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Effect of Alternative Tillage Systems on Rodent Density in the Palouse Region

Abstract

Social behavior and seasonal breeding regulate the numbers of deer mice (*Peromyscus maniculatus*) below that causing significant damage to grain crops under both conventional and conservation tillage systems in the Palouse region. Montane vole (*Microtus montanus*) populations are regulated through social behavior, variation in the length of the breeding season and changes in vegetative cover. Local populations of this species demonstrate both multi-year and annual patterns of density change. At higher densities voles cause damage to grain crops irrespective of the tillage system in effect, particularly where crops adjoin uncultivated shrub-grassland.

Introduction

Alternative forms of tillage are being adopted in the Palouse region to reduce erosion, soil moisture loss and energy costs. In one method, termed "no-till," the seed is drilled directly into residue of the preceding crop, thus eliminating the need to prepare a seed bed by conventional plowing. Herbicides are used to control weeds and fertilizers are applied as necessary to improve yields. Among its unfavorable effects, conservation tillage delays maturation of the crop due to insulative effects of residues and establishes a microenvironment favorable to insect pests and plant diseases (Papendick and Miller 1977; Phillips *et al.* 1980). Although rodents "thrive" in corn under conservation tillage (Johnson *et al.* 1985), their response to conservation tillage of winter wheat has not been investigated. Here I report population levels of deer mice and voles at sites under alternative methods of tillage and compare vole numbers in winter wheat cropland with that in adjoining shrub-grassland.

Methods

Abundance of deer mice was monitored using Museum Special traps baited with rolled oats and peanut butter and set out at 3 m intervals in transects of 50-200 traps. Trap lines were maintained 1-2 days at 7 locations in Whitman County, Washington, and Latah County, Idaho, in 1980 and 1981. During 1983-85, I monitored vole density at Waha, Nez Perce County, Idaho, using a 4 x 9 grid of pitfall traps (Boostra and Krebs 1978) with 12.3 m (40 ft) spacing in an uncultivated shrub-grass site. In 1985 vole abundance was concurrently monitored in adjoining cropland under conservation tillage and chemical fallow (2 transect lines of 9 pitfall traps with 12.3 m spacing in each). Pitfall traps were prebaited with rolled oats for one day and activated for 1-3 days between April and October at 2-week (1983) or monthly intervals (1984 and 1985). Snowfall prevented sampling in October, 1985. Cotton batting was provided to reduce mortality. Voles were weighed, toe-clipped and released at the site of capture.

The abundance of deer mice is reported as N/100 trap-days. I have not analyzed these data statistically because the trapping sites were arbitrarily chosen (treatments were not randomly assigned). The abundance of montane voles is reported as minimum number alive (MNA) where MNA is the sum of animals captured at time t and those assumed to be present based on their capture both previous and subsequent to t. To equalize trapping effort on the grid and transect lines, I compared the number of voles captured on the outer lines of the grid with the number captured on paired transect lines at other sites. Thus each sample represents captures on transect lines of 9 pitfall traps each with the lines spaced at least 36 m apart.

Results

Deer mice occurred in low to moderate numbers (1-34/100 trap days) in winter wheat under conventional and conservation tillage at the sites sampled during the spring and summer months, 1980 and 1981 (Table 1). Since site and treatment (tillage method) are confounded, I cannot attribute the differences observed to treatment

TABLE 1. Capture rates (N/100 trap-days) of deer mice at conventional and conservation tillage sites, 1980 and 1981. — Not trapped.

Month/ Year	Idaho Sites		Washington Sites	
	Conventional	Conservation	Conventional	Conservation
April 1980	10	6.5	2.7	11
May	10	4.3	7.5	16.5
May-June	8	3	4	7.5
June	7	4.5	5	6.5
June-July	5	10	2	7
July-August	6	1	0	—
September	9	—	2	3
Sept-October	6.5	3	0	4.5
May 1981	—	—	12.5	14.4
May-June	4	4	27.5	34

alone. However, the values reported represent indices of density at these locations. Small numbers of house mice (*Mus musculus*), vagrant shrews (*Sorex vagrans*) and western jumping mice (*Zapus princeps*) were captured at sites under both tillage systems.

The montane vole population in uncultivated shrub-grassland at Waha demonstrated an annual spring peak in numbers during 1983-85 (Fig. 1). Temporary decreases in population size due to application of a zinc phosphide rodenticide in 1983 will be presented elsewhere. The differences in peak numbers between years were nearly identical to a density index of voles captured in drift fences at Coyote Grade, Nez Perce County (Fig. 2), an indication of local synchrony in density change. In 1985 the peak number of voles in shrub-grass was twice that in chemical fallow where cropping was postponed and weeds were controlled with herbicides. No voles were captured in a wheat field under conservation tillage during the summer months (Fig. 3).

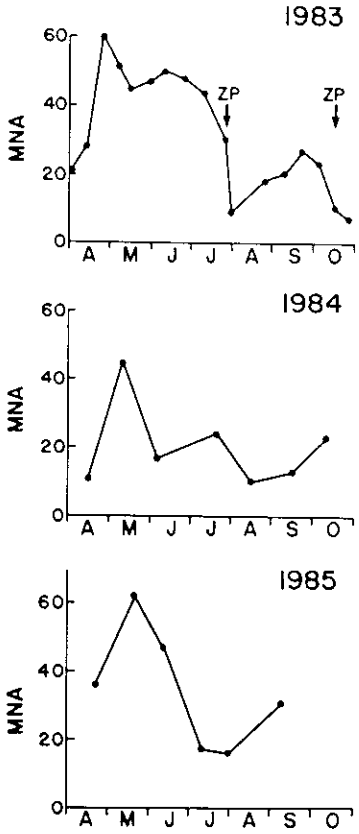

Figure 1. Minimum number of montane voles alive (MNA) on a 0.35 ha grid of pitfall traps at Waha, Nez Perce County, Idaho 1983-85. ZP—application of pelletized zinc phosphide rodenticide.

DISCUSSION

Although deer mouse populations occasionally reach high densities, (e.g. Hoffmann 1955), their numbers are regulated below an economic threshold through territoriality and winter breeding rarely occurs (Metzgar 1980). The large numbers of deer mice (43/100 trap days) captured in wheat stubble near Pullman, Washington, in November, 1983 (D. Johnson, unpubl.) and in

barley stubble in an earlier study (Janulewicz 1971), probably represent a response to an increased availability of waste grain. These high-density populations steadily decline during the winter months when breeding is suspended.

Birney *et al.* (1976) have confirmed that voles increase in density and establish a multiyear cycle at sites with sufficient grass cover on the Great Plains. Since both montane and long-tailed voles (*Microtus longicaudus*) demonstrate a 3-4 year cycle of density change in uncultivated Palouse grassland (Randall and Johnson 1979), one would expect periodic damage to adjoining crops. This however did not occur at the Waha site where the population fluctuated in an annual rather than multiyear pattern (Fig. 1).

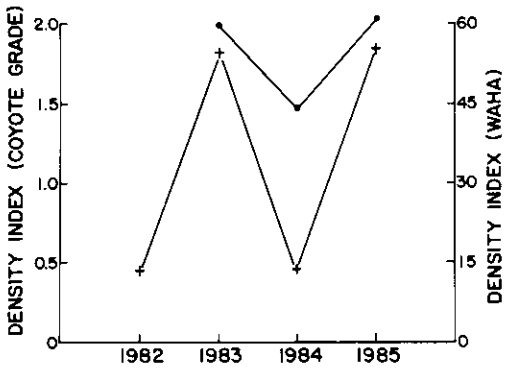

Figure 2. Density indices of montane vole populations, Nez Perce County, Idaho: Waha (.) based on minimum number alive in May (this study) and Coyote Grade (+) based on number of voles captured/30 m drift fence/ 100 trap-days (R. L. Wallace and L. V. Diller, pers. comm.).

The factors inducing cyclic change in vole density are much disputed despite extensive efforts to identify them (Meserve and Klatt 1985). In the West, the most severe irruptions of montane voles occur in large, interior basins allotted to forage crops, especially alfalfa (Murray 1965). Voles caused significant damage to seedling winter wheat under both conventional and conservation tillage at Waha in November, 1981, particularly where cropland adjoined uncultivated ground (R. Lloyd, pers. comm.).

Montane voles are capable of reproduction during the winter months if phytoestrogenic compounds are available in green forage (Negus *et al.* 1977). The social biology of montane voles is complex with females demonstrating intra-sexual

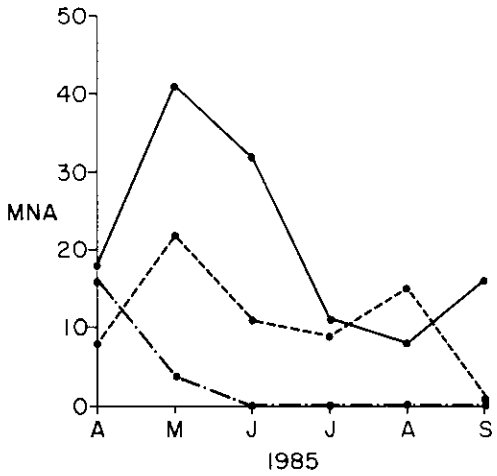

Figure 3. Minimum number of montane voles alive (MNA) in shrub-grass (solid line), chemical fallow (dashed line) and no-tillage winter wheat (dot-dash line) at Waha, Nez Perce County, Idaho, 1985. MNA in shrub-grass is adjusted to reflect trapping effort equivalent to that at the other locations.

territoriality. Their territories overlap those of adult males. Only territorial males are sexually mature in high density populations. Females form extended maternal families at high densities and the sexual maturation of young associated with these families is delayed (Jannett 1984). Thus the regulation of montane vole populations is complex, making prediction of density change difficult.

The impact of voles on grain crops has received limited attention. Citing earlier work, Ryszkowski *et al.* (1973) reported that European voles can cause serious damage to seedling wheat which sometimes results int he loss of the entire crop. Based on estimates of food requirements and density, Grodzinski *et al.* (1977) concluded that voles had little impact on winter wheat during "normal" years and only 2-3% of the crop was destroyed during periods of high density. Unfortunately, these estimates of total impact (food plus wastage) did not include the fall and winter months when voles are mostly like to cause damage to grain crops.

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