Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2018; 6(2): 2422-2426

Received: 16-01-2018
Accepted: 18-02-2018

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Avian composition and damage assessment in guava fruit crop at Ludhiana, Punjab

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Abstract
The present study was carried out to assess bird community characteristics and bird damage in guava orchards at three locations named Punjab Agricultural University (PAU) campus (location I), village Birmi (location II) and village Baranhara (location III) in district Ludhiana. Species richness values of 20, 19 and 25 were found at location I, II and III respectively. Rose-ringed Parakeet (*Psittacula krameri*) was observed as major pest species in selected locations. Different methods of bird manual scaring were employed at location I and bird damage to guava fruit was found to be 5.5 per cent at ripening stage. Bird manual scaring methods were not implemented at farmer owned orchards at location II and III; fruit damage was estimated to be 42.50 per cent and 23.50 per cent at fruit ripening stage at location II and location III respectively. Bird manual scaring methods were found effective in reducing the bird damage in guava crop at location I as compared to location II and III.

Keywords: bird damage, bird pest management practices, bird species richness, guava orchard

Introduction
Guava (*Psidium guajava*) is a popular fruit; gives two crops a year and widely cultivated in Indian subcontinent. Winter season crop is considered more superior than the rainy season crop [8]. Insects and bird pests are two major factors which lead to decrease in fruit production [5, 15]. Birds reduce crop yields by consuming fruit, damaging fruit which leave it susceptible to infection and requiring fruit to be harvested before it is fully ripen [4]. Anderson mentioned that apple and grape producers suffer losses up to millions of dollars each year due to direct bird damage and expenditures on management measures in U.S.A [2]. Bird damage is a common and costly problem for fruit producers, who try to limit damage by using management techniques [6]. Birds are frequently found in almost all agroecosystems and their foraging activities often results in significant beneficial or detrimental effects on crop yields [25]. The abundance of frugivorous and insectivorous bird species in orchards worked as key factor explaining the local variations in fruit consumption [18]. Fruit size at the ripening stage explained the substantial amount of variation in the assemblage of frugivorous bird species [30]. House Crow is omnivorous species in its habits and causes serious damage to ripening fruits [28]. Activities of insectivorous bird species preying on beneficial pollinators resulting in reduced fruit set [31]. Fruit producers have identified bird damage as a critical issue that has received restricted attention from researchers [15]. Limited research has been done on the economic impacts of bird damage to fruit crops, and much of this research has focused on wine grapes [3]. The present study was undertaken with objective to assess bird damage in protected and unprotected guava orchards. Winter season crop was selected for the present study. Winter crop of guava has three phases; flowering occurs in August- September, fruit set stage occurs in October-November and fruit ripening stage occurs between December and January [24].

Materials and Methods
The present study on bird damage assessment to guava crop was undertaken at ripening stage (August 2015 to February 2016) in orchards at different locations surrounded by agricultural/ cereal crop fields having predominant pattern of wheat and rice. The effect of different manual scaring methods on different bird pest species and their abundance was recorded at different developmental stages. Orchards without management practices were also selected for comparison of bird community characteristics. The locations of present study were guava orchard in Punjab Agricultural University (PAU) campus Ludhiana, orchard at village Birmi

and village Baranhara (Ludhiana district); these were taken as location I, location II and location III respectively. Location I lies at latitude of 30 54` 147 N and longitude of 075 47` 642 E and 244 m above mean sea level. Location II lies at latitude of 30 54` 173 N and longitude of 075 43` 477 E and 235 m above mean sea level. Location III lies at latitude of 30 93` 56 N and longitude of 075 77` 49 E. Birds inhabiting/ foraging in the study locations were counted by employing line transect method [26, 11]. All bird species visiting the guava trees were noted down like utilizing the branches as perching sites and those foraging under tree canopies. Total bird population in guava orchards were recorded. The locations were visited weekly in morning from 8.00 am -10.00 am in morning and from 4.00 pm – 6.00 pm in evening during winter.

At location I manual scaring practices were mainly used. Different types of manual scaring methods like drumming, loud sounds, crackers and scare crows to scare the birds were performed by the workers in Guava fruit crop orchard to protect the fruit crops from damage. Farmers did not implement bird manual scaring practices at location II and III. Ten trees were selected from each location. At the ripening stage weight of fruits per tree was noted from the location I, location II and location III. Differences in yield at different locations were found to calculate the percentage damage from the said locations [17].

Statistical analysis

Mann- Whitney U test was carried out to find out difference between the relative abundance of bird species observed at flowering, fruit set and fruit ripening stages of guava crop at location I with location II and location I with location III. Independent T Test was carried out to compare the damage production of guava fruit in location I with Location II and location I with location III.

Results and Discussion

Species richness values of 13, 10 and 11 were observed at flowering, fruitset and fruit ripening stage respectively at location I (Table 1). Species diversity 1.79 was found to be maximum at flowering stage at location I. Relative abundance (%) of House Crow and Rose-ringed Parakeet was found more at location I as compare to Location II and III. Rose-ringed Parakeet was observed hovering in large flocks over the guava trees and observed roosting on the poplar trees grown as hedgerows around the orchard.

At location II, species richness 16, 10 and 13 was observed at flowering, fruitset and fruit ripening stage respectively. Shannon- Wiener Index for diversity richness for different habitats showed maximum diversity (2.45) at the flowering stage in location II (Table 1). Increase in fruit weight seemed to attract more parakeet population towards the crop. The population of frugivorous birds visiting guava crop increased with the ripening stage at location II. Rose-ringed Parakeet was observed as the major avian pest, its relative abundance (49.74%) was recorded maximum at fruit ripening stage.

There were recorded a total of 25 species at fruit developmental stages which were maximum as compared to other studied locations. The values of species richness 15, 16 and 18 were observed at flowering, fruitset and fruit ripening stage respectively (Table 1). Maximum number of insectivorous species namely Small Bee-eater, Wire-tailed Swallow, Indian Chat, Plain Prinia and Black Drongo were observed at the flowering stage. Bird species belonging to different trophic level like omnivorous, insectivorous and carnivorous were observed having high abundance which was because of the easy availability of insect diversity, small invertebrates, reptiles and amphibians at unmanaged orchard at location III. It was further noted that decaying leaves and plant matter covered the orchard floor which seemed provide space for small invertebrates and rodents. No significant difference was found between the abundance of bird species at different developmental stages in the comparison of location I with location II and location I with location III (Table 1).

Table 1: Bird Community characteristics at different fruit developmental stages of Guava crop at different locations in Ludhiana

Location	Location I			Location II			Location III		
Crop stage	**Flowering stage (August-September)**	**Fruit set stage (October-November)**	**Fruit ripening (December-January)**	**Flowering stage (August-September)**	**Fruit set stage (October-November)**	**Fruit ripening (December - January)**	**Flowering stage (August-September)**	**Fruit set stage (October-November)**	**Fruit ripening (December - January)**
Bird species	**Relative abundance (%)**								
House Crow	19.48	23.52	28.92	21.00	21.21	25.38	20.43	16.03	16.84
Rose-ringed Parakeet	46.75	36.76	37.19	17.00	34.84	49.74	30.10	25.47	28.26
Red-wattled Lapwing	5.19	-	-	10.00	3.03	4.56	-	-	-
Cattle Egret	6.49	22.05	17.35	9.00	4.54	2.53	7.52	2.83	2.17
Black-winged Stilt	-	-	-	7.00	-	-	-	-	-
Black Drongo	2.59	-	-	6.00	-	0.50	1.07	0.94	1.08
Common Myna	2.59	-	-	5.00	-	3.55	7.52	16.98	15.76
Common Babbler	-	-	-	5.00	7.50	4.06	2.15	1.88	-
Stone-curlew	-	-	-	4.00	-	-	-	-	-
Wire-tailed Swallow	-	2.94	5.78	3.00	21.21	1.52	6.45	6.60	2.17
Black Ibis	-	-	-	3.00	1.51	-	-	-	-
Indian Treepie	1.29	-	0.82	3.00	3.03	0.50	-	1.88	-
Indian Peafowl	-	-	1.65	2.00	-	-	-	-	-
Blue Rock Pigeon	-	-	-	2.00	-	1.01	2.15	7.54	6.52
Paddyfield Pipit	-	-	-	2.00	1.51	-		0.94	0.54
Yellow-legged Green-pigeon	-	-	-	1.00	-	-	-	-	7.06
Greater Coucal	-	1.47	1.65	-	1.51	1.01	1.07	3.77	1.63
Indian Chat	-	2.94	-	-	-	4.06	2.15	-	5.97
Red-vented Bulbul	-	4.41	-	-	-	1.52	-	-	4.89
Black Francolin	1.29	-	-	-	-	-	-	-	-
Purple Sunbird	2.59	-	-	-	-	-	-	-	-
Indian Roller	5.19	1.47	0.82	-	-	-	-	-	-
Little Egret	3.89	-	-	-	-	-	-	-	-
Indian Grey Hornbill	1.29	-	-	-	-	-	-	-	-

Black Redstart	-	1.47	-	-	-	-	-	-	1.08
Black Kite	-	-	2.47	-	-	-	-	-	-
Grey Francolin	-	-	0.82	-	-	-	-	-	-
Small Bee-eater	-	-	-	-	-	-	8.60	3.77	-
Asian Koel	-	-	-	-	-	-	7.52	7.54	0.54
Plain Prinia	-	-	-	-	-	-	1.07	-	-
Eurasian Collared-dove	-	-	-	-	-	-	1.07	-	1.08
White-breasted Kingfisher	-	-	-	-	-	-	1.07	-	-
Common Tailorbird	-	-	-	-	-	-	-	1.88	2.71
Indian Robin	-	-	-	-	-	-	-	0.94	-
Shikra	-	-	-	-	-	-	-	0.94	-
Red Junglefowl	-	-	-	-	-	-	-	-	1.08
Black-shouldered Kite	-	-	-	-	-	-	-	-	0.54
Species Richness	13	10	11	16	10	13	15	16	18
Species Diversity	1.79	1.67	1.63	2.45	1.76	1.58	2.14	2.26	2.24
Species Evenness	0.70	0.72	0.68	0.88	0.76	0.61	0.79	0.81	0.77

Flowering stage of guava crop at Location I and Location II
Z- 0.836 (NS)
Fruit set stage of guava crop at Location I and Location II
Z- 0.608 (NS)
Fruit ripening stage of guava crop at Location I and Location II
Z- 0.261 (NS)
Flowering stage of guava crop at Location I and Location III
Z- 0.348 (NS)
Fruit set stage of guava crop at Location I and Location III
Z- 0.635 (NS)
Fruit ripening stage of guava crop at Location I and Location III
Z- 0.496 (NS)
Z is the coefficient of Mann- Whitney U test
NS- Difference is non significant

The analysis of foraging habits of bird community has shown insectivorous/ omnivorous to be the dominant species at selected locations. Observations had shown that Rose-ringed Parakeet was only bird species causing damage to guava fruit at selected locations. Large flocks of parakeet were observed hovering at ripening stage. The pattern of Rose-ringed Parakeet damage on guava was like triangular marks and deep gouges. Different ways of manual scaring like drumming, loud sounds, crackers and scare crows were employed at location I at the onset of bird damage and the said methods were continued to be practiced till the harvesting of crop. Flock size of 40-50 of Rose-ringed Parakeet was found feeding on ripening guava at unmanaged orchard at location II and III.

Fruit trees were randomly sampled for damage at said locations. It was found that the average yield per tree was 135 kg at location I. Average damage per tree was 7.5 kg; which amounted to 5.5% loss in guava crop. Maximum damage was recorded at location II; average yield per tree was 122 kg. Average damage per tree was recorded 51.85 kg; which amounted to 42.5% loss at location II (Table 2). In location III average yield per tree was 130 kg. Average damage per plant was recorded 30.5 kg; which amounted to the 23.5% loss (Table 2).

Table 2: Statistical comparison of the damage of guava fruit crop in selected locations

	Location I With Manual scaring practices		**Location II Without Manual scaring practices**		**Location III Without Manual scaring practices**	
Sampled trees	**Fruit damage/tree (in kg)**	**Fruit yield/tree (in kg)**	**Fruit damage/tree (in kg)**	**Fruit yield/tree (in kg)**	**Fruit damage/tree (in kg)**	**Fruit yield/tree (in kg)**
1	9	135	35	129	34	130
2	6	148	50	117.5	32	143
3	8	162	35	113.5	28	126
4	5	155	45	136	33	119
5	11	128	69.5	124	31	138
6	7	120	50	118	25	140
7	7	136	49	120	35.5	113
8	8.5	130	60	123	31.5	120
9	6.5	121	80	126	29	136
10	7.0	115	45	113	26	135
Total	75 (5.5%)	1350	518.5 (42.5%)	1220	305 (23.5%)	1300

Comparison in location I Fruit Research Farm, PAU and Location II orchard at village Birmi T- 6.56**
**Significance at 1% level of significance (p<0.01)
Comparison in location I Fruit Research Farm, PAU and Location III orchard at village Baranhara
T- 13.68**
**Significance at 1% level of significance (p<0.01)

Statistical method Independent T test had been carried out to compare fruit damage per tree (in kg) at location I with location II and also location I with location III of Ludhiana district. The statistical comparison showed the significant difference at 1% level of significance (p<0.01) in the fruit yield and damage of location I with location II and location I with III (Table 2). The maximum bird damage was recorded at location II as compared to location I and III. Possible reason was the roosting and perching sites of Rose-ringed Parakeet provided by the hedgerows of eucalyptus and poplar trees at location II. This location was within 250 m from canal side forest plantation predominantly of eucalyptus and poplar. These trees were the abode of cavity nester bird species like Rose-ringed Parakeet. Said factors contributed to the heavy fruit crop losses at location II as compared to the other selected locations. It was further observed that maximum fruit

damage seemed to be related to colour changing state at ripening stage which attracted flocks of Rose-ringed Parakeet at location II and location III. Comparison of fruit yield/ tree showed that the implementation of bird scaring methods helped in reducing the Rose-ringed Parakeet damage at location I (Fig 1).

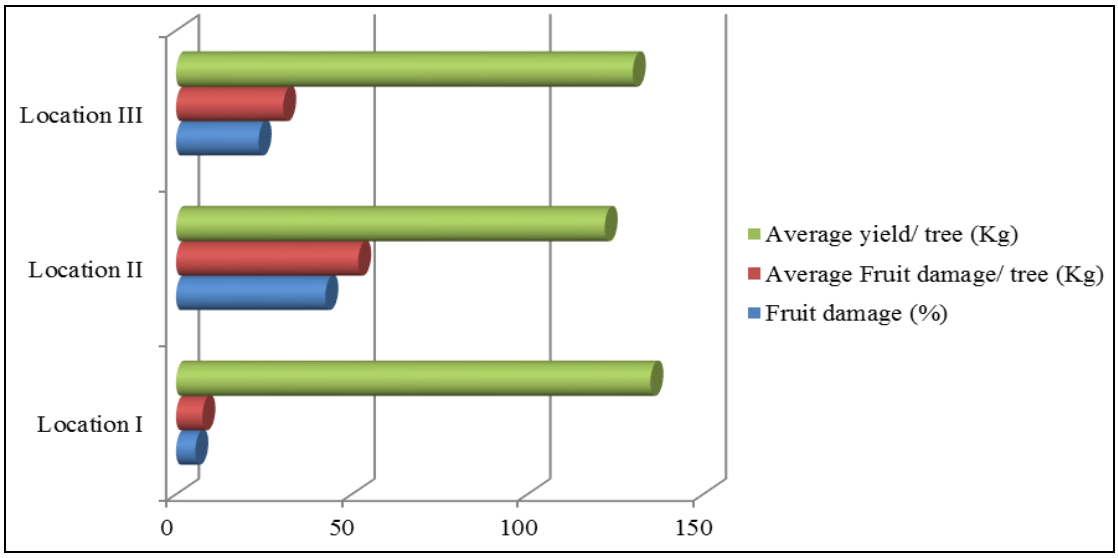

Fig 1: Comparison of production and damage of Guava fruit at three different locations

Location I- Guava orchard Fruit Research Farm, PAU Ludhiana
Location II- Guava orchard village Birmi, Ludhiana
Location III- Guava orchard village Baranhara, Ludhiana

Present study had shown the relative abundance of Rose-ringed Parakeet to be 37.19%, 49.74% and 28.26% at the ripening stage of guava crop in location I, II and III respectively. Sidhu and Kler found 30 bird species belonging to six orders in the guava orchard Baranhara, Punjab [23]. Jacobson mentioned the more damage by the granivorous and frugivorous bird species in different parts of the world [9]. Workers had mentioned that Rose-ringed Parakeet was most depredatory species in agricultural crops of Punjab state [12, 14]. Patyal and Rana also stated that Rose-ringed Parakeet inflicted the huge damage to the standing crops, orchard fruits and vegetable crops [21]. Workers had mentioned that large and tall tree plantations along canalsides and roadside forests providing the roosts and nests to several hole nester bird species [1]. Kross stated that many bird species, including parakeets and small passerines inflicted economic loss to growers by consuming crops [13]. Rose-ringed Parakeet is the major pest species causing damage to guava crop up to large extent [14]. Luck found that parakeets caused a huge damage in the almond orchard [16]. Grasswitz and Fimbers also found that the amount of damage was depended on the preference of red colour of apple at late ripening stage and it was further mentioned that the lower bird damage was in the orchards having management practices [7]. Zachary had also discussed management practices followed by the farmers to decrease the bird damage in the orchards [27]. Rajashekara and Venkatesha stated species diversity, species evenness and richness of bird communities were significantly different in different landscapes [22]. Katayama studied species richness and abundance of breeding birds in apple orchard in Japan and also mentioned that insectivorous and frugivorous bird species were more abundant [10]. Workers stressed upon the importance of hedgerows for providing cover and shelter to the insectivorous and granivorous bird species [19]. Organic apple orchards provided habitat for a large number of both human-adapted and human-sensitive species were relatively similar to adjacent hedgerow habitats [20].

Conclusion

Location wise bird community characteristics like bird diversity and composition were found to be related with fruit development of guava crop. Implementation of bird manual scaring methods reduces the bird damage at ripening stage of guava at location I as compared to location II and III. It may be suggested that incorporation of different bird scaring methods should be included in agronomic schedules of guava crop for better fruit yield and lesser economic losses to the farmers. Ecofriendly bird management studies are required to be conducted to understand the complexities involved in foraging behaviour of bird community and location specific habitat features to different agroclimatic regions of Punjab state.

Acknowledgment

Authors are grateful to the Head, Department of Zoology, Punjab Agricultural University, Ludhiana for providing necessary facilities. I would also like to thank Dr. Karan Bir Singh Gill for guidance related to horticultural crops.

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