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SEASONAL OCCURRENCE OF HONEY BEES IN CORIANDER

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ABSTRACT

A multi-location trail was carried out at the Beekeeping Unit, TCA, Dholi (Muzaffarpur District, India) and University Apiary, RPCAU, Pusa (Samastipur District, India) during Rabi 2021-22 on Rajendra Dhania-2 variety of coriander. Spatial distribution of bee species in Pusa and Dholi showed that occurance of Italian bee *Apis mellifera* (F) was comparatively higher at Pusa (19.03± 6.29/ m^2/ 10 min) as compared to Dholi (16.56± 5.47/ m^2/ 10 min). Other species of honey bees viz. Indian hive bee, *Apis cerana* (F), rock bee *Apis dorsata* (F) and little bee *Apis florea* (F) were more abundant in Dholi as compared to Pusa. Maximum (number of bee/ m^2/ 10 min) of *Apis mellifera* (24.02, 27.60), *Apis dorsata* (16.88, 14.89), *Apis cerana* (14.55, 11.64) and *Apis florea* (10.47, 8.63) were observed at 13:00, 15:00, 11:00 and 09:00 at Dholi and Pusa, respectively. The underlying factors of this distribution were identified as body size and dietary overlap. This study highlights the complexity of interactions between *Apis* spp. genus and shows how factors like body size and diet influence their distribution patterns.

Key words: *Coriandrum sativum*, *Apis* spp., multi-locations, ecological interactions, spatial distribution, temporal distribution, abundance, body size, dietary overlap, population fluctuation, population pressure and interspecific competitive displacement

Coriander (*Coriandrum sativum* L.) is important tropical spice crop belonging to the Apiaceae (Umbelliferae) family. Among the spices, the cultivated area of coriander is around 5.3 lakh ha with a production of 7.01 lakh mt with productivity of 1325 kg/ ha (Anonymous, 2019). Coriander pollination is entirely dependent on pollinators due to protandrous condition of flowers. Studies on effect of pollination on yield parameters denoted around 50 to 70% of reduction in the yield (Thakur, 2022; Ranjitha et al., 2023). Around 11 to 14 insect pollinators were documented as the important agents responsible for pollinating coriander with major abundance of *Apis* spp. (Thakur et al., 2022). The current study focuses on the seasonal occurrence of *Apis* spp. in two locations in Bihar. This study evaluates the spatial distribution and temporal dynamics in different *Apis* spp. with special concern to interspecific competitive displacement among them by uncovering their foraging strategies and how these strategies intersect with interspecific competition. Understanding these competitive dynamics is essential for developing targeted pollinator management strategies, promoting the coexistence of different *Apis* spp. and enhancing efficient pollination in coriander. Honey bees are resource dependent in their activity (Semida and Elbanna, 2006). This research will help to unravel the complexities of these interactions, illuminating how different *Apis* species compete for dominance in the context of coriander pollination. Using a spatial perspective, our goal is to identify the preferred distribution patterns of these bee species within coriander fields. The findings from this research are crucial, especially in the context of declining pollinator populations and increasing ecosystem vulnerability.

MATERIALS AND METHODS

Multi-location experimental trials were conducted at two places i.e. beekeeping unit, TCA, Dholi, Muzaffarpur (25˚59' N, 85˚35' E) and University Apiary, RPCAU, Pusa, Samastipur (25˚59' N, 85˚48' East longitude) during rabi 2021-22' on Coriander C V Rajendra Dhania-2. Distribution of *Apis mellifera, Apis cerana indica, Apis dorsata* and *Apis florea* were checked at the apiary of Pusa and Dholi by counting the number of individuals/ m2 for 10 min. The number of foragers was recorded during flowering period at different time intervals, i.e. 07:00, 09:00, 11:00, 13:00, 15:00 and

17:00 hr at alternate day for 10 min from 01.03.2022 to 17.03.2022 (flowering period). Observations on temperature and relative humidity were also recorded and correlations worked out with OPSTAT software.

RESULTS AND DISCUSSION

The spatial distribution of bee species in two districts within Bihar, India, as detailed in Table 1, revealed that *Apis mellifera* was the most prevalent bee species in both locations. The population of *Apis mellifera* displayed a higher count at Pusa (19.03± 6.29 individuals/m^2/10 min) in contrast to Dholi (16.56± 5.47 individuals/ m^2/ 10 min). Conversely, *Apis cerana*, *Apis dorsata* and *Apis florea* exhibited greater abundance in Dholi compared to Pusa (Table 1). No significant discrepancies were observed in bee counts. The minor fluctuations in could be attributed to the diversity of forage available at both sites. These findings align with previous research that has demonstrated the dependency of bee population on the environmental attributes of a particular location. Mary et al. (2002) noted significant fluctuations in flower visits/ min in two divergent sites characterized by varying environmental conditions. However, when the environmental conditions and availability of floral resources were held constant, no noteworthy disparities were observed. This result was also corroborated by Rader et al. (2012).

The findings derived from the temporal distribution analysis of bee species in Dholi yielded the conclusion that *Apis mellifera* dominated across all time intervals of the day at both locations (Table 1). The peak in counts for each bee species varied according to the time of day. Specifically, *Apis mellifera* displayed its maximum count (24.02 individuals) at 13:00, *Apis dorsata* at 15:00 (16.88 individuals), *Apis cerana* at 11:00 (14.55 individuals), and *Apis florea* at 09:00 (10.47 individuals) in Dholi. Whereas at Pusa, the maximum was of *Apis mellifera* (27.60 individuals), *Apis dorsata* (14.89 individuals), *Apis cerana* (11.64 individuals), and *Apis florea* (8.63 individuals) was observed during the same time intervals as in Dholi. Throughout the entire day, *Apis dorsata* remained relatively steady, The notable maximum count of *Apis mellifera* can be attributed to the presence of its colonies nearby, particularly at the Beekeeping Unit. *Apis mellifera* and *Apis dorsata* showed higher counts during the afternoon and late afternoon, respectively. Meanwhile, *Apis florea* and *Apis cerana* exhibited their peak abundance during morning and late morning hours, respectively. Factors operated on population within confined spaces, which resulted in suppression of the weaker groups. Notably, the larger body sizes of *Apis dorsata* and *Apis mellifera* emerged as key limiting factors for *Apis florea* and *Apis cerana*, constraining their activity primarily to the early morning hours.

Apis florea and *Apis cerana* were most abundant during early flowering (Fig. 1) and mid flowering stage, respectively; whereas *Apis mellifera* and *Apis dorsata* were abundant at peak flowering stage. The observed peaks at different time and dates intervals can be attributed to competitive displacement dynamics between bee species. The competitive pressure stemming from dietary overlap among honey bees, bumble bees, and solitary bees has been previously explored (Wignall et al., 2020). The present research has significantly contributed to the identification of interspecific competitive pressures existing among *Apis* spp. The findings from the temporal distribution analysis are corroborated by the observations of previous researchers. Chaudhary and Singh (2007)

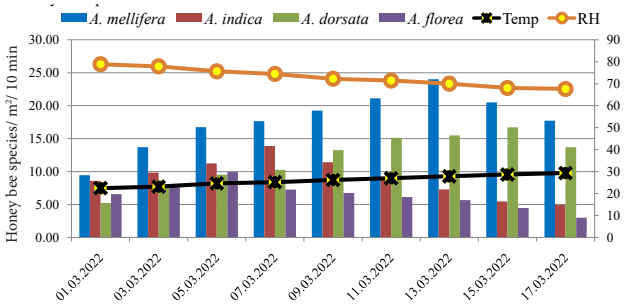

Fig. 1. Mean temporal distribution (No. of honey bee species/ m2/10 min) of honey bee species on coriander flower on different dates of observations and in relation with weather

Table 1. Distribution (No. of honey bee species/ m^2/ 10 min) and population dynamics of honey bees in different hours of the day on coriander (Pusa and Dholi, 2021-22)

Time	*Apis mellifera*		*Apis cerana*		*Apis dorsata*		*Apis florea*		Mean	
	Pusa	Dholi	Pusa	Dholi	Pusa	Dholi	Pusa	Dholi	Pusa	Dholi
07:00	10.35	9.02	6.02	9.03	8.12	10.70	6.73	8.16	7.80	9.23
09:00	17.14	14.90	9.15	11.34	9.74	11.66	8.63	10.47	11.16	12.09
11:00	23.22	20.21	11.64	14.55	11.36	14.63	7.26	8.81	13.37	14.55
13:00	27.60	24.02	9.80	12.23	13.21	15.79	5.36	6.49	13.99	14.63
15:00	21.51	18.68	7.23	7.52	14.89	16.88	4.47	5.42	12.03	12.12
17:00	14.38	12.51	4.62	5.68	7.67	8.09	3.27	3.96	7.49	7.56
Mean ± SD	19.03± 6.29	16.56± 5.47	8.08± 2.60	10.06± 3.26	10.83± 2.86	12.96± 3.37	5.95± 1.96	7.22± 2.38	10.97± 2.77	11.70± 2.84

identified *Apis mellifera* as the predominant species, Roy (2014) found that among the three honey bee species, *Apis dorsata* exhibited the highest abundance Nagpal et al. (2017) reported that the population of *Apis florea* reached its pinnacle from 08:00 to 10:00 hours and diminished as temperatures rose. Meena et al. (2018) reported that *Apis mellifera* exhibited its peak foraging activity between 12:00 to 14:00 hr, concluding at 18:00 hr. Joshi and Joshi (2019) noted that *Apis cerana* reached its zenith between 10:00 to 11:00 hr and declined in the evening. Sathya (2019) observed that *Apis mellifera* predominated, trailed by *Apis dorsata* and *Apis florea*, while foraging on onions. Das et al. (2019) found that *Apis florea* peaked during the morning hours (9:00 to 11:00 hr) but decreased as temperatures escalated. Bijarniya et al. (2024) reported that *A. cerana*, *A. dorsata* and *A. mellifera* were highest during 12:00 to 14:00, 14:00 to 16:00 and 18:00 to 14:00 hr, respectively. Verma et al. (2024) found the same results i.e., abundance of *Apis florea* and *Apis indica* in morning to late morning hours, whereas *Apis mellifera* and *Apis dorsata* in afternoon to late afternoon hours.

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AUTHOR CONTRIBUTION STATEMENT

MVT and NK conceived and designed research. MVT, GSG and RDV conducted experiments and collected data. MVT, GSG and NK analyzed data and interpreted results. SSM wrote the manuscript. All authors read and approved the manuscript.

CONFLICT OF INTEREST

No conflict of interest.

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