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Role of insectivorous birds in suppression of fruit borer, *Helicoverpa armigera* (Hubner) in tomato

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Abstract
The insectivorous bird community of tomato crop was found effective in suppression of larval population of tomato fruit borer, *Helicoverpa armigera* (Hubner). The mean larval population observed in treatment plots was lower, perch plot (6.00 larva/10 plant) and open plot (7.24 larva/10 plant) and resulted in increase the yield. It is recommended to install "T" shaped bird perches 100/ha to promote birds activity.

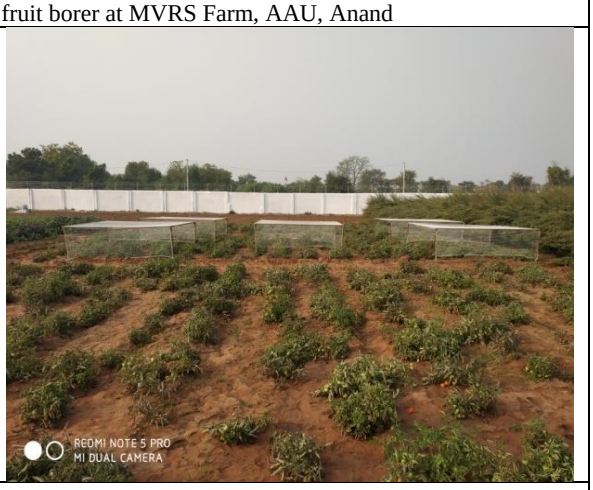
Keywords: Rose- ringed parakeet, tomato, *Helicoverpa armigera*, "T" Shaped perch

Introduction
Tomato (*Solanum lycopersicum*) is an important Solanaceous crop grown throughout the world. Tomato is cultivated as an important *rabi* (August or September) vegetable crop in Gujarat. This crop is attacked by as many as 21 different species of insect pests. Among these insect pests, tomato fruit borer, (*Helicoverpa armigera* Hub.) (Lepidoptera: Noctuidae) is one of the most serious pest. It causes as high as 70 per cent loss in fruit yield (Kakar *et al*., 1990) [2]. In the initial stage of the crop, it feeds on leaves and later bores into the fruit, rendering the fruit unfit for human consumption. Birds are natural regulators of insect population and their mobility allows them to respond numerically to pest increase. In this respect they resemble insecticides and other catastrophes, which destroy a large proportion of a pest population quickly (Woods, 1974) [6]. In Chickpea, birds like Myna, Sparrow, Baya, Babbler, Black drongo, Cattle egret etc feeds on *Heliothis* larvae and cause significant reduction in pod damage which results in tremendous increase in the yield (Parasharya *et al*., 2002) [3]. Birds have also been reported to reduce the larval population of *Spodoptera* and *Helicoverpa* significantly in groundnut crop (Rao *et al*., 1998) [5]. However, the useful role of birds against *H. armigera* in tomato crop has not been studied. Therefore, insectivorous birds were evaluated against tomato fruit borer *H. armigera* larvae in tomato.

Materials and Methods
The present study was carried out in middle Gujarat, MVRS Farm and Agronomy Farm, Anand Agricultural University, Anand. Net plot size was 15 m X 27 m. Variety of tomato was selected as AT-3. Tomato (*Solanum lycopersicum*) seedlings was transplanted at 0.90 m X 0.30 m spacing in the beds (4 X 3 m) and crop was further maintained as per the cultural practices given in authority of university, AAU, Anand. One plot (five quadrate) of tomato crop was covered with nylon anti bird net of mesh size (2.5 X 2.5 cm) to prevent the access of birds to their prey. This served as bird-free area (netted area). Net was install in each bed to the height of 1.8 m with the help of wooden stick (Plate-1). Another plot was served as perch plot and perch was arranged in that plot. The remaining area of the entire field served as control plots where birds could freely prey upon *Helicoverpa* larvae. Observation of birds recorded during morning (6:00 am to 7:00 am), afternoon (13:00 to 14:00 pm) and yet again in the evening (18:00 pm to 19:00 pm). Total number of birds observed was recorded from the perch. Total number of successful and unsuccessful attempt made by birds from the perch was also recorded. Population of *H. armigera* larvae in perch, control and netted plots was counted in the morning at weekly interval in 10 randomly selected plants. Number of healthy and larval infested fruits at every flush were recorded. During the year 2019-20, lower population of larvae (below ETL level) was recorded in open, netted and perch area. So, data of year 2018-19 and 2020-21 is considered for valid conclusion. The data obtained thus, subjected to statistical analysis after appropriate transformation to draw valid conclusion.

Damage of *Helicoverpa armigera*, tomato fruit borer at MVRS Farm, AAU, Anand

"T" shaped perch in tomato field



Netted plot in tomato field

Plate 1: Experimental view of Tomato field at MVRS Farm and Agronomy Farm, AAU, Anand.

Open plot of tomato field at Agronomy Farm, AAU, Anand

Installation of "T" shaped perch in tomato field

Result and Discussion

During the period, total 150 observations were recorded for visitation of birds on tomato field in open and perch area (Table-1). Average 4.16 birds were recorded in open plot while 4.62 birds in perch plot during morning. Difference in bird visitation during morning period in both treatments was found statistically significant. While average 3.06 birds observed in open plot and average 3.68 birds were observed in perch plot during afternoon hours. Difference in bird visitation during afternoon period in both treatments was found statistically highly significant. Then average number of birds observed during evening hours in open (3.41) and perch (3.97) plot, respectively. Difference in bird visitation during evening period in both treatment was found statistically highly significant. The Highest average number of larvae (9.17) observed in net plot while the lowest average number of larvae per ten plants (6.00) was observed in perch plot. So, all the treatments were differing from each other and statistically best treatment was perch plot which have 7.28 kg average healthy fruits were observed while 0.62 kg damaged fruits were recorded (Table-2).

Table 1: Birds visitation to tomato plot during different day period.

No. of Birds																				
	Year-2018-19							Year- 2020-21							Pooled					
	No. of Observation	Morning		Afternoon		Evening		No. of Observation	Morning		Afternoon		Evening		No. of Observations	Morning		Afternoon		Evening	
Treatment		Mean	SEM	Mean	SEM	Mean	SEM		Mean	SEM	Mean	SEM	Mean	SEM		Mean	SEM	Mean	SEM	Mean	SEM
T1 Tomato (Open area)	100	4.47	0.140	3.13	0.146	3.46	0.139	50	3.54	0.167	2.96	0.167	3.34	0.123	150	4.16	0.114	3.06	0.111	3.41	0.101
T3 Tomato (perches)	100	4.90	0.181	4.01	0.187	4.10	0.171	50	4.06	0.179	3.02	0.175	3.70	0.157	150	4.62	0.138	3.68	0.143	3.97	0.126
Pair t Test		-2.420 **		-5.137 *		-4.019 *			2.427 **		0.319		2.310 *			3.335 **		4.759 *		4.705 *	
Df		99		99		99			49		49		49			149		149		149	
Sig. (2-tailed)		0.017		0.00		0.00			0.019		0.751		0.025			0.001		0.000		0.000	

Table 2: Larval population and yield of tomato in various treatments during Year 2018-19 & 2020-21

Sr. No.	Treatments	Number of larvae/10 plants			Weight of damaged fruits (kg/10 plants)			Weight of healthy fruits (kg/10 plants)		
		2018-19	2020-21	Pooled	2018-19	2020-21	Pooled	2018-19	2020-21	Pooled
1.	T1 Tomato (Open area)	2.86* (8.18)	2.53 (6.40)	2.69 (7.24)	0.92	0.99	0.96	6.78	6.85	6.81
2.	T2 Tomato (Netted)	3.28 (10.76)	2.78 (7.73)	3.03 (9.17)	1.22	1.29	1.25	5.86	6.20	6.03
3.	T3 Tomato (perches)	2.58 (6.66)	2.33 (5.43)	2.45 (6.00)	0.59	0.65	0.62	7.44	7.13	7.29
	S.Em.±	0.07	0.06	0.05	0.03	0.04	0.02	0.17	0.19	0.13
	S.Em.± (Y)						0.02			0.10
	S.Em.± (Y x T)			0.06			0.03			0.18
	C.D. at 5%	0.22	0.18	0.13	0.08	0.12	0.07	0.52	0.59	0.37
	C.D. at 5% (Y)			0.11			0.06			NS
	C.D. at 5% (Y x T)			NS			NS			NS
	C.V. %	5.42	5.00	5.29	6.64	8.76	7.85	5.58	6.38	6.00

Figures in the parentheses are retransformed values, while outsides are square root

Bird community also recorded. Red vented bulbul (*Pycnonotus cafer*) observed in higher average number (32.67), (19.67) while House crow (*Corvus splendens*) observed in the lowest average number in open plot and Red vented bulbul (*Pycnonotus cafer*) observed in higher average number (36.50), (25.50) while Pigeon (*Columba livia domestica*) observed in the lowest average number perch plot (Table-3).

Table 3: Avian community observed in experimental plot. (Year 2018-19 & 2020-21)

Sr.no	Name	Bird Observation																			
		T1 Tomato (Open area)										T3 Tomato (perches)									
		Morning			Afternoon			Evening			Total	Morning			Afternoon			Evening			Total
		2019	2021	Pooled	2019	2021	Pooled	2019	2021	Pooled		2019	2021	Pooled	2019	2021	Pooled	2019	2021	Pooled	
1	Common Myna (*Acridotheres tristis*)	50	31	40.50	25	16	20.50	26	17	21.50	27.50	50	33	41.50	26	16	21.00	32	14	25.00	29.17
2	House crow (*Corvus splendens*)	54	24	39.00	12	6	9.00	14	8	11.00	19.67	57	27	42.00	31	15	23.00	31	21	22.50	29.17
3	Black Drongo (*Dicrurus macrocercus*)	37	30	33.50	28	15	21.50	41	16	28.50	27.83	39	32	35.50	40	20	30.00	41	23	31.00	32.17
4	House Sparrow (*Passer domesticus*)	40	21	30.50	40	20	30.00	47	24	35.50	32.00	41	21	31.00	47	22	34.50	46	20	34.50	33.33
5	Red vented bulbul (*Pycnonotus cafer*)	56	29	42.50	38	13	25.50	40	20	30.00	32.67	58	30	44.00	45	21	33.00	45	18	32.50	36.50

6	Jungle babbler (*Turdoides striatus*)	32	17	24.50	32	16	24.00	34	17	25.50	24.67	33	16	24.50	36	18	27.00	36	18	27.00	26.17
7	Black Ibis (*Pseudibis papillosa*)	33	17	25.00	29	13	21.00	31	16	23.50	23.17	38	19	28.50	37	17	27.00	36	21	27.00	27.50
8	Red naped Ibis (*Pseudibis papillosa*)	38	19	28.50	30	15	22.50	34	17	25.50	25.50	45	21	33.00	42	21	31.50	42	15	31.50	32.00
9	Red wattled Lapwing (*Vanellus indicus*)	36	18	27.00	23	12	17.50	26	13	19.50	21.33	49	22	35.50	33	14	23.50	33	16	24.00	27.67
10	Pigeon (*Columba livia domestica*)	30	15	22.50	25	13	19.00	24	12	18.00	19.83	39	18	28.50	32	16	24.00	32	18	24.00	25.50
11	Cattle Egret (*Bubulcus ibis*)	41	18	29.50	31	16	23.50	29	14	21.50	24.83	41	19	30.00	32	16	24.00	36	14	27.00	27.00

Foraging activity of selected three birds species and observation were recorded from focal group of each bird's species. In morning hours, The highest average number of attempt (4.87) was done by Red vented bulbul (*Pycnonotus cafer*) while the highest average number of successful attempt (1.86) was done by Common Myna (*Acridotheres tristis*) (Table-4).

Table 4: Foraging behavior of three selected bird species in perch plot during Year 2018-19 & 2020-21

Year	Common Myna (*Acridotheres Tristis*)						Black Drongo (*Dicrurus macrocercus*)						Red vented bulbul (*Pycnonotus cafer*)					
	Morning		Afternoon		Evening		Morning		Afternoon		Evening		Morning		Afternoon		Evening	
	Attempt	Success	Attempt	Success	Attempt	Success	Attempt	Success	Attempt	Success	Attempt	Success	Attempt	Success	Attempt	Success	Attempt	Success
2019	4.54	2.82	4.14	2.46	3.82	2.06	3.67	0.14	3.48	0.40	3.06	0.06	4.51	0.75	4.09	0.68	4.06	0.35
2021	4.61	0.89	4.11	1.00	4.28	0.83	4.89	0.33	4.50	0.45	3.94	0.11	5.22	1.00	5.28	1.00	5.28	0.44
Average	4.58	1.86	4.13	1.73	4.05	1.45	4.28	0.24	3.99	0.43	3.50	0.09	4.87	0.88	4.69	0.84	4.67	0.40

Table 5: Economics of perches against fruit borer on tomato

Tr. No.	Name of Treatment	Quantity of required perch (perch/ha)	Price of perch (Rs./ha)	Labour cost (Rs./ha)	Total cost of plant protection (Rs./ha)	Tomato yield (kg/ha)	Yield increase (kg/ha)	Additional Income (Rs./ha)	Net Realization (Rs./ha)	ICBR
1	2	3	4	5	6	7	8	9	10	11
1	T1 Tomato (Open area)	-	-	-	-	25,222	11,777	17,770	12,770	1: 3.55
2	T2 Tomato (Netted)	-	-	-	-	-	-	-	-	-
3	T3 Tomato (perches)	100	4,000	1000	2,000	26,999	-	-	-	1: 2.55

Note 1: Labour charges @ Rs. 10 per perch = 1000 Rs./ha
2. price of perch @ Rs. 40 per perch= 4,000 Rs./ha
3. Price of Tomato= Rs. 10/kg

Conclusion

Difference in bird visitation during total period (Morning, Afternoon, Evening) in both (open, perch) treatment was found statistically highly significant. The lowest average number of larvae per ten plants (6.00) was observed in perch plot. All the treatments were differing from each other and statistically best treatment was perch plot which have 7.29 kg average healthy fruits were observed while 0.62 kg damaged fruits were recorded. From different bird community, Red vented bulbul (*Pycnonotus cafer*) observed in higher average number (32.67) in open plot as compared to perch plot (36.50). In morning hours, the highest average number of attempt (4.87) was done by Red vented bulbul (*Pycnonotus cafer*) while the highest average number of successful attempt (1.86) was done by Common Myna (*Acridotheres tristis*).

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