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Introduction

Methiocarb [3,5-dimethyl-4-(methylthio)phenol methylcarbamate = R Mesurol[1]] showed promise as a bird repellent for protecting crops in 1964, when field tests in South Dakota indicated reduced pheasant damage to sprouting corn (West *et al.,* 1969). Stickley and Guarino (1972) then showed marked reduction of blackbird damage to sprouting corn in South Carolina when methiocarb in a water slurry formulation was used as a seed treatment at the 0.5-percent level by weight of seed.

Our test, in 1973, was conducted to determine the repellent efficacy of methiocarb on sprouting field corn when the powdered chemical is placed directly in the planter hopper with the corn seed. Ease of chemical application makes this "hopper box" technique preferred by farmers and, hence, the manufacturer.

Procedures

The test was conducted from 15 May-10 June, 1973 at the New York State Department of Environmental Conservation's Three Rivers Wildlife Management Area near Baldwinsville in the Syracuse area. Sixteen plantings of field corn were used to compare the repellency of seed treated with methiocarb against untreated seed (control). Methiocarb-treated seed was coated in the planter hopper box with 1 lb. of 50 percent methiocarb per 100 lb. of seed (0.5-percent level).

The test site (Fig. 1) was partitioned into four blocks containing four fields each. Fields ranged from 1.0 to 3.0 acres and averaged 1.8 acres in size. The assignment of treatments (methiocarb and control) to experimental units (fields within blocks) was random. Thus, the experimental design called for a randomized block design with two replications of each treatment within a block. The selection of this design over a completely randomized design was predicated on the belief that bird pressure would be more uniform over the smaller blocks. If this were true, blocking would result in a more sensitive test of the treatment effect.

Fields C-1 and C-2, and E-1 and E-2 were planted on 15 May. Fields C-3 and C-4, all D fields, and E-3 and E-4 were planted on 16 May. Heavy rains after 16 May prevented the planting of F fields until 24 May.

Bird censuses were conducted in each field to determine the species composition and to obtain an index of bird activity. Fields within Blocks C,D, and E were observed twice daily, 19 May-31 May and twice daily 25 May-3 June and 5-6 June. A census consisted of a tally by species of all birds presnet in a field. The observer remained at the observation post for a field only

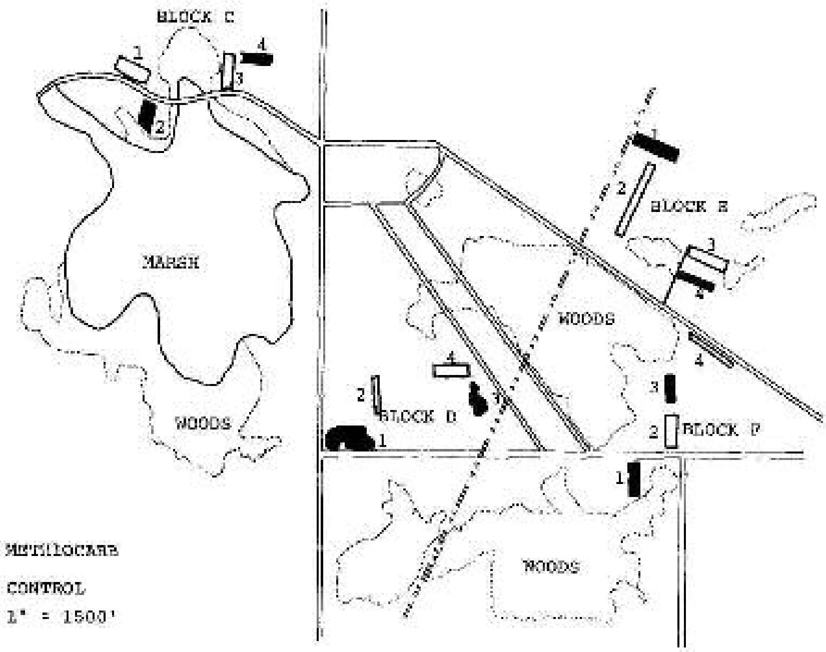

Figure 1. Three Rivers Management Area, Baldwinsville, New York

long enough to accomplish this. Census data were averaged over days for each treatment and pre- or post-sprout emergence period; bird activity was expressed in terms of an index (birds/field/day).

To assess damage, 10 observational subsampling units were randomly selected within each field. Each observational unit consisted of 200 row-feet of sprouting corn (two 100-foot adjacent rows); observational units were established prior to the first damage assessment, which was conducted approximately 3 days after first evidence of sprout emergence. Three assessments were made on each observational unit at 3-day intervals. For each assessment, the number of damaged sprouts was recorded separately by observational units. All uprooted sprouts were removed and all evidence of damage was obliterated so that damaged sprouts would not be counted twice. Thus, the subsampling responses for a particular field are the total counts obtained from the three assessments on the 10 observational units within that field.

Damage assessments were made as follows: in C fields on 31 May, 3 and 6 June; in D and E fields on 1, 4, and 7 June; and in F fields on 4, 7, and 10 June.

Damage data were transformed to stabilize variances and approximate normality by adding 0.5 to the raw data and taking the square root of this sum; these transformed data then were subjected to an analysis of variance. Since the purpose of the experiment was to evaluate treatment effects, this treatment factor appears as the single fixed effect in the mathematical model. Blocks and the block-by-treatment interaction are not of primary interest and are detailed as the random or variance components of the model. Since a preliminary test of the interaction effect showed no significance, the subsequent test of the fixed-treatment effect was based on the pooled interaction and error sums of squares.

Results and Discussion

The average number of sprouts damaged per treatment (methiocarb and control) is given for each block in Table 1. An average of 28 sprouts per subsample was destroyed in control fields compared with one sprout per subsample in methiocarb-treated fields. Utilizing transformed counts, an analysis of variance (Table 2) indicated that the difference in sprout damage between treatments was highly significant ($\underline{P} < 0.01$). Thus, methiocarb was effective in reducing damage. The analysis of variance also indicated that the variance components corresponding to blocks and block-by-treatment interaction were not statistically different from zero ($\underline{P} > 0.10$). This indicates that blocking was unnecessary and that treatments could have been randomly allocated to fields.

Table 1. Mean number of sprouts damaged per subsample per field according to block and treatment.

	Block				
Treatment	C	D	E	F	Average
Methiocarb	0.850	0.450	3.100	0.100	1.125
Control	13.850	34.500	61.450	3.300	28.275
Average	7.350	17.475	32.275	1.700	14.700

Table 2. Analysis of variance of transformed data

Source	df	Sums of squares	Mean square	F-ratio
Treatments	1	410.0065	410.0065	11.6916***
Blocks	3	243.7024	81.2341	2.7751NS
Treatments x block interaction	3	142.5784	47.5261	1.6236NS
Experimental (whole plot) error	8	234.1721	29.2715	
Observational (subsampling) error	144	248.2147	1.7237	

***highly significant ($P < 0.01$); tested using pooled interaction and error sums of squares

NS not significant ($P > 0.10$)

Rankings of fields according to bird damage, and target birds counted per day are given in Table 3. Target birds are those species known to damage sprouting corn (i.e. Common Grackle, Red-winged Blackbird, Brown-headed Cowbird, Common Crow, Canada Goose, and Ring-necked Pheasant). A comparison of rank (column 1) with bird damage (column 2) reveals that the greatest amounts of bird damage were recorded in six control fields and that six of the seven fields with the least damage were methiocarb-treatment fields. This separation in rank of damage between groups of treated and untreated fields attests the effectiveness of the methiocarb treatment. Greater interspersal (Table 3) of treated and untreated fields occurred when fields were ranked according to bird activity (columne 3, 4, and 5) than when ranked according to bird damage (column 2). This suggests that a test of the effectiveness of methiocarb based on overall bird activity would be less sensitive than a test based on measured damage.

A comparison of column 5 with column 4 indicates the effect of methiocarb treatment on target bird activity. Ascribing numbers corresponding to the rank of fields (all fields in a tie were assigned the mean ranking) and totaling treated and untreated rankings for pre- and post-sprout emergance, an increase of 5.5 rank points (74.0-79.5) from pre- to post-emergence is obtained for treated fields with a similar decrease (62.0-56.5) for untreated fields. These rank-point changes indicate a relative decrease of post-sprout emergence bird activity in treated fields and a relative increase in untreated fields. There was an overall decrease of target bird activity in the test area (Table 4) during this period.

During census periods, 298 birds of target species were seen in the fields (160 Red-wings, 60 Grackles, 56 Cowbirds, 16 Crows, and 6 Pheasants). Canada Geese, also considered target birds, were common in the area, but neither geese nor their tracks were seen in the test fields. Target bird activity is reported in Table 4, wherein the overall decrease of target species

Table 3. Ranking of field treatments as to bird damage and target bird activity.

		Target bird activity (birds/day)		
Rank (most to least)	Bird damage	Overall	Pre-sprout emergence	Post-sprout emergence
1	C[1]	C	C	C
2	C	C	C[2]	C
3	C	C	C	C
4	C	C	T[3]	T
5	C	C	T	C
6	C	T	C	T
7	T	T	T	T
8	T	T	T	C
9	C	T	T	T
10	T	T	T	T
11	T	T	C	C
12	C	C	C	C
13	T	C	C	T
14	T	C	C	C
15	T	T	T	T
16	T	T	T	T

[1]control (untreated) field
[2]vertical line indicates ties
[3]methiocarb (treated) field

in the post-emergence period is shown to be about 54 percent. A 67-percent decrease in birds in the methiocarb-treated fields compared with a 44-percent decrease in birds in the control fields is another indication of the repellency of methiocarb.

A breakdown of the activity index for the four most prominent target bird species (Table 5) shows that post-emergence activity decreased in the test area from pre-emergence levels for all species except Grackles, which were not deterred from methiocarb fields. Further, bird activity, especially that of Red-wings and Cowbirds, decreased more in the methiocarb fields than in the controls. Again, Grackles were an exception, showing a 96-percent decrease in control fields and a 6-percent increase in methiocarb fields. It must be remembered, nevertheless, that the above results arise from bird counts that were intended to provide insight into species composition, not an absolute measure of damage nor a measure of the true effect of the methiocarb treatment on these species. It is not known, for instance, what proportions of these species were actually inflicting damage.

Table 4. Target-bird activity index (birds/field/day) by block and treatment, and percentage decrease in target-bird activity from pre-emergence average.

Treatment	Pre-sprout emergence					Post-sprout emergence					Percentage decrease from pre-emergence average[1]				
	Block					Block					Block				
	C	D	E	F	Av	C	D	E	F	Av	C	D	E	F	Av
Methiocarb	1.06	1.67	1.83	1.06	1.41	0.71	0.36	0.43	0.38	0.47	33.0	78.4	76.5	64.2	66.7
Control	0.94	1.67	1.33	3.19	1.78	0.50	0.93	2.14	0.38	0.99	46.8	44.3	-60.9*	88.1	44.4
Average	1.00	1.67	1.58	2.12	1.59	0.61	0.64	1.29	0.38	0.73	39.0	61.7	18.4	82.1	54.4

[1]all entries computed using entries from pre- and post-sprout emergence tables

*negative number indicates an increase from pre-emergence average

Table 5. Target-bird activity index (birds/field/day) by species and treatment for both pre- and post-emergence periods.

	Red-winged Blackbird		Common Grackle		Brown-headed Cowbird		Common Crow	
	Treatment Methiocarb	Control	Treatment Methiocarb	Control	Treatment Methiocarb	Control	Treatment Methiocarb	Control
Pre-sprout emergence	0.63	0.91	0.17	0.54	0.46	0.20	0.13	0.07
Post-sprout emergence	0.18	0.86	0.18	0.02	0.10	0.10	0.02	0.02
Difference between pre- and post-sprout emergence	-0.45[a]	-0.05	0.01	-0.52	-0.36	0.10	0.11	0.05
Percent decrease from pre-emergence average	71.4	5.5	-5.9	96.3	78.3	50.0	84.6	71.4

[a]negative number indicates an increase from pre-emergence average

Table 6. Non-target bird activity index (birds/field/day) by block and treatment, and percentage decrease in non-target bird activity from pre-emergence average.

	Pre-sprout emergence					Post-sprout emergence					Percent decrease from pre-emergence average[1]				
	Block					Block					Block				
Treatment	C	D	E	F	Av	C	D	E	F	Av	C	D	E	F	Av
Methiocarb	0.45	1.00	1.15	0.31	0.73	0.70	3.00	1.25	0.13	1.27	-55.6	[a]-200.0	-8.7	58.1	-74.0
Control	2.10	1.90	1.85	0.75	1.65	2.70	0.80	1.50	1.00	1.50	-28.6	57.9	18.9	-33.3	9.1
Average	1.27	1.45	1.50	0.53	1.19	1.70	1.90	1.38	0.57	1.38	-33.9	-31.0	8.0	-7.5	-16.0

[1]all entries computed using entries from pre- and post-sprout emergence tables
[a]negative number indicates an increase from pre-emergence average

During census periods, 327 birds of non-target species were seen in the fields: 161 Starlings, 107 Robins, 28 Mourning Doves; and 31 other birds, consisting of Bluejays, Killdeers, Flickers, Wood Thrushes, Meadowlarks, and a Kingbird. The index values for numbers of non-target birds observed per field per day are given in Table 6. Unlike the decrease of 67 percent in the activity of target species in methiocarb fields after sprout emergence, a 74-percent increase in non-target species activity occurred. This increase is mostly attributable to the presence of fledgling Starlings observed in the fields in June and to Robins. The number of Starlings observed increased 176 percent in treated fields after sprout emergence, Robins 58 percent. This would imply that methiocarb had no repellent effect on Starlings and Robins. Like target bird activity, which decreased in control fields after emergence, non-target bird activity decreased 9 percent (a 49-percent decrease in Robin activity offset a 166-percent increase in Starling activity).

Conclusions

Analysis of sprout damage data shows conclusively that 0.5-percent methiocarb treatment of field corn seed will effectively protect sprouts from bird damage under these test conditions.

Bird censuses reveal that overall post-emergence activity of target species in methiocarb fields decreased from pre-emergence levels as opposed to an increase in post-emergence activity in treated feilds for non-target species. Redwing and Cowbird activity decreased markedly in the methiocarb-treated fields. In contrast, Grackle activity remained relatively constant in these fields.

Recommendations

The next step in determining the efficacy of methiocarb for protecting sprouting corn from bird damage should be to test the chemical under commercial conditions with regular-sized fields as experimental units. The suggested refractoriness in the response of Common Grackles to the repellent treatment should be investigated since Grackles are one of the major sprout-pulling species.

Acknowledgments

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[1]Mesurol, product of Chemagro, Division of Baychem, Corporation, is not yet registered for use on crops as a bird repellent.

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