EFFICACY OF TRIMETHACARB AS A SMALL MAMMAL REPELLENT IN NO-TILL CORN PLANTINGS

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ABSTRACT: Trimethacarb (2,3,5-trimethylphenyl methycarbonate) was evaluated as a mouse repellent in no-till corn plantings. Two studies were conducted. One involved an early spring planting and included 5 treated and 5 control plots. The second involved a late spring planting and included 3 treated and 3 control plots. Species composition and relative abundance of small mammals were determined for each plot by trap and release before treatment. On the 10 early spring plots, species composition was 85% prairie voles (Microtus ochrogaster), 14% deer mice (Peromyscus spp.), and 1% house mice (Mus musculus). On the 6 late spring plots, species composition was 66% prairie voles, 28% deer mice, and 6% house mice. Trimethacarb (15% by weight) was applied in a 15-20 cm band on the ground surface over the planted corn seed at a maximum rate of 9.2 kg/ha. Corn seeds consumed by small mammals and intact corn sprouts were counted when the corn was approximately 10 cm tall, or about 17 days after planting. At harvest, the numbers of corn stalks and yield in kg per ha were estimated. In the early spring planting, mice consumed a total of 657 and 755 seeds on the 200 sampling sites (treated and control plots, respectively). In the late spring planting, mice consumed a total of 122 and 87 seeds on the 120 sampling sites (treated and control plots, respectively). Differences between the mean numbers of seeds consumed by mice on the treated and control plots were not statistically significant in either planting. In the early spring plantings, a total of 1,784 and 1,641 intact sprouts were present on the 160 sampling sites (treated and control plots, respectively). In the late spring plantings, a total of 1,267 and 1,114 intact sprouts were present on the 120 sampling sites (treated and control plots, respectively). Differences between the mean numbers of intact sprouts on the treated and control plots were not statistically significant in either planting. The average numbers of stalks per ha at harvest for the early spring planting were 42,230 and 31,604 (treated and control plots, respectively); estimates for the late spring planting were at 42,929 and 40,597 (treated and control plots, respectively). Differences between the numbers of stalks on the treated and control plots were not statistically significant for either planting. Average yield for the early spring planting was 8492 kg/ha and 6267 kg/ha (treated and control plots, respectively); and for the late spring planting was 6618 kg/ha and 6831 kg/ha (treated and control, respectively). There was no statistically significant difference in kg/ha between treated and control plots for either planting. These results indicate that trimethacarb is not an effective mouse repellent in no-till corn plantings.

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INTRODUCTION

The conventional method of seed-bed preparation by plowing is being replaced by a number of conservation tillage systems that prepare a seed bed without turning the soil. In one system, called no-till, a slit for placement of the seed is the only disturbance of the soil. A herbicide treatment controls weeds after the planting. Although no-till planting has many advantages, (e.g., retention of soil moisture, prevention of wind and water erosion, reduced fuel and manpower requirements, and more consistent crop yields (Fenska and Licks 1977)), one disadvantage has been identified. Mice consume the seeds and sprouts, particularly when the planting is in pastures (Beasley and McKibben 1974).

The first efforts to prevent mouse damage were with acute rodenticides. Beasley and McKibben (1974, 1975) evaluated the effects of 2.0% zinc phosphide in no-till corn. Results were as follows: (1) zinc phosphide baits were broadcast at 16 lbs./acre and mouse damage was reduced by 67%; and (2) zinc phosphide baits were placed underground with the corn seeds at 4-6 lbs./acre; mouse damage was reduced by 84%. A 24-C label was registered in Illinois for this latter technique, but the registration was subsequently cancelled for lack of data on zinc phosphide residues in plant tissue.

Repellents also have been evaluated for reducing rodent damage. Beasley and McKibben (1976) treated corn seeds with four concentrations (0.25%, 0.50%, 0.67%, and 1.34%) of methiocarb. They observed reduced damage by meadow voles, deer mice, house mice, and rice rats (Synaptomys cooperi). Methiocarb at a 0.5% concentration on corn seeds failed to repel 13-lined ground squirrels (Spermophilus tridecemlineatus) (Johnson et al. 1985). When increased to 2.5% and 5.0% concentration, methiocarb significantly reduced damage to seeds, but there is evidence that these levels may significantly reduce corn stand counts under cool and wet conditions (Koehler 1583). Johnson et al. (1985) reported

that another repellent, thiram, at a 1.25% concentration on corn seeds, significantly reduced seed damage by 13-lined ground squirrels.

In 1984, we had the opportunity to evaluate a third chemical, trimethacarb, as a potential rodent repellent in no-till corn. This compound has demonstrated repellency to birds (Bruggers et al. 1984). Trimethacarb is registered as an insecticide for corn rootworm. If proven effective as a rodent repellent, data would be available to apply for a section 3 registration from the Environmental Protection Agency. The results of two field trials of trimethacarb as a mouse repellent in no-till corn are presented here.

STUDY AREA

This study was done in south central Illinois on the Dixon Springs Agricultural Center, Simpson, Illinois. In 1984, 10 plots (5 treated and 5 control totaling 71.7 ha) in fields of cool season perennial grass pastures or in corn stalk residue from the previous year were planted by the no-till method in early spring (21-25 May 1984), and 6 pasture plots (3 treated, and 3 control totaling 59.0 ha), were planted by the no-till method in late spring (11-12 June 1984). Trimethacarb (Broot)* was applied to the treated plots; the control plots received no treatment.

METHODS

Small Mammal Trapping

Early Spring Planting - Mouse species (includes prairie voles, deer mice and house mice) were identified and their abundance was estimated by live-trapping the 10 plots for 5 days pre-treatment. Based on research conducted by Beasley and McKibben (1974), prairie voles were identified as the major problem species on pastures planted to no-till corn in south central Illinois; therefore, 5 transects, each 50 m long, were established on each plot in areas of prairie vole activity. Two steam-cleaned Sherman traps were placed at right angles to prairie vole runways at the starting point of each transect and every 10 m thereafter. All traps were shaded with asbestos shingles to prevent mouse mortality due to heat stress, baited with rolled oats and peanut butter, and wired open for 2 days to acclimatize the mice to the traps. At sunset on the second day of acclimatization, all traps were rebaited and set. The next day (Day 1) the traps were examined twice, at sunrise and just before sunset. On days 2 through 5, traps were examined at sunrise, closed, and reopened at sunset. After the traps were examined at sunrise on day 5, they were removed.

Each trapped mouse was identified as to species and sex, 1 ear was punched, and the animal released at point of capture. After the 5-day trapping period, the total number of individuals captured per species on each plot became the index of abundance for that plot. Treated and control plots were paired based on mouse abundances.

Late Spring Planting - Mouse species and relative abundance were estimated by live-trapping on the 6 plots for 5 days pretreatment. Procedures followed were the same as for the early spring planting, except that on Day 1 the traps were examined at sunrise, closed, and reopened at sunset.

Statistical Analysis - The differences in prairie vole and deer mouse population sizes between paired treated and control plots, and the differences between the early and late spring plantings, were compared by two-factor repeated measures analysis of variance.

Planting and Chemical Treatments

Early Spring Planting (21-25 May 1984) - The corn was planted after completion of the pretreatment trapping. Treatments (trimethacarb and control) were allocated among the 10 plots as follows: The 10 plots were ranked from highest to lowest based on the number of prairie voles trapped per plot; beginning with the 2 plots with the highest number of prairie voles, the first was randomly assigned to receive either the trimethacarb or no trimethacarb; the second plot received the alternate treatment. This procedure continued until each plot was assigned a treatment.

On treated plots, granular fertilizer and trimethacarb were applied by an International Cyclo Model 400, 6-row Planter as the corn was planted. The seed was planted approximately 5 cm below the surface and spaced approximately 20 cm apart. The distance between rows was 76.2 cm. The seed corn (DeKalb T 1230)* had been treated with Diazinon® for control of beetles and maggots. Fertilizer (18-46-E) was applied at the rate of 112 kg/ha. Trimethacarb (15 percent active ingredient by weight), was applied on the ground surface in a 15 to 20 cm band centered over the planted corn seed at a rate of 9.2 kg/ha or 1.46 kg of active ingredient/ha. Control plots received the same planting and fertilizing treatment, but no trimethacarb. The day after planting, all plots were treated with 2 herbicides, paraquat* and atrazine*, at the rate of 1.12 and 2.24 kg of active ingredient/ha each, respectively. When the corn in each plot was 30-35 cm tall, nitrogen (anhydrous ammonia) was applied at 140 kg/ha.

Late Spring Planting (11-12 June 1984) - The corn was planted after completion of the pretreatment trapping. Treatments (trimethacarb or control) were allocated among the 6 plots by the procedure described earlier. Seed treatment, fertilizer, trimethacarb, and herbicide applications, were done as described earlier. The only difference was the variety of seed corn (Princeton 850)*, which was a faster maturing variety.

Assessment of Mouse Damage

Sampling Design - Mouse damage was assessed by counting intact corn seedlings and missing seeds on both treated and control plots in both the planting periods. Assessment began when seedlings were approximately 10 cm in height, or about 17 days after planting.

Five areas surrounding the original 5 trapping transects were used as sampling sites for damage assessment and to determine plant density and the corn yield per ha. At each

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transect, a rectangular sampling area (6.10 x 50.0 m) was established with the transect bisecting the rectangle lengthwise. Eight corn rows within the rectangle were randomly selected for sampling. A 3.05 m segment to be sampled from each 6.10 m corn row was determined by randomly selecting a number between 6 and 10; that number of feet along the row will be the starting point for the 3.05 m segment to be sampled. Each 3.05 m segment was defined with marking flags, 1 at each end of the segment (i.e., a starting flag and stopping flag).

The area of each plot outside of the 5 sampling areas also was sampled. Six additional sampling sites were selected in each plot by counting the number of rows per plot, and selecting 6 rows at random. The length of each selected corn row was measured and the starting point of a 3.05 m segment of each was selected by randomly choosing a number between 0 and X-10 (where X =length of corn row in feet).

Overall, 46 different corn rows totaling 140.3 m were sampled in each plot. Forty of these were from the 5 trap lines (5 trap lines per plot x 8 rows per trap line), and 6 rows from random sampling in each plot.

Damage Assessment - seeds consumed or intact sprouts on each 3.05 m segment were determined when the corn seedlings were approximately 10 cm tall. If spacing between seedlings or corn seeds in each segment was greater than 30 cm, a tile spade was used to excavate the ground just past the last corn seed or corn seedling, thereby exposing ungerminated seeds, germinated seeds that failed to emerge, or other abnormalities. In this manner, a profile of the plant population and mouse damage for each 3.05 m segment was constructed. A total and mean were calculated for both intact corn seedlings and seeds consumed on the 5 trap-line sampling sites and on the 6 random sampling sites of each plot.

Statistical analysis - Four damage responses were tested in a two-factor repeated measures analysis of variance. For both early and late plantings the four damage responses tested were as follows:

1. Seeds consumed — trap lines 1-5
2. Seeds consumed — random sampling sites
3. Intact sprouts — trap lines 1-5
4. Intact sprouts — random sampling sites

Assessment of Plant Density and Corn Yield

Sampling Design - Plant density and corn yield was estimated for all plots. Selection of the sampling sites followed the same procedure as outlined in the damage assessment section except that 6 random lines were omitted. The 3.05 m sampling segments were established at the time the damage assessment segments were established. Eight sampling segments were established per trap line, with 40 sampling segments per plot.

Harvesting began in October and was completed in November 1964. Numbers of stalks and ears per stalk within each 3.05 m segment on each plot were counted. After pulling and shelling the ears, a wet corn weight for the sampling sites was obtained. Dry corn weight was calculated by determining the moisture content of a 100 g corn sample with a Steinlite electronic tester (Fred Stein Laboratories, Atchison, Kansas). Plant density on the 5 sampling sites per plot was converted to number of stalks per ha, and the corn yield per 5 sampling sites was converted to kg per ha.

Statistical analysis - A two-factor repeated measures analysis of variance was used to test for differences in the number of stalks per ha and kg of corn per ha between treated and control plots for early versus late plantings.

RESULTS

Small Mammal Trapping

Early Spring Planting - Three mouse species were trapped on the 10 plots, prairie voles (Microtus ochrogaster) comprised 85% of the catch, deer mice (Peromyscus spp.) 14%, and house mice (Mus musculus) 1%. A total of 289 prairie voles was captured on all 10 plots, and 47 deer mice were captured on 6 plots. Two house mice were captured on 1 plot. Prairie voles were present on 42 (84%) of the 50 traplines, deer mice were present on 18 (36%), and house mice were present on 2 (4%).

Late Spring Planting - Three mouse species were trapped on the 6 plots; prairie voles comprised 66% of the catch, deer mice 28%, and house mice 6%. A total of 43 prairie voles was captured on all 6 plots, and 18 deer mice were captured on 6 plots. Four house mice were captured on 1 plot. Prairie voles were present on 26 (67%) of the 30 traplines, deer mice were present on 13 (43%), and house mice were present on 3 (10%).

Statistical Analysis - For both the vole and mice data, no significant differences in the numbers of animals trapped were detected between treated and control plots, nor between early versus late plantings, nor in the plantings by treatment interaction.

Mouse Damage

Seed Loss - Mice and voles were the major cause of seed corn losses in no-till planting on both the treated and control plots in early and late spring plantings. In the early spring plantings, mice consumed a total of 657 and 755 corn seeds (treated and control plots, respectively) on the 200 sampling sites. Mice consumed a total of 77 and 83 corn seeds (treated and control plots, respectively) on the 30 random sampling sites. In the late spring plantings, mice consumed a total of 122 and 87 corn seeds (treated and control plots, respectively) on the 120 sampling sites. Mice consumed a total of 17 and 10 corn seeds (treated and control plots, respectively) on the 18 random sites.

For early spring planting, the total number of seeds consumed by mice (trapline plus random sampling sites), 734 (treated plots) and 838 (control plots) represent approximately 21% and 24% of the theoretical number of seeds planted (3450 seeds) on the 230 sampling sites for the treated and control plots, respectively. For the late spring planting, the total number of seeds consumed by mice, 139 (treated plots) and 88 (control plots) represent approximately 7% and 4% of the theoretical number of seeds planted (2070 seeds) on the 138 sampling sites for the treated and control plots, respectively.

Seed losses, other than those from mice, were due to germination failure or improper planting, i.e., seeds planted on the surface, missing seeds, planter failing to create a furrow.

Intact Sprouts - In the early spring plantings, a total of 1,784 and 1,641 intact sprouts (treated and control plots, respectively) were present on the 200 sampling sites; at the random sampling sites a total of 281 and 277 intact sprouts (treated and control plots, respectively) were present on the 30 sampling sites. In the late spring plantings, a total of 1,267 and 1,114 intact sprouts (treated and control plots, respectively) were present on the 120 sampling sites; at the random sampling sites a total of 207 and 157 intact sprouts (treated and control plots, respectively) were present on the 18 sampling sites.

Statistical Analysis - No significant difference in the number of seeds consumed by mice on the 5 trap lines was detected between the treated and control plots. However, a significant difference was found between the early and late plantings ($p = .030$) with a mean seed loss of 29.01 for the early plantings versus a mean seed loss for 7.30 for the late plantings. The interaction between plot treatment and planting time was not significant. For the random rows, no significant differences were detected between the treated and control plots, nor for the early versus late plantings, nor for the treatment by planting time interaction. For both the sampling sites located on the 5 traplines and the sampling sites located in the random rows, no significant differences in the numbers of intact sprouts were detected between treated and control plots, nor between the early and late plantings, nor in the treatment-by-planting-time interaction.

Plant Density and Corn Yield

Plant Density - Unfortunately, 1 control plot was harvested before yield measurements were taken, leaving only 4 control plots with stalk and ear measurements; therefore its paired treatment plot was not used. For 160 sampling sites on the 4 early spring treated plots, there were 1772 stalks with 1812 ears, and the wet and dry weight for the corn was 408 and 309 kg, respectively. For the 160 sampling sites on the 4 early spring planting control plots, there were 1175 stalks with 1207 ears, and the wet and dry weight for the corn was 272 and 197 kg, respectively. These data were extrapolated to numbers of stalks and yield per ha. In the early spring planting, a higher yield occurred in the treated plots in both numbers of stalks and kg per ha than in the control plots; mean numbers of stalks per ha were 42,230 (treated plots) compared to 31,604 stalks (control plots), and mean kg of corn per ha were 8492 (treated plots) and 6267 (control plots).

Corn Yield - For 120 sampling sites on the 3 late spring treatment plots, there were 1203 stalks with 1259 ears, and the mean wet and dry weights for the corn were 237 and 165 kg, respectively. For the 120 sampling sites on the 3 late spring control plots there were 1126 stalks with 1147 ears, and the mean wet and dry weights for the corn were 221 and 151 kg, respectively. These data were extrapolated to numbers of stalks and yield per ha. In the late spring planting, a higher yield occurred in numbers of stalks per ha in the treated plots than in the control plots; mean numbers of stalks per ha were 42,929 (treated plots) and 40,597 (control plots). This difference was not reflected by kg of corn per ha which were 6831 (control plots) and 6618 (treated plots).

Statistical Analysis - For both corn yield and stalks per ha, no significant differences were detected between control and treated plots, between early versus spring plantings, nor in the treatment-by-planting time interaction. However, it should be noted that the interaction effect for yield was approaching significance ($p = 0.09$). More plots would be needed to examine this effect.

DISCUSSION

Results of this study revealed no detectable significant repelling of mice by trimethacarb in no-till corn. There were no significant differences between control and trimethacarb treated plots with respect to the numbers of seeds consumed by mice, or the numbers of intact corn sprouts when measured at about 17 days after planting. At harvest there were no significant differences between control and trimethacarb treated plots with respect to the numbers of corn stalks per ha, nor yield in kg per ha.

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