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Short Communication

Effectiveness of Methylanthranilate and Anthraquinone as Repellent against House Crows (*Corvus splendens*) on Wheat Seeds and Seedlings in Captivity

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ABSTRACT

Present study was aimed to investigate the efficacy of two bird repellents anthraquonine and methylanthranilate against house crows on wheat seeds and seedlings in caged conditions. Anthraquinone was found significantly more effective than methylanthranilate when repellent treated seeds of wheat were offered to house crows. These repellents did not have any significant results when seedlings of repellent treated wheat seeds were provided to house crows. Birds displayed a perceptible head-shaking and feather ruffling response after a few minutes of treatment exposure and less food consumption was observed.

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Authors' Contributions
SA, ZS and HAK conceived and designed the study. SY and KS helped in construction of cages to establish the research. MI and TS supervised the experimental work. ZS and SM collected and analyzed the data. FJ and SA wrote the article.

Key words
House crow
Anthraquinone
Methylanthranilate
Wheat seeds
Seedlings
Corvus splendens

Various bird pests like crows, rooks, sparrows, pigeons, parrots, blackbirds and mynas cause serious economic losses to valuable crops and fruit orchards all over the world (Dhindsa and Saini, 1994). This damage has been found not only at mature fruits and crops but also at seed and seedling stages, for example house crows (*Corvus splendens*) caused severe damage to wheat seedlings in India and Pakistan (Dhindsa and Saini, 1994; Khan, 2003) and rooks (*Corvus frugilegus*) in Ireland (Kennedy and Connery, 2008). In South and Southeast Asia the major bird pests are rose-ringed parakeet (*Psittacula krameri*), Asiatic house crows (*Corvus splendens*), doves (*Streptopelia species*), common mynas (*Acridotheres tristis*), common pigeons (*Columba livia*), house and tree sparrows (*Passer domesticus*, and *P. montanus).* In Haripur, India, the estimated losses caused by pigeons, crows, sparrows and mynas were 244 g/day/yard in a 30-day threshing season (Garg *et al.*, 1966).

In subcontinent including Pakistan the house crow (*Corvus splendens*) is very destructive pest in their nature and caused heavy damage to wheat seeds and seedlings. Wheat damage due to house crows has become so severe in some areas that tillage of certain crops is threatened. Different repellents such as Starlicide, Endrin and Fenthion, Avitrol, Methiocarb, methylanthranilate, and anthraquinone have been used to control the pest birds (Brooks and Hussain, 1990; Kennedy and Connery, 2008).

Methylanthranilate, a natural compound present in grapes and other plant materials acts as chemosensory repellent by irritating pain receptors associated with taste and smell and hence used for controlling birds on feed lots, horticultural crops, rice and field crops (Avery *et al.*, 1993; Mason *et al.*, 1989, 1991). Anthraquinone is emodin (*i.e.*, phenolic) purgative, and has been effectively used to protect rice seed from blackbirds under captive and field conditions (Avery and Mason, 1997; Avery *et al.*, 1998; Cummings *et al.*, 2002a,b). This study was designed to ascertain the relative effectiveness of anthraquinone and methylanthranilate against house crow on wheat seeds and seedlings in captive conditions and their relative concentration to repel best from treated wheat seeds and seedlings. Also the behavioral response of house crows against the untreated and treated seeds and seedlings was determined.

Materials and methods

Present study was conducted in two aviaries placed in the vicinity of Wildlife and Fisheries Research Station and Botanical Garden at New Campus of Government College University, Faisalabad, Pakistan. There was somewhat natural and undisturbed environment for the birds. Aviary-I was taken as trial while aviary-II as reference (control) group. Twenty house crows of

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undetermined sex and age, captured from local area, were tagged and released in two aviaries, ten in each, having dimension of 12×12×8 feet (length × width × height). All birds were weighed at the beginning of the experiment on 01-07-2013. In each aviary, wooden bars, tree branches, stones were provided for roosting the birds. Two closed circuit cameras were also adjusted in the corners of each aviary to monitor the feeding behaviour against the untreated and treated seeds and seedlings. The water was provided *ad libitum* to the crows throughout the experimental period. For a week of acclimatization period, grains, fruits, garden plants, wheat seeds in food bowls were provided *ad libitum* to all the house crows in each aviary.

Four different concentrations, *viz*., 0.25%, 0.5%, 0.75% and 1.0% of methylanthranilate (*W268208/ ALDRICH)*, and anthraquinone (*A90004 /ALDRICH)* in acetone were used as avian repellents. To treat the seeds 62.5ml of each concentration was mixed with 250g seeds which were later air dried and stored in darkness in an air-conditioned laboratory.

Each treatment was given to crows in aviary-I for about three hours in morning, followed by maintenance diet after that. Each day a known quantity of treated and untreated seeds was provided to the birds and unconsumed seeds were collected and weighed from both treated and control group in both the aviaries. There was one day gap in every treatment phase and birds were provided with maintenance diet the whole day. During the whole experiment, every day same amount of seeds was kept in a small vacant cage in a bowl to determine the change in seeds weight as a result of desiccation. According to above mentioned methodologies, the efficacy of both bird repellents was evaluated against the house crows by providing the seeds of wheat treated with different concentrations of Methylanthranilate and Anthraquinone.

This experiment was repeated with seedlings of wheat. For this purpose, the 35g seeds of wheat were grown in the pots. Ten pots were placed in each aviary having seedlings. It was sprayed with above mentioned doses of both repellents and then provided to the birds in the treatment group in aviary-I, and similarly the unsprayed seedling in pots were offered to the control group in aviary-II.

To observe the behavioral response of house crows against the different doses of the both repellents, two closed circuit cameras in opposite corners of each aviary were adjusted in such a way that all the activities of birds were recorded in it.

Analysis of variance (ANOVA; Keppel, 1973) and LSD test were used to determine the significant difference among the means. Student's t-test was used to determine the significance of variance between the two means. All analyses were performed with Statistix 8.0.

Results and discussion

Table I shows that wheat seeds consumption, among treatment (T) groups and chemicals (Ch) were highly significant ($P<0.01$), whereas among different concentrations (C) there existed a significant ($P<0.05$) difference. Interaction between treatment and chemicals (T × Ch) was significant ($P<0.05$), whereas a non-significant ($P>0.05$) interaction was observed between concentrations and treatment (C × T), and between concentration and chemicals (C × Ch). The interaction among treatment, concentrations and chemicals (T × C × Ch) was also non-significant (Table I). In this study, the wheat seeds consumption (g) by house crow treated with anthraquinone was 26.10±1.57, whereas with methylanthranilate was 33.64±0.69 (Table II). It was observed that anthraquinone was best repellent than methylanthranilate against house crows on wheat seeds treatment (Table II) and among concentrations, 0.75% (22.45±1.61) of anthraquinone had greater repellency than other concentrations (Table III). In the first phase of experiments bird repellents showed highly significant results between anthraquinone and methylanthranilate along with treatment and control groups against house crows. Greater seeds consumption was noticed in aviary-II which was control group as compared to aviary-I which was treatment group. It showed that bird repellents have deterrent effects against house crows and between chemical repellents anthraquinone has more repellency effect than methylanthranilate which is in good agreement with findings of Avery *et al.* (2001), Esther *et al.* (2013) and Werner *et al.* (2009) who also found anthraquinone as more efficient deterrent instead of methylanthranilate on different crops against birds.

For four treatment concentrations, the consumption of wheat seedlings (number = n) was investigated by providing the seedlings to the crows in early morning for three hours period. Analysis of variance of wheat seedlings showed highly significant differences ($P<0.01$) between treatment (T) and control group, and a significant difference ($P<0.05$) among different concentrations (C), while a non-significant difference ($P>0.05$) between chemical repellents (Ch) was found. Interactions between treatment and chemicals (T × Ch), concentrations and treatment (C × T) and chemicals and concentrations (Ch × C) were non-significant ($P>0.05$). A non-significant difference was also observed among the interaction of treatment, concentration and chemical (T× C × Ch) (Table I). The consumption of wheat seedlings (n) treated with anthraquinone and methylanthranilate was 31.13±2.07 and 32.12±1.41, respectively, and there

Table I.- Effect of anthraquinone and methylanthranilate chemical repellents on consumption of wheat seeds (g) and wheat seedlings (n) by house crows along with F-values showing significance of main effects.

Chemical	Control group		Trial group		Main Effects	Seeds	Seedlings
	Seeds	Seedlings	Seeds	Seedlings	Treatment (T)	F-value	F-value
Anthraquinone	42.27±1.20	40.54±2.53	26.10±1.57	31.13±2.07	Chemical (Ch)	121.15**	21.63**
Methylanthranilate	44.70±1.74	40.50±1.57	33.64±0.69	32.12±1.41	Concentration (C)	16.26**	0.06^{NS}
					T x Ch	3.45*	3.33*
					T x C	4.27*	0.07^{NS}
					Ch x C	0.83^{NS}	0.22^{NS}
					T x Ch x C	2.41^{NS}	0.82^{NS}
						0.41^{NS}	0.15^{NS}

NS, Non-significant (P>0.05); *, Significant (P<0.05); **, highly significant (P<0.01).

Table II.- Comparison of mean for wheat seeds (g) and seedlings (n) consumption with four different concentrations of anthraquinone (AQ) and methylanthranilate (MA) chemical repellents.

Chemical	Concentration	Seeds		Seedlings	
		Control group	Trial Group	Control group	Trial Group
AQ	0.25%	46.00±2.24	29.87±4.87	49.39±4.20	37.14±2.86
	0.50%	41.48±3.79	25.49±2.52	38.07±5.61	30.96±5.12
	0.75%	39.87±0.86	22.45±1.61	39.27±2.99	27.26±2.51
	1.00%	41.74±1.19	26.57±2.76	35.41±5.17	29.17±5.07
MA	0.25%	48.13±2.19	35.98±0.93	42.70±2.20	34.62±2.40
	0.50%	40.99±1.00	34.23±0.40	41.90±4.23	33.21±3.85
	0.75%	49.39±4.77	33.71±0.52	39.87±2.31	30.69±3.74
	1.00%	40.31±2.17	30.64±1.27	37.53±4.23	29.97±1.52

was a non-significant difference between both repellents (Table II). Table III, shows that 0.75% concentration of anthraquinone and 1% of methylanthranilate treated wheat seedlings showed least consumption by house crows. In the second phase of experiments when seedlings of wheat were provided to the house crows a non- significant difference (P>0.05) was seen among the anthraquinone and methylanthranilate treatment which indicated that in case of seedlings both repellents showed similar consequences. However, Esther *et al.* (2013) and Kennedy and Connery (2008) observed reverse effect in both caged and field study with pigeons and crows, respectively, where both deterrent substances were unsuccessful. Like house crows many birds have been reported to prefer sown seeds or pluck off seedlings of wheat and rice (Cummings *et al.*, 2002a,b; Kennedy and Connery, 2008).

Weight of birds was measured at the start and end of the experiment. A non-significant difference was obtained when compared the initial and final weight which indicated that repellents did not affect the weight of birds. Caged test birds maintained body weight and all seemed healthy when experiment was over. The body weight of aviary-I birds throughout experiment was significantly not different that was supported with the Avery *et al.* (1993) work. Insignificant illness, aching and queasiness behavioural responses were seen in some birds during videotaped observation in aviary-II. Avery *et al.* (2001) and Mason and Bonwell (1993) found similar results with the applications of turpentine, insecticide, mint derivates and methylanthranilate in studies on red-winged blackbirds, brown headed cowbirds and grackle corroborated.

Table III.- Comparison of mean between weight (g) of house crows at the start and end of experiment.

Crow weight	Control (n=11)	Treatment (n=10)
Initial weight	263.00±8.57	$242.30±9.48^{ns}$
Final weight	260.72±8.76	$241.52±9.87^{ns}$

NS, Non-significant (P>0.05); SD, Standard deviation; SE, Standard error.

Throughout the house crow's experiments, discomfort of all birds was noticed. Head shaking were seen in birds when higher concentrations were given and later they vomit it. After that, during this period birds did not eat and next days they avoided feeding during treatment time. There was no evidence of change in overall body weight and physical fitness throughout the experiment in house crows.

In previous studies, numerous avian species like European starlings (*Sturnus vulgaris*), house sparrows (*Passer domesticus*), feral pigeons (*Columba livia*), red-winged blackbirds (*Agelaius phoeniceus*), common grackles (*Quiscalus quiscula*), brown headed cowbirds (*Molothrus ater*), American kestrels (*Falco sparverius*), Canada geese (*Branta canadensis*), mallards (*Anas platyrhynchos*), cedar waxwings (*Bomby cillacedrorum*) and yellow-headed blackbirds (*Xanthocephalus xanthocephalus*) also showed the similar results and suppress the depredations when seeds treated with anthraquinone and methylanthranilate were provided to the birds (Cummings *et al*., 1998). Similar results were also found when methylanthranilate treated seeds were provided to different birds and similarly when anthraquinone treated seeds were offered to ring-necked pheasants (*Phasianus colchicus*), red-winged blackbirds (*Agelaiusphoeniceus*), Canada geese (*Brantacanadensis*), Dickcissels (*Spizaamericana*), ducks and feral pigeons (*Columba livia*), depredations to seeds significantly becomes suppressed (Avery *et al.*, 2001; Esther *et al.*, 2013; Werner *et al.*, 2009). According to Linz *et al.* (2006), even in the absence of alternative food, anthraquinone significantly reduced the damage to seeds.

Conclusions

The study clarified that anthraquinone and methylanthranilate have a repellent potential on seeds and seedlings of wheat against house crows in aviary condition. It further revealed that 0.75% concentration of anthraquinone and 1% concentration of methylanthranilate for wheat seeds and seedlings are more effective against house crows and it could be recommended that these bird repellents can further be utilized in the field study on crops in Pakistan and beyond against these house crows.

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Statement of conflict of interest

Authors have declared no conflict of interest.

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