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Neeraj Kumar
Department of Entomology, TCA, Dhoi, Muzaffarpur, Bihar, India

GS Giri
Department of Entomology, TCA, Dhoi, Muzaffarpur, Bihar, India

Corresponding Author:
Neeraj Kumar
Department of Entomology, TCA, Dhoi, Muzaffarpur, Bihar, India

Foraging behaviour of *Apis mellifera* L. on Onion, *Allium cepa* L. bloom

Neeraj Kumar and GS Giri

Abstract
The experiments on "Foraging Behaviour of *Apis mellifera* L. on Onion, *Allium cepa* L. bloom" were carried out during the year 2019 at ELP Apiary, TCA, Dholi. Objectives of this investigation were to study the, foraging behaviour of *Apis mellifera* on onion. The result on foraging behaviour of *Apis mellifera* revealed that they started visiting onion flowers in early morning and ceased their activity later in the evening. It remained active throughout the flowering period. The foraging rate of *Apis mellifera* was minimum in afternoon (11.6 flowers/min) and maximum during evening (24.3 flowers/min) and its foraging speed was maximum in afternoon (12.1 sec) and minimum in evening (6.5 sec) and there was inverse relation between foraging rate and speed. The heaviest pollen load was carried by the *Apis mellifera* in afternoon which indicated that more pollens were collected by *Apis mellifera* during afternoon from onion flowers. The result depicts that insect pollinators provide an important pollination service to the onion seed production. Among different insect pollinators, *Apis mellifera* was found most efficient pollinator of onion. Utilization of *Apis mellifera* bee colonies for seed production in onion will be highly remunerative as due to pollination, higher quantity of quality seed is produced.

Keywords: Foraging behaviour, foraging rate, foraging speed, onion

Introduction
Onion is the most important vegetable and demand of onion is very high among consumers throughout the year in India. So, it is possible to meet up the consumers' demand of onion by increasing the seed production of onion. Onion can be established from seeds, bulblets. Direct seeding has the lowest establishment cost and the longest growth time while bulblets increase the cost of establishment but require less time to reach the maturity in the field. There are two methods of onion seed production. The seed to seed and bulbs to seed methods and both the methods are prevalent for onion seed production. Bulb to seed method is most commonly used method of onion seed production. During bulbing, harvesting and curing of seed, fairly high temperature and low humidity is desirable. Seed production is widely adapted in temperate and subtropical regions. Onion seed loses its viability within a year and hence fresh seed is essentially required every year. Onion being a biennial crop, it takes two full seasons to produce seed. It requires cool conditions during early development of the bulbs and again at the bolting stage. Onion flowers are incapable of self-pollinating themselves and the out-crossing becomes more critical due to the protandrous nature of the onion plant. So, pollen of onion should be transferred from one umbel to another umbel from the same plant or from the different plant of onion (Wilkaniec *et al*., 2004) [22]. Onion does not produce good quality seed in the absence of abundant pollinators. The presence of pollinators increases quantity and quality of the seeds (Patil *et al*., 2011 and Chandel *et al*., 2004) [14, 3]. Baswana (1984) [1] reported that onion flowers are very important nectar and pollen producing crops and the receptivity of onion stigma attracts more pollinators for pollination. Estimates of increased seed set due to pollinators have been made by various workers in different parts of the world. One of the major problems in onion seed production is pollination and fertilization of their flowers. It is entomophilous, pollinated by insects including honey bees as the main pollinators of onion flowers (Yucel and Duman, 2005) [24].

Pollinators like ants, beetles, bees, moths, thrips, wasps, flies, mosquitoes, are essential pollinators of cultivated cross pollinated crops (Mcgregor, 1976) [9] and bees are very important pollinator and plays important role in pollination (Crane, 1990) [4]. Pollinators are essential for the reproduction of many wildflowers and crops, and for one third of world food production (Kluser and Peduzzi, 2007) [8]. Honey bee, bumble bee, solitary bees, hoverflies, beetles, butterflies and moths are the most frequently visiting insect pollinator species

(Ollerton *et al.*, 2011) [12]. The employment of honey bees in onion seed production is cheapest and eco-friendly method for increasing the seed production of onion and other cross pollinated crop in this world (Gupta, 2012) [6]. Onion pollination with bees is not only used for increasing quantitate production but also for increasing the qualitative production of onion like even maturity, germination percentage (Benedek and Gall, 1972) [2]. Honey bees can also be utilized as input to this crop for enhancing the yield.

Materials and methods

India has variety of ecological conditions from north to south and east to west. The flora, agriculture practices, cropping pattern and diverse climatic conditions make it a veritable scenario for different species of honey bees and pollinators. The behaviour of honey bees in obtaining nectar or pollen may differ in different kind of flowers. The present studies, therefore, carried out to find out the foraging behaviour of *Apis mellifera* on onion. The onion bulbs variety "Patna Red" were planted as *Rabi* crop at ELP apiary, TCA, Dholi on loamy and well-drained soil in uniform topography of 21 plots with recommended agronomic practices and packages during 2019.The observations were recorded on the following parameters:

A) Duration of foraging

Ten observations were recorded on different dates at 3 days intervals in morning and evening hours. During morning hour when *Apis mellifera* started visiting onion flower was recorded as initiation time. Similarly, the time where there was no *Apis mellifera* on the flower in the evening then it was considered as cessation time. Duration of foraging (in minutes) was calculated as follows:

Duration of foraging = Initiation time – Cessation time

B) Foraging rate

Foraging rate (the number of flower visited by *Apis mellifera* per minutes) was recorded at 3 days interval from 15.2.2019 to 27.2.2019 at 0700, 1100, 1300 and 1500 hours of the day.

C) Foraging speed

Foraging speed (the time spent on onion flower by *Apis mellifera* in second) was recorded at 3 days interval at 0700, 1100, 1300 and 1500 hours of the day from 15.2.2019 to 27.2.2019 with the help of stop watch. For the purpose, as soon as the particular species of honey bees arrived at particular flower, the stop watch was switched on and just after leaving the flower, the stop watch was switched off. The time spent between arriving to leaving the flower was recorded time (sec) spent on foraging speed.

D) Pollen load per trip/bee (mg)

The pollen load carried out by *Apis mellifera* from the onion flowers were recorded at 0700, 1100, 1300 and 1500 hours of the day at weekly intervals on different dates by capturing the returning foraging bees from field to hives. The pollen was dislodged from the bee body with help of fine brush. The collected pollen was weighed on the electronic precision balance.

Results and discussion

The results obtained from different aspects of the present investigation on foraging behaviour of honey bees on onion crop have been presented and discussed as under:

Duration of foraging

To find out the duration of foraging of *Apis mellifera* on onion, ten observations were recorded visually at 3 days intervals on different dates from 12.02.2019 to 11.03.2019 in morning and evening hours of the day to know the initiation and cessation time of *Apis mellifera* on onion. During morning hour, when *Apis mellifera* started visiting onion flower were recorded as initiating time. Similarly, the time where there was no *Apis mellifera* on the flowers in the evening then it was considered as cessation time. The duration of foraging of *Apis mellifera* on onion was calculated by initiation and cessation time of *Apis mellifera*. The data recorded on duration of foraging by *Apis mellifera* on onion have been presented in table 1.

Table 1: Initiation time and Cessation time of *Apis mellifera* visiting flowers of onion

Date of observation	*Apis mellifera* L.		
	Initiation time (I)	Cessation time (C)	Foraging period (P)
12.02.2019	6.35	5.35	11.00
15.02.2019	6.45	5.25	10.40
18.02.2019	6.30	5.45	11.15
21.02.2019	6.10	6.15	12.05
24.02.2019	6.15	6.05	11.50
27.02.2019	6.10	5.40	11.30
02.03.2019	6.30	6.00	11.30
05.03.2019	6.10	5.50	11.30
08.03.2019	6.45	5.20	10.35
11.03.2019	6.40	5.00	10.20
Mean	6.31	5.33	9.82

The data revealed that *Apis mellifera* started their visit earlier during initiation of flowering in onion and ceased their activity quiet later. The foraging period of *Apis mellifera* increased with an increase in day length and flowers availability. The duration of foraging of *Apis mellifera* on onion was maximum on 21.02.2019 being 12.05 h and minimum on 11.03.2019 being 10.20 h. The duration of foraging of *Apis mellifera* on onion was very low at the initiation of flowering and increased as the flowering progressed and towards maturity.

These findings are in accordance with the past reports which showed that duration of foraging of *Apis mellifera* on onion also depends on weather parameters and floral availability. Yucel and Duman (2005) [24] studied the effects of foraging activity of honey bees (*Apis mellifera* L.) on onion and they reported that foraging on onion plant from 8.15 to 16.30 h

with peak foraging between 11.00 and 12.00 h. Oh and Woo (1980) [11] noticed that insect activity on pollination of crops was increasing after sunrise and decreasing before sunset. Sarviva (1985) [17] considered that daily activity of insect pollinators depends on metrological parameters like temperature, humidity, etc. Chandel *et al*. (2004) [3] noticed that *Apis dorsata* was important pollinator of with foraging period of 0630-1855 h followed by *Apis cerana* and syrphids having foraging period of 0635-1830 h and 0725-1820, respectively.

Jadhav (1981) [7] worked on onion seed production with pollinators and noticed *Apis florea* had started the activity of foraging (0855 h) on onion bit earlier than *Apis dorsata* (0930 h). Sajjanar *et al*. (2004) [16] also reported that *Apis dorsata* foraging activity on cucumber flowers was around 0600 h.

Foraging rate

To know the foraging rate (the number of flowers visited per minute by *Apis mellifera*) at different day hours, the observations were recorded on onion crop at six times at 2 hours interval, *viz*. 0700 h, 0900 h, 1100 h, 1300 h, and 1700 h at 3 days intervals during the flowering period. The data recorded has been depicted in table 2.

The result indicated that the *Apis mellifera* had differential foraging rate on different dates and hours of the day. The foraging rate of *Apis mellifera* was minimum in midday hour (1300 h) being 11.6 flowers/min. The maximum foraging rate was recorded during 1700 h of the day being 24.3 flowers/min followed by 21.2, 19.4 and 17. flowers/min. at 0700 h, 1500 h and 0900 h of the day, respectively. *Apis mellifera* visited more number of flowers during evening which might be due to less availability of pollen and nectar in onion flower. The maximum foraging rate was observed 20.6 flowers/ minute on 15.02.2019 indicating that less availability of floral rewards were available to bees and thus requires more flowers to fulfil their food requirement. Both the factors date and time and their interaction were found significant, reflecting that date and time have significant impact on foraging rate of *Apis mellifera*.

Table 2: Foraging rate of *Apis mellifera* visiting onion bloom at different hours of the day

Date of observation	Mean number of flowers visited per minute						Mean
	0700	0900	1100	1300	1500	1700	
15.02.2019	24.0	20.3	15.3	16.0	22.6	26.6	20.6
18.02.2019	21.6	18.6	14.3	11.6	21.0	25.3	18.7
21.02.2019	19.3	17.6	12.3	11.3	19.3	24.6	17.4
24.02.2019	23.6	16.6	11.3	9.0	16.6	23.3	16.7
27.02.2019	18.6	15.3	11.3	10.0	17.3	21.6	15.7
Mean	21.2	17.6	12.9	11.6	19.4	24.3	17.8

Factors	S.Em±	C.D at 5%	CV%
Date	0.32	0.93	
Time	0.36	1.02	7.84
Date*Time	0.80	2.28	

These findings were in close proximity with the earlier published reports in which foraging rate has been reported to be depend upon weather parameters and floral availability. When the availability of floral resource decreased, the pollinators increased visiting towards the onion blooms and vice versa. Tribhuwan (2016) [21] reported that *Apis mellifera* exhibited the most efficient foraging behaviour by visiting 17.14±1.38 flowers in 147.5±8.14 seconds on an umbel. Yucel and Duman (2005) [24] noticed averaged flower visited by *Apis mellifera* 8.0, 13.0, and 4.0 flowers per minute at 09.00, 12.00 and 15.00 h, respectively. Tchindebe and Tuchuenguem (2014) [20] reported that honey bee visited 47.12+ 7.19 flowers per minute. Gupta *et al*. (1984) [5] noticed that *Apis mellifera* visited 25.8 and 33.6 flowers/min in morning and evening. Weather condition highly influenced the foraging activity of bees (Melendez-Ramirez *et al*., 2002) [10]. Sharma and Singh (1999) [18] reported that *Apis dorsata* visited 4.31 flowers/min and *Apis florea* visited 2.20 flowers/min.

Foraging speed

The data on foraging speed, *i.e.* time spent by *Apis mellifera* on onion flowers has been presented in table 3. The time spent per flower for collecting floral rewards from onion flower by *Apis mellifera* differed significantly.

The result showed that *Apis mellifera* spent more time (12.1 second/ flower) at 1300 h of the day and lesser time 6.5 and 6.8 second/flower at 1700 h and 0700 h of the day, respectively. The minimum and maximum time spent by *Apis mellifera* on onion flower was recorded as 7.7 and 10.3 sec/flower on 15.02.2019 and 27.02.2019. These results indicated that *Apis mellifera* spent more time when the availability of pollen and nectar was more and spent lesser time on when the availability of pollen and nectar was less. Both the factors date and time and their interactions were found significant, reflecting that date and time have significant impact on foraging speed of *Apis mellifera*.

Table 3: Foraging speed (the time spent in second on a flower) of *Apis mellifera* visiting onion flowers

Date of observation	Time spent on flowers (in second)						Mean
	0700	0900	1100	1300	1500	1700	
15.02.2019	6.8	8.4	9.7	10.8	6.0	4.5	7.7
18.02.2019	7.8	10.1	10.7	11.4	7.7	6.4	9.0
21.02.2019	6.5	10.0	11.3	12.7	8.0	7.0	9.3
24.02.2019	5.7	10.1	12.7	13.1	8.7	6.5	9.5
27.02.2019	7.1	11.3	13.3	12.5	9.3	8.1	10.3
Mean	6.8	10.0	11.5	12.1	7.9	6.5	9.1

Factors	S Em (±)	CD (P=0.05)	CV (%)
Date	0.17	0.49	
Time	0.19	0.54	8.13
Date x Time	0.42	1.21	

These findings are in concurrence with the prior records which showed that foraging speed also depends on weather parameters and availability of floral rewards. Tribhuwan (2016) [21] reported that *Apis melifera* exhibited the most efficient foraging behaviour by visiting 17.14±1.38 flowers in 147.5±8.14 seconds on an umbel. Sihag and Khatkar (1999) [19] reported that honey bee foraging activity differed significantly with relative humidity with negative correlation. Sharma and Singh (1999) [18] reported that *Apis dorsata* spent 9.20 sec/flower and *Apis florea* spent 37.99 sec/flower.

Pollen load

The data recorded pollen load carried by *Apis mellifera* after foraging from the flowers of onion is presented in table 4. The results showed significant difference in pollen load carried out by *Apis mellifera* in different trips. The heaviest weight of pollen load was observed (10.80 mg) at 1100 h of the day and lightest weight of pollen load was observed (5.4 mg) at 1700 h of the day. It indicated that more pollen rewards were available at 1100 h, as compared to 1700 h of the day. *Apis mellifera* collected more pollen in midday and less pollen load in evening and morning, being 5.4 mg and 6.6 mg, respectively. There were significant variations in pollen load at different hour of the day.

Table 4: Pollen load carried out by *Apis mellifera* from the flowers of onion

Time of observation	Pollen load/trip/bee (mg)
0700	6.60
0900	8.30
1100	10.80
1300	10.60
1500	6.40
1700	5.40
Mean	8.01
S. Em (±)	0.24
CD (P=0.05)	0.71

Data is mean of 3 observations on five dates

The variation in pollen load carried out by *Apis mellifera* from the onion field have also been worked out by earlier workers. Witter *et al.* (2003) [23] noticed that 70% of pollen of onion transformed by *Apis mellifera* for the pollination of onion. Yucel and Duman (2005) [24] found that *Apis mellifera* collected 8.0, 10.0 and 6.0 mg of pollen from onion umbel. Mcgregor (1976) [9] noticed that *Apis mellifera* was important pollinator of onion and had collected more pollen during morning hours and noon of the day. Parker (1982) [13] reported that amount of pollen collection from onion flower by insect pollinators depend on kind of insect pollinator and the onion cultivar.

The present findings are more or less in conformity to earlier workers findings. Time spent on flower for both collection of forage depends on type and quality of forage, easiness for collection rewards and atmospheric factors. The results showed that pollination was important for onion to increase the seed yield. The data depicted that all the quantitative and qualitative yield parameters of onion increased significantly in open pollination. The observations on foraging behaviour of Apis mellifera on onion, it might be concluded that that this crop has vast scope in the state of Bihar and might be ascertain as good bee flora and provide floral rewards to honey bees for sustaining colony as the onion crop is highly cross-pollinated crop and solely depends upon insect pollinators for pollination for seed setting.

References

1. Baswana KS. Screening of coriander germplasm against chalcid fly (*Systole albipennis*). *Annals of Applied Biology Supplement: Tests of Agrochemicals and Cultivars*. 1984;104:114-115.
2. Benedek P, Gaal E. The effect of insect pollination on seed onion, with observations on the behaviour of honeybees on the crop. *Journal of Apicultural Science*, 1972;11(3):175-180.
3. Chandel RS, Thakur RK, Bhardwaj NR, Pathania N. Onion seed crop pollination: a missing dimension in mountain horticulture, *Acta Hortticulture*. 2004;631:79-86.
4. Crane E. *Bees and Beekeeping: Science, Practice and World Resource*, Heinemann, Oxford, UK. 1990, 64 pp.
5. Gupta JK, Mishra RC, Kumar J. *Plectranthus* as forage for *Apis cerana indica* F. and *Apis mellifera* L. *Apidologie*. 1984;15(1):75-82.
6. Gupta SN. *Instant Horticulture*. Jain Brothers, New Delhi, 2012, 97 pp.
7. Jadhav LD. Role of insects in the pollination of onion (*Allium cepa* L.) in the Maharashtra State, India. *Indian Bee Journal*. 1981;43(3):61-63.
8. Kluser S, Peduzzi P. Global Pollinator Decline: A Literature Review: UNEP/GRID Europe, United Nations, 2007.
9. McGregor SE. Insect pollination of cultivated crop plants. Agriculture Handbook, United States Department of Agriculture, 1976, 496 pp.
10. Melendez-Ramirez V, Magana-Rueda S, Parra-Tabla V, Ayala R, Navarro J. Diversity of native bee visitors of cucurbit crops (Cucurbitaceae) in Yucatan, Mexico. *Journal of Insect Conservation*. 2002;6:135-147.
11. Oh HW, Woo KS. A study of foraging and pollen collecting activity of honey bee (*Apis mellifera* L.) in the spring. *Korean Journal of Apiculture*. 1990;5(1):1-22.
12. Ollerton J, Winfree R, Tarrant S. How many flowering plants are pollinated by animals, *Oikos*, 2011;120(3):321-326.
13. Parker FD. Efficiency of bees pollinating onion flowers. *Journal of Kansas Entomological Soc*iety. 1982;55:171-176.
14. Patil JS, Mokat RB, Mopade RV, Kamate GS. Role of bee attractants in pollination and productivity of onion (*Allium cepa* L). *Journal of Entomological Research*. 2011;35(2):127-131.
15. Pavana B. Studies on insect pollinators of bitter gourd (*Monordica charantia* L). M.Sc. (Ag.) Thesis, Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana, 2010.
16. Sajjanar SM, Kuberrappa GC, Pabhuswamy HP. Insect

visitors of cucumber (*Cucumis sativa* L.) and the role of honey bee, *Apis cerana* F. in its pollination. *Pest Management and Economic Entomology*. 2004;12(1):23-31.
17. Sarviva JAPG. Bioclimatic factors affecting flights of honey bee, *Apis mellifera* L. (Hymenoptera: Apidae). Ph.D. Thesis, Colorado State University Fort Collins. USA, 1985, 148 pp.
18. Sharma SK, Singh JR. Pollination efficiency of *Apis dorsata* F. and *A. florae* F. on carrot (*Daucus carota* L.). *Indian Bee Journal*. 1999;61(1):1-4.
19. Sihag RC. Influence of environmental factors on the pollination activity of bees. *Environment and Ecol*ogy. 1984;2:149-152.
20. Tchindebe G, Tuchuenguem FF-N. Foraging and pollination activity of *Apis mellifera dansonii* Latreille (Hymenoptera: Apidae) on flowers of *Allium cepa* L. (Liliaceae) at Cameroon. *International Journal of Agronomy and Agricultural Research*. 2014;5(2):139-153.
21. Tribhuwan AP. Comparative study of cross pollination on onion by *Apis mellifera* and *Apis indica*. *International Journal of Life Science Research.* 2016;3:29-32.
22. Wilkaniec Z, Giejdasz K, Prószyński G. Effect of pollination of onion seeds under isolation by the red mason bee (*Osmia rufa* L.) (Apoidea: Megachilidae) on the setting and quality of obtained seeds. *Journal of Apicultural Science*. 2004;48(2):35-41.
23. Witter Sidia, Blochtein, Betina. Effect of pollination by bees and other insects on the production of onion seeds. *Pesquisa Agropecuaria Brasileira*. 2003;38(12):1399-1407.
24. Yucel B, Duman I. Effects of foraging activity of honeybees (*Apis mellifera* L.) on onion (*Allium Cepa* L.) seed production and quality. *Pakistan Journal of Biological Sciences.* 2005;8(1):123-126.