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LABORATORY AND FIELD EVALUATION OF 4-AMINOPYRIDINE (AVITROL[R]) AS A BIRD REPELLENT IN BANGLADESH

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Abstract

The acute oral LD_{50} of 4-aminopyridine and the effective dose to elicit distress alarm calls were established in the laboratory on rose-ringed parakeets (*Psitticula krameri)*, a major pest bird of maize and sunflower in Bangladesh. The LD_{30} was found to be 3.0 mg/Kg and the effective dose was 10.0 mg/Kg. At this dose parakeets gave distress calls in an average of 15 min after dosing. Spraying of ears at milk stage in the field with 2% and 4% 4-Aminopyridine solution just once before harvest caused 66 to 93% reduction in damage to maize ears at harvest when compared to that of the nearby untreated plots. Even though 4-aminopyridine is expensive, the amount required per maize ear is inexpensive and development of techniques to utilize this material in the field appear worthwhile.

Introduction

Maize is a relatively new food crop in Bangladesh. At the "milk" stage of maturity, it is attacked by rose-ringed parakeets *(Psitticula krameri)*, jungle crows *(Corvus macrorhynchos)* and other birds, with observed damage ranging from 10 - 22% crop loss. Since parakeets and crows travel and feed in social flocks, it is possible to use a distress-producing chemical, 4-aminopyridine (4-AP) to frighten them away from food crops. 4-AP has a long history of having been used against a variety of bird pests (Goodhue and Baumgartner, 1965 : De Grazio *et al*, 1971. and 1972 : Stickley *et al.*, 1972 : Besser, 1976 ; Mott, 1977 Wornecki *et al.*, 1978) but most particularly against blackbirds attacking corn (maize), sunflower, sorghum, and sprouting rice in the United States (Besser, 1978). It has also been used in Uruguay in attempts to protect corn and sunflower from attack by monk parakeets *(Myiopsitta monachus)*, with more effectiveness in corn than in sunflower (Besser, 1978).

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4-AP was discovered to act by causing birds (in this case, house sparrows) to become disoriented and to emit distress calls (Goodhue *et al.*, 1964). The affected birds sometimes give distress calls while ascending in circular flights, often to heights of 150 m or more, and these actions frighten away other members of flocking species : gregarious birds, eg. brown-headed cowbirds *(Molothrus ater)*, starlings *(Sturnus vulgaris)*, common crows *(Corvus brachyrhnchos)*, and herring gulls *(Larus argentatus)* also gave distress display flights after ingesting 4-AP treated baits.

The objectives of the present study were to evaluate the actute oral LD_{50} and ED_{50} (effective dose to elicit distress symptoms) doses of 4-AP to rose-ringed parakeets and to attempt to protect experimental maize plots from damage by this species. Our long-range goal is to develop cost : effective and inexpensive methods of protecting maize from bird damage that can be used by small-scale farmers in Bangladesh.

Materials and Methods

4-AP was given to parakeets by stomach gavage in solution in propylene glycol. After dosing, parakeets were caged individually and given food and water. They were observed closely for the next 6 h and initial symptoms of immobilization, emission of distress calls and time to death were recorded. Generally 6 birds were dosed at each level and doses were halved or doubled, depending upon the observed reactions and resulting mortality of the initial dose.

Replicated field trials of 4-AP were carried out at the agricultural research farm located 10 Km north of Dinajpur. Maize plots at this farm were severely attacked by parakeets in all seasons. The first trial was set up with 6 plots per treatment and 3 replications. Each plot measured 4 × 5 m. Five maize ears per plot were exposed by pulling back the husks and then they were sprayed with either 3 or 4% 4-AP dissolved in acetone. The spray was applied with a hand-pumped spray bottle. The maize ears were tagged and left on the stalks for 2 weeks until harvest. At harvest each plot was assessed for damage by sampling every 10th ear and recording the commulative lengths in cm of (1) all kernel rows on each ear, and (2) the damaged portions (Granett *et al.* 1974). Damage, measured by this method is hereafter referred to as "row-cm damage".

In the second replicated trial, run at the same field station, larger, plots measuring 12 × 16m were used. The same spraying procedure was followed as before, but 4-AP was dissolved in ethanol at 2 and 4% concentrations. Spray

bottles were calibrated for amount delivered per 5 pumps in order to calculate the dose applied to each maize ear. In this trial 10 ears were exposed on the outer rows of each plot within a larger field. Treated ears were tagged and left in place until harvest 24 days after spraying. At harvest every 10th ear was picked from each row in each plot. Damage was recorded as row-cm damage. Differences between treatments and replications were assessed with ANOVA.

Results and Discussion

LD_{50} and ED_{50} determinations : The observed results of the bioassay of 4-AP when given by stomach gavage to rose-ringed parakeets are detailed in Table 1. The acute oral LD_{50} was calculated to be 3.0mg/Kg for parakeets. The effective dose to elicit distress calls is 10.0mg/Kg, which produced calls in an average of 15 min after dosing. These are the first reports for this species.

Table 1. Effect of 4-aminopyridine on rose-ringed parakeets when given by stomach gavage

Dose (mg/Kg)	Mean body weight (g)	Mortality	Time (min) First distress call	Death
1.25	103	0/3	None	—
2.50	116	0/6	None	—
3.75	132	3/3	53	83
5.00	118	6/6	39	63
10.00	105	3/3	15	38
20.00	111	3/3	12	20

Field trials in maize plots : The summarized row-cm damage to the 4-AP treated maize plots expressed as percentages for the first field trail run in June are given in Table 2. ANOVA indicated that the two treatments both were significantly different (at the 1% level) from the reference plots on all replicates. The reduction in damage with 3% 4-AP was 88% and that of 4% was 92.6% of the untreated references.

Summary results for the second trial run in October are given in Table 3. ANOVA again indicated that the treatments differed significantly (at the 1%

Table 2. Observed percent damage (cm-rows) to maize ears treated with 4-aminopyridine by rose-ringed parakeets at Dinajpur, June, 1982

Replication	Percent Damage			Total
	3% 4-AP	4% 4-AP	Reference	
1	2.3	1.6	21.0	24.9
2	2.1	1.2	13.7	17.0
3	2.3	1.4	22.3	26.0
Total	6.7	4.2	57.0	67.9
Means	2.2	1.4	19.0	—

ANOVA :

SV	df	SS	MSS	Obs. F	Required F 5%	1%
Replication	2	16.04	8.02	1.2 NS	6.94	18.0
Treatment	2	590.25	295.12	44.11**	6.94	18.0
Error	4	26.78	6.69			
Total	8	633.07				

NS = Not significant, ** = Significant at 1% level

Table 3. Observed percent damage (cm-rows) to maize ears treated with 4'-aminopyridine by rose-ringed parakeets at Dinajpur, October, 1982

Replication	Percent Damage			Total
	2% 4-AP	4% 4-AP	Reference	
1	1.5	3.3	6.0	10.8
2	5.2	4.2	8.2	17.5
3	3.7	3.2	16.8	23.7
Total	10.4	10.6	31.0	52.0
Means	3.4	3.5	10.3	

ANOVA :

SV	df	SS	MSS	Obs. F	Required F 5%	1%
Replication	2	30.99	15.49	10.6*	6.94	18.0
Treatment	2	132.79	66.40	45.5**	6.94	18.0
Error	4	5.84	1.46			
Total	8	169.62				

* Significant at 5% level, ** Significant at 1% level

level) from the untreated plots. The reduction in damage on this trial was not as good as on the first. At 2% 4-AP spray it was reduced 67% and at 4% was reduced 66%. This lesser damage reduction may be due to the longer period that the maize was exposed to damage before harvest (14 vs 24 days).

During the second trial, other species of birds noted as being affected by the 4-AP included red-vented bulbuls (*(Pyenonotus cafer)*, Indian tree-pie *(Dendrocitta vagabunda)* and the rose-finch *(Carpodacus erythrinus)*. These birds were recovered within a few hours after the spraying, being found on the ground unable to fly but showing no other symptoms of poisoning and subsequently recovered.

Both these preliminary small-scale trials have indicated that spraying of selected perimeter maize ears (3 to 5 ears exposed per fiend side) has merit for more study and development. An improvement in method would be to expose maize ears on the first day and allow parakeets to feed freely all day, then remove them. On the second day, exuose fresh ears and spray with 4-AP solution. After this pre-baiting, parakeets should feed quickly on the treated ears (J. De Grazio, personal commn.). Secondly, a re-treatment 1 week or 10 days following the first should reduce damage even more. Of prime importance is to treat only ears in the 'milk' state of maturity.

The amount of 4-AP solution applied with 5 pumps on the Windex spray bottles used was found to be 3ml into each exposed ear. Using a 2% 4-AP solution this would deliver 60 mg of chemical per ear ; using 4% solution it would be 120 mg. This amount of spray goes onto approximately half the ear, since the husks are pulled back only part way to expose the kernels. A 110g parakeet would have to eat 1 to 2% of the exposed kernels on one ear to receive 10 mg /Kg at a 2% application or less than 1% when using the 4% spray. This should be ample to elicit the display light reaction. The cost of 4-AP in Bangladesh is about US$40.00 per pound. The cost of treatment for 20 maize ears (using a 2% spray) would be Taka 3·50 for the active ingredient. This suggests that the use of 4-AP could be economically feasible in Bangladesh.

These findings are encouraging enough to warrant further field testing and development of damage control methods. Field trials of 4-AP, methiocarb and copper oxychloride in maize will be done during the coming season. It has been learned also that the present stocks of 4-AP, have been found to under go severe degradation in storage and in the field, thus giving erratic control results (J. De Grazio, personal commn.), but that a stabilized salt, the hydrochloride has overcome these shortcomings. This new material will be used in future work.

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