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Chemicals recently have been used to reduce bird damage in a variety of crops. One such chemical, 4-aminopyridine (4AP), first reported for this use by Goodhue, et al. (1964), was tested by De Grazio, et al. (1971, 1972) and was shown to be a safe, economical, and effective chemical for reducing blackbird damage to ripening field corn. Blackbirds ingesting 4AP emit distress cries and perform aerial displays that frighten other members of the flock from the field. An advantage of this method of reducing damage is that usually less than one percent of the blackbird flock ingest baits and become affected (De Grazio, et al., 1972).

A logical extension for the use of 4AP would be in preventing blackbird damage to ripening sweet corn. On 27 June 1974, the Environmental Protection Agency granted a permit (No. 11649-EXP-3G) to test the effectiveness of Avitrol FC Corn Chops-99[1] (cracked corn treated with 3 percent 4AP and diluted with untreated cracked corn at a 1:99 ratio) in reducing blackbird damage to this crop. This paper reports the results of a study conducted in 1974 to evaluate aerially-broadcast 4AP baits to protect ripening sweet-corn fields from blackbirds.

I am indebted to L. Baer and D. Stohr of American Fine Food, Inc., of Payette, Idaho, for providing data on field locations and history of bird damage, and to the many landowners who allowed me to use their fields. I acknowledge field assistance given by R. L. Martinez (Bureau of Plant Industry, Philippines), A. Ouattara (FAO trainee), and R. N. Smith (U.S. Fish and Wildlife Service). I thank coworkers of the Denver Wildlife Research Center--J. E. Peterson for analysis of the sweet-corn samples for 4AP residues; J. F. Besser and J. L. Guarino for assistance in planning this study; and A. H. Jones for review of the manuscript.

METHODS AND MATERIALS

Test Sites

Twelve irrigated sweet-corn fields under contract to American Fine Foods, Inc., were used in this test. The fields, ranging in size from 3.0 to 19.0 ha, were located from 3.2 km south to 8.8 km southeast of Weiser, Washington County, Idaho. The minimum distance between fields was 0.4 km. Sugar beets, onions, small grains, alfalfa, field corn, and other sweet corn were also grown in the area. Buttermilk Slough, a marsh roost 7.2 km southeast of Weiser, contributed most of the blackbirds that caused damage to the test fields. All test fields were within 4.0 km of this roost.

Baiting

Avitrol FC Corn Chops-99, supplied by the Avitrol Corporation, Tulsa, Oklahoma, was aerially applied in swaths by a Piper Pawnee aircraft to six, randomly-selected sweet-corn fields at 1.12 kg per hectare (1 1b. per acre), based on the total acreage per field. (Actually 3.36 kg per hectare, or 3 1b per acre, were applied to one-third of each field.) The bait swaths were approximately 10.7 m wide, and 21.3 to 24.4 m of untreated sweet corn were left between swaths. A 15.2-m strip was left untreated around the perimeter of each field.

A total of 17 baitings were required on the six treated fields, for an average of 2.8 baitings per field. In all, 212.3 kg of bait were applied to 66.4 ha. The first field was baited on 26 July and the last on 16 August. One field was baited four times, three fields three times, and two fields twice. Blackbird damage and baiting usually began about 10 days before harvest. Fields were initially baited at the first sign of blackbird damage and were re-treated immediately after any irrigation, or occasionally when baits were depleted by blackbirds. The interval between baitings was 2 to 5 days. Final irrigation of the fields was usually completed about 3 to 5 days before harvest. No measurable precipitation fell during the test period.

Evaluation

Damage surveys in the 12 test fields were conducted at normal crop harvest time. Fifteen, randomly selected appraisal plots, each consisting of 40 consecutive ears (600 ears total), were examined in each field. The amount of damage was determined by recording the number of bird-damaged ears and the greatest length of damaged corn (in centimeters) along a kernel row for each damaged ear. Data analyses, were performed on plot

values using a one-way analysis of variance with subsamples (Steel and Torrie 1960). The length and row width for each plot were also recorded. Since the plot lengths varied, damage data for each plot were projected to a per-hectare basis for comparison.

From 26 July through 18 August we estimated the number of blackbirds entering test field during 92 morning observations totaling 69.2 h. Each field was observed from 4 to 11 times. Similarly, 55 observations totaling 38.7 h were made in late afternoon between 26 July and 17 August, and each field was observed from 1 to 7 times. Observation periods lasted from 10 to 120 min and were made from sunrise to 1030 and from 1725 to dusk. Just before harvest, five percent of the rows in each treated field were systematically searched for target and nontarget species that might have been killed by the baiting.

Three ears and husks from each of two randomly-chosen damage appraisal plots in five treated (Fields No. 2, 3, 5, 7, and 8) and two untreated fields (42 ears total) were collected just before harvest, immediately frozen, and returned to the Wildlife Research Center at Denver for residue analysis by the method developed by Peterson (1975).

RESULTS AND DISCUSSION

Damage Reduction

Blackbirds, primarily Red-winged Blackbirds, damaged 1,283 ears and 6,056 cm of corn in survey plots in untreated fields and 400 ears and 1,670 cm of corn in plots in treated fields (Table 1). These differences were significant ($P < 0.05$). Blackbirds damaged an average of 3.4 times as many ears per hectare in untreated fields (15,564 ears) as in treated fields (4,561 ears) and an average of 3.9 times as many centimeters of corn per hectare in untreated fields (75,563 cm) as in treated fields (19,174 cm). Four of the six untreated fields received greater damage per hectare (based on number of ears and total length of damage) than the most heavily damaged treated field.

Blackbird numbers and damage in individual fields were generally variable. However, field No. 2 (treated) and Nos. 7 and 8 (untreated) were in the same general area and should have received similar damage. The number of ears damaged in plots in the two untreated fields was almost identical (349 and 353) but averaged almost four times greater than the number damaged in plots in the treated field (91).

Two varieties of sweet corn (Style Pack and Dominator) were included in this test. Cannery personnel had suggested that Style Pack was less susceptible to bird damage than Dominator. Style Pack was grown in the two untreated fields, where the greatest number of ears were damaged, but Donminator also sustained substantial damage in an untreated field (No. 9). Thus, there was no conclusive evidence that one variety was more susceptible to blackbird damage than the other.

Bird Observations

Most blackbirds causing damage in the test fields roosted at Buttermilk Slough. On 7 and 16 August there were an estimated 6,400 and 4,100 Redwings, respectively, and 10,000 and 9,100 Starlings (*sturnas valgaris),* respectively, roosting in the slough.

In general, blackbird observation data on test fields were not as reliable as damage data for determining the efficacy of the 4AP treatment. Biases, such as differences in the starting time of observation periods, may have influenced count data. Although Redwings were the primary species damaging sweet corn in this study, occasionally a few Yellow-headed Blackbirds (*xanthocephalus xanthocephalus)* and Brewer's Blackbirds *(Euphagus cyanocephalus)* also visited the test fields.

There was little difference between numbers of blackbirds entering treated and untreated fields. The average number of blackbirds entering each field per hectare per minute during morning counts was 6.9 blackbirds for each untreated field and 7.6 for each treated field (Table 2). However, if treated field No. 5 is excluded, an average of only 5.3 entered each treated field per minute. Field No. 5 was adjacent to Buttermilk Slough and was under one of the main flightlines of each morning's roost exodus. Blackbirds used it as a brief staging area daily. Most of these birds perched on the tassels for a short time, without feeding, and then departed.

Fewer birds visited either the treated or untreated fields in late afternoon. An average of 2.1 birds per minute entered each untreated field, and an average of 1.2 per minute entered each treated field.

A total of 12 4AP-affected blackbirds was noted in or over treated fields during this study. An additional unknown number was suspected as being affected, because a reaction of other blackbirds in a field was noted. On five occasions, flocks of blackbirds were observed leaving baited fields in apparent response to affected birds. Twelve dead blackbirds (10 Redwings, 1 Yellow-head, and 1 Brewer's) were found during dead-bird searches. Few nontarget species were seen in test fields, and none was found dead. Twenty California Quail (*Lophortyx californicus*) and several Lazuli Buntings *(Passerina anoena)* were noted in an untreated field, and a few Song Sparrows (*Melospiza melodia*) were seen in a treated field. A population of 100 or more House Sparrows (*Passer domesticus*) also visited the edge of a treated field.

Residue Samples

Sweet-corn ears that were collected for residue analysis contained from 0.02 to less than 0.01 ppm of 4AP, well within the 0.1 ppm permitted.

CONCLUSIONS

Blackbird damage to irrigated sweet corn in Idaho was significantly reduced by aerially broadcasting Avitrol FC Corn Chops-99. Hazards to nontarget birds were minimal.

As a result of data generated from this and similar studies, Federal Registration (EPA Registration No. 11649-12) for use of Avitrol FC Corn Chops-99 in field corn was amended to include sweet corn "(except sweet corn in the northeast and southeast United States, including the states of New York, Pennsylvania, West Virginia, Kentucky, Tennessee, Arkansas, and Louisiana)." Adequate efficacy data were not available for these areas.

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[1]Reference to trade names does not imply U.S. Government endorsement of commercial products.

Table 1. Blackbird damage to sweet-corn fields, Idaho, 1974

Field	Corn variety	Field size (ha)	No. of baitings	Total ears damaged			Total length of damage (cm)	
				On plots[a]	Per cent	Projected per hectare[b]	In plots[a]	Per hectare[b]
Treated								
1	Style Pk	16.2	3	140	23.3	8,307	409	24,216
2	Dominator	10.1	3	91	15.2	5,501	573	40,819
3	Style Pk	4.1	3	68	11.3	4,765	249	17,401
4	Dominator	12.1	4	50	8.7	4,463	260	20,773
5	Style Pk	4.9	2	45	7.5	3,078	166	11,402
6	Style Pk	19.0	2	4	0.7	254	7	436
Totals		65.4	17	405			1,670	
Means				67.7*	11.3	4,561*	278*	19,174*
Untreated								
7	Style Pk	10.7	-	353	58.8	24,026	1,733	123,707
8	Style Pk	3.0	-	349	58.2	28,130	1,427	103,332
9	Dominator	4.1	-	255	42.5	22,040	1,718	148,425
10	Style Pk	15.2	-	189	31.5	11,972	713	45,846
11	Style Pk	8.1	-	91	15.2	6,098	282	18,742
12	Dominator	4.1	-	46	7.7	3,315	103	13,326
Totals		45.2		1,283			5,056	
Means				213.8	35.7	15,564	1,009	75,563

[a]Damage for 600 ears examined per field (15 plots per field, 40 ears per plot).

[b]Based on size (length x width) of damage survey plots.

*Significantly different from untreated fields ($P < 0.05$).

Table 2. Blackbird numbers in test fields, Idaho, 1974

Field No.	Estimated numbers of blackbirds (average) Entering field per minute		Entering field per hectare per minute	
		Treated Fields		
	AM	PM	AM	PM
1	6.0	0.9	0.37	0.06
2	13.5	3.9	1.34	0.35
3	0.9	1.0	0.22	0.24
4	5.9	0.6	0.49	0.05
5	18.9	0.4	3.86	0.08
6	0.1	0.5	0.01	0.03
Average	7.6	1.2	1.05	0.14
		Untreated Fields		
7	11.6	5.5	1.08	0.51
8	2.2	0.8	0.73	0.27
9	19.8	5.3	4.83	1.29
10	2.8	0.7	0.77	0.04
11	0.7	0.1	0.09	0.01
12	4.5	0.0	1.10	0.00
Average	6.9	2.1	1.33	0.35