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Study of various Alpha Diversity Indices for different Insect Pollinators on Coriander

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ABSTRACT: Experimental trials were conducted at research field of Beekeeping Unit, Dholi (Muzaffarpur) during *Rabi* season of 2021-22 on coriander. Diversity among insect pollinators is very much essential for higher yield as well as maintaining ecological balance. Total visited insect pollinators were 76 belonging to 11 genus, 6 families and 5 orders. *Apis mellifera* was most abundant species at Dholi location (19.74 per cent). Several diversity indices revealed that the region has a substantial amount of rich diversity. Diversity of insect pollinators was due to richness of natural resources surrounding the research field. There were no predominant species present and number of individuals in maximum species was quite similar. Evenness in population was due to the presence of flowering in crops at surrounding fields.

Keywords: *Coriandrum sativum* L, Insect pollinators, Diversity index, Richness, Evenness and Dominance.

INTRODUCTION

Coriander (*Coriandrum sativum* L.) is a major tropical spice crop in the Apiaceae family (Umbelliferae). Despite it's origin in the eastern Mediterranean area, India accounts for more than 70 per cent of total global output (Coskuner and Karababa 2007). Protandrous condition of coriander flowers is main reason behind cross pollination in this spice crop (Hawthorn *et al*., 1960). Hence, coriander pollination is entirely dependent on pollinators. Research on coriander in Russia in 1950 revealed a 49% to 68% drop in seed set as a result of pollinator exclusion (Glukhov, 1976). Honey bee is a potential pollinator among all other, while the *Apis* genus predominates among pollinating bee species in India.

Plant-pollinated mutualisms date back to the Cretaceous era (Tepedino, 1979). Pollinators are equally as crucial to the survival of these plants as light and water (Levin, 1971). Plant-pollinator interactions are highly valued mutualisms in agricultural food production because they provide essential ecological activities that promote world biodiversity. Pollinators are groups of animal species that transmit pollen in blooming plants (Ollerton, 2017). Insect, such as Hymenoptera, Diptera, Coleoptera, Lepidoptera and odonata are the most diverse and abundant pollinators (Devi *et al.*, 2015). Pollinator diversity is critical for seed formation in flowering plants (Blitzer *et al.*, 2016). Plants pollinated by a functionally diverse pollinator population have been found to generate large quantities of high-quality seeds (Gomez *et al*., 2007; Celep *et al*., 2020). Pollinator diversity has great impact on agricultural production quality. Pollinator exclusion studies in coriander have revealed that seed weight improves exclusively in portions pollinated by either honey bees or all pollinators (Thakur, 2022).

Higher diversity of insect pollinators is very important in maintaining ecological balance. Biodiversity is calculated by various indices which used to measure the richness and evenness of different species in population. High diversity index is referred as a key indicator of healthy area.

METHODOLOGY

Research trials were conducted at research field of Beekeeping Unit, Dholi (Muzaffarpur) during *Rabi* season of 2021-22 on coriander. Population abundance of insect pollinators was checked at Dholi location by visually counting the number of individuals per one square meter for 15 minute. The observations were recorded during flowering period at different time intervals, *i.e.* 09:00, 11:00, 13:00 and 15:00 hours at alternate day for 15 minute from 25.02.2022 to 12.03.2022. Pollinators visiting the crop were collected, preserved and identified during the period of observations with the help of available taxonomic keys and Insect taxonomists. Data collected from experiment was used to evaluate the following diversity indices

using analytical tools : Richness (R), Berger Parker Index (B), Shannon Index (H), Shannon Equitability Index (EH), Simpson Dominance Index(1-D), Gini-Simpson Index, Margalef Richness Index, Buzas and Gibson's Index and Menhinick Index.

RESULTS

Population abundance of insect pollinators at Dholi location showed (Table 1) that total number of insect pollinators per one square meter for 15 minute was 76 at Dholi having 5 orders, 6 families and 11 genus. Most abundant pollinator was *Apis mellifera* at Dholi location (19.74 per cent) followed by other *Apis* sp. The least abundant insect pollinator at Pusa location was *Coccinella septempunctata* (03.95 per cent). Population of *Apis* sp. dominated Dholi location with 55.26 per cent relative abundance. The reason behind dominance of *Apis mellifera* was bee hive near the field. Same results of Dominance by *Apis* sp. were obtained by Ranjitha *et al.* (2019) during study on relative abundance.

Table 1: Population of different insect pollinators at Dholi location on coriander.

Order	Family	Name of insect pollinator	Population size	Relative abundance (%)
Hymenoptera	Apidae	*Apis mellifera*	15*	19.74
		Apis cerana	9	11.84
		Apis dorsata	11	14.47
		Apis florea	7	09.21
Diptera	Syrphidae	*Episyrphus balteatus*	6	07.89
		Eupeodes sp.	7	09.21
	Muscidae	*Musca sp.*	4	05.26
Lepidoptera	Pieridae	*Pieris brassicae*	4	05.26
Odonata	Corduliidae	*Macromia magnifica*	5	06.58
Coleoptera	Coccinelidae	*Coccinella septempunctata*	3	03.95
		Unidentified	5	06.58
		Total	**76**	

*- Population size is converted into integral value for analytical process.

Results of various indices (Table 2) derived through experiment are given below,

Richness. Number of different species present at Dholi location was 11.

Berger Parker Index. This index was low at Dholi location (19.7 per cent), which means the community was not dominated by any single species and well diversity was maintained.

Shanon Index. This index showed optimum diversity at Dholi location (2.29). Higher Shanon index reflected more diverse species in the habitat. If the index equals to 0 then only one species is present in the community.

Shannon Equitability Index. This index was observed to be higher at Dholi location, which means almost same number of individuals from each species were present in area. This index indicates evenness in number of species in area.

Table 2: Different diversity indices for population of different insect pollinators at Dholi location on coriander.

Indices	Value
Richness (R)	11
Berger Parker Index (B)	19.70 %
Shannon Index (H)	2.29
Shannon Equitability Index (EH)	95.40 %
Simpson Dominance Index (1-D)	11.30 %
Gini-Simpson Index (G)	88.70 %
Margalef Richness Index	2.31
Buzas and Gibson's Index	0.90
Menhinick Index	1.26

Simpson Dominance Index. Value for Simpson Dominance Index was lower *i.e.* 11.3 per cent. Lower value of index represented higher species diversity and no any single species with dominant number of individuals. This index shows the dominance of species having maximum individuals.

Gini-Simpson Index. Index was higher at Dholi location (88.7 per cent). This index measured the probability that two randomly selected individuals belongs to different species. Higher index represented high probability of diversity. Lorenz curve (Fig. 2) obtained from this index.

Margalef Richness Index. Value for this index was higher, which denoted species richness in population. High index value denoted presence of many types of species in the population.

Buzas and Gibson's Index. This is evenness index and similar to Shannon Equitability Index. Value of this index was higher at Dholi location (0.90) which indicated almost same number of individuals from each species in the area.

Menhinick's Index. Result for this index was comparatively higher. Higher index denotes diversity in species or small population size.

Current results of diversity indices were slightly different from few previous studies *i.e.* Bhowmik *et al.* (2017) calculated H index in coriander which was 1.09 - 1.19, Devi *et al.* (2015) found that Diptera was most dominant order among insect pollinators. These deviations in results were due to some external factors as like climatic conditions etc. Results for Berger-Parker index were slightly similar to previous work *i.e.* 28.8 per cent in other crops like onion observed by Karuppaiah *et al.* (2017). Kasina *et al.* (2009) also observed that among all pollinators honey bee was most

predominant. Sharma and Meena (2019) observed that hymenoptera was the dominant pollinator group followed by Diptera.

DISCUSSION

Coriander attracted more pollinators due to high fragrance. Flowering in crops present at nearby fields also attracted insect pollinators which was a reason for evenness in population. *Apis mellifera* was abundant due to presence of bee hive. Optimum diversity index was maintained at Dholi due to more natural resources and forest area at nearby regions of the research field.

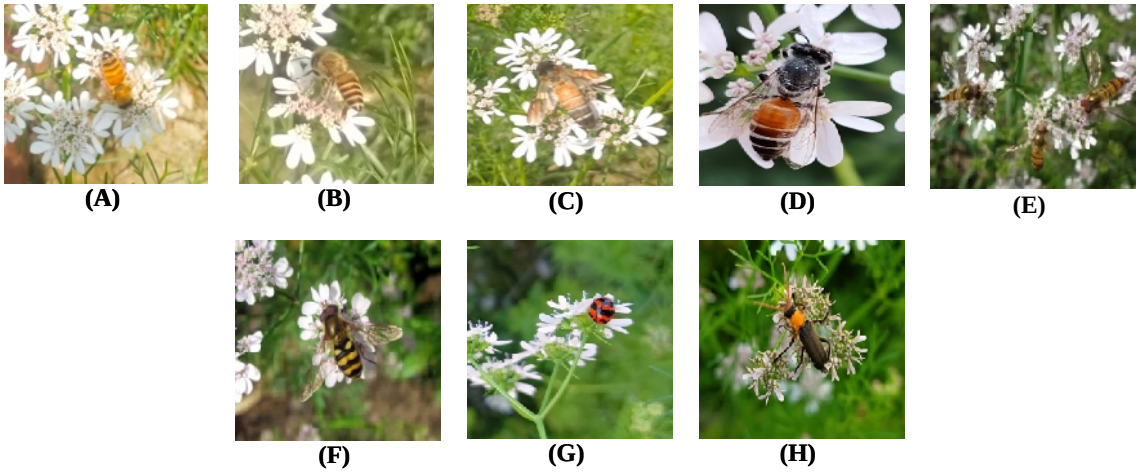

Fig. 1. (A) *Apis mellifera* (B) *Apis cerana* (C) *Apis dorsata* (D) *Apis florea* (E) *Episyrphus balteatus* (F) *Eupeodes* sp. (G) *Coccinella septempunctata* (H) Unknown insects.

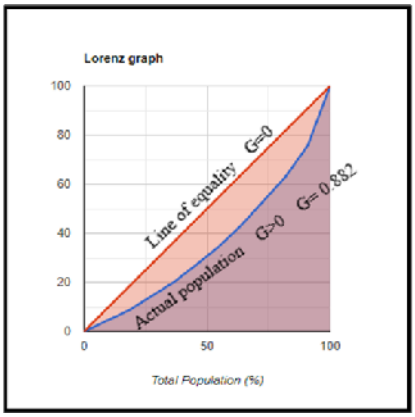

Fig. 2. Lorenz curve showing diversity based on Gini-Simpson Index (G) at Dholi location.

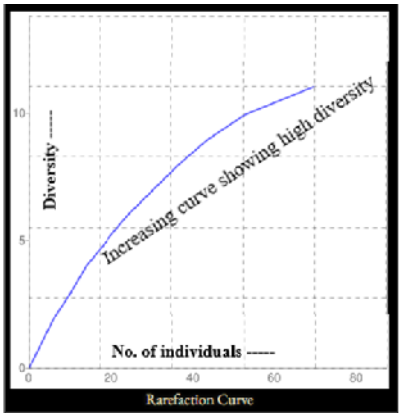

Fig. 3. Rarefaction curve showing high diversity at Dholi location.

CONCLUSION

In the present study, coriander flowers were visited by different insect pollinators. Total visited insect pollinators were 70 at Dholi belonging to 11 genus, 6 families and 5 orders. Pollinators from Apidae family contributed more pollination with more than 50 per cent share in population abundance. Various diversity indices showed that area had sufficiently rich diversity. Population of each species was more or less similar and no any over dominated species observed. Abundance of insect pollinators at Dholi location was due to richness of natural resources surrounding the research field. Slight variations between previous reports and results of the present study are may be due to change in the crop variety, floral reward, existing foraging source, climatic condition and native pollinator's guilds. This study furthermore provides an insight into the efficient species, foraging habits and surrounding flora that might encourage more pollinators to this cross-pollinated crop.

FUTURE SCOPE

Diversity of pollinators at each time interval of the day can be calculated, which will help to identify the effect of weather parameters on diversity of pollinators and diversity indices. Unidentified species should be thoroughly studied by taxonomist for increasing accuracy in diversity indices. Excess use of pesticides should be avoided for maintaining biodiversity of insect pollinators at optimum level.

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