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Damage assessment and management strategies for house crow (*Corvus splendens* L) on the seedling stages of maize and wheat in an irrigated agricultural farmland of Punjab, Pakistan

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Abstract

The house crow (*Corvus splendens* L.) of the order 'corvidae', inhabits a wide range of habitats throughout the medium sized cultivations in the varied agro-ecosystems. In Pakistan, it roosts among light timbered vegetation, abandoned and old buildings and in close association with man. Crow roosts predominantly range from large to moderate depending on the availability of food resources and occurrence of predators. Crows are considered as potential vertebrate pest among varied habitats and depredate on seedling through mature stages of different crops. Moreover, their depredatory impacts have also been recorded on the post-harvested sheaves in good proportions. Present study was conducted to assess the damage caused by *Corvus splendens* to seedling stages of wheat and maize. For wheat, the damage profiles in the morning and evening remained maximum 15.34 ± 1.27 through 17.94 ± 2.24 , while in the hawk eye protected conditions for the same morning and evening durations, lowered damage intensities 5.15 ± 1.11 and 5.25 ± 0.93 were recorded. For the maize in both the situations also depicted lower crow depredatory profiles, therefore, evincing the effectiveness of the hawk eye rotator. It remains pertinent the implication of various repellents should prove amply effective and sustainable for various cropping patterns as they are devoid of any of undesirable impacts on the cultivations, non-targeted species and sustainable agriculture, not only to promote better crops, but also improve on cost-effective ecosystem sustainability.

Keywords: damage, wheat, maize, *Corvus splendens*, irrigated crops

1. Introduction

The house crow (*Corvus splendens* L.), is considered as one of the important vertebrate pests throughout the cultivations, stored grains, human habitations and native wildlife^[1]. It has also been reported to depredate on small breeding passerine birds and young chicks^[2-4] the crow inhabits a wide range of habitats throughout Pakistan^[5-7] and brings about considerable damage and resulting economic losses, and being a native of the sub-continent, its damage proportions have also been recorded in considerable proportions in India^[8-13]. The crow is a crop-raider during the diurnal conditions and intermittently spoils various crops including the maize and wheat at different developmental stages besides the soft fruits viz. mangoes, paw paws and bananas, to cause them unsuitable for market selling^[3]. Cultivations in Pakistan predominantly rely on multiple cropping practices spread over small ecological landscapes of about 12.5 acres, with the cropping of various food crops to facilitate the farmers, but have a major predicament with the small and large mammalian pests with a variety of birds' to inflict significant damage and the resultant economic losses to affect farming communities and invariably on the national economy^[14-18]. The crows often are a nuisance to people and can be inhibitory factor in reducing the visitations by the frequent travellers to the scenic habitats in many regions of the world^[19]. Communal roosting among the members of the corvid family has been well recognized using radio-telemetry in the region of Queensland, Australia, with the old and permanent roosting sites, comprising the adults and natal populations^[20]. The crows use light timbered vegetation in establishing their roosts alongside the close association with man in many village sides, towns and urban environment, where the daily visitations from and to their roosts to a variety of food sources result in a less expenditure of energy^[21]. Damage caused by crows on grapes and almonds can be severe in various situations. Growers employ different strategies and techniques to combat crop loss including the use of repellents and avicides to reduce the crow depredations^[22].

Studies by suggest the depredatory impacts of birds on crops has presented a major ecological concern to the ecologists due their aerial mode of life. However, as reported by [23], availability of sufficient moisture and temporary roosts diurnally can be important bird control measures. Increase of forest plantations over the tropical habitats has augmented in the bird populations with suitable roosts and nests [24]. Although use of ecologically effective repellents has mostly proved effective to inhibit bird damage on various agricultural habitats, but may also fail in reducing their depredations for some reasons [26]. Bird repellents classified as primary and secondary, are frequently used against a variety of bird pests in various situations, and wherein, there has been a tendency among birds to avoid primary repellents; however, in the longer perspectives, can manifest with the use of secondary repellents to indicate their effectiveness [26-28]. Effective management for wheat and maize was recorded using reflecting ribbons and distress sound players against the rose-ringed parakeet (*Psittacula krameri*), among three equally subdivided (left, middle and corner) both the crops fields. Although there were depredations recorded on the corners, but their middle parts remained more or less protected, indicating their significance for crop protection [18]. It seems more productive to incorporate with a combination of repellent stimuli to inhibit bird damage patterns on various food sources, with a continuous replacement after about two weeks to reduce the possibility of habituation among bird pests, as more effective means to deter the damage incurred by marauding [29]. Control measures can affect targeted bird populations spaced over large landscapes of any habitat. This seems to be valid for various game birds [30]. Predominantly, such activities appear to focus on longer perspectives to deter the impacts of bird pests on crops [31, 32]. As various birds inhibitory devices viz. the pyrotechnics, sound deterrents, gas exploders lasers and reflecting ribbons, appear to be integral to repel away the attacking birds, their effectiveness largely depends on the pest populations in a given habitat and

precision with which birds can be reduced from visitations to crops [33]. Moreover, the roost distance of pest birds from the food sources is another important ecological factor. Shorter distances can optimize the attacks during different times of the day with lower energy budgets spent for each visit, while longer distances prove to less economize in larger expenditure of energy for each bird visitation [34, 35, 18]. Objective of the present study was, therefore, designed to determine the damage proportions of house crow with regard to maize and wheat at the seedling stages under the unprotected and protected conditions, for a comparison of the crow depredations in Faisalabad.

2. Materials and Methods

2.1 Study sites

Observations on avian hawk eye rotator were extended for a period of 12 weeks (March through May, 2013; eight for wheat and four for maize in the unprotected and protected conditions) for the assessment of depredatory profiles of house crow with respect to early seedling stages of wheat and maize in an agricultural farmland. Observations were made on one acre each for wheat and maize and were checked in the early morning and again in the late afternoon periods on the damage proportions of house crow. The protection was provided by the incorporation of avian repellent (Hawk eye model) which is cost effective and as such, can be easily obtained by farmers. It is without any secondary hazards and does not harm the agro-eco system. It is devoid of any secondary hazards to inflict serious damage to the agro-ecosystems. The model comprised an adjustable iron stand with multiple right and left facets and a vantage point on upper surface, to affix fearsome models. This repellent rotated in all directions of the sampled crops and repels the bird depredations for more than a week, before being replaced with another repellent to avert any habituation. Present study was in Faisalabad city with a latitude (31°25) north and a longitude (73°04) south located in central Punjab, Pakistan.



Fig 1: Location of the study site in the region of Central Punjab, Pakistan.

In this study direct field observations were recorded for both the crops consecutively for a period of 12 weeks in a sufficiently large agricultural landscape for unprotected and protected conditions to adjudge about the tenacity of the crow damage profiles. All the observations included successive and direct field observations in the morning and evening hours to collate the required data. For the observations convenience, both the crops were sub-divided into three parts viz. left, middle and right [36], while observations regarding the bird visitations in the fields were determined from a vantage position. Four hawk eye rotators were installed in the fields at equal distances (about 50 m) for both treated and control plots of crops which existed in a shorter distance from each other. Field assessments were made for three hours consecutively in the morning and again for similar durations in the evening for knowing the relative abundance based on their numerical counts for both the diurnal sessions. The data so obtained was statistically analyzed using the descriptive statistics for interpretation of results [37].

3. Results and Discussion

Observations were made directly through field observations for house crow (*Corvus splendens* L) without and with the incorporation of a repellent, avian hawk eye rotator, on one acre each for the wheat and maize crops at their sowing (seedling) stages during two daily (early morning and late

afternoon) periodicities in an agricultural farmland of Faisalabad, Pakistan.

3.1 Observations on wheat

Seemingly, intensive crow damage (11.31±0.83; 4.03±0.44) was recorded for attacking and leaving crows during the morning foraging durations. In the evening, minor fluctuations regarding the house crow inward and outward movements were recorded (Table1). The degree of depredations remained fairly high on the edges of the crop, suggesting the safety factors for the crows to exit in the unsuitable ecological conditions. The tenacity remained intensive towards the edges of the crop which signifies their safety factor to escape during ecologically hazardous situation. Therefore, their feeding efficiencies remained of lower intensity with their safety at risk. It was, therefore, evident that the foraging periodicities were nearly comparable for the morning and evening durations. Apparently, majority of the crows had vacated their roosts in search of food from the nearby crops after the night hiatus. Concurrently, the return of crows to roosting sites after diurnal activities. Since majority of the crops happened to be close to their roost which did not seem to affect the energy budgets. However, with the inception of the hawk eye rotators in the wheat field, their depredatory profiles were considerably reduced, which evinced its effectiveness to reduce their damage pattern (Table 2).

Table 1: Number of house crows inflicting damage at the seedling stage of wheat in the unprotected conditions of an agricultural farmland in Faisalabad.

Weeks	Morning		Evening		Total
	Incoming	Outgoing	Incoming	Outgoing	
1 st	12.00±2.20a-d	4.50±0.96bcd	11.00±4.45a-d	4.50±2.40bcd	8.00±1.55AB
2 nd	9.50±2.06a-d	4.50±2.02bcd	13.00±3.03a-d	12.00±4.14a-d	9.75±1.57B
3 rd	10.50±1.94a-d	6.00±1.58bcd	11.25±4.19a-d	3.50±1.44cd	7.81±1.41AB
4 th	9.25±1.38a-d	2.50±0.65cd	2.00±0.91cd	1.00±0.41d	3.69±0.93B
5 th	15.25±2.29a-d	5.25±0.85bcd	11.25±5.96a-d	3.50±2.25cd	8.81±1.95AB
6 th	9.25±2.95a-d	3.00±1.08cd	14.00±5.43a-d	5.25±2.39bcd	7.88±1.85AB
7 th	8.50±2.60bcd	2.75±1.03cd	17.75±1.89ab	5.25±0.85bcd	8.56±1.66AB
8 th	16.25±1.03abc	3.75±1.32cd	23.25±4.01a	5.00±1.58bcd	12.06±2.33A
Overall Means	11.31±0.83A	4.03±0.44B	12.94±1.63A	5.00±0.87B	8.32±0.62

Mean sharing similar letter in a row or in a column are statistically non-significant (P>0.05). Small letters represent comparison among interaction means and capital letters are used for overall mean.

Table 2: Movement patterns of house crow (*Corvus splendens*) recorded at the seedling stage of wheat in the avian hawk eye protected stage in the study area.

Weeks	Morning		Evening		Total
	Incoming	Outgoing	Incoming	Outgoing	
1 st	1.75±0.48bc	1.00±0.41bc	1.75±0.63bc	0.50±0.29bc	1.25±0.25B
2 nd	4.25±1.03bc	1.25±0.63bc	2.75±1.03bc	0.50±0.29bc	2.19±0.52B
3 rd	2.00±0.91bc	0.75±0.75bc	5.25±0.63bc	1.50±0.65bc	2.38±0.55B
4 th	13.75±2.87a	4.50±1.55bc	1.25±0.63bc	0.75±0.48bc	5.06±1.54A
5 th	1.75±0.48bc	0.75±0.25bc	2.75±0.85bc	0.50±0.29bc	1.44±0.33B
6 th	1.00±0.41bc	0.25±0.25c	5.50±2.60bc	3.00±1.58bc	2.44±0.87B
7 th	3.00±0.82bc	1.00±0.41bc	6.75±3.12bc	3.25±1.80bc	3.50±0.99AB
8 th	3.25±1.32bc	1.00±0.41bc	4.25±0.63bc	1.75±0.48bc	2.56±0.48AB
Overall Means	3.84±0.8A	1.31±0.31B	3.78±0.59A	1.47±0.34B	2.60±0.29

Mean sharing similar letter in a row or in a column are statistically non-significant (P>0.05). Small letters represent comparison among interaction means and capital letters are used for overall mean.

3.2 Observations on Maize

Seemingly, there were abrupt activities of house crow at as they emerged from their roosts. The performance of day long activities mainly close to their roosting site were comparable to that of evening with their returns to it. As of the past, the damage proportions were mainly focused on the edges of the crop while the birds avoided going in the middle of the maize due to risk of predation by larger birds. There was a decline in damage patterns with incorporation of bird hawk eye rotator as

comparable with unprotected phases (Tables 3, 4), which again suggested on the effectiveness exerted by the applied repellent. Data of the present studies indicates the point indicators of crow damage for two time intervals, the morning and evening respectively. Seemingly, the incidence of damage for both the crops in the control (unprotected) and treated (protected) stages indicated contrasting patterns being pronounced and reduced, expressing the effectiveness of the repellent to inhibit the crow impairment to wheat and maize and curtailing the

economic losses. Predominantly, majority of the bird depredatory activities are anticipated to be restrained whenever the protection is available for the food sources, but depredatory profiles seem to be at their peak when the crops are devoid of them, as have been with bird depredations for some earlier studies^[9, 38-41]

Emergence of crows from the roost was recorded to be with the impulsive movement patterns at about sunrise after the hiatus of night, for varying diurnal activities, most significant being that of the foraging in the nearby seedling stages of wheat and maize, and also to other crops at a reasonably short distance, to affect their energy budgets to least extent. Mostly the crows ruthlessly uprooted their seeds from the ground and, therefore, impacted markedly on their growth activities. It appears probable that, similar damage proportions would also result at the other growth stages of the crops, at the mature and post-harvest conditions, with the ears and grains filled with nutritious fluids, and attract sufficiently large crows and the other bird populations of not only house crows but for other birds' as the rose-ringed parakeet, house sparrow and rosy starling, to cause substantial damage and the resulting economic losses. Present studies also conform to those of^[18] who reported that, the rose-ringed parakeets' had also exhibited two foraging peak rhythms of early morning hours and late evening durations, inflicting losses to important agricultural and horticultural croplands in the unguarded conditions, at the varying crop growth stages, while^[24] have strongly emphasized on suitable ecological factors which act as positive ecological indicators for the damage caused to

various fruit crops by invasive birds in local agro-climatic zones in varying hours of the day.

It is important to assess the effectiveness of any specific device to reduce bird damage among croplands largely relies on its exact installation and inclusive population size of a specific pest or a variety of pest birds to cause maximum depredatory impacts, spoil the crops and result in substantial economic damage. Although, there has been improvement in overall approach by the farmers and stakeholders to assess the effects of vertebrate pests on their crops; however, many remain deficient for it and suffer from brunt of bird damage^[42] Use of repellents for the past some years to reduce bird's depredatory effects on both agricultural and horticultural practices has proved fairly effective^[18, 43-45] largely doing away with the chemical manifestations for their management and as such, without any lethal impacts of the sustainability of agro-ecological systems, but one of their predicaments remains on being protracted in the fields, which seems ecologically acceptable as long as no harm occurs to their eco-sustainability. It is also significant to note that efficiency of a particular bird repellent largely depends on functional approach of a deterrent, population densities and type of species to be managed ecologically. Some repellents can be fearsome, others induce pain and sensory irritations among the targeted animals. They are more effective with better results than those only depending on the taste aversion^[46]

Maize

Table 3: Magnitude of house crow depredations recorded on the seedling stage of maize in unguarded phase.

Weeks	Morning		Evening		Total
	Incoming	Outgoing	Incoming	Outgoing	
1 st	18.00±1.58ab	18.00±2.74ab	4.50±0.87c	3.25±1.32c	10.94±1.99A
2 nd	5.75±1.49c	5.50±1.85c	2.00±0.82c	0.50±0.29c	3.44±0.81B
3 rd	25.50±3.40a	21.25±5.79a	10.00±1.08bc	2.25±1.11c	14.75±2.83A
4 th	8.50±1.50bc	4.75±1.32c	2.00±0.91c	0.50±0.29c	3.94±0.93B
Overall Means	14.44±2.24A	12.38±2.43A	4.63±0.94B	1.63±0.50B	8.27±1.08

Mean sharing similar letter in a row or in a column are statistically non-significant (P>0.05). Small letters represent comparison among interaction means and capital letters are used for overall mean.

Table 4: Damage profiles of house crow for the seedling stage of maize in bird hawk eye protection of the agricultural farmland of Faisalabad.

Weeks	Morning		Evening		Total
	Incoming	Outgoing	Incoming	Outgoing	
1 st	5.50±1.20bc	18.80±1.70a	20.00±1.90a	5.50±1.80	12.40±1.90A
2 nd	1.30±0.60c	5.30±0.90bc	5.80±0.60bc	1.30±0.60c	3.40±0.60B
3 rd	8.80±1.10b	24.00±3.00a	20.50±1.90a	4.80±0.90bc	14.50±2.20A
4 th	2.30±0.50bc	6.00±0.90bc	6.50±1.40bc	1.00±0.40c	3.90±0.70B
Overall Means	4.40±0.90B	13.50±2.20A	13.20±2.00A	3.10±0.70B	8.60±1.00

Mean sharing similar letter in a row or in a column are statistically non-significant (P>0.05). Small letters represent comparison among interaction means and capital letters are used for overall mean.

4. Conclusions and Recommendations

It was evident from the present study that the depredatory profiles remained fairly high for both the crops (maize and wheat) in the morning and evening foraging periods with considerable economic losses. Situation was markedly improved with the inception of hawk eye rotators installed in the fields, with a lesser degree of foraging activities. It is anticipated that induction of similar repellents would minimized further damage profiles not only from the present crops, but other economically important croplands, and provide beneficial results against the various other bird pests.

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