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Foraging Duration of *Apis mellifera* and *Apis florea* on different Cultivars of Brassica

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Abstract

The present research work was planned to gather information pertaining to honey bee pollinators *Apis mellifera* and *Api florea*, for their foraging duration while visiting different cultivars of *Brassica*. Following locally suited procedures the crops were grown in a plot of 2m x 4m, located at Mushari block of Muzaffarpur district, Bihar. Four observations were made on different dates at weekly interval during morning and evening hours for two consecutive years 2022-23 and 2023-24. The result suggested that Brassica juncea var. Raya was most preferred by both the Apis mellifera and Apis florea. Among Raya cv. Varuna, among Tori cv. Panchali and among Sarson cv. Jhumka was most preferred by Apis species. The minimum duration of foraging was observed on cv. Pushabold among Ray, cv. T-9 among Tori and cv. Swarna among Sarson variety in case of both *Apis mellifera* and *Apis florea.* During both the years the effects of species, variety and interaction effects of species x variety on foraging behaviours of Apis species were significant (P = 0.05). On the other hand, effects of year, and interaction effects of year x species, year x variety and year x species x variety were non-significant (p >0.05).

***Key words*:** *Apis mellifera*, *Apis florea, Brassica,* Foraging

Brassica crops are among the most important oilseed crops worldwide and depend substantially on insect pollination for improved seed yield and quality. Among the various pollinators, honey bees play a pivotal role in enhancing pollination efficiency, with *Apis mellifera* and *Apis florea* being two of the most abundant bee species visiting Brassica flowers. Their foraging behaviour, particularly the duration of floral visits, directly influences pollen transfer efficiency and ultimately affects crop productivity [1-2]. The efficiency of these bee species as pollinators depends not only on their abundance but also on their foraging behaviour, including the time spent on individual flowers, which determines the extent of pollen deposition and cross-pollination [3]. Foraging duration varies among bee species and is influenced by floral characteristics, nectar and pollen availability, environmental conditions, and crop cultivar. Differences in floral morphology and nectar rewards among Brassica cultivars may alter the time spent by bees on individual flowers, thereby affecting pollination success and seed set [4-5]. Understanding the foraging duration of *Apis mellifera* and *Apis florea* on different Brassica cultivars is therefore essential for identifying cultivars that are more attractive to pollinators and for developing effective pollination management strategies. Moreover, comparative information on the foraging duration of different honey bee species across Brassica cultivars remains limited, highlighting the need for systematic studies to support pollinator conservation and enhance crop productivity through efficient pollination management.

Fillip in oilseed production is a measure thrust area of government to minimize imports and maximize endogenous availability. Increase in production cannot be achieved only by increase in acres. Instead, proper pollinator activity has also to be insured. Pollinators such as honey bees are as critical as light and water for cross pollinated plants [6]. They ensure seed and fruit development as well as reproduction and thus affects the quality and quantity of the products derived from the vast majority plants [7]. Sushil *et al*. [8] studied a key role of honey bees in increasing the seed production of three crops: broccoli, kohlrabi and Chinese cabbage. According to Singh [9] majority of the fruit, pulses, and oilseeds are pollinators dependent. Since different species of honey bees, particularly the *Apis mellifera* and *Apis florea* are major pollinators of oilseed crops in general and *Brassica* in particular, the foraging behaviour of *Apis mellifera* and *Apis florea* and factors affecting it are a major determinant of the production of Brassica. Mishra *et al*. [10] suggested other benefits of foragers such as in the deposition of nitrogen (in faeces) on plants during visits. As a bio-indicator the foraging activity of honey bees is also important for indirect studies of environmental contamination with pesticides [11]. Chamberlain *et al*. [12] suggested the role of foraging bees in the identification of pest infestation. The present study was undertaken to evaluate and compare the foraging duration of *Apis mellifera* and *Apis florea* on different Brassica cultivars, with the objective of generating information that can contribute to improving pollination efficiency and sustainable Brassica production.

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MATERIALS AND METHODS

The present investigation was conducted during the rabi seasons of 2022-23 and 2023-24 to evaluate the foraging duration of *Apis mellifera* and *Apis florea* on different cultivars of Brassica. The field experiment was carried out in a farmer's field at Mushari Block, Muzaffarpur district, Bihar, India, while observations and data analysis were undertaken in the University Department of Zoology, Babasaheb Bhimrao Ambedkar Bihar University, Muzaffarpur.

Three Brassica crops, namely Brassica juncea var. *Raya*, Brassica campestris var. *Tori*, and Brassica campestris var. *Sarson*, were included in the study. Each crop was represented by three cultivars, namely Varuna, Kranti, and Pusa Bold (*B. juncea* var. *Raya*); Bhawani, Panchali, and T-9 (*B. campestris* var. *Tori*); and Jhumka, Swarna, and Rajendra Sarson-1 (*B. campestris* var. *Sarson*). The crops were sown on 1 November in each experimental year in plots measuring 2 m × 4 m following the locally recommended agronomic practices. Details of the crops and cultivars used in the experiment are presented in (Table 1).

Table 1 Brassica crops and cultivars included in the study

S. No.	Crop	Cultivars
1.	*Brassica juncea* var. *Raya*	Varuna, Kranti, Pusa Bold
2.	*Brassica campestris* var. *Tori*	Bhawani, Panchali, T-9
3.	*Brassica campestris* var. *Sarson*	Jhumka, Swarna, Rajendra Sarson-1

Observations on the foraging duration of *Apis mellifera* and *Apis. florea* were recorded at weekly intervals from 20 December to 18 January during both years of study. Four observations were taken on different dates in the morning and evening flowering periods. The initiation of foraging was recorded as the time when the first bee of the respective species visited the flowers, whereas the cessation of foraging was considered as the time after which no individual of that species was observed visiting the flowers. The foraging duration was calculated as the interval between the initiation and cessation of foraging activity and expressed in minutes using the following equation:

$$\text{Foraging duration (min)} = \text{Cessation time} - \text{Initiation time}$$

The experiment was laid out in a Factorial Randomized Block Design (FRBD) with three replications. Data recorded over the two cropping seasons were subjected to analysis of variance (ANOVA) following the procedures described by Panse and Sukhatme [13]. Treatment means were compared at the 5% level of significance ($P \leq 0.05$).

Table 2 Duration of foraging (minutes) of *Apis mellifera* and *Apis florea* on different cultivars of rapeseed and mustard during two consecutive years 2022-23 and 2023-24

S. No.	Cultivars	*Apis mellifera*	*Apis florea*	Mean
	Year : 2022-23			
		Brassica juncea (Brown mustard) var. Raya		
1.	Varuna	411.25	321.83	366.54
2.	Kranti	406.35	315.75	361.05
3.	Pusa bold	402.75	311.25	357.00
	Mean	406.78	316.28	361.53
		Brassica campestris (var. Toria)		
4.	Panchali	366.1	306.68	336.39
5.	Bhawani	328.02	291.35	309.69
6.	T-9	322.35	264.2	293.28
	Mean	338.82	287.41	313.12
		Brassica campestris (var. Sarson)		
7.	Jhumka	329.35	289.75	309.55
8.	Swarna	320.75	278.85	299.8
9.	Rajendra Sarson - 1	314.25	290.58	302.42
	Mean	321.45	286.39	303.92
	Year : 2023-24			
		Brassica juncea (Brown mustard) var. Raya		
1.	Varuna	408.89	321.75	365.32
2.	Kranti	405.35	320.75	363.05
3.	Pusa bold	399.25	307.85	353.55
	Mean	404.5	316.78	360.64
		Brassica campestris (var. Toria)		
4.	Panchali	489.37	305.08	397.23
5.	Bhawani	362.35	302.75	332.55
6.	T-9	316.75	262.75	289.75
	Mean	389.49	290.19	339.84
		Brassica campestris (var. Sarson)		
7.	Jhumka	322.75	302.76	312.76
8.	Swarna	312.15	288.43	300.29
9.	Rajendra Sarson - 1	318.78	294.25	306.52
	Mean	317.89	295.15	306.52

RESULTS AND DISCUSSION

The data on duration of foraging of *Apis mellifera* and *Apis florea* revealed that among Brassica species, *Brassica juncea* var. Raya were most preferred by Apis species followed by *Brassica campestris* var. Tori and *Brassica campestris* var. sarson (Table 2). Among *Brassica juncea* cultivars, both the bee species exhibited maximum duration of foraging on cv. Varuna while minimum on cv. Pusa bold. In case of *Apis mellifera*, the maximum duration (411.25 min. and 408.89 min.) of foraging were recorded on cv. Varuna while minimum (402.75 min. and 399.25 min.) on Pusa bold, whereas for *Apis florea* the maximum durations (321.83 min. and 321.75 min.) of foraging were recorded on cv. Varuna while minimum (311.25 min. and 307.85 min.) on Pusa bold during years 2022-23 and 2023-24 respectively.

Among var. Tori, cv. Panchali was preferred the most but cv. T-9 the least by both the Apis species. The maximum durations (366.1 min. and 489.37 min.) of foraging were recorded on cv. Panchali while the minimum durations (322.35 min. and 316.75 min.) on cv. T-9 in case of *Apis mellifera*, whereas the maximum durations (306.68min. and 305.08 min.) of foraging were recorded on cv. Panchali and minimum (264.20 min. and 262.75 min.) on cv. T-9 in case of *Apis florea*, during years 2022-23 and 2023-24 respectively.

The maximum durations of foraging by both the bee species among Sarson cultivars were recorded on cv. Jhumka. By contrast, the two species exhibited differences in their minimum foraging durations. In case of *Apis mellifera*, the maximum durations (329.35 min. and 322.75 min.) of foraging were recorded on cv. Jhumka while minimum durations (314.25 min. and 318.8 min.) on cv. Rajendra Sarson -1 during 2022-23 and 2023-24, respectively. On the other hand, in the case of *Apis florea*, the maximum durations (289.75 min. and 302.76 min.) of foraging were recorded on cv. Jhumka while minimum (278.85 min. and 288.43 min.) on cv. Swarna during 2022-23 and 2023-24, respectively. The durations of foraging of *Apis mellifera* (321.45 min. and 317.89 min.) were greater when compared with those of *Apis florea* (286.39 min. and 295.15min.) during 2022-23 and 2023-24, respectively.

Across all Brassica cultivars, *Apis mellifera* consistently exhibited a significantly longer foraging duration than *Apis florea*. The mean foraging duration of *Apis mellifera* ranged from 321.45 to 406.78 min during 2022–23 and 317.89 to 404.50 min during 2023–24, whereas the corresponding values for *Apis florea* ranged from 286.39 to 316.28 min and 290.19 to 316.78 min, respectively. The longer foraging period of *Apis mellifera* may be attributed to its larger body size, greater foraging efficiency, and higher colony-level resource requirements, enabling it to exploit floral resources more effectively than *Apis florea*. Extended floral visitation increases the probability of pollen transfer and thereby enhances pollination efficiency, ultimately contributing to improved seed set and yield [14-17].

Analysis of variance (Table 3) further revealed that the effects of bee species, Brassica cultivar, and the species × cultivar interaction were significant ($P \leq 0.05$), indicating that the response of honey bees depended on the cultivar under consideration. In contrast, the effects of year and its interactions with species and cultivars were non-significant, suggesting that the observed foraging behaviour remained relatively stable across the two cropping seasons. The low coefficient of variation (CV = 3.15%) also indicated good experimental precision and consistency of observations.

Table 3 Mean of three replications

Factors	SEM (±)	CD (p = 0.05)
Year	-	NS
Species	1.4	3.89
Varieties	2.98	8.25
Year × Species	-	NS
Year × variety	-	NS
Species × variety	4.21	11.66
Year × species × variety	-	NS
CV%	3.15	

The observed differences in foraging duration among Brassica cultivars are primarily associated with variation in floral morphology, nectar secretion, pollen availability, and nectar sugar concentration, all of which strongly influence pollinator preference and floral constancy. Cultivars offering greater floral rewards generally retain pollinators for longer periods, resulting in enhanced pollen transfer and improved pollination success. Similar cultivar-dependent variation in honey bee visitation has been reported in Brassica and other entomophilous crops [18-19]. Furthermore, the consistently longer foraging duration exhibited by *A. mellifera* compared with *A. florea* corroborates previous reports that *A. mellifera* is a highly efficient managed pollinator because of its larger colony size, greater floral fidelity, and superior foraging capacity [20-21]. Recent studies have also emphasized that pollinator efficiency is determined not only by visitation frequency but also by the duration of floral visits, which directly influences pollen deposition and reproductive success in insect-pollinated crops [22-23]. Therefore, the present findings identify Varuna, Panchali, and Jhumka as comparatively more attractive Brassica cultivars for honey bees and highlight the importance of selecting pollinator-friendly cultivars for maximizing pollination services and sustaining oilseed productivity [24].

CONCLUSION

The present investigation demonstrated significant differences in the foraging duration of *Apis mellifera* and *Apis florea* on different Brassica cultivars. Among the Brassica species evaluated, *Brassica juncea* var. *Raya* was the most preferred by both bee species, followed by *B. campestris* var. *Tori* and *B. campestris* var. *Sarson*. The cultivars Varuna, Panchali, and Jhumka recorded the longest foraging durations within their respective Brassica groups, indicating greater attractiveness to pollinators. *Apis mellifera* consistently exhibited significantly longer foraging durations than *A. florea*, suggesting its superior efficiency as a pollinator under the prevailing agro-climatic conditions. The non-significant year effect indicated that the foraging behaviour of both bee species remained stable over the two consecutive cropping seasons. These findings highlight the importance of selecting pollinator-attractive Brassica cultivars and conserving honey bee populations to enhance pollination efficiency, improve seed

yield, and promote sustainable oilseed production. Further studies integrating floral traits, nectar characteristics, and pollination efficiency are recommended to develop bee-friendly Brassica cultivars and optimize crop pollination strategies. The duration of foraging of the two honey bee species *Apis mellifera* and *Apis florea* were different for different mustard and rapeseed cultivars. The result suggested that the *Apis mellifera* foraged for longer duration as compared to *Apis florea* for all cultivars of mustard and rapeseed crop.

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LITERATURE CITED

1. Free JB. 1993. *Insect Pollination of Crops*. 2nd Edition. Academic Press, London.
2. Klein AM, Vaissière BE, Cane JH, Steffan-Dewenter I, Cunningham SA, Kremen C, Tscharntke T. 2007. Importance of pollinators in changing landscapes for world crops. *Proceedings of the Royal Society B: Biological Sciences* 274(1608): 303-313.
3. Silva DP, Moisan-De Serres J, Souza DR, Hilgert-Moreira SB, Fernandes MZ, Kevan PG, Freitas BM. 2013. Efficiency in pollen foraging by honey bees: Time, motion and pollen depletion on flowers of *Sisyrinchium palmifolium* Linnaeus (Asparagales: Iridaceae). *Journal of Pollination Ecology* 11: 27-32. https://doi.org/10.26786/1920-7603(2013)8
4. Abrol DP. 2012. *Pollination Biology: Biodiversity Conservation and Agricultural Production*. Springer, Dordrecht.
5. Delaplane KS, Mayer DF. 2000. *Crop Pollination by Bees*. CABI Publishing, Wallingford, UK.
6. Bernauer OM, Tierney SM, Cook JM. 2022. Efficiency and effectiveness of native bees and honey bees as pollinators of apples in New South Wales orchards. *Agriculture, Ecosystems & Environment* 337: 108063. doi:10.1016/j.agee.2022.108063
7. Khalifa SAM, Elshafiey EH, Shetaia AA, El-Wahed AAA, Algethami AF, Musharraf SG, AlAjmi MF, Zhao C, Masry SHD, Abdel-Daim MM, Halabi MF, Kai G, Al Naggar Y, Bishr M, Diab MAM, El-Seedi HR. 2021. Overview of bee pollination and its economic value for crop production. *Insects* 12(8): 688.
8. Sushil SN, Stanley J, Hedau NK, Bhatt JC. 2013. Enhancing seed production of three Brassica vegetables by honey bee pollination in north-western Himalayas of India. *Universal Journal of Agricultural Research* 1: 49-53.
9. Singh Y. 1997. Role of honeybees in farm production, agricultural growth and rural reconstruction in India. *Indian Bee Journal* 59(1): 24-30.
10. Mishra A, Afik O, Cabrera ML, Delaplane KS, Mowrer JE. 2013. Inorganic nitrogen derived from foraging honey bees could have adaptive benefits for the plants they visit. *PLoS One* 8(7): e70591. DOI:10.1371/journal.pone.0070591.
11. Balayiannis G, Balayiannis P. 2008. Bee honey as an environmental bioindicator of pesticides' occurrence in six agricultural areas of Greece. *Archives of Environmental Contamination and Toxicology* 55: 462-470. DOI: 10.1007/s00244-007-9126-x.
12. Chamberlain K, Briens M, Jacobs JH, Clark SJ, Pickett JA. 2012. Use of honey bees (*Apis mellifera* L.) to detect the presence of Mediterranean fruit fly (*Ceratitis capitata* Wiedemann) larvae in Valencia oranges. *Journal of the Science of Food and Agriculture* 92: 2050-2054. DOI: 10.1002/jsfa.5742.
13. Panse VG, Sukhatme PV. 1967. *Statistical Methods for Agricultural Workers*. 2nd Edition. Indian Council of Agricultural Research (ICAR), New Delhi, India.
14. Sihag RC, Khatkar S, Khatkar S. 1999. Effect of different environmental factors on the foraging activity of honey bee species visiting eight cultivars of oilseed crops. *Annals Agril. Bio-Research* 2: 257-261.
15. Kumar M, Singh R, Chand H. 2000. Foraging activity of honey bees on different varieties of sunflower. *Indian Bee Journal* 62(3/4): 63-64.
16. Sharma SK, Singh JR, Mahla JC. 2001. Foraging behaviour of *Apis* spp. in semi-arid sub-tropical climate on flowers of mustard, onion, carrot, berseem and sunflower in Hisar, India. *Crop Research* 21(3): 332-334.
17. Kumar SS, Govindaraj M. 2013. A detailed study about foraging behavior of artificial bee colony (ABC) and its extensions. *International Journal of Engineering and Technology* 5: 992-997.
18. Abrol DP. 2003. Foraging behaviour of honeybees and its impact on crop pollination. *Journal of Asia-Pacific Entomology* 6(2): 143-150.
19. Bernauer OM, Tierney SM, Cook JM. 2022. Efficiency and effectiveness of native bees and honey bees as pollinators of apples in New South Wales orchards. *Agriculture, Ecosystems & Environment* 337: 108063. doi:10.1016/j.agee.2022.108063.
20. Abrol DP. 2012. *Pollination Biology: Biodiversity Conservation and Agricultural Production*. Springer, Dordrecht.
21. Khalifa SAM, Elshafiey EH, Shetaia AA, El-Wahed AAA, Algethami AF, Musharraf SG, AlAjmi MF, Zhao C, Masry SHD, Abdel-Daim MM. 2021. Overview of bee pollination and its economic value for crop production. *Insects* 12(8): 688.
22. Koltowski Z. 2002. Influence of flowering characteristics of winter oilseed rape cultivars on honey bee foraging. *Journal of Apicultural Science* 46(2): 29-39.
23. Kumar R, Singh R, Chand H. 2000. Foraging behaviour of honey bees on different mustard cultivars. *Indian Bee Journal* 62(1/2): 24-28.
24. Blazyte-Cereskiene L, Vaitkeviciene G, Venskutonyte S, Buda V. 2010. Honey bee foraging in spring oilseed rape crops under high ambient temperature conditions. *Zemdirbyste Agriculture* 97: 61-70.