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by Jerome F. Besser and John W. De Grazio/1/

ABSTRACT

In 1984 4-aminopyridine baits, stabilized with hydrochloric acid, were appraised in ripening cornfields being attacked by blackbirds on the Sand Lake National Wildlife Refuge, South Dakota. In 1982, it had been discovered that 4-aminopyridine, the active agent in commercial Avitrol® baits for crop protection rapidly vaporized at summer storage and field baiting temperatures.

In July, baiting lanes were created in 12 cornfields by destroying every 55th row. In August after a 3-day pretreatment period, fields were baited with Avitrol® FC Corn Chops-99 for a 2-week period when corn was most vulnerable to damage. Bait was applied from baiting lanes at the rate of 1 lb/acre of field with an electric seeder mounted on an all-terrain cycle. Rebaitings were made at half the initial rate; 0 to 3 rebaitings were needed, largely because of depletion of baits by insects and rodents. An insecticidal pretreatment, 5% carbaryl pellets, did not significantly lower the rate of bait depletion. Blackbird damage was 87% less (P=<0.001) during the baited than the pretreatment period (19 vs 142 bu of corn lost per day). From 2,000 to 17,000 blackbirds, mostly red-winged and yellow-headed blackbirds, were observed in test fields.

An estimated 825 dead or affected blackbirds and 1 mourning dove were observed or collected in test fields.

Application of baits on baiting lanes with a seeder mounted on a cycle proved both economical and efficient. About 100 acres/h were baited at an estimated cost of <15 cents/acre/application. About $5:50 worth of corn was saved for each $1 spent for bait and loss of corn yield in baiting lanes. Growers would have saved about $400/h for time spent in creating lanes and baiting.

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INTRODUCTION

Bird damage to ripening corn accounts for the largest monetary loss of any bird problem in a single crop in the United States. In 1981, the nationwide loss of ripening corn was estimated at 13.4 million bushels worth $34.8 million (Besser and Brady 1982). Approximately 5.2 million bushels (39%) of this loss is estimated to occur in fields that incur more than 3 bu/acre loss (Besser 1983), perhaps the threshold for economically combating losses with the chemical frightening agent, 4-aminopyridine hydrochloride (4-AP HCl). If 4-AP HCl has the capability to reduce blackbird losses in high damage fields so that a 2:1 benefit-cost ratio is obtained, chemical frightening agents have the potential to save U.S. corn growers 2.6 million bushels of corn. At the November 1984 price of corn ($2.78/bu) this would represent an annual saving of $7.2 million.

Avitrol® FC-Corn Chops-99 /2/, the federally registered commercial product for protecting ripening corn from blackbirds, had acquired a reputation for poor performance in protecting ripening corn from bird damage in the 1970's. Recent studies have shown the major cause of this poor performance was rapid sublimation of 4-AP from treated baits at the high temperatures occurring during late summer (Besser 1982; Cunningham 1983). This shortcoming was corrected with the substitution of 4-AP HCl for the free base (4-AP) in 1983; that year 4-AP HCl baits afforded 92% protection in a South Dakota trial (Besser and Hanson 1985). These results were similar to the 85% protection obtained by De Grazio et al. (1972) in 1965 baiting trials in South Dakota. However, De Grazio et al. (1972) obtained a $9:$1 benefit-cost ratio during a full season of treatment, whereas Besser and Hanson (1985)

2. Mention of commercial products does not imply government endorsement.

obtained a $2.76:$1 ratio during a shorter 6-day test period, primarily because bait-feeding insects necessitated rebaiting frequently (sometimes daily) in the latter study. The purpose of the present study was to determine if the benefit:cost ratio of 4-AP HCl baitings could be improved through use of an insecticidal pretreatment and a longer (2-week) baiting period.

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METHODS

The study was conducted from 12 August to 13 September 1984 in 12 (6 pairs) experimental units in ripening cornfields planted on Sand Lake National Wildlife Refuge in Brown County, South Dakota (Table 1).

Units ranged in size from 9 to 28 acres. Two of the pairs of units were fields separated by strips of 100 yards of small grains. The other four pairs were obtained by splitting larger (1/2-mile long) fields of 20-31 acres. Baiting lanes were formed by removing a row of corn at 55-row (58-yd) intervals from all but one of the fields in July to facilitate bait application in August. In one field (#6), lanes were left unplanted.

When blackbirds began damaging milk-stage corn, sampling plots of 6 ft of corn row were randomly established in each pair of experimental units, by gridding each unit into 2.2 acre strata and randomly locating two plots in each stratum. Damage was assessed using measuring techniques and the empirical table developed by De Grazio et al. (1969). Simultaneously, 1 gallon can-traps were buried at three random locations in each experimental unit and half-filled with water to entrap and measure insect and rodent populations. In addition, 2 x 3 ft x 2-inch bird and rodent exclosures, made of 1/2-inch welded wire, were also established at three random locations in each experimental unit

Table 1. Acreages of six pairs of experimental units and test periods for Brown County, South Dakota test cornfields, 1984.

Experimental unit pair	Acres			Test period
	Control[a]	Treated[b]	Total	
1	13.1	15.3	[c]	11-28 August
2	26.2	28.3	[c]	14-31 August
3	13.1	17.4	30.5	18 Aug. - 4 Sep.
4	15.3	15.3	30.6	19 Aug. - 5 Sep.
5	8.7	10.9	19.6	20 Aug. - 6 Sep.
6	13.1	13.1	26.7	27 Aug. - 13 Sep.
Totals	89.5	100.3	189.8	

[a] Baited with 4-AP HCl only.

[b] Insecticide-treated and baited with 4-AP HCl.

[c] Two separate fields.

and 30 kernels of pearled barley were placed in each exclosure daily to measure insect removal of grain baits. Insects and rodents were removed daily from traps and bait removal from exclosures was determined daily throughout the (17-day) test period. Three days after the initial installation of traps, exclosures, and damage assessment plots, damage was reassessed on the original plots in each pair of units, and one unit was randomly chosen for insecticidal treatment. A 5% carbaryl bait, Hopkins 5% Sevin (pellets), was broadcast from baiting lanes at the rate of 0.5 lb/acre of field (4.5 lb/acre on a 19-ft wide swath) by means of an electric seeder (Herd, Co., Logansport, Indiana) mounted on a Honda Model 110 all-terrain cycle (ATC). The insecticide was usually applied late in the afternoon after birds had gone to roost. The following morning, usually between dawn and sunrise, before birds arrived at the field, 4.8% 4-AP HCl (3% 4-AP) 1:99 chopped corn baits were broadcast on both experimental units at the rate of 1 lb/acre of unit (9.0 lb/acre of swath). The amount of bait used and time spent baiting were recorded.

Insecticide-treated and control (4-AP HCl only) units were randomly observed for 10-minute periods between sunrise and 1000 h, and the peak number of blackbirds observed in the unit and adjacent (50 yards) cover were recorded each day during the test period. In addition, all units were observed for 1-h periods (from the time birds first entered the unit) the day of the first 4-AP HCl baiting, and as often as time permitted thereafter, to determine the number of affected birds and the speed of distress display actions and field clearance.

Units were rebaited with half the initial rate (0.5 lb/acre of field) of 4-AP HCl when more than 0.5 inch of rain fell. Portions of the field were also rebaited at this rate when less than 10% of the bait (<1 particle/12 ft^2) remained on any of 10 random 12 ft^2 locations in a 100-yard section of the baiting lane.

A third and a fourth damage assessment were made on both pairs of experimental units 1 and 2 weeks after baiting to determine loss of corn to birds during the baited period. A fifth assessment was made near harvest to determine post-test losses.

Baiting lanes were searched daily for dead birds. A final search of 3-5% of randomly chosen rows in the units was made at the end of the test to determine the ratio of target to nontargets killed. All intact dead birds were necropsied to determine the presence, size, and number of chopped corn bait particles in the gullet and gizzard.

Data obtained on bushels of corn lost to birds during the 3-day pretreatment and 14-day treatment periods and differences in insect numbers and remaining bait particles in enclosures were analyzed by paired t-tests (Snedecor and Cochran 1967). Differences in bushels of loss were divided by costs of baiting to arrive at a cost-benefit ratio.

RESULTS AND DISCUSSION

Efficacy of the Insecticide Treatment

Insecticide-treated units of 4-AP HCl-baited test fields lost 155.8 bushels of corn to birds during the 2-week treatment period, whereas control units lost only 107.0 bushels (Table 2). This 31.5% difference in loss had a low probability of being a real difference ($P = 0.46$). Despite the lack of a positive difference in corn loss to birds between insecticide-treated and control units, 39.4% fewer beetles (4.5 vs 7.5/trap/day, $P = <0.01$), the predominant order of insects taken in can traps, and overall 47.2% fewer insects (6.7 vs 12.7/trap/day, $P = 0.27$) were taken in insecticide-treated baiting lane swaths than in control units. These lower beetle numbers on insecticide-treated units did not result in a significant reduction in the daily removal of barley baits exposed in rodent and bird exclosures (46.0% vs 61.0% removed daily; $P = 0.15$) or in 4-AP HCl chopped corn baits (38.8% vs 40.2% removed daily; $P = <0.5$) in

Table 2. Bushels of corn (± SE) lost to blackbirds in 6 control (C) and 6 insecticide-treated (IT) experimental units, Brown County, South Dakota, 12 August - 13 September 1984.

Exp. unit No.	Pretreatment	Treatment
1-C	34.7 (±13.7)	15.6 (±6.8)
1-IT	45.0 (±18.2)	4.5 (±2.1)
2-C	53.3 (±6.7)	23.0 (±6.8)
2-IT	8.9 (±2.0)	55.8 (±5.9)
3-C	30.0 (±4.6)	2.3 (±0.6)
3-IT	49.9 (±11.1)	3.9 (±1.9)
4-C	22.6 (±7.8)	24.2 (±4.4)
4-IT	54.4 (±9.5)	15.3 (±6.0)
5-C	55.2 (±10.5)	32.5 (±9.5)
5-IT	32.4 (±8.5)	75.7 (±9.3)
6-C	36.9 (±11.6)	9.4 (±2.9)
6-IT	3.8 (±3.1)	0.6 (±0.3)
Total C	232.7	107.0
IT	194.4	155.8
C	38.8 (±5.3)[a]	17.8 (±4.5)[b]
IT	32.4 (±8.8)a	26.0(±13.0)[b]

[a] P = 0.37, 2-tailed t-test.

[b] P = 0.46, 2-tailed t-test.

insecticide-treated baiting swaths. Barley baits were replenished daily throughout the test whereas chopped corn baits were only added to the exclosures when broadcast baits landed in the exclosures when units were baited (or rebaited). Barley baits were deemed better for judging insect removal of baits because they were preferred by insects in preliminary tests (50.6% vs 31.7% removed daily) and because chopped corn bait particles could not always be distinguished with certainty from particles of corn occasionally dropped by blackbirds when they were feeding on ears of corn above the exclosures.

For evaluating insect abundance, cans half-filled with water were also deemed better than cans without water, because in a preliminary test, cans without water took more beetles than cans with water (58.5 vs 34.3/day). It appeared that the noise made by fighting and clamoring beetles, or perhaps the odor emitted by them, served to attract additional beetles to traps. Cans without water also allowed beetles to destroy crickets, leaving only exoskeletal fragments, and in one case allowed a fox to consume many beetles from a can.

Despite the large number of dead beetles and crickets observed on baiting lanes in insecticide-treated units throughout the 2-week treatment period, the amount of blackbird damage that occurred in insecticide-treated units indicated, and our observations confirmed, that the feeding patterns of most birds had been changed by the initial baiting before 4-AP HCl baits had been depleted by insects. The rate of bait disappearance in this study was less than that reported by Besser and Hanson (1985) in August 1983 in some test fields in this same area.

Disappearance of baits in South Dakota appeared to be caused more by ground beetles, chiefly *Harpalus erraticus*, a brown ground beetle, than black field crickets (*Gryllus assimilis*). Beetles taken in traps outnumbered crickets by 2.4:1 (3667 vs 1497). In Ohio, Woronecki et al. (1979) thought crickets largely responsible, but did not use traps to determine relative insect numbers. The 55 rodents taken in 648 trap-nights, including 46 plains pocket mice (*Perognathus flavescens*), suggest that rodents may also be important in the depletion of baits. The weight of rodents taken in can traps in this

study was approximately 45% of that of the insects taken.

Efficacy of 4-AP HCl Baits

Since corn losses to birds on insecticide-treated and control units were similar, data from all experimental units during pretreatment and treatment periods were combined to determine the efficacy of 4-AP HCl baitings. Test fields lost 427.1 bushels of corn to birds during the 3-day pretreatment period, or 142.4 bushels/day, whereas they lost only 263.8 bushels, or 18.8 bushels/day, during the 14-day 4-AP HCl baited period (Table 3). Test fields lost 86.8% less corn/day during the treatment period than during the pretreatment period (P =<0.001). Based on losses occuring during the 3-day pretreatment period on test fields, expected losses during the baited period would have been 1994.0 bushels. Observed losses were 263.8 bushels, or 1730.2 bushels less.

Bird Observations

The peak number of blackbirds damaging test pairs of experimental units ranged from 2000 (#3) to 16,500 (#5) during the 17-day test period (Table 4). Most of these peak populations were noted during the 1-h observational period following the initial baiting. Little was learned from the 10-minute observational periods other than that birds were usually absent from test fields during these periods, since 10 minutes is less than 2% of the time available for birds to feed during their approximately 13-h feeding day. Damage data and daily searches of baiting lanes were better indicators of the dates when species of blackbirds caused most damage in test fields. Of the 82 blackbirds seen affected or collected on baiting lanes 29 (35.4%) were noted the first day that a field was baited, and 61 (74.4%) were noted the first week (Table 5). Similarly, 65.2% of the 263.8 bu lost during the 4-AP HCl baited period occurred the first week that fields were baited.

Most of the damage was caused by red-winged blackbirds (Agelaius phoeniceus)

Table 3. Bushels of corn lost to blackbirds in 12 4-AP HCl baited, 6 control (C) and 6 insecticide-treated (IT), experimental units in Brown County, South Dakota, cornfields 12 August - 13 September 1984.

Exp. Unit No.	Pretreatment	Treatment
1-C	11.58	1.12
1-IT	15.01	0.32
2-C	17.78	1.71
2-IT	2.97	3.99
3-C	10.00	0.16
3-IT	16.64	0.28
4-C	7.55	1.73
4-IT	18.13	1.09
5-C	18.38	2.32
5-IT	10.81	5.41
6-C	12.29	0.67
6-IT	1.28	0.04
Total C	77.58	7.71
IT	64.84	11.13
Mean C	12.93[a]	1.29[a]
IT	10.81[b]	1.86[b]
Total C & IT	142.42	18.84
Mean C & IT	11.87[c]	1.57[c]

[a] P = <0.0001.

[b] P = 0.04.

[c] P = <0.001.

and yellow-headed blackbirds (Xanthocephalus xanthocephalus). Based on the observed kills and the proportion of the fields sampled, 825 blackbirds were estimated to have been killed by the baitings (Table 6). Of these, 432 (52.4%) were red-wings and 303 (36.7%) were yellow-heads, generally agreeing with the composition of species noted damaging corn during

Table 4. Peak blackbird numbers observed in 6 pairs of 4-AP HCl baited experimental units in Brown County, South Dakota, cornfields, 12 August - 13 September 1984.

Exp. unit pair	Pretreatment	Treatment
1	2,700	12,100
2	3,000	4,000
3	1,000	2,000
4	5,000	3,800
5	9,500	16,500
6	700	3,300
Totals	21,200	30,700

Table 5. Numbers of affected blackbirds seen and dead blackbirds collected by days after 6 pairs of 4-AP HCl baited experimental units were baited in Brown County, South Dakota, cornfields, 15 August - 13 September 1984.

Kills by day after first baited			
Day	No.	Day	No.
1	29	8	1
2	11	9	4
3	5	10	0
4	5	11	7
5	4	12	9
6	3	13	0
7	4	14	0
Subtotal	61	Total	82[a]

[a] Kill consisted of 45 red-winged blackbirds, 34 yellow-head blackbirds, 2 common grackles, and 1 brown-headed cowbird.

observational periods. Of the 78 red-wings and yellow-heads collected in fields and sexed, 64 (82.0%) were males, and of 74 red-wings and yellow-heads collected and aged, 72 (97.3%) were adults.

Particle Size of Baits Consumed by Blackbirds

Twenty-seven blackbirds (14 red-wings and 13 yellow-heads) were necropsied to determine the particle size of corn baits selected. Most food was only in the gizzard, but six birds had food in the gullet as well. Particles of corn in the gizzard were 13.1% smaller than those in the gullet. The mean weight of corn particles in the gizzard was 17.6 mg (± SD 10.7) for 3 yellow-head females, 11.8 mg (± SD 4.5) for 10 yellow-head males, 7.7 mg (± SD 2.9) for 12 red-wing males, and 4.9 mg (± SD 3.0) for 2 red-wing females. These data indicated that red-wings (and yellow-head males) were selecting the smaller sizes of the 22.3 (± SD 1.4) mg 4-AP baits exposed and breaking some of them before consuming them, since 8 mg was the smallest particle found in 300 particles of commercial baits sampled. These data confirm laboratory findings that red-wings break many large corn baits (Besser and Cunningham 1982; Mason et al. 1984) and similar field findings (Besser et al. 1984). Smaller-size chopped corn baits would probably perform better in protecting corn.

Hazards

One mourning dove (Zenaida macroura) was the only non-blackbird seen affected or found dead, giving an estimated target: nontarget kill ratio of 825:1. Although few nontargets were seen in most test fields, 20 ring-necked pheasants (Phasianus colchicus), mostly small young birds, were regularly seen on or near baiting lanes

Table 6. Target and nontarget birds found dead, seen affected, and collected in 6 pairs of 4-AP HCl baited experimental units in Brown County, South Dakota, cornfields, 15 August - 13 September 1984.

Exp. unit pair	Random row kill[a] RW[b]	YH[b]	GR[b]	CB[b]	Rows searched/ total rows	Extrapolated kill RW	YH	GR	CB
1	1	0	1	0	4/104	26	0	26	0
2	5	5	0	0	4/104 & 4/88	118	118	0	0
3	1	1	0	0	4/116	39	39	0	0
4	2	2	0	0	8/232	78	78	0	0
5	5	1	2	1	4/80	100	20	40	20
6	0	0	0	0	4/136	0	0	0	0
Subtotal	14	9	3	1		361	255	66	20
Killed on baiting lanes						26	12	1	0
Collected from or near baited fields[c]						45	36	1	2
Estimated total kill						432	303	68	22
Total target kill					825				
Total nontarget kill					1[d]				

Sex of blackbirds collected:

Species	No. males	No. females	Total
Red-wings	33 (32 adults)	10 (9 adults	43
Yellow-heads	31 (31 adults)	4	35

[a] Birds collected before final search excluded.
[b] RW = red-wings, YH = yellow-heads, GR = grackles, CB = cowbirds
[c] During 10.5 hours observation.
[d] Mourning dove, collected before final search.

in Field #5 during the test period; 19 of these were flushed on 6 September, while making the final treatment period survey. Schafer et al. (1975) have noted a possible hazard to young (7-week old) pheasants taking three or more 4-AP-treated corn particles in laboratory trials.

Cost Effectiveness

The cost of 4-AP HCl bait ($366.05) and loss of corn from installing baiting lanes ($502.98) for the 12 experimental units amounted to $869.03, or $4.58 per acre. The benefits (corn saved) were calculated to be $4,809.96, or $25.34 per acre (Table 7). Therefore, the benefit-cost ratio was $5.53:$1 (exclusive of equipment amortization and labor). It required 9.92 h to bait the fields and to install baiting lanes. The net benefits of $3,940.93 ($20.76 per acre) would have resulted in a payment to the grower of $397.29/h for labor.

The preceding calculations were made with the assumption that damage would have proceeded at approximately the same rate during the 14-day treatment period as during the 3-day pretreatment period. This appears to be a reasonable assumption since in 1983 damage in

Table 7. Benefit-costs of baiting cornfields (6 pairs of experimental units) with 4-AP HCl baits for 2-week periods, Brown County, South Dakota, 15 August - 2 September 1984.

Exp. unit pair	Costs			Benefits		B-C ratio	Labor	
	Bait[a]	Baiting lanes[b]	Total	Bu. saved[c]	$ saved[d]		H[e]	Earnings per hour
1	$ 48.99	$ 75.26	$124.25	352.1	$ 978.84	7.88	1.51	$ 565.95
2	125.35	144.43	269.78	210.7	585.75	2.17	3.45	91.59
3	52.67	80.83	133.50	366.8	1,019.70	7.64	1.63	543.68
4	52.56	81.09	133.65	320.0	889.60	6.56	1.63	463.77
5	56.35	51.94	108.29	300.5	835.39	7.71	1.44	504.93
6	30.13	69.43	99.56	180.1	500.68	5.03	0.21[f]	1,910.10
Totals and means	$366.05	$502.98	$869.03	1730.2	$4,809.96	5.53	9.92	$ 397.27

[a] $1.15/lb (applicator price in 1-ton Lot, delivered).
[b] Yield loss calculated at (80 bu/acre - 34.6% growth compensation x 1.82% of each acre destroyed x 2.78 per bu for corn lost.
[c] Expected minus observed losses for the baited period. Expected based on losses occurring on units during the 3-day pretreatment period.
[d] $2.78 ber bu (price 1 Nov. 1984, Chicago, IL, market).
[e] Based on rates of 100 acres/h for application of baits and 30 acres/h for creating baiting lanes.
[f] Lanes not planted.

Note: $29.58 cost of insecticide-treated pellets (50.2 lb of Hopkins 5% Sevin Pellets @ 59¢/lb) not included as a baiting cost.

six untreated experimental units of cornfields in this area (6 of the 12 units were in the same 1/4-sections in 1983) was 27.2 bushels/day during 3-day pretreatment periods and 31.6 bushels/day, or 16.1% more, during 6-day periods following this (Besser and Hanson 1985). Also, the median date of the 14-day treatment period for the 12 experimental units in 1984 was 29 August, well within the 25 August - 10 September period that roosting blackbird populations annually peak in Brown County, South Dakota (De Grazio et al. 1971).

Units were rebaited 0 to 3 times during the treatment period, chiefly because of bait depletion by insects and rodents. Only one major rain of 0.68 inches fell (on 20 Aug.) during the baited period, necessitating rebaiting of four fields. Three other rains of from 0.03 - 0.15 inches fell on 14, 25, and 26 Aug. but fields were not rebaited since birds continued to be affected.

Growth compensation on rows adjacent to unplanted baiting lanes was less than one would have expected from Minnesota data that indicated a

decrease in yield of only 6% when plant populations were decreased from 20,000 to 10,000 per acre (DeLoughery and Crookston 1979). In a survey of the yield of plots adjacent to unplanted baiting lanes in Field #6 and of plots 32 ft away, only a 34.6% growth compensation was indicated. The 20 plots sampled indicated that growth compensation would have been higher in 1984 if plant populations had exceeded 20,000 per acre. Two plots adjacent to baiting lanes containing 20,000 and 22,000 plants/acre yielded 109 and 120 bu/acre, whereas two other plots containing 11,500 plants/acre yielded only 53 bu/acre each.

Posttreatment Losses on Test Fields

From 2-4 October, an additional survey of all plots in the 12 experimental units was made to determine losses between the final test survey and the near-harvest loss. The October survey showed that posttreatment losses were 0.83 bushels/field/day, only 45.5% of the rate occurring during the treatment period and 7.0% of that occurring during the pretreatment period. These data suggest that the corn became less palatable and less vulnerable as it dented and matured, but does not rule out possible carry-over effects from the 4-AP HCl baitings. These data show that about the same amount of corn was lost in a 2-week period posttreatment as was lost in a single day of the pretreatment period.

RECOMMENDATIONS

Further studies are needed to demonstrate the cost-effectiveness of 4-aminopyridine hydrochloride baits for protection of field corn from blackbirds in additional geographic areas.

A smaller chopped corn bait particle in the commercial product is also recommended. A 12-mg particle size is suggested. To obtain the same level of 4-AP ingestion by birds, 4-AP HCl concentrations on a 12-mg particle would have to be increased to about 9.6% (6.0% 4-AP). To allow the product to be applied under the present 0.03% 4-AP label, the dilution ratio of untreated particles would need to be increased to 1:199. This dilution rate would not decrease the number of treated baits distributed at the 1 lb/acre of field (baiting) rate.

A final recommendation would be to use a lower (0.5 or 0.3 lb/acre) baiting rate and bait more frequently. Because (a) insects and perhaps rodents steadily deplete baits, (b) most of the application cost on baiting lanes is for bait, (c) most birds are cleared from fields the same day the bait is applied in pre-sunrise baiting, and (d) 0.5-inch rains deactivate baits, it appears that use of lowered baiting rates and more frequent baitings would be more cost-effective. Use of 0.33 lb/acre of field of the 0.03% 4-AP bait on 18- or 19-foot swaths would allow the product to be covered by the present label and further reduce possible hazards to nontarget species.

SUMMARY

It appears that stabilized Avitrol® FC-Corn Chops-99 baits are capable of economically alleviating a considerable portion of the estimated $18 million annual national loss of corn in fields that receive more than 3 bu/acre damage. Demonstrations of techniques used in this study in additional geographical areas are recommended. Use of smaller corn particles, lower baiting rates, and more frequent baitings should be evaluated in future studies.

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