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Efficacy of caffeine and garlic oil against rose-ringed parakeet on maize seeds in captive conditions

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Abstract

Among various bird pests rose-ringed parakeet iscategorically the nastiest one that caused economic losses to crops and fruit orchards. Different mechanical and chemical repellents have been reported to manage these losses throughout the world. Present study was designed to probe the efficacy of caffeine and garlic oil against rose-ringed parakeet in captive conditions. It has been observed that consumption of maize seeds was (0.48±0.26) and (17.00±3.61) in trial and control groups respectively, which showed highly significant ($P \leq 0.01$) variance when maize seeds treated with garlic oil were provided to the caged parakeets. Similarly with caffeine treated maize seeds a highly significant difference ($P \leq 0.01$) was also observed among trial (5.70±0.44)and control (17.27±3.95)group. It showed that both chemicals showed better repellency against the caged parrots when treated seeds were provided.

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Introduction

Many bird pests cause serious economic losses to valuable crops and orchards all over the world. Cereal crops and fruit orchards are seriously affected fields by the birds. Way (1968) observed more than 90% losses on cherry fields whereas in Northeastern United States farmers of blueberry calculated 30% bird damage and according to Dellamano (2006), 10 % damage was recorded in USA at a cost of $10 million. Bird depredation has been found not only at mature fruits and crops but also at seeds and seedlings stages. In Pakistan, yield of maize varieties are shockingly lower and it is planted on an estimated area of 0.9 million hectares with an annual production of 1.3 million tons. Maize is the highest productive cereal crop in the world and has a vital importance for countries like Pakistan, where rapidly increasing population has already facing the shortage of food supply (PARC, 2006). Shafi *et al.* (1986) suggested that the rose-ringed parakeet *(Psittacula krameri)* intensively feeds on maize and sunflower and caused heavy economic losses to crops and fruit orchards in Pakistan. Long (1981) found that rose-ringed parakeet damaged the maize vigorously. He further reported that there is average loss of 21% of maize crop due to parakeet depredations. Ahmad *et al.* (2011) observed that in unguarded conditions a heavy economic loss caused by rose-ringed parakeets due to damage of maize and sunflower crop in Central Punjab, Pakistan.

It has been observed that some mechanical devices are effective for a short period of time after that bird become familiar for a specific technique. Therefore, the treatment of seeds, crops and fruit orchards with bird repellents could be more beneficial, if we want to protect the crops and fruits on large scale areas and can also increase the yield as well. Only small numbers of chemicals are present to control the avian depredations of crops and orchards. Avery *et al.* (2005) observed that a treatment of 0.25% (2500ppm) reduced the consumption of rice seeds treated with caffeine as much as 76% in the cage feeding trials against blackbirds and in the field experiments also concluded that it was highly effective. More than 90% of the caffeine treated rice seeds remained unconsumed when treated with 1% caffeine while more than 80% untreated rice seeds were consumed by the blackbirds. Zobia *et al.* (2015) investigated that anthraquinone is the best repellent than methylanthranilate and shown highly significant difference ($P \leq 0.01$) when seeds of maize were given to house crows in captivity.

Present studies were designed as the economic losses caused by avian pests are in millions every year and to overcome these losses eco-friendly chemical repellents are necessary to be introduced. A huge gap have been found in the field of bird pest management as the literacy rate is low in many developing countries and farmers rely on traditional methods to control the bird pests. In our study different concentrations of caffeine and garlic oil were prepared and evaluated in the caged experiments, against the rose-ringed parakeets on maize seeds. In all six rose-ringed parakeets were captured from the vicinity of Faisalabad, Pakistan. Of these, three were kept in aviary-I (treatment group) and three in aviary-II (control group). Following objectives were made for our study.

- To observe the relative effectiveness of caffeine and garlic oil on maize seeds against rose-ringed parakeet.
- To ascertain the concentration of caffeine and garlic oil which best repel from treated maize seeds.
- To determine the feeding behavior of rose ringed parakeet (*Psittacula krameri*) against the treated and untreated seeds of maize.

Materials and methods

Rose-ringed parakeet (*Psittacula krameri*) foraging experiment was conducted on June 20, 2014, in the vicinity of Botanical Garden at New Campus, Government College University, Faisalabad, Pakistan which provided rather natural and undisturbed environment to the birds. Parakeets of undetermined sex and age were captured from the local area and were tagged and released into two aviaries (large bird cages, dimension 12Lx12Wx8H feet) and weight of each bird was determined at the start and end of the experiment.

Acclimatization

In each aviary, for roosting and perching the birds, wooden bars, tree branches, stones or models were provided and to monitor the feeding responses against the untreated and treated maize seeds two closed circuit cameras were also adjusted in roof corners in opposite sides. Through the entire period of research, the water was provided *ad libitum* in each aviary. All the birds were provided grains, fruits, garden plants, sunflower and maize *ad libitum* for 10 days of acclimatization period. Four food bowls were placed in each aviary in the center. Aviary-I, was treated as treatment group whereas aviary-II, as control group.

Feed preparation and repellent concentrations

Different w/w concentrations that are 0.25%, 0.5%, 0.75%, 1% of caffeine and 4%, 8%, 12%, 16%, 20% and 25%of garlic oil were prepared and evaluated, for this purpose 150grams of maize seeds were taken and soaked in water for one night then treated with different concentrations of both repellents. Then seeds were air dried and again weighed and three packets of 50gram with each concentration of both repellents were packed in separate polythene bags and stored in air conditioned laboratory of Department of Zoology, Government College University, Faisalabad, Pakistan, in darkness.

Treatment experiment

In all six rose-ringed parakeets *(Psittacula krameri)* were taken. Of these, three were kept in aviary-I (treatment group) and three were in aviary-II (control group). After pretreatment trial, food choice experiments were conducted for three consecutive days with each concentration for about three hours in each morning, whereas left over the day maintenance diet was provided. Each day consumed and unconsumed weight of treated and untreated seeds was measured. There was one day gap in every treatment phase during this period in both aviaries maintenance diet was provided.

Statistical analysis

For each experiment daily consumption was estimated by subtracting the weight remaining in pots from the initial weight. Resultant weight was divided by the initial weight to get the percentage consumption. Finally, the recovered data was statistically analyzed by using Analysis of Variance.LSD test was further used to isolate the significance difference among means. All analyses were performed with software statistics 8.0

Results

After 10 days of acclimatization period treatment tests were carried out from June 2014 to September, 2014. The maize treatment phase against rose-ringed parakeet was conducted from 5^{th} July 2014 to 20^{th} August 2014 treated with both repellents.

Table 1. Analysis of variance for maize seeds treated with garlic oil against rose-ringed parakeet.

Source of variation	Degrees of freedom	Sum of squares	Mean squares	F-value
Date	2	6.92	3.46	4.79**
Conc. (C)	5	164.87	32.97	180.48**
Trial (T)	1	1242.33	1242.33	8.70**
(C x T)	5	299.36	59.87	
Error	22	151.44	6.88	
Total	35	1864.92		

** = Highly significant (P<0.01).

Treatment with garlic oil

Aviary-I was designated as treatment group in which rose-ringed parakeets were first provided the seeds of maize treated with garlic oil. Fifty grams treated and untreated seeds of maize were provided to these birds in each aviary for three consecutive days in the morning time for three hours. Statistically, it was observed that a highly significant (P<0.01) difference was seenamongtrial and control groups (T) and between interaction of different concentrations (C) of garlic oil and treatment while in between different concentrations (C) there existed a significant (P<0.05) difference (Table 1).

The comparison of means between trial (T) and control group shows that the garlic oil is a best repellent for controlling the depredation of parakeets on maize.

At the concentration of 25% of garlic oil the consumption of maize seeds was (0.48±0.26) while in control group was (17.00±3.61) and the overall mean maize seed consumption when treated with different concentrations of garlic oil in trial group is (3.59±0.97) while in control group the overall mean consumption is (15.34±1.05) when untreated maize seeds were provided. This shows that the garlic oil is much effective in controlling the consumption of maize seeds. Moreover, the comparison among the various concentrations of garlic oil shows that the rate of consumption decreased with the increase in concentration of garlic oil (Table 2).

Table 2. Comparison of means of maize seeds consumption (gms) when treated with different concentration of garlic oil between control and trial group.

Conc.	Trial group			Control group			Mean		
4%	9.77	±	1.96de	13.96	±	0.98bcd	11.87	±	1.35A
8%	7.93	±	0.95e	14.36	±	1.22bc	11.15	±	1.60A
12%	1.43	±	0.22f	10.39	±	1.90cde	5.91	±	2.18B
16%	1.01	±	0.25f	14.73	±	1.27bc	7.87	±	3.12B
20%	0.92	±	0.36f	21.59	±	0.83a	11.26	±	4.64A
25%	0.48	±	0.26f	17.00	±	3.61b	8.74	±	4.03AB
Mean	3.59	±	0.97B	15.34	±	1.05A			

Means 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.

Treatment with caffeine

In the next phase the maize seeds treated with different concentrations of caffeine were offered to the caged rose-ringed parakeets and it was seen that a highly significant (P<0.01) variance existed among the trail and control group (T) and a significant (P<0.05) difference was found among different concentrations (C) of caffeine whereas a non-significant difference was existed among the interaction (C x T), of concentrations and treatment (Table 3). The comparison of means between trial and control groups showed that the caffeine is also effective repellent in controlling the depredations of parakeets on maize seeds.

Table 3. Analysis of variance for caffeine against rose-ringed parakeet on maize seeds.

Source of variation	Degrees of freedom	Sum of squares	Mean squares	F-value
Date	2	46.08	23.041	
Conc. (C)	3	218.47	72.822	4.14*
Trial (T)	1	534.21	534.210	30.36**
(C ×T)	3	16.18	5.395	0.31^{NS}
Error	14	246.38	17.598	
Total	23	1061.32		

NS = Non-significant (P>0.05); * = Significant (P<0.05); ** = Highly significant (P<0.01).

At the concentration of 1% of caffeine the consumption in trial group was (5.70±0.44) while in control group (17.27±3.95). The overall mean consumption in trial group was (10.01±1.33) while in control group the overall mean consumption of untreated maize seeds was (19.45±1.49). Moreover, the comparison among the various concentrations of caffeine shows that the rate of consumption decreased with the increase in concentration of caffeine (Table 4).

Table 4. Comparison of means for maize seeds consumption (gms) when treated with different concentrations of caffeine between control and trial group.

Conc.	Trial group			Control group			Means		
0.25%	15.78	±	2.11bc	23.54	±	0.84a	19.66	±	2.01A
0.50%	10.17	±	2.05cd	18.08	±	3.91ab	14.13	±	2.65B
0.75%	8.40	±	1.63d	18.90	±	2.39ab	13.65	±	2.68B
1.00%	5.70	±	0.44d	17.27	±	3.95abc	11.48	±	3.14B
Means	10.01	±	1.33B	19.45	±	1.49A			

Means sharing similar letter in a row or in a column are statistically non-significant (P>0.05).

It was observed that rose-ringed parakeets were influenced quickly by consuming maize seeds treated with caffeine and garlic oil. Parakeets displayed notable head-shaking and feather disrupting after few minutes of exposure and less consumption was observed in trial group, though some parrots ate gradually for about 25 minutes and sign of discomfort and vomiting were observed. However, throughout the study no death was observed.

The currents study disclosed that caffeine and garlic oil posses a repellent capability when maize seeds treated with caffeine and garlic oil were provided to rose-ring parrots in an aviary condition.

Discussion

The present study reveals that caffeine and garlic oil have the repellent capability when seeds of maize treated with both chemicals were provided to rose-ringed parakeet in captive conditions. In the first phase of experiment garlic oil was used as repellent and seeds of maize seeds when treated with garlic oil a highly significant difference (P≤0.01) was observed and the mean consumption (g) of maize seeds among trial and control group was (0.48±0.26) and (17.00±3.61) respectively. In the second phase of experiment the seeds of maize treated with the different concentrations of the caffeine were offered to parakeets, and highly significant variations was observed in trial and control group (P≤0.01). The mean consumption of maize seeds in trial and control group were (5.70±0.44) and (17.27±3.95) respectively. Moreover, it was observed that the lowest consumption (g) of maize seeds occurred when treated with 25% v/v garlic oil concentration (0.48±0.26) and with caffeine 1% w/v, it was (5.70±0.44). The present results were very much consistent with Avery *et al.* (2005), who observed the similar results with caffeine treated rice seeds against the blackbirds.

Avery *et al.* (2005) observed that a treatment of 0.25% caffeine on rice seeds reduced the consumption as much as 76%. During field experiments in Louisiana for the control of damage caused by the blackbirds on rice seeds treated with 1%they concluded that caffeine was highly effective. More than 90% of the caffeine treated rice seeds remained unconsumed when treated with 1% caffeine while greater than 80% untreated rice seeds were consumed by the blackbirds.

Similar results were also obtained 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 (*Agelaius phoeniceus*), Canada geese (*Branta canadensis*), Dickcissels (*Spiza americana*), ducks and feral pigeons (*Columba livia*) depredations to seeds significantly becomes suppressed (Avery *et al.,* 2001; Werner *et al.,* 2009; Esther *et al.,* 2013). Werner *et al.* (2009) also pointed out that anthraquinone is a typical escaping agent for the wild birds and so the birds can be repelled from the food items.

Numerous avian species like European starlings (*Sturnus vulgaris*), house sparrow (*Passer domesticus*), feral pigeons (*Columba livia*), red-winged blackbirds (*Algelaius phoeniceus*), common grackles (*Quiscalus quiscula*), brown-headed cowbirds (*Molothrus ater*), American kestrels (*Falco sparverius*), Canada geese (*Branta canadensis*), mallard (*Anas platyrhynchos*), cedar waxwings (*Bombycilla cedrorum*) and yellow headed black birds (*Xanthocephalus xanthocephalus*) also showed the same results and reduction occur in depredation when seeds treated with anthraquinone and methylanthranilate were provided to birds (Mason *et al.,* 1991b; Avery, 1992;Cummings *et al.,* 1992; Cummings *et al.,* 1994; Cummings *et al.,* 1998a; Cummings *et al.,* 1998b; Cummings *et al.,* 1998c; Nicholls *et al.,* 2000). Our study proved that caffeine and garlic oil has the potential to repel the bird pests as will.

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