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Avian diversity across growth stages of maize (*Zea mays* L.): A comparative study of sowing-seedling and ripening stages with depredation management

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Abstract

The present study aimed to achieve the key objectives to assess the avian diversity effectiveness of depredatory bird management techniques during the sowing-seedling and ripening stages of spring maize (PMH 10). The experiment was conducted near Experimental Farms of the School of Organic Farming and Integrated Farming fields at Punjab Agricultural University (PAU), Ludhiana, with five designated plots—five treatment plots and one control plot. The treatments included netting (T1), a combination of scare balloons and paper bag wrapping (T2), reflective ribbons (T3), a combination of bioacoustics and leaf wrapping (T4), and Integrated plot (T5) while the control plot (C) remained unmanaged. Field surveys recorded 41 bird species were recorded belonging to 38 genera and 30 families under 12 orders, with higher species richness in the sowing-seedling stage compared to the ripening stage. Among these 41 species, nineteen were insectivores, nine were omnivorous, four were grainivores, three were frugivores, three were carnivores and three were herbivores. Overall, the implemented bird-scaring techniques significantly reduced the feeding activity and abundance of depredatory bird species in treatment plots compared to the unmanaged control plot. While scare devices were effective initially, bird habituation reduced long-term efficacy. These findings emphasize the need for sustainable bird deterrent strategies that minimize crop losses while maintaining avian biodiversity, contributing to eco-friendly agricultural practices.

Keywords: Avian diversity, bird management, depredatory species, maize crop, relative abundance, sowing-seedling stage

Introduction

India's agricultural sector plays a crucial role in supporting the economic and daily needs of more than half of its population. As of the 2024-25 Rabi season, wheat cultivation in India has reached approximately 32 million hectares, reflecting a 1.38% increase from the previous year's 31.56 million hectares. Regarding maize (corn), India's recent policy shift towards corn-based ethanol production has significantly impacted domestic maize dynamics. In 2024, India utilized about 3.5 million tons of corn to produce 1.35 billion liters of ethanol, a fourfold increase from the previous year (Anonymous 2024) ^[3]. This expansion reflects the advancements in agricultural practices, improved irrigation facilities, and the adoption of high-yielding varieties. Over the past five decades, Punjab has played a pivotal role in enhancing food grain production, largely due to the Green Revolution, which introduced modern farming techniques and mechanization.

The state is endowed with diverse natural resources and is a major producer of crops such as wheat, maize, rice, and sugarcane, contributing significantly to agricultural output (Kaur *et al* 2018) ^[8]. Maize outperforms many other food crops due to its exceptional yield potential, resilience to challenging environmental conditions, and fast growth rate. Consequently, its yearly production has surpassed that of both rice and wheat. As a staple in numerous countries, maize plays a dual role as a primary food source and an essential component of livestock fodder. It is cultivated throughout the year across various seasons, including Kharif, Rabi and Zaid (Erenstein *et al* 2022) ^[6].

In India, maize is the third most cultivated cereal after wheat and rice, covering over 7 million hectares. It is mainly grown in Punjab, Bihar, Uttar Pradesh, Madhya Pradesh, and Andhra Pradesh, with Punjab as a key hub (Anonymous 2018) ^[2]. Bird and insect pests reduce maize yield, with birds causing damage from sowing to ripening. They uproot seedlings and feed on milky-stage grains, impacting crop productivity (Klosterman *et al* 2012) ^[10]. Research has indicated that certain species, such as the house crow, primarily infest maize fields during the grain-filling stage and the development of corn ears (Mohamed and El-Bakhshawngi 2018) ^[15]. Kaur *et al* (2025) ^[7] evaluated the effectiveness of integrated depredatory bird management strategies in maize crops at different growth stages.

This study assesses avian diversity during the sowing-seedling and ripening stages of maize, analyzing bird depredation impacts and feeding behaviors. It also evaluates depredation management strategies to develop sustainable pest control methods for improved maize yield.

Materials and Methods

Study Area and Duration

The study site was located near the Experimental Farms of the School of Organic Farming and Integrated Farming fields at Punjab Agricultural University, Ludhiana. Positioned at an elevation of 229 meters above sea level, the site is geographically situated at 30°59'28.74"N latitude and 75°44'10.87"E longitude. This study on avian foraging preferences in maize crops was conducted from the sowing to harvesting stage (March 2021 to June 2021) covering critical phases of maize growth, including the sowing-seedling and ripening stages in maize fields.

Experimental Design and Sampling Procedure

Spring season maize variety PMH 10 was taken under study. To assess avian foraging preferences and the effectiveness of integrated bird management techniques, experimental plots measuring 1000 sqm each were established. A control plot with no management interventions was also maintained for comparative analysis. The applied management techniques included:

1. Netting (T1)
2. Combined scare balloons and tassel bag wrapping (T2)
3. Reflective ribbons (T3)
4. Combined bioacoustics and leaf wrapping (T4)
5. Integrated plot (combination of all methods) (T5)
6. Control plot (no intervention)

Bird populations were surveyed using point count method and line transect method, ensuring standardized observations. Each plot was surveyed during peak bird activity hours (early morning: 06:00-09:00 AM and late afternoon: 04:00-06:00 PM) to record species richness, diversity, and abundance.

Data Collection and Instruments Used

A variety of tools and instruments were employed for accurate data collection in this study. A Canon Power shot SX 540 HS camera with 20.3 megapixels and a 50X zoom range was used for photographic documentation. For bird observation, a Bushnell H20 binocular with an 8X42 range was utilized. To deter bird species, a bioacoustic device, Kethirakshak (KR-18), was employed, purchased from Gamyam Technologies Pvt. Ltd. Additionally, a Freemans Top-line fiberglass measuring tape was used to measure the length and width of the treatment and control fields.

Community Characteristics

To quantify the structure of the bird community, various community characteristics were assessed by pooling data from all developmental stages. Species richness was determined as the total number of avian species recorded in the study areas. Species diversity was evaluated using the Shannon-Weiner Index, while relative abundance was calculated to determine the proportion of each bird species in the total recorded population. Species evenness, also referred to as equitability, was measured (Krebs *et al* 1985) ^[12] to assess the uniformity of species distribution within the bird community.

Bird Identification and Classification

Bird species were identified using field guides and validated against the International Union for Conservation of Nature (IUCN) Red List. Avian status was categorized as resident (R) or resident migrant (RM). Feeding guilds were classified based on dietary habits into insectivorous (I), granivorous (G), frugivorous (F), plant-based (P), small invertebrate feeders (SI), and small vertebrate feeders (SV).

Data Analysis

Non-parametric Kruskal-Wallis Analysis was done using SPSS software version IBM SPSS Statistics 28.0.0.0 was used to compare bird composition across different treatment and control plots during both the sowing-seedling and ripening stages of maize and to analyze the difference between feeding preferences and abundance of avian species at each stage plot-wise.

Results and Discussion

Bird diversity and composition in treatment plots during sowing-seedling stage of maize crop

Bird Composition

A total of 36 bird species were recorded in five treatment plots and one control plot of field I during spring season of maize 2021 (Table 1). House Crow was found to be most abundant species with relative abundance of 20.26%, 18.72%, 18.30%, 18.25, 17.76%, and 14.61% in netting, combined scare balloons and tassel bag wrapping plot, control plot, reflective ribbons, integrated plot and combined bioacoustics and leaf wrapping plot respectively. Common Myna was found to be second most abundant species with relative abundance of 46.20%, 15.08%, 14.88%, 12.10%, 12.03% and 9.54% in netting, integrated plot, combined scare balloons and tassel bag wrapping plot, combined bioacoustics and leaf wrapping plot, reflective ribbons, and control plot respectively. Asian Pied Starling was found to be third most abundant species in netting plot with relative abundance of 8.86%. Cattle Egret was found to be third most abundant species with relative abundance of 12.04%, 9.79%, 7.21%, and 5.08% in combined bioacoustics and leaf wrapping plot, reflective ribbons, combined scare balloons and tassel bag wrapping plot, and integrated plot respectively. In control plot, White Wagtail was found to be third most abundant species with relative abundance of 7.13%. Black-winged Stilt, Jungle Babbler, Little brown Dove and Red wattled Lapwing were not seen in the netting plot but found in rest of the plots. Indian Roller and Pheasant-tailed Jacana were observed to be present while Indian Silverbill and Black Drongo and Black Kite were not noted in the control plot. Common Moorhen, Glossy Ibis, Grey Francolin, Indian Robin, Scaly-breasted Munia, Spotted Dove, White-breasted Waterhen, White-browed Wagtail and Yellow Wagtail were observed to be present only in the integrated and control plot. White-throated Kingfisher was present only in the combined bioacoustics and leaf wrapping

plot, integrated and control plot. Red vented bulbul was found to be present only in the netting plot and integrated plot.

Community characteristics

The species richness peaked (33 species) in control plot followed by integrated plot (32 species), combined bioacoustics and leaf wrapping plot (21 species), combined scare balloons and tussel bag wrapping plot (21 species), reflective ribbons (20 species) and it was lowest (16 species) in netting plot.

Species diversity was highest (3.50) in control plot followed by integrated plot (3.47), combined bioacoustics and leaf wrapping plot (3.04), combined scare balloons and tussel bag wrapping plot (3.04), reflective ribbons (3.00) and it was lowest (2.77) in netting plot.

The species evenness was highest (0.91) in combined bioacoustics and leaf wrapping plot followed by reflective ribbons (0.90), combined scare balloons and tussel bag wrapping plot (0.89), integrated plot (0.88), control plot (0.84) and it was lowest (0.69) in netting plot.

Bird diversity and composition in treatment plots during ripening stage of maize crop

Bird Composition

A total of 36 bird species were recorded in five treatment plots and one control plot of field I during spring season of maize 2021 (Table 2). House Crow was found to be among three most abundant species with relative abundance of 15.51%, 18.13%, 16.09%, 15.35, 13.69%, and 17.98% in netting, combined scare balloons and tussel bag wrapping plot, reflective ribbons, combined bioacoustics and leaf wrapping plot, integrated plot and control plot respectively. Common Myna was found to be among three most abundant species with relative abundance of 35.49%, 14.98%, 13.36% and 13.24% in netting, combined scare balloons and tussel bag wrapping plot, reflective ribbons and combined bioacoustics and leaf wrapping plot respectively. Asian Pied Starling was found to be third most abundant species in integrated plot with relative abundance of 8.57%. Rose-ringed Parakeet was found to be among three most abundant species with relative abundance of 11.41%, 12.46%, 20.08%, 26.03 and 25.30% in combined scare balloons and tussel bag wrapping plot, reflective ribbons, combined bioacoustics and leaf wrapping plot, integrated plot and control plot respectively. In netting plot, Paddy Field Pipit was found to be third most abundant species with relative abundance of 9.33%. Rock Pigeon was found to be third most abundant species with relative abundance 13.65% in control plot. Asian Koel was found to be present only in reflective ribbons, combined bioacoustics and leaf wrapping plot and integrated plot. Bank Myna was present only in reflective ribbons plot. Black-winged Stilt, Indian Roller, Indian Silverbill, Pheasant-tailed Jacana, Red naped Ibis, Red-wattled Lapwing, Scaly-breasted Munia and White-browed Wagtail were found to be present while Jungle Babbler was not seen in the control plot. Cattle Egret was found while House Sparrow was not noted in the reflective ribbons and integrated plot. During the study period, Common Hoopoe was found only in the netting, combined bioacoustics and leaf wrapping plot and control plot. Common Tailorbird was present only in the combined scare balloons and tussel bag wrapping plot and reflective ribbons plot. Greater Coucal was not found in the integrated plot. Green Bee-eater was found to be present only in the netting, integrated plot and control plot. Grey Francolin was present only in the combined bioacoustics and leaf wrapping plot and control plot. Indian Pond Heron and White-breasted Waterhen were found to be present only in

integrated and control plot. Indian Robin was present only in integrated treatment plot. Little brown Dove was not seen in the netting plot and combined bioacoustics and leaf wrapping plot. Pied Bushchat and Rock Pigeon was not found in the reflective ribbons and combined bioacoustics and leaf wrapping plot respectively.

Community characteristics

The species richness peaked (31 species) in control plot followed by integrated plot (21 species), reflective ribbons plot (18 species), similar (17 species) in netting plot and combined bioacoustics and leaf wrapping plot and it was lowest (16 species) in combined scare balloons and tussel bag wrapping plot.

Species diversity was highest (3.43) in control plot followed by integrated plot (3.04), reflective ribbons plot (2.89), similar (2.83) in netting plot and combined bioacoustics and leaf wrapping plot reflective ribbons plot and it was lowest (2.77) in combined scare balloons and tussel bag wrapping plot.

The species evenness was highest (0.90) in combined bioacoustics and leaf wrapping plot followed by combined scare balloons and tussel bag wrapping plot (0.89), integrated plot (0.85), netting plot (0.82), reflective ribbons plot (0.77) and it was lowest (0.74) in control plot.

Bird composition was compared in relation to different treatments T1, T2, T3, T4 and control plot at sowing-seedling stage. There was found non-significant difference at $p \leq 0.05$ (5% level of significance). Kruskal-Wallis H analysis has shown that, during ripening stage of maize significant difference was found with respect to bird composition in between five treatment plots and one control plot at $p \leq 0.05$ (5% level of significance).

During the spring season of maize crop, a total of 41 bird species were recorded belonging to 38 genera and 30 families under 12 orders from March 2021 to June 2021 (Table 3). Among these 41 species, nineteen were insectivores, nine were omnivorous, four were grainivores, three were frugivores, three were carnivores and three were herbivores. Nearly, half of the birds belong to order Passeriformes. Also, only one species was found of order Psittaciformes. Majority of the birds are resident but nine among forty one are resident migrant. All, the forty one bird's species comes under the category of least concern (LC) in IUCN status (Kler and Kumar 2015) [9].

Akram (2013) [1] investigated the impact of house crows (*Corvus splendens*) on maize crops and evaluated the use of reflecting ribbons as a deterrent. Their findings demonstrated that reflecting ribbons significantly reduced crow-induced damage during the dough and mature stages of maize growth. Kross *et al* (2012) [13] explored the role of predatory birds in agricultural landscapes and their potential to control pest populations. Their research highlighted that encouraging the presence of native predatory bird species can naturally reduce pest numbers, thereby decreasing the reliance on chemical pesticides. Manz *et al* (2024) [14] examined the effectiveness of laser scarecrows in deterring avian pests in crop fields. The study found that laser devices significantly reduced bird presence and associated crop damage, offering a non-lethal and environmentally friendly pest management solution. Otieno and Mukasi (2023) [16] investigated the predation patterns of tropical insectivorous birds on maize pests in forest-adjacent farms in western Kenya. Their research demonstrated that birds from families such as Muscicapidae (flycatchers) and Ploceidae (weavers) significantly reduced Lepidoptera pest populations, highlighting the importance of conserving these avian species to enhance natural pest control in maize fields. Behney and Gammonley (2023) [4] conducted a

study on the efficacy of using the herbicide indaziflam to control cheatgrass, an invasive species that degrades habitats essential for bird populations. Their findings indicated that indaziflam treatments effectively reduced cheatgrass cover, thereby improving habitat quality for avian species such as the northern bobwhite (*Colinus virginianus*). This research underscores the role of habitat management in supporting bird diversity in agricultural landscapes. Benedetti *et al* (2023) ^[5] explored the relationship between vegetation indices and avian diversity across urban areas in Europe. Utilizing Enhanced Vegetation Index (EVI) and Normalized Difference Vegetation Index (NDVI) data, they found that higher NDVI values correlated with increased taxonomic and functional diversity of bird communities. Although this study focused on urban environments, the methodology and findings offer valuable

insights into how vegetation management in agricultural settings, including maize fields, can influence avian diversity. Klug *et al* (2019) ^[11] was reported that for improving effectiveness of bio-acoustics devices, understanding of Rose-ringed Parakeet response to alarm calls and distress calls was important. Number of healthy seedlings in the netted plot was significantly greater than that in any other treatment plot. The findings highlighted the role of specific bird deterrent techniques in reducing crop damage while maintaining avian diversity. Sieving *et al* (2025) ^[17] found that laser scarecrows significantly reduced the likelihood of European starlings feeding on sweet corn ears. However, for birds that did forage in laser-treated areas, the duration of their feeding bouts remained unchanged. The primary deterrent effect of laser scarecrows was attributed to preventing birds from initially settling on the corn ears.

Table 1: Overall analysis of bird management methods applied at T1, T2, T3, T4 and T5 in comparison to Control at sowing-seedling stage of maize crop

S No.	Name of Plot	Netting	Combined scare balloons and tussel bag wrapping	Reflective ribbons	Combined bioacoustics and leaf wrapping	Integrated plot	Control
	Bird Species	Relative abundance (%)					
1	Asian Koel	1.06	-	-	-	-	2.09
2	Asian Pied Starling	8.86	5.63	5.20	3.67	3.96	4.50
3	Black Drongo	2.27	3.83	3.78	3.29	3.82	-
4	Black Kite	1.64	1.99	2.68	3.10	0.68	-
5	Black-winged Stilt	-	2.29	1.99	1.52	1.75	0.83
6	Cattle Egret	2.11	7.21	9.79	12.04	5.08	5.41
7	Common Moorhen	-	-	-	-	1.13	3.90
8	Common Myna	46.20	14.88	12.03	12.10	15.08	9.54
9	Common Tailorbird	-	3.82	-	-	0.52	2.66
10	Eurasian Collard Dove	1.38	3.39	3.22	3.53	3.10	3.95
11	Glossy Ibis	-	-	-	-	0.30	0.41
12	Greater Coucal	0.34	1.23	1.98	3.09	1.02	0.94
13	Green Bee-eater	-	3.56	5.72	8.24	4.97	3.48
14	Grey Francolin	-	-	-	-	1.01	0.71
15	House Crow	20.26	18.72	18.25	14.61	17.76	18.30
16	House Sparrow	1.23	2.33	2.42	1.62	2.49	1.21
17	Indian Pond Heron	-	3.28	1.47	1.38	0.45	0.46
18	Indian Robin	-	-	-	-	2.04	0.69
19	Indian Roller	-	-	-	-	-	1.27
20	Indian Silverbill	-	-	-	-	-	4.17
21	Jungle Babbler	-	2.50	2.44	4.05	4.95	0.26
22	Little brown Dove	-	2.89	2.24	2.85	1.52	3.30
23	Paddy Field Pipit	1.63	2.89	4.01	4.44	3.00	1.19
24	Pheasant-tailed Jacana	-	-	-	-	-	0.61
25	Red naped Ibis	1.68	6.86	2.09	3.02	1.73	1.70
26	Red vented bulbul	1.48	-	-	-	4.12	-
27	Red wattled Lapwing	-	4.19	6.08	4.15	3.73	3.61
28	Rock Pigeon	6.65	3.22	6.30	2.61	2.56	5.60
29	Rose-ringed Parakeet	1.99	4.16	4.52	5.99	3.78	2.86
30	Scaly-breasted Munia	-	-	-	-	1.30	4.25
31	Spotted Dove	-	-	-	-	0.45	0.31
32	White Wagtail	1.21	1.13	3.80	3.64	3.14	7.13
33	White-breasted Waterhen	-	-	-	-	2.22	2.39
34	White-browed Wagtail	-	-	-	-	0.76	0.83
35	White-throated Kingfisher	-	-	-	1.06	1.07	0.69
36	Yellow Wagtail	-	-	-	-	0.51	0.73
	Species Richness	16	21	20	21	32	33
	Species Diversity	2.77	3.04	3.00	3.04	3.47	3.50
	Species Evenness	0.69	0.89	0.90	0.91	0.88	0.84

Table 2: Overall analysis of bird management methods applied at T1, T2, T3, T4 and T5 in comparison to Control at ripening stage of maize crop

	Name of plot	Netting	Combined scare balloons and tussel bag wrapping	Reflective ribbons	Combined bioacoustics and leaf wrapping	Integrated plot	Control
S No.	Bird Species	Relative abundance (%)					
1	Asian Koel	-	-	2.59	4.52	2.10	-
2	Asian Pied Starling	3.12	2.16	2.53	3.67	8.57	1.90
3	Bank Myna	-	-	7.84	-	-	-
4	Black Drongo	1.04	3.01	3.59	6.02	1.23	1.11
5	Black Kite	1.49	2.40	2.55	3.23	0.85	0.27
6	Black-winged Stilt	-	-	-	-	-	0.18
7	Cattle Egret	-	-	2.72	-	2.16	1.04
8	Common Hoopoe	0.30	-	-	2.39	-	0.41
9	Common Moorhen	-	-	-	-	-	4.94
10	Common Myna	35.49	14.98	13.36	13.24	4.29	4.46
11	Common Tailorbird	-	2.22	1.20	-	-	-
12	Eurasian Collard Dove	3.60	1.30	2.58	2.08	1.78	3.73
13	Greater Coucal	0.60	3.58	1.60	2.33	-	0.35
14	Green Bee-eater	2.07	-	-	-	4.79	0.20
15	Grey Francolin	-	-	-	1.46	-	1.26
16	House Crow	15.51	18.13	16.09	15.35	13.69	17.98
17	House Sparrow	3.12	5.76	-	2.84	-	0.38
18	Indian Pond Heron	-	-	-	-	0.64	0.79
19	Indian Robin	-	-	-	-	4.77	-
20	Indian Roller	-	-	-	-	-	0.28
21	Indian Silverbill	-	-	-	-	-	3.81
22	Jungle Babbler	3.10	8.11	8.42	9.43	4.40	-
23	Little brown Dove	-	5.78	2.25	-	1.35	0.27
24	Paddy Field Pipit	9.33	4.28	8.92	5.41	1.21	0.89
25	Pheasant-tailed Jacana	-	-	-	-	-	0.33
26	Pied Bushchat	4.60	-	3.00	2.58	4.60	0.03
27	Red naped Ibis	-	-	-	-	-	2.21
28	Red vented bulbul	2.80	-	-	-	6.13	2.56
29	Red-wattled Lapwing	-	-	-	-	-	3.18
30	Rock Pigeon	4.50	6.96	5.99	-	1.28	13.65
31	Rose-ringed Parakeet	8.87	11.41	12.46	20.08	26.03	25.30
32	Scaly-breasted Munia	-	-	-	-	-	0.03
33	White Wagtail	-	8.67	-	3.59	6.74	5.40
34	White-breasted Waterhen	-	-	-	-	2.26	1.68
35	White-browed Wagtail	-	-	-	-	-	0.05
36	White-throated Kingfisher	0.45	1.25	2.30	1.78	1.11	1.33
	Species Richness	17	16	18	17	21	31
	Species Diversity	2.83	2.77	2.89	2.83	3.04	3.43
	Species Evenness	0.82	0.89	0.77	0.90	0.85	0.74

Table 3: Overall avian diversity and composition observed at three fields along with their IUCN status, feeding behavior and economic status

S No.	Common name	Scientific name	Order	Family	Status	Food	IUCN Status	Economic status
1	Asian Koel	<i>Eudynamys scolopaceus</i>	Cuculiformes	Cuculidae	RM	I, SI, SV, F	LC	B
2	Asian Pied Starling	<i>Sturnus contra</i>	Passeriformes	Sturnidae	R	I, F	LC	B
3	Bank Myna	<i>Acridotheres ginginianus</i>	Passeriformes	Sturnidae	R	I, G	LC	D
4	Black Drongo	<i>Dicrurus macrocercus</i>	Passeriformes	Dicruridae	R	I, F	LC	B
6	Black Kite	<i>Milvus migrans</i>	Accipitriformes	Accipitridae	R	I, SI, SV	LC	B
5	Black winged Stilt	<i>Himantopus himantopus</i>	Charadriiformes	Recurvirostridae	RM	I, SI	LC	B
7	Black-winged Kite	<i>Elanus caeruleus</i>	Accipitriformes	Accipitridae	R	I, SI, SV	LC	B
8	Cattle Egret	<i>Bubulcus ibis</i>	Pelecaniformes	Ardeidae	RM	I, SI	LC	B
9	Common Hoopoe	<i>Upupa epops</i>	Bucerotiformes	Upupidae	RM	I	LC	B
10	Common Moorhen	<i>Gallinula chloropus</i>	Gruiformes	Rallidae	RM	I, SI, G, P	LC	H
11	Common Myna	<i>Acridotheres tristis</i>	Passeriformes	Sturnidae	R	I, F	LC	H
12	Common Tailorbird	<i>Orthotomus sutorius</i>	Passeriformes	Cisticolidae	R	I, G	LC	D
13	Eurasian Collard Dove	<i>Streptopelia decaocto</i>	Columbiformes	Columbidae	R	G	LC	H
14	Glossy Ibis	<i>Plegadis falcinellus</i>	Pelecaniformes	Threskiornithidae	RM	I, SI	LC	B
15	Greater Coucal	<i>Centropus sinensis</i>	Cuculiformes	Cuculidae	RM	I, SI, SV	LC	B
16	Green Bee-eater	<i>Merops orientalis</i>	Coraciiformes	Meropidae	R	I, SI	LC	B
17	Grey Francolin	<i>Francolinus pondicerinus</i>	Galliformes	Phasianidae	R	I, G, P	LC	B
18	House Crow	<i>Corvus splendens</i>	Passerine	Corvidae	R	I, SI, F, G, P	LC	D
19	House Sparrow	<i>Passer domesticus</i>	Passeriformes	Passeridae	R	I, G	LC	D
20	Indian Pond Heron	<i>Ardeola grayii</i>	Pelecaniformes	Ardeidae	R	I, SI, SV	LC	B
21	Indian Robin	<i>Saxicoloides fulicata</i>	Passeriformes	Muscicapidae	R	I, SI	LC	B

22	Indian Roller	<i>Coracias benghalensis</i>	Coraciiformes	Coraciidae	R	I	LC	B
23	Indian Silverbill	<i>Euodice malabarica</i>	Passeriformes	Esterildidae	R	I, P	LC	D
24	Jungle Babbler	<i>Turdoides striatus</i>	Passeriformes	Timaliinae	R	I, F	LC	D
25	Little brown Dove	<i>Stigmatopelia senegalensis</i>	Columbiformes	Columbidae	R	G	LC	H
26	Paddy field Pipit	<i>Anthus rufulus</i>	Passeriformes	Motacillidae	R	I, P	LC	B
27	Pheasant-tailed Jacana	<i>Hydrophasianus chirurgus</i>	Charadriiformes	Jacanidae	R	I, SI, P	LC	D
28	Pied Bushchat	<i>Saxicola caprata</i>	Passeriformes	Muscicapidae	R	I	LC	B
29	Red naped Ibis	<i>Pseudibis papillosa</i>	Pelecaniformes	Threskiornithidae	R	I, G	LC	D
30	Red vented bulbul	<i>Pycnonotus cafer</i>	Passerine	Pycnonotidae	R	I, P, F	LC	D
31	Red-wattled Lapwing	<i>Vanellus indicus</i>	Charadriiformes	Charadriidae	R	I, SI	LC	B
32	Rock Pigeon	<i>Columba livia</i>	Columbiformes	Columbidae	R	G	LC	H
33	Rose-ringed Parakeet	<i>Psittacula krameri</i>	Psittaciformes	Psittacidae	R	F, P, G	LC	H
34	Rufousbacked Shrike	<i>Lanius schach</i>	Passeriformes	Laniidae	R	SI, SV	LC	D
35	Scaly-breasted Munia	<i>Lonchura punctulata</i>	Passeriformes	Esterildidae	R	I, P	LC	D
36	Spotted Dove	<i>Stigmatopelia chinensis</i>	Columbiformes	Columbidae	R	G	LC	H
37	White Wagtail	<i>Motacilla alba</i>	Passeriformes	Motacillidae	RM	I	LC	B
38	White-breasted Waterhen	<i>Amaurornis phoenicurus</i>	Gruiformes	Rallidae	R	I, SI, G, P	LC	B
39	White-browed Wagtail	<i>Motacilla maderaspatensis</i>	Passeriformes	Motacillidae	R	I, SI	LC	B
40	White-throated Kingfisher	<i>Halcyon smyrnensis</i>	Coraciiformes	Alcedinidae	R	I, SV	LC	B
41	Yellow Wagtail	<i>Motacilla flava</i>	Passeriformes	Motacillidae	RM	I	LC	B

Status: R- Resident (bird species which remains on native place throughout the year); RM Resident Migrant (bird species which migrates temporarily from their native place)

Food habit: I- Insectivorous; G- Granivorous; F- Fruits; P- Plants; SI- Small Invertebrates; SV- Small vertebrates; O-Omnivorous

IUCN status: LC- Least Concern (Kler and Kumar 2015) ^[9]

Economic Status: B- beneficial role; D-dual role; H-harmful

Conclusion

The findings reveal significant variations in bird assemblages between growth stages, emphasizing the need for targeted management strategies that minimize crop losses while preserving ecological balance.

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