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Abstract. No difference in field control of pine voles was found between 3 different pellet sizes broadcast at either 5.6 kg/ha (5 lbs/acre) or 11.2 kg/ha (10 lbs/acre) for either Volid or ZP Rodent Bait^{AG}. Comparison of the 18 Volid plots with the 18 ZP Rodent Bait plots showed a statistical difference in animal control between these materials of 95% and 85% respectively. Place packs of Volid or ZP Rodent Bait^{AG} were opened at approximately 95% of the active sites. Since about 5% of the sites were active by the apple indexing, we believe a low but residual population existed which could repopulate the area. Good control was achieved using these products.

Introduction

The choice of a vole control program may largely depend on the degree of control achieved and the cost of the program. Cultural programs which depend on close mowing, cultivation, and herbicides has been found to be very costly with only moderately good control in some locations and not in others (1, 3, 9). The ground cover sprays of Endrin or chlorophacinone costs on the order of $34/ha ($30/acre) for materials and an additional $11/ha ($10/acre) for application costs (8). The hand placement of Brodifacoum (BFC), chlorophacinone (CPN), Ramik Brown (DPN), and ZP Rodent Bait have given the lowest cost programs in recent years with good control of voles (2, 4).

The objective of this experiment was to determine if broadcast baiting with low rates of the more acute baits could provide effective control. Since previous field data had shown no preference between the 3 pellet sizes (0.48 cm, 0.36 cm, 0.24 cm diameter) when hand placed in active pine or meadow vole sites (6), acceptance of different pellet sizes was not thought to be a complicating factor. However, broadcast baiting of a given rate per acre would result in different pellet densities per unit area of orchard floor. Since effective control was achieved with the 0.48 cm pellet at rates of 15-20 lbs/acre of ZP Rodent Bait^{AG} or Volid, reduction in pellet size to 0.24 cm would increase the pellet density approximately 5X. Therefore, this experiment was designed to determine if equivalent control could be achieved with broadcast applications at low rates using smaller pellet sizes.

Materials and Methods

1. Field trials --- Evaluation of pine vole control plots was determined using apple-indexing and final dead trapping methods previously described (3, 4, 5). In addition, apple consumption was obtained for each 24 hr monitoring period by weighing each apple before placement into each station and again weighing when apple indexing data was taken. In these experiments, plots were blocked according to pretreatment activity readings by first ranking plots from high to low and

assigning treatments randomly into activity categories high, medium, and low. Data summarized in Tables 1 and 2 were taken from an orchard having 35 trees per acre (35' X 35').

2. Since plastic packaged bait has an advantage of continuous availability to voles as well as to non-target animals, site covers (split tires or cinder blocks 2 X 8 X 16 inches) were evaluated as a station for placing plastic packaged Volid or ZP packets. Volid or ZP packets were placed at 47 sites in each of three replicate plots for tires or cinder blocks. Two treatments were made within 45 days so that packets would be available for a period of at least six months. Data are summarized in Figure 2.

Results and Discussion

The data in Table 1 show that no difference existed between the control achieved with 3 different pellet sizes or rates at 6 or 11 kg/ha of Volid or ZP. Previous results with Rozol indicated that poor control was achieved when rates were lowered to 10 lbs/A. Since Volid and ZP require approximately 1.5 g or 0.03 g respectively to deliver a lethal dose, voles apparently were able to find sufficient bait for a lethal dose since good control was achieved. Poor results with CPN (Rozol) in 1980 at 11 kg/ha were probably the result of inadequate bait being found by the voles to deliver a lethal dose (3). Previous laboratory experiments have shown that 11 g of CPN (Rozol) would be consumed by a vole before death.

In conclusion, acute baits which have the advantage of low bait consumption by voles require that only one or a few particles must be found to deliver a lethal dose. The disadvantage of sub-acute baits is that sufficient bait quantities must be available for 3-5 days and voles must consume a considerable quantity of bait before a lethal dose is obtained. Therefore, rates/ha are dependent more on the quantity of bait required for a lethal dose than on pellet density. Better coverage would be expected with pellets of smaller sizes.

The maintenance of lethal baits in an acceptable form continuously over long periods of time may be achieved by packaging the bait in a cellophane or plastic place-pack. Placement of either BFC or ZP Rodent Bait under split tire or cinder block stations in the spring of 1979, fall of 1979, and the fall of 1980 did not completely control the animals. Some packets (5-15 percent) were not opened after each baiting even though voles were known to be present as indicated by the apple index (Fig. 1). We believe that a sufficient number of animals existed within the hand-placed packet plots for animal reproduction to continue to supply new animals during the periods from July to November in both years as indicated by the high number of packets opened (Fig. 1). Vole activity levels were maintained quite low over the period due to the continuous availability of packaged bait. Since the population could not be completely eliminated by hand-placed packets, we believe that packet placement would be required just as frequently as hand placement of unpackaged bait. Cage trials using packets also showed that some pine voles did not open all of the BFC packets (7). The greatest advantage of a place packet system would be the maintenance of toxic baits under snow cover especially when invasion from surrounding areas was a potential hazard. The use of bait in plastic cups placed under split

tires may be a better system than place packets for presenting bait over long periods of time in a dry very accessible condition.

As a part of a large non-target hazard trial, 15 orchards were treated with Volid at 16.6 kg/ha. The broadcast treatment was monitored with the apple index technique and a pre-treatment mark-recapture Schnabel estimate was made. Since vole numbers were so low in the post treatment period, live trapping was done only in the Old Home - Rome orchard. No animals were caught at this location using live traps. Obviously, the control achieved was outstanding. Data from Table 1 indicate that rates of 5.6 to 11.2 kg/ha would be adequate for control in most orchards of this area.

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Table 1. Effect of pellet size on efficacy of broadcast baits for pine vole activity and populations treated November 9-10, 1981.

Treatment	Pellets per 50 g	Rate kg/ha	% Active sites[y] Oct 21	% Active sites[y] Nov 24	Voles/plot (Nov 30-Dec 7)	Voles/site (Nov 30-Dec 7)	% Control
1. Control	--	--	88 a[z]	80 a	23.3 a	0.97 a	0
2. ZP	1694	5.6	92 a	28 b	6.0 b	0.25 b	74
3. ZP	1694	11.2	94 a	25 b	3.7 b	0.15 b	84
4. ZP	884	5.6	99 a	21 b	3.3 b	0.14 b	86
5. ZP	884	11.2	96 a	18 b	5.3 b	0.22 b	77
6. ZP	666	5.6	88 a	14 b	1.3 b	0.05 b	94
7. ZP	666	11.2	92 a	29 b	1.0 b	0.04 b	96
8. Volid	1780	5.6	100 a	22 b	1.3 b	0.05 b	94
9. Volid	1780	11.2	97 a	7 b	0.3 b	0.01 b	99
10. Volid	1044	5.6	97 a	19 b	1.0 b	0.04 b	96
11. Volid	1044	11.2	94 a	11 b	1.0 b	0.04 b	96
12. Volid	364	5.6	100 a	7 b	1.7 b	0.07 b	93
13. Volid	364	11.2	90 a	11 b	1.7 b	0.07 b	93

[y] Apples placed in 2 holes or runs 5-15 cm below the soil surface on opposite sides of the tree trunk were examined 24 hours after placement. Percent activity refers to all sites with vole tooth marks on the apple.

[z] Mean separation, within columns by Duncan's multiple range test, 5%. Three replicate plots per treatment.

Table 2. Effect of pellet size on efficacy of broadcast baits for pine vole activity and populations treated November 9-10, 1981.

Treatment	Rate kg/ha	% Active sites[y] Oct 21	% Active sites[y] Nov 24	Voles/plot	Voles/site	% Control
Control	---	88 a	80.0 a	23.3 a	0.97 a	0
ZP Pellet	5.6-11.2	94 a	22.5 b	3.4 b	0.14 b	85
BFC, Volid	5.6-11.2	96 a	12.8 c	1.2 c	0.05 c	95

[y] Apples placed in 2 holes or runs 5-15 cm below the soil surface on opposite sides of the tree trunk were examined 24 hours after placement. Percent activity refers to all sites with vole tooth marks on the apple.

[z] Mean separation, within columns by Duncan's multiple range test, 10%. Three replicate plots per treatment.

Table 3. Pre- and post-treatment 24-hour vole activity and population estimates in 0.8 ha plots from 1981 secondary poisoning study, Frederick County, Virginia. Blocks treated at average rate of 16.6 kg/ha broadcast with 0.001% brodifacoum bait (VOLID).

Block	Trees per plot monitored	Pre-treatment activity[z]	Pre-treatment Schnabel[y] estimate	Pre-treatment Schnabel 95% C.I.	Total voles captured pre-treatment	Pine voles: meadow voles captured	3-week Post-treatment activity
Bauserman	150	27% (23 Oct)	62	36-98	41	9:1	0% (23 Dec)
Cline's Barn	234	21% (9 Nov)	--	--	--	--	0% (24 Dec)
Clover	50	--	--	--	--	--	0% (23 Dec)
Cedar Hill	144	12% (9 Nov)	--	--	--	--	0% (24 Dec)
Greenwalt	64	0% (18 Nov)	--	--	--	--	0% (10 Dec)
Old Home-Romes	118	30% (30 Oct)	40	3-111	13	12:1	5% (10 Dec)
Old Home-Woods	80	22% (16 Oct)	24	4-135	9	3.5:1	1% (8 Dec)
Robinson-Cather	146	23% (12 Nov)	--	--	--	--	0% (8 Dec)
Robinson-Shed	170	24% (5 Nov)	41	13-105	20	5.7:1	0% (4 Dec)
Robinson-York	78	20% (22 Oct)	19	1-370	7	6:1	0% (4 Dec)
Rt. 649	100	19% (29 Oct)	20	13-29	22	0:22	0% (28 Dec)
Smith	80	59% (15 Oct)	56	43-74	55	1:26.5	0% (11 Dec)
Smith-522	72	11% (18 Nov)	--	--	--	--	0% (10 Dec)
Snapp's	169	43% (5 Nov)	65	46-88	54	54:0	2% (17 Dec)
Swing's	104	23% (23 Oct)	20	10-38	16	1:15	1% (10 Dec)

[z] Percent activity refers to percent index apples placed at each tree site with vole feeding in 24 hours.

[y] Mark and recapture. Mark and recapture was not done post-treatment due to low vole numbers and low trap success.

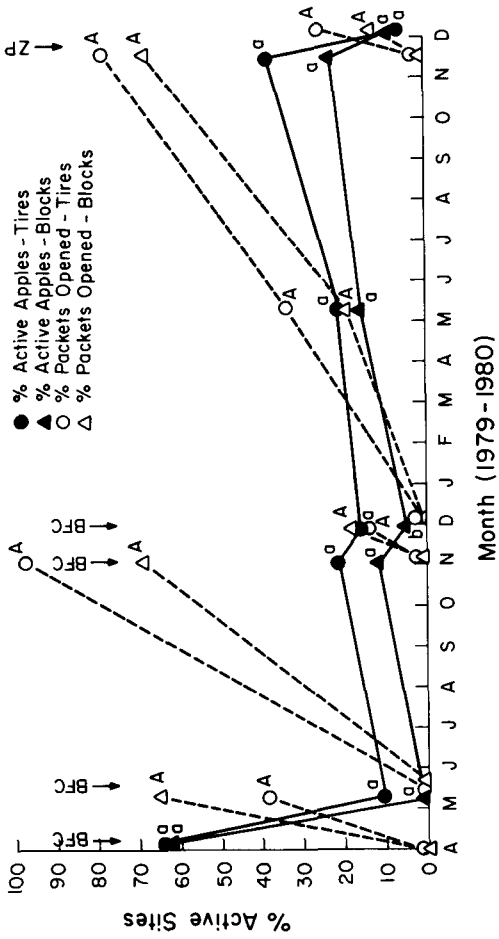

Fig. 1. Effect of BFC or ZP packets on % active apples in a 24 hour period (———) and % of packets opened (---) when replacement packets were placed under split tires or cinder blocks. Mean separation by date by Duncan's multiple range (5% level) for either % packet opening (A, B) or % active apples (a, b) (from Byers et al. 1982).