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Toxicity of 16 Granular Insecticides to Wild-caught Songbirds

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Granular insecticides are formulations composed of small particles (approximately 10 - 50 mesh) that typically contain 10 to 20 percent pesticide by weight. These products are used widely on corn, cotton, rice, soybeans, sorghum, sugarbeets and other crops in the United States. Field corn is the most heavily treated crop; 1980 use in major growing areas (89% of U.S. acreage) included 4.2×10^6 kg active ingredient (a.i.) terbufos (Counter 15G), 4.0×10^6 kg a.i. carbofuran (Furadan 10G), 3.2×10^6 kg a.i. fonofos (Dyfonate 10G and 20G), and 1.6×10^6 kg a.i. phorate (Thimet 15G) (Hanthorn et al. 1982).

Many insecticides highly toxic to birds (LD_{50} < 20 mg/kg) have been formulated as granules. Although product uses typically require soil-incorporation or covering of granules, exposed granules will occur with currently used farm equipment (Erbach and Tollefson 1982). Thus it seems likely that birds feeding in treated fields will routinely have the opportunity to consume granules. Moreover, field studies of granular carbofuran, the only granular product extensively monitored, have consistently shown mortalities among small birds resulting from routine applications (Flickinger et al. 1980, Overgaard et al. 1983, Balcomb 1983, Balcomb et al. 1984).

The objective of this study was to determine the toxicity of graduated doses (1, 5, 10, 20 and 40 granules) of commonly used granular products to house sparrows (Passer domesticus) and red-winged blackbirds (Agelaius phoeniceus). The potential for field kills of many species may be a function of the number of granules required to kill them.

METHODS AND MATERIALS

Wild-caught adult house sparrows and red-winged blackbirds were banded and maintained in sheltered outdoor cages (4x3x3m). Birds were conditioned to captivity for at least two weeks prior to testing. Water, turkey starter mash and a mixed wild bird seed

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were available ad libitum.

Granules were selected from samples of formulated product supplied by the manufacturers. Doses were prepared by placing granules in Lilly No. 5 gelatin capsules. Capsules were lubricated with glycerine and orally administered with forceps. Birds were randomly assigned to each treatment level. Controls received empty capsules. Survival was monitored for the first 3 hours after dosing and daily thereafter for one week.

To determine granule weights 3 (<100 mg) samples were drawn from each product with a small spatula. Samples were weighed on a Mettler Model AC 100 digital balance, granules counted and arithmetic means computed. Grand means and 95% confidence intervals for each product were based on the 3 sample means (Table 1).

Statistical analyses were done with SAS procedures CORR (Pearson product-moment correlation), PROBIT, and TTEST (SAS Institute Inc., Box 8000, Cary, NC 27511) on an IBM 370 computer.

RESULTS AND DISCUSSION

Single granules of 6 of the 16 products tested resulted in mortality in at least one species (Tables 2 and 3). Single granules of Dasanit, Furadan and Temik caused mortality in both house sparrows and red-winged blackbirds. Least toxic were the formulations

Table 1. Identification and mean granule weights for the products tested.

Trade Name	Percent Active Ingredient	Chemical Name	Mean granule Weight (mg) & 95% C.L.	
Abate	4	Temephos	0.078	0.063-0.092
Amaze	15	Isofenfos	0.089	0.050-0.129
Counter	15	Terbufos	0.098	0.049-0.146
Dasanit	15	Fensulfothion	0.079	0.063-0.096
Diazinon	14	Diazinon	0.331	0.181-0.482
Di-syston	15	Disulfoton	0.083	0.050-0.116
Dyfonate	20	Fonofos	0.176	0.106-0.245
EPN	4	EPN	0.084	0.071-0.096
Furadan	10 (sample 1)[a]	Carbofuran	0.575	0.519-0.631
	10 (sample 2)[b]		0.379	0.353-0.404
Lorsban	15	Chlorpyrifos	0.069	0.067-0.070
Mocap	10	Ethoprop	0.051	0.038-0.063
Nemacur	15	Fenamiphos	0.087	0.058-0.116
Parathion	10	Parathion	0.083	0.060-0.105
Tattoo	10	Bendiocarb	0.559	0.523-0.596
Temik	15	Aldicarb	0.474	0.449-0.498
Thimet	15	Phorate	0.092	0.079-0.104

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[b]Received April 1982

Table 2. Percent mortality in house sparrows dosed with granular insecticides. Five birds were tested at each concentration[a] except as noted.

	Number of Granules			
Product	1	5	10	20
Furadan 10G (sample 1)	100[b]			
(sample 2)	80			
Dasanit 15G (Trial 1)	83[b]			
(Trial 2)	60	100		
Temik 15G (Trial 1)	83[b]			
(Trial 2)	40	80		
Tattoo 10G	60	80		
Diazinon 14G	40	80	80	
Dyfonate 20G	0	60	100	
Nemacur 15G	0	40	80	
Counter 15G	0	0	40	
Mocap 10G			20	40
Di-syston 15G	0	0	20	20
Lorsban 15G			20	20
Parathion 10G	0	0	20	
Thimet 15G	0	0		
EPN 4G			0	0
Abate 4G				0

[a]Approximately equal numbers of males and females.
[b]Six birds tested.

Table 3. Percent mortality in red-winged blackbirds dosed with granular insecticides. Five birds were tested at each concentration.

	Number of Granules				
Product	1	5	10	20	40
Dasanit 15G[a]	80	80			
Temik 15G[a]	40	80			
Diazinon 14G[a]	0	100			
Furadan 10G[a]	20	80			
Thimet 15G[b]	0	60	80		
Nemacur 15G[a]	20	40	60		
Tattoo 10G[b]	0	20	100	100	
Counter 15G[b]	0	0	100	80	
Dyfonate 20G[b]	0	20	20	80	
Amaze 15G[b]	0	0	0	40	
Di-syston 15G[a]			0	20	
Lorsban 15G[b]			0	0	
Mocap 10G[b]		0	0	0	
EPN 4G[a]					0
Abate 4G[b]					0

[a]Approximately equal numbers of males and females.
[b]Males only.

of EPN and Abate which caused no mortality at doses up to 40 granules. All other products showed some mortality at doses of 5 to 20 granules.

Onset of symptoms of anticholinesterase poisoning (Tucker and Crabtree 1970) and death were rapid. Three of the pesticides tested were carbamates (Furadan, Tattoo, and Temik), the others were organophosphate compounds. Time to first death was shortest for the carbamates (red-winged blackbirds: Tattoo = 9 minutes, Furadan = 12 minutes, Temik = 15 minutes; house sparrows: Tattoo = 9 minutes, Furadan = 14 minutes, Temik = 18 minutes). Among the organophosphates the dose-to-death interval was shortest for Nemacur and Dasanit (27 and 40 minutes, respectively, in house sparrows). Virtually all mortality (96%, 51 of 53 deaths) among birds dosed with carbamates occurred during the 3-hour observation period on the day-of-dosing. The organophosphate deaths were more evenly spaced between the day-of-dosing and the 24-hour check. For house sparrows 71% occurred within 3 hours of dosing with 18% more recorded at 24 hours (N = 44). In red-winged blackbirds 43% occurred within 3 hours with an additional 55% observed at 24 hours (N = 44). Mortality in control birds was low (7.9% [3/38] in house sparrows, 0% [0/31] in red-winged blackbirds) and none occurred within 48 hours of dosing.

Table 4. Comparison of granular product and technical LD_{50} values[a].

Chemical (Granular Product)	House Sparrows		Red-winged Blackbirds	
	Granular LD50	Technical LD50[b]	Granular LD50	Technical LD50[b]
Aldicarb (Temik 15G)	3.8	0.8	1.9	1.8
Carbofuran (Furadan 10G)			2.3	0.4
Diazinon (Diazinon 14G)	2.5	7.5	1.8	3.2
Fonofos (Dyfonate 20G)	5.2	13.3	7.2	10.0
Phorate (Thimet 15G)			1.0	1.0[c]
Fensulfothion (Dasanit 15G)	0.3	0.3		
Ethoprop (Mocap 10G)	4.8	4.2		

[a]All values are mg a.i./kg body weight. Active ingredient dosage for granular products was estimated from mean granule weights and nominal pesticide concentrations. LD_{50} calculations were by probit analysis with the exception of Dasanit and Diazinon (red-winged blackbird trial) which were by graphical extrapolation.

[b]Schafer and Brunton 1979, except as noted.

[c]Schafer 1972.

Our granular assays were not designed for the purpose of calculating LD_{50} values. However, to test the assumption that lethality of granules is a direct function of the toxicity of the technical pesticide, the weight of the granule and the percent active ingredient of the formulation, we calculated LD_{50}s (as mg a.i./kg body wt.) where dose-response data permitted. These values were compared to published LD_{50} values based on technical grade pesticide (Table 4). Results indicate that LD_{50}s estimated from the granular products are not significantly different from those determined with technical material: (1) a paired t-test of technical and granular forms indicated LD_{50} differences are not significant ($P > t = 0.29$), (2) granular and technical values are significantly correlated (Pearson product-moment correlation [r] = 0.72, $P > r = 0.02$). We appreciate that these comparisons are approximate but they suggest that mathematical extrapolations of granular product toxicity from technical LD_{50}s, which are much more frequently reported, are probably accurate enough for preliminary estimations of hazard.

Using bobwhite (Colinus virginianus) Hill and Camardese (1984) compared the toxicity of granular and technical forms of 13 of the pesticides we tested. Their testing showed that granular and technical LD_{50}s are often equivalent (5 of 13 comparisons) but that when significant differences occur the granular formulations were less toxic (8 of 13) than technicals. Differences were not usually great; in 11 of 13 comparisons granules were 50 to 100% as toxic as technicals. Based on their testing with 200 g bobwhite these authors predict that 1 to 5 granules of Dasanit, Diazinon, Dyfonate, Furadan, Nemacur and Temik are likely to be lethal to smaller, sparrow-sized species. Our testing confirms this prediction (Table 2); however, the high toxicity we observed for Tattoo (bendiocarb) in house sparrows, that was not apparent in bobwhite, demonstrates the unpredictability of differences in species sensitivity and the need to use all toxicity extrapolations cautiously. As many factors will contribute to actual hazards, field studies of granular applications are probably necessary for final judgments concerning the acute hazards of most of the pesticide products considered here.

For small birds that forage for food and grit on the soil surface and that may pick up exposed granules, the number of granules required to cause death may be an important indicator of potential hazards. Products for which single granules are lethal clearly leave little margin for safety. The mortality results in Tables 2 and 3 have been arranged in approximate toxicity-rank order (most to least toxic). We believe these rankings may correlate with field hazards of granular products, when use patterns are similar, for small species that may directly pick up granules.

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