Response of small mammals to no-till agriculture in southwestern Iowa

by

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A Thesis Submitted to the Graduate Faculty in Partial Fulfillment of the Requirements for the Degree of MASTER OF SCIENCE

Department: Animal Ecology
Major: Wildlife Biology

Iowa State University
Ames, Iowa
1984
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACKNOWLEDGEMENTS</td>
<td>1</td>
</tr>
<tr>
<td>GENERAL INTRODUCTION</td>
<td>2</td>
</tr>
<tr>
<td>Explanation of thesis format</td>
<td>3</td>
</tr>
<tr>
<td>SECTION I. SMALL MAMMAL POPULATION AND HABITAT RESPONSES TO NO-TILL AGRICULTURE IN SOUTHWESTERN IOWA</td>
<td>4</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td>5</td>
</tr>
<tr>
<td>INTRODUCTION</td>
<td>6</td>
</tr>
<tr>
<td>METHODS</td>
<td>9</td>
</tr>
<tr>
<td>Site description</td>
<td>9</td>
</tr>
<tr>
<td>Experimental design</td>
<td>9</td>
</tr>
<tr>
<td>Trapping</td>
<td>10</td>
</tr>
<tr>
<td>Population studies</td>
<td>10</td>
</tr>
<tr>
<td>Habitat studies</td>
<td>11</td>
</tr>
<tr>
<td>Statistical analysis</td>
<td>12</td>
</tr>
<tr>
<td>RESULTS</td>
<td>13</td>
</tr>
<tr>
<td>Field characteristics</td>
<td>13</td>
</tr>
<tr>
<td>Small mammal abundance and diversity</td>
<td>13</td>
</tr>
<tr>
<td>Deer mouse populations</td>
<td>18</td>
</tr>
<tr>
<td>Population density</td>
<td>18</td>
</tr>
<tr>
<td>Distances moved</td>
<td>23</td>
</tr>
<tr>
<td>Proportion of juveniles</td>
<td>23</td>
</tr>
<tr>
<td>Proportion of lactating females</td>
<td>24</td>
</tr>
<tr>
<td>Habitat utilization</td>
<td>24</td>
</tr>
<tr>
<td>Deer mice</td>
<td>27</td>
</tr>
<tr>
<td>Other species</td>
<td>30</td>
</tr>
<tr>
<td>DISCUSSION</td>
<td>32</td>
</tr>
<tr>
<td>LITERATURE CITED</td>
<td>36</td>
</tr>
<tr>
<td>SECTION II. CROP DEPREDATION AND FOOD RESOURCE UTILIZATION BY SMALL MAMMALS IN NO-TILL FIELDS OF SOUTHWESTERN IOWA</td>
<td>41</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td>42</td>
</tr>
<tr>
<td>INTRODUCTION</td>
<td>43</td>
</tr>
<tr>
<td>METHODS</td>
<td>45</td>
</tr>
<tr>
<td>Site description</td>
<td>45</td>
</tr>
</tbody>
</table>
**LIST OF TABLES**

<table>
<thead>
<tr>
<th>TABLE</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TABLE 1.</strong> Residue cover (%), depth (cm), and weed cover (%) within three corn tillage treatments in southwestern Iowa during 1982 and 1983</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td><strong>TABLE 2.</strong> Mean total captures of small mammals (animals/six days) on 10 x 10 m trapping grids at edge (E) and middle (M) locations on three corn tillage treatments in southwestern Iowa during 1982 and 1983</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td><strong>TABLE 3.</strong> Mean captures (animals/year) on 10 x 10 m trapping grids at edge (E) and middle (M) locations within three corn tillage treatments in southwestern Iowa</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td><strong>TABLE 4.</strong> Mean Shannon-Weaver diversity values (natural bels/year) on 10 x 10 m trapping grids at edge (E) and middle (M) locations within three corn tillage treatments in 1982 and 1983</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td><strong>TABLE 5.</strong> Density (number/ha) of deer mice and adult thirteen-lined ground squirrels during crop emergence within three corn tillage treatments in southwestern Iowa</td>
<td>51</td>
<td></td>
</tr>
<tr>
<td><strong>TABLE 6.</strong> Mean percent dry weight of food items in the diets of deer mice during corn emergence within three tillage treatments in southwestern Iowa</td>
<td>55</td>
<td></td>
</tr>
<tr>
<td>FIGURE</td>
<td>Description</td>
<td>Page</td>
</tr>
<tr>
<td>--------</td>
<td>-------------</td>
<td>------</td>
</tr>
<tr>
<td>FIGURE 1</td>
<td>Seasonal changes in small mammal captures within three corn tillage treatments in southwestern Iowa during 1982 and 1983</td>
<td>17</td>
</tr>
<tr>
<td>FIGURE 2</td>
<td>Seasonal changes in deer mouse densities within three corn tillage treatments in southwestern Iowa during 1982 and 1983</td>
<td>22</td>
</tr>
<tr>
<td>FIGURE 3</td>
<td>Proportion of juveniles among live-trapped deer mice within three corn tillage treatments in southwestern Iowa during 1982 and 1983</td>
<td>25</td>
</tr>
<tr>
<td>FIGURE 4</td>
<td>Seasonal changes in proportions of lactating female deer mice within three corn tillage treatments in southwestern Iowa during 1982 and 1983</td>
<td>26</td>
</tr>
<tr>
<td>FIGURE 5</td>
<td>Total small mammals captured within three habitat types in three corn tillage treatments in southwestern Iowa during 1983</td>
<td>28</td>
</tr>
<tr>
<td>FIGURE 6</td>
<td>Utilization of three habitat types by deer mice in three corn tillage treatments in southwestern Iowa during 1983</td>
<td>29</td>
</tr>
<tr>
<td>FIGURE 7</td>
<td>Utilization of three habitat types by thirteen-lined ground squirrels in three corn tillage treatments in southwestern Iowa during 1983</td>
<td>31</td>
</tr>
<tr>
<td>FIGURE 8</td>
<td>Mortality factors of corn seedlings on three tillage treatments in southwestern Iowa during 1982 and 1983. Sample size is given above each bar</td>
<td>53</td>
</tr>
</tbody>
</table>
ACKNOWLEDGEMENTS

The completion of this study would not have been possible without the assistance of numerous individuals. Foremost, I would like to thank Bill Clark for his continuous encouragement, guidance, and energy during the study. Through his efforts and friendship the task of graduate school has been an enjoyable one to undertake.

I am also fortunate to have been able to conduct this study with Nancy Basore. Her professional and moral support were both timely and generous during many long field hours.

During the study, I received invaluable assistance from technicians Sharon Peterson and Carol Sweeney. I appreciate the dedication and friendship each provided, oftentimes under stressful field conditions. Dr. Louis Best offered timely suggestions during many phases of the project.

Without the financial assistance of the Iowa Agricultural and Home Economics Experiment Station, this study would not have been possible.

Through all of my educational endeavors, my parents have been an inspiration to me, and much of my success can be attributed to them.

Finally, I extend my thanks to the many residents of Adair County with whom I have been able to associate during the past two years. Their interest and warm hospitality will always be fondly remembered.
GENERAL INTRODUCTION

Responses of small mammal communities to two types of no-till agriculture were compared to those of communities existing on conventional-till corn fields. Investigations were made in Adair County, southwestern Iowa, a region that has seen rapid increases in the use of no-till during the past four years (USSCS 1983). Of several types of no-till practices currently implemented by farmers, corn planted into corn residue was chosen as a study treatment because it has been the predominant no-till treatment. Additionally, corn planted into chemically treated sod was investigated because economically significant levels of crop depredation by thirteen-lined ground squirrels (Spermophilus tridecemlineatus) have been implicated in this rotation by many farmers and agricultural agencies.

The investigation had three major objectives: (1) to determine the changes in density and species composition of the small mammal community from conventional to no-till systems, (2) to determine the extent of small mammal crop depredations in conventional and no-till systems, and (3) to determine food habits of major small mammal species on conventional and no-till fields.

Although extensive research has been conducted on small mammal communities in agroecosystems (Whitaker 1966, 1967,
Fleharty and Navo 1983, Yahner 1983), cropfield rodents often go undetected by agriculturalists unless they pose a specific threat to crops. Methodologies for the control of rodents in agroecosystems also have been widely addressed (FAO 1977, Greaves 1982), but the potential benefits of rodents are often overlooked.

Because no-till is just beginning to gain wide acceptance among farmers, this is the first study to comprehensively address the role of small mammal communities in these systems. Acceptance of new techniques, such as no-till farming, relies to a large extent on understanding the potential problems or benefits that may arise, and a more complete understanding of small mammal densities and associated crop depredation problems may aid in diminishing some expressed concerns about no-till agriculture.

Explanation of thesis format

This thesis has been organized and written in the alternate thesis style as discussed in the Iowa State University Graduate College Thesis Manual. Two papers for publication have been written by myself and edited by Dr. William R. Clark. These papers comprise the sections of the thesis.
SECTION I. SMALL MAMMAL POPULATION AND HABITAT RESPONSES TO NO-TILL AGRICULTURE IN SOUTHWESTERN IOWA
Small mammal populations were studied in no-till and
discêd corn fields during the 1982 and 1983 growing seasons
in southwestern Iowa to determine population demographics,
community structure, and habitat utilization. Tillage
 treatments included corn planted into corn residue, corn
planted into chemically treated sod, and disêd or plowed
corn fields. Animals were live-trapped using trap grids
placed along the field edge, in the center of the fields,
and in unfarmed roadsides during May, July and November.
Deer mice (Peromyscus maniculatus) dominated the populations
of small mammals trapped on all treatments during both
years, comprising 64% of all captures in 1982 and 70% in
1983. Tillage treatment's, and locations within fields did
not influence total captures or demographic parameters of
deer mice. Small mammal communities were more diverse near
field edges and in no-till treatments compared with
conventional tillage. Based on equal utilization of the
three habitat types and similar home ranges at edge and
middle locations, it was concluded that stable population
levels occurred in all areas of these agroecosystems with no
evidence of encroachment from surrounding unfarmed areas.
Declines in rodent populations in 1983 were attributed to
severe winter weather.
INTRODUCTION

Minimum tillage agriculture features a wide diversity of systems where varying amounts of crop residue are left on soil surfaces to combat erosion. These agricultural practices have become increasingly popular among farmers as alternatives have been developed to control weed competition and insect pests (Phillips et al. 1980). Additional benefits can be attained through decreased man and machine hours afield (Blevins et al. 1971), and better retention of soil moisture due to increased mulch on the soil surface (Harold et al. 1970).

Residue cover may also provide favorable habitat for ground nesting and foraging birds (Basore 1984). Small mammals may reside in residue or be better able to exploit subterranean habitats because of the decreased surface disturbance (Fitzpatrick 1925). Available food in the form of weed seeds or insects (Blumberg and Crossley 1983, House and Stinner 1983) also may enhance utilization by agricultural wildlife. Positive wildlife responses to no-till would be encouraging if one considers the deleterious effects intensive agriculture has had on wildlife populations (Vance 1976). Even if small increases in wildlife usage occur, overall implications may be significant if predictions are correct that 45% of all U.S. cropland will be no-tilled by the year 2000 (USDA 1975).
Gradual increases in no-till farming have occurred in southwestern Iowa during the past decade due to its gently rolling topography. Areas devoted to no-till in the past four years, however, have undergone a thirtyfold increase, largely attributed to planting crops into corn residue from the previous year. During 1983, no-till represented 3% of the county's agricultural land with an additional 40% being idled under the Federal Payment-In-Kind set-aside program (Marvin Lundstedt, U.S. Soil Conservation Service, Greenfield, Iowa, personal communication).

In spite of the increased potential for wildlife, little intensive study has been done to determine effects of no-till agriculture on wildlife. Basore (1984) reported increased nest densities for upland birds in no-till fields. Castrale (1983) found avian usage of cropfields to increase as residue cover increased. Warburton (1983) described greater abundances of avian species and more stable small mammal populations in no-till fields.

Past studies of small mammals in agricultural systems have focused primarily on population thresholds relating to economically significant damage levels (Fleharty and Navo 1983) and have pertained primarily to colonial rodents (Greaves 1982). Researchers (Johnson et al. 1982, Holm et al. 1984) have cited damage caused by thirteen-lined ground
squirrels (*Spermophilus tridecemlineatus*) on no-till fields, that were previously pastured. Potential problems with rodents in no-till systems exist if densities of mammals capable of causing significant levels of crop damage are attained. Increased rodent densities may be beneficial, however, if food selectivity is for deleterious insects and competing weed species (Gregory and Musick 1976).

The objective of this study was to determine the affects of no-till agriculture on small mammal populations and community structure. Additionally, small mammal utilization of surrounding unfarmed areas was investigated to determine if populations are resident or encroaching from field edges. Results of small mammal crop depredation and food resource utilization studies are given elsewhere (Young 1984).
METHODS

Site description

Research was conducted on privately owned farms in Adair County, southwestern Iowa. The regional climate is subhumid and continental, with an average annual precipitation of 84 cm, 73% of which occurs during the April-September growing season (Sherwood 1980). Agricultural production emphasizes row crops (46.2%), and forage production (30.8%) (Sherwood 1980). Moderately well-drained silty-clay loams of the Sharpsburg and Shelby series dominate on the uplands (Sherwood 1980).

Experimental design

Fields studied in 1982 and 1983 included two replications of the treatments: corn planted into corn residue (CC), corn planted into herbicide treated sod (CS), and fall-plowed or spring-disced corn (SD). New fields were selected in 1983, and all but one field was being no-tiled for the first time. Individual fields ranged in size from 12 to 57 ha.

Field measurements included residue coverage and depth, and weed coverage. Each variable was measured at 10 random locations within 20 m of the edge and at 15 random locations in the middle of the fields. Measurements were made twice monthly from mid-May through July.
Residue coverage and depth were estimated by using a 15-m bead string, with beads every 15 cm (Sloneker and Moldenhauer 1977). Presence or absence of residue at each bead was recorded and depth measured every 3 m along the string.

In 1982, weed coverage was estimated by using a 15-m line transect placed parallel to the bead string, and the percentage of the line covered by weeds was recorded (Canfield 1941). Because of difficulty encountered in 1982 in estimating weed coverage in heavy vegetation, weed coverage was estimated within a 50 by 50-cm quadrat positioned at the end of the bead string in 1983.

**Trapping**

**Population studies** Small mammals were trapped in Sherman live-traps (7.6 by 8.8 by 22.8 cm) spaced 10 m apart in 10 by 10 trap grids. To document movements of animals occurring within individual fields, one grid was located along the field edge, and one in the middle, away from any vegetative cover. Distances between grids averaged 100 m and ranged from 50 to 200 m.

Trapping sessions were conducted for six consecutive days during crop emergence (15 May-15 June), at the time of maximum corn height (9 July-7 August), and within 2 weeks of harvest (4 October-25 November) in 1982 and 1983. Traps
were baited with a mixture of rolled oats and peanut butter and checked early in the morning. Captured animals were weighed and marked by toe clipping or ear tagging. In addition, age (adult or juvenile based on pelage coloration and weight), sex, and reproductive condition (males testes descended or undescended, females lactating or nonlactating) were recorded at initial capture. Resulting captures were analyzed as minimum numbers of individuals occurring on each grid during each session (Krebs et al. 1973).

Because grids of finite dimensions include only portions of the home ranges of many individuals, total captures are considered to be poor estimations of population density (Stickel 1954, White et al. 1982). For this reason, individual capture histories also were recorded to improve density estimation by incorporating data on home range size.

Population densities were estimated from models for closed populations developed by Otis et al. (1978). Only one species, the prairie deer mouse (*Peromyscus maniculatus*) occurred in sufficient numbers to allow density estimation.

**Habitat studies** In 1983, small mammals were trapped in three replicate grids of 10 Sherman live traps (2 by 5 with 6-m spacing) in locations at the edge (E) and middle (M) of the fields along with adjacent unfarmed areas (UE). Grids within each location were spaced 150-m apart;
distances between grid locations were 75-m. Sessions of six consecutive days were conducted during crop emergence and maximum corn height but were not concurrent with density trapping sessions. Captures were analyzed as minimum numbers of individuals of each species using each area during each session (Krebs et al. 1973).

Statistical analysis

Analysis of variance was used to test for significance of main effects (tillage treatment, location, session, and year) on population levels and density estimates. Because of distributional problems associated with large numbers of grids without captures, Kruskal-Wallis and Wilcoxon-Mann-Whitney nonparametric ranking procedures (Sokal and Rohlf 1969) were used to test for significant differences in habitat utilization. Throughout the tables and text, all means are reported plus or minus one standard error.
RESULTS

Field characteristics

No-till treatments had significantly greater cover ($F=91.73$, df=1,6, $P<0.01$) and depth of residue ($F=5.46$, df=1,6, $P=0.05$) than SD treatments (Table 1). Residue coverage was greatest on CS treatments, 6-25 times the amount found on SD treatments. Weed coverage for all treatments was less than 1.0% during both years and tended to reflect differences of individual fields rather than characterize specific treatments.

Small mammal abundance and diversity

Total numbers of all small mammal species captured did not vary significantly among treatments in 1982 ($F=0.93$, df=2,3, $P=0.48$) or 1983 ($F=5.23$, df=2,3, $P=0.11$) (Table 2). A significant decline of overall captures was evident during 1983, however ($F=9.65$, df=1,6, $P=0.02$).

Mean captures at edge locations were not significantly different from those on middle grids in 1982 ($F=0.01$, df=1,3, $P=0.93$) or 1983 ($F=1.71$, df=1,3, $P=0.28$) (Table 2). Similarly, analysis for treatment and location interaction showed no significant differences in either 1982 ($F=0.09$, df=2,3, $P=0.91$) or 1983 ($F=0.64$, df=2,3, $P=0.59$) indicating that the significant decline previously noted occurred throughout all fields.
TABLE 1. Residue cover (%), depth (cm), and weed cover (%) within three corn tillage treatments in southwestern Iowa during 1982 and 1983

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<tr>
<td>Corn-Corn</td>
<td>84.9±2.5</td>
<td>81.5±2.8</td>
<td>7.8±0.7</td>
<td>10.1±0.9</td>
<td>0.8±0.6</td>
<td>0.1±0.0</td>
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<tr>
<td>Corn-Sod</td>
<td>91.3±2.3</td>
<td>86.4±3.4</td>
<td>7.8±1.9</td>
<td>4.6±0.6</td>
<td>0.9±0.2</td>
<td>0.1±0.0</td>
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<tr>
<td>Spring-Disc</td>
<td>14.3±3.0</td>
<td>3.5±0.6</td>
<td>1.5±0.3</td>
<td>0.3±0.1</td>
<td>0.3±0.1</td>
<td>0.2±0.1</td>
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TABLE 2. Mean total captures of small mammals (animals/six days) on 10 x 10 m trapping grids at edge (E) and middle (M) locations on three corn tillage treatments in southwestern Iowa during 1982 and 1983

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<tr>
<td>Corn-Corn</td>
<td>6</td>
<td>30±2</td>
<td>28±5</td>
<td>20±4</td>
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<td>27±5</td>
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<tr>
<td>Corn-Sod</td>
<td>6</td>
<td>35±9</td>
<td>35±4</td>
<td>15±3</td>
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<tr>
<td>Treatment Mean</td>
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<td>16±2</td>
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<tr>
<td>Spring-Disc</td>
<td>6</td>
<td>25±4</td>
<td>28±3</td>
<td>20±2</td>
<td>23±2</td>
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<tr>
<td>Treatment Mean</td>
<td>27±2</td>
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<td>22±2</td>
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<tr>
<td>Total</td>
<td>30±3</td>
<td>30±2</td>
<td>18±2</td>
<td>24±4</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>30±2</td>
<td>21±2</td>
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Seasonal changes in total captures were not significantly different during 1982 ($F=0.19$, $df=2, 18$, $P=0.83$) although they were highly variable among treatments in November (Figure 1). In 1983, significant differences existed in monthly captures pooled for all treatments ($F=59.91$, $df=2, 18$, $P<0.01$) with levels being significantly less in May ($t=6.75$, $df=22$, $P<0.01$) and July ($t=3.53$, $df=22$, $P<0.01$) but regaining 1982 levels by November ($t=0.05$, $df=22$, $P=0.96$). The population recovery was different among treatments with both CS and SD fields remaining significantly lower in May ($t=7.91$, $df=4.1$, $P<0.01$ and $t=3.25$, $df=6$, $P=0.02$ respectively) and July ($t=2.33$, $df=6$, $P=0.06$ and $t=5.14$, $df=6$, $P<0.01$ respectively), whereas CC treatments attained levels similar to 1982 by July ($t=1.23$, $df=6$, $P=0.26$).

Deer mice dominated the populations of small mammals trapped at all locations in both years, comprising 64% of the captures in 1982 and 70% in 1983 (Table 3). Western harvest mice (*Reithrodontomys megalotis*) were captured almost exclusively on CS fields or near grassy field edges. Shorttail shrews (*Blarina brevicauda*) were associated with grassy field edges of all treatments. House mice (*Mus musculus*) and northern grasshopper mice (*Onychomys leucogaster*) were captured equally on all treatments,
FIGURE 1. Seasonal changes in small mammal captures within three corn tillage treatments in southwestern Iowa during 1982 and 1983.
however, house mice occurred in higher proportions at edge locations (67%) and grasshopper mice in higher proportions at middle locations (66%). Thirteen-lined ground squirrels were ubiquitous in 1982, but, in 1983 were captured almost exclusively on no-till treatments (95%).

Community diversity, quantified using the Shannon-Weaver Diversity Index (Poole 1974), was significantly greater at field edges in 1982 ($F=39.33$, $df=1,3$, $P=0.01$) and 1983 ($F=19.18$, $df=1,3$, $P=0.02$) (Table 4). Treatment effects on community diversity approached significance in 1982 ($F=4.23$, $df=2,3$, $P=0.13$) and diversity was significantly greater on no-till treatments in 1983 ($F=10.77$, $df=2,3$, $P=0.04$).

**Deer mouse populations**

**Population density** Data analyzed for this study fit model $M_h$, the jackknife estimator (Otis et al. 1978), for 35 of the trapping experiments. Because $M_h$ performs poorly without substantial numbers of recaptures (Otis et al. 1978), it was necessary to use additional models in data analysis. Models $M_b$, the Zippin estimator, and $M_t$, the Darroch estimator, were used in two data analyses. Model $M_o$, the null estimator allowing for no variation in capture probability, was used in three data analyses. Insufficient animal captures to allow appropriate model testing or data
<table>
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<th>Treatment</th>
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<th>E</th>
<th>M</th>
<th>E</th>
<th>M</th>
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<td>Corn - Corn</td>
<td>104±24</td>
<td>97±6</td>
<td>72±17</td>
<td>81±20</td>
<td>101±6</td>
<td>95±1</td>
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<td>White-footed mouse (Peromyscus leucopus)</td>
<td>Corn - Sod</td>
<td>0±0</td>
<td>2±1</td>
<td>0±0</td>
<td>0±0</td>
<td>1±1</td>
<td>0±0</td>
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<td>Western-harvest mouse (Reithrodontomys megalotis)</td>
<td>Spring-Disc</td>
<td>1±1</td>
<td>1±1</td>
<td>22±22</td>
<td>16±13</td>
<td>0±0</td>
<td>1±1</td>
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<td>House mouse (Mus musculus)</td>
<td>M</td>
<td>4±4</td>
<td>23±11</td>
<td>12±9</td>
<td>14±8</td>
<td>10±4</td>
<td>17±10</td>
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<td>Northern grasshopper mouse (Onychomys leucogaster)</td>
<td>E</td>
<td>6±3</td>
<td>4±4</td>
<td>7±7</td>
<td>3±3</td>
<td>3±1</td>
<td>1±1</td>
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<td>Shorttail shrew (Blarina brevicauda)</td>
<td>M</td>
<td>1±0</td>
<td>22±6</td>
<td>2±1</td>
<td>8±6</td>
<td>0±0</td>
<td>14±7</td>
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<tr>
<td>Masked shrew (Sorex cinereus)</td>
<td>E</td>
<td>0±0</td>
<td>0±0</td>
<td>0±0</td>
<td>1±1</td>
<td>0±0</td>
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<tr>
<td>Meadow vole (Microtus pennsylvanicus)</td>
<td>M</td>
<td>0±0</td>
<td>2±0</td>
<td>3±1</td>
<td>4±3</td>
<td>0±0</td>
<td>1±1</td>
</tr>
<tr>
<td>Meadow Jumping mouse (Zapus hudsonius)</td>
<td>E</td>
<td>0±0</td>
<td>1±1</td>
<td>0±0</td>
<td>0±0</td>
<td>0±0</td>
<td>0±0</td>
</tr>
<tr>
<td>Thirteen-lined ground squirrel (Spermophilus tridecemlineatus)</td>
<td>E</td>
<td>13±5</td>
<td>17±0</td>
<td>15±9</td>
<td>14±1</td>
<td>7±6</td>
<td>9±8</td>
</tr>
</tbody>
</table>
TABLE 4. Mean Shannon-Weaver diversity values (natural bels/year) on 10 x 10 m trapping grids at edge (E) and middle (M) locations within three corn tillage treatments in 1982 and 1983.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn-Corn</td>
<td>0.48±0.08</td>
<td>1.15±0.00</td>
<td>0.79±0.12</td>
<td>1.31±0.10</td>
</tr>
<tr>
<td>Corn-Sod</td>
<td>1.11±0.24</td>
<td>1.35±0.10</td>
<td>0.84±0.02</td>
<td>1.09±0.09</td>
</tr>
<tr>
<td>Spring-Disc</td>
<td>0.68±0.15</td>
<td>0.99±0.04</td>
<td>0.44±0.08</td>
<td>0.71±0.16</td>
</tr>
</tbody>
</table>
ill-suited for any model occurred in 30 of the trapping experiments.

Because density is a function of both numbers caught and strip width (Otis et al. 1978), computing density by dividing number of animals captured by grid area results in exaggerated density estimates (Stickel 1946). For this reason, in experiments where capture data were ill-suited to model testing, density was calculated by adding one-half of the mean maximum distance between captures to the outside of the grid (Dice 1938, Blair 1941, Stickel 1946, Van Horne 1982). Only animals captured four or more times during a given session were used to estimate such boundary strips. Density estimates computed from the same data using the methods of Otis et al. (1978) then were compared to densities calculated in this manner to determine compatibility of the two methods. Results showed estimates to be similar regardless of the density estimator used ($t = 0.17$, $df = 18$, $P = 0.87$).

Density responses to individual treatments fluctuated widely, but differences were not significant in 1982 ($F = 2.88$, $df = 2,3$, $P = 0.20$). In 1983, however, CS fields had significantly lower densities than either CC or SD treatments ($t = 3.18$, $df = 3$, $LSD = 4.0$) (Figure 2). Consistent with total captures of all species, deer mouse densities were significantly lower in 1983 ($F = 13.64$, $df = 1,6$, $P = 0.01$).
FIGURE 2. Seasonal changes in deer mouse densities within three corn tillage treatments in southwestern Iowa during 1982 and 1983.
During both years, density levels were similar over the entire field. No significant differences were detected between edge (12.8±2.0) and middle (15.9±2.0) locations in 1982 ($F=0.90$, $df=1,3$, $P=0.41$) or edge (9.9±1.7) and middle (9.2±1.7) in 1983 ($F=0.30$, $df=1,3$, $P=0.62$).

During 1982, there were no significant differences in densities among months ($F=0.62$, $df=2,18$, $P=0.56$). Overall densities remained significantly lower for the first two samples of 1983 but regained 1982 levels by November ($t=2.18$, $df=12$, $LSD=4.4$). Seasonal changes in densities of deer mice paralleled changes in total captures and undoubtedly reflect the high proportion of the overall community represented by this species.

**Distances moved** Mean maximum distances travelled by animals captured on four or more occasions were inversely related to density estimates on all treatments. Distances moved by individuals captured at middle locations (49.7±2.4) were slightly greater than those trapped at edge locations (43.1±3.0). However, location effects were not significant during either 1982 ($F=1.85$, $df=1,3$, $P=0.27$) or 1983 ($F=0.74$, $df=1,3$, $P=0.45$). The maximum distance moved by any recaptured individual was 840 m by an adult male.

**Proportion of juveniles** Treatment effects on the proportion of juveniles was not significant in either year.
Changes in proportion juveniles during the season were similar on both middle and edge locations ($\bar{F}=3.12$, $df=1,3$, $P=0.18$ in 1982, $\bar{F}=2.69$, $df=1,3$, $P=0.20$ in 1983). Proportions tended to be lower during the mid-summer samples although results were variable.

**Proportion of lactating females**  
Peak proportion of females lactating occurred in July ($68.7\pm5.7\%$) in 1982, and were significantly greater than proportions for either May ($35.3\pm4.3\%$) or November ($34.3\pm5.9\%$) ($t=2.18$, $df=12$, $LSD=13.5$) (Figure 4). This peak corresponded to the lower juvenile segment of the population during this same sample.

The proportion of females lactating was not significantly different among treatments in either year ($\bar{F}=4.83$, $df=2,3$, $P=0.12$ and $\bar{F}=0.77$, $df=2,3$, $P=0.54$ in 1982 and 1983, respectively). During 1983, proportions were characterized by great variability, especially on no-till fields, and showed no definite peak. Mean proportions increased slightly from May ($41.0\pm8.5\%$) to July ($48.1\pm9.3\%$) and remained stable through November ($48.3\pm5.7\%$).

**Habitat utilization**  
Small mammals used the three habitat types relatively equally in all treatments over both months (Figure 5).
FIGURE 3. Proportion of juveniles among live-trapped deer mice within three corn tillage treatments in southwestern Iowa during 1982 and 1983.
FIGURE 4. Seasonal changes in proportions of lactating female deer mice within three corn tillage treatments in southwestern Iowa during 1982 and 1983.
Consistent with population levels on large grids, captures increased slightly in all habitats from June to August.

Captures pooled by month were not significantly different among habitats within each treatment (CC, \( U=0.82 \), CS, \( U=1.78 \), SD, \( U=3.90 \), \( P>0.05 \)). Likewise, similar habitat types were not significantly different among treatments (M, \( U=5.66 \), E, \( U=0.34 \), UE, \( U=0.36 \), \( P>0.05 \)).

**Deer mice**  Captures of deer mice during both months were greatest at middle locations and least in the unfarmed edges surrounding fields (Figure 6). Differences were not significant among any of the habitats in the CC treatment in any month (\( U=1.21 \), \( P>0.05 \)). In both CS and SD fields, however, significantly more animals were captured at middle locations than in unfarmed edge areas (CS, \( U=6.61 \), SD, \( U=13.33 \), \( P<0.05 \)).

Neither edge (\( U=3.42 \), \( P>0.05 \)), nor unfarmed edge locations (\( U=0.42 \), \( P>0.05 \)) were significantly different among treatments. Middle locations, however, had significantly more captures occurring on the SD treatment than either no-till treatment (\( U=10.47 \), \( P<0.01 \)). Generally, lower populations of deer mice occurring at unfarmed edge and edge locations, supports the idea that these areas maintain a more diverse community of small mammals because overall populations were not different (Figure 5).
FIGURE 5. Total small mammals captured within three habitat types in three corn tillage treatments in southwestern Iowa during 1983.
FIGURE 6. Utilization of three habitat types by deer mice in three corn tillage treatments in southwestern Iowa during 1983.
Other species  Non-parametric tests on habitat use by other species were impractical due to the lack of captures at many locations, however, certain trends are evident. Captures of thirteen-lined ground squirrels occurred at all locations in CS fields during both months, and greatest captures were always at the middle of fields (Figure 7). In SD treatments, most captures were in adjacent unfarmed areas, and no captures were in field middles.

Captures of northern grasshopper mice were highest at middle locations (5.0±2.0) and decreased substantially at edge (0.8±0.5) and unfarmed edge locations (0.3±0.3). Shorttail shrews occurred in unfarmed areas associated with all fields. White-footed mice were captured on all treatments, with captures at unfarmed edge locations (5.2±2.1) being higher than edge locations (4.3±2.0). Similarly, house mice captures were higher in unfarmed areas (3.2±1.6) compared with edge areas (0.5±0.5).
FIGURE 7. Utilization of three habitat types by thirteen-lined ground squirrels in three corn tillage treatments in southwestern Iowa during 1983.
DISCUSSION

Small mammal communities in agroecosystems of the Midwest typically are dominated by prairie deer mice because of their ability to exploit disturbed areas with minimal vegetative cover (Johnson 1926, Dambach 1948, Whitaker 1966, 1967). With adequate food and cover, deer mice may reproduce 12 months a year and thus maintain stable population levels year round (Linduska 1942, Flake 1974, Voight and Glenn-Lewin 1979). Such populations are often characterized by low densities with minimal fluctuation during a given year (Terman 1968).

Increased residue cover on no-till fields had little observable effect on deer mouse densities or demographic parameters. In early spring, population levels of no-till treatments were less than SD treatments which may have been attributable to increased soil compaction. Gantzer and Blake (1978) reported significantly higher bulk densities in no-till fields on clay-loam soils in the upper 30 cm, with the most pronounced difference occurring in spring, and Whitaker (1968) observed that soil compaction may become a potentially limiting factor to Peromyscus. Ease of burrowing, however, may be most important in limiting distribution rather than density of deer mice.
Generally similar densities in middle and edges of fields indicate homogeneous populations throughout these fields. Additionally, similar distances moved on all areas of these fields indicate minimal encroachment from edge locations. Previous studies of deer mice in agroecosystems support this finding (Linduska 1946, Fleharty and Navo 1983).

Deer mouse densities were considerably reduced between November 1982 and May 1983 in agroecosystems in Iowa. This reduction may have been related to the severe winter of 1982 when subzero temperatures, combined with minimal snow cover through late December, presumably adversely affected population densities (Ferguson and Folk 1970, Hill 1983). The recovery of densities to former levels, which occurred from July to October 1983, supports the idea of nonfluctuating population levels with major changes attributable to severe weather patterns (Stickel 1968). Evidence supporting the delayed population responses during 1983 include, greater proportions of non-breeding juveniles in the May population and the greatest proportion of females lactating during July.

Stable population levels in an area can be maintained by immigration of individuals from surrounding habitats or by reproduction of resident individuals. Recruitment from adjacent habitats would most likely be reflected by an
increase in the juvenile segment of the population (Yahner 1983, Hingtgen and Clark 1984). The parallel changes in percentage of juveniles at edge and middle locations supports the idea of homogeneous populations maintained by reproduction and not immigration from adjacent habitats. Equal utilization of unfarmed roadsides and habitats within fields indicate this homogeneity may include areas adjacent to these fields.

Although populations of deer mice were homogeneous in these agricultural systems, overall small mammal community diversity was greater near edges and in roadsides. Community diversity was also greater in no-till verses SD treatments, although the magnitude difference was not as pronounced at locations along field edges. Additional habitat provided by residue, roadside vegetation, and decreased disturbance near edge locations would create a wider diversity of niches, thus facilitating coexistence of a greater number of small mammal species (M'Closky 1976, Holbrook 1978). Structural attributes of other communities, such as grasslands, have been found to be a primary factor in determining composition of these communities (Grant et al. 1982). The occurrence of species such as shrews, voles, and thirteen-lined ground squirrels, which accounted for increased diversity at edge locations, is directly related to these microhabitat features (Hamilton 1943, Walker 1975).
Species contributing to middle diversity values were primarily insectivores (Flake 1973, Young 1984). This may reflect the ease with which this food resource is readily obtained within the agricultural fields proper. The less pronounced effect of no-till treatments on diversity presumably reflects the moderate increase in structure provided by residue compared to roadsides.

Implications to farmers of increased rodent diversity might be serious if species which damaged crops became more prevalent. Specific depredation concerns have focused on thirteen-lined ground squirrels, which were more prevalent near edge locations and in no-till fields. However, the low population levels of this species indicate that widespread concern of crop depredation is unwarranted. Additionally, Young (1984) reported that food of these rodents in no-till systems consists primarily of animal matter.

Thus, the effect of no-till agriculture on small mammal populations is one characterized by increased community diversity rather than increases in the total abundance. The effect on communities is immediate, occurring within the first year after transition to no-till practices. There is no evidence to suggest that populations of small mammals might increase in such fields over the longer term.
LITERATURE CITED


Linduska, J.P. 1946. Edge effect as it applies to small mammals on southern Michigan farmland. Trans. 11th N. Amer. Wildl. Conf. 200-204.


SECTION II. CROP DEPREDATION AND FOOD RESOURCE UTILIZATION

BY SMALL MAMMALS IN NO-TILL FIELDS OF SOUTHWESTERN IOWA
Food habits and population levels of major small mammals present in no-till and disced corn fields were studied during the 1982 and 1983 growing seasons in southwestern Iowa to determine the extent of small mammal damage to emerging corn seedlings. Tillage treatments included corn planted into corn residue, corn planted into chemically treated sod, and disced or plowed corn fields. Deer mice (Peromyscus maniculatus) comprised 75% of all small mammal captures in 1982 and 86% in 1983. Thirteen-lined ground squirrels (Spermophilus tridecemlineatus) accounted for 12% of animals captured in 1982 and 5% in 1983. Rodent damage resulted in complete mortality to plants because detected damage was from seed excavation. Overall, mortality caused by small mammals (0.57%) was less frequent than insect (1.38%) and weather-induced mortality (0.66%). Arthropods comprised 55-94% of the dry weight of all food items in diets of deer mice and 59-88% in diets of ground squirrels. Corn was a minor dietary constituent of both species from all treatments.
INTRODUCTION

No-till agriculture has become increasingly popular in the Midwest largely in response to public demands for increased soil preservation. The benefits of no-till are well-documented and include decreased man and machine hours afield (Blevins et al. 1971), increased retention of soil moisture (Harold et al. 1970), and improved soil stabilization (Sloneker and Moldenhauer 1977).

Expressed concerns regarding no-till have focused on pest species destroying crops. These concerns have escalated with the conversion to no-till systems because tillage has been a primary means used to control many of these pests (Phillips et al. 1980). Specific concerns have focused on armyworms (*Pseudaletia unipuncta*), black cutworms (*Agrotis ipsilon*), European stalk borers (*Papaipema nebris*), corn rootworms, slugs, and mice (Gregory and Musick 1976). This paper addresses the impacts of rodents on corn seedling survival in no-till and conventional-till fields. Responses of rodent populations to no-till agriculture are given elsewhere (Young 1984).

Research on small mammals in agroecosystems has focused primarily on population thresholds relative to economically significant damage levels and pertained primarily to colonial rodents (Greaves 1982, Fleharty and Navo 1983).
Potential problems with rodents in no-till systems exist if densities capable of causing significant levels of crop damage are attained. Benefits of increased rodent densities may be realized, however, if they consume deleterious insects and competing weed species.

Johnson et al. (1982) cited reports of increased depredation to corn seeds and seedlings in minimum tillage systems. Holm et al. (1984) reported rodent damage to corn seedlings in no-till fields of western Nebraska. Beasley and McKibben (1975) documented increased corn yields (4-13 bu/ha) in no-till fields treated with the rodenticide zinc phosphide. Currently, however, little quantification exists concerning either increased small mammal densities or increased crop damage associated with no-till compared with conventional-till practices.

The objective of this study was to quantify small mammal crop depredation occurring in no-till and conventional-till fields. Additionally, food habits of these small mammals were investigated to determine diets at the time of crop emergence.
METHODS

Site description

Research was conducted on privately-owned farms in Adair County, southwestern Iowa. Climate of the region is subhumid and continental, with an average annual precipitation of 84 cm, 73% of which occurs during the April-September growing season (Sherwood 1980). Agricultural production emphasizes row crops (46.2%) and forage production (30.8%) (Sherwood 1980).

Tillage practices  Gently rolling topography in Adair County has led to gradual increases in no-till farming during the past decade. Acreages devoted to no-till in the past 4 years have undergone a thirtyfold increase, but in 1983 represented only 3% of the county's agricultural land (Marvin Lundstedt, U.S. Soil Conservation Service, Greenfield, Iowa, personal communication). Study fields used in 1982 and 1983 included two replications each of the treatments: corn planted into corn residue (CC), corn planted into herbicide-treated sod (CS), and fall-plowed or spring-disced corn (SD). New fields were selected in 1983, and all but one field was being no-tilled for the first time.
Population studies

Small mammals were trapped in Sherman live-traps (7.6 by 8.8 by 22.8 cm) spaced 10 m apart within 10 by 10 trap grids. Two trapping grids were established on each field to document differential densities of animals occurring within individual fields. One grid was located along the field edge and one in the middle away from vegetative cover. Distances between grids averaged 100 m and ranged from 50 to 200 m.

Trapping sessions were conducted for six consecutive days during crop emergence (15 May-15 June). Traps were baited with a mixture of rolled oats and peanut butter and were checked early in the morning. When initially captured, animals were marked by ear tagging or toe clipping and weighed to determine age (Wade 1927, Evans 1951, Young 1984). Because insufficient captures of thirteen-lined ground squirrels (*Spermophilus tridecemlineatus*) were made to facilitate precise density estimation, densities of adults capable of causing damage to emerging corn were reported as number of adults trapped/grid area (Otis et al. 1978). Density estimates for deer mice (*Peromyscus maniculatus*) are taken from Young (1984).
Crop damage

To assess crop damage, 10 50-m transects were established along crop rows on each field in 1982. In 1983, each 50-m transect was divided into two parallel 25-m transects to identify patterns of rodent depredation occurring in adjacent rows. In both years, half of these transects were located within 60 m of the field edge and half in the middle of the field. Upon emergence (15 May-3 July), corn seedlings were marked with a numbered "popsicle" stick to facilitate relocation (modified from Heisterberg 1979). Seedlings were examined and damage noted every other day for the first 10 days post-emergence. Damage assessment included monitoring for rodent, insect, weather, and injury caused by farm implements. Rodent damage was identified by excavated and partially consumed seeds and resulted in seedling mortality. During the final assessment, individual seedlings were noted as surviving or succumbing as a result of the damage incurred (Heisterberg 1979).

Food habits

To determine food habits of major small mammal species, individuals were snap-trapped on two fields of each treatment type during corn emergence (1 June-15 July). Eight individuals of each species were collected from both middle and edge locations on each treatment. Middle
locations were at least 100-m from any unfarmed area (Young 1984). Traps were arranged to achieve the most effective coverage at each location. Stomach contents of the animals were washed, oven-dried, ground to uniform particle size (1.3 mm), and examined under a 100X microscope field to determine percent relative densities of selected food species. Values for percent dry weight of food species were determined by the methods of Sparks and Malechek (1968). Although food items such as arthropods and weed seeds may not be most accurately represented by a 1:1 relationship of relative density to relative dry weight in the diet, such a relationship was assumed for estimating food consumption. Analogous structures, such as undigested plant epidermal remnants, seed coats, and chitinous remnants of arthropods, were used to identify food items in the histological analysis.

Statistical analysis

Contingency analysis was used to test for disproportionate distributions of rodent mortality to corn seedlings. Analysis of variance was used to test for significance of main effects (tillage treatment and location) in analyzing small mammal densities. Multivariate analysis of variance on arcsin transformed food percentages (Snedecor and Cochran 1980) was used to examine treatment
and location effects on diet composition. Throughout tables and text, all means are reported plus or minus one standard error.
RESULTS

Small mammal populations

Deer mice dominated the populations of small mammals trapped at all locations in both years, comprising 74.9% of the captures in 1982 and 85.5% in 1983. Thirteen-lined ground squirrels accounted for 11.7% of all captures in 1982 and 5.3% in 1983. A comprehensive list of species captured is given in Young (1984).

Deer mouse densities were significantly greater on SD treatments during 1982 ($F=17.63$, $df=2,3$, $P=0.02$). In 1983, however, no significant differences were detected among treatments ($F=4.40$, $df=2,3$, $P=0.13$). During both years, no significant differences were observed between locations ($F=0.24$, $df=1,3$, $P=0.64$ in 1982, and $F=0.01$, $df=1,3$, $P=0.92$ in 1983) (Table 5). Densities of adult thirteen-lined ground squirrels were not significantly different between treatments in either 1982 ($F=1.69$, $df=2,3$, $P=0.32$) or 1983 ($F=8.38$, $df=2,3$, $P=0.06$) (Table 5). Similarly, no significant differences were detected between locations in either 1982 ($F=2.17$, $df=1,3$, $P=0.20$) or 1983 ($F=0.57$, $df=1,3$, $P=0.48$).
<table>
<thead>
<tr>
<th>Year</th>
<th>Treatment</th>
<th>Corn-Corn</th>
<th>Corn-Sod</th>
<th>Spring-Disc</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Middle</td>
<td>Edge</td>
<td>Middle</td>
<td>Edge</td>
</tr>
<tr>
<td>Deer Mice</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1982</td>
<td>12.0±0.0</td>
<td>11.5±0.5</td>
<td>11.0±7.0</td>
<td>14.5±5.5</td>
</tr>
<tr>
<td>1983</td>
<td>10.5±2.5</td>
<td>11.0±1.0</td>
<td>5.5±0.5</td>
<td>7.5±2.5</td>
</tr>
<tr>
<td>Ground Squirrels</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1982</td>
<td>1.2±0.0</td>
<td>0.0±0.0</td>
<td>8.0±5.6</td>
<td>4.9±3.7</td>
</tr>
<tr>
<td>1983</td>
<td>0.0±0.0</td>
<td>1.9±0.6</td>
<td>1.9±0.6</td>
<td>1.2±0.0</td>
</tr>
</tbody>
</table>
Crop damage

A total of 27,346 corn seedlings was monitored during 1982 and 1983. Mortality from insects was the primary factor decimating seedlings on both no-till treatments, but mortality caused by runoff erosion was the greatest single mortality factor on SD treatments (Figure 8).

Rodent depredation and weather-related mortality were the most treatment-specific damages and also were most variable among individual fields. Rodent-induced mortality occurred predominantly on CS tillages and ranged from 0.0 to 5.1%. Weather-related mortality characteristically was observed on SD tillages with slopes exceeding 9.0% and reached a maximum of 6.5% of all seedlings on one field.

Contributing factors to seedling mortality varied yearly and were largely dependent on external factors such as weather patterns and individual crop management systems. During 1982, insects were responsible for 54.0% of all seedling mortality, whereas rodent depredations accounted for an additional 31.0%. In 1983, insects were again a major contributor to overall mortality (43.0%), weather-related mortality accounted for 55.0% of all seedling losses, and rodent depredations accounted for <0.4%.

Contingency analysis comparing rodent and total mortality between treatments in 1982 showed different
FIGURE 8. Mortality factors of corn seedlings on three tillage treatments in southwestern Iowa during 1982 and 1983. Sample size is given above each bar.
proportions of rodent-induced mortality on no-till verses SD fields ($X^2=72.6$, df=2, $P<0.01$). Similar analysis for 1983 was inappropriate because the small amount of rodent damage detected resulted in cell sizes that were too small.

Food habits

Deer mice Animal matter was the major food component in the diet of deer mice, comprising 77.3% by weight of all food items in 1982 and 71.2% in 1983. During both years, consumption of arthropods was greatest on SD treatments (86.4±3.5%) followed by CS (77.1±4.9%) and CC (59.2±5.0%) fields ($F=9.81$, df=2,90, $P<0.01$). In 1982, corn, seed, grass, and forb components were consumed in greatest amounts on CC treatments and least on SD treatments ($F=3.80$, df=10,76, $P<0.01$) (Table 6). A similar relationship existed during 1983, except that mean corn percentages on SD treatments (4.5%) were higher than on CS treatments (3.3%) ($F=1.65$, df=10,76, $P=0.11$).

Effects of location were not evident in dietary composition during either 1982 ($F=0.85$, df=5,38, $P=0.53$) or 1983 ($F=0.38$, df=5,38, $P=0.86$). Similarly, treatment-location interactions showed no differences in either year ($F=1.17$, df=10,76, $P=0.32$ and $F=1.27$, df=10,76, $P=0.26$ for 1982 and 1983, respectively).
TABLE 6. Mean percent dry weight of food items in the diets of deer mice during corn emergence within three tillage treatments in southwestern Iowa

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Corn-Corn</th>
<th>Corn-Sod</th>
<th>Spring-Disc</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Food Item</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Arthropod larvae</strong></td>
<td>55.2±7.4</td>
<td>63.3±6.7</td>
<td>82.3±4.4</td>
</tr>
<tr>
<td><strong>other</strong></td>
<td>41.3±6.4</td>
<td>45.0±7.4</td>
<td>61.2±3.8</td>
</tr>
<tr>
<td><strong>Corn</strong></td>
<td>6.6±1.8</td>
<td>4.5±1.3</td>
<td>4.8±1.8</td>
</tr>
<tr>
<td><strong>Seed</strong></td>
<td>25.4±5.6</td>
<td>7.0±1.2</td>
<td>7.1±2.7</td>
</tr>
<tr>
<td><strong>Grass</strong></td>
<td>9.6±3.1</td>
<td>14.0±3.7</td>
<td>4.5±1.7</td>
</tr>
<tr>
<td><strong>Foxtail</strong></td>
<td>2.6±1.9</td>
<td>1.8±1.3</td>
<td>2.1±1.7</td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td>7.0±2.5</td>
<td>12.2±3.1</td>
<td>2.4±0.6</td>
</tr>
<tr>
<td><strong>Forb</strong></td>
<td>3.2±0.7</td>
<td>11.2±2.2</td>
<td>1.3±0.5</td>
</tr>
<tr>
<td><strong>Velvetleaf</strong></td>
<td>0.1±0.1</td>
<td>0.3±0.2</td>
<td>0.1±0.1</td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td>3.1±0.7</td>
<td>10.9±2.2</td>
<td>1.2±0.5</td>
</tr>
</tbody>
</table>
Corn was a minor dietary component on all treatments, ranking last among the five major food categories on all treatments in 1983 and only as high as 6.6% in 1982 (Table 6). During both years, deer mice residing on fields with corn residue remaining from the previous years' crop had the greatest amount of corn in their diet. Frequency of occurrence of corn in the stomachs of all deer mice was 56.3%.

Insect species regarded as deleterious to corn seedling growth (e.g. black cutworms or army worms) represented a large portion of the diet during both years, ranging from 13.9% to 39.0%. Occurrence of larval insects was greatest in diets of deer mice residing on SD fields and least on CC fields. Larval fragments occurred in 84.4% of all stomachs examined.

Consumption of herbaceous material (grass and forbs) was highly variable among treatments and between years. Foxtail (Setaria spp.) and velvetleaf (Abutilon theophrasti) were the major identifiable constituents of these respective categories. Numerous vegetative fragments without positively identifiable species specific structures undoubtedly caused these vegetative components to be underestimated.
Ground squirrels Thirteen-lined ground squirrels were collected on both CC treatments (n=10) and CS treatments (n=4) in 1982. Arthropods were the major dietary food item of squirrels from both treatments, comprising 59.3±7.6% on CC fields and 88.0±3.8% on CS fields. Herbaceous material (grass and forbs) accounted for an additional 31.6±7.0% on CC treatments and 8.2±2.7% on CS treatments. Corn ranked last among the five major food categories on both treatments during this year (5.6±2.6% on CC and 0.9±0.9% on CS).
DISCUSSION

Small mammal populations and crop damage

Small mammal communities in agroecosystems of the Midwest typically are dominated by prairie deer mice because of their ability to exploit disturbed areas with minimal vegetative cover (Johnson 1926, Dambach 1948, Whitaker 1966, 1967). In no-till systems, increased residue and lack of disturbance may offer suitable habitats to crop damaging rodents such as thirteen-lined ground squirrels (Fitzpatrick 1925).

During this study, CS tillages supported the greatest densities of resident ground squirrels. This is consistent with literature accounts that preferred ground-squirrel habitat consists of short-grass uplands (Clark 1970). Depredation problems were most severe on CS treatments, but were not common to all fields examined.

High variation in rodent-related mortality factors between fields emphasizes the idea that depredation concerns should be directed towards individual fields rather than no-till as a whole. That <1.0% of corn seedlings on no-till fields were damaged by rodents indicates that the problem of small mammal depredation is not serious. However, individual fields with depredation rates exceeding 5.0% indicate attention to the potential problem is warranted.
Early identification of problem areas would facilitate treatment to control depredation problems. Johnson et al. (1982) discuss various control measures available to limit depredation problems. Problem fields may effectively be treated by delaying planting until alternative foods such as insects or green vegetation become more available. These areas would only include fields with established populations of ground squirrels at planting time since emergence and dispersion of young occur after the time when corn seedlings are vulnerable (Wade 1927, Rongstad 1965).

**Food habits**

Deer mice and thirteen-lined ground squirrels are considered opportunistic omnivores readily feeding on available food items (Johnson 1961, Landry 1970, Whitaker 1972, Houtcooper 1978). In agricultural and other disturbed systems, a major diet component typically is animal matter, especially lepidopteran larvae (Fitzpatrick 1926, Whitaker 1966, Osborne and Sheppe 1971). However, cultivated crops may be an important food before insects are available in early spring (Houtcooper 1978). The low proportion of corn found in the diets of deer mice and ground squirrels during this study probably reflect an abundance of available insects.
Treatment differences in deer mouse diets reflect the greater diversity of available food on no-till treatments. Increased corn availability in the form of waste grain also may account for much of the dietary corn. This is supported by the fact that deer mice residing on CC tillages had the greatest amount of corn in their diet.

In light of the diet composition of rodent species and the low crop depredation found in this study, widespread control of small mammal populations in no-till systems is unwarranted. Although regarded as pest species by many farmers, the role these animals play is undoubtedly more beneficial through consumption of deleterious insects and competing weed species than it is detrimental through consumption of corn seeds or seedlings.
LITERATURE CITED


SUMMARY

Rodent population levels in no-till fields in Iowa were similar to those in conventional-till systems. The major effect of increased residue was to diversify small mammal communities. Microhabitat features associated with no-till (residue cover, less disturbance) provide small mammals with a greater diversity of exploitable niches, thus facilitating coexistence of a greater number of species. This effect is immediate, occurring within the first year after transition to no-till.

Fluctuations in population levels were attributed to severe winter weather which may have limited breeding activity and/or caused mortality of resident individuals.

Encroachment of individuals from adjacent, unfarmed areas was minimal as population levels were similar on all areas of these agricultural fields. More diverse communities near field edges might imply potentially more crop-damaging species, however, low population levels of rodents indicate that widespread concern is unwarranted.

Low amounts of rodent depredation on corn seedlings (<1.0%), indicate that this problem is not serious. Food habits indicate rodents consume large amounts of deleterious insects and weed seeds compared with corn seeds or seedlings.
In light of the diet composition of rodent species and low amounts of crop depredation found in this study, widespread control of small mammal populations in no-till systems is unwarranted. Although regarded as pest species by many farmers, the role these animals play is undoubtedly more beneficial through consumption of deleterious insects and competing weed species than it is detrimental through consumption of corn seeds or seedlings.


