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Repellency and toxicity of bird control chemicals to pest birds in Bangladesh

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Abstract. The acute oral toxicity of 4-aminopyridine and the repellency of methiocarb, trimethacarb and copper oxychloride were determined on: rock doves, *Columba livia*; rose-ringed parakeets, *Psittacula krameri*; house sparrows, *Passer domesticus*; and white-backed munias, *Lonchura striata*, common pest birds to crops in Bangladesh. Methiocarb was the most repellent, and copper oxychloride was the least repellent, of the compounds. The chemical 4-aminopyridine was extremely toxic to all species, with doves being the most susceptible (LD_{50} = 2·5 mg/kg) and the house sparrow being the least susceptible (LD_{50} = 4·2 mg/kg). The toxicity (LD_{50}) of methiocarb ranged from 3·5 mg/kg for munias to 14·1 mg/kg for sparrows. These data will permit a safer, more effective use of these chemicals to protect food crops from birds in Bangladesh.

Introduction

Birds damage several grain crops in Bangladesh. The most important pest birds to wheat are: rock doves, *Columba livia*; common mynas, *Acridotheres tristis*; pied mynas, *Sturnus contra*; house sparrows, *Passer domesticus*; and jungle crows, *Corvus macrorhynchos* (Poché *et al.*, 1980; Brooks *et al.*, 1982). The principal pest birds to maize are: rose-ringed parakeets, *Psittacula krameri*; and jungle crows. Small birds such as munias (mannikins) of the genus *Lonchura* (*L. striata* and *L. malacca*) and Baya weavers, *Ploceus philippinus*, also damage maturing millet, rice and sorghum. Sunflower is prone to attack by rose-ringed parakeets and jungle crows.

Chemical repellents have recently been used to protect field crops from pest birds (Crase and DeHaven, 1976; Poché *et al.*, 1980; Bruggers *et al.*, 1981; Brooks *et al.*, 1982; Bruggers *et al.*, 1984). Repellents generally are toxic chemicals used at concentrations that normally do not cause mortality. These concentrations vary among chemicals and bird species. Laboratory repellency tests provide comparative sensitivity data among species and sometimes permit prediction of initial field application levels. Toxicity and repellency data for bird control chemicals are essential to permit safe and effective field use.

Our objectives were to determine the sensitivity (repellency and toxicity) of four chemicals used in bird damage control to four species of birds (*C. livia*, *P. krameri*, *P. domesticus* and *L. striata*) that are pests to crops in Bangladesh. The chemicals we evaluated were Avitrol (4-aminopyridine), methiocarb (3, 5-dimethyl-4-(methylthio)phenyl methylcarbamate), trimethacarb (3, 4, 5- and 2, 3, 5-trimethylphenyl methylcarbamate) and copper oxychloride ($3Cu[OH]_2CuCl_2$).

Methods and materials

The test methods used to determine repellency in the laboratory were similar to those described by Shumake *et al.* (1976) and Shefte *et al.* (1982), with appropriate modifications for each species. Individually caged potential test birds were fed only wheat seed, rice or dehulled foxtail millet, depending upon the species tested, for 2–3 days. Daily food intake was recorded to assure normal food consumption. Birds had continuous access to water.

Wheat, rice or millet seed for the repellency tests was prepared by mixing the amount of chemical required to achieve the desired application level with water-moistened grain. Treated seed was then air-dried for several hours.

Individual birds were offered treated seeds in amounts approximating 2% of their body weight: doves—5·0 g wheat seed; parakeets—2·5 g rice; munias—0·3 g hulled foxtail millet seed; and sparrows—0·4 g rice seed. Food consumption was measured to the nearest 0·1 g on a torsion balance. Birds were offered their respective diet for an 18-h period. Remaining seeds were weighed, and birds that had consumed ≤50% of the amount offered were considered repelled. Treatment levels were spaced at one-half log steps above and below the initial level of 0·56% until all or almost no birds were repelled. Repellency indexes (R_{50}s) and 95% confidence limits (CL) were calculated by using the Thompson-Weil method (Thompson, 1948; Weil, 1952).

Test methodology for acute oral toxicity (LD_{50}) was based on that previously described by Shefte *et al.* (1982). Birds were gavaged with propylene glycol solutions of each chemical with the dose volume adjusted for the birds' weight. Munias and house sparrows were given an amount equal to 0·5% of their body weight; doves and parakeets were given amounts equal to 1% of their body weight. Munias and sparrows were gavaged using a microsyringe with a short length of polyethylene tubing attached to a hypodermic needle; a regular ball-tipped gavage needle was used for doves and parakeets. After dosing, birds were individually caged, provided with food and water, and observed for 6 h for signs of toxicosis and 48 h for mortality. From four to eight birds of each species were tested at each treatment level. Doses were raised or lowered by three tenths log steps, depending upon the mortality at the initial dose. LD_{50}s were calculated using the Thompson-Weil method.

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Table 1. R_{50} and LD_{50} of bird control chemicals to pest birds in Bangladesh

Chemical	Species	R_{50} (%) (95% CL)	LD_{50} (mg/kg) (95% CL)
Trimethacarb	Rock dove	0·11 (0·16–0·07)	67·3 (114–39·6)
	Rose-ringed parakeet	0·34 (0·48–0·23)	11·9 (20·2–7·00)
	House sparrow	0·22 (0·38–0·13)	33·6 (47·5–23·8)
	White-backed munia	0·14 (0·18–0·11)	23·8 (40·4–14·0)
Methiocarb	Rock dove	0·15 (0·24–0·10)	11·9 (20·2–7·00)
	Rose-ringed parakeet	0·18 (0·26–0·12)	7·07 (18·8–2·68)
	House sparrow	0·11 (0·18–0·06)	14·1 (23·1–8·66)
	White-backed munia	0·05 (0·09–0·03)	3·54 (5·77–2·17)
Copper oxychloride	Rock dove	0·41 (0·57–0·30)	ND[a]
	Rose-ringed parakeet	0·46 (0·66–0·32)	ND
	House sparrow	0·46 (0·66–0·32)	ND
	White-backed munia	0·46 (0·66–0·32)	ND
4-Aminopyridine	Rock dove	ND	2·50 (3·73–1·68)
	Rose-ringed parakeet	ND	3·02 (3·02–3·02)
	House sparrow	ND	4·20 (7·14–2·48)
	White-backed munia	ND	2·97 (4·26–2·08)

[a] Not determined.

Results and discussion

R_{50} values for trimethacarb, methiocarb and copper oxychloride are given in Table 1. Except for doves, all species were more sensitive to methiocarb than to trimethacarb. Munias were particularly sensitive to methiocarb. Methiocarb causes illness-induced, conditioned aversion in birds (Rogers, 1978), and as a consequence birds quickly learn to discriminate between treated and untreated seed (Rogers and Linehan, 1977). Trimethacarb is chemically similar to methiocarb and probably acts in a similar manner. Although copper oxychloride is less repellent to all species than methiocarb or trimethacarb, it is probably the most appropriate chemical for use in Bangladesh. Copper oxychloride is inexpensive and generally available in Bangladesh where it is used as a fungicide on potatoes. It has also been used for several years by wheat farmers in the Bogra District for protecting wheat sprouts from birds. Field trials at experimental research stations and in farmers' fields have demonstrated its repellency at a 1·2% applied rate (Brooks *et al.*, 1982). The present cost of treating 5 kg of wheat seed is about US $0·12, and seems to give a cost : benefit ratio ranging from 1 : 30 to 1 : 60 (Brooks *et al.*, 1982). Copper oxychloride may act in the same manner as cupric oxylate, a compound Schafer (1981) suggested birds detect through some unknown taste mechanism.

4-Aminopyridine was toxic to all species between 2·5 and 4·2 mg/kg (Table 1). These results were similar to those reported by Garrison *et al.* (1982) for several other species of munias (mannikins) and the tree sparrow, *Passer montanus*. The LD_{50} of 4-aminopyridine to rose-ringed parakeets was 3·0 mg/kg. At 5·0 mg/kg, parakeets gave distress calls at an average of 39 min after gavaging, while at 10 mg/kg distress occurs in an average of 15 min. All birds died at these dose levels. This response indicates that 4-aminopyridine could be useful for protecting maize and sunflower in Bangladesh from parakeet damage. Field trials are in progress to develop safe, effective and inexpensive application techniques for 4-aminopyridine in maize.

Methiocarb LD_{50}s were consistent with those reported by Schafer *et al.* (1973) and Shefte *et al.* (1982) for other species of finches, weavers and the house sparrow. The LD_{50} of 11·9 mg/kg for doves may partially explain heavy mortalities during trials in farmers' fields when methiocarb was applied to wheat at 0·5% (Brooks *et al.*, 1982). Doves feed extensively on exposed wheat seed, eating from 5 to 10 g per feeding. At 0·5%, individual birds could ingest a dose of 100–200 mg/kg methiocarb; we observed 100% mortality at gavaged doses of 40 mg/kg. We have since used methiocarb at 0·25% without any reports of dove mortality.

Trimethacarb was considerably less toxic to all species and especially to doves and white-backed munias. However, it is not yet available in Bangladesh.

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