International Journal of Entomology Research
www.entomologyjournals.com
ISSN: 2455-4758
Received: 27-04-2026, Accepted: 28-05-2026, Published: 12-06-2026
Volume 11, Issue 2, 2026, Page No. 437-439

Impact of weather factors (temperature and relative humidity) on the relative abundance of two honey bee (*Apis*) species on *Linum usitatissimum*

Braj Kishor Prasad Singh[1], Prabal Chatterjee[2]
[1] Department of Zoology, Babasaheb Bhimrao Ambedkar Bihar University, Muzaffarpur, Bihar, India
[2] Ramdayalu Singh College, Babasaheb Bhimrao Ambedkar Bihar University, Muzaffarpur, Bihar, India
Corresponding Author: Braj Kishor Prasad Singh
DOI: https://doi.org/10.66856/ijer.2026.11.2.11196

Abstract
The present research work was planned considering the importance of linseed in the rabi oilseed economy of Bihar. The field works were conducted at Mushari block of Muzaffarpur district, Bihar during rabi season in two consecutive years 2022-23 and 2023-24. *Linum usitatissimum* was cultivated in the experimental plots and the number of foragers (Apis *mellifera* and *Apis florea*) were noted at 900h, 1100h, 1300h and 1500h of the day at one-week intervals. In both years the mean population of *Apis* species on linum was highest at 900h and lowest at 1500h. *Apis florea* were the dominant visitors followed by *Apis mellifera.* To document the impact of weather factors on foraging behaviour, the abundance of *Apis mellifera* and *Apis florea* was correlated with mean temperature and mean relative humidity. Mathematical regression models revealed the combined contributions of temperature and relative humidity to populations of *Apis* mellifera and *Apis florea*. The present study suggested that the populations of both the *Apis* species were increased with increase in temperature and decrease in relative humidity.

Keywords: Abundance, foraging behaviour, relative humidity, temperature

Introduction
Two honey bee species *Apis mellifera* and *Apis florea* have been selected for the present study. Among insects, ninety percent of the pollination is performed by the bees. The role of honey bees as pollinators have been increased as the habitats of natural pollinator are being destroyed in this modern era of agriculture where pesticides are being used in large quantity. *Linum usitatissimum* the crop subjected to current study is commonly known as flaxseed or linseed. It is a self-pollinated crop grown both for the oil extracted from its seed and for the fibers extracted from the stem (Bisen *et al*., 2024) [3]. In India, among rabi oilseed crops it acquires a higher rank (FAO, 2020; Directorate of Economics and Statistics, 2021) [5, 6]. Although flaxseed is the second most important oilseed crop in India based on both the cultivated area and production, (Pujari *et al*., 2024; Samui *et al*., 2000) [10, 12], its average productivity in India is considerably lower than that of major linseed-producing countries, mainly due to poor adoption of improved technologies (Singha *et al*., 2020) [16]. In Bihar low productivity of linseed is mainly due to rain fed cultivation and dependence on residual soil moisture (Singh *et al*., 2017; Singh *et al*., 2014) [14, 15]. The crop is cultivated not only for its edible oil but also for medicinal purposes as well as industrial purposes such as in making plastics and paper. (ATARI Patna, 2019–2024. Brady & Weil, 2017) [2, 4]. Declined quality, yield, and low crop productivity are also due to inadequate pollination and variations in weather parameters and thus are challenges to substantial agriculture. Hence the knowledge of bee behaviour particularly foraging behaviour and the impact of weather factors on relative abundance of bee species are important for maintaining crop productivity.

Materials and Methods
The field work was done during the rabi season in two consecutive years 2022-23 and 2023-24 at Mushari block of Muzaffarpur district (Bihar). The experimental works related to present study were conducted at University department of Zoology, B. R. A. Bihar University Muzaffarpur. The experiments were carried out following factorial RBD and three replications were done. Farmers cultivated the crop following locally suited procedures. The details of crops grown are as follows:

Crops	Cultivers	Date of Sowing	Seed rate	Spacing
L. usitatissimum	Subhra	20 Dec.	8kg / ha.	45×20

In experimental plots (plot size 2m x 5.00m) an area of one square meter was marked randomly. When crops came to bloom, the number of foragers (both *Apis* species*)* was counted for 10 minutes in the marked area. At interval of one week the number of foragers was recorded at different hours i.e. at 900h, 1100h, 1300h and 1500h of the day. The crop observation dates of are given below:

Crop	Date of Observation	
	2023	2024
Linum usitatissimum	30.03.2023	30.03.2024
	07.04.2023	07.04.2024
	15.04.2023	15.04.2024
	23.04.2023	23.04.2024

On different dates at different times, the temperature and relative humidity were recorded. Both mean temperature and mean relative humidity were correlated with abundance of *Apis mellifera* and *Apis florea*. The correlation and regression equations were work out following Statistical

methods suggested by Panas and Sukhatme (1967). The data were statistically analyzed in factorial RBD. All data are mean. The level of significance was set at $P < 0.05$.

The relative abundance of *Apis mellifera* and *Apis florea* were observed on flowers of *Linum usitatissimum* on different dates at weekly intervals and results were noted at 900h, 1100h, 1300h and 1500h of the day.

Result and discussion

Table 1: Relative abundance (No. of bees/10 minute/m^2) of *Apis mellifera* and *Apis florea* on *Linum usitatissimum* at different hours of the day during two constitutive years 2022-23 and 2023-24

Month	Week	Species	*Mean population at different hours of the day (h)					Avg. temp (°C)	Avg.RH (%)
			900h	1100h	1300h	1500h	Mean		
Year: 2022-23									
March	V	*Apis mellifera*	10.75	8.87	8.50	6.25	8.59		
		Apis florea	18.75	16.75	12.65	11.08	14.81	26.0	64
		Mean	14.75	12.81	10.58	8.67	11.70		
April	II	*Apis mellifera*	11.50	9.73	8.25	6.50	9.00		
		Apis florea	21.88	18.65	15.15	11.67	16.84	26.9	63
		Mean	16.65	14.19	11.70	9.09	12.92		
	III	*Apis mellifera*	15.50	12.25	10.35	6.25	11.09		
		Apis florea	25.32	21.15	18.25	14.35	19.77	29.5	54
		Mean	20.41	16.70	14.30	10.30	15.43		
	IV	*Apis mellifera*	17.35	14.60	12.25	9.25	13.36		
		Apis florea	26.24	23.34	20.35	14.65	21.15	30.05	46
		Mean	21.80	18.97	16.30	11.95	17.26		
		Grand Mean	18.41	15.67	13.22	10.00	14.33		
Year 2023-24									
March	V	*Apis mellifera*	10.33	8.75	6.85	5.50	7.86		
		Apis florea	13.50	12.25	10.15	8.75	11.16	24.8	64
		Mean	11.82	10.50	8.50	7.13	9.51		
April	II	*Apis mellifera*	12.55	9.65	6.75	5.85	8.70		
		Apis florea	17.50	15.25	12.50	9.35	13.65	25.95	65.5
		Mean	15.03	12.45	9.63	7.60	11.18		
	III	*Apis mellifera*	16.15	12.50	9.15	6.75	11.14		
		Apis florea	19.75	18.25	15.15	11.25	16.10	28.55	55
		Mean	17.95	15.38	12.15	9.0	13.62		
	IV	*Apis mellifera*	19.55	16.35	9.75	8.55	13.55		
		Apis florea	22.85	21.48	8.25	13.15	16.62	29.65	49.8
		Mean	21.20	18.92	14.00	10.85	15.09		
		Grand Mean	16.52	14.31	9.82	8.64	12.35		

The populations of both the species were recorded by counting their number for 10 minutes in an area of one square meter. The observations were recorded in two consecutive years 2023 and 2024. The results presented in table1 indicate that the population of *Apis florea* was higher than those of *Apis mellifera*. The highest mean populations (17.26 and 15.09) were recorded in the 4th week of April while minimum (11.70 and 9.51) in the 5th week of March in the year 2023 and 2024 respectively. The population of *A. florea* was the lowest (18.75 and 13.50) in the 5th week of March at 900h but increased (26.24 and 22.85) in the 4th week of April, near maturity of crop during both the years respectively. The population trend of *A. mellifera* was similar to *A. florea* having lowest population (10.75 and 10.33) in the 5th week of March and highest (17.35 and 19.55) in the 4th week of April at 0900h in both the years, respectively.

The data on the population of *A. mellifera* and *A. florea* at different hours of the day indicate the highest abundance at 900h, followed by 1100h, and 1300h while the lowest at 1500h. The grand mean populations of *Apis* species at different hours of the day were highest (18.41 and 16.52) at 0900h, followed by 1100h (15.67 and 14.31), 1300h (13.22 and 9.82) and the lowest (10.00 and 8.64) at 1500h in the year 2023 and 2024, respectively.

Apis florea were the dominant visitors followed by *Apis mellifera*. This is because linseed flora could not provide higher energy requirements of heavier and big species of honey bees. Abrol (1992) [1] reported that the honey bees with higher energy requirements do not visit flowers which give low caloric rewards. Priti and Sihag (1998) [9] found that A. florea were dominant visitors of carrot flowers.

The effects of year, hour, date and interaction effects of year x hour, year x date, hour x date and year x hour x date on the population of *A. mllifera* are significant (P=0.05). The interaction effect of year x hour on *A. florea* is non-significant (Table 2).

Table 2: * Means of three replications

Factors	*Apis mellifera*		*Apis florea*	
	SEM (±)	CD(P=0.05)	SEM (±)	CD(P=0.05)
Year	0.06	0.17	0.13	0.37
Hour	0.09	0.24	0.19	0.53
Date	0.09	0.24	0.19	0.53
Year × hour	0.12	0.34	NS	NS
Year × date	0.12	0.34	0.27	0.74
Hour × date	0.17	0.48	0.38	1.05
Year × Hour ×date	0.24	0.68	0.54	1.49
CV (%)	4.06		5.59	

The peak activity of *Apis* species were recorded in the morning hours. It might be due to higher availability of

pollen in the morning hours (Rana, Raj and Kaushik, 1997; Kumar and Singh, 2005) [7, 11].

The correlation coefficients (table 3) of *A. mellifera* (0.949**) and *A. florea* (0.913**) populations are positive and highly significant with temperature. The population of *A. florea* is negative and highly significantly correlated with relative humidity (-0.998**). The correlation coefficient of *A. millifera* population is negative and non-significant with relative humidity (-0.690). The mathematical regression model showed that the combined contribution of temperature and relative humidity to populations of A. mellifera and A. florea are 99.2% and 89.2%, respectively. Oritz- Sanchez and Tinaut (1994) [8] also found positive and significant correlation between the populations of honey bees and temperature. Similar observations were made by Sihag and Khatkar (1999) [13].

Table 3: Correlation coefficients and multiple regression equations between mean population *(A. meliifera and A. florea)* and weather parameters on *Linum usitatissimum*

Independent variable (X)	Dependent variable (Y)	
	***Apis mellifera* (Y_1)**	***Apis florea* (Y_2)**
Temperature ((°C) (X_1)	0.949**	0.913**
Relative humidity (X_2)	−0.690 NS	−0.998**

Multiple regression equation

$Y_1 = 21.389 + 0.841\ X_1 - 0.235\ X_2$ ($R^2 = 0.992$** Adj. $R^2 = 0.989$**)

$Y_2 = 4.442 + 0.961\ X_1 - 0.230\ X_2$ ($R^2 = 0.892$** Adj. $R^2 = 0.849$**)

**Significant at 1% probability level

*Significant at 5% probability level

Conculision

The population of *Apis mellifera* and *Apis florea* were observed to be increasing with the maturation of linseed bloom. The lowest populations of *Apis florea* and *Apis mellifera* were noted in the beginning of the flowering when the temperature was relatively low and humidity was high. As the temperature increased and relative humidity decreased, the population increased and attained the peak near the maturity of linseed crop. This could be due to scarcity of other bee flora in the vicinity at the time of flowering of linseed.

Acknowledgements

The authors greatly acknowledge the field owner for site access.

Financial support

The research work was self-funded.

References

1. Abrol DP. Pollination biology - pollinator plant interaction. Korean J. Apiculture,1992:7(2):130-155.
2. ATARI Patna. Annual FLD Reports. ICAR–Agricultural Technology Application Research Institute, Patna, 2019–2024.
3. Bisen UK, Solanki RS, Gaur VS. Performance of frontline demonstration on productivity and profitability, 2024.
4. Brady NC, Weil RR. The nature and properties of soils. Pearson India. of utera cropping of linseed (*Linum usitatissimum* L.) under rainfed conditions in tribal district Balaghat of Madhya Pradesh, India. Asian Research Journal of Agriculture,2017:17(1):86–92.
5. Directorate of Economics and Statistics. Agricultural statistics at a glance. Ministry of Agriculture and Farmers' Welfare, Government of India, 2021.
6. FAO. FAOSTAT Statistical Database. Food and Agriculture Organization of the United Nations, Rome, 2020.
7. Kumar N, Singh R. Relative abundance of Apis spp. on rabi season sunflower *(Helianthus annus L.)*, J. Ent. Res, 2005, 29(1).
8. Ortiz – Sanchez FJ, Tinaut A. composition and dynamics of the community of potential pollinators of sunfl; ower (*Helianthus annus L.)* in Granada (Spain). Boletin-de Sanided Vegetal, plagas,1994:20(3):737-756.
9. Priti, Sihag RC. Diversity, visitation frequency, foraging behaviour and pollination efficiency of different insect pollinator visiting carrot, Daucus Carota L. var. HC-1 blossoms, Indian Bee j,1998:59(4):1-8
10. Pujari D, Sarma CK, Das BK, Ahmed P, Sarma MS, Das G, *et al*. Impact of cluster front-line demonstration on yield, yield gap and economics of linseed in Bongaigaon district, Assam. International Journal of Research in Agronomy,2024:7(1):21–24.
11. Rana VK, Raj D, Kaushik R. Comparative pollinating activities of *Apis mellifera* and *Apis cerana indica* on rapeseed bloom. J. Ent. Res,1997:21(1):59-64.
12. Samui SK, Maitra S, Roy DK, Mondal AK, Saha D. Evaluation of frontline demonstration on groundnut. Journal of the Indian Society of Coastal Agricultural Research,2000:18(2):180–183.
13. Sihag RC, Khatkar S, Khatkar S. Effect of different environmental factors on the foraging activity of honey bee species visiting eight cultivars of oilseed crops. Annals Agril. Bio-Res,1999:2:257-261.
14. Singh P, Sharma R, Verma A. Productivity and profitability of linseed under improved production technologies. Indian Journal of Agronomy,2017:62(4):456–461.
15. Singh AK, Singh KC, Singh YP, Singh DK. Impact of Frontline Demonstration on Adoption of Improved Practices of Oilseed Crops. Indian Res. J. Ext. Edu,2014:14(3):75-77.
16. Singha AK, Deka BC, Parisa D, Nongrum C, Singha A. Yield gap and economic analysis of cluster frontline demonstrations (CFLDs) on pulses in Eastern Himalayan Region of India. Journal of Pharmacognosy and Phytochemistry,2020:9(3):606–610.