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Breeding biology and nest tree use preference by house crow (*Corvus splendens*) in agricultural areas of Ludhiana, Punjab, India

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Abstract

An attempt has been made to gather firsthand information on the breeding biology and nest tree use preference by House Crow. The breeding season of House Crow observed was mainly from April to September. A total of 99 nests were studied during the two breeding seasons. The House Crow preferred 16 different tree species for nesting, most commonly used trees species in both seasons were the Eucalyptus (29 nests i.e. 29.2% used) and Poplar (13 nests, i.e. 13% used), which together comprised 42.2% of trees used (n = 99). The highest nesting tree height favoured for nesting was 25.3m and the lowest was 6.9m in the first breeding season, while in the second breeding season, the highest height preferred was 25.2m, and the lowest was 7.2m. The egg-laying was started early in mid-June and all the clutches were completed up to mid-July. Clutch size ranged from 2-5 eggs, incubation 15-18 days, and fledging 25-32 days. Hatching success of 86.51% and 77.35% observed in 2 breeding seasons, while nesting success recorded was 66.66% in 2015 and 69% in 2016. Reasons for lower breeding success were un-hatched eggs, falling of eggs and chicks from trees and predation by other birds.

Keywords: Agricultural area, breeding biology, breeding success, house crow, nest tree preference

1. Introduction

The House Crow is a monogamous bird. Its breeding mainly occurs during the hotter and drier months i.e. April to July (Soh *et al.*, 2002) ^[23]. Even in the non-breeding period pairs sit out of the sun in the shady branches during day time snuggled loving together (Ali, 2008) ^[1]. House Crow in the courtship often sits on a shady branches through the day, snuggle loving together, making dumpy tuneful crocks from time to time, bill open, throat puffed with a feather, etc. Courtship followed by copulation through which males mounted on females facing the same direction and the male maintained its stability by fluttering its wings, it lasted for about one minute or more (Goutam and Kushwaha, 2012) ^[15].

The House Crow is a tree nester, it favors nesting in high trees with a large crown to avoid human harassment and to spot food sources from afar (Dutta, 2007) ^[9]. House Crow does not favor nesting on man-made structures when trees fulfilling the demands of nesting (Awais *et al.*, 2015). As a result, vegetation is a very significant feature for breeding birds to construct their nest, get protection, and forage on them (Sarkar *et al.*, 2009) ^[22]. The nesting sites of House Crow is related to the food availability within an area, nesting sites are located close to food resources, an area with poor sanitation had the highest number of nesting sites. House Crow choose appropriate vegetation for their nesting. House Crow possibly will select trees with a greater crown volume because they offer better camouflage of nests from likely overhead predators, such as raptors (Soh *et al.*, 2002) ^[23].

The objective of the present study was to present brief results on all of the aspects of the breeding biology and nest tree preference by House Crow, including details on nest and tree height, nest characteristics and reproductive success in agricultural areas of Ludhiana, Punjab, India, as nothing has been reported in such vast detail before from the study area.

2. Materials and Methods

2.1. Study area

Punjab Agricultural University (PAU), Ludhiana: The study area is situated on the outskirts of Ludhiana city towards the west. Geographically, it lies 30°56' North latitude and altitudinally, 247 m above the mean sea level. The study area covers an area of 475 hectares in the north-west of Ludhiana along the Ferozpur Road. In addition to various teaching

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departments and research laboratories of the constituent colleges, playgrounds, and grassy lawns, it has a large stretch of agricultural fields. The field area is distributed under different categories of crops such as wheat, maize, rice, vegetables, fodder, and orchards. Besides, there is a rich diversity of trees in the study area.

2.2. The research methodology followed in conducting the present study is as below

The present study was carried out in five transects of PAU, Ludhiana as shown in Table 1 from April 2015 to September 2016. Breeding biology included the study of House Crow nesting sites, courtship and pair formation, mating behavior, egg-laying, clutch size, incubation period, hatching, nest tree preference, nest and tree height, nest characteristics, parental care, growth of juveniles, fledging and breeding success. The observations on nest building were started at the beginning of the breeding season. The breeding behavior was observed with the naked eye and field binoculars (Nikon Action 10×50) by walking slowly along the roads, parks, etc. throughout the study area. All accessible nests were climbed (multiple times), marked and recorded for regular observations on clutch size, incubation period, and hatching success and in case of inaccessible nests, tree climbers were used. The nests were monitored daily or on alternate days to record all the aspects of breeding biology. Observations were taken in each transect in the morning/evening twice a month during the non-breeding season, while daily morning/evening during their breeding season at the study area.

2.2.1 Nesting

All five transects in the study areas were surveyed for nests/nesting sites of these birds. The birds lay and incubate their eggs in nests and raise young ones. The nests were studied for their structure, nest building material, and eggs. The status of the nest, i.e. whether active or not, was determined by examining its contents at regular intervals. Numbers of nests, type, and quality of nests, nesting material, and nesting sites were recorded.

2.2.2 Egg Laying, Clutch Size, Incubation, Hatching, Young ones and Parental Care

The egg-laying, clutch size, incubation, hatching, young ones, and parental care of House Crow were studied and for this, nests were observed periodically at all study areas for the presence of eggs. The numbers of eggs in each nest were counted to observe the clutch size. The morphological parameters of the eggs like color etc. were also recorded. Breeding success was calculated by the formula given by Jehle et al. 2004 ^[16], (Number of Fledglings survived)/(Number of eggs incubated×100).

2.2.2 Haglof EC-II clinometer

This instrument was used during the study period to calculate the heights of the tree and the height at which the nest was made.

3. Results and Discussion

For the propagation of any species, breeding is an essential requirement. For breeding, House Crow was found to prefer sites where there is the availability of abundant food nearby.

3.1. Breeding season

The breeding season of House Crow in the present study was

started early in April and extends up to early September. From different studies, it was concluded that the breeding season of House Crow varies from place to place. For instance, the breeding season in Islamabad-Rawalpindi, Pakistan was recorded in May-August by Ali, 2008 ^[1]. From India, Madge and Burn, (1993) ^[17], reported that the species breeds from March to August, mainly just before the summer rainfall. In South Africa, nests were found in October, which is very late reported by Allan and Davies, (2005) ^[3]. In another study from Pakistan, Awais *et al.*, (2015) ^[5] reported that the breeding season starts in June and extends till September. However, the breeding season recorded by Behrouzi-Rad, (2010) ^[6], is somewhat similar to the present study, who reported it extends from late May to early September in Iran on Kharag Island.

3.2. Nesting

During the study period, it was observed that House Crow preferred a wide range of trees for nesting. Both males and females actively participated in nest formation, incubation, and other parental duties. This statement is in contradiction with Campbell and Lack, 1985, according to them, mostly females take part in nest construction; however, the male often helps. Total 99 nests were found during two breeding seasons in PAU, Ludhiana, out of which 42 nests were found in the 2015 breeding season, while 57 were recorded during the 2016 breeding season.

House Crow preferred nesting in areas close to food sources, most areas with poor sanitation. These areas had the maximum number of nesting sites. House Crow pairs were often seen building their new nests in early April and this nest-building activity extends up to early June. Nest's construction activities were at a peak in May in PAU, Ludhiana (Table 2). While walking through the transects in early April, they were usually seen picking up nesting materials like metallic wires, broken tree twigs, thin plastic strings, dry grass in their beaks.

It was observed that House Crow favored nesting in Transect IV in both breeding seasons with 14 nests in 2015 breeding season and 20 nests (35.1%) in the 2016 breeding season (see Tables 3 and 4). On the other hand, Transect I in the 2015 breeding season and Transect V in the 2016 breeding season were least favored for nesting (see Tables 3). High Eucalyptus trees, abundant food availability due to the presence of mess waste nearby, would be the reasons for more preference of nesting in Transect IV.

3.3. Nest tree use

All the nests were found on the trees and none of the nest was present on a man-made structure in the present study. This suggests that the House Crow is a tree nester. This statement is in confirmation with the Dutta, 2007 ^[9]. The number of nesting trees used in the first year of breeding was 10 and in the second year, it was 15 (see Tables 5, 6). In total, at least 16 different tree species were used for nesting in PAU, Ludhiana (see Table 7). The two most preferred tree species in this area in both seasons were the Eucalyptus (29 nests i.e. 29.2% used) and Poplar (13 nests, i.e. 13% used), which together comprised 42.2% of trees used (n = 99) (see Table 7). The reason for selecting these particular trees would be due to their tall size and evergreen nature. This finding is somewhat similar to Dutta, (2007) ^[9]; according to him, Indian House Crow prefers nesting in tall trees to avoid human persecution and to see food sources from far. House

Crow nests on different tree species shown in Fig. 1.

In the present study, House Crow choose 16 different tree species *viz.* Eucalyptus, Poplar, Saptaparni, Sheesham, Ear leaf acacia, Golden rain, Subabul, Toona, Bottle brush, Black mulberry, Mango, Ashoka, Gulmohar, Amaltas, Pipal, and Dharek for nesting (see Table 7). House Crow nested in 12 different species in Durban, South Africa (Allan and Davis, 2005) ^[3]. In Calcutta, House Crow used 13 different tree species to build their nests (Dutta, 2007) ^[9]. In Islamabad-Rawalpindi, this bird used 23 different tree species for nest construction (Ali, 2008) ^[1]. Elsewhere tree species used for nesting were entirely different from tree species observed in the present study, except the Mango tree. Allan and Davis, (2005) ^[3] recorded maximum nesting on a Mango tree, contrary to this in the present study only a single nest was observed on the Mango tree (which was inactive). Tree species were a very significant feature for breeding birds to construct their nests, get protection, and forage on them (Sarkar *et al.*, 2009) ^[22]. Both tree nesting and nesting on man-made structures were observed by other researchers who proposed that the House Crow is predominantly a tree nester (Awais *et al.*, 2015; Dutta, 2007; Dutta and Raut, 2010) ^[5, 9, 11]. Anvery, (2002) ^[4] also found House Crow building their nests on man-made structures such as lamp posts and pylons in cities where big trees are rare. But in this study, no nest was found on buildings or other man-made structures.

3.4. Active/Inactive nests

Numbers of active and in-active nests were also recorded in the study. According to Behrouzi-Rad, (2010) ^[6], nests are categorized into active and old nests. The nests those which are with eggs and chicks are recorded as active nest or breeding nest and old nests are non-active nest at this time crow did not start to breeds yet. In the present study, out of total 99 nests, 61 nests found to be active and 38 nests remained in-active on 16 different tree species in both breeding seasons (Table 8). A maximum number of active nests (21 nests) were located on Eucalyptus tree (34.4%) followed by Poplar tree (12 nests, 19.7%) and the minimum number of active nests (1 nest) were located on Ashoka, Gulmohar, Amaltas, Pipal, Dharek and Mango tree (1.64% each), while no active nest was observed on the Black mulberry tree. On the other hand, a maximum number of inactive nests (8 nests) were situated on the Eucalyptus tree (21%) and Sheesham tree (21%) and minimum on Poplar tree (1 nest, 2.63%). No inactive nests were located on the Gulmohar tree, Bottle brush, Amaltas, Dharek, Mango tree, and Pipal.

3.5. Number of nests per nest tree

In both breeding seasons, nesting was found to be exclusively monospecific with only House Crow nests on the nesting trees. All trees carried single nest per tree during the first breeding season. But in the second breeding season, out of total 54 trees, 3 trees carried 2 nests. The number of nests per tree was shown in Table 9. This suggested that breeding pairs, although possibly loosely colonial, were tolerant of conspecifics nesting in the same nest tree. Elsewhere, both lonely and colonial nesting of House Crow has been reported (Fry *et al.*, 2000) ^[12]. Goutam and Kushwaha, (2012) ^[15] reported 3-4 nests on the single nesting tree. Up to 10 nests were recorded on the single nesting tree in Durban, South Africa, by Allan and Davies, (2005) ^[3].

3.6. Nesting tree height and Nest height

It was observed that in the first breeding season, House Crow preferred highest tree height for nesting was 25.3m which was on a Eucalyptus tree and lowest was on Ear leaf acacia tree (6.9m) (Table 10), while in the second breeding season, House Crow choose the highest height of tree for nesting was 25.2m which was on Toona tree and lowest was on Sheesham tree (7.2m) (Table 11). This finding was somewhat similar to Allan and Davies, (2005) ^[3], who reported nesting tree heights of 7-27m in Durban, South Africa. But these findings were slightly different from Awais *et al.*, (2015) ^[5], who reported nesting tree heights of 8.1-23.2m in Mansehra, Pakistan.

Nest height was also recorded in the study area. It was found that the highest nest height measured was greater in Eucalyptus tree (22.1m) and lowest in Subabul tree (4.2m) in the first breeding season (Table 10), while in the second breeding season, highest nest height measured was greater in Toona (23.5m) and lowest in Subabul (5.7m) (Table 11). This finding is also somewhat similar to Allan and Davies, (2005) ^[3] who reported nests were positioned at a height of 5-26m above the land in the high trees in Durban, South Africa. But these findings were slightly different from Awais *et al.*, (2015) ^[5] who reported nesting tree heights of 7.1-19.4m in Mansehra, Pakistan.

3.7. Nest Characteristics

A bird's nest provides a safe environment for its eggs and chicks to develop during the breeding season. Some bird species do not build the nest, instead, they lay their eggs directly on the ground, some in a cavity, or even directly on the tree branch. In some species, nests are elaborate work of avian architecture. The House Crow nest observed was an example of such architecture. In the present study, we found that the House Crow nest was a huge platform of sticks and twigs, which were repeatedly intertwined with metal wires, plastic ropes, and polythene bits to hold twigs together from outside. While from inside it was lined with soft materials like dry grass, animal hair, and wool and looked like a cup so that eggs did not break, and young ones were not injured by twigs and metallic wires. These nest characteristics were similar to Awais *et al.*, 2015 ^[5], study, who reported the use of twigs, wire, and grass in nest construction. However, they do not report the use of any human-associated material in nest construction. Contrary to this, in this study House Crow found using human-associated materials like wool, polythene, plastic ropes. Moreover, Fry *et al.*, (2000) ^[12] also observed similar nest structure characteristics. Materials used in the nests were different, vary from nest to nest. But as compared to metallic and plastic contents used in nests, the frequency of twigs and sticks were much more in the nests of the House Crow (Fig. 2). But Ryall, (2002) ^[21] reported that House Crow used much wire in nest construction is related to its availability in Mombasa.

3.8. Nest dimensions and weight

The measurements of the nest's diameter and the nest cup diameter were also recorded (Table 12). Maximum, minimum, range, and mean of nest diameter, nest depth, nest cup diameter, and nest cup depth were measured in 8 nests. The mean nest diameter recorded was 39.3cm, while mean nest depth was measured to be 19.5cm. Similarly mean nest cup diameter and depth were measured to be 17.3cm and 7.4cm, respectively. Ali, (2008) ^[1], reported maximum and

minimum nest diameters were 29.2cm and 26.7cm, respectively, nest depth was 23.6cm and maximum and minimum nest cup diameter was 16.3cm and 15.8cm, respectively, while nest cup depth was 9.5cm in Islamabad-Rawalpindi, Pakistan.

3.9. Egg-laying, Clutch size, and Egg characteristics

Usually, egg-laying occurs immediately after the nest was fully constructed by both parents. But, in this study, it was observed egg-laying occurred much later, i.e. almost after one month. During egg-laying, one of the parents was found more frequently near the nest thereby spending more and more time in the vicinity of nests.

In both breeding seasons, egg-laying was started early in mid-June and all the clutches were completed up to mid-July. A maximum number of clutches were found in late June. No egg-laying was recorded after 15th of the July (Table 2). These findings are somewhat similar to that of (Awais *et al.*, 2015) [5], they observed egg-laying started early in the first week of June and all the clutches were completed up to mid of July in Pakistan. Clutch size refers to a number of eggs laid in a nest. In the present study, the clutch size varied from 2 to 5, but clutches of 4 eggs were more frequent in both breeding seasons. Of 28 clutches in 2015, 8 were of 2 eggs, 10 were of 3 eggs, 7 were of 4 eggs and 3 were of 5 eggs (Table 13). Whereas in 2016, out of 33 clutches, 8 were of 2 eggs, 13 were of 3 eggs, 9 were of 4 eggs and 3 were of 5 eggs (Table 13). The 61 clutches (28 in the first breeding season and 33 in second breeding season) were observed with 2-5 eggs, were similar to the range of 2-5 eggs reported by Allan and Davies, (2005) [3]. On the contrary, according to, Ali, (2008) [1] normal clutch size of House Crow was 4-5 eggs and rarely 6-7. According to Goodwin, (1976) [14], the clutch size of House Crow was of 3-6 eggs. Clutch size variation can originate from genetic variation (Noordwijk *et al.*, 1980) [19] or phenotypic response to environmental conditions (Murphy, 1983) [18]. During the study, it was observed that bluish-green blotched eggs with black spots were laid by the House Crow. Eggs were appeared elliptical with a narrow end and laid towards the center of the nest. The Colour and characteristics of eggs were matched with Behrouzi-Rad, (2010) [6].

3.10. Incubation Period

The incubation period was calculated as the time elapsed between the laying of the last egg of the clutch and hatching of the last young. Incubation duties were shared by both males and females. One bird always was seen sitting on the nest, while others sitting nearby. According to this study, at PAU, Ludhiana, incubation period of the House Crow was 15-17 days in the first breeding season and 15-18 days in the second breeding season (Table 13). It was concluded that total incubation time for the eggs laid was variable from 15 to 18 days, very much similar to Ali *et al.*, (2007) [2], who reported an incubation period of 15 -17 days.

3.11. Hatching

In both breeding seasons hatching of the eggs was started in 1st week of July and maximum numbers of hatchings were observed in the 2nd week of July (Table 2). This statement is in contradiction with the findings recorded by Sullivan *et al.*, (2008) [24], according to him, hatching of the eggs was observed in June end and maximum numbers of hatchings were observed in the 3rd week of July. Most of the eggs hatched on the 16th day.

3.12. Young-ones, Parental Care and Fledging

During the present study, it was noted that the House Crow chicks were altricial i.e. they were small, blind, immobile, and naked (Fig. 3). The hatching was followed by parental care. Good parental care was observed in House Crow and both the parents shared the duty of parental care. The possible reason for having good parental care may be the defencelessness of the newly hatched young ones, who needed their parents to keep them warm and safe for several weeks after hatching. At PAU, Ludhiana, in both seasons, there was no fledging until 25-32 days (Table 13). Fledging of young ones was started in late July and by the 1st week of September, all young ones left the nests (see Table 2). Young ones started leaving the nests in the 3rd week of July and all nestling left the nests in the 1st week of September. Nest leaving activities by the House Crow chicks were at a peak in the mid of August. In Durban, the young ones fledged in 28-38 days (Allan and Davies, 2005) [3]. In Islamabad-Rawalpindi fledgling took a period of 22–36 days (Ali, 2008) [1].

3.13. Breeding success (Hatching success and Nesting success)

Information related to the breeding success of the House Crow is in (Table 13). The breeding success in a population was recorded using hatching success and nesting success. Hatching success was recorded in 61 nests in all. In PAU, Ludhiana, the total number of eggs laid was 89 in 2015 breeding season, of these 77 young ones recorded. While in the 2016 breeding season, 82 young ones recorded out of 106 eggs laid. Therefore, hatching success was 86.51% in 2015 and 77.35% in 2016. Hatching success was much higher than recorded by Ali, (2008) [1] and Awais *et al.*, (2015) [5], where the estimates were 34.6% and 55.1%, respectively. During the study period, the nesting success in study areas was also studied. Every nest was carefully observed throughout the breeding period in both seasons. A nest was considered to be successful (active) if egg-laying, incubation, and hatching were alive. In PAU, Ludhiana, in the first breeding season (2015), 28 nests out of 42 nests were successful; therefore nesting success recorded was 66.66%. In the second season (2016), 57 nests were recorded, out of which 33 nests were successful and 24 were unsuccessful, therefore nesting success recorded was 57.89%. Nesting success was found lower than Awais *et al.*, (2015) [5] who recorded 69% Nesting Success.

Table 1: Transects in PAU, Ludhiana.

Transect No.	Name of the transect	Type of area
I	PAU Library road, Gate no. 2 Road and Nursery area	Sports ground, Mela ground, trees, library building, roads
II	PAU Floriculture department area, gate no. 7 road area	Flowers, agriculture fields, trees, landscape, water bodies, roads
III	PAU New orchard area (Forestry area)	Tree plantation mainly Popular, Eucalyptus and some other trees, wastage dump
IV	PAU Museum, hostel no. 11, home science college area	Lawns, trees and hostel dump, roads, building
V	PAU Orchard college area, Veterinary Hospital Road area	Orchard, agriculture fields, buildings, trees, roads

Table 2: Breeding season of House Crow in PAU, Ludhiana.

S. No.	Breeding activity	Time period
		In PAU, Ludhiana
1	Nest construction	1 st week of April to last week of May
2	Courtship displays	Last week of May to Last week of June
3	Pairing	1 st week of April
4	Egg laying	Mid June to mid July
5	Incubation	Mid June to end of July
6	Hatching	1 st week of July to end of July
7	Fledging	End of July to 1 st week of Sept

Table 3: Number and percentage of nests of House Crow during the 2015 and 2016 breeding season in different transects of PAU, Ludhiana.

S. No.	Transects	Total nests in 2015	Total nests in 2016	Percentage (%)	Percentage (%)
I	Library road, Gate no. 2 Road and Nursery	4	10	9.5	17.5
II	Floriculture, gate no. 7 road	6	11	14.3	19.2
III	New orchard (Forestry area)	13	10	31	17.5
IV	Museum, hostel no. 11, home science college	14	20	33.3	35.1
V	Orchard college, Veterinary Hospital Road	5	6	11.9	10.5
	Total	42	57	100	100

Table 4: Total number and percentage of nests of House Crow during the 2015 and 2016 breeding seasons in different transects of PAU, Ludhiana.

S. No.	Transects	Total nests	Percentage (%)
I	Library road, Gate no. 2 Road and Nursery	14	14.1
II	Floriculture, gate no. 7 road	17	17.1
III	New orchard (Forestry area)	23	23.2
IV	Museum, hostel no. 11, home science college	34	34.3
V	Orchard college, Veterinary Hospital Road	11	11.1
	Total	99	100

Table 5: Tree species preferred by House Crow for nesting (%) during the 2015 breeding season in PAU, Ludhiana.

S. No.	Tree species		Number of nests	Percentage (%)
	Common Name	Scientific Name		
1	<i>Eucalyptus</i>	<i>Eucalyptus tereticornis</i>	15	35.7
2	Poplar	<i>Populus tremula</i>	8	19
3	Ear leaf acacia	<i>Acacia auriculiformis</i>	5	11.9
4	Sheesham	<i>Dalbergia sissoo</i>	4	9.5
5	Golden rain	<i>Koelreuteria paniculata</i>	3	7.1
6	Toona	<i>Toona ciliate</i>	2	4.8
7	Saptaparni	<i>Alstonia scholaris</i>	2	4.8
8	Mango	<i>Mangifera indica</i>	1	2.4
9	Bottle brush	<i>Melaleuca citrina</i>	1	2.4
10	Subabul	<i>Leucaena leucocephala</i>	1	2.4
	Total		42	100

Table 6: Tree species preferred by House Crow for nesting (%) during the 2016 breeding season in PAU, Ludhiana.

S. No.	Tree species		Number of nests	Percentage (%)
	Common Name	Scientific Name		
1	Eucalyptus	<i>Eucalyptus tereticornis</i>	14	24.6
2	Saptaparni	<i>Alstonia scholaris</i>	8	14
3	Sheesham	<i>Dalbergia sissoo</i>	6	10.5
4	Poplar	<i>Populus tremula</i>	5	8.8
5	Golden rain	<i>Koelreuteria paniculata</i>	5	8.8
6	Subabul	<i>Leucaena leucocephala</i>	5	8.8
7	Ear leaf acacia	<i>Acacia auriculiformis</i>	4	7
8	Toona	<i>Toona ciliate</i>	2	3.5
9	Black mulberry	<i>Morus nigra</i>	2	3.5
10	Ashoka	<i>Saraca asoca</i>	1	1.75
11	Bottle brush	<i>Melaleuca citrina</i>	1	1.75
12	Gulmohar	<i>Delonix regia</i>	1	1.75
13	Amaltas	<i>Cassia fistula</i>	1	1.75
14	Pipal	<i>Ficus religiosa</i>	1	1.75
15	Dharek	<i>Melia azedarach</i>	1	1.75
	Total		57	100

Table 7: Total tree species preferred by House Crow for nesting (%) during the 2015 and 2016 breeding season in PAU, Ludhiana.

S. No.	Tree species		Number of nests		Total number of nests	Percentage (%)
	Common Name	Scientific Name	First year	Second year		
1	Eucalyptus	<i>Eucalyptus tereticornis</i>	15	14	29	29.2
2	Poplar	<i>Populus tremula</i>	8	5	13	13
3	Saptaparni	<i>Alstonia scholaris</i>	2	8	10	10.1
4	Sheesham	<i>Dalbergia sissoo</i>	4	6	10	10.1
5	Ear leaf acacia	<i>Acacia auriculiformis</i>	5	4	9	9
6	Golden rain	<i>Koelreuteria paniculata</i>	3	5	8	8
7	Subabul	<i>Leucaena leucocephala</i>	1	5	6	6.6
8	Toona	<i>Toona ciliata</i>	2	2	4	4
9	Bottle brush	<i>Melaleuca citrina</i>	1	1	2	2
10	Black mulberry	<i>Morus nigra</i>	-	2	2	2
11	Mango	<i>Mangifera indica</i>	1	-	1	1
12	Ashoka	<i>Saraca asoca</i>	-	1	1	1
13	Gulmohar	<i>Delonix regia</i>	-	1	1	1
14	Amaltas	<i>Cassia fistula</i>	-	1	1	1
15	Pipal	<i>Ficus religiosa</i>	-	1	1	1
16	Dharek	<i>Melia azedarach</i>	-	1	1	1
Total			42	57	99	100

Table 8: Tree species used by breeding House Crow at PAU, Ludhiana during 2015 and 2016 breeding season presented separately for trees containing active and inactive nests (%).

S. No.	Tree species		Number of active nests	Active nest percentage (%)	Number of inactive nest	Inactive nest percentage (%)
	Common Name	Scientific Name				
1	Eucalyptus	<i>Eucalyptus tereticornis</i>	21	34.4	8	21
2	Saptaparni	<i>Alstonia scholaris</i>	4	6.56	6	15.8
3	Sheesham	<i>Dalbergia Sissoo</i>	2	3.28	8	21
4	Poplar	<i>Populus tremula</i>	12	19.7	1	2.63
5	Golden rain	<i>Koelreuteria paniculata</i>	5	8.20	3	7.89
6	Subabul	<i>Leucaena leucocephala</i>	2	3.28	4	10.53
7	Ear leaf acacia	<i>Acacia auriculiformis</i>	5	8.20	4	10.53
8	Toona	<i>Toona ciliata</i>	2	3.28	2	5.26
9	Black mulberry	<i>Morus nigra</i>	0	0	2	5.26
10	Ashoka	<i>Saraca asoca</i>	1	1.64	0	0
11	Bottle brush	<i>Melaleuca citrine</i>	2	3.28	0	0
12	Gulmohar	<i>Delonix regia</i>	1	1.64	0	0
13	Amaltas	<i>Cassia fistula</i>	1	1.64	0	0
14	Pipal	<i>Ficus religiosa</i>	1	1.64	0	0
15	Dharek	<i>Melia azedarach</i>	1	1.64	0	0
16	Mango	<i>Mangifera indica</i>	1	1.64	0	0
Total			61	100	38	100

Table 9: Number of House Crow nests per tree during the 2015 and 2016 breeding season in PAU, Ludhiana.

S. No.	Number of nests	Total trees in 2015	Total trees in 2016	Percentage (%) in 2015	Percentage (%) in 2016
1	1	42	51	100	94.7
2	2	0	3	0	5.3
Total		42	54	100	100

Table 10: Estimated heights of trees and House Crow nests during the 2015 breeding season in PAU, Ludhiana.

S. No.	Tree species		No. of nests	Minimum tree height (m)	Maximum tree height (m)	Av. tree height (m)	Minimum nest height (m)	Maximum nest height (m)	Av. nest height (m)
	Common Name	Scientific Name							
1	<i>Eucalyptus</i>	<i>Eucalyptus tereticornis</i>	15	9.1	25.3	17.94±1.460	8.2	22.1	14.54±1.275
2	Poplar	<i>Populus tremula</i>	8	9.7	19.2	13.86±1.113	7.3	15.5	10.60±1.035
3	Ear leaf acacia	<i>Acacia auriculiformis</i>	5	6.9	17.2	13.16±1.748	6.4	16.3	11.32±1.575
4	Sheesham	<i>Dalbergia sissoo</i>	4	16.3	19.2	17.57±0.683	10.4	15.7	13.17±1.309
5	Golden rain	<i>Koelreuteria paniculata</i>	3	12.9	16.5	15.53±1.332	6.7	13.7	11.03±2.185
6	Toona	<i>Toona ciliata</i>	2	12.8	14.5	13.65±0.850	9.4	12.2	10.80±1.400
7	Saptaparni	<i>Alstonia scholaris</i>	2	11.6	17.3	14.45±2.850	8.9	14.1	11.50±2.600
8	Mango	<i>Mangifera indica</i>	1		12.6			9.2	
9	Bottle brush	<i>Melaleuca citrine</i>	1		9.9			5.2	
10	Subabul	<i>Leucaena leucocephala</i>	1		10.1			4.2	

Table 11: Estimated heights of trees and House Crow nests during the 2016 breeding season in PAU, Ludhiana.

S. No.	Tree species		No. of nests	Minimum tree height (m)	Maximum tree height (m)	Av. tree height (m)	Minimum nest height (m)	Maximum nest height (m)	Av. nest height (m)
	Common Name	Scientific Name							
1	Eucalyptus	<i>Eucalyptus tereticornis</i>	14	10.4	24.7	17.18±1.157	6.9	20.9	12.60±1.299
2	Saptaparni	<i>Alstonia scholaris</i>	8	7.8	19.4	13.65±1.164	5.9	15.5	10.27±1.037
3	Sheesham	<i>Dalbergia sissoo</i>	6	7.2	18.2	12.76±1.816	6.1	15.1	9.76±1.511
4	Poplar	<i>Populus tremula</i>	5	10.4	18.4	14.44±1.393	7.2	14.2	10.64±1.483
5	Golden rain	<i>Koelreuteria paniculata</i>	5	12.2	17.2	14.84±0.984	6.7	13.7	10.7±1.369
6	Subabul	<i>Leucaena leucocephala</i>	5	7.6	13.9	10.22±1.368	5.7	8.9	7.28±0.675
7	Ear leaf acacia	<i>Acacia auriculiformis</i>	4	12.8	17.2	14.97±0.898	9.9	16.3	11.97±1.465
8	Toona	<i>Toona ciliata</i>	2	12.8	25.2	19.00±6.200	10.1	23.5	16.80±6.700
9	Black mulberry	<i>Morus nigra</i>	2	9.7	9.7	9.7±0.000	6.7	7.1	6.9±0.200
10	Ashoka	<i>Saraca asoca</i>	1		12.9			10.1	
11	Bottle brush	<i>Melaleuca citrina</i>	1		9.9			8.2	
12	Gulmohar	<i>Delonix regia</i>	1		21.4			17.2	
13	Amaltas	<i>Cassia fistula</i>	1		10.3			6.7	
14	Pipal	<i>Ficus religiosa</i>	1		21.1			19.2	
15	Dharek	<i>Melia azedarach</i>	1		12.6			9.7	

Table 12: Nest parameters of House Crow nests (n=8) at PAU, Ludhiana.

S. No.	Nest parameters	N	Maximum (cm)	Minimum (cm)	Range (cm)	Mean±S.E. (cm)
1	Nest diameter	8	43.5	36.2	36.2-43.5	39.3±0.942
2	Nest depth	8	22.4	17.5	17.5-22.4	19.5±0.617
3	Nest Cup diameter	8	22.2	12.5	12.5-22.2	17.3±1.233
4	Nest Cup depth	8	8.3	6.9	6.9-8.3	7.4±0.181

Table 13: Reproductive achievement of the House Crow at PAU, Ludhiana during the 2015 and 2016 breeding season.

S. No.	Parameters	Reproductive achievement in 2015 breeding season	Reproductive achievement in 2016 breeding season
1	Total number of nests	42	57
2	Number of active nests	28	33
3	Clutch size Range (Mean±S.E.)	2-5 3.17±0.185	2-5 3.21±0.172
4	Total number of eggs	89	106
5	Incubation (days) Range (Mean±S.E.)	15-17 15.93±0.153	15-18 16.00±0.144
6	Hatching success (%)	86.51	77.35
7	Nesting success (%)	66.66	57.89
8	Number of Young ones	77	82
9	Fledging (days) Range (Mean±S.E.)	25-31 27.21±0.480	25-32 27.82±0.299

**Fig 1:** House Crow nests on different tree species

(a) House Crow nest on Bottle brush tree (b) House Crow nest on Subabul tree (c) House Crow nest on Eucalyptus tree (d) House Crow nest on Golden rain tree (e) House Crow nest on Poplar tree



Fig 2: Nest of House Crow presenting the work of art of nest



Fig 3: (a-b) Young ones of House Crow

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