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Avian use of rice-baited corn stubble in east-central South Dakota

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Abstract

Blackbirds (Icteridae) cause substantial damage to ripening sunflower (*Helianthus annus*) in the northern Great Plains. One management option to reduce damage is to bait spring-migrating blackbirds with the compound DRC-1339 (3-chloro-*p*-toluidine hydrochloride). In March and April 1994 and 95, we evaluated nontarget risks associated with use of DRC-1339-treated rice baits broadcast in fields of corn stubble in east-central South Dakota. In 1994, we counted 159 nontarget birds during 105 15-min observations in rice-baited and unbaited plots. In 1995, 178 nontarget birds were recorded during 816 1-min periods. We detected no difference in granivorous bird abundance between rice-baited and unbaited plots in either year (P's $\geqslant 0.05$). Of the 15 identified nontarget species, meadowlarks (*Sturnella* spp.) and ring-necked pheasants (*Phasianus colchicus*) probably are most at risk because of their high susceptibility to DRC-1339. Prebaiting blackbirds into small plots placed away from field edges and diluting bait with untreated rice might mitigate nontarget losses.

Keywords: Avicide; Bait preference; Cornfields; DRC-1339; Nontarget birds; Red-winged blackbirds; South Dakota; Sunflower

1. Introduction

Red-winged blackbirds (*Agelaius phoeniceus*), common grackles (*Quiscalus quiscula*), and to a lesser extent, yellow-headed blackbirds (*Xanthocephalus xanthocephalus*) forage in sunflower crops in the northern Great Plains from mid-August until sunflower harvest in October (Linz and Hanzel, 1997). Direct economic losses from blackbird damage averaged \$5.1 and \$7.9 million in 1979 and 80, respectively (Hothem et al., 1988). Red-winged blackbirds cause the most damage because of their abundance throughout the northern Great Plains (Nelms et al., 1999) and their strong dietary preference for sunflower (Homan et al., 1994). With few exceptions, nonlethal damage abatement techniques have been rejected by growers because of poor efficacy, negative cost-benefit ratios, and difficult logistics (Linz and Hanzel, 1997). Presently, mechanical scare devices (e.g., propane boomers) and management of dense cattail-dominated (*Typha* spp.) wetlands used by roosting blackbirds are the principal nonlethal means of protecting sunflower (Linz and Hanzel, 1997). Despite the intensive use of these techniques, 26% of North Dakota's sunflower growers annually report crop losses >10% (Lamey et al., 1993).

The apparent successful use of the compound DRC-1339 (3-chloro-*p*-toluidine hydrochloride) for protecting sprouting rice (Glahn and Wilson, 1992) prompted sunflower producers to seek the expanded use of DRC-1339 for baiting blackbirds in the northern Great Plains (Linz and Homan, 1998). Linz and Bergman (1996) assessed the efficacy of DRC-1339-treated rice applied in ripening sunflower and found that blackbird damage was not reduced. Thus, research has turned to baiting spring-migrating blackbirds, particularly red-winged blackbirds, as they near the sunflower growing areas of northern South Dakota and North Dakota. Millions of red-winged blackbirds migrate into east-central South Dakota and congregate in large roosts before moving to northern breeding grounds (Knittle et al., 1996; Otis et al., 1986), providing an opportunity to bait these birds before they nest.

Nontarget birds also are present in east-central South Dakota during peak red-winged blackbird migration from late March to mid-April (Linz et al., 1995). Some of these species are granivorous and therefore could be attracted to plots baited with brown rice. The purpose of this study was to evaluate the potential hazard to nontarget birds from spring application of DRC-1339-treated rice in the northern Great

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Plains. Our objective was to compare nontarget bird use of rice-baited plots and unbaited (reference) plots placed in fields of corn stubble.

2. Study area

East-central South Dakota lies in the Coteau des Prairies physiographic region. Also called the 'Prairie Pothole Region', it is characterized by low, rolling hills interspersed with wetlands (South Dakota Geological Survey SDGS, 1989, South Dakota Ornithologists' Union SDOU, 1991). Temperatures range from $\leqslant -18^{\circ}$C in winter to $\geqslant 38^{\circ}$C in summer. Average annual temperature is 8°C. Precipitation may vary widely between years, averaging 56 cm (South Dakota Agricultural Statistical Service SDASS, 1999). Most of the region has been converted from tall-grass and mixed-tall grass prairie to crop and livestock agriculture (South Dakota Ornithologists' Union SDOU, 1991). Corn, soybeans, and wheat dominate the planted crops (South Dakota Agricultural Statistical Service SDASS, 1999). Wooded corridors are associated with rivers that run through the state. Woodlots and shelterbelts have been planted in residential areas and around farmsteads.

3. Toxicology of DRC-1339

In the 1960s, the US Fish and Wildlife Service developed DRC-1339 to control starlings (*Sturnus vulgaris*) at feedlots (DeCino et al., 1966). Its use was later expanded to include baiting of blackbirds, crows, ravens, magpies, and gulls (US Department of Agriculture USDA, 1994). The LD_{50}'s for these species are between 1 and 10 mg/kg, which allows a toxic dose to be placed on a single rice bait. Acute oral toxicity tests indicated that there may be differential toxicity among taxonomic families of birds (Schafer et al., 1983; Schafer and Bowles, 1985). These studies, representing the best available science, show that most raptors, sparrows, and finches and mammals, are less susceptible to DRC-1339 (LD_{50}'s > 100 mg/kg) than waterfowl (LD_{50}'s 10–100 mg/kg), and doves, galliformes, and owls (LD_{50}'s < 20 mg/kg) (Eisemann et al., 1999; US Department of Agriculture USDA, 1994).

The mode of action of DRC-1339 in highly susceptible birds is irreversible kidney and heart damage causing death from 24 to 72 h following ingestion. In less susceptible birds, the central nervous system is depressed, and 10–100 times more DRC-1339 is needed to cause death, which occurs after 2–10 h (Felsenstein et al., 1974).

DRC-1339 is metabolized and excreted within 30 min, accounting for low residues in poisoned birds (Johnston et al., 1999). DRC-1339 is not accumulated in the body; thus the compound's residues are $\leqslant 0.1$ ppm when death occurs. Repeated exposure to sublethal doses of DRC-1339 can result in death (Schafer et al., 1977). However, DRC-1339 does not appear to affect reproduction except at levels very close to where toxicity is expressed (Schafer et al., 1977). Finally, DRC-1339 degrades rapidly in the environment, with a half-life of 25 h under normal conditions of light and humidity (US Department of Agriculture USDA, 1994).

4. Methods

4.1. 1994

In mid-March, we selected 16 cornfields $\leqslant 5$ km from 4 blackbird roosts in Codington, Clark, Miner, and Lake counties in South Dakota. We placed three 100×100-m plots in each of the 16 fields. Eight fields were randomly designated to receive untreated brown rice and the other fields were unbaited and served as references. In the baited fields, an all-terrain vehicle was used to broadcast 56 kg of brown rice. The plots were placed so that bait lanes were $\geqslant 100$ m apart and $\geqslant 25$ m away from shelterbelts or woodlots. The bait lanes were perpendicular to the roads from which our observations were taken.

From 29 March to 21 April, we used binoculars to scan the three plots in each field for 5 min each from stationary vehicles. We divided daylight hours into 2 time periods of equal length; the first observation began 0.5 h after sunrise and the last observation ended at 0.5 before sunset. Fields were observed in random order.

4.2. 1995

In mid-March, we established paired 0.8-ha plots 50–100 m apart in six fields of corn stubble. Each field was $\leqslant 1.2$ km from a roost. One plot in each pair was initially baited with untreated brown rice; the other served as an unbaited reference. Treated fields were rebaited every 7–10 days. From 23 March to 23 April, we used binoculars to scan the paired plots from a stationary vehicle parked $\geqslant 25$ m from the plots. Observation periods lasted 1 h with 1-min counts made on each plot every 5 min. We divided daylight hours into three equal periods. The first observation started within 30 min of the beginning of each time period. In both years, we did not count in winds $\geqslant 24$ km/h or if there was steady precipitation (Dawson, 1981).

4.3. Statistical analysis

Ring-necked pheasants and meadowlarks (scientific names of species in Table 1) were analyzed separately because of their known susceptibility to DRC-1339; other species were grouped according to feeding ecology. For analysis of 1994 data, we combined our three separate 5-min observation periods into one 15-min period because of the scarcity of birds in the plots. For 1995 data, we compared activity on an hourly basis and assumed bird

Table 1
Birds, excluding blackbirds, observed in harvested cornfields in east-central South Dakota during March and April 1994 and 1995

Common Name	Scientific name	Year 1994[a] ($n = 159$) percent	1995[b] ($n = 177$) percent	Mean percent
Ring-necked pheasant	*Phasianus colchicus*	11.9	34.3	23.1
American robin	*Turdus migratorius*	15.0	9.5	12.2
House sparrow	*Passer domesticus*	23.9	0.0	12.0
American tree sparrow	*Spizella arborea*	15.7	1.1	8.4
Unidentified species	Aves	3.2	10.7	7.0
Killdeer	*Charadrius vociferus*	8.3	3.9	6.1
Canada goose	*Branta canadensis*	0.0	10.7	5.4
Mallard	*Anas platyrhynchos*	4.4	4.5	4.4
Northern flicker	*Colaptes auratus*	1.3	7.3	4.3
Unidentified sparrows	Emberizidae	6.3	1.7	4.0
Meadowlark	*Sturnella spp.*	4.4	3.4	4.4
Downy woodpecker	*Picoides pubescens*	0.6	5.6	3.1
Dark-eyed junco	*Junco hyemalis*	0.0	4.5	2.2
Green-winged teal	*Anas crecca*	0.0	1.1	0.6
Horned lark	*Eremophila alpestris*	1.3	0.0	0.6
Song sparrow	*Melospiza melodia*	0.6	0.0	0.3
Unidentified waterfowl	Anatidae	0.6	0.0	0.3
Mourning dove	*Zenaida macroura*	1.9	1.1	1.5

[a] $n = 105$ 15-min observations.
[b] $n = 816$ 1-min observations performed at 12 consecutive 5-min intervals for 68 60-min periods.

activity in one plot did not affect bird use of the other plot. Wilcoxon 2-sample tests were used to compare numbers of granivores, insectivores, waterfowl, ring-necked pheasants, meadowlarks, and total nontarget birds in rice-baited and unbaited plots (Cody and Smith, 1997). We used χ^2 analysis to evaluate the null hypotheses that presence and absence of these species were similar between baited and unbaited plots (Cody and Smith, 1997). Significance was accepted for P-values $\leqslant 0.05$. A detailed analysis of the results on ring-necked pheasants was published elsewhere (Avery et al., 1998), we present some of these data here for completeness.

5. Results

5.1. 1994

We counted 159 nontarget birds, consisting of 12 different species, during 105 15-min observation periods; house sparrows (24%), American tree sparrows (16%), American robins (15%), ring-necked pheasants (12%), and killdeer (8%) accounted for 75% of the observations (Table 1). No differences in means were detected ($P \geqslant 0.05$) between rice-baited and unbaited plots for total nontarget birds, ring-necked pheasants, granivores, waterfowl, and meadowlarks (Table 2). Total nontarget birds, granivorous birds, ring-necked pheasants, waterfowl, and meadowlarks were present equally ($P \geqslant 0.05$) in rice-baited and unbaited plots, with ring-necked pheasants, meadowlarks, and waterfowl observed $\leqslant 10\%$ of the time. For unknown reasons, insectivores were more abundant and were present 20% more often in rice-baited plots than in unbaited plots ($P \leqslant 0.05$).

5.2. 1995

We counted 178 birds, representing 12 species, in 816 1-min observations ($n = 68$ 1-h periods); pheasants (34%), Canada geese (11%), and American robins (10%) accounted for 55% of the birds (Table 1). No differences in means were detected ($P \geqslant 0.05$) between rice-baited and unbaited plots for total nontarget birds, meadowlarks, insectivores, granivores, and waterfowl (Table 3). Presence of insectivores (15%), waterfowl (5%), granivores (5%), and meadowlarks (4%) was similar ($P \geqslant 0.05$) between rice-baited and unbaited plots. Ring-necked pheasants were more abundant and were present more often in unbaited plots than in rice-baited plots ($P \leqslant 0.05$).

For both years pooled, 5 day moving averages indicated that nontarget granivorous bird numbers peaked in mid-April then declined over the next 2 weeks; in contrast, numbers of insectivorous birds increased after 13 April and remained high until the end of the study in late April (Fig. 1).

6. Discussion

Our data show that the nontarget granivorous bird population peaks about mid-April, while large numbers of female red-winged blackbirds are still present in the study area (Barras, 1996). Thus, exposure and susceptibility of recommendation by the authors or the U.S. Department of Agriculture.

References

Avery, M.L., Kenyon, M.J., Linz, G.M., Bergman, D.L., Decker, D.G., Humphrey, J.S., 1998. Potential risk to ring-necked pheasants from application of toxic bait for blackbird control in South Dakota. Journal of Wildlife Management 62, 388–394.

Barras, A., 1996. Evaluation of the efficacy of DRC-1339 for reducing spring migratory blackbird populations. M.S. Thesis, North Dakota State University, Fargo, North Dakota.

Bent, A.C., 1962. Life Histories of North American Shore Birds. Dover Publ., Inc., New York.

Best, L.B., Whitmore, R.C., Booth, G.M., 1990. Use of cornfields by birds during the breeding season: the importance of edge habitat. American Midland Naturalist 123, 84–99.

Cody, R.P., Smith, J.K., 1997. Applied Statistics and the SAS Programming Language, 4th Edition. Prentice-Hall, Englewood Cliffs, NJ, USA.

Cummings, J.L., Glahn, J.F., Wilson, E.A., Davis Jr., J.E., Bergman, D.L., Harper, G.A., 1992. Efficacy and nontarget hazards of DRC-1339 baited rice baits used to reduce roosting populations of depredating blackbirds in Louisiana. US Department of Agriculture, Denver Wildlife Research Center, Bird Section Research Report No. 481.

Dawson, D.G., 1981. Counting birds for a relative measure (index) of density. in: Ralph, C.J., Scott, J.M. (Eds.), Estimating the Numbers of Terrestrial Birds. Study Avian Biology 6. Allen Press, Inc., Lawrence, Kansas, pp. 12–16.

DeCino, T.J., Cunningham, D.J., Schafer, E.W., 1966. Toxicity of DRC-1339 to starlings. Journal of Wildlife Management 30, 249–253.

Eisemann, J.D., Linz, G.M., Johnston, J.J., 1999. Nontarget hazard assessment of using DRC-1339 avicide to manage blackbirds in sunflower. American Chemical Society National Meeting, Pesticides and Wildlife, August 22–26, 1999, New Orleans, LA, pp. 197–211.

Fair, J.M., Kennedy, P.L., McEwen, L.C., 1995. Diet of nesting killdeer in North Dakota. Wilson Bulletin 107, 174–178.

Felsenstein, W.C., Smith, R.P., Gosselin, R.E., 1974. Toxicological studies on the avicide 3-chloro-4-methylaniline. Toxicology and Applied Pharmacology 28, 110–125.

Flickinger, E.L., King, K.A., 1972. Some effects of aldrin-treated rice on Gulf Coast wildlife. Journal of Wildlife Management 36, 706–727.

Glahn, J.F., Wilson, E.A., 1992. Effectiveness of DRC-1339 baiting for reducing blackbird damage to sprouting rice. Proceedings Eastern Wildlife Damage Control Conference 5, 117–123.

Homan, H.J., Linz, G.M., Bleier, W.J., Carlson, R.B., 1994. Dietary comparisons of adult male common grackles, red-winged blackbirds, and yellow-headed blackbirds in north central North Dakota. Prairie Naturalist 26, 273–281.

Hothem, R.L., DeHaven, R.W., Fairazl, S.D., 1988. Bird damage to sunflower in North Dakota, South Dakota and Minnesota, 1979–81. US Fish and Wildlife Technical Report 15, 11pp.

Johnston, J.J., Hurlbut, D.B., Avery, M.L., Rhyan, J.C., 1999. Methods for the diagnosis of acute 3-chloro-p-toluidine hydrochloride poisoning in birds and the estimation of secondary hazards to wildlife. Environmental Toxicology and Chemistry 18, 2533–2537.

Knittle, C.E., Linz, G.M., Cummings, J.L., Davis Jr., J.E., Johns, B.E., Besser, J.F., 1996. Spring migration patterns of male red-winged blackbirds (Agelaius phoeniceus) from two migratory roosts in South Dakota and Minnesota. American Midland Naturalist 136, 134–142.

Knutsen, G.A., 1998. Avian use of rice-baited and unbaited stubble fields during spring migration in South Dakota. M.S. Thesis, North Dakota State University, Fargo, North Dakota.

Lamey, H.A., McMullen, M.P., Berglund, D.R., Luecke, J.L., McBride, D.K., Zollinger, R.K., 1993. 1991 sunflower grower survey of pest problems and pesticide use in Kansas, Minnesota and North Dakota. North Dakota State University Extension Service Report No. 12. Fargo, North Dakota.

Lanyon, W.E., 1994. Western Meadowlark. The Birds of North America, No. 104. Academy of Natural Sciences, Washington, DC.

Linz, G.M., Bergman, D.L., Bleier, W.J., 1995. Birds associated with blackbird spring feeding sites in South Dakota. Prairie Naturalist 27, 11–15.

Linz, G.M., Bergman, D.L., 1996. DRC-1339 avicide fails to protect ripening sunflower. Crop Protection 15, 307–310.

Linz, G.M., Hanzel, J.J., 1997. Birds and sunflower. In: Schneider, A. (Ed.), Sunflower Science and Technology. American Society of Agronomy, Madison, Wisconsin, pp. 381–394.

Linz, G.M., Homan, H.J., 1998. Tracing the history of blackbird research through an industry's looking glass: the sunflower magazine. Vertebrate Pest Conference 18, 35–42.

Naugler, C.T., 1993. American tree sparrow. The Birds of North America, No. 37, Academy of Natural Sciences, Washington, DC.

Nelms, C.O., Otis, D.L., Linz, G.M., Bleier, W.J., 1999. Cluster sampling to estimate breeding blackbird populations in North Dakota. Wildlife Society Bulletin 27, 931–937.

Otis, D.L., Knittle, C.E., Linz, G.M., 1986. A method for estimating turnover in spring blackbird roosts. Journal of Wildlife Management 50, 567–571.

Sallabanks, R., James, F.C., 1999. American Robin. The Birds of North America, No. 462, Academy of Natural Sciences, Washington, DC.

Schafer Jr., E.W., Brunton, R.B., Cunningham, D.J., Lockyer, N.F., 1977. The chronic toxicity of 3-chloro-4-methyl benzamine HCL to birds. Archives of Environmental Contamination and Toxicology 6, 241–248.

Schafer, E.W., Bowles, W.A., Hurlbut, J., 1983. The acute oral toxicity, repellency, and hazard potential of 998 chemicals to one or more species of wild and domestic birds. Archives of Environmental Contamination and Toxicology 12, 355–382.

Schafer, E.W., Bowles, W.A., 1985. Acute oral toxicity and repellency of 933 chemicals to house and deer mice. Archives of Environmental Contamination and Toxicology 14, 111–129.

Smith, J.A., 1999. Nontarget avian use of DRC-1339 treated plots during an experimental blackbird control program in eastern South Dakota. M.S. Thesis, South Dakota State University, Brookings, South Dakota.

South Dakota Agricultural Statistical Service (SDASS), 1999. South Dakota Agricultural Statistics 1999. South Dakota Agricultural Statistics Service, Sioux Falls, South Dakota.

South Dakota Geological Survey (SDGS), 1989. Quaternary Geology of Northeastern South Dakota. South Dakota Geological Survey Guidebook #3. Sioux Falls, South Dakota.

South Dakota Ornithologists' Union (SDOU), 1991. The Birds of South Dakota, 2nd Edition. Northern States University Press, Aberdeen, South Dakota.

Trautman, C.G., 1982. History, ecology and management of the ring-necked pheasant in South Dakota. South Dakota Department of Game, Fish and Parks. Wildlife Research Bulletin No. 7. Pierre, South Dakota.

US Department of Agriculture (USDA), 1994. Animal Damage Control Program Final Environmental Impact Statement. Appendix P. Risk assessment of wildlife damage control methods used by the USDA Animal Damage Control Program. Washington, DC, pp. 194–210.