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Estimation of Predatory Bird Damage to Winter Guava Crop

K. Yodha, D. Singh, A. Kour, R. Yadav, P. Dahiya and R. Kumar[1]

Department of Zoology and Aquaculture, CCS Haryana Agricultural University, Hisar-125 004, India
[1]College of Agriculture, Bawal, CCS Haryana Agricultural University, Hisar-125 004, India
**E-mail: kiranyodha3@gmail.com*

Abstract: The present study was aimed to record bird community characteristics and extent of damage caused by birds in guava orchard at Haryana Agricultural University, Hisar and village Salemgarh from August, 2019 to January, 2020. Rose-ringed Parakeet was the worst avian pest at both locations. In guava crop, the pestilence at location I was caused by Rose-ringed Parakeet, Alexandrine Parakeet, Red-vented Bulbul, Brown-headed Barbet and Western Koel. At location II, the frugivorous species which inflicted damage to the guava crop were Rose-ringed Parakeet and Red-vented Bulbul. The parakeets preferred both unripe and ripened fruits, while the other species preferred only ripened fruits. Birds other than parakeets thrived only on the pulp and seeds of those fruits that the parakeets had previously consumed. Different effective methods of bird manual scaring were employed at location I and bird damage to guava fruit was 4.92%. Bird manual scaring methods were not implemented on a regular basis at location II, fruit damage was estimated to be 8.91%. There was significant difference in the mean damage fruit yield production of guava crop at location I and II. Therefore, implementation of auditory technique were effective to minimise bird depredatory attacks, reduce economic losses and improve crop quality and yield.

Keywords: Avian pest, Crop loss, Damage estimates, Guava

Agricultural productions are cornerstone of the world economy. The goal of World Health Organization is to increase fruits and vegetables consumption because fruits and vegetables have such a tremendous positive influence on human health. As a result, expanding fruit production offers both social and economic advantages (Lindell et al 2016, Balkrishna et al 2022). *Psidium guajava L.* (Guava) is India's fifth most significant commercial fruit crop after *Mangifera indica, Musa* sp., *Citrus* sp. and *Vitis vinifera*. Being inexpensive and widely accessible, guava is common fruit in India and it is widely cultivated and commercialised (Sharma 2020, Santhosh kumar et al 2022). Its cultivation has become a very profitable agricultural enterprise in India. Insects and birds are two significant factors contributing to a decrease in agricultural output. Bird pests are regarded as a potential threat to agriculture since they devour a wide range of crops, from fruits to cereals (Brady 2022). Agricultural bird pest are as ancient as agriculture itself, both in India and across the world. Of the world's 8650 bird species about 1,200 are found in the Indian subcontinent, representing 20 orders (Rana and Narang 2004, Sausse and Levy 2021). In India, 2.1% birds species have been documented to cause agricultural damage primarily to fruit-bearing and grain-yielding crops (Schackermann et al 2014, Kiran et al 2022). Damaged fruits can be susceptible to infection by microorganisms and lower the quality as well as quantity of fruit (Steensma et al 2016, Mirzazadeh et al 2021). The problem is that birds damage more fruit than they consume, rendering hanging fruit unsuitable for market and causing premature ripening, resulting in inferior commodities being supplied (Elser et al 2019). The percentage of damage may vary in different crops e.g. small berry production is estimated to be damaged by 30 to 35%, wine and table grapes by 7%, apples and pears by 13%, stone fruits by 16 % and nut crops by 22 % (Imarohi 2014). Numerous bird species are the most pestiferous species, inflicting damage to crops in different seasons depending on environmental circumstances such as the accessibility of alternative food sources because of drought and cold (Elser et al 2019). To reduce bird damage, knowledge about the bird species abundance in a specific area and crop is essential because assemblage of birds varies according to the area (Luck et al 2015, Sauer et al 2017). Long-term studies on the biology, flocking movement, behaviour and crop-specific information of the main pest species are required to control bird damage. These studies can help to identify which species cause damage and which bird mitigation strategies may be most efficient as species may respond differently to control measures (Hannay et al 2019). Fruit growers have identified bird damage as a serious problem that has received little attention. There has been little research on the economic implications of bird damage to fruit crops, with much of it focusing on wine grapes (Anderson et al 2013). The present studies were therefore, aimed to evaluate the nature and extent of damage caused by birds on winter guava crop.

MATERIAL AND METHODS

Study site: The location of the present study were experimental orchard of HAU (Location I) and village Salemgarh (Location II) situated in the district of Hisar, Haryana, India. Location I lies at latitude of 29°09'17.3"N and longitude of 75°41'28.0" E. Location II lies at latitude of 29°11'18.1"N and longitude of 75°32'39.8"E. To study the pattern and extent of damage by birds, well-maintained orchards with an area of 1acre were selected at both the locations.

Methodology: The study was conducted to assess birds community composition, nature and extent of damage by birds in guava orchard from August, 2019 to January, 2020 at selected locations. The observations were taken on weekly basis from 8.00 to 10.00 A.M. and 4.00 to 6.00 P.M. during the winter season, but harsh weather conditions were avoided in order to minimise the weather-related errors. A Nikon COOLPIX P900 digital camera and Nikon ACULON binoculars (8×42, 8°) were used for photography and observations were recorded from long distances so as not to disturb the normal activity of birds. Bird's species visiting the guava crop were recorded to check whether they were perching on the branches, foraging under tree canopies, roosting or using the standing crop as a cover to avoid aerial predators and feeding on guava fruit. Reference book was used to identify the birds (Ali 2002, Grimmet et al 2016). Details on the nature and extent of fruit damage by birds were noted down. Observations related to avifaunal diversity, richness and relative abundance at the flowering, fruit setting and ripening stage of guava crop were also recorded. Relative abundance was calculated by the given formula:

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

The management practices were used to minimise the damage to fruit crops at both locations, but intense auditory techniques (shouts by human beings, beating of empty drums, catapult, and crackers) were used at experimental orchards of HAU as compared to village Salemgarh.

Assessment of guava fruit damage by frugivorous birds: Bird damage to fruits was calculated using the weighing method. Ten trees were selected from the total area, five from the periphery and another five from middle of the orchard. The weight of fruits per tree at the fruit setting and ripening stage was recorded from both the locations. Fruits damaged and dropped by birds were collected, placed in polythene bags and weighed until the research was completed to record total fruit production and depredation by birds. Differences in yield at both the location were used to estimate the percent damage by following formula:

$$\text{\% damage} = \frac{\text{Number of damaged fruits}}{\text{Total numbers of fruits}} \times 100$$

Data analysis: Shannon-Weiner Diversity Index, Simpson's Index of Diversity and Species evenness were calculated using the software PAST version 4.0.

Independent T-test: Independent T-test was carried out to compare the mean damaged production of guava fruits of location I with location II using statistical software SPSS (Version 28.0.1.1(14)).

RESULTS AND DISCUSSION

The present study was conducted to study the avian diversity in different growth stages of guava crop and to assess the damage and evaluation of bird pest management methods.

Species abundance: A total of 32 and 23 bird species were observed at location I during morning and evening hours respectively (Table 1). A total of 17 and 11 bird species were observed at location II during morning and evening hours respectively. Sidhu and Kler (2017) reported 30 bird species belonging to six orders in orchard of guava at Baranhara (Punjab). Diversity and abundance of birds was higher at location I because of mixed cropping system (date, ber, grape, apple, ber, sapota, mulberry, mango and kinnow) as compared to location II (only ber) which ensures abundance and variety of food resources to birds. Round (2000) also observed that mixed-species forest provides plenty of food sources to birds. Genghini et al (2006) also stated that in organic orchards avian community are more diversified. Species richness was 24, 16 and 21 at flowering, fruit setting and ripening stage respectively during morning hours whereas species richness was 19, 10 and 16 at flowering, fruit setting and ripening stage respectively during evening hours at location I. Species richness was low at location II. Avian community composition was recorded maximum during morning hours at flowering and ripening stage at both locations, because flowering stage attracts many insectivorous species like Black drongo and Asian green bee-eater whereas ripening stage provides large quantity of food to birds. Similar kinds of observations were reported by Sidhu and Kler (2018).

Relative abundance at three stages of guava viz flowering, fruit setting and ripening stages revealed that the Rose-ringed Parakeet and Alexandrine Parakeet were the most dominant species at location I and Rose-ringed Parakeet at location II. Kler and Kumar (2015), Arora et al (2023) also reported that Rose-ringed Parakeet is the major pest species inflicting serious damage to guava crop.

Diversity index: Shannon-wiener index for diversity richness showed maximum diversity 2.30 at the flowering

Table 1. Avian community composition at different developmental stages of winter guava crop at location I and II

Crop stage	Flowering stage	Fruit setting stage	Ripening stage	Flowering stage	Fruit setting stage	Ripening stage
	(Aug-Sep)	(Oct-Nov)	(Dec-Jan)	(Aug-Sep)	(Oct-Nov)	(Dec-Jan)
	Morning			Evening		
Bird species	Relative abundance (%)					
Milvus migrans (Black kite)	1.97	-	-	2.01	-	-
Elanus caeruleus (Black-winged kite)	(0.96)	(0.44)	-	-	-	(0.19)
Accipiter badius (Shikra)	(0.48)	(0.44)	-	-	-	-
Ocyceros birostris (Indian grey hornbill)	(0.96)	0.75 (0.87)	0.53 (0.29)	2.35	1.63 (0.67)	0.54 (0.38)
Streptopelia decaocto (Eurasian collared-dove)	-	-	1.33	-	-	1.09
Halcyon smyrnensis (White-breasted kingfisher)	1.18 (0.96)	0.75 (0.87)	0.80 (0.29)	0.67 (0.46)	0.98 (0.67)	0.54 (0.57)
Coracias benghalensis (Indian roller)	(0.48)	-	-	(0.46)	(0.33)	(0.19)
Merops orientalis (Asian green bee-eater)	3.94	-	-	3.36	-	-
Vanellus indicus (Red-wattled lapwing)	6.30 (6.25)	3.36 (12.23)	3.18	1.68 (3.67)	0.65	1.63 (1.14)
Eudynamys scolopaceus (Western koel)	0.79	1.12	1.59 (0.88)	2.01	0.33	1.09
Clamator jacobinus (Jacobin cuckoo)	0.39	-	-	-	-	-
Francolinus pondicerianus (Grey francolin)	-	-	-	2.68	-	-
Gallinula chloropus (Common moorhen)	-	-	0.27	-	-	-
Corvus splendens (House crow)	2.36 (8.65)	2.61 (3.06)	2.39 (3.53)	4.70	-	1.90
Corvus macrorhynchos (Indian Jungle crow)	-	-	0.80	-	-	0.27
Dendrocitta vagabunda (Rufous treepie)	0.79 (0.96)	0.75	1.33 (1.18)	1.34 (0.92)	1.31 (0.67)	0.54 (0.38)
Dicrurus macrocercus (Black drongo)	0.79 (1.44)	0.37	0.53	0.67	-	-
Lonchura punctulata (Scaly breasted munia)	-	-	-	2.01	-	-
Euodice malabarica (Indian silverbill)	0.39	-	0.53	-	-	-
Argya striata (Jungle babbler)	6.30	5.22	10.08	4.36	5.23	5.43
Anthus rufulus (Paddy field pipit)	-	-	-	(0.92)	-	-
Motacilla alba (White wagtail)	-	1.87	1.06	-	-	-
Motacilla flava (Western yellow wagtail)	-	4.10	1.86	-	-	0.82
Phoenicurus ochruros (Black redstart)	-	-	0.53 (0.88)	-	-	0.27
Saxicoloides fulicatus (Indian robin)	-	-	0.27	-	-	-
Cinnyris asiaticus (Purple sunbird)	0.39 (0.96)	-	-	0.34 (0.46)	-	-
Pycnonotus cafer (Red-vented bulbul)	3.94 (3.37)	2.24 (2.18)	3.98 (3.24)	2.01 (1.83)	1.96 (2.33)	2.17 (3.42)
Gracupica contra (Asian pied starling)	0.79	-	-	3.36	-	-
Acridotheres tristis (Common myna)	7.87 (10.10)	4.48 (7.86)	4.77 (1.47)	4.03	-	1.09
Pastor roseus (Rosy starling)	0.39	-	-			
Ardeola grayii (Indian pond-heron)	0.39	-	-			
Bubulcus ibis (Cattle egret)	5.12	4.48 (3.06)	-			
Threskiornis melanocephalus (Black-headed ibis)	1.18	-	-			
Pseudibis papillosa (Red-naped ibis)	1.97 (7.21)	-	(1.76)	(5.96)	-	-
Psilopogon zeylanicus (Brown-headed barbet)	1.97	1.49	2.39	1.01	1.31	1.36
Dinopium benghalense (Black-rumped flameback)	0.79	-	-			
Palaeornis eupatria (Alexandrine parakeet)	9.05	14.18	15.65	16.44	25.82	24.46
Alexandrinus krameri (Rose-ringed parakeet)	40.94 (57.21)	52.24 (69.00)	46.15 (86.47)	44.97 (85.32)	60.78 (95.33)	56.79 (93.73)
Species richness	24 (14)	16 (10)	21 (10)	19 (9)	10 (6)	16 (8)

Without bracket - Location I, Bracket ( ) - Location II stage in location I during morning hours and lowest (0.26) at the fruit setting stage in location II during evening hours (Fig. 2, 3). Species evenness was maximum (0.42) at the flowering stage at location I during morning hours while minimum (0.17) was at ripening stage at location II during evening hours. D, calculated from the location I with its highest value as 0.80 at the flowering stage during morning hours and lowest value as 0.09 at fruit setting stage during

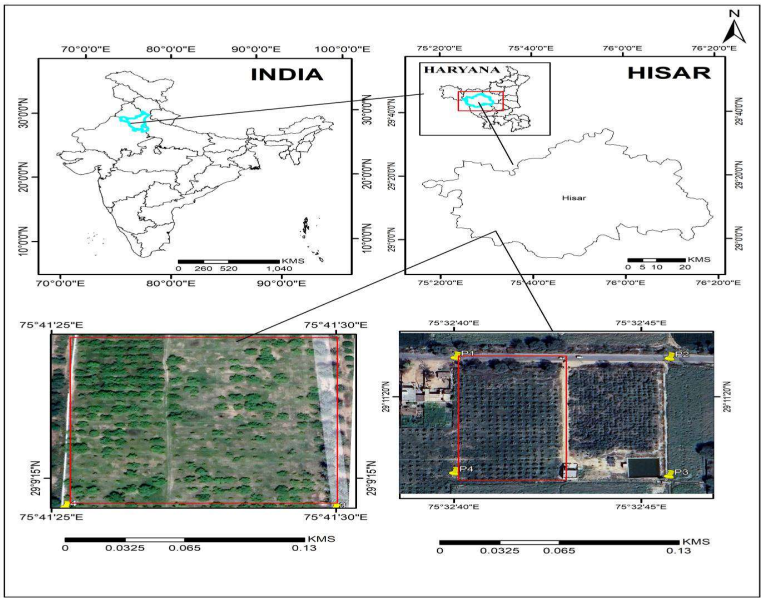

Fig. 1. Location map of study site in region Hisar, Haryana

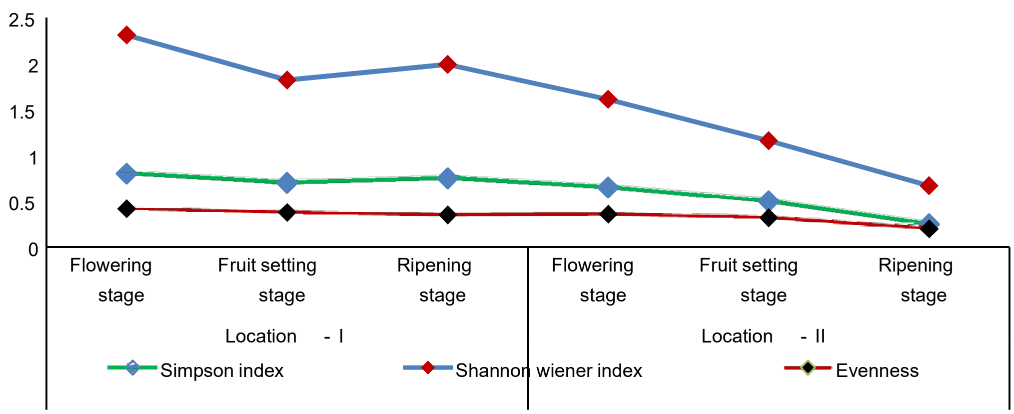

Fig. 2. Diversity indices of avian community at different developmental stages of winter guava crop during morning hours

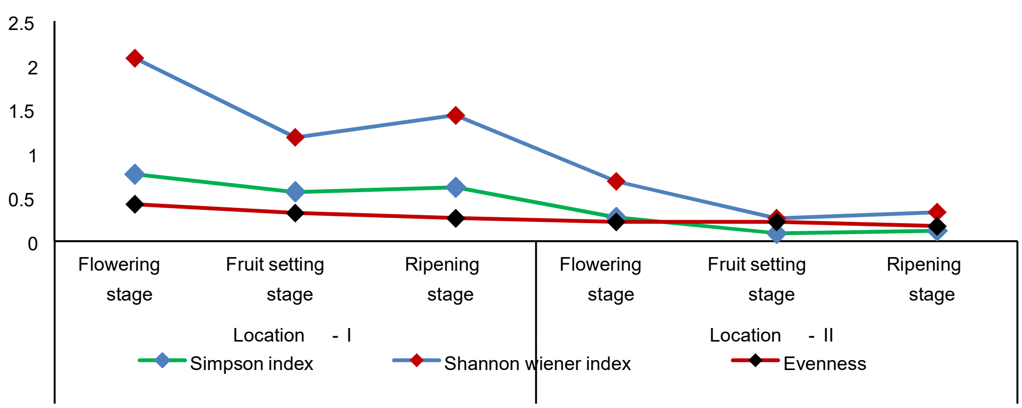

Fig. 3. Diversity indices of avian community at different developmental stages of winter guava crop during evening hours

evening hour from location II. The higher value of species diversity, species evenness and simpson index were recorded at the flowering stage during morning hours. Maximum number of insectivorous species were observed at the flowering stage which was because of the easy availability of insect diversity. The highest species richness and species diversity at different developmental stages of the guava crop recorded at location I as compared to location II could be due to presence of different types of vegetations as well as crops in the surrounding areas at location I whereas, more uniform cropping pattern was observed at location II. The findings are in line with Kaur and Kumar (2022). Rajashekara and Venkatesha (2015) also confirm present findings that the species richness, species diversity and evenness of avian communities vary significantly in different landscapes.

Nature of damage inflicted by frugivorous bird species: Rose-ringed Parakeet, Alexandrine Parakeet, Red-vented Bulbul, Brown headed Barbet, Western Koel and House Crow were the frugivorous bird species inflicting damage to guava fruit at location I (Fig. 4). At location II, the frugivorous species which inflicted damage to guava crop were Rose-ringed Parakeet and Red-vented Bulbul. Kross et al (2012) reported that many bird species, including parakeets and small passerines inflicted economic loss to growers by consuming crops. Rose-ringed Parakeet was the main depredatory bird at location I and location II and inflicted damage to the guava fruits, which led to decrease in the yield of crops and loss to the farmer. The present findings are similar to the observations recorded by Arora et al (2023). House Crow was sighted rarely to cause damage to guava fruit during the study period. Hussain and Vashishat (2021) has also reported that house crow attack the guava fruit and rendered them unfit for the market. A large flock of parakeets were observed hovering above the guava orchard. Rose-ringed Parakeet and Alexandrine Parakeet depredates at both ripen and unripe stages and dropped fruits under the parent tree. Red-vented Bulbul, Brown headed Barbet, Western Koel and House Crow feed on guava fruit at the ripening stage and are pulp gleaners. The pattern of parakeet damage on guava was like triangular marks and deep gouges. Dulera and Nayi (2022) also reported similar pattern of damage on guava fruit. Red-vented Bulbul, Brown-headed Barbet, Western Koel and House Crow peck on the fruit which were already eaten by parakeets. Sometimes it was recorded that parakeet detach the unripe guava from the tree and fly away to the date palm tree which surrounds the guava tree and use one foot to hold the guava for feeding purposes. It was also observed that parakeets fly away to nearby roosting sites after detaching the guava holding the fruit in their beak to feed their young ones. Maximum fruit damage seemed to be related to colour changing state at ripening stage which attracted flocks of Rose-ringed Parakeet. Grasswitz and Fimbers (2013) also observed that as the fruit weight increased at the ripening stage, the extent of damage also increased. The clear correlation was observed between parakeet visits and fruit damage in the orchard. In order to meet their food needs for spending the fasting night in their roost, the damage was observed at a higher rate in the evening as compared to the morning. Similar results have also been described by Manzoor et al (2013).

Assessment of crop damage: Out of 10 sampled trees tested, total fruit yield was 677 kg at location I and total weight of damaged fruit and healthy fruit was 33.35 and 644 kg

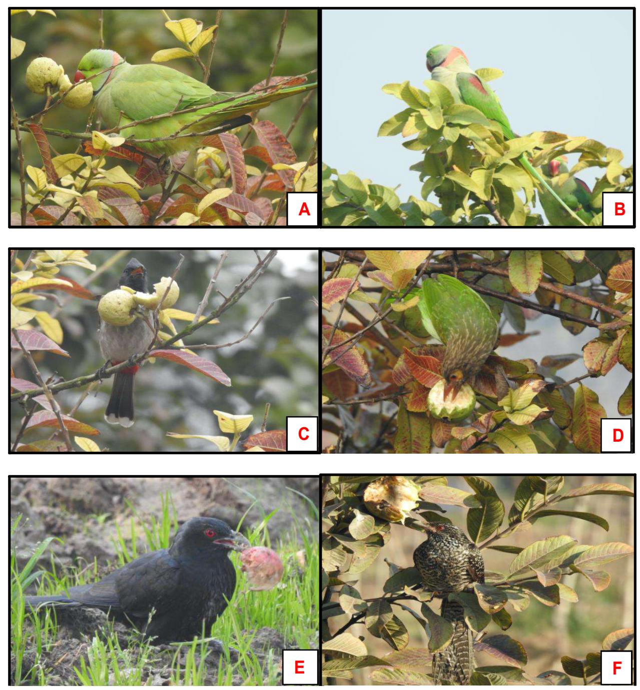

Fig. 4. Frugivorous bird species inflicting damage to guava fruit. A-Rose-ringed Parakeet | B-Alexandrine Parakeet | C- Red-vented Bulbul | D-Brown-headed Barbet | E-Western Koel (Male) | F. Western Koel (Female) © Kiran

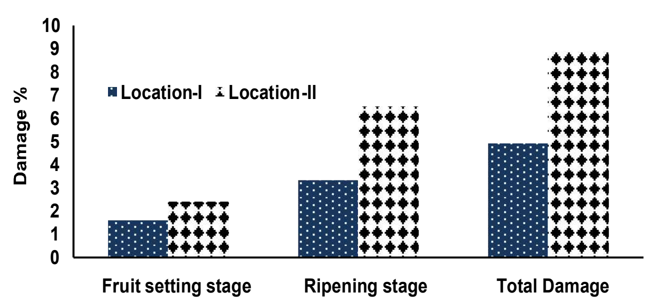

Fig. 5. Comparison of damage to guava crop by birds at location I and II

Table 2. Damage to guava fruit by birds at location I and II

Sampled trees	Total production of fruit (kg)		Undamaged production of fruit (kg)		Unripe fruit damage (kg)		Ripening fruit damage (kg)		Total fruit damage (kg)	
	L I	L II	L I	L II	L I	L II	L I	L II	L I	L II
Periphery of the orchard										
Total damage	333	263	316.5	240	5.60	6.97	12	16.03	17.60	23
% Damage			95.04%	91.25%	1.68%	2.65%	3.60%	6.09%	5.28%	8.74%
Middle of the orchard										
Total damage	344	240	328.25	218.2	5.26	5.09	10.49	16.71	15.75	21.8
% Damage			95.42%	90.92%	1.53%	2.12%	3.05%	6.96%	4.58%	9.08%
Overall total damage (kg)	677	503	644.75	458.2	10.86	12.06	22.49	32.74	33.35	44.8
Overall total damage (%)			95.23%	91.09%	1.60%	2.40%	3.32%	6.51%	4.92%	8.91%

L I-Location-I, L II- Location-II

respectively (4.92 % loss) (Table 2). Sidhu and Kler (2018) also recorded 5.5 % damage by birds to guava fruit at the PAU fruit research farm, due to the adoption of rigorous management measures. The damage to the guava was more in the ripening stage (3.32 %) as compared to the unripe stage (1.06 %). Hussain and Vashishat (2021) also observed same trend. At the periphery and middle of the orchard the damage was recorded 5.28 and 4.58 %, respectively. Khan et al (2015) and Senar et al (2016) also found that damage was fairly high on the edges of the crop, primarily due to the presence of trees, bushes and fencing along the edge suggesting the safety factors for the birds to exit in the unsuitable ecological conditions.

At location II, total fruit yield was 503 kg. Total weight of damaged fruit and healthy fruit was 44.80 and 458 kg respectively which was equal to 8.91 % loss. The findings are in line with those of Khan et al (2013) and Dulera and Nayi (2022) with damage of 8.01% and 11.66% respectively in unprotected guava fields due to Rose-ringed parakeet. The damage at ripen stage was 6.51% and at unripe stage was 2.40 %. At the periphery and middle of the orchard the damage was 8.74 and 9.08% respectively. Variation in damage from edge to interior is affected by factors such as crop size and the environmental surroundings of the field (Kale et al 2014). The maximum bird damage was recorded at location II, because manual scaring practices were not used on regular basis at location II (Fig. 5). Total mean damaged yield (kg) of guava fruit was 3.30±1.17 and 4.48±0.87 at location I and location II respectively. The statistical comparison showed the significant difference in the mean damage fruit yield of guava fruit at location I and II and implementation of bird scaring methods helped in reducing the damage at the location I.

CONCLUSION

Bird depredation on guava fruit remained fairly high in areas where manual scaring techniques were not used on ongoing basis. Situation was markedly improved with the implementation of intense management practices. Incorporation of manual scaring techniques significantly minimised bird damage while simultaneously maximised crop yield.

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