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Frugivorous birds and mammalian pests of cultivated fig, *Ficus carica* L. in Punjab, India

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ABSTRACT: The present paper discusses the frugivorous bird and mammalian pest species on cultivated fig, *Ficus carica* L. in Punjab, India. This study was conducted for 10 years from 2014 to 2024. A total of 11 frugivorous pests including 9 bird species namely; Indian Grey Hornbill *Ocyceros birostris* (Scopoli), Asian Koel *Eudynamys scolopacea* (Linnaeus), House Crow *Corvus splendens* (Vieillot), Jungle Babbler *Turdoides striata* (Dumont), Red-vented Bulbul *Pycnonotus cafer* (Linnaeus), Common Myna *Acridotheres tristis* (Linnaeus), Brown-headed Barbet *Megalaima zeylanica* (Gmelin), Coppersmith Barbet *Megalaima haemacephalus* (Statius Muller), Rose-ringed Parakeet *Psittacula krameri* (Scopoli) falling under 5 orders and 8 families and two mammals (Indian flying fox, *Pteropus giganteus* (Brunnich) and Northern palm squirrel, *Funambulus pennantii* (Wroughton) were recorded to act as pests of fruits of *F. carica* at the three locations of the Punjab state, India. Passeriformes was found to be the dominating amongst all with birds of four families damaging the fruits. Amongst all, Rose-ringed parakeet and Northern palm squirrel were observed causing significant damage to the fruits throughout the fruiting season. Rose-ringed parakeet was observed causing damage at all the three locations surveyed. All the recorded species are of least concern status as per IUCN. These pests caused 18.3-29.4 per cent damage on fig fruits at different locations in Punjab.

Keywords: *Ficus carica* L, avian, depredatory, frugivore, pests, punjab

INTRODUCTION

Ficus carica Linnaeus, commonly known as 'Fig', is one of the earliest cultivated fruit trees in the world. It is a deciduous, perennial tree belonging to the family Moraceae. The fig tree is one of the unique *Ficus* species widely spread in the tropical and subtropical countries which has edible fruits with high commercial value. The fig is juicy and sweet when ripe, gummy with latex before ripening. Because of the high content of beneficial compounds in fresh or dried fig fruits, their consumption should be encouraged as a potential healthy alternative for sweets (Robert and Maja, 2016). Fig consists of numerous varieties with significant genetic diversity and outstanding pharmacological activities that are of remarkable commercial importance. Black Fig 1 and Brown Turkey are the important varieties being grown in Indian Punjab (Anonymous, 2024).

Like other fruit crops, figs are also attacked by many pests. Worldwide, 100 species of insects and other arthropods have been reported to attack fig trees (Singh *et al*., 2022). Atwal and Dhaliwal (2009) reported 50 insect species feeding on fig trees in India. Previously, Singh and Kaur (2017a) recorded 14 insect and mite pests and 1 pollinator from Punjab to be associated with fig trees. Recently, Singh *et al*. (2022) have check listed 48 species of insect-pests and 4 of mite-pests infesting *F. carica* worldwide. Though, lots of data on invertebrate pests of *F. carica* are available but rarely any information are available on its vertebrate pests.

In Africa, Ostrich *(Struthio camelus)* has been recorded eating the introduced *Ficus carica* (Cramp, 1977). In Australia, Rooke (1983) found Silver eye (*Zosterops lateralis*) preferring figs as alternatives to grapes. In the Canary Islands, *Corvus corax* regurgitated pellets of up to 980 *F. carica* seeds (Nogales *et al*., 1999). Tracey *et al*. (2007) also found many species of birds like European blackbirds (*Turdus merula*), mynas (*Acridotheres tristis*), noisy friarbird (*Philemon corniculatus*), rainbow lorikeet (*Trichoglossus haematodus*), red wattlebird (*Anthochaera carunculata*) and scaly-breasted lorikeet (*Trichoglossus chlorolepidotus*) causing damage to figs in Australia. Singh *et al*. (2022) also observed Garden Warbler, (*Sylvia borin* (Boddaert)), ground and tree squirrels to be pests of fig.

Ficus is the most important plant genus for tropical frugivores (Corner, 1988; Berg, 1989) and is being described as 'keystone resources' in tropical forests for potentially sustaining frugivores through lean periods of low fruit availability (Korine *et al*., 2000). Shanahan *et al*. (2001) check listed a small number of reptiles and fish, 1274 bird and mammal species in 523 genera and 92 families known to eat fruits of various *Ficus* species. In terms of the number of species and genera of fig-eaters and the number of fig species eaten, they identified the avian families interacting most with *Ficus* to be Columbidae, Psittacidae, Pycnonotidae, Bucerotidae, Sturnidae and Lybiidae. Among mammals, the major fig-eating families they check listed were Pteropodidae, Cercopithecidae, Sciuridae, Phyllostomidae and Cebidae. O'Brien *et al*. (1998) credited the high calcium levels in figs as one of the main reasons of its dietary consumption by tropical frugivores.

Birds can incur harm to the yields as well as loss to the agronomists in every phase of yields directly from planting until harvesting (Dhindsa *et al.,* 1993; Dhindsa and Saini, 1994; Manakadan & Pittie, 2001; Malhi, 2008; Kale *et al.,* 2014; Grimmett *et al.,* 2014; Kler and Kumar, 2015a). Globally, avian pests cause severe damage to crops in many agricultural systems (Linz *et al*., 2011; 2015). Australia, for example, loses a$290 million annually to crop damage by 60+ bird species (Tracey *et al*., 2007). The United States experiences US$189 million in fruit crop loss (Anderson *et al*., 2013) and US$47 billion in commercial grain crop loss due to birds (Pimentel *et al*., 2005). Severe productivity loss to birds also occurs in regions of Asia (Gupta *et al*., 1998; Kale *et al*., 2014), Europe (Pinowski and Zając, 1990; Hake *et al*., 2010), and Africa (de Mey and Demont 2013). Birds like Jungle Myna (*Acridotheres fuscus* (Wagler)), House Crow (*Corvus splendens* Vieillot), Common Myna (*Acridotheres tristis* (Linnaeus)), White cheeked Bulbul (*Pycnonotus leucogenys* (Gray) and Brahminy Starling (*Sturnia pagodarum* (Gmelin)) harm the fruit plants particularly of grapes greatly in Himachal Pradesh, India (Patyal and Rana, 2006). As a result, many crop producers prioritize reducing bird populations in their agricultural fields to protect the crops (Avery and Werner, 2017).

Managing bird damage in crops is generally depends on a few cultural (trap cropping, altered sowing time), physical (visual scarring and audio devices), chemical methods (repellent, pesticides) and botanical repellents (Dhindsa and Saini, 1994; Anonymous, 2002).−The objective of the present study was to determine the diversity of frugivorous bird and mammal pests of cultivated Fig trees in Punjab.

MATERIALS AND METHODS

Study area

To study the abundance, diversity and the pest activities of frugivorous bird and mammal species in relation to fig trees, three districts of the Punjab state, namely Ludhiana, Bathinda and SBS Nagar were selected. In Ludhiana, the survey area was College Orchard of the Punjab Agricultural University (PAU), Ludhiana. The University Campus is situated on outskirts of city towards the west at latitude of 30˚ 56' N, and longitude of 75˚ 52' E and 247 m above sea level on the Ferozepur Road. Punjab Agricultural University site comprises of agronomic grounds, orchard plantations, official campus and housing areas. In Bathinda, the observations were taken from trees planted at Krishi Vigyan Kendra and Regional Research Station of the University (Latitude 30°18’ N, Longitude 74°94’E) at Dabwali Road. At these stations, Black Fig variety of fig has been planted. In district SBS Nagar, PAU Zonal Research Station for Kandi area at Ballowal Saunkhri was selected as study area. This station is located in the Shivalik foothills of Punjab, (latitude 31° 6’ 5”N and longitude 76° 27’ 26” E) at height of 355 m above sea level. At this research Farm, trees of Fig (Variety Brown Turkey; Age >15 years) which bears medium to large sized fruits, are grown. The research work was carried out at Ludhiana from 2014 to 2024 during May-June while at the other locations; the studies were conducted during 2021- 2024.

Identification of the birds and mammals was done with the help of key given by Ali (2002) and Grimmett *et al.* (2014). The nomenclature given by Manakadan and Pittie (2001) was followed. Point count method by Javed and Kaul (2002) was followed.

The fauna recorded during the surveys were presented with their taxonomic position, place of occurrence, IUCN status, food and habitat details. The locations were visited weekly from 8.00 am to 10.00 am in the morning and from 4.00 pm to 6.00 pm in evening during May-June to observe the fruit damage. For this, the method of fruit damage assessment suggested by Patyal and Rana (2006) was followed.

Instruments used

Digital Camera (Nikon P 500), Nikon Binocular (8X50) for observing birds.

RESULTS AND DISCUSSION

A total of 11 frugivorous pests including 9 bird species and 2 mammals were recorded as pests of fruits of cultivated fig, *F. carica* at the three locations of the Punjab state, India (Table 1). The bird species namely Indian Grey Hornbill (*Ocyceros birostris* (Scopoli)), Asian Koel (*Eudynamys scolopacea* (Linnaeus)), House Crow (*Corvus splendens* Vieillot), Jungle Babbler (*Turdoides striatus* (Dumont)) Red-vented Bulbul (Pycnonotus cafer (Linnaeus)), Common Myna (*Acridotheres tristis* (Linnaeus)), Brown-headed Barbet (*Megalaima zeylanica* (Gmelin)), Coppersmith Barbet (*Megalaima haemacephala* (Statius Muller)), Rose-ringed Parakeet **(***Psittacula krameri* (Scopoli)**)** were observed and fall under 5 orders and 8 families. Amongst mammalian fauna, there was Indian Flying Fox (*Pteropus giganteus*) and a rodent (Northern palm squirrel, *Funambulus pennantii*) recorded to be frugivorous on the fig trees (Plate 1). Amongst all, Rose-ringed parakeet and Northern Palm Squirrel were observed causing significant damage to the fruits throughout the season. The rest were found to damage the fruits occasionally. All the recorded species are of least concern as per IUCN (2020). Rose-ringed parakeet was observed as a frugivorous species on *F. carica* at all the three locations surveyed (Table 1). Jungle Babbler, Brown-headed Barbet and Red-vented Bulbul were only found causing damage at Ludhiana. Coppersmith Barbet, Northern Palm Squirrel and Indian Flying Fox were recorded only from district Bathinda. Asian Koel, Common myna and Indian grey hornbill were recorded from both Ludhiana and Bathinda locations of the survey. House crow as a fruit eating species of fig

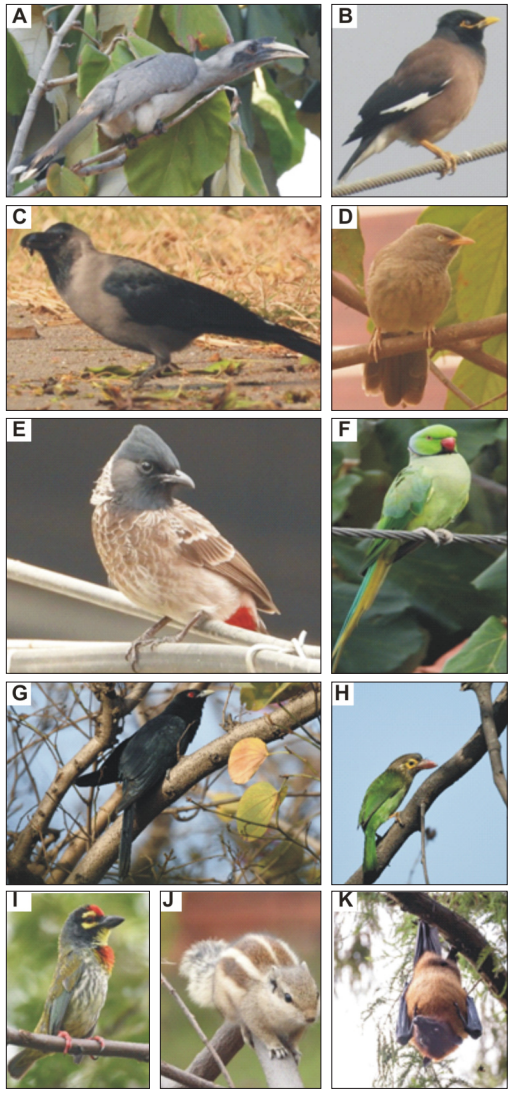

Plate.1. Frugivorous vertebrates of *F. carica*, a. Indian Grey Hornbill, b. Common Myna, c. House Crow, d. Jungle Babbler, e. Red-vented Bulbul, f. Rose-ringed Parakeet, g. Asian Koel, h. Brown-headed Barbet, i. Coppersmith barbet, j. Northern palm squirrel (five-striped palm squirrel) and k. Indian flying fox

was recorded from Ludhiana and SBS Nagar districts. Both the sexes of Asian Koel were found feeding on fig fruits. These pests were found causing 18.3-29.4 per cent damage on fig fruits at different locations in Punjab (Fig 1). Shanahan *et al*. (2001) also check listed the avian families like Psittacidae, Pycnonotidae, Sturnidae and Sciuridae causing significant damage to *Ficus* fruits as observed in the present studies. In the Canary Islands, *Corvus corax* was found feeding on *F. carica* seeds (Nogales *et al*., 1999). Tracey *et al*. (2007) also found mynas (*Acridotheres tristis*), causing damage to figs in Australia. Singh *et al*. (2022) also observed ground and tree squirrels to be pests of fig.

1. **Common Myna, *Acridotheres tristis* (Linnaeus, 1766) (Sturnidae)** It is also known as *Lalri/Gutar/ Shark* in local language. It is a familiar bird in areas adjoining human habitations. Common Myna population along with Rock Pigeon has increased in urban areas in recent years because of supplemental feeding sites (Ali and Ripley 1983; Dhindsa *et al.,* 1993; Dhindsa and Saini, 1994; Ali, 2002).

Size: Its body size is 23 cm.

Identifying features: The body is dark brown, with lustrous black head; yellow legs, bill and naked patch below and behind eye. A large white patch on the wings is visible in flight and under tail coverts are also white. Sexes are alike. Young ones are duller, less dark brown than adults, with the ashy brown head rather than black (Kler and Kumar, 2015b; Kaur and Kumar, 2018).

Resident status: It is resident and having wide distribution.

Habitat: Found almost everywhere except in very dense forests. Stays in family parties of 5 or 6 birds except in the breeding season joining into flocks sometimes of many hundred, roosting communally in large trees, reed-beds and fields. Railway stations warehouses and other large sheds are preferred roosts in urban areas (Kler and Kumar, 2015a; Kaur and Kumar, 2018).

Breeding: The breeding season ranges from April-August with two-three successive broods being raised. Nest is usually a messy collection of twigs, roots, and rubbish stuffed in holes in trees, earth banks, walls of houses or between the ceiling and roof. Same site often

Table 1. Depredatory birds and mammalian pests recorded on cultivated fig, *Ficus carica* L. in Punjab during 2014 to 2024

Scientific Name	Common Name	Recorded from	Status	Food	IUCN status	Habitat
Class Aves						
Order Coraciiformes						
Family Bucerotidae						
Ocyceros birostris (Scopoli, 1786)	Indian Grey Hornbill	B, L	R	F,I	LC	AB
Order Cuculiformes						
Family Cuculidae						
Eudynamys scolopacea (Linnaeus, 1758)	Asian Koel	B, L	R	F, I	LC	AB
Order Passeriformes						
Family Corvidae						
Corvus splendens Vieillot,1817	House Crow	S, L	R	O	LC	AB
Family Leiothrichidae						
Turdoides striatus (Dumont, 1823)	Jungle Babbler	L	R	F, I	LC	AB

Family Pycnonotidae						
Pycnonotus cafer (Linnaeus,1766)	Red-vented Bulbul	L	R	I,P,F	LC	AB
Family Sturnidae						
Acridotheres tristis (Linnaeus,1766)	Common Myna	B, L	R	I,F	LC	AB
Order Piciformes						
Family Megalaimidae						
Megalaima zeylanica (Gmelin, 1788)	Brown-headed Barbet	L	R	F,P	LC	AB
Megalaima haemacephala (Statius Müller, 1776)	Coppersmith Barbet	B	R	F, I	LC	AB
Order Psittaciformes						
Family Psittacidae						
Psittacula krameri (Scopoli,1769)	Rose-ringed Parakeet	B, S, L	R	F,P,G	LC	AB
Class Mammalia						
Order Chiroptera						
Pteropus giganteus (Brünnich, 1782)	Indian flying fox	B	R	F	LC	A
Order Rodentia						
Family Sciuridae						
Funambulus pennantii Wroughton, 1905	Northern palm squirrel or five-striped palm squirrel	B	R	F,G,P	LC	AB

Habitat: Type A-Agricultural Habitat; Type B-Residential area; **Status**: R–Resident; **Food Habit**: I-Insectivorous; G-Granivorous; F-Fruits/berries; P-Plants/aquatic vegetation/nectar; O-Omnivorous; **IUCN Status**: LC-Least Concern; **Recorded from:** B-Bathinda, S- SBS Nagar and L-Ludhiana.

used year after year. Lays 4 to 6 turquoise blue eggs (Ali and Ripley, 1983; Dhindsa and Saini, 1994; Grimmett *et al.,* 2014).

Feeding habits: It is an omnivorous bird and can feed on fruit, grain, insects and everything else that can be eaten like kitchen waste, small animals such as baby mice, frogs, lizards and crabs,

and flower-nectar. Often seen following grazing cattle or the plough for insects and invertebrates. Also observed in large number at waste/garbage disposal sites (Dhindsa and Saini, 1994; Manakadan and Pittie, 2001; Malhi, 2008; Kale *et al.,* 2014).

Damaging status: Causes some damage to orchard fruit and cereal crops, but is also beneficial as a destroyer of serious agricultural pests (Kale *et al.,* 2014).

2. **House Crow, *Corvus splendens* Vieillot, 1817 (Corvidae)** House Crow commonly known as *Kan* in vernacular language is an opportunist birds and can feed on variety of food available. Because of wide-spread distribution, it has been noted causing damage on maize and other cereals at sowing stages. Large numbers of House crows were observed at waste/garbage dumps and at animal flaying centres in villages and small towns (Ali, 2002; Dhindsa and Saini, 1994; Kaur and Kumar, 2018a).

Size: Its body size is approximately 43 cm.

Identifying features: It has glossy black body with greyish nape, neck (all round), upper breast and upper back. Bill, legs, forehead, crown and throat are contrasting glossy black. Sexes are alike.

Resident status: It is resident bird, very adaptable and it associates with human habitation and cultivation.

Habitat: Inseparable from human habitations; abundant to pest proportions in many urban and metropolitan areas. Its habitat has wide range; commonly found in rural/urban areas, cultivation and forest edges (Ali and Ripley, 1983; Dhindsa *et al.,* 1993; Dhindsa and Saini, 1994; Kler and Kumar, 2015a).

Breeding: Its breeding season ranges from April-August. Nest is usually an untidy platform of sticks and twigs intermixed with iron wire, threads, etc. placed in the fork of a branch, with a cuplike depression in the centre lined with coir, and other fibers. Lays 4-5, pale blue green eggs, speckled and streaked with brown, in one clutch (Kler and Kumar, 2015; Kaur and Kumar, 2018).

Feeding habits: It is bold, cunning and omnivorous scavenger. Gregarious behaviour noted during feeding and roosting times. Commonly seen at rubbish dumps. Food includes grain, fruits, flower-nectar, eggs and young or sickly birds, lizards, small rodents, land crabs, kitchen scraps, and garbage (Dhindsa and Saini, 1994; Kale *et al.,* 2014; Grimmett *et al.,* 2014; Kler and Kumar, 2015b).

Damaging status: Crow causes damages to crops by pulling out freshly sown seeds of cereals, pulses, oilseeds and feeding on matured maize cobs and horticultural crops (Dhindsa *et al.,* 1993; Malhi, 2008; Kale *et al.,* 2014; Kler and Kumar, 2015a).

3. **Indian Grey Hornbill, *Ocyceros birostris* (Scopoli, 1786) (Bucerotidae)** It is also known as *Dhan Chidi* in vernacular language. It is a common hornbill, mostly arboreal and seen in pairs (Ali and Ripley, 1983).

Size: Its body size is 61 cm.

Identifying features: It is a medium sized clumsy brownish grey bird having long tail with white tip and dark sub terminal band. Heavy curved bill is dual toned - black and yellow, with a peculiar pointed protuberance or casque. In females, casque is smaller in size. Juveniles are like adult but have no casque (Dhindsa *et al.,* 1993; Kler and Kumar, 2015a).

Resident status: It is resident and having wide distribution.

Habitat: Largely arboreal, but will occasionally descend to the ground. Usually found in open woodlands, plantations, gardens, and parks in cities.

Breeding: The breeding season ranges from March-June. It is a cavity nester and builds nest in a hole of tree, wall, ceiling etc. Nest is usually a natural hollow in an old tree-trunk, sometimes enlarged to suit. Eggs, normally 2 or 3, rarely 4, dull glossless white (Dhindsa *et al.,* 1993; Kler and Kumar, 2015a).

Feeding habits: The Indian grey Hornbill largely feed on fruits, especially wild figs (*Ficus* spp.), berries and flower petals; also insects and lizards, mice and other small animals.

Damaging status: It is both beneficial as well as harmful in nature as it feeds on insects as well as fruit and berries.

4. **Red-vented Bulbul, *Pycnonotus cafer* (Linnaeus, 1766) (Pycnonotidae)** It is also known as *Bulbul or Guldum* locally. It has been commonly observed throughout Punjab. It is included in the list of the world's 100 worst invasive alien species as it has established in many countries where it has been introduced (Dhindsa and Saini, 1994; Ali, 2002; Kaur and Kumar, 2018a).

Size: Its body size is approximately 20 cm.

Identifying features: It has earth-brown colour with a short crest which gives squarish appearance to the head. It has black throat and scale-like markings on back and breast. Rump is white and vent is red. Blackish tail has white tip, evident in flight. Sexes are alike.

Resident status: It is a resident species.

Habitat: It lives in pairs or in small loose flocks according to season usually keeping itself to lower or middle level of trees and bushes. Dry scrub, open forest, cultivated lands, gardens and roadside avenues are the preferred sites.

Breeding: It breeds in the months of February-October. Nest is cup shaped generally made of rootlets, placed in shrubs, hedges, tree, or sometimes inside buildings. It lays 2 - 4 eggs of pinkish white colour with purplish brown markings (Dhindsa *et al.,* 1993; Kler and Kumar 2015a).

Feeding habits: Fruits and berries, flower nectar, insects, grains and even kitchen waste constitutes its food. It is an efficient pollinating and seed-disseminating agent.

Damaging status: Solitary bird or pair has been noted to cause damage to ripening fruits especially in kitchen gardens. Damage level may be moderate to high on individual or solitary fruit plant (Dhindsa *et al.,* 1993; Dhindsa and Saini, 1994; Kale *et al.,* 2014).

5. **Rose-ringed Parakeet, *Psittacula krameri* (Scopoli, 1769) (Psittaculidae)** Rose-ringed Parakeet is also commonly known as *Tota.* It is one of the most destructive depredatory bird species in cultivated areas of Punjab. There has been observed a shift in its preferred trees for nesting from traditional to agro forestry trees in recent years. Large flocks are often observed at grain store facilities. Orchard owners use variety of methods, both traditional and mechanical like cracker fire gun/acetylene gas powered guns to scare them away from fruiting trees. Netting has been found to be the most successful and efficient method to reduce parakeet damage. The birds clamber about among the twigs and gnaw into the half-ripe fruits, one after another, wasting far more than they actually eat (Ali and Ripley, 1983; Dhindsa *et al.,* 1993; Ali, 2002; Kler and Kumar, 2015b; Kaur and Kumar, 2018).

Size: Its body size is approximately 42 cm.

Identifying features: A vibrant bright green parakeet with a short, deeply hooked red coloured bill. Males have a rose-pink and black collar which is absent in females but they have an indistinct emerald-green ring around the neck. Juveniles are like female. Male acquires pink-and-black collar in the third year (Dhindsa *et al.,* 1993; Kler and Kumar, 2015a).

Resident status: It is resident bird, very adaptable and it associates with human habitation and cultivation.

Habitat: Its habitat also included grain storage facilities, markets, open forests, gardens and vicinity of habitation.

Breeding: Its breeding season ranges from February-April. Nest is usually an unlined hollow in a tree-trunk, usually some small natural hole cut and enlarged to size. It prefers readymade nest-hole of barbet or woodpecker. Holes in rock scarps and walls of ruined buildings are commonly occupied, many pairs often nesting close to each other in a loose colony. Lays 3-5 pure white roundish oval eggs (Dhindsa *et al.,* 1993; Kler and Kumar 2015).

Feeding habits: The foraging behaviour of parakeet is gregarious in nature. Feeds and roosts in large flocks. Fruits, cereal, grain, and wild as well as cultivated seeds; flower-petals and nectar form its main diet (Dhindsa *et al.,* 1993; Kale *et al.,* 2014; Kler and Kumar 2015a).

Damaging status: It is observed to cause serious damages to cereals, pulses, oilseeds, fruits and vegetables in standing crops, orchards and gardens (Dhindsa *et al.,* 1993; Kale *et al.,* 2014; Kler and Kumar 2015).

6. **Asian Koel, *Eudynamys scolopaceus* (Linnaeus, 1758) (Cuculidae)** It is the most well known song bird of the region. Usually arboreal and confined to inner canopy of trees and seldom showing itself (Dhindsa and Saini, 1994; Ali, 2002).

Size: Its body size is approximately 43 cm.

Identifying features: Males are glossy black with yellowish green bill and crimson eyes noticed by distinctive shrieking calls: Females are dark brown above with tailfeathers and wing-quills barred with white. Chin, throat and fore neck has white spots, barred on rest of underparts. Juveniles more or less like adult, sex for sex, but female far darker and more sooty above with blackish head, throat and breast; thus closer in the character of its plumage, especially upperparts, to male rather than to adult female as usually seen in birds. This probably serves as survival tactic amidst the black nestlings of its normal fosterers, the House and Jungle crows. Bill is black and not green as in the adult (Ali, 2002).

Resident status: It is resident, nomadic and local bird.

Habitat: It inhabits lightly wooded areas like gardens, orchards, and groves of trees in and around human habitation.

Breeding: Brood-parasitic almost exclusively on House and Jungle crows cunningly laying in their nests. Its breeding season ranges from March to August. Eggs very similar in appearance to crows' but smaller and greenish in ground colour, profusely blotched and speckled with reddish brown. (Malhi, 2008; Grimmett *et al.,* 2014). In the present study, male and female koels were observed to sit together on fig trees while eating the fruits.

Feeding habits: Largely feeds on fruits, berries, nuts, hairy caterpillars, bugs and various insects, terrestrial snails, eggs of small birds and flower nectar (Malhi, 2008; Kale *et al.,* 2014; Grimmett *et al.,* 2014).

Damaging status: Adults being largely frugivorous, cause some damage to fruits in orchards and gardens (Dhindsa *et al.,* 1993; Kale *et al.,* 2014; Grimmett *et al.,* 2014).

7. **Brown-headed Barbet**, ***Megalaima zeylanica*** **(Gmelin, 1788) (Megalaimidae)** In vernacular language, it is called *Bada Basanta,* usually an arboreal bird (Ali, 2002).

Size: Its body size is approximately 27 cm.

Identifying features: it has a chubby, heavy-billed grass-green feathers with head, neck, upper back and breast brown, having conspicuous orange bare patch around eyes, sexes alike (Ali, 2002).

Resident status: It is resident bird.

Habitat: It is commonly found in places where fruiting trees are available especially various species of wild fig, whether in gardens, orchards or groves of trees (Malhi, 2008; Grimmett *et al.,* 2014; Kler and Kumar, 2015a).

Breeding: Breeding season ranges from January to June. Eggs are glossless white (Dhindsa and Saini, 1994; Ali, 2002).

Feeding habits: Feeds on fruits, berries and sometime winged termites (Malhi, 2008; Kale *et al.,* 2014).

Damaging status: Being largely frugivorous, cause some damage to fruits in orchards and gardens specifically wild and cultivated species of fig (Dhindsa and Saini 1994; Dhindsa *et al.,* 1993; Malhi, 2008; Kale *et al.,* 2014).

8. **Coppersmith Barbet,** ***Megalaima haemacephala*** **(Statius Müller, 1776) (Megalaimidae)**, known as *Basanta* in vernacular, it is a commonly heard but hard to see, entirely arboreal bird (Dhindsa *et al.,* 1993; Ali, 2002; Grimmett *et al.,* 2014; Kler and Kumar, 2015b).

Size: Its body size is approximately 17 cm.

Identifying features: A small green barbet with yellow throat, crimson breast and forehead, and green-streaked yellowish underparts. Tail is short, truncated and distinctly triangular in-flight silhouette. Sexes are almost alike, the female being little duller. Juveniles lack the red colour and are duller (Malhi, 2008; Kale *et al.,* 2014; Grimmett *et al.,* 2014; Kler and Kumar, 2015a).

Resident status: Resident; common and very widely distributed

Habitat: Inhabits lightly wooded countryside, roadside avenues and groves of tree near villages and cultivation, and in urban gardens and compounds

Breeding: Breeding season ranges from November to June. Nest is generally a shaft excavated in a dead or decaying softwood branch ending in a slightly widened chamber. Lays 2-4 white, longish ovals eggs on bare wood at bottom of shaft (Dhindsa *et al.,* 1993; Kler and Kumar, 2015a).

Feeding habits: Banyan, peepal and other wild figs are preferred food. Also eats drupes and berries. Occasionally eats moths and flying termites captured in air.

Damaging status: It has been observed to cause minor damages to fruits (Dhindsa *et al.,* 1993; Malhi, 2008; Kale *et al.,* 2014).

9. **Jungle Babbler,** ***Turdoides striatus*** **(Dumont, 1823) (Leiothrichidae) c**ommonly called *Jungli Serhri* in vernacular. Very gregarious bird and noisy seen all through the year in parties of six to twelve, and thus also called 'Seven Sisters' (Ali and Ripley, 1983; Kaur and Kumar, 2018).

Size: Its body size is approximately 25 cm.

Identifying features: Earthy brown colour, untidy appearance with creamy white eyes, yellowish bill and legs. Head and nape are a little greyer. Rump and tail-coverts buff; tail rufous brown, belly is creamy buff. Sexes are alike (Dhindsa and Saini, 1994; Ali 2002).

Resident status: It is resident and fairly common bird.

Habitat: Inhabits open forest, urban gardens and cultivated areas around human habitation.

Breeding: Breeds from March to September. Nest are generally a loosely put together cup of twigs, roots, grass, placed in bushes and trees in gardens, orchards, hedges etc. Lays 4-6 eggs deep turquoise blue in colour (Ali, 2002; Grimmett *et al.,* 2014).

Feeding habits: Mainly feeds on insects like grasshoppers, ants, beetles, cockroaches, caterpillars, etc., and spiders. Also eats grains, seeds, figs, Lantana and other berries (Ali 2002; Dhindsa *et al.,* 1993; Dhindsa and Saini, 1994; Malhi, 2008; Kale *et al.,* 2014; Grimmett *et al.,* 2014).

Damaging status: It is observed to cause minor damage to crops.

10. **Indian flying fox,** ***Pteropus giganteus*** **(Brunnich, 1782) (Pteropodidea) c**ommonly called *Chamgidar* in vernacular. It is native to Indian sub-continent and one of the large bat species (Ramakrishna *et al.,* 2017).

Size: Body length 16-22 cm, wingspan ranges from 1.2-1.5 meter.

Identifying features: It has lightly streaked black back with grey, a pale, yellow-brown mantle, a brown head, and dark, brownish underparts. It has large eyes, simple ear (Francis and Priscilla, 2008; Ramakrishna *et al.,* 2017; Prasad, 2020).

Resident status: It is resident bat and widely distributed throughout Indian subcontinent.

Habitat: It roosts in large colonies on open tall tree branches, especially near human residences, agricultural land in urban areas or in abandoned buildings or ruins and prefers to be in close proximity to bodies of water (Francis and Priscilla, 2008;. Ramakrishna *et al.,* 2017).

Breeding: Breeding season ranges from July to October and give birth to 1-2 pups and reproductive maturity occurs at 18-24 months.

Feeding habits: It is frugivorous in nature and feeds on fruits and berries (Francis and Priscilla, 2008; Ramakrishna *et al.,* 2017).

Damaging status: It can be a pest as it poaches ripe fruits in orchards (Ramakrishna *et al.,* 2017; Prasad, 2020) and was also observed to be causing damage at different locations in Punjab in the present studies.

11. **Northern Palm Squirrel, *Funambulus pennantii* Wroughton, 1905 (Sciuridae)** Commonly called *Gilehri or Galad* in vernacular, it is the most common mammal in urban areas with a shrill, bird like call often accompanied by tail jerks and cause damage to several fruit and cereal crops (Kenward, 2008; Chakravarthy, 2012).

Size: Head and body length 13-16 cm, Tail length 14-16 cm

Identifying features: It has five pale stripes on its greyish brown or olive brown body. The tail does not have a mid-ventral line and resembles a grey bottlebrush. The top coat color ranges from grayish brown to almost black, while the head is usually grayish to reddish brown.

Resident status: It is resident squirrel and widely distributed.

Habitat: A semi-arboreal squirrel found in grasslands, scrublands, plantations, urban gardens, rural and forested areas. Northern palm squirrels are gregarious and up to 10 may inhabit a tree.

Breeding: Breeding occurs several times a year, usually with different partners each time. Able to reproduce throughout most, if not all, of the year. Females have 2 to 3 litters yearly. Litter sizes range from 1 to 5 (Kenward, 2008; Chakravarthy, 2012). Commonly nest in the branches of trees, holes in the tree trunk or in man-made structures such eaves of houses, attic spaces, electricity boxes, etc. Squirrel nests are made of grasses, threads, wool, cotton, jute fibers and other fibrous materials

Feeding habits: Northern palm squirrels are herbivorous and omnivorous. They typically feed on a wide variety of foods including seeds, nuts, buds, young bark, leaves, insects, flowers, and grubs. They have also been known to eat baby birds. They feed both in trees and on the ground and store food for later use (Kenward, 2008; Chakravarthy, 2012).

Damaging status: It can be a pest commonly eating buds and seeds of food producing plants

Habitat: Type A-Agricultural Habitat; Type B-Residential area; **Status**: R–Resident; **Food Habit**: I-Insectivorous; G-Granivorous; F-Fruits/berries; P-Plants/aquatic vegetation/nectar; O-Omnivorous; **IUCN Status**: LC-Least Concern; **Recorded from:** B-Bathinda, S- SBS Nagar and L-Ludhiana.

FRUIT DAMAGE

Data on fruit damage by various depredatory and mammalian pests of *F. carica* at different locations in the present study during 2021-2024 are presented in Figure 1. During 2021, 20.0 to 28.3% damage in *F. carica* fruits was observed across the locations studied, being maximum and minimum at Ludhiana and Bathinda, respectively. The fruit damage varied from 18.3 to 26.5% during 2022. It remained maximum at Ludhiana and minimum at Bathinda locations. During 2023, fruit damage observed between 19 to 27.9 % which increased up to 29.4 % during 2024 at Ludhiana (Fig 1).

The extent of the damage caused to different crops varied between study plots and also within plants and trees. Slack and Reilly (1994) reported that the damage to the citrus trees was greatest in the top canopy, almost four times greater than damage to the middle and lower branches of the" trees. Similar pattern of damage was recorded in peach and almonds (Dhindsa and Saini 1994). Prasad and Verghese (1985) recorded a similar pattern of damage in guava, with most of the damage occurring in the upper central core of the tree. Subramanya (1994) stated that the parakeet damage was positively correlated with the height of the plant, and was greater on varieties

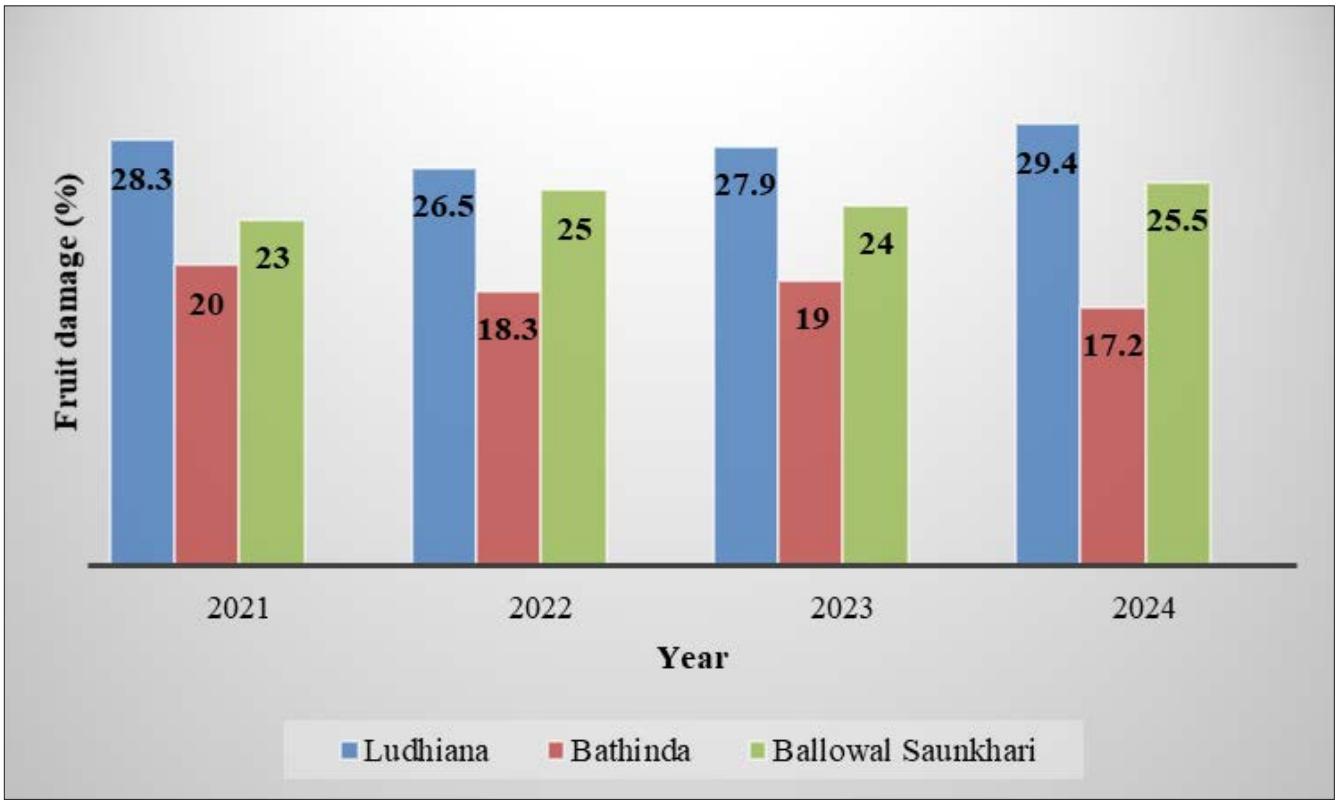

Fig.1. Fruit damage by various depredatory and mammalian pests of *F. carica* at different locations during 2021-2024

with the erect heads. This was thought to be due to the better visibility, and hence the predators can be avoided. The edges of the fields have more damage (Kler 2015), especially where the perching and refuging sites are available near to the crops, and away from the human disturbances (Saini *et al.,* 1992). Damage to oilseed crops *viz.* brassica, sunflower, and canola, were also reported apart from a variety of orchards trees (Khan and Aziz 1993; Ali and Ripley 1983; Dhindsa and Saini 1994; Kler and Kumar 2015). A loss of 25-100% to mangoes, guava, brassica, and sunflower by parakeet was reported by Prasad and Verghese (1985) in India. Saini *et al.* (1992) analyzed the gut contents of the Rose-ringed parakeets for one year which was consisted of cereals (45%), tree orchards (38%) and oilseeds (16%).

Depletion of indigenous tree cover and invasion of exotic tree species directly affects the distribution of avian and mammalian fauna. Old and indigenous trees account to be an important substrate for nesting in the form of dense canopies and cavities. Indigenous trees must be promoted over exotic ones because the services provided by them are already part of local ecology.

Among feeding habits, omnivorous species were in higher proportion as compared to other diets. Invasion of few migratory birds and mammals was also observed in indigenous trees during the fruiting periods. The study suggests that different communities make use of indigenous trees in different ways. So, plantation of these trees must be popularized over exotic trees.

Out of the eleven recorded species, Rose-ringed parakeet and northern palm squirrel were found to cause significant damage to the fruits of *F. carica* (Plate 2). The rest of the species were found to cause the damage occasionally. Though, the recorded species are protected under The Indian Wild Life (Protection) Act, 1972 suitable eco-friendly methods are needed to be worked out for their management. Using effective integrated pest management approaches, there may be opportunities to simultaneously reduce disservices, enhance services and conserve biodiversity. We can achieve the objective of sustaining current and future human well-being within ecological limits. Hence, there is a need for interdisciplinary research in the development of eco-friendly depredatory bird and animal management techniques as well as enhancing beneficial avian population in the agro-ecosystem. The positive relationships between people, birds, and sustainable agriculture may be a key starting point to develop a shared conservation vision for the future.

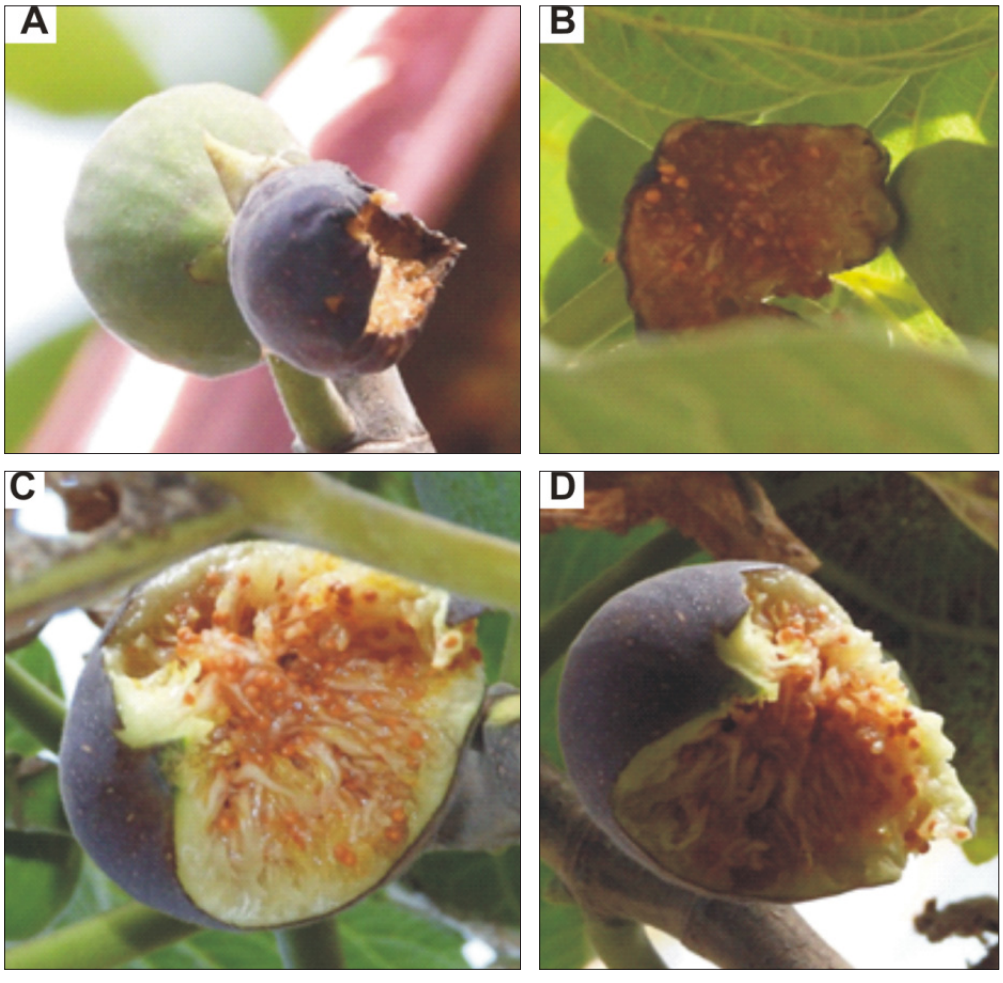

Plate.2. Fruits of *F. carica* damaged by bird and mammal pests

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