RESEARCH ARTICLE

STUDIES ON THE FORAGING ACTIVITY OF INDIAN HONEY BEE, *APIS CERANA INDICA* FABR. AND OTHER HONEY BEE SPP. ON BUCKWHEAT FLOWERS

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Abstract: The foraging activity of Indian honey bee, *Apis cerana indica* Fabr. and other honey bee spp. on buckwheat flowers was undertaken at Research cum Instructional Farm of RMD CARS, Ajirma, Ambikapur (C.G.) of Indira Gandhi Krishi Vishwavidyalaya Raipur during year 2016-2017. The activity of *Apis cerana indica* was found higher in third week of December 2016 (69.71 bees/5min/m^2). Its maximum visitation was found at 1200 hrs (98.62 bees/5min/m^2). The maximum foraging activity of *Apis dorsata* was found at 1200 hrs (61.12 bees/5min/m^2). Whereas, the lowest was observed at 1700hrs (1.25 bees/5 min/m^2) in *Apis cerana indica* and *Apis dorsata* the lowest was observed at 1700hrs (0.75 bees/5 min/m^2). The foraging activity of *Apis florea* was noticed at 1400hrs (3.25 bees/5min/m^2) and was found least at 0800hrs (0.57 bees/5min/m^2).

Keywords: Foraging behavior, *Apis cerana indica, Apis dorsata, Apis florea*, Buckwheat

INTRODUCTION

Buckwheat is the most important crop of the mountain regions both for grain and greens. It occupies about 90% of cultivated lands in the higher Himalayas with a solid stand. It is a short duration crop (2-3 months) and fits well in the high Himalayas where a crops growing season is of limited period because of early winter and snow fall. In the higher Himalayas, up to 4500m, this is the only crop grown (Joshi and Paroda, 1991).

There are two species of buckwheat cultivated in the Himalayas *(F. esculentum* and *F. tataricum).* Buckwheat is one of the alternative crops which obtain a repeated revival of growing these days. The increased in this crop is caused by its nutritive value but also by its short vegetation period, maximum foliar feeding, pollination and low requirements on growing condition. It is highly nutritive, unlike cereals which are deficient in lysine, one of the essential amino acids for human health.

Buckwheat, *Fygopyrum esculentum* L. is an important pseudocereal crop grown extensively in the hilly areas of Northern Hill Zone of Chhattisgarh specially at Mainpath block in Surguja district in approximately 10-15 ha. Area is by the" Tibbati" refuge people in the past 7-8 year. It is herbaceous plant, grows upon a height of 3-4 meter. The buckwheat plant is complete its life cycle in 90-115 days. The white flower heads of 2-3 cm develop in the leaf axil.

Buckwheat is cross pollinated and an entomophilic plant. Honey bees are the major pollinators. The cultivation of buckwheat along with bee keeping may produce 40 to 60 kg of honey per hectare, due to its extended flowering period for more than 30 days (Rajbhandari, 2010).

METERIAL AND METHOD

The experiment was conducted at Research cum Instructional Farm of RMD CARS, Ajirma, Ambikapur of Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) during rabi season in year 2016-17. It was upland single plot keeping plot size 10x10m, variety- Local spacing 20x10cm. When the buckwheat crop started flowering different honey bee spices were recorded starting from 0600hrs to 1800hrs at two hours intervals one square meter area within five minutes early as well as peak flowering period of crop.

RESULT AND DISCUSSION

The findings of the present study as well as relevant discussion have been presented under the following heads:

1. Foraging activity of Indian honey bee (*Apis erana indica*)

The foraging behavior of Indian honey bee (*Apis cerana indica* Fab.) on niger flowers was observed from 0600 to 1800hrs from starting to full blooming period of the crop. The activity of Indian honey bee was recorded during the year (206-17) 4th week of Oct. 2016 to 2nd week of Jan. 2017 at weekly interval at different dates and different hours of the day, *viz*. 0600hrs, 0800hrs, 1000hrs, 1200hrs, 1400hrs, 1600hrs and 1800hrs. The mean number of bees recorded on each date of observations *i.e.* Number of bees/ 5min/ m2 is depicted in (Table.1).

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During 1st week of observation the foraging activity of *Apis cerana indica*, was started foraging on niger flowers at 0800hrs (40 bees/ 5min/ m2) and gradually reached its peak at 1200hrs (85bees/5min/m^2) thereafter it started decreasing at 1400hrs (44 bees/5min/m^2) and at 1600hrs (35 bees/ 5min/m^2). The lowest activity was recorded at 180hrs (0.00bees/5min/m^2). The activity of bees was not observed early in the morning i.e. at 0600hrs. The mean activity of bees was 37.71bees/5min/m^2.

During 2nd week, the maximum foraging activity of bees was recorded at 1200hrs (119 bees/5min/m^2). It started declining at 1400hrs and 1600hrs accounting 62 and 20 bees/ 5min/m^2, respectively. The activity of bees was not observed in early morning 0600hrs. Whereas started its activity at 0800hrs (42 bees/5min/m^2). However, the least activity of bees was recorded at 1600hrs (03 bees/5min/m^2). The mean activity of bees was 48.00bees/5min/m^2.

On 3rd week of observation the activity of bees was not seen at 0600hrs, while it started its activity at 0800hrs (49 bees/5min/m^2) and reached its peak at 1200hrs (145 bees/5min/m^2) with suddenly decreased at 1400hrs and at 1600hrs with population of 81 bees/ 5min/m^2 and 25 bees/5min/m^2, respectively. The least activity of bees was noticed at 1800hrs (00 bee /5min/m^2) and the mean activity of bees was 57.14bees/5min/m^2.

During the 4th week, the least activity of bees was noticed at 1800hrs (3 bees/5min/m^2) and started its foraging activity at 0800hrs (69 bees/5min/m^2) with maximum activity at 1200hrs (169 bees/5min/m^2) and decreased at 1400hrs (96 bees/5min/m^2) and 1700hrs (03 bees/5min/m^2). The activity of bees was not seen at early morning at 0600hrs. During this week the average bee activity was 69.71bees/5min/m^2.

On 5th week, the maximum activity was noticed at 1000hrs (110 bees/5min/m^2). It started foraging at 0800hrs (59 bees/5min/m^2) and reached its peak at 1200hrs (135 bees/5min/m^2) and started decreasing at 1400hrs (27 bees/5min/m^2) and at 1600hrs (03bees/5min/m^2). There was no foraging activity observed at 0600hrs and 1800hrs.

During 6th week, the foraging activity of bees was started at 0800hrs (24 bees/5min/m^2) thereafter increased to its peak at 1200hrs (85.00 bees/5min/m^2) and started declining at 1400hrs and 1600hrs with 36 bees/5min/m^2 and 11 bees/5min/m^2 respectively. There was no foraging activity observed at 0600hrs. The average activity of bees was 31.00 bees/5min/m^2.

During 7th week, the maximum foraging activity was observed at 1200hrs with (32 bees/5min/m^2) and decreased at 1400hrs (16 bees/5min/m^2) whereas at 1600hrs the population was 09 bees/5min/m^2. No bee activity was recorded at 0700hrs and mean bee activity was 14.57bees /5min/m^2.

During last week, the activity of bees was not observed at 0600hrs and at 1800hrs While its activity was observed starting at 0800hrs (7 bees/5min/m^2) and increased to its peak at 1200hrs (19 bees/5min/ m^2) and suddenly decreased at 1400hrs (11 bees/5min/ m^2) and 1600hrs (5 bees/5min/m^2). The average activity of bees was 8.14 bees/5min/m^2.

The present findings are more or less conformity with the earlier workers Chaudhary *et al*. (2002) reported foraging activity of *Apis cerana indica* on litchi flowers whereas. Chakrabarty and Sharma (2007) observed the maximum activity of bees at 1000 and 1800hrs (1.24 bees/min/ capitulum) with least number at 1400hrs (0.69 bees/ min/capitulum) on sunflower. Gogoi *et al.* (2007) who observed *Apis cerana indica* with maximum number of 9.42 foragers visited flowers of lemon during 1000- 1100 hrs. Shaw *et al*. (2008) recorded the Indian bee in 39 flora belonging to 23 families from October to March whereas, the foraging behaviour of Italian bee was recorded in 23 flora belonging to 18 families from January to March.

2. Foraging behaviour of Rock bee (*Apis dorsata*) on buckwheat flowers

During 1st week, the foraging activity of *A. dorsata* started at 0800hrs (30 bees /5min/m^2), further, it increased and reached the peak at 1200hrs and it declined at 1400hrs and 1600 hrs. The bee activity was not seen at morning 0600hrs and 1800hrs. The average foraging activity of bees was 26.00 bee/5min/m^2 at different hours of the day (Table 2).

On 2nd and 3rd week, the least bee similar activity was observed at 1600hrs (25bees /5min/m^2) whereas it started its activity at 0800hrs (25 and 38 bees/5min/m^2) and reached its maximum activity at 1200hrs (80 and 96 bees/ 5min/m^2), further, it decreased at 1800hrs with 1 and 0 bees/5min/m^2, respectively. No bee activity was found at 0600hrs. The average bee activity was 35.28 and 41.57 bees/ 5min/m^2.

During 4th week, *A. dorsata* started visiting at 0800hrs (45bees/5min/m2) and reached its peak at 1200hrs (117 bees/5min/m^2) thereafter decreased at 1400hrs (75 bees /5min/m^2).The least foraging activity of *A. dorsata* was observed at 1600hrs (40 bees/5min/m^2) whereas average activity during 4th week was 52.00 bees/5min/m^2.

On 5th week, the maximum foraging activity was recorded at 1200hrs (92 bees/5min/m^2) which suddenly decreased at 1400hrs (49 bees/5min/m^2), further, it disappeared at 1800hrs. It was started foraging at 0800hrs (40 bees/5min/m^2). There was no bee activity found at morning 0600hrs. The average bee activity was 40.42 bees/5min/m^2.

On 6th week, there was no foraging activity noticed at 0600hrs and 1800hrs. It started its activity at 0800hrs (09 bees/5min/m^2) and reached its peak at 1200hrs (19bees/5min/m^2) and decreased at 1400hrs (14bees/5min/m^2) and further it declined at 1600hrs. The average activity of *A. dorsata* was recorded (9.14 bees/5min/m^2).

On 7th week, the maximum foraging activity of *A. dorsata* was recorded at 1200hrs (19 bees/5min/ m^2) further it decreased at 1400hrs (8 bee/5min/m^2) and declined at 1600hrs and 1800hrs. The activity was started at 0800hrs (7 bees/5min/m^2). While, the bees activity was not recorded at 0600hrs. The average activity of *A. dorsata* was recorded (7.42 bees/5min/m^2).

During 8th week, no foraging activities was observed at 0600hrs and 1800hrs. However, it started its activity at 800hrs (5 bees/5min/m^2) and maximum activity was recorded at 1200hrs (15 bees/5min/m^2), thereafter it declined at 1400 and 1600hrs. The mean activity of bee was 5.57 bees/5min/m^2). The present results are in close agreement with the earlier workers of Kumar and Singh (2008) reported peak activity of *Apis dorsata* on safflower crop at 1100hrs and the least at 1500hrs. Singh (2008) who recorded the maximum foraging frequency of *Apis species* at 1200hrs, followed by 1000, 1400 and 1600hrs on parental lines of *Brassica napus*. Dhurve (2008) noticed maximum foraging activity of *Apis dorsata* in between 1000 to 1600hrs of the day which ranged from 36.90 to 45.56 bees/m2/5min. It was less at 0800hrs with 22.73 bees/m2/5min and least at 1800hrs which recorded 18.96 bees/m2/5min. Selvakumar *et al*. (2001) who also recorded the activity of *Apis dorsata* on cauliflower constituted 28.23 per cent and the pollen gatherers reached to its peak at 1400hrs while nectar collectors remained constant throughout the day.

3. Foraging behaviour of Little bee (*Apis florea*) on buckwheat flowers

The mean foraging behaviour of *Apis florea*, is depicted in (Table 3).

During 1st week of observation at the time flowering of crop, the foraging activity of *Apis florea* was started at 0800hrs (04 bees/5min/m^2) and the activity of bees was not recorded at 1000hrs, 1200hrs 1400 hrs, 1600hrs and 1800hrs. The mean activity of bees was 0.57 bee/5min/m2.

During 2nd week, the bee activity was not observed at 0600hrs. However, bees started its activity at 0800hrs (3bees/5min/m^2), it reached maximum activity at 1400hrs (3bees/5min/m^2) and 1800hrs (3 bees/5min/m^2) thereafter, it declined at 1600hrs. The average activity of bee was 1.42 bees /5min/m^2.

During 3rd week, the maximum foraging activity of *A. florea* was recorded at 0800hrs (05 bees/5min/ m^2), further it declined at 1000hrs and 1400hrs. There was not foraging activity noticed at 0600hrs and 1800hrs. The average activity of bees was 1.71bees/5min/m^2.

During 4th week, the bees were not observed at 0600hrs. However, it started its activity at 0800hrs (6 bees/5min/m^2) and declined it at 1200hrs (3bees/5min/m^2). The average activity of bee 1.85 bees/5min/m^2 was recorded.

On 5th week, the foraging activity of *A. florea* was not recorded at 0600hrs, later, reached its maximum activity at 0800hrs (04 bees/5min/m^2).. The activity of bees was not observed at 1600hrs and 1800hrs. The mean activity of bee was (1.00 bees/5min/m^2).

On 6th week, the bees started its activity at 1000hrs with 03 bees/5min/m^2 and at 1200hrs with 03 bees/5min/m^2 thus two maximum activity periods were recorded. Further, it was not any activity during 1400hrs and 1800hrs. The mean activity of bee was 1.14 bees/5min/m^2.

On 7th week, the maximum activity of bees was observed at 1000hrs and 1200hrs (3& 6 bees /5min/m^2). The average activity of bee was 1.28bees/5min/m^2.

During 8th week, the peak activity was similar recorded at 1000hrs, and 1400hrs accounting to 02 bees/5min/m^2, respectively. But it was not observed at 0600hrs. The mean foraging activity of bee was accounting to 0.57 bees/5min/m^2. The present results are in close agreements with the earlier workers. Lal (2011) recorded *Apis florea* on different crops. The maximum foraging activity was observed in between 1200hrs to 1400hrs time period. Painkra and Shaw (2016) noticed at the higher foraging activity of *Apis florea* on niger constituted 1300hrs (4.00 bees/5min/m^2) and was found least at 0.56 bee/5min/m^2.

Table 1. Foraging behavior of *Apis cerana indica* on buckwheat flowers

S.No.	Date of observation	(Number of bees visit/5min/m^2), Hours of the day (H)							Total	Mean
		0600	0800	1000	1200	1400	1600	1800		
1	25.11.2016	0	40	60	85	44	35	0	**264**	**37.71**
2	02.12.2016	0	42	90	119	62	20	03	**336**	**48.00**
3	09.12.2016	0	49	100	145	81	25	0	**400**	**57.14**
4	16.12.2016	0	69	125	169	96	29	03	**491**	**70.14**
5	23.12.2016	0	59	110	135	85	27	03	**419**	**59.85**
6	30.12.2016	0	24	60	85	36	11	01	**217**	**31.00**
7	06.01.2017	0	19	26	32	16	09	0	**102**	**14.57**
8	13.01.2017	0	07	15	19	11	05	0	**57**	**8.14**
	Total	**0**	**309**	**586**	**789**	**431**	**161**	**10**	**2286**	**326.15**
	Mean	**0.00**	**38.62**	**73.25**	**98.62**	**53.87**	**20.12**	**1.25**	**285.75**	**40.82**

Table 2. Foraging behavior of *Apis dorsata* on buckwheat flowers

S.No.	Date of observation	(Number of bees visit/5min/m^2), Hours of the day (H)							Total	Mean
		0600	0800	1000	1200	1400	1600	1800		
1	25.11.2016	0	30	49	51	37	15	0	**182**	**26.00**
2	02.12.2016	0	25	70	80	47	25	01	**248**	**35.42**
3	09.12.2016	0	38	79	96	53	25	0	**291**	**41.57**
4	16.12.2016	0	45	87	117	75	40	03	**367**	**52.42**
5	23.12.2016	0	40	77	92	49	25	0	**283**	**40.42**
6	30.12.2016	0	09	15	19	14	07	0	**64**	**9.14**
7	06.01.2017	0	07	13	19	08	05	02	**54**	**7.71**
8	13.01.2017	0	05	10	15	08	01	0	**39**	**5.57**
	Total	**0**	**199**	**400**	**489**	**291**	**168**	**06**	**1528**	**218.28**
	Mean	**0.00**	**24.87**	**50.00**	**61.12**	**36.37**	**21.00**	**0.75**	**191.00**	**27.28**

Table 3. Foraging behavior of *Apis florea* on buckwheat flowers

S.No.	Date of observation	(Number of bees visit/5min/m^2), Hours of the day (H)							Total	Mean
		0600	0800	1000	1200	1400	1600	1800		
1	25.11.2016	0	04	0	0	0	0	0	**04**	**0.57**
2	02.12.2016	0	03	0	0	03	01	03	**10**	**1.42**
3	09.12.2016	0	05	0	0	03	02	0	**12**	**1.71**
4	16.12.2016	0	06	0	03	01	03	0	**13**	**1.85**
5	23.12.2016	0	04	0	02	01	0	0	**07**	**1.00**
6	30.12.2016	0	0	03	03	0	02	0	**08**	**1.14**
7	06.01.2017	0	0	03	06	0	0	0	**09**	**1.28**
8	13.01.2017	0	0	02	0	02	0	0	**04**	**0.57**
	Total	**0**	**22**	**08**	**14**	**10**	**08**	**03**	**65**	**9.25**
	Mean	**0.00**	**2.75**	**1.00**	**1.75**	**1.25**	**1.00**	**0.00**	**8.12**	**1.15**

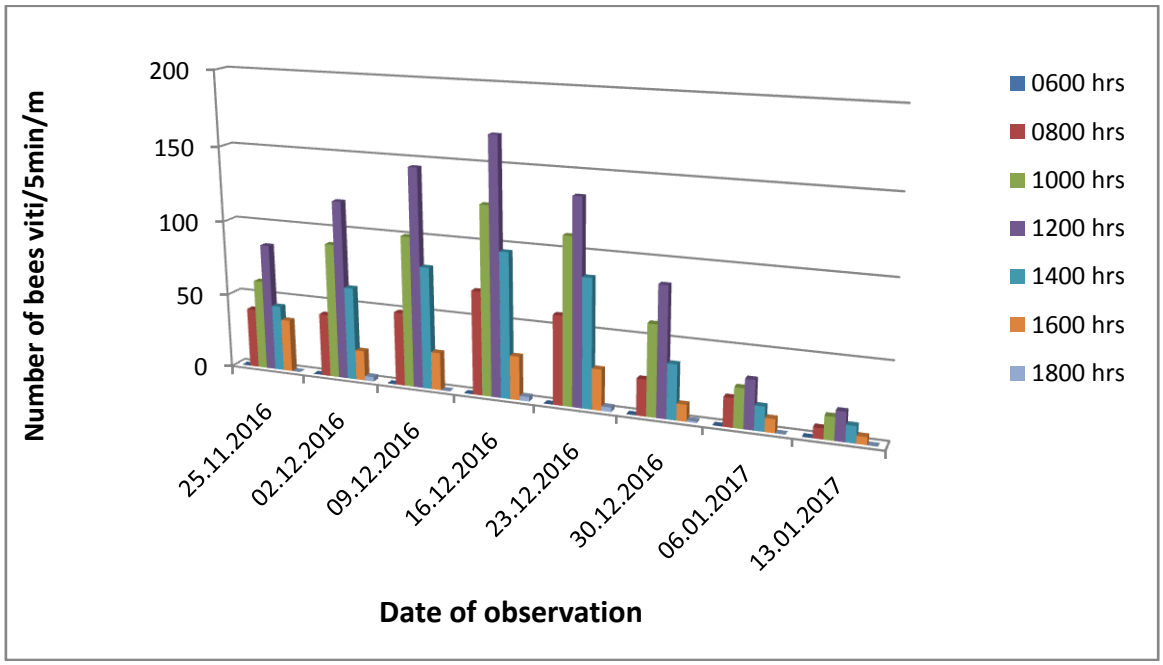

Fig. 1. Foraging behavior of *Apis cerana indica* on buckwheat flower

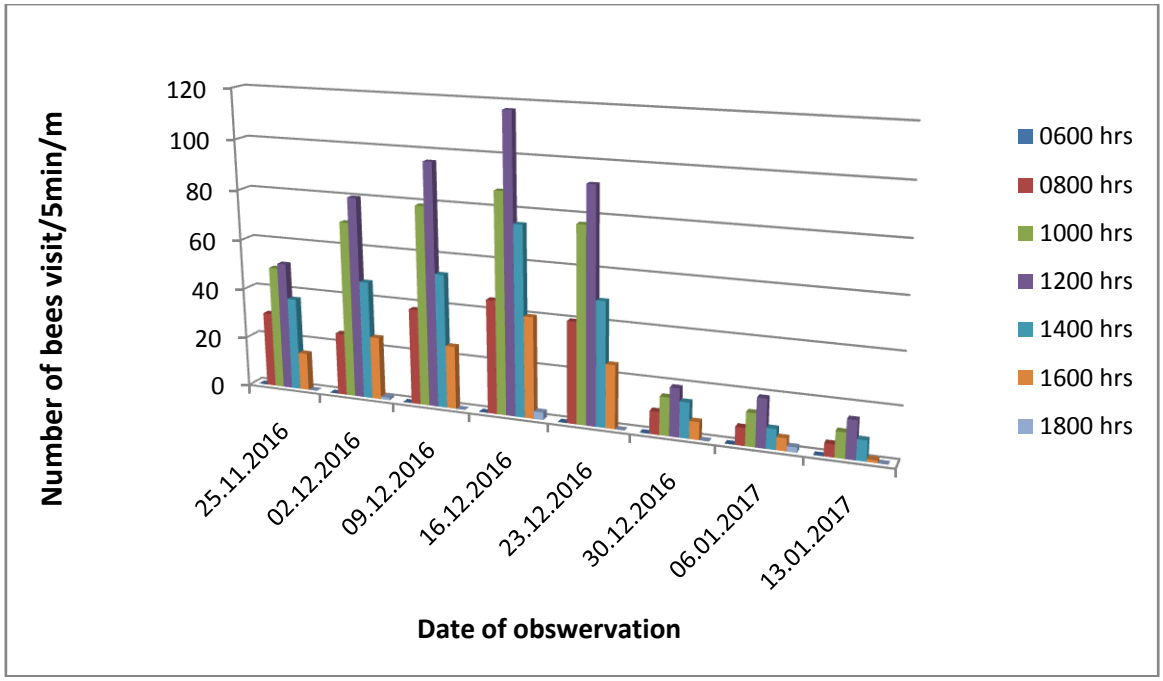

Fig. 2. Foraging behavior of *Apis dorsata* on buckwheat flower

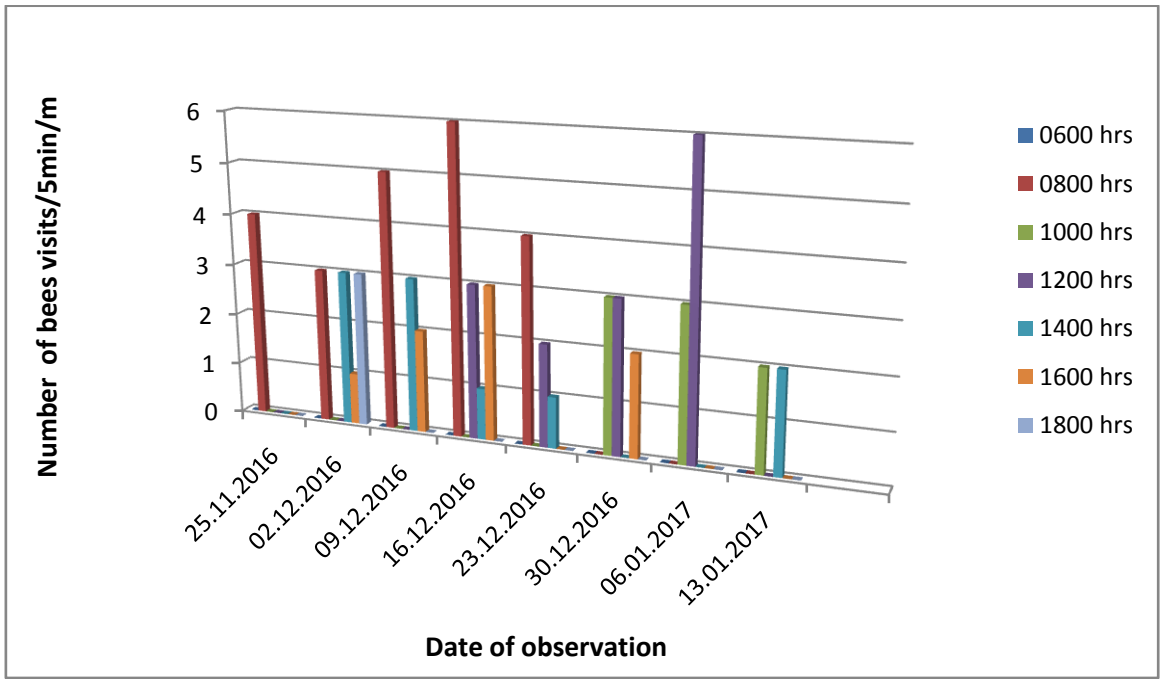

Fig. 3. Foraging behavior of *Apis florae* on buckwheat flowers

CONCLUSION

It is concuded that *Apis cerana indica* L. foraged more extra time per day on buckwheat flower as compared to *Apis dorsata and Apis florea*. The peak flowering hours for both bee species were recorded around 1400 to 1600hrs. The *Apis cerana indica* F. visited higher number of flowers and plants as the compared to *Apis dorsata* and *Apis florea* has lowest foraging against in other honey bee species.

REFERENCES

Chaudhary, D.K., Singh, B. and Singh, P.P. (2002). Population dynamics of honey bees foraging on litchi flowers. *J. Entomological Res.*, **26**(1) :71-75.

Chakrabarty, S.K. and Sharma, S.P. (2007). Foraging behaviour of honeybees in hybrid seed production of sunflower (*Helianthus annus*). *Indian J. Agril. Sci.*, **77** (9): 629-631.

Chandran, N. and Viraktamath, S. (2010). Foraging behaviour of honeybees on three elite genotypes of niger. *Ecology Pollen & Fungal Spore*, **28** : 33-37.

Dhurve, S.S. (2008). Impact of honey bee pollination on seed producton of niger. M.Sc.(Ag.) Thesis, Uniersity of Agricultural Sciences, Dharwad, KARNATAKA (INDIA).

Gogoi, B., Rahman, A., Rahman, S., and Deka, M.K. (2007). Foraging behaviour and effect of *Apis cerana* pollination on fruit set and yield of Assam lemon (*Citrus lemon*). *Indian J. Agril. Sci.,* **77**(2) :120-22.

Joshi, B. D. and R. S. Paroda, (1991). Buckwheat in India. NBPGR, Shimla Sci. Monogr , No.2 pl17.

Kumar, N. and Singh, R. (2008). Relative abundance of honey bee foragers visiting safflower (*Carthamus tinctorius* L.) and nectar-sugar concentration in bloom. *Pest-Management & Econ. Zool.,* **16**(2) : 135-141

Lal, M. (2011). Irradiation impact of cell phone on the behaviour, growth and development of honey bee *Apis cerana indica* L. under Northern hills zone of Chhattisgarh. M.Sc.(Ag.) Thesis, Indira Gandhi Krishi Visvavidyala, Raipur (C.G.) INDIA

Painkra, G.P. and Shaw, S.S. (2016). Foraging behaviour of honey bees in niger flowers, *Guizotia Abyssinica* Cass. in North Zone of Chhattisgarh**.** *International J. P.Protection* **9**(1):100-106

Rajbhandari, B. P. (2010). Buckwheat in the land of Everest. Himalayan College of Agricultural Sciences and Technology (HICAST), Kathmandu, Nepal: 314-316.

Shaw, S.S., Thakur, B.S., Ganguli, R.N. and Nema, S. (2008). Status and prospects of beekeeping in Chhattisgarh State. *National Conference on Pest management Strategies for Food security Raipur*. 2-3 May. pp. 42-53.

Singh, J. (2008). Foraging frequency and pattern of movement of different *Apis spp*. on parental lines of *Brassica napus* L. *Entomon.,* **33**(2) : 91-99.

Selvakumar, P., Sinha, S.N. Pandita, V.K. and Shrivastava, R.M. (2001). Foraging behavior of honeybee on parental lines of hybrid cauliflower Pusa hybrid-2. Standing Commission of Pollination and bee Flora.www.apimondia.org. *Apimondia Journal* .