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Influence of Tillage Practices on the Diets of Deer Mice

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Introduction

Small mammal populations in cultivated ecosystems have received limited research attention (11, 15, 20, 23, 28). Because of the tremendous amount of acreage devoted to agricultural crops, especially in the midwestern United States, these ecosystems and the animals that utilize them deserve study. Additionally, major shifts in farming practices may dramatically impact wildlife that utilize these early successional habitats. One such change is the recent and ever increasing adoption of zero tillage or no-till and a variety of other tillage practices, collectively referred to as conservation tillage. All have in common reduced disturbance of the soil surface resulting in the retention of greater amounts of surface residues. The impacts of conservation tillage practices on small mammals have only recently been addressed and have been concerned primarily with species occurrence, population levels, and damage to crop seedlings by rodents (7, 8, 13, 19, 25, 30).

The deer mouse (*Peromyscus maniculatus*) is generally the most abundant small mammal, and many times the only permanent resident species, inhabiting row-crop fields over much of the United States (7, 8, 11, 13, 20, 25). Although food habits of deer mice have been described for a variety of habitats and locations (5, 9, 10, 12, 17, 18, 21, 24, 29), few studies have been conducted in corn and soybean fields where tillage methods are detailed (8, 13, 16, 27). The purposes of our study were to document summer and winter foods of deer mice in agricultural fields and to explore the influence of crop and tillage practices on diets.

Study Area and Methods

During 1983 and 1984, deer mice were captured from 36 winter (January-February) and 35 summer (June-July) row-crop fields in Scott Co., southeastern Indiana. All fields were on privately owned farms. The topography is flat to moderately rolling with silt loam soils derived from glacial till. Cultivated fields were generally irregular in shape due to topography and numerous small waterways. Fields surveyed in winter and summer averaged 14.4 ha and 10.3 ha, respectively.

Winter fields were classified into four categories: corn residue, soybean residue, tilled, or fallow (Table 1). Corn residue fields had been planted to corn the previous summer and residues left unchopped after fall harvest. Of these, five fields also had an aerially seeded cover crop (wheat, ryegrass, hairy vetch, or crown vetch) present. Seven of the soybean residue fields had been conventionally planted to soybeans the previous summer, three had wheat residue due to double cropping, one had been no-tilled into corn residue, and one had a cover crop of crown vetch. Tilled fields included six disced corn fields, one chisel-plowed corn field, one moldboard-plowed corn field, and two chisel plowed soybean fields. The fallow fields were sampled only in 1984 and had been entered in the U.S. Department of Agriculture Payment-

TABLE 1. Dear mice examined for food habits from Indiana row-crop fields, 1983 and 1984.

Fields		Mice captured			
Type	N	Trap-nights	N	$\overline{X}$	Range
Winter					
Corn residue	11	3200	70	6.4	1-12
Soybean residue	12	3000	66	5.5	1-10
Tilled	10	3400	117	11.7	2-31
Fallow	3	600	39	13.0	4-24
Summer					
Tilled corn	7	2200	36	5.1	2-11
Tilled soybeans	9	2600	89	9.9	4-22
No-till corn	7	1400	50	7.1	1-18
No-till soybeans	8	1600	28	3.5	1-7
Fallow	4	800	35	8.8	3-22

In-Kind (PIK) program the previous summer (6). Each PIK field had been previously planted to corn, contained cover crops (wheat, sweet-clover, ryegrass, or crown vetch), and had been mowed in the fall.

Summer fields were classified into five categories: tilled corn, tilled soybeans, no-till corn, no-till soybeans, or fallow fields (Table 1). Tilled fields had been conventionally prepared for planting by plowing or discing in the spring resulting in less than 15% surface residues. No-till fields were slot-planted into existing residues following applications of fertilizers, herbicides, and, sometimes, insecticides. Conventionally tilled corn fields had been planted to corn (five fields) or soybeans (four fields) or had been fallowed (one field). No-till corn fields were established in fields that contained corn residue (three fields), soybean residue (one field), soybean-wheat residue (one field), or had been fallowed (two fields). Five of the no-till soybean fields followed winter wheat harvest. The remaining were slot-planted into corn residue (two fields) or soybean residue (one field). The fallow fields were studied during their inclusion in the PIK program in 1983. All had been planted previously to corn, and three had cover crops.

Deer mice were captured in snap traps placed at 10-m intervals along linear transects extending from the field edge to the field interior. Transects contained 25 traps, and two or four transects were established in each field. Traps were attended for four consecutive nights so trapping effort totaled 18,800 ($\overline{X}$ = 265) trap-nights (Table 1). Summer trapping began 13-74 days ($\overline{X}$ = 37) after crops were planted. Traps were baited with peanut butter or a peanut butter-rolled oats mixture. Captured mice were immediately frozen, later thawed, and the stomachs removed and placed in formalin or ethanol until contents were examined. Stomach contents from each mouse were segregated into similar items, and the percent volume represented by each item was estimated visually. The mean percent volume for each food item was calculated; i.e., the aggregate percentage method (22) was used. Stomachs less than half full were discarded. Items were identified to species when possible but in many cases classification was to animal order or class, or plant family. The total number of different foods present in each stomach was used as a measure of dietary diversity and statistically analyzed using Chi-square tests and analysis of variance of a nested factorial design. Relative frequency of occurrence of the major food categories (cultivated grains, other seeds, invertebrates, and miscellaneous) also was calculated and used to test statistical differences in diets using Chi-square tests.

Relative availability of potential deer mouse foods was not determined because sampling radically different foods to make accurate comparisons among food types is difficult. Furthermore, it also is difficult to decide what items are acceptable foods and under what circumstances they are available to deer mice.

Results

Deer mice utilized a large variety of foods (Table 2) attesting to their highly omnivorous habits. Seeds other than cultivated grain included plants of the genera *Cerastium, Oxalis, Setaria, Capsella,* and *Prunus.* Invertebrate foods were mostly insects that included the following families: Scarabaeidae, Gryllidae, Chrysomelidae, Acrididae, Tupulidae, Lygaeidae, Carabidae, Formicidae, Curculionidae, and Otitidae. *Solanum* fruit and *Endogone* (fungi) were minor miscellaneous items.

TABLE 2. Percent volume of food items identified from deer mouse stomachs in Indiana row-crop fields, 1983 and 1984.

Item	Winter (N = 292)			Summer (N = 238)		
Grain	71.9			32.5		
Corn		38.3			5.1	
Soybeans		25.3			18.3	
Wheat		3.9			9.1	
Unidentified		4.3			0.0	
Seeds	4.8			26.9		
Grass		2.9			7.8	
Forbs		0.7			15.4	
Unidentified		1.3			3.7	
Invertebrates	13.9			39.4		
Insecta (larva)		7.4			18.1	
Coleoptera			2.4			9.0
Lepidoptera			2.4			8.5
Diptera			1.8			0.7
Unidentified			0.8			0.0
Insecta (adults)		2.6			15.4	
Orthoptera			0.9			7.0
Coleoptera			0.6			3.7
Lepidoptera			0.0			1.1
Hemiptera			0.2			0.7
Diptera			<0.1			0.5
Trichoptera			0.0			0.3
Hymenoptera			<0.1			0.2
Homoptera			<0.1			0.0
Unidentified			0.7			2.0
Oligochaeta		1.5			2.1	
Gastropoda		1.6			0.0	
Arachnida		0.6			3.0	
Chilopoda		0.1			0.1	
Nematoda		0.0			0.1	
Unidentified		<0.1			0.5	
Miscellaneous	9.4			1.2		
Green vegetation		6.4			0.7	
Fleshy fruit		2.3			0.1	
Fungi		0.0			<0.1	
Vertebrate flesh		0.8			0.5	

Diets of deer mice, as reflected by stomach contents, showed marked seasonal differences (Figure 1, 2). Waste grain was an important food during both periods, but it was found much more frequently during the winter (X^2 = 92.5, df = 1, P

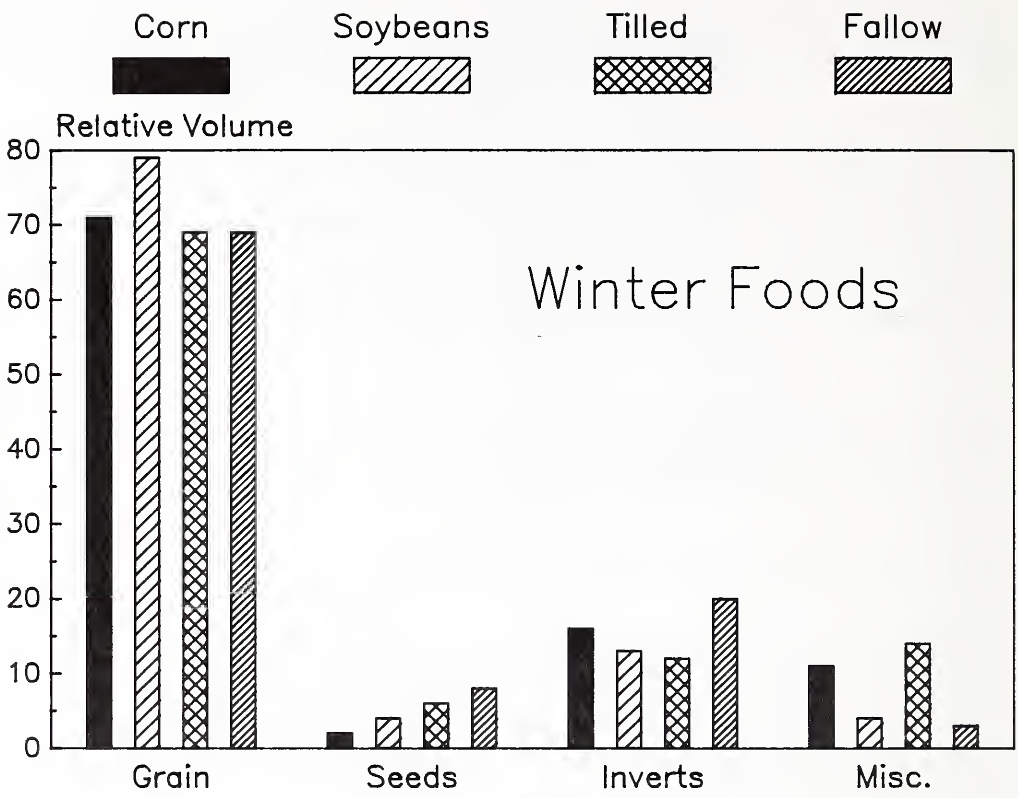

FIGURE 1. Percent volume of foods from deer mice during winter in southeastern Indiana row-crop fields, 1983 and 1984.

< 0.001). During summer, invertebrates ($X^2 = 76.6$, df = 1, $P < 0.001$) and seeds ($X^2 = 83.4$, df = 1, $P < 0.001$) were much more important than during winter. Seeds were a relatively minor component of winter diets. Miscellaneous items were consumed more frequently during the winter ($X^2 = 18.4$, df = 1, $P < 0.001$).

In contrast to distinct seasonal differences, occurrences of major food items among crop and tillage types were similar within each season. In winter, the frequency of grain ($X^2 = 3.5$, df = 3, $P > 0.05$) and invertebrates ($X^2 = 4.1$, df = 3, $P > 0.05$) did not differ appreciably among field types (Figure 1). Statistical differences among tillage categories, however, did exist for seeds ($X^2 = 9.6$, df = 3, $P < 0.05$) and miscellaneous foods ($X^2 = 15.8$, df = 3, $P < 0.001$). These differences were relatively minor, however, and were due primarily to a greater frequency of occurrence of seeds in stomachs from idled fields and a greater than expected occurrence of miscellaneous items from mice in corn residue and tilled fields.

Dietary variation attributable to field types was greater for the summer period (Figure 2). Differences in the frequency of grain eaten by deer mice ($X^2 = 16.5$, df = 4, $P < 0.01$) are due mostly to no-till soybean fields where wheat was eaten much more than other foods, probably reflecting the super abundance of wheat resulting from double cropping. Statistical differences in the occurrence of seeds ($X^2 = 44.4$, df = 4, < 0.001) are due to their greater frequency in mice from fallowed fields coupled with lower frequency in mice from tilled soybean and tilled corn fields. Invertebrates differed ($X^2 = 25.0$, df = 4, $P < 0.001$) by being found more often in mouse stomachs from tilled soybean fields and less often from no-till soybean

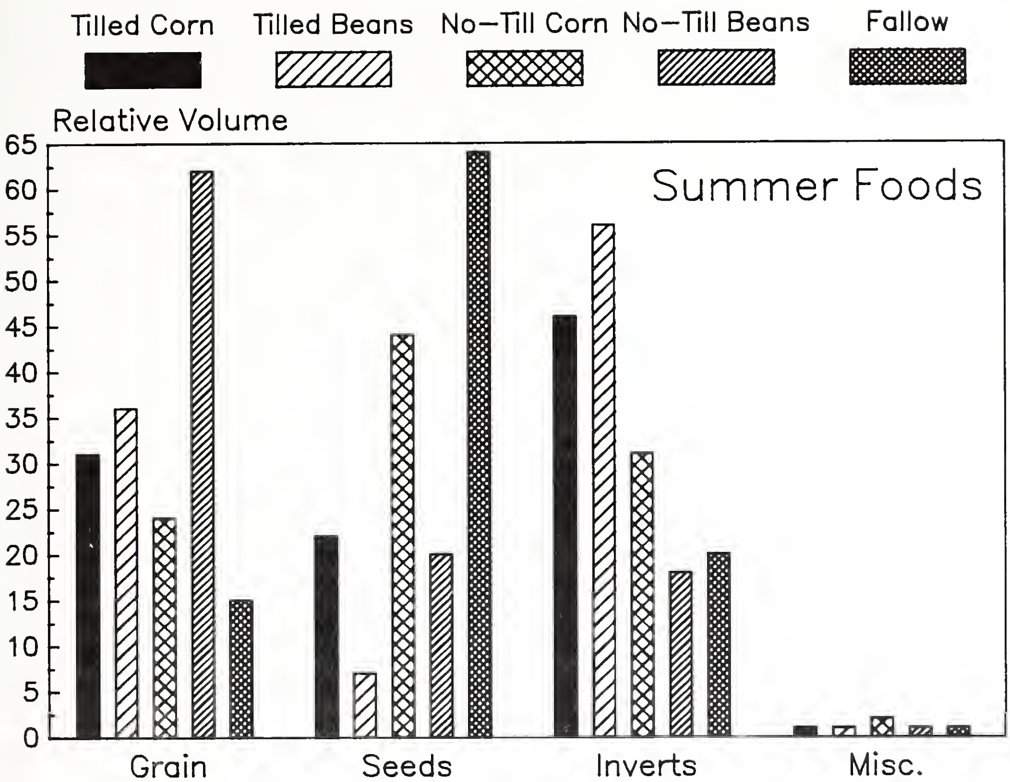

FIGURE 2. Percent volume of foods from deer mice during summer in southeastern Indiana row-crop fields, 1983 and 1984.

fields. Miscellaneous items showed no discernible differences (X^2 = 2.6, df = 4, P < 0.05) among field types.

The mean (±SE) number of different food items tallied in deer mouse stomachs showed consistent seasonal differences, but minor differences among field types within a season. Deer mouse diets during winter contained 1.52 ± 0.05 items compared to 2.13 ± 0.07 items during summer (X^2 = 60.0, df = 3, P < 0.001). During the winter period, means ranged from 1.44 ± 0.16 items/stomach for tilled fields to 1.77 items for fallowed fields. Corn (1.50 ± 0.08) and soybean (1.53 ± 0.09) residue fields had intermediate values, but no statistical differences could be shown using analysis of variance (F = 2.04; df = 3, 28; P > 0.05) or Chi-square analysis (X^2 = 8.68, df = 6, P > 0.05).

The mean (±SE) number of items/stomach for summer samples was greatest for tilled soybean (2.21 ± 0.11) and corn (2.19 ± 0.14) and lowest for no-till corn (2.02 ± 0.14) and soybean (2.04 ± 0.22) fields. Fallowed fields had an intermediate value (2.11 ± 0.19), but no statistically significant difference could be detected among field types (F = 0.35; df = 4, 26; P > 0.05) (X^2 = 7.64, df = 23, P > 0.05).

Discussion

Dear mice inhabiting corn and soybean fields take advantage of the readily available waste grain present, especially during winter. The absolute abundance of some food items has been shown to be affected by tillage practices. Fall discing and deep plowing reduced waste corn in Texas by 77% and 97%, respectively (1). Warner et al. (26) found similar levels of waste grain reductions from fall tillage in Illinois corn and soybean fields. Weed seeds may follow a similar pattern of reduction, but seed abundance at harvest is influenced primarily by weed control using herbicides and mechanical cultivation during the growing season (3).

Patterns of arthropod abundance due to tillage practices are less clear than for waste grain. Basore (2) found comparable numbers of insects in Iowa no-till and conventionally tilled fields during summer. Other researchers have reported greater abundance and diversity of invertebrates in no-till fields (4, 14, 25). Tillage and the use of insecticides may have only temporary impacts on arthropod densities. The basic similarity of diets of deer mice within each season during our study suggests either that different food items are not seriously limited, each field type has roughly similar relative amounts of food available, or that deer mice actively select food items in order to balance their diets. Without accurate information on food availability, these hypotheses cannot be tested.

Comparisons of deer mouse food habits among different studies are tenuous because of differences in methodology, timing, and site characteristics. Post-planting samples of deer mouse stomachs from studies in Iowa (8) and Nebraska (13) no-till cornfields, showed a greater preponderance of inverteberates and herbaceous items than our study. Seeds other than grain were considerably more prevalent in the diets of deer mice inhabiting Indiana cornfields. The frequency of occurrence of corn was similar in the Indiana and Iowa studies, although other cultivated grains were detected more frequently in mice from Indiana. Corn was a more important constituent in Nebraska deer mice, but the amount was comparable to total grain from mice in Indiana no-till cornfields.

Summary

Stomach contents from 530 deer mice from southeastern Indiana corn and soybean fields were examined in 1983 and 1984. During winter, 292 mice were collected from 36 fields categorized as corn residue, soybean residue, tilled, or fallow. Major food items summarized as relative volume using the aggregate percentage method, were waste grain (72%), invertebrates (14%), seeds (5%), and miscellaneous (9%). Diets were similar among field types although seeds occurred more often in fallow fields, and miscellaneous foods were more prevalent in corn residue and tilled fields. During summer, 238 stomachs were examined from 35 fields classified as tilled corn, tilled soybeans, no-till corn, no-till soybeans, or fallow. Diets differed noticeably from the winter season and consisted of invertebrates (39%), grain (33%), seeds (27%), and miscellaneous (1%). Field types influenced diets to a greater extent in summer than in winter. The frequency of grain eaten by deer mice was greatest in no-till soybean fields, which were primarily double-cropped fields containing abundant wheat left after harvest. Intevertebrates appeared in diets disproportionately more often in tilled soybean fields and less often in no-till soybeans. Seeds were again more prevalent in mice from fallow fields and encountered less frequently from those in tilled soybean fields.

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