93	15.33± 02.51	309.00± 12.49	294.33± 16.50	141.67± 34.03	84.67± 09.29
6	05.00± 01.00	8.33± 01.52	149.00± 04.00	152.33± 03.51	101.00± 32.04	109.33± 48.05
7	20.67± 04.04	24.00± 08.66	290.67± 29.50	304.00± 09.53	169.33± 01.52	161.33± 20.00
8	26.33± 12.85	29.00± 14.79	285.00± 26.51	279.00± 06.08	150.00± 22.33	175.33± 33.94
9	74.67± 14.84	76.33± 27.30	251.00± 37.51	239.00± 63.49	207.33± 40.64	120.00± 31.56
10	108.33± 08.08	102.67± 26.68	191.00± 01.73	178.00± 58.96	152.00± 37.51	153.67± 34.81
11	220.33± 04.93	228.00± 06.92	203.00± 05.00	202.00± 08.18	147.67± 32.39	141.33± 32.51
12	232.00± 18.08	264.66± 18.77	189.67± 71.12	186.00± 71.33	144.67± 19.73	132.00± 16.37
13	211.33± 18.90	250.66± 01.15	175.00± 24.33	288.00± 20.42	111.00± 15.39	138.00± 34.59
14	238.67± 19.55	225.00± 18.33	133.00± 07.00	150.33± 41.19	160.67± 51.05	133.00± 23.38
15	113.33± 31.56	115.66± 35.21	137.67± 24.54	136.33± 25.69	154.00± 11.78	156.00± 19.97
16	173.66± 41.78	170.00± 66.84	150.67± 29.09	185.33± 21.59	102.67± 08.50	120.33± 08.73
17	149.67± 17.93	133.33± 43.37	124.33± 12.85	147.00± 20.42	117.67± 31.89	115.67± 16.62
18	10.33± 01.53	11.33± 02.08	09.67± 03.51	136.67± 00.57	19.00± 02.64	21.67± 04.72
19	108.67± 18.58	106.33± 09.01	88.67± 43.61	110.67± 52.53	111.67± 15.30	94.67± 18.87
20	135.67± 21.22	117.66± 42.52	95.33± 25.73	110.00± 28.16	129.00± 12.16	125.00± 19.28
21	107.00± 20.22	110.66± 27.50	85.67± 12.67	108.67± 09.81	117.00± 12.16	129.67± 12.50
22	132.67± 31.09	136.33± 26.63	126.67± 21.59	125.67± 12.58	122.00± 15.87	120.00± 09.53
23	228.67± 30.62	201.00± 63.37	164.67± 23.79	166.00± 47.65	94.33± 04.50	106.00± 07.21
24	66.33± 08.62	73.00± 05.68	67.33± 24.50	59.33± 22.47	53.67± 26.10	62.00± 21.00
25	134.33± 25.43	137.66± 27.59	102.33± 30.07	87.00± 05.29	89.00± 20.22	87.00± 18.52
26	96.33± 24.78	98.33± 20.79	55.00± 06.24	67.67± 04.04	54.00± 05.56	65.33± 10.21
27	89.67± 42.19	82.67± 38.68	96.67± 01.52	95.00± 02.64	66.67± 24.66	62.33± 27.79
28	11.00± 07.21	09.00± 07.00	00.33± 00.57	00.33± 00.57	04.00± 01.73	04.66± 02.08
29	29.33± 04.61	28.33± 03.05	22.33± 03.21	23.33± 02.51	19.67± 06.02	17.33± 02.30
30	47.67± 13.61	48.33± 13.05	31.67± 06.11	28.67± 05.03	32.33± 12.85	36.33± 12.74
31	71.67± 39.80	69.66± 38.47	47.67± 12.67	46.33± 14.01	40.00± 07.81	38.33± 12.58
32	70.33± 23.71	63.33± 15.30	10.00± 07.54	18.00± 10.14	21.33± 6.80	26.00± 08.00
33	92.33± 09.45	82.67± 13.31	28.00± 13.74	28.33± 10.40	36.67± 18.92	41.67± 22.50
34	83.67± 20.84	72.33± 25.32	34.67± 10.59	26.00± 08.18	65.33± 23.86	62.33± 10.40
35	79.67± 34.12	91.00± 44.19	6.33± 05.68	01.00± 01.73	56.67± 34.81	60.33± 32.92
36	95.67± 22.54	89.00± 31.95	53.67± 21.58	29.33± 01.52	40.00± 17.05	47.00± 22.53
37	64.33± 18.61	57.66± 42.52	10.33± 09.07	12.33± 05.85	50.00± 29.51	58.33± 21.38
38	34.33± 03.51	34.00± 10.44	22.00± 02.64	27.67± 01.52	22.33± 11.93	14.67± 19.59
39	01.00± 01.00	01.33± 00.57	00.33± 00.57	00.33± 00.57	9.00± 06.08	04.33± 03.21
40	85.33± 16.50	79.00± 10.53	102.00± 11.26	97.00± 12.12	57.67± 09.29	60.67± 11.01
41	22.00± 20.67	25.00± 22.27	19.33± 10.50	25.33± 03.78	20.00± 10.39	19.00± 09.53
42	14.33± 04.61	16.67± 04.93	59.33± 12.89	64.67± 23.50	53.00± 13.07	46.33± 06.80
43	14.67± 03.51	15.33± 03.21	12.00± 05.00	17.00± 08.18	29.67± 06.50	26.67± 06.50
44	39.67± 17.21	36.00± 10.81	20.33± 1.15	26.67± 06.11	52.33± 21.12	52.33± 16.25
45	27.67± 16.50	28.00± 17.08	45.67± 17.03	48.67± 25.96	23.67± 13.20	24.33± 14.46
46	06.33± 02.08	07.66± 02.51	43.67± 20.52	64.33± 15.01	13.33± 06.11	16.67± 08.50
47	20.00± 11.53	16.00± 07.21	62.00± 24.55	59.33± 17.24	10.00± 01.73	17.00± 10.44
48	18.67± 10.78	21.00± 15.52	97.00± 41.79	117.33± 37.55	30.33± 14.01	35.66± 11.67
49	30.00± 01.00	34.00± 07.00	151.67± 24.44	120.33± 28.29	88.67± 19.34	87.67± 22.30
50	22.67± 09.07	30.20± 20.22	60.33± 07.37	77.00± 19.05	20.33± 05.13	25.33± 01.53
51	15.33± 04.04	15.33± 04.50	17.33± 39.31	169.33± 42.25	52.33± 17.21	56.67± 21.22
52	24.00± 13.11	27.66± 13.01	251.00± 56.67	233.00± 06.08	13.67± 05.50	17.00± 08.88

with the above mentioned literatures due to variation in prevailing environmental condition, topography and position of colony with the food sources. Keeping these results in view, it is advisable not to apply insecticides during mid-hours when the honey bees are more active.

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AUTHOR CONTRIBUTION STATEMENT

R N and N L conceived and designed experiments. R N and P P performed experiments. S S and N L analyzed data. S S and N L wrote the manuscript.

CONFLICT OF INTEREST

No conflict of interest.

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