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# Meadow Vole Control Using Anticoagulant Baits[1]

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*Abstract.* **Commercially prepared pelletized baits of 3-[3-(4'bromo[1,1'-biphenyl]-4-yl-1, 2,3,4-tetrahydro-1-naphthalenyl]-4-hydroxy-2H-1-benzopyran-2-one (Brodifacoum, BFC, ICI 581, Talon), 2-[(p-chlorophenyl)phenylacetyl]-1,3-indandione (Chlorophacinone, CPN, Rozol), and 2-diphenylacetyl-1,3-indandione (Diphacinone, DPN, Ramik-Brown) resulted in 93%, 86%, and 74% control, respectively, of meadow voles, *Microtus pennsylvanicus,* when broadcast in 2 late fall applications at a 21 day interval. A single hand placed treatment of these baits performed as well or better than the 2 broadcast treatments.**

Zinc phosphide ($Zn_3P_2$) grain baits are used widely for control of meadow vole infestations in orchards throughout the United States. Since broadcast treatments of $Zn_3P_2$ may give only partial control of this species (3), severe tree damage may result after treatment when populations are high. Young orchards (1-7 years of age) are most vulnerable to meadow vole attack since the tree bark is easily gnawed and populations build up in the fall when the grower is involved in bearing orchard activities. In bearing orchards, activities such as spring and summer spraying and mowing, preharvest mowing, pickers trampling, ladder sets, and tractor hauling contribute to lower vole populations. In addition, older trees have thicker bark and are less susceptible to meadow vole injury.

Many growers in the midwest are reluctant to use endrin ground-cover sprays as a general method for meadow vole control because of its toxicity and application technique requirements. Since no alternative to endrin and $Zn_3P_2$ exists, the anticoagulants BFC, CPN, and DPN baits, which were shown to be effective against pine voles (1), were used in this experiment.

The $LD_{50}$ of DPN and BFC was previously determined to be 14 mg/kg and 0.36 mg/kg respectively in meadow voles trapped in Virginia (1). The $LD_{50}$ for CPN in meadow voles trapped in Virginia was determined to be 2.5 (1.2-5.3) mg/kg using similar techniques (1) with doses of 1.0, 2.5, 10, 20 mg/kg. The Litchfield-Wilcoxon method (4) was used to determine the $LD_{50}$ in this experiment. Since the acute $LD_{50}$ of DPN, CPN, and BFC were about 4×, 6×, and 2×, respectively, more toxic in meadow voles compared to pine voles, these materials should be very effective for meadow vole control.

A block of 3-year-old apple trees near Vincennes, Indiana, planted 3m × 6m, was selected for this study. Trees were cultivated in a tree line strip 2 m wide the previous spring and summer, thus causing meadow voles to reside in the middles. In the fall, grass and weeds grew up in the middles where runway systems developed parallel and adjacent to the cultivated strips.

Since vole runways appeared to be confined to each middle, movement appeared to be confined to longitudinal movement within middles between rows of trees, not across rows. Spot checking of the runway systems suggested that the population was a serious commercial concern throughout the block.

The orchard block consisted of rows 84 trees long and 48 rows wide. Rows were cross-sected by 2 cross roads at 28 tree intervals. Each plot was 7 rows wide (6 middles) × 28 trees long. Twenty-four sites were established per plot on top of the soil about 1 m from the trunk adjacent to the cultivated strip and in a meadow vole runway at each of the interior 24 trees in the center row of each plot. Since the voles might invade adjoining plots in a longitudinal fashion, because of the nature of the cultivated strips, plots were not arranged in a standard experimental design. Rather, plots were arranged so that treatments were joined on the end by the same treatment so that invasions of voles would be a remote possibility. Therefore, plots 1-3; 4-6; 7-9; 10-12; 16-18; 19-20; and 22-23 were treated with the same broadcast treatments (Table 1). Plots 13, 14, and 15 were treated with a single hand placed application of Ramik, Rozol, and Talon, respectively, on November 12. In addition, to identify the species, plot #13 was trapped October 21-26 and 37 meadow voles were caught. By November 3, meadow voles from border rows of plot #13 sufficiently invaded this plot so that it could be treated on November 12.

The apple activity test, used in pine vole studies (1, 2), was adapted for use on meadow voles. An apple with a 3-4 cm slice removed from the apple was placed in a runway and covered with a shingle. After 24 hr the places were checked for vole tooth marks and recorded as highly or slightly active. Percent high activity referred to the % of apples having a portion larger than a semisphere of 2.5 cm (about 2.5 g) removed by the voles. Percent activity referred to % of apples with vole tooth marks. Only % high activity is presented (Table 1) since it was much better correlated to the vole populations at trap out (r = 0.86, y = 3.35 + 41.4x, Fig. 1) than % activity (r = 0.47, y = 50 + 30.2x). The quadratic regressions were not significant.

The reason % activity was not well correlated is assumed to be related to the larger range of the meadow vole (5). Small amounts of feeding at each monitor site would result in unusually high activity readings even though low populations actually exist. However, since % high activity was dependent on consumption of at least 2.5g of apple at each site, a better correlation was obtained. Weights of apple consumed may give a better correlation with population than this estimate; however weighing each apple may not be practical when large numbers of plots and sites are to be evaluated. The number of sites per ha may also be important to standardize, since populations of meadow voles may overlap a number of monitor sites. However, this may be difficult to accomplish because of the great variation in tree numbers per ha and orchard design from experiment to experiment. In previous pine vole experiments, 2 sites per tree were established for tree populations below 173 trees per ha (70 trees per acre); and 1 site per tree above about 198 trees per ha (80 trees per acre) (1). This site spacing may have allowed population overlap of about 2 monitor sites in a 24 hr period. Meadow vole overlap may involve many more sites when sites are closely spaced; and even a very small population in the vicinity of a monitor site may be detected. In addition, dropped apples in bearing orchard experiments would probably lower visitation and feeding at monitor sites thus differentially influencing the relationship compared to a non-bearing orchard situation.

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Table 1. Effect of anticoagulant baits on meadow vole activity and populations.

| Treatment | Plot no. | High activity (%)[zx] Oct. 20 | Nov. 3 | Nov. 10 | Nov. 26 | Voles/plot[z] (Dec. 1-5, 1977) | Voles/site[zy] (Dec. 1-5, 1977) | Vole control[z] (%) |
|---|---|---|---|---|---|---|---|---|
| Control – no treatment | 1, 2, 3 | Avg 58<br>UL (92)<br>LL (21) | 68<br>(97)<br>(28) | 71<br>(90)<br>(48) | 51<br>(83)<br>(19) | 25 ± 16 | 1.04 ± 0.63 | 0.0 |
| Ramik-Brown (DPN)<br>Broadcast<br>13.4 kg/ha Oct. 22<br>13.4 kg/ha Nov. 12 | 4, 5, 6,<br>22, 23 | Avg 52<br>UL (73)<br>LL (30) | 29<br>(34)<br>(25) | 31<br>(43)<br>(21) | 6<br>(13)<br>( 1) | 6.2 ± 2.6 | 0.28 ± 0.09 | 74<br>(83)<br>(66) |
| Rozol (CPN)<br>Broadcast<br>13.4 kg/ha Oct. 22<br>13.4 kg/ha Nov. 12 | 10, 11, 12,<br>19, 20, 21 | Avg 66<br>UL (78)<br>LL (55) | 34<br>(50)<br>(18) | 42<br>(55)<br>(28) | 12<br>(18)<br>( 4) | 3.7 ± 3.4 | 0.15 ± 0.14 | 87<br>(96)<br>(74) |
| Talon (BFC)<br>Broadcast<br>13.4 kg/ha Oct. 22<br>13.4 kg/ha Nov. 12 | 7, 8, 9<br>16, 17, 18 | Avg 49<br>UL (72)<br>LL (28) | 26<br>(36)<br>(15) | 35<br>(48)<br>(19) | 10<br>(17)<br>( 2) | 1.7 ± 1.9 | 0.07 ± 0.08 | 96<br>(100)<br>(88) |
| Hand Placed<br>Ramik-Brown (DPN)<br>11.2 kg/ha Nov. 12 | 13[w] | 38 | 38 | 21 | 4 | 3 | 0.14 | 87 |
| Rozol (CPN)<br>11.2 kg/ha Nov. 12 | 14 | 38 | 54 | 54 | 13 | 3 | 0.14 | 87 |
| Talon (BFC)<br>5.4 kg/ha Nov. 12 | 15 | 33 | 42 | 29 | 0 | 0 | 0.00 | 100 |

[z]Confidence interval, 90%, determined within columns within treatments. Percent data was transformed to arc sin before upper (UL) and lower (LL) limits were determined.

[y]One site was established per tree by placing an apple in an active runway and covering with a shingle. All plots contained 24 sites except plots 22, 23, and 17 which had 21, 17, and 21 sites, respectively.

[x]Refers to the % of sites having apple consumption greater than a semi-sphere of 2.5 cm.

[w]Plot #13 was dead trapped Oct. 21-26 and 37 meadow voles were caught. Invasion from border rows was sufficient by Nov. 3 to use as a test plot on Nov. 12.

The first 13.4 kg/ha (12 lb./acre) broadcast treatment (October 22) appeared to reduce the % high activity in all of the treated plots; however, a heavy population still appeared to be present as indicated from activity records of November 3 and November 10. For this reason, a second application of baits was applied November 12 at the same rate per ha; untreated plots 13, 14, and 15 were treated November 12 by hand placing baits in runways at the rates indicated (Table 1). A greater effect from the second application was suspected and may have been the result of greater feeding on the bait due to a number of freezes occurring between the first application and the second application and/or the possible accumulation of anticoagulant in the animals.

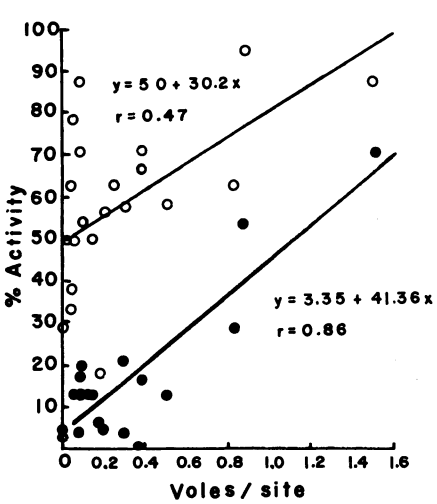


Fig. 1. Linear regression of % active sites (○) and highly active sites (●) on voles/site in 23 plots.

The single hand placed applications of DPN, CPN, and BFC appeared to have given excellent control. However, hand trail baiting for meadow voles may not be advisable unless sites are covered with some type of site cover to reduce hazard to dogs, cats, or non-target species. Broadcasting of bait appears to be the best way of avoiding non-targets in meadow vole areas. Non-target species hazard is much less for pine vole trail baiting since baits are placed in underground trials and removed by animals to underground caches.

This field experiment revealed that 1) given a heavy meadow vole infestation, a single field application of any one of these materials may not give adequate control, therefore, growers should monitor the population approx 3 weeks after the application to determine if another treatment would be required; 2) spring and summer cultivation techniques did not control the infestation and serious damage could have occurred if no toxicant was used; and 3) baits containing the anticoagulants DPN, CPN, and BFC were effective in controlling the animals either as a broadcast or hand placed bait.

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