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Abstract: Pine voles (Microtus pinetorum) and meadow voles (Microtus pennsylvanicus) were studied in a commercial apple orchard in the Hudson Valley of New York during April and May 1981. Selected voles were given miniature radiotransmitters and then tracked before and after herbicide application. A total of eight pine and meadow voles were tracked throughout the experimental period. Home range size decreased on the day following herbicide application but showed an increase from day 1 to day 5 & 7 after application. Movements away from the tree line into the aisles did not change significantly after herbicide use. We conclude that if herbicide is to have a significant impact on vole management in orchards, it must be used regularly in conjunction with other cultural practices.

INTRODUCTION

The problem of pine and meadow vole control in orchard habitat has been approached in different ways. Studies have included the use of toxicants, alternate food supplies, habitat manipulation (mowing, herbicide use, cultivation), interspecific vole competitors, apple tree stock that is unattractive to voles, and others (Bart and Richmond, 1979; Byers, 1977; Horsfall et al., 1974; Madison et al., 1981, McAninch, 1978; Pagano and Madison, 1982; Pearson et al., 1980; Young, 1977). One difficulty in evaluating some of these control procedures in the orchard environment is that the response or fate of the voles during experimentation is not clearly known. The use of radiotelemetry allows one to monitor vole movement and mortality following experimental treatments in the orchard.

In a previous study, we demonstrated that mowing without thatch removal has little effect on the immediate survival and movement of pine and meadow voles (Madison et al., 1981). In another study, we measured the effect of clearing a border strip on vole movement between the orchard and surrounding habitats, and suggested that the border populations of voles should be considered in vole management programs (Pagano and Madison, 1982). The present study reports the results of a small scale effort to see what happens to pine and meadow vole movement following the application of the herbicide Paraquat.

METHODS

The study was conducted from 20 April to 15 May 1981 within Stanley Orchards, Modena, Ulster Co., New York. A 2.0 acre (0.8 hectare) section of orchard consisting of 8 rows, 16 trees/row, was used. All tree bases were censused regularly with Spencer live traps for the occurrence of both pine and meadow voles. Eleven voles (9 pine voles, 2 meadow voles) were captured for radiotracking following an intensive census period during late April and early May. Since the population density of both species, and especially of meadow voles, was low during this spring, it was difficult to find many voles for tracking. The 11 adults captured consisted of a sample of 9 adult pine voles and all the adult meadow voles that could be found within the orchard plot at the time of the census.

The voles were given radiotransmitters between 20 April and 4 May, and then were radiotracked during intensive sessions between 5 May and 15 May. The surgical technique for implanting the radiotransmitters, and the technique used to track the voles, are reported in Madison et al. (1981). The tracking sessions consisted of recording the position of each vole once every 30 minutes from 1600 h to 2300 h, thus generating 15 positions for each session. This time interval was chosen because earlier studies revealed that this was an active period for voles. The sessions were conducted 3 days before herbicide application and on days 1, 5, and 7 following application.

The herbicide Paraquat was administered on 8 May at a concentration of approximately 0.56 Kg/hectare (0.5 lb/acre). The tractor-hauled spray unit with boom covered a strip 1.5 m (5 feet) to either side of every row. Since the grass was very high and thick at the time of spraying, penetration of the herbicide was incomplete in some areas, as evidenced by green patches of vegetation in the treated zone following herbicide application.

The 15 position fixes per study session were used to determine whether movement of the voles changed after herbicide application. Two measures were chosen. One was the area covered by the 15 positions, and the other was the average distance of these positions from the nearest tree row (see details in Madison et al., 1981). Since we did not have the resources to establish a concurrent control plot (one having radiotagged voles but not receiving herbicide), we used the movements of the voles before herbicide treatment as a control for the movements after herbicide application. Since all the radiotelemetry positions were recorded during an 11-day period, we felt that any effects due to environmental conditions unrelated to treatment would be small compared to the effect of a sudden, grass/forb die-off in the habitat following herbicide application.

RESULTS

General. Of the 11 voles initially radiotagged, 8 were tracked throughout the study period. Three voles disappeared during tracking, and one additional vole disappeared before the voles were recaptured for transmitter removal on 17 May. Since the study plot was censused regularly following this herbicide study, and since none of the 4 voles was ever recaptured, predation is the most likely cause of the disappearance of these voles. The records of the 8 voles tracked throughout the 11-day period of intensive tracking constitutes the data set for the analyses to follow.

Home Range Size. The size of the short term home range covering 15 positions for each vole during each tracking session averaged 2.8 m 3 days before herbicide application and 2.4 m, 5.0 m and 6.0 m on days 1, 3 and 5 following application, respectively (Table I). Relative to the size of the area used by each of these voles before treatment, the area used by the 8 voles one day after treatment was

Table 1: Home range size (HR, m^2) and average distance from the nearest tree row (AD, m) for the eight adult pine voles (PV) and meadow voles (MV) radiotracked during all study sessions before and after herbicide application.

			Day Relative to Application							
			-3		+1		+5		+7	
Species	Sex	Wt.(g)	HR	AD	HR	AD	HR	AD	HR	AD
PV	M	27	1.2	0.9	0.8	1.0	3.7	1.1	3.3	1.1
PV	M	25	7.0	0.9	0.8	0.9	0.9	0.9	1.2	0.9
PV	F	29	4.1	0.5	9.4	0.7	10.0	0.7	18.0	0.5
PV	F	28	1.6	0.7	0.8	0.5	8.6	0.8	14.7	0.9
PV	F	30	1.6	0.9	1.8	1.0	0.4	0.9	1.2	1.0
PV	F	22	0.4	0.5	0.3	0.4	7.4	0.4	3.7	0.4
PV	F	27	2.9	0.0	2.8	0.9	0.8	1.1	2.0	1.0
MV	F	35	3.7	0.2	2.5	0.4	8.6	0.5	4.1	0.3
	Mean		2.8	0.7	2.4	0.7	5.0	0.8	6.0	0.8
	SD		2.0	0.3	3.0	0.3	4.0	0.2	6.5	0.3

smaller for 6 of the 8 individuals. On days 5 and 7 after application, 12 of the 16 home ranges these days were larger than those for the same voles one day after treatment. The shift from smaller areas on the day following application to larger areas on days 5 and 7 after application was significant (Fisher's Test, $p = 0.03$).

Distance Moved From Row. The average distance moved perpendicular to the tree rows was 0.7 m 3 days before application and 0.7 m, 0.8 m and 0.8 m on days 1, 5 and 7 following application, respectively (Table 1). Although these distances were greater on the average after herbicide application, the number of voles showing greater movement away from the rows after application was not significantly different from random expectation.

DISCUSSION

The normal effect of herbicide application in an apple orchard is the death of most grasses and forbs in the area of application. Since this area along tree rows is also the preferred habitat of pine and meadow voles in the orchard, and since both pine and meadow voles benefit from the vegetative cover in these areas (McAninch, 1978), our initial expectation was that the herbicide would cause the death or dispersal of voles in the treated areas. However, our data indicate only small effects on death or movement.

The loss of 4 of the 11 voles during the 2 weeks after herbicide application is high; the normal loss rate is about 9% per week, thus a 1 to 2 vole loss would have been normal. The increased number of voles lost, probably to predators, is likely the result of increased susceptibility due to the reduction in the grass/forb canopy.

The decreased home range size on the day following application is not surprising considering the fact that most of the grass in the sprayed area had turned brown within 24 h of spraying. Thus, upon being suddenly more exposed on day 1 after application, the voles were probably temporarily inhibited in their movements. The increased home range size noted on days 5 and 7 after treatment is consistent with food shortage and with the voles having to forage more widely for green vegetation. Since the voles did not increase their movements into areas towards the aisles where the grass had not been sprayed, the voles must have moved farther along the rows, or across rows. Both of these adjustments in movement were observed. The increased movement along rows probably occurred because a substantial amount of green grass still remained in this area. The green grass remaining was in such high and thick clumps at the time of spraying that a good portion of it survived. Both pine and meadow voles foraged in these green patches in preference to moving into the green grass next to the aisles.

Our general impression is that herbicide application is not in itself an effective cultural method for the control of voles in orchards. The effect of herbicide application would have been more noticeable had the herbicide been applied to the entire area under the trees at a time when the grass cover was not as thick or tall (e.g., less than 12 inches high). We predict that under these circumstances the meadow voles would have been forced into the pine vole burrows or out of the orchard altogether. The pine voles would likely become exclusively subterranean, at least until regrowth, and would probably begin to feed more on tree roots. For the latter reason, herbicide application combined with poison baits would be a recommended control procedure for pine voles.

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