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Research Article

Species diversity and abundance of birds in ber (*Zizyphus mauritiana)* crop

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ABSTRACT

The present study was conducted to record birds species assemblage in ber crop from September, 2019 to March, 2020 and September, 2020 to March, 2021 at experimental orchard of HAU and village Salemgarh of district Hisar. A total of 33 species from 23 families and 11 orders were recorded during the study period. Passeriformes was the most predominant order at both locations. Avian species were classified based on migratory status, 30 species were resident and 3 species were winter migratory. According to the IUCN Red list, 32 species were under the category of least concern and only one species (Alexandrine parakeet) has been enlisted as near threatened. The most dominant species was Rose-ringed Parakeet with maximum relative abundance (97.47%) in the ripening stage. Insectivores (27.27%) birds were most abundant followed by omnivores (21.21%), carnivores (15.15%), granivores (12.12%), frugivores (9.09%), insectivores/frugivores (6.06%), frugivores/granivores (6.06%) and nectarivores (3.03%). Insectivores, omnivores and carnivores birds were observed to feed exclusively on insects and soil invertebrates and act as biocontrol agents. Thus, ber crop is a pivotal bird habitat. This underscores the importance of these study sites as crucial habitats for the conservation of precedence bird species and dominance of insectivores species helps in regulation of insect pest of ber crop.

Key words: Agriculture, Avian, Conservation, Passeriformes, Richness

INTRODUCTION

Agriculture contributes vital nutrients to the globe's diet. According to the Ministry of Agriculture research, India's agricultural crop output increased by 3% in 2020 -21 compared to prior years (Gotame *et al*., 2018). Fruit and vegetables provides an enormous amount of minerals, proteins and vitamin C (Ali *et al*., 2023). As a result, expanding fruit production offers both social and economic advantages. Among various fruit crop, ber, a member of the rhamnaceae family and a significant tropical and deciduous fruit crop in India, is also referred to as the "poor man's fruit." It is resistant to harsh weather conditions and is cultivated extensively in South-East Europe and Southern Asia. In India, ber is grown in Haryana, Punjab, Rajasthan, Bihar, Maharashtra and Andhra Pradesh etc. (Shilpa *et al*., 2023). Insects and birds are two of the main pests that wreak havoc ber crops and affect the quality and yields. Birds are commonly found in almost every agroecosystem, and their feeding preferences frequently have a significant positive and negative impact on crop productivity (Sidhu & Kler, 2018). The financial costs that avifauna impose on an agroecosystem seems insignificant in light of the immense ecological advantages that birds deliver (Hossain & Aditya, 2016). Birds control the insect population through the consumption of beetles, termites, moths, spiders, ants and other insects. Raptors regulate the population of reptiles, birds and mammals in agriculture (Kumar & Sahu, 2020). Birds such as drongos, mynas, shrikes and kingfishers spend the entire day foraging for insects and caterpillars in rice fields. Different species of owls hunt rodents that attack crops especially in food grain farming throughout the night (da Silva *et al*., 2021). Some of the birds like oriental white-eye, sunbirds, flycatchers, drongos and magpie robins, aid in crop pollination. Important predators such as insectivores birds, must be encouraged in the agroecosystem through appropriate management (Kaur & Kumar, 2022). Agricultural practices have changed dramatically over the preceding decades with the massive use of pesticides, as well as escalating urbanisation and industrialization. All of these activities pertaining to development have resulted in substantial ecological modification, affecting the diversity of avifauna in agroecosystem (Kaur & Sidhu, 2022). To offset the diminution in bird diversity, it is essential to recognise hotspot areas. Hence the current study aims to investigate the ber crop as a habitat for birds by exploring their richness and diversity. The active role of birds at various phases of crop development was recorded to develop a strategy to minimise crop ruination and conservation strategies for agriculturally important species.

MATERIALS AND METHODS

The present study was conducted in the ber crop fields at experimental orchard of HAU (Location I) and village Salemgarh (Location II) from September, 2019 to March, 2020 and September, 2020 to March, 2021 in

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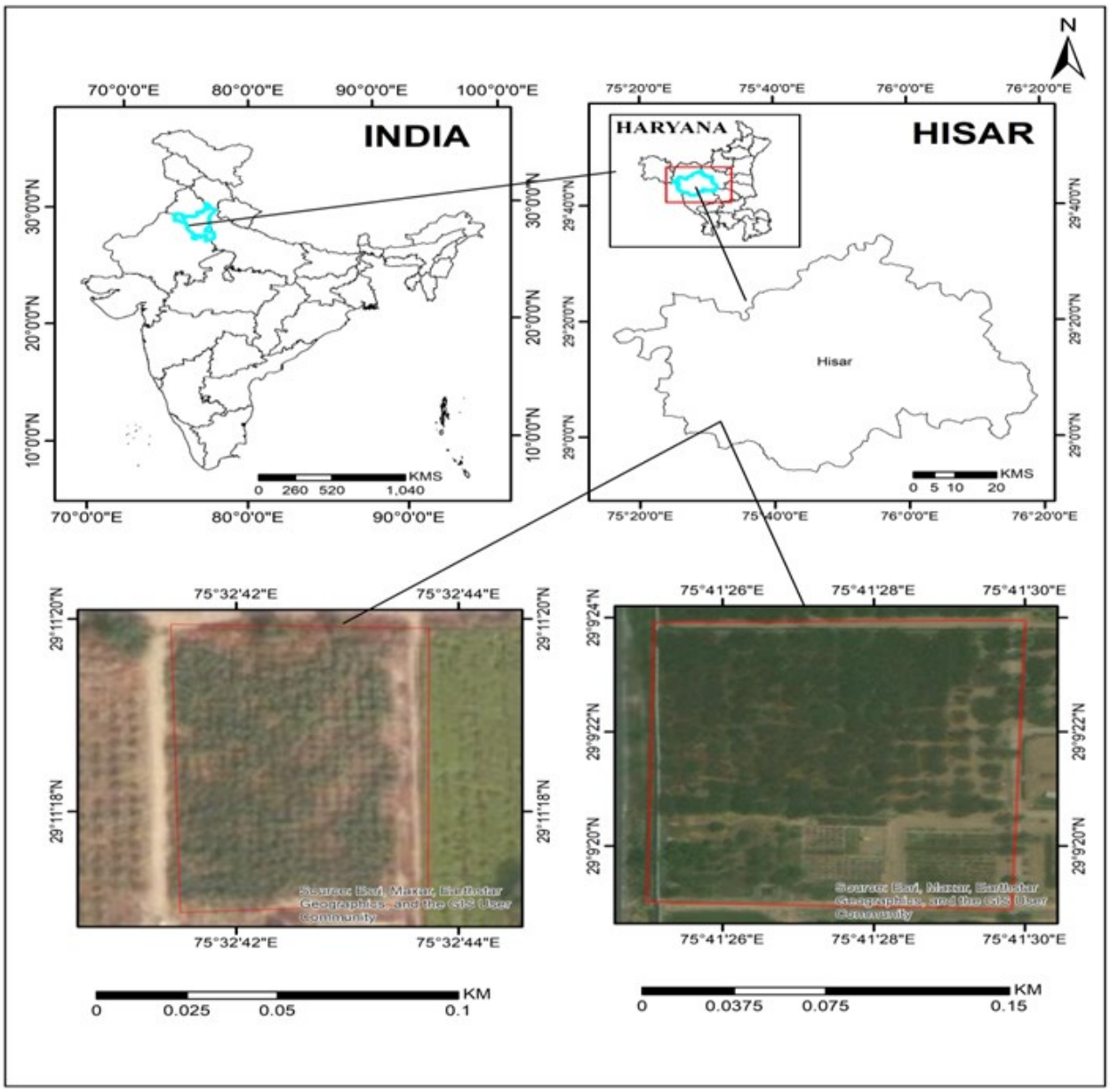


Figure 1. Location map of study area Forest (CRF)

district Hisar. Location I lies between (29° 09'21.8"N 75°41'29.1"E) and location II lies between (29° 11'18.5"N 75°32'42.7"E) (Figure 1). Fields with one acre of area were selected for both locations. The field investigations were conducted once a week from 5:00 to 8:00 A.M. and from 4.00 P.M. to 6.00 P.M. during the season. The line transects method was used to estimate bird diversity. Every month, 4 transects (500 m each) were laid in both sides of the agricultural field. Each transect was thoroughly explored on foot to record the presence of any bird species sighted within a 100-meter radius (Verner, 1985). Birds were observed by using binoculars (8×42, 8o) to identify their specific morphological characteristics. After that, photographs were taken with a COOLPIX NIKON P900 camera. A Reference book was used for the identification of birds (Grimmett *et al.,* 2016). Authentic avian resources werealso used for checklist preparation. Based on field observations, feeding guild status (e.g. Insectivores, Nectarivores, Carnivores, Omnivores, Granivores and Frugivores) were classified (Ali, 2002).

Based on observations, data was analysed for the status of local abundance, according to MacKinnon & Phillipps (1993), species that were very common (VC) were observed more than ten times, common (C) seven to nine times, uncommon (UC) three to six times, and rare (Ra) were observed just once or twice.The presence or absence of birds during a specific period of the year was used to classify the residential status. The conservation status of the species was assessed by using IUCN (2021) criteria. Observations related to avifaunal diversity, richness and relative abundance at the flowering, fruit setting and ripening stages of ber crop were also recorded. The following formula was used to calculate relative abundance (Torre-Cuadros *et al*., 2007).

$$\text{Relative abundance (\%)} = \frac{\text{Total number of individual species}}{\text{Total number of species population}} \text{ X } 100$$

Shannon-weiner diversity index, simpson's index of diversity and species evenness were calculated using the software PAST version 4.0.

Shannon-weiner index (H′): It reflects how many different species there are in a dataset, and simultaneously takes into account how evenly the basic entities are distributed among those types (Shannon & Weaver, 1963).

It is calculated by the following formula.

$$H' = - [\sum Pi \ln Pi]$$

Where, Pi = Proportion of each species in the sample
lnPi = Natural logarithm of this proportion

Simpson's index (D): It is a measure of diversity which takes into accounts both richness and relative abundance of species (Simpson, 1949). It has been measured by the given formula.

$$D=1-\{\sum n(n-1)/N(N-1)\}$$

Where, n = Total number of particular species of birds
N = Total number of birds of all species

Evenness (E): It is used to calculate how evenly the species are distributed in the studied area (Hammer *et al*., 2001). It is calculated by the given formula.

$$E= H' / \ln S$$

Where, H′ = Shannon-weiner diversity index
ln = Natural log of the number
S = Species richness

RESULTS AND DISCUSSION

The presence of various bird communities recorded in ber crop at different locations in Hisar district of Haryana is given in Table 1. A total of 33 species from 23 families and 11 orders were recorded during the study period out of which 33 and 17 species were recorded from location I and location II respectively. All the 17 species recorded at location II were also observed at location I (Figure 2). According to our study, species richness was higher at location I because of mixed cropping system (Date, Guava, Grape, Apple ber, Sapota, Mulberry, Mango and Kinnow) as compared to location II (Guava and Fig) which ensures the survival of birds. The birds assemblage is influenced by number of factors like availability of food resources, type of vegetation, roosting sites, predation pressure and degree of human interference etc. (Chiawo, 2018).

As per findings the highest population (31 and 17) of bird species was observed at location I and II respectively during the morning hours. Birds feed most frequently in the early morning and late afternoon (Tracey *et al*., 2007). Species richness (22) was high in fruit setting stage in morning hours during the year 2020 -2021 at location I. At location II, the highest bird species richness (13) was recorded at the flowering stage in morning hours during the year 2019-2020. The results revealed that species abundance was recorded maximum at the flowering and fruit setting stage because both stages attract large number of insectivores birds. Higher bird species abundance observed at the flowering stage due to easy availability of insects, small invertebrates, reptiles and amphibians at orchard (Sidhu & Kler, 2018).

Passeriformes was the most dominant order followed by Columbiformes, Piciformes, Coraciiformes, Pelecaniformes, Psittaciformes, Accipitriformes, Bucerotiformes, Cuculiformes, Galliformes and Strigiformes (Figure 3). Kiran *et al*. (2022) observed a similar trend as order passeriformes was the most abundant bird taxon in India.

Muscicapidae and Columbidae (4 sp.) were the most diverse family in study area. Rajashekara & Venkatesha (2017) also recorded muscicapidae as the most prevalent family in India. Out of 33 species recorded 19 were categorised as abundant species, 12 were very common, one was uncommon and one was rare. Avian species were categorized according to migratory status, 30 species were resident and three species were winter migratory. According to the IUCN Red list, 32 species were under the category of least concern and only one species (Alexandrine parakeet) has been enlisted as Near threatened. A total of eight feeding guilds were recorded including insectivores (9 sp.), omnivores (7 sp.), carnivores (5 sp.), granivores (4 sp.), frugivores (3 sp.), insectivores/frugivores (2 sp.), frugivores/ granivores (2 sp.) and nectarivores (one sp.). Insectivores (27.27%) birds were most abundant followed by omnivores (21.21%), carnivores (15.15%), granivores (12.12%), frugivores (9.09%), insectivores/frugivores (6.06%), frugivores/granivores (6.06%) and nectarivores (3.03%) (Figure 4). The findings were similar to previous records that insectivores is the prevailing foraging guild in agricultural area of India (Kumar & Sahu, 2020; Platt *et al*., 2021). During the study period Black drongo, Asian green-bee eater, Jungle babbler, large grey babbler, White-breasted kingfisher and Indian robin were observed to feed exclusively on insects and soil invertebrates. Kaur & Kumar (2022) stated that white-breasted kingfishers, bee-eaters and black drongos act as biological control agents against white grub in agricultural landscapes. House crow, Cattle egret and Red-wattled lapwing were observed devouring ants on the ground. These insectivores birds keep a potent check on various insect pests thriving in agroecosystems (Kumar & Sahu, 2019). Frugivores birds (Yellow-footed green pigeon, Rose-ringed parakeet, Alexandrine parakeet, Brown-headed barbet and Red-vented bulbul) were observed to be good in abundance during the fruit setting and ripening stage of ber crop. Shilpa *et al*. (2023) studied that frugivores birds dominated the fruit setting and ripening stage of guava crop.

Figure 2. Number of species overlap among the two sites illustrated by Venn diagram.

Relative abundance

The most dominant species was Rose-ringed parakeet with maximum relative abundance (75.71%) in the ripening stage; followed by Alexandrine parakeet which constituted 33.82 per cent abundance of the total bird community in the flowering stage at location I during evening hours (Table 1). Relative abundance of Rose-ringed parakeet (97.47%) and Cattle egret (21.65%) was recorded maximum in ripening and flowering stage respectively at location II during evening hours as compared to other birds. As per the findings of study Rose-ringed parakeet relative abundance was recorded maximum at both locations during evening hours. Parakeets number was comparatively higher during evening hours as compared to morning hours and may be to meet the food requirement for spending the fasting night on the roost (Khan *et al*., 2013).

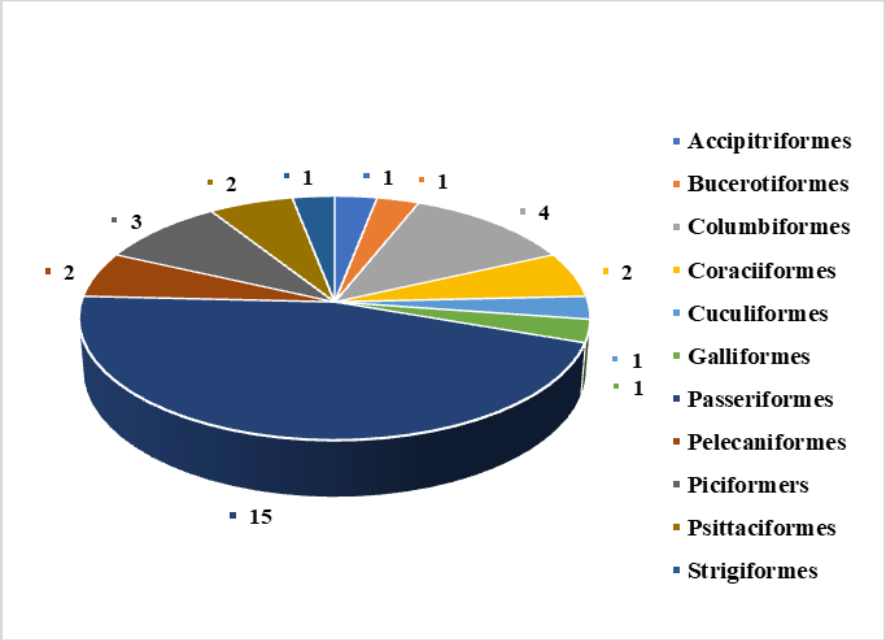


Figure 3. Orderwise abundance of recorded avian species

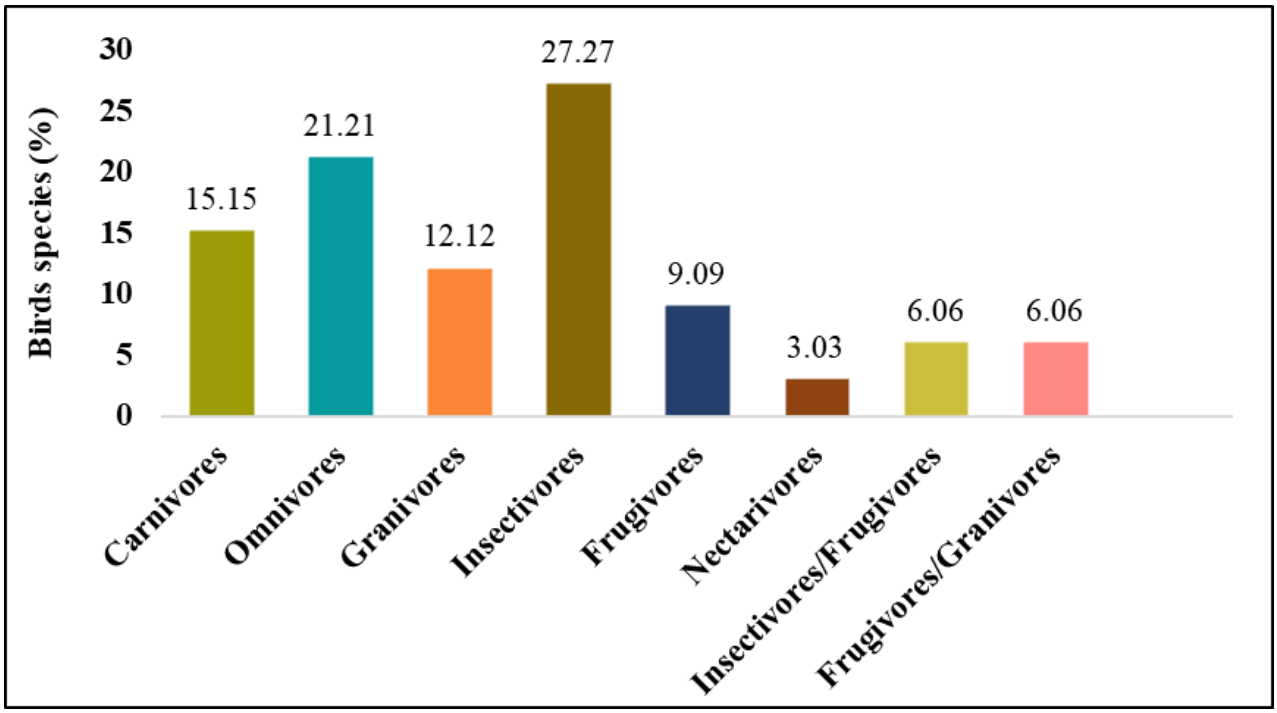


Figure 4. Feeding guild status of recorded avian species

Table 1. Avian Community composition at different developmental stages of ber crop during morning and evening hours at location I and II

Crop stage	Flowering stage	Fruit setting stage	Ripening stage	Flowering stage	Fruit set-ting stage	Ripening stage	Flowering stage	Fruit set-ting stage	Ripening stage	Flowering stage	Fruit set-ting stage	Ripening stage
	(Sep 19-Oct 19)	(Nov 19-Dec 19-Jan 20)	(Feb 20-Mar 20)	(Sep 20-Oct 20)	(Nov 20-Dec 20-Jan 21)	(Feb 21-Mar 21)	(Sep 19-Oct 19)	(Nov 19-Dec 19-Jan 20)	(Feb 20-Mar 20)	(Sep 20-Oct 20)	(Nov 20-Dec 20-Jan 21)	(Feb 21-Mar 21)
	Morning hours						Evening hours					
Bird species	Relative abundance (%)											
Black Kite	3.25	-	-	0.86	-	0.12	-	-	0.09	0.56	-	-
Indian Grey Hornbill	(2.26)	(0.77)	0.52(0.46)	(1.78)	0.41	0.12 (0.36)	0.74 (0.43)	(0.46)	0.34 (0.26)	0.56 (0.55)	0.78 (0.60)	0.33 (0.25)
Eurassian collared dove	-	(4.12)	0.65	-	-	0.99	-	0.80	0.86	(1.65)	1.72	0.78
Laughing dove	-	-	-	-	0.41	-	-	-	0.17	-	-	-
Rock dove	-	-	-	-	1.23	-	-	-	0.52	-	-	-
Yellow-footed Green-pigeon	-	6.72	6.63	-	6.13	6.56	-	3.46	4.98	-	4.55	6.44
White-breasted Kingfisher	1.95 (0.75)	0.65 (0.26)	0.39	(1.18)	0.41 (0.42)	0.12 (0.36)	1.47 (1.30)	0.27 (0.46)	0.26 (0.26)	1.11 (0.55)	0.63 (0.20)	0.22 (0.13)
Asian Green Bee-eater	4.55	1.08	1.69	1.72 (0.59)	-	0.37	2.94	-	0.43	1.11	-	-
Western Koel	(0.75)	1.08	0.65	0.86	0.82	0.37	0.74	0.40	0.43	1.11	1.41	0.55
Grey Francolin	-	-	-	-	-	0.12	-	-	-	-	-	-
Plain Prinia	-	-	-	-	0.20	-	-	-	-	-	-	-
House crow	5.84 (20.30)	(3.61)	(1.08)	3.45 (6.51)	(10.99)	-	5.15 (6.06)	(2.05)	(0.92)	7.22	(0.80)	(0.76)
Rufous Treepie	1.95 (0.75)	1.08 (0.26)	0.78 (0.15)	0.86 (0.59)	0.82 (0.42)	0.25 (0.18)	0.74	0.40 (0.23)	0.09 (0.26)	1.11 (0.55)	0.63 (0.40)	0.22 (0.13)
Black Drongo	1.30	-	0.13	0.86 (0.59)	0.20	-	0.74	-	-	-	-	-
Indian Silverbill	-	-	0.13	-	-	-	-	-	-	-	-	-
Large grey babbler	-	-	-	-	-	-	-	0.93	-	3.89	-	-

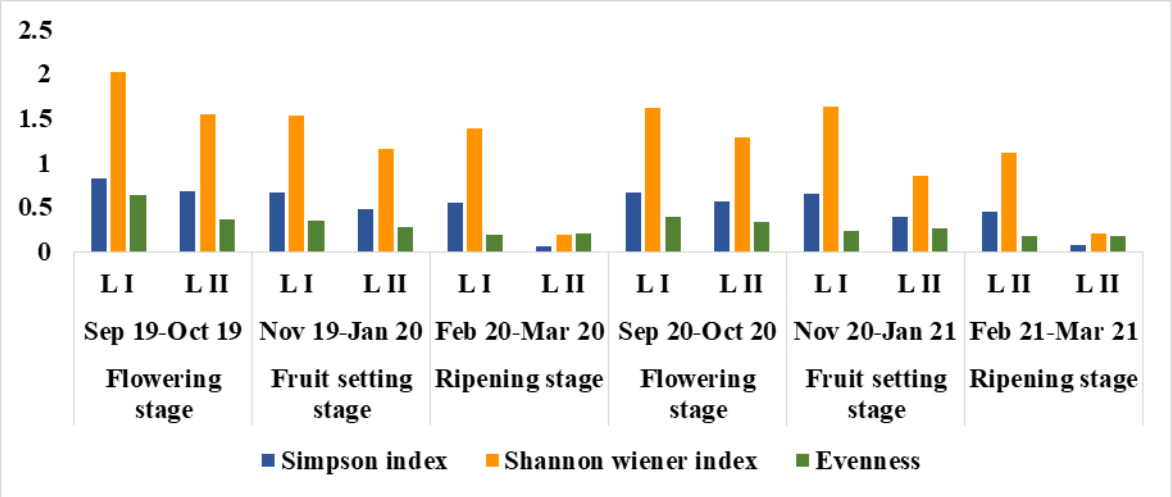
Jungle Babbler	**16.23**	**3.47**	**3.77**	**11.21**	**9.20**	**3.47**	**7.35**	**2.66**	**0.86**	**10.00**	**2.51**	**0.44**
Black Redstart	(0.75)	0.87 (0.77)	0.39 (0.15)	-	0.82 (0.42)	0.25 (0.36)	-	0.27 (0.68)	0.09 (0.13)	-	0.31 (0.40)	0.33 (0.13)
Indian robin	-	-	-	-	0.20	-	-	-	-	-	-	-
Oriental Magpie-robin	(0.75)	(0.26)	0.26	(1.18)	0.20 (0.42)	(0.18)	(0.43)	-	(0.26)	1.11 (0.55)	0.16	(0.13)
Verditer Flycatch-er	-	-	-	-	0.20	0.12	-	0.13	-	-	-	-
Purple Sunbird	(0.75)	-	0.13	-	-	-	-	-	0.09	0.56	-	-
Common Chiff-chaff	-	-	-	-	0.41	-	-	-	-	-	-	-
Red-vented Bul-bul	1.30 (0.75)	2.17 (1.03)	2.34 (1.38)	1.72 (1.18)	1.02 (0.63)	1.61 (2.01)	1.47	1.06	1.12 (1.05)	1.67	2.04 (0.20)	2.22 (1.01)
Common Myna	15.58 (6.77)	4.12 (5.93)	1.04	5.17 (13.61)	3.68 (8.88)	1.24	4.41 (9.96)	1.06 (1.82)	-	6.67 (3.30)	1.72 (2.59)	4.41 (9.96)
Cattle Egret	-	(10.57)	0.52	-	-	-	(21.65)	-	0.60	4.44 (17.03)	-	-
Red-naped Ibis	(14.29)	(1.80)	-	(8.28)	(1.27)	-	(4.76)	1.20	-	2.22 (1.10)	-	-
Brown headed Barbet	1.95	1.52	1.17	1.72	1.43	1.36	1.47	1.06	0.77	1.11	1.41	1.00
Coppersmith Bar-bet	-	-	-	-	0.41	-	-	0.13	-	-	-	-
Black-rumped Flameback	(0.75)	-	0.13	-	-	-	-	-	0.09	-	-	-
Alexandrine Para-keet	13.64	22.99	13.39	14.66	15.54	10.15	33.82	18.48	12.45	15.00	17.87	12.87
Rose-ringed Para-keet	32.47 (50.38)	53.36 (70.62)	65.02 (96.77)	55.17 (64.50)	55.62 (76.53)	72.77 (96.53)	38.24 (55.41)	67.55 (94.31)	75.71 (96.85)	40.00 (74.73)	64.26 (94.81)	74.58 (97.47)
Spotted Owlet	-	0.87	0.26	1.72	0.61	-	0.74	0.13	0.09	0.56	-	-
Species richness	12 (13)	13 (12)	21 (6)	13 (11)	22 (9)	17 (7)	14 (8)	17 (7)	20 (8)	19 (9)	14 (8)	12 (8)

Location I - Without bracket, Location II - With bracket

Diversity index

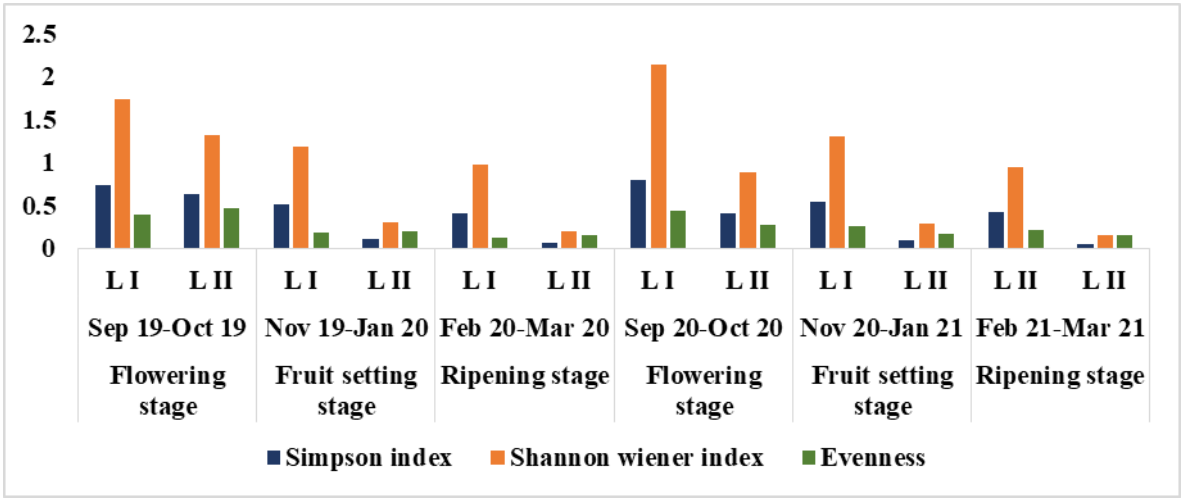
Different bird diversity indices calculated from location I and II during the study period are presented in figure 5 and 6. Simpson index of diversity was recorded as highest (0.82) at the flowering stage in morning hours at location I during the year 2019-2020. Shannon-wiener index for diversity richness showed maximum diversity (2.14) at the flowering stage in evening hours at location I during the year 2020-2021. Species evenness was maximum (0.63) at the flowering stage in morning hours at location I during the year 2019-2020. The values of simpson index, shannon-weiner index and species evenness was recorded highest at location I indicated that the highest species richness and diversity was recorded at location I because of presence of different types of crops and plantation (*Psidium guajava*, *Citrus sinensis*, *Mangifera indica*, *Brassica* sp. and *Populous deltoids*) in the surrounding areas which provide various food like grains, fruits and insects to the birds. There is less variation in species diversity during the both years in same site. Farming intensity and anthropogenic activities influence the abundance of birds in agricultural fields (Kumar & Sahu, 2020).

As per the findings of our study, higher values of simpson index, species diversity and species evenness were recorded at the flowering stage because maximum number of insectivores species were observed at the flowering stage due to easy availability of insect diversity. Our findings are in line with Kaur & Kumar (2022). Observations by Rajashekara & Venkatesha (2015) also confirm our findings that the species richness, species diversity and evenness of avian communities vary significantly in different landscapes.



L I - Location I, LII - Location II

Figure 5. Diversity indices of avian community in ber crop during morning hours



L I - Location I, LII - Location II

Figure 6. Diversity indices of avian community in ber crop during evening hours

CONCLUSION

The present study showed that different developmental stages of ber crop attract diverse avian fauna due to the availability of food resources. These findings indicate that ber crops indeed serve as habitats for birds, showcasing richness and diversity. The active engagement of insectivores, carnivores and omnivores birds species keep a potent check on pest control in the agricultural area. Hence, beneficial species should be conserved in the agricultural landscapes through adoption of appropriate management practices and control of depredatory bird species by using eco-friendly management techniques.

FUTURE PERSPECTIVE

The future perspective of this study include a comprehensive strategy that integrates ecological research, conservation efforts, and practical applications to promote sustainable and eco-friendly agriculture that benefits both farmers and the environment. Conduction of longitudinal studies to monitor avian species can provide a more accurate depiction of the interplay between bird populations and crop stages. The information gathered may be used to develop strategies for minimising crop damage and improving conservation measures for agriculturally important bird species.

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CONFLICT OF INTEREST

The authors declare that they do not have any competing interests.

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