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In fall, 1990 we became involved in a National Pesticide Clearance Inter-regional Research Program (NPCIRP) project to test the efficacy of zinc phosphide in controlling vole *(Microtus* spp.) damage in sugar beets in Western Nebraska. During the course of the project we observed some rather remarkable short-term movements by deer mice *(Peromyscus maniculatus).* Although mice have the physical capability of moving up to 300 m in 1 hr (Rawson 1964), typical observed-range lengths are much less. Farming practices that affect food availability and cover likely affect small mammal movements (Warburton and Klimstra 1984, Vessey 1987). Average daily movements of white-footed mice *(Peromyscus leucopus)* in agricultural fields ranged from 13.2 m (no-till corn stubble) to 36.9 m (chisel-plowed corn stubble) (Albers et al. 1990). Linduska (1942) noted that deer mice with adequate food and cover in shocked corn fields had minimal movements, while those in adjacent wheat stubble displayed "exceptional" movements of 60 to 90 m from nest sites in a single night.

In this paper we will report on the short-term movements of deer mice that we observed and will speculate on factors that may have caused such movements.

STUDY AREA AND METHODS

We conducted the study in a 32 ha sugarbeet field at the Panhandle Research and Extension Center near Scottsbluff, Nebraska in September and October 1990. The canopy cover, determined by ocular estimate, was 80 to 100%. The study area was bounded to the north by a sugarbeet field, east by a golf course, south by an irrigation canal and west by an irrigated corn field.

Four groups of 3, 0.2-ha treatment sites were randomly located along the margins of the study area. Within each group, treatment sites were selected randomly and treated with 0, 11.2, or 22.4 kg/ha of 2.0% zinc phosphide-treated oats (Bell Laboratories, Inc., Madison, Wisconsin).

We established 4 x 4 square trapping grids in each of the treatment sites with 16 traps placed 13.8 m from each other in the furrows between the rows of sugarbeet plants. Traps were baited with a mixture of peanut butter and oatmeal. We checked the traps 3 consecutive mornings before and 2 consecutive mornings after the sites were baited with zinc phosphide.

We identified captured mice to species, earmarked, and released them during the afternoons of the first 2 days of pre-treatment. On the third day, mice were identified and released but not earmarked. During the first day of post-treatment trapping, recaptured mice were identified to species and released. New captures were anesthetized using halazone and toe clipped. We identified and released recaptures during the second day of post-treatment trapping.

RESULTS AND DISCUSSION

Captures indicated that both deer mice and house mice *(Mus musculus)* were located throughout all treatments and blocks (Fig. 1). Adjacent habitats of corn, golf course turf, or cool season grass associated with the irrigation canal appeared to be insignificant in influencing spatial distribution.

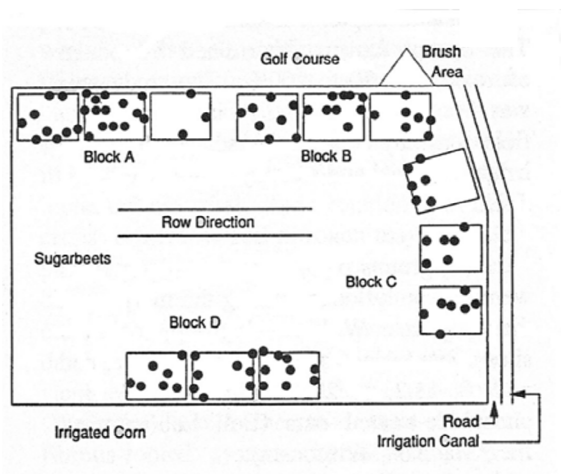

Fig. 1. Spatial distribution of deer mice live trapped in a sugarbeet field in Western Nebraska before application of zinc phosphide-treated oats.

We captured 149 and 60 mice during the pre-treatment and post-treatment periods, respectively (Table 1). Capture rates from pre-treatment to post-treatment periods declined in the zinc phosphide treatment sites as well as in the controls (Table 2). This indicates that environmental factors may have been responsible for differences in capture rates rather than zinc phosphide treatment levels.

Table 1. Mean capture rates of deer and house mice in a sugarbeet field in Western Nebraska before and after application of zinc phosphide-treated oats. Twelve trapping grids included 16 live traps located 13.8 m apart on 0.2 ha areas.

	Captures/ 100 trap nights	Number of captures
Pre-treatment (3 days)		
Deer mice	17.4	100
House mice	8.5	49
Total	12.9	
Post-treatment (2 davs)		
Deer mice	12.5	48
House mice	3.2	12
Total	7.8	

Table 2. A comparison of capture rates of deer mice across 3 zinc phosphide (ZnP) treatments in a sugarbeet field in Western Nebraska.

	Captures/100 trap nights		
	0 kg/ha	11.2 kg/ha	22.4 kg/ha
Pre-treatment	6.6	5.4	5.4
Post-treatment	4.2	4.9	3.4

Daily movements of deer mice were more pronounced than anticipated. The longest observed movements of the mice during the 2-day pre-treatment period were 310, 265, 260, and 240 m; and 260, 225, and

143 m during the 3-day post-treatment period (Fig. 2). Average daily movements of deer mice for successive days of capture during the pre- versus post-treatment periods were 78 m and 94 m, respectively (Table 3). Between days 2 and 3 of the pre-treatment period, however, 5 deer mice moved an average of only 22 m. During both pre- and post-treatment periods, 20 mice moved across <20 rows, including 5 individuals that were recaptured at the same trap. Three mice moved across 20 to 100 rows. Six mice moved >100 rows, including 3 individuals that moved across 250 to 300 rows.

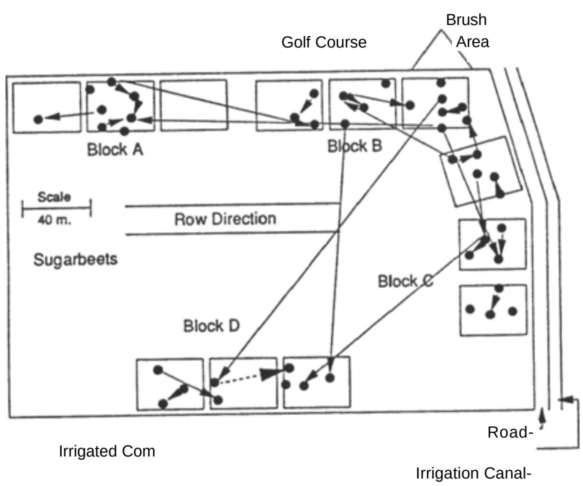

Fig. 2. daily movements of deer mice in a sugaibeet field in Western Nebraska.

Table 3. Average daily distances moved by deer mice and house mice in a sugarbeet field in Western Nebraska.

	Distances moved (m) (number of individuals)
Pre-treatment	
Deer mice	77.5 (24)
House mice	7.0 (2)
Post-treatment	
Deer mice	94.0 (8)
House mice	0.0 (1)

Movements among blocks were as likely as movements among treatment sites within a block (Table 4). Movements among traps within treatment sites were more common than among treatment sites or blocks. Of the movements within treatment sites, one-third constituted a return of the individual to the same trap on subsequent days. The attractiveness of sugarbeets to mice may be in providing cover from heat, cold, or predators. However, the proximity of alternative habitat providing such needs suggests that the sugarbeets are not attractive solely for such purposes.

Table 4. Movements of deer and house ( ) mice among blocks, within blocks and within treatment sites in a sugarbeet field in Western Nebraska.

	No. of mice	% of total mice moved
Pre-treatment		
Among blocks	6	18.5
Within blocks among treatment sites	6	18.5
Within treatment sites	20 (8)	63 (25.0)
Post-treatment		
Among blocks	7	33
Within blocks	6	29
Within treatment Sites	8 (1)	38 (4)

Environmental conditions and habitat type greatly affect daily movements of many small mammals. Observed-range lengths of 33 *Peromycus glossypinus* in a Northern Florida swamp ranged from 0 to 848 m over a 1 to 11-day recapture period. J =115 m (Pournelle 1950). The average range of movements of deer mice during a 1-month period in a Nevada desert was 159 m for males and 101 m for females (Allred and Beck 1963). The maximum short-term (2-

day) dispersal was 323 m by an adult male. Average home ranges for white-footed mice in a Virginia deciduous woodlot were 0.24 ha for males and 0.26 ha for females with a maximum cross-sectional distance of 100 m (Madison 1977). Movements of deer mice in the forested Cascade Mountains of Oregon ranged from 95 to 515 m during a 5-month period after the site had been cut and burned (Gashwiler 1959). Although live-trapping data does provide information on day-to-day movements, home ranges are typically underestimated when using this technique (Gesy et al. 1989).

We observed no rodent damage to sugarbeet roots or tops during the fall study. Flood irrigation, as practiced in Western Nebraska, consists of a constant supply of water during late June through September. Gravity flow irrigation creates a saturated soil profile and ground surface. This may deter field mice and other rodents from occupying sugarbeet fields during summer and thus, precludes damages. Ridges where the sugarbeets are planted, however, may be dry enough to allow mice to enter fields at the borders, or to run down the length of the ridge toward the center of the field. This wet environment under the maturing sugarbeet canopy is maintained until 1 to 3 weeks prior to harvest in late September, after which fields are allowed to dry. During the drying period, field mice may be able to disperse into sugarbeet fields from surrounding areas.

The long distances travelled by mice throughout sugarbeet fields in the fall may have several implications. Damage across an entire field may not necessarily be an indication of high mouse populations. Relatively few mice could cause widespread, but relatively low levels of damage. Conversely, recognition of damage may be more difficult if mice are using extensive areas of sugarbeet fields instead of concentrating along field borders. It is difficult to ascertain the reason of such wide-ranging movements of field mice. Mature sugarbeet fields provide an abundance of food and shelter for small mammals' requirements. Extensive movements may be advantageous in a heterogeneous habitat, such as in a field containing scattered concentrations of weed seeds, fungi, or broad-leaved or grassy weeds.

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