International Journal of Agriculture and Environmental Research

ISSN: 2455-6939

Volume: 10, Issue: 04 "July-August 2024"

ROLE OF INSECTIVOROUS BIRDS IN REDUCING INSECT PESTS OF BHENDI (*Abelmoschus esculentus* L.)

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DOI: https://doi.org/10.51193/IJAER.2024.10408

Received: 25 May 2024 / Accepted: 19 Jun. 2024 / Published: 24 Aug. 2024

ABSTRACT

To quantify the role of insectivorous birds in reducing major insect pests of Bhendi crop for three years (2015-16, 2016-17 & 2017-18) during *Kharif* season. Incidence of major pest complex in terms of number of larvae per plant was recorded at alternate day during different stages of the crop up to harvest. The Bird activity was also recorded in relation to larval density and also recorded bird species composition at weekly intervals by using point count method. A total 15 species of birds were recorded during the crop period. The predominant predatory birds noticed in the field on bird perches include Common myna, Black drongo, Green Bee eater, House crow, Common babblers, Indian robin, Pied bush chat and Red-wattled lapwing. Among the species, the per cent utilization of bird perches was recorded high by common myna (48%), black drongo (28%), Indian robin (12%), common babbler (7%) and pied bush chat (5%). Among the treatments, farmers practice was effective in reducing the pest population followed by combination of bird perches and NPV showed reduction in fruit borer incidence and tobacco caterpillar. The per cent fruit damage was less in Bird perches + NPV plot (21.6%), followed by Bird perches alone (23.17%) and NPV plot (24.12%). However, in farmers practice plot also showed less incidence of fruit damage (14.1%). The treatment bird perches + NPV solution were environmentally friendly and cost-effective practices that can be adopted by farmers compared to chemical control.

Keywords: Bhendi, Insect pests, Insectivorous birds

1. INTRODUCTION

Okra (*Abelmoschus esculentus* L) is commonly known as bhendi or lady's finger belonging to family Malvaceae. It is an important fruit vegetable crop cultivated in various states of India. The

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crop is cultivated for its young tender fruits, used in curry and soups after cooking. It is a good source of vitamins A and B, protein and minerals.

The major bhendi (okra) producing states are Uttar Pradesh, Bihar, West Bengal, Odisha, Assam, Andhra Pradesh and Karnataka. The productivity of okra in India is low compared to other countries due to yield losses caused by several insect pests, diseases and nematodes. The crop in general is attacked by more than 72 insect pests and infest the crop from seedling to harvesting stage. Among these pests the shoot borer, tobacco caterpillar and fruit borer are the important pests which causes qualitative and quantitative losses during fruiting stage of the crop. Although there are chemicals which will use for management of these pests, these can be used under strictly supervised conditions otherwise the insect will quickly develop resistance. To combat this use of bio agents to control insect pests and reduce the pollution and health hazards. Many insectivorous and omnivorous birds provide essential privileges by removing arthropod pests from many crops (Girard *et al*., 2012; Garcia *et al*., 2018; Garfinkel *et al.*, 2020). Depending on their foraging and ranging patterns, flocking behavior, diet specializations, or daily time budgets, some of these avian insectivores may provide pest removal services across many crop types and spatial scales (Shakelford and Corner, 1997). Nyffeler *et al*. (2018) estimated the annual global value of insects consumed by insectivorous birds on croplands to be in the region of 30 million metric tons. Insectivorous bird species inhabiting transitional habitat regions can be especially important in contributing to pest regulation from multiple plant hosts, whether agricultural or wild-growing, or across habitat boundaries such as farmland–prairie, farmland–wetland, or farmland–forest ecotones (Exnerová, *et al*., 2003; Massemin *et al*., 2006). In the Indian context, a large number of birds are mainly insectivorous and they help in reducing large numbers of the crop pest species in agricultural landscape. Insects are the core diet of many insectivores' birds (Gokhale, 1992). They are the potential natural enemies of a variety of insect pests and helps in the integrated pest management of several insects of important crops. The composition and quantification of various insectivorous birds and their role in controlling the crop pests is not documented in many agriculture and vegetable crops. Hence, the present study was aimed to quantify the role of insectivorous birds in reducing major insect pests in Okra crop.

2. MATERIALS AND METHODS

The study was carried out in an experimental Bhendi field at All India Network Project on Vertebrate Pest Management, PJTSAU, Rajendranagar, Hyderabad, Telangana for three years (2015-16, 2016-17 & 2017-18) during *Kharif* season. Bhendi seeds were sown in 800m^2 area with four replications. Each plot was 8m length and 5 m width with a row to row spacing of 60x30cm, recommended agronomic practices were followed like application of FYM, NPK, fertilizers and weedicides. Daily pest scouting was conducted in the bhendi crop and recorded the pest incidence & damage. Incidence of major pest complex in terms of number of larvae per plant

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was recorded at alternate day during different stages of the crop up to harvest. The pests shoot and fruit borer, tobacco caterpillar and fruit borer were observed during the fruiting stage and recorded the number of larvae on randomly selected 10 plants in each plot. When the larval number (shoot and fruit borer, tobacco caterpillar and fruit borer) was observed above ETL ie., @ 5 larvae/plant. At that time to control these insects five treatments were imposed namely 1.NPV Solution @ 5 ml/lt (both HNPV and SNPV) 2. Bird perches @20/ac (It consisted of a vertical wooden stick of 1-m length with a horizontal 60-cm stick affixed at the top, secured tightly with nylon rope to provide solid platform for alighting avian predators. The T-shaped bird perch was fixed at a height of 30 cm above the crop height in all experimental plots). 3. NPV+Bird perches 4. Farmers practice 5. Control. In farmers practice the insecticides like Chloropyriphos and acephate chemicals were used. After implementation of treatments recorded the insect number in each plot again whenever the insect population reached above ETL second spray of treatments were imposed. The Bird activity was also recorded in relation to larval density and also recorded Bird species composition at weekly intervals by using point count method. All birds detected irrespective of distance from the observer are counted, and calculated species richness. Number of damaged fruits were recorded and compared Yield data with control plots. Data on fruit infestation was taken by counting damaged and undamaged fruits from each plot. Percentage fruit infestation was calculated by using following formula. The data obtained during the three years subjected to statistical analysis for interpretation of results.

$$\%\ \text{Fruit infestation} = \frac{\text{Number of damaged fruits}}{\text{Total Number of fruits}}$$

3. RESULTS AND DISCUSSION

The results of the pooled data (2015-16 to 2017- 18) revealed that the pretreatment count for number of larvae per plant was non-significant showing almost homogenous distribution of pest population in all plots. After treatment among the treatments, farmers practice was effective in reducing the pest population followed by combination of bird perches and NPV showed reduction in shoot and fruit borer, fruit borer incidence and tobacco caterpillar (4.00, 1.16 and 2.83 larvae/ plant, respectively) at one week after treatments. The treatment bird perch shows 4.00, 1.66 and 4.33 larvae/ plant, NPV treatment shows 7.3, 1.3 and 3.5 larvae/ plant were the next best (Table 1).

The per cent fruit damage was less in Bird perches + NPV plot (21.6%), followed by Bird perches alone (23.17%) and NPV plot (24..12%). However in farmers practice plot also showed less

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incidence of fruit damage (14.1%). The input cost in NPV was comparatively high when compared to farmers practice, but it is environmentally safe.

The predatory behavior of insectivore birds in bhendi ecosystem from summer ploughing to harvest was recorded (Table.2). A total 15 species of birds were recorded during the crop period. The predominant predatory birds noticed in the field on bird perches include Ashy wren warbler, Common myna, Black drongo, Indian roller, Common tailor bird, Pied wagtail, Indian robin, Bay backed shrike, Green bee eater, House crow, Common babbler, Eurasian hoopoe, and Pied bush chat. During the period (2015-16, 2016-17, 2017-18) among the species, The per cent utilization of bird perches highest by Ashy wren warbler (82%, 73%, 60%), Common myna and Black drongo (76%, 73%, 60%), Indian roller(74%, 80%,63%), Common tailor bird (62%, 70%, 43%), Pied wag tail (41%, 33%, 34%), Indian robin (35%, 40%, 26%), Bay backed shrike(20%,20%,14.2%) and remaining birds utilizes T- perches less than 20% (Table.3).

The mean occurrence common myna (3.28 ± 0.46) was highest during the year 2015 – 16, followed by Black drongo (2.52 ± 0.33), Indian roller (2.42 ± 0.34) and the minimum occurrence was recorded in Common babbler and white throated kingfisher (0.33 ± 0.33), during the year 2016 – 17 the highest mean occurrence was noticed in Black drongo (2.82 ± 0.39), followed by Indian roller (2.52 ± 0.39), Common myna (2.39 ± 0.25) and the lowest mean occurrence was seen in Yellow wagtail (0.14 ± 0.14), during the year 2017 – 18, highest mean was noticed in Common myna (3.11 ± 0.52), followed by Indian roller (2.15 ± 0.37), Black drongo (2.00 ± 0.35) and the minimum mean occurrence was recorded in House crow (0.2 ± 0.20) (Table 4).

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Table 1: Number of larvae per plant before and after treatment and Per cent fruit damage & yield comparison among the treatments implemented in Bhendi crop (Pooled data)

Treatments	Fruit and shoot borer (*Earias vitella*)		Fruit borer (*Helicoverpa armigera*)		Tobacco caterpillar (*Spodoptera litura*)		Damage %	Yield Kg/Ha
	Before treatment	After treatment	Before treatment	After treatment	Before treatment	After treatment		
NPV	7.833	7.333	6.167	1.333	6.333	3.500	24.12[b]	3,502
BP	8.500	4.000	4.500	1.667	5.300	4.333	23.17[b]	3,539
NPV+BP	7.667	4.000	5.500	1.167	6.000	2.833	21.6[b]	3,141
FP	8.833	1.167	6.167	0.667	5.833	1.833	14.1[a]	4,525
Control	7.833	10.000	5.667	6.833	6.317	21.000	33.3	1,824
CD	N/A	1.686	N/A	1.345	N/A	2.047	4.2	693
SED	0.782	0.803	0.622	0.640	0.603	0.975	1.8	296
CV	16.648	26.235	19.233	47.531	17.523	25.197	9.4	11

International Journal of Agriculture and Environmental Research

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Plate 1: Experimental plot, frequently seen pests and installation of T perches

Experimental Plot

Spodoptera

Earias vitella

Helicoverpa armigera

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T perches installed in Bhendi field

Table 2: Bird species recorded during the crop period

Stage of the Crop	Beneficial birds in Bhendi field
Land preparation (at the time of ploughing)	Cattle egret (*Bubulcus ibis*), Common babbler (*Argya caudata*), Black drongo (*Dicrurus macrocercus*), Greater coucal (*Centropus sinensis*), Oriental magpie-robin (*Copsychus saularis*), Indian robin (*Copsychus fulicatus*), Common myna (*Acridotheres tristis*), House crow (*Corvus splendens*), Jungle crow (*Corvus macrorhynchos*), Pied wagtail (*Motacilla alba*), Indian Roller (*Coracias benghalensis*).
Ploughed field	Common myna (*Acridotheres tristis*), Western yellow wagtail (*Motacilla flava*), Cattle egret (*Bubulcus ibis*), White-throated kingfisher (*Halcyon smyrnensis*), Yellow-billed babbler (*Turdoides affinis*), Black drongo (*Dicrurus macrocercus*) and Red-wattled lapwing (*Vanellus indicus*), Pied wagtail (*Motacilla alba*).
Seedling stage	Red-wattled lapwing (*Vanellus indicus*), White-throated kingfisher (*Halcyon smyrnensis*), Greater coucal (*Centropus sinensis*), Green bee-eater (*Merops orientalis*), Yellow-billed babbler (*Turdoides affinis)* and Black drongo (*Dicrurus macrocercus*), Indian Roller (*Coracias benghalensis*).

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Vegetative stage	Black drongo (*Dicrurus macrocercus*), Green bee-eater (*Merops orientalis*), Yellow-billed babbler (*Turdoides affinis)*, Ashy wren warbler (*Prinia socialis*), Asian palm swift (*Cypsiurus balasiensis*), Indian Roller (*Coracias benghalensis*), Red-wattled lapwing (*Vanellus indicus*) and Oriental magpie-robin (*Copsychus saularis*)
Flowering stage	Ashy wren warbler (*Prinia socialis*), Black drongo (*Dicrurus macrocercus*), Greater coucal (*Centropus sinensis*), Green bee-eater (*Merops orientalis*)and Yellow-billed babbler (*Turdoides affinis*), Indian Roller (*Coracias benghalensis*) Plain wren warbler (*Prinia inornata*).
Fruiting stage	Ashy wren warbler (*Prinia socialis*), Black drongo (*Dicrurus macrocercus*), Plain wren warbler (*Prinia inornata*) Greater coucal (*Centropus sinensis*), Indian pond heron (*Ardeola grayii*) Green bee-eater (*Merops orientalis*), Yellow-billed babbler (*Turdoides affinis)*, Asian palm swift (*Cypsiurus balasiensis*) Indian Roller (*Coracias benghalensis*) and Pied bush chat (*Saxicola caprata*).

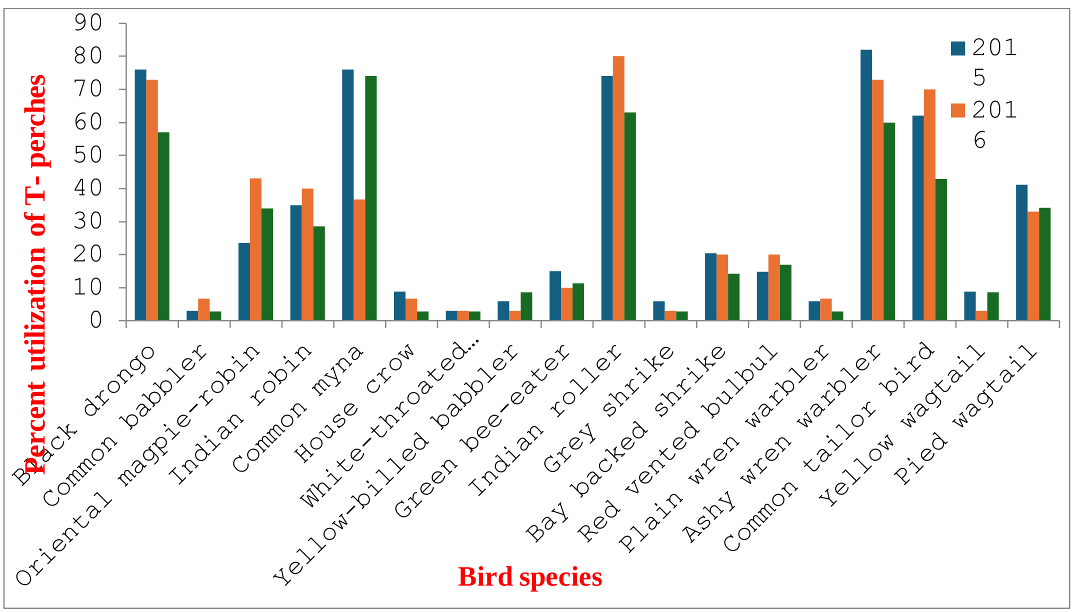

Fig. 1: Showing the percent utilization of the T- perches by birds during various years in Bhendi crop

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Table 3: Per cent utilization of T-perches by different species of birds

Sl. No	**Name of the bird species**	**2015-16 (N=34)**	**2016-17(N=30)**	**2017-18(N=35)**
1	Black drongo (*Dicrurus macrocercus*)	26 (76%)	22 (73%)	20 (57%)
2	Common babbler (*Argya caudata*)	1 (2.9%)	2 (6.6%)	1 (2.8%)
3	Oriental magpie-robin (*Copsychus saularis*)	8 (23.5%)	13 (43%)	12 (34%)
4	Indian robin (*Copsychus fulicatus*)	12 (35%)	12 (40%)	10 (28.5%)
5	Common myna (*Acridotheres tristis*)	26 (76%)	21 (36.6%)	26 (74%)
6	House crow (*Corvus splendens*)	3 (8.8%)	2 (6.6%)	1 (2.8%)
7	White-throated kingfisher (*Halcyon smyrnensis*)	1 (2.9%)	1 (2.9%)	1 (2.8%)
8	Yellow-billed babbler (*Turdoides affinis*)	2 (5.8%)	1 (2.9%)	3 (8.5%)
9	Green bee-eater (*Merops orientalis*)	5 (15%)	3 (10%)	4 (11.4%)
10	Indian roller *Coracias benghalensis*	25 (74%)	24 (80%)	22 (63%)
11	Grey shrike (*Lanius excubitor)*	2(5.8%)	1(3 %)	1(2.8%)
12	Bay backed shrike (*Larius vittatus)*	7(20.5%)	6(20%)	5(14.2%)
13	Red vented bulbul (*Pycnonotus cafer)*	5(14.7%)	6(20%)	6(17%)
14	Plain wren warbler (*Prinia inornata)*	2(5.8%)	2 (6.6%)	1(2.8%)
15	Ashy wren warbler (*Prinia socialis)*	28(82%)	22 (73%)	21(60%)
16	Common tailor bird (*Orthotomus sutorius)*	21(62%)	21(70%)	15(42.8%)
17	Yellow wagtail (*Motacilla flava)*	3(8.8%)	1(3%)	3(8.5%)
18	Pied wagtail (*Motacilla alba)*	14(41.1%)	10(33%)	12(34.2%)

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Table 4: Year wise mean occurrence and standard error of insectivorous birds in Bhendi crop during the study period

Sl.No	Name of the bird species	2015-16 (N=34)	2016-17(N=30)	2017-18(N=35)
1	Black drongo (*Dicrurus macrocercus*)	2.52 ± 0.33	2.82 ± 0.39	2.00 ± 0.35
2	Common babbler (*Argya caudata*)	0.33 ± 0.33	0.75 ± 0.48	0.33 ± 0.33
3	Oriental magpie-robin (*Copsychus saularis*)	1.00 ± 0.32	1.09 ± 0.25	1.73 ± 0.48
4	Indian robin (*Copsychus fulicatus*)	1.78 ± 0.48	1.94 ± 0.55	0.83 ± 0.32
5	Common myna (*Acridotheres tristis*)	3.28 ± 0.46	2.39 ± 0.25	3.11 ± 0.52
6	House crow (Corvus splendens)	0.6 ± 0.40	0.4 ± 0.25	0.2 ± 0.20
7	White-throated kingfisher (*Halcyon smyrnensis*)	0.33 ± 0.33	0.33 ± 0.33	0.33 ± 0.33
8	Yellow-billed babbler (*Turdoides affinis*)	0.5 ± 0.34	0.5 ± 0.50	0.67 ± 0.33
9	Green bee-eater (*Merops orientalis*)	1.00 ± 0.33	0.67 ± 0.36	0.75 ± 0.37
10	Indian roller *Coracias benghalensis*	2.42 ± 0.34	2.52 ± 0.39	2.15 ± 0.37
11	Grey shrike (*Lanius excubitor)*	0.75 ± 0.48	0.25 ± 0.25	0.5 ± 0.5
12	Bay backed shrike (*Larius vittatus)*	0.5 ± 0.19	0.78 ± 0.30	0.56 ± 0.19
13	Red vented bulbul (*Pycnonotus cafer)*	0.53 ± 0.22	0.8 ± 0.22	0.6 ± 0.21
14	Plain wren warbler (*Prinia inornata)*	0.75 ± 0.48	0.5 ± 0.29	0.25 ± 0.25
15	Ashy wren warbler (*Prinia socialis)*	1.82 ± 0.25	1.35 ± 0.25	0.94 ± 0.15
16	Common tailor bird (*Orthotomus sutorius)*	1.32 ± 0.28	1.93 ± 0.32	1.07 ± 0.22
17	Yellow wagtail (*Motacilla flava)*	0.71 ± 0.36	0.14 ± 0.14	0.86 ± 0.46
18	Pied wagtail (*Motacilla alba)*	0.77 ± 0.16	0.89 ± 0.25	0.69 ± 0.16

The use of bird perches as substrates for predation activity was recorded to be the maximum in case of common myna and black drongo and thus served an important strategy as a part of bio-intensive management of insect pests in bhendi. The profile of the bird populations observed under present study indicated that majority of the birds were either exclusively feeding on insect based food or deriving a significant part of their food from this source. The evidence is supported by earlier studies on food and feeding habits of birds in Faisalabad district and its vicinity which reported that 23-33 bird species were insectivorous and reportedly playing an important role in inhibiting insect populations[3,4,5,6].

The present study helps to conclude that at least five bird species, Common myna, Black drongo, Green Bee eater, House crow, Common babbler, have an important role in predation on insects. Among these, the Common myna and the Green bee-eater are of special significance as they were feeding directly on insects infesting the bhendi crop.

Virus can also be spread large distance by birds which can excrete in their feces after feeding on diseases larvae[7]. If the degree of NPV infection can be enhanced, the larval population can be decimated without deleterious effects on any other organisms. An integrated application of bird perches+ HaNPV has resulted in lower the insect damage and produced higher bhendi yield. This might be due to the faster virus spread by the bird excreta leading to larval mortality.

Combination of bird perches and NPV solution reduced the insect population on bhendi crop. The evidence is supported by[8] evaluated the IPM modules against *S. litura*, *Bt* 0.1% + bird perches was found significantly superior. Whereas, trap crop + *S. litura NPV* + bird perches and *Sl*NPV + bird perches proved to be equally effective against *S. litura* and production of green forage yield. *Bt* 0.1% + bird perches and trap crop + *Ha*NPV + bird perches showed less than 1 larva of *H. armigera*/m^2.

Current sensitivities regarding environmental pollution, human health, and pest resurgence are a consequence of the improper use of synthetic pesticides. Host-plant resistance, natural plant products, bio-pesticides, natural enemies, and agronomic practices offer a potentially viable option for integrated pest management (IPM). They are relatively safe for non-target organisms and human beings. Though the world is bestowed with a rich heritage of avian diversity[9], the beneficial role of insectivorous birds in insect-pest management has not received much recognition beyond faunistic documentation. This is mainly due to the over-dominance of broad-spectrum insecticides in the plant protection scenario[10,11,12]. Therefore, the development and implementation of eco-friendly management of the insect pests on Bhendi is of paramount importance in achieving sustainable production.

ISSN: 2455-6939

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4. CONCLUSION

The treatment bird perches + NPV solution were environmentally friendly and cost-effective practices that can be adopted by farmers compared to chemical control.

COST OF TECHNOLOGY

Cost in installing bird perches is negligible, farmers can use locally available sticks and only labour cost is involved approximately need to be born to the extent of Rs/- 1000, while NPV cost is around Rs/- 500/ha and labor charge is Rs.1000/ha.

FUTURE SCOPE OF RESEARCH

Assessing a wider range of herbivore species could result in a more thorough evaluation of birds' relative contribution to the management of insect pests. Ultimately, more comprehensive research that includes plant damage rate assessment, stable isotope tests, and a sampling strategy for the exclusion of pests or birds would make it easier to precisely quantify the value of the pest management services that birds provide and effectively.

ACKNOWLEDGEMENTS

The authors are sincerely extending they're thanks to ICAR for providing financial support. Our thanks are also to Professor Jayashankar Telangana State Agricultural University, Hyderabad for providing necessary facilities during the field work. Our thanks are also to National Institute of Plant Health Management for providing *Sl*NPV and *Ha*NPV.

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