

International Journal of Applied Sciences and Biotechnology

A Rapid Publishing Journal

ISSN 2091-2609



Available online at:

<http://www.ijasbt.org>

&

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Indexing and Abstracting

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CODEN (Chemical Abstract Services, USA): IJASKD

Vol-2(4) December, 2014



Impact factor*: **1.422**

Scientific Journal Impact factor#: **3.419**

Index Copernicus Value: **6.02**

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Research Article

COMPARATIVE FORAGING BEHAVIOR OF *APIS CERANA* F. AND *APIS MELLIFERA* L. IN RAPESEED UNDER CAGE CONDITION IN CHITWAN, NEPAL

Rameshwor Pudasaini^{1*} and Resham Bahadur Thapa²

Institute of Agriculture and Animal Science, Rampur, Chitwan, Nepal

*Corresponding Author email: rameshwor.ent@gmail.com

Abstract

An experiment was conducted to determine the foraging behavior of *Apis mellifera* L. and *Apis cerana* F. in rapeseed under cage condition in Chitwan, Nepal during 2012-2013. This experiment showed that *Apis cerana* F. foraged extra 42 minute per day as compared to *Apis mellifera* L. *Apis cerana* F. were more attracted to nectar, whereas *Apis mellifera* L. were more attracted to pollen collection throughout the day. The activities, in into hives and out from hives, for both species were recorded more at 2:00 pm and least at 8:00 am. The highest in-out were observed at 2:00 pm on both species as *Apis mellifera* L. 44.33 bees entered into hives and 49.66 bees went out of hives, whereas lower number of *Apis cerana* F. 43.66 bees entered into hives and 48.16 bees were out of hives. *Apis mellifera* L. collect 1.22:1 and 0.41:1 pollen nectar ratio at 10:00 am and 4:00 am whereas at same hours *Apis cerana* collect 1.16:1 and 0.30:1 pollen nectar ratio. *Apis cerana* F. foraged significantly higher number of rapeseed flowers and plants as compared to *Apis mellifera* L. under caged condition. It shows that *Apis cerana* F. was more efficient pollinator as compared to *Apis mellifera* L. under caged condition.

Key words: *Apis mellifera* L.; *A. cerana* F.; Cage plots; foraging efficiency

Introduction

The flowers of rapeseed, important sources for both pollen and nectar, are very attractive to honeybees. They are major pollinators of rapeseed (*Brassica campestris* L. var. *toria*) (Dhakal, 2003). Among the total pollination activities, over 80% is performed by insects and bees contribute nearly 80% of the total insect pollination and therefore, they are considered the best pollinators (Robinson and Morse, 1989). Bee pollination improves the yield and quality of crops, such as fruits, vegetable seeds, spices, oilseeds and forage crops (Partap and Partap, 1997; Dhakal, 2003; NARC, 2008).

The number of flowers visited per minute by any type of bee species depends upon the number of factors including instinctive foraging behaviour, length of proboscis (Inouye, 1980) floral structure (Free, 1970) particularly the corolla depth (Gilbert, 1980) type and quantity of floral rewards (Rao and Suryanarayana, 1990; Rao, 1991) density of flowers on particular cultivar of the crop concerned and hours of the day. Foraging behavior play an important role on the production and productivity of the crops which is use to compare pollination efficiency of different honeybee species. More foraging frequency indicated the more pollination efficiency (Singh *et. al.* 2006). The knowledge on bee behaviour and foraging activity and their interactions with different plant species are pre-requisite to frame on

strategy for effective crop pollination. Similarly, initiation and cessation of foraging time help on determine the environmental effect on foraging behavior. Likewise, the number of bees per meter square in field gives the density of honeybee, availability of pollinators and their effect on crop production. Therefore, this study attempts to compare foraging activities of the *Apis cerana* F. and *Apis mellifera* L. in rapeseed under cage condition of subtropical climate in inner terai, Chitwan, Nepal.

Materials and Methods

An experiment was conducted at Jutpani VDC, Chitwan district Nepal during October 2012 to February 2013. The plot size of each treatment was 3 m x 5 m (15 m²) separated by 0.5m distance between plots and 1m between replications. Rapeseed variety Pragati was sown on 03 November 2012 with all the agronomical practices followed. The seeds were sown at 3-4 cm depth of soil @ 6 kg / ha in well prepared field maintaining 20 cm x 5 cm spacing between row to row and plant to plant, respectively. Native honeybee, *Apis cerana* F. and exotic honeybee, *Apis mellifera* L. plots were covered with mosquito nets (5m×3m×2.5m size). The caged were erected on field plots when the crop reached at 5-10% flowering stage. Thereafter, already produced four colonies of *Apis cerana* F. and four colonies of *Apis mellifera* L. with fully covered two- frame hives with a queen, and containing broods and

eggs of each species were placed separately inside cage at 29 DAS on experiment field.

Observation on foraging behaviors of *Apis cerana* F. and *Apis mellifera* L., such as commencement and cessation, number of plants and flowers visits/minute, number of bees in per meter square area per minute under caged condition were recorded. These records were taken four times at 10:00 am, 12:00 noon, 2:00 pm and 4:00 pm of the day at different rapeseed flowering stages. Number of outgoing and incoming bees with pollen/without pollen of *Apis cerana* F. and *Apis mellifera* L. were also recorded under caged condition. These records were taken five times at 8:00 am, 10:00 am, 12:00 noon, 2:00 pm and 4:00 pm of the day at different rapeseed flowering stages.

Results and Discussions

Table 1 clearly shows that *Apis cerana* F. foraged extra 42 minute per day on rapeseed flower as compared to *Apis mellifera* L. and numbers of bees per meter square per minute of both honeybees species were recorded highest at 2:00 pm and lowest number at 4:00 pm (Fig. 1). At morning and late hour of the day number of *Apis cerana* F. was

recorded higher than number of *Apis mellifera* L. whereas at mid-day hour number of *A. mellifera* L. recorded higher. Early initiation of foraging by *Apis cerana* F. than *Apis mellifera* L. also reported by Devkota (2000) as *Apis cerana* at 8:40 am and *Apis mellifera* at 9:07 am. This was in comparison to foraging activities of *Apis cerana* F. starting early in the morning at 06.14 am and ceasing late in the evening at 17.28 pm (Singh, 2008). Dhakal (2003) reported 6.52 am and 6.59 am as initiation of foraging activities of *Apis cerana* and *Apis mellifera* on rapeseed in Chitwan. It was due to foggy condition and low temperature during rapeseed cropping season. This result clears that under slightly unfavourable environmental condition the activity of *Apis mellifera* L. is decreases whereas but *Apis cerana* F. does not. It shows that *Apis cerana* F. can forage flower even slightly unfavourable environmental condition. In a study it showed that the number of bees per meter ranged between 4.0-12.0 and 2.6-10.2 in the case of *Apis mellifera* L. and *Apis cerana* F. respectively (Verma, 1990). Similar result were reported as more number of *Apis mellifera* L. at noon and least at 9:00 am and 15:00 pm as compared to *Apis cerana* F. (Kasina, 2009).

Table 1: Different parameters of foraging behavior of *Apis cerana* F. and *Apis mellifera* L. on rapeseed under caged condition in Chitwan, 2012/013*

Parameters		<i>Apis cerana</i> F.	<i>Apis mellifera</i> L.
Initiation of foraging time		7:51 am	8:18 am
Cessation of foraging time		5:41 pm	5:26 pm
Number of bees per meter square per minute	10:00 am	8.667b	7.668c
	12:00 pm	10.67ab	11.00b
	2:00 pm	12.83a	15.17a
	4:00 pm	5.500c	5.000d

* Means followed by the same letter in each column are not significantly different by DMRT at ≤ 0.05 percent level.

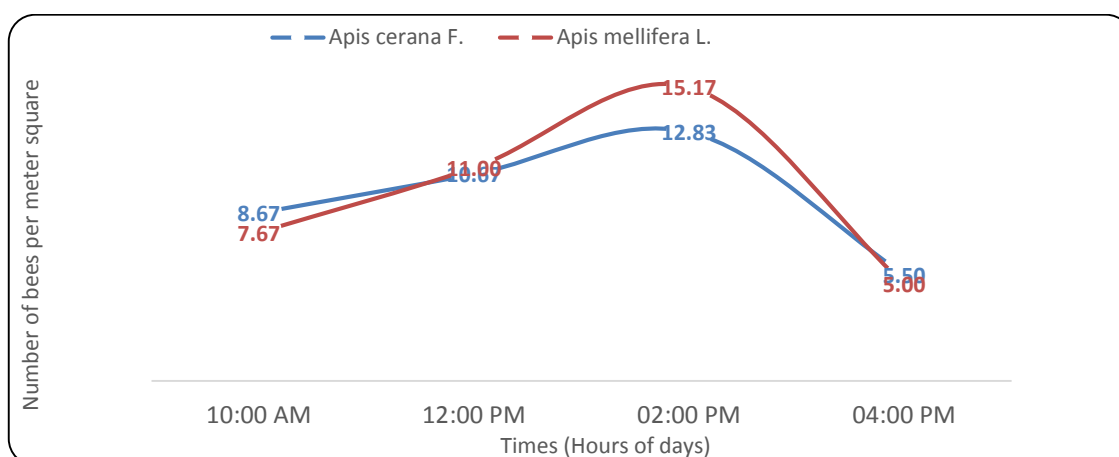


Fig. 1: Number of *Apis cerana* F. and *Apis mellifera* L. in per meter square area under caged condition in Jutpani VDC, 2012/2013

Table 2: In and out from hives with pollen: nectar ratio by *Apis cerana* F. and *Apis mellifera* L. on rapeseed under caged condition in Chitwan, 2012/013

Parameters	Time	<i>Apis cerana</i> F.	<i>Apis mellifera</i> L.
In into hives	8:00 am	0.5d	0d
	10:00 am	12.16c	17c
	12:00 pm	21.16b	36b
	2:00 pm	43.66a	44.33a
	4:00 pm	13c	16.5c
Out from hives	8:00 am	0.66e	0e
	10:00 am	8.83d	11.66d
	12:00 pm	23.5b	33.66b
	2:00 pm	48.16a	49.66a
	4:00 pm	16.5 c	24c
Pollen: nectar collectors ratio	10:00 am	1.16:1	1.22:1
	12:00 pm	0.82:1	0.85:1
	2:00 pm	0.51:1	0.58:1
	4:00 pm	0.30:1	0.41:1

* Means followed by the same letter in each column are not significantly different by DMRT at ≤ 0.05 percent level.

Table 2 shows that the number of *Apis cerana* F. and *Apis mellifera* L. in and out of hives was significant at different times of the day. At 8:00 am, no movement of *Apis mellifera* L. was observed but there were some *Apis cerana* F. in rapeseed fields. The highest in-out were observed at 2:00 pm on both species as *Apis mellifera* L. 44.33 bees entered into hives and 49.66 bees went out of hives, whereas lower number of *Apis cerana* F. 43.66 bees entered into hives and 48.16 bees were out of hives. The foraging activity of *Apis cerana* F. was observed at 11:00 to 13:00 hrs and then a steady decline was recorded which abruptly decreased between 17:00 to 18:00 hrs. However, in the case of *Apis mellifera* L., the increase was steady and reached its peak between 1300 to 1500 hrs (Joshi and Joshi, 2010). Similarly, higher pollen: nectar ratio was recorded at morning hours of the day in both species. *Apis mellifera* L. had more pollen nectar ratio in all over the day hours as compare to *Apis cerana* F. *A. mellifera* collect 1.22:1 and 0.41:1 pollen nectar ratio at 10:00 am and 4:00 am whereas at same hours *Apis cerana* collect 1.16:1 and 0.30:1 pollen nectar ratio. This result indicated that *Apis cerana* F. were more attracted to nectar, whereas *Apis mellifera* L. were more attracted to pollen collection throughout the day in rapeseed crop. Higher pollen: nectar ratio was also reported by Partap et al. (2000) in *Apis cerana* F. that pollen collection excelled nectar collection throughout the day, whereas for *Apis mellifera* L., P>N at 10.00h, N=P at 12.00 h and N>P at 14.00 h. Similarly, Devkota (2000) reported higher amount of pollen collection 1:054 and 1:3.33 by *Apis*

cerana F. and 1:0.33 and 1.1.01 by *Apis mellifera* L. at 10:00 am and 4:00 pm.

Similarly, *Apis cerana* F. also had greater flower and plant visiting efficiency as compared to *Apis mellifera* L. under caged condition. The average number of flowers and plants visited by *Apis cerana* F. were 24.33 and 15.50 flower per minute and 14.17 and 9.333 plants per minute at 2:00 pm and 10:00 am of day hours. But *Apis mellifera* L. visited fewer flowers and plant number at same day hours, i.e. 19.00 and 12.67 flower numbers per minute and 12.83 and 7.50 plants number per minute. It showed that *Apis cerana* F. visited higher number of flowers and plants and hence more efficient pollinator (Fig. 2). The highest number of plants and flowers were visited by both species at 2:00 pm followed by 12:00 pm and 4:00 pm, while the lowest number visited at 10:00 am. Similar result was also presented on rapeseed as *Apis cerana* F. visited 18.0, 19.8 and 14.2 flowers, and *Apis mellifera* L. visited 14.2, 15.4 and 14.5 flower at 9:00, 12:00 and 15:00, respectively (Dhakal, 2003). Longer duration was given by *Apis mellifera* on apple flower as reported by Verma and Dutta (1986) and Desh and Rana (1994) on rapeseed flower. Desh and Rana (1994) on rapeseed reported that these species spent maximum time per flower at 09.00 h than at 12.00 h and 15.00h. In another experiments, it was reported that *Apis cerana* F. foraged higher number of broccoli flowers 11.39 and 12.11 flowers per minute as compared to *Apis mellifera* L. 9.03 and 10.89 flowers per minute under caged and open conditions, respectively (Devkota and Thapa, 2005).

Table 3: Flowers and plant visited per minute by *Apis cerana* F. and *Apis mellifera* L. on rapeseed under caged condition in Jutpani VDC, Chitwan, 2012/013

Parameters	Time	<i>Apis cerana</i> F.	<i>Apis mellifera</i> L.
Plant visited per minute	10:00 am	9.333b	12.83b
	12:00 pm	13.00a	10.17b
	2:00 pm	14.17a	8.167a
	4:00 pm	9.667b	7.500b
Flower visited per Minute	10:00 am	15.50c	19.00b
	12:00 pm	21.00b	16.67ab
	2:00 pm	24.33a	13.33a
	4:00 pm	17.17c	12.67b

* Means followed by the same letter in each column are not significantly different by DMRT at ≤ 0.05 percent level.

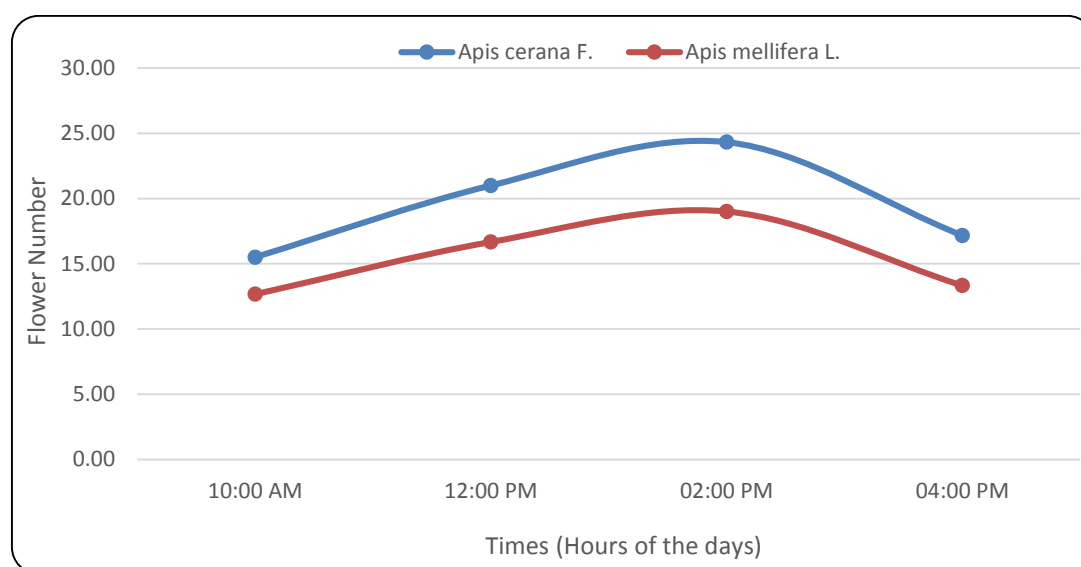


Fig. 2. Number of flowers visited per minute by *Apis cerana* F. and *Apis mellifera* L. at different times of the day under caged condition in Jutpani VDC, 2012/013

Conclusions

It is concluded that *Apis cerana* F. foraged more extra time per day on rapeseed flower as compared to *Apis mellifera* L. The peak foraging hours for both bee species were recorded around 12:00 noon to 14:00 pm. The *Apis cerana* F. visited higher number of flowers and plants as compared to *Apis mellifera* L. under cage condition and hence, *Apis cerana* F. is efficient pollinators as compared to *Apis mellifera* L.

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