Susceptibility of Apple and Peach Stems to Attack by Pine Voles[1,3]

R. E. Byers[2]
Virginia Polytechnic Institute and State University
Winchester Fruit Research Laboratory, Winchester

Abstract. **Stems of 3 peach, 3 apple, and 11 apple rootstock cultivars were compared to 'Golden Delicious' apple stems for differences in susceptibility to attack by pine voles, (*Microtus pinetorum* LeConte) in cage-trials. 'Ambergem', 'Glohaven' and 'Elberta' peach and 'Halford' peach seedling stems were significantly less damaged than 'Golden Delicious' apple. No differences in susceptibility were detected among the apple scion and rootstock cultivars. In an interplanted peach and apple orchard apple trees were more severly damaged by voles than peach trees.**

Meadow voles, *M. pennsylvanicus,* exhibited a consistent preference for the roots of certain inbred and hybrid carrot lines in field plantings (3). Comparing lines which showed no damage and those which had severe damage, Lane et al. (3) found no relationship between the amount of carrot root exposed above the soil and either the nutritive value or taste panel scores. No relationship was found between vole preference and growth responses of young voles fed diets of these carrot lines. Genetic variation in carrots was demonstrated to be sufficient to provide a degree of resistance to vole attack.

Although no experiments have been conducted on the relative susceptibilities of apple cultivars to attack by pine voles, Cummins (1) characterized 'Hibernal' rootstocks as very attractive to mice.

Experiments reported herein were designed to gather information on the susceptibility of apple tissue to attack by pine voles, and to determine if differences in damage to apple and peach trees may be related to the susceptibility of the tissue to damage.

Cage experiments. Adult pine voles caught from orchards in the vicinity of Winchester, Virginia were placed singly in standard laboratory cages (LC 75 SA, Wahmann Co., Timonium, Maryland) having 7 mm stainless steel wire bottoms. Animals were offered water and commercial rat food ("Lab-Blox," Allied Mills, Inc., Chicago, Illinois) continuously throughout all experiments. Each cage was fitted with a metal partition to separate the bedding and feeding areas. Burlap strips were provided for bedding. The animal room was kept on a 16-hr day, 8-hr night, 20° ± 2°C, and a relative humidity of 50 ± 10%.

Each single caged vole represented 1 replicate. Stems were placed vertically in each cage, and the lower part submerged in about 1.5 cm of water. All stems were taken from 1-year-old growth, approx 7 mm in diam and 15-17 cm long. Approx 13 cm of each stem remained inside the cage. After 24 hr the stem pieces were removed and rated as follows: 0 = no damage; 1 = less than 1/2 girdled; 2 = 1/2 girdled or more; 3 = completely girdled; and 4 = cut into at least 2 pieces. The data were transformed to a rank system, and a nonparametric Friedman test (2) was applied.

In the first experiment, 1 stem each of 'Golden Delicious', 'Delicious' and 'York' apple and 'Glohaven' and 'Elberta' peach scions was placed in each of 17 single vole cages. The 3 apple stems were damaged to a greater degree than the 2 peach cultivars (Table 1). In the second experiment, 2 stem pieces of 'Golden Delicious' apple and 2 of 'Ambergem' peach were placed in each of 27 single vole cages. 'Ambergem' was damaged less than 'Golden Delicious' and the average ranks were 3.1 and 1.9 respectively (significant at the 1% level).

Table 1. Damage to apple and peach stems by caged pine voles.

Cultivar	Avg rank
Golden Delicious	3.56 a[z]
Red Delicious	3.62 a
York	3.56 a
Glohaven	2.35 b
Elberta	1.91 b

[z]Mean separation in comumn by the Friedman test, 1%.

The testing procedures were standardized in all subsequent experiments which included 24 single vole cages (24 replicates) each supplied with 2 stems of 'Golden Delicious' and 2 stems of the challenge stem material ('M 2', 'M 4', 'M 7', 'M 7a', 'M 9', 'M 26', 'MM 104', 'MM 106', 'MM 111', 'Alanarp 2', 'Red Delicious' apple seedlings, or 'Halford' peach seedlings). Each stem material was directly compared to 'Golden Delicious' in a paired comparison relationship (Table 2). The data were transformed to a rank system, and a nonparametric Friedman test was applied (2). Paired comparisons between each rootstock were not made; and therefore, rootstocks listed in Table 2 cannot be compared within each other. None of the apple materials tested were significantly different from 'Golden Delicious' in damage. The 'Halford' peach seedlings were significantly less damaged when challenged with 'Golden Delicious' stems.

Field Observations. To determine if the measured difference in damage between peach and apple tissue in the

Table 2. Damage to apple and peach rootstock stem tissue by pine voles in 24-hour caged trials using 'Golden Delicious' stems as the standard in paired comparisons.

Rootstock	Avg rank		Friedman Test Q
	Rootstock	'Golden Delicious'	
M 2	2.47	2.53	0.79 ns
M 4	2.41	2.60	1.59 ns
M 7	2.27	2.73	3.34 ns
M 7a	2.44	2.57	1.04 ns
M 9	2.52	2.47	1.15 ns
M 26	2.49	2.51	0.71 ns
MM 104	2.32	2.68	2.09 ns
MM 106	2.54	2.47	1.375 ns
MM 111	2.62	2.39	1.61 ns
Alnarp 2	2.38	2.63	2.43 ns
Apple 'Red Delicious' seedlings	2.52	2.49	0.82 ns
Peach 'Halford' seedlings	2.10	2.91	11.54 **

**Plant material was less susceptible to pine vole attack in comparison with 'Golden Delicious' stems by the Friedman test, 1%.

Table 3. Pine vole damage in a 16-year-old interplanted peach and apple planting near Gore, Virginia, abandoned for 3 years, 1973.

Orchard tree	Trees per damage rating[z]						Avg rating	No. of trees	
	0	1	2	3	4	5		Alive	Dead
Peach	24	0	0	0	0	0	0.0	24	0
Apple	3	1	3	2	1	14	3.6	14	10

[z]Damage rating: 0, no damage; 1, less than ¼ girdled; 2, less than ½; 3, less than ¾; 4, less than complete; 5, completely girdled.

[1]Received for publication January 3, 1974. Journal paper No. 2000 of the Virginia Polytechnic Institute and State University.

[2]Department of Horticulture.

[3]Grateful acknowledgement is made for the assistance of C. Y. Kramer, Professor of Statistics, V. P. I. and S. U., Blacksburg, for experimental design and analysis of data. The partial support of the Virginia Agricultural Foundation was greatly appreciated.

laboratory was significant under field conditions, a study near Gore, Virginia was made in an abandoned interplanted apple and peach orchard. The orchard was under comparable cultural, environmental, and soil conditions and had been abandoned approximately 3 years. A random selection of 4 tree blocks (2 apple and 2 peach trees) was made in each of the first 12 rows of the planting. In early spring 1973 these 24 apple and 24 peach trees were excavated 10-15 cm at the trunk and rated on the scale: 0 = no damage; 1 = less than 1/4 girdled; 2 = less than 1/2 girdled; 3 = less than 3/4 girdled; 4 = 3/4 girdled or more; and 5 = completely girdled (Table 3). The planting was examined in June 1973 for the number of living and dead trees. All tree deaths appeared to have been caused by vole damage to the trunk and large roots below the soil level; an extensive tunnel system characteristic of the pine vole (7, 8) was evident.

These data show that differences in apple and peach bark susceptibility to pine vole damage exists under both laboratory and field conditions. Peach stems may provide a useful standard against which to compare such susceptibilities.

Most pine vole control research has been directed to the elimination of rodents from the orchard by reducing populations through chemical control (4, 5, 6, 7). A preventative procedure based on rootstock resistance could eliminate the annual labor, toxicant, and equipment costs for cultural or toxicant vole control. To date, we have not found an apple stem having resistance to pine vole attack.

Literature Cited

1. Cummins, J. N. 1971. Rootstock notes. N.Y. St. Agr. Expt. Sta. Spec. Rpt. No. 2. Geneva, N.Y.
2. Friedman, M. 1937. The use of ranks to avoid the assumption of normality implicit in the analysis of variance. *J. Amer. Stat. Assoc.* 32:675-701.
3. Lane, R. P., C. E. Peterson, and F. C. Elliot. 1969. Feasibility of using the meadow vole, *Microtus pennsylvanicus*, to bioassay the nutritive value and culinary quality of some carrot inbred lines and hybrids. *J. Amer. Soc. Hort. Sci.* 94:96-98.
4. Horsfall, Frank, Jr., G. M. Shear, R. E. Webb, and R. W. Young. 1971. Potentials for pine mouse control with ground sprayed Chlorophacinone. *Va. Fruit* 59:64-68.
5. ———. 1956. Pine mouse control with ground sprayed Endrin. *Proc. Amer. Soc. Hort. Sci.* 67:69-74.
6. ———. 1956. Rodenticidal effect on pine mice of Endrin used as a ground spray. *Science* 123:61.
7. ———. 1953. Mouse control in Virginia orchards. *Va. Agr. Expt. Sta. Bul.* 456.
8. Paul, J. R. 1970. Observations on the ecology, populations and reproductive biology of the pine vole, *Microtus pinetorum*, in North Carolina. Rpt. of Invest. No. 20, Ill. St. Museum, Springfield, Ill.

Apple Bud Explants as a Screening Test for Growth Regulating Chemicals[1]

L. E. Powell[2] and L. J. Edgerton[2]
Cornell University, Ithaca, New York

Abstract. **Bud explants of apple (*Malus domestica* Bork.) grown aseptically *in vitro* have been shown to respond to several chemicals in a manner similar to intact trees treated with the same chemicals, except that much lower concentrations are required. The method should be useful as a screening test for chemicals which have shoot-regulatory properties.**

Large numbers of chemicals are screened each year for their effects on biological systems. Some of these are eventually selected for additional tests on specific plants. In the case of woody plants these tests are often carried out in the field or greenhouse. This approach requires that relatively large quantities of the chemical be applied, generally to an intact plant or branch unit, with the time of application often limited to the growing season (4). Recently methods have been described for the aseptic culture of axillary apple bud explants *in vitro* (1, 2, 3, 5). We have compared the response of apple bud explants and intact trees to several growth-regulating chemicals. The responses have been similar enough to suggest that the explant technique should prove useful as a screening test for effects on apple shoot growth.

Axillary buds were taken from the mid-portion of growing shoots (20-40 cm long) of 'Northern Spy' apple seedlings grown in the greenhouse. The stationary culture technique was employed (1). Buds so cultured can be expected to grow into miniature shoots 4-5 cm in length within 3-4 weeks. Bud explants were treated with various chemicals by incorporating them into the agar medium. For comparison, young 'McIntosh' apple trees growing in the greenhouse were sprayed with the same chemicals.

Comparison of 4 chemicals in the bud explant test (Fig. 1) and the whole-tree experiments (Table 1) show that similar results were obtained in both types of tests, but at a lower concn in the case of explants. The comparisons can be summarized as follows:

SADH applied to whole trees at 2000 ppm gave about 50% inhibition of shoot growth. SADH at 10 ppm in the bud explant test gave approx the same degree of inhibition, while 100 ppm almost completely suppressed growth. Epinasty was not evident in either case.

Am 70-19 applied to whole trees at 1000 ppm resulted in normal growth and appearance. Only at the very high concn of 5000 ppm was retardation of growth evident. Am 70-19 as high as

[1]Received for publication February 22, 1974.

[2]Department of Pomology.

Table 1. Effect of some growth retardants on young 'McIntosh' apple trees in the greenhouse.[z]

Treatment 2/17/70	Concn (ppm)	Shoot growth (cm) Days after treatment 11	18	27	Notes
NIA 10637[y]	1000	7.0	11.5	16.2	Slight leaf epinasty and necrosis.
NIA 10637[y]	5000	5.5	6.1	7.1	Epinasty and leaf curling; some defoliation.
NIA 10656[x]	1000	4.9	8.4	11.2	Small, lance-shaped leaves.
NIA 10656[x]	5000	2.9	4.2	5.8	Some leaf curling; rosette appearance, new leaves small and narrow.
Am 70-19[w]	1000	9.2	16.6	21.2	Normal growth and appearance.
Am 70-19[w]	5000	7.8	11.1	12.9	Some retardation, no injury.
SADH[v]	2000	5.2	9.1	11.6	Retardation, shortened internodes.
Control	–	10.3	18.2	20.8	Normal growth and development.

[z]Treatments applied February 17, 1970 on 4-year-old 'McIntosh' apple trees in the greenhouse; 4 replicate shoots per treatment. Shoots averaged about 7 cm long at time of application. Measurements indicate shoot growth after treatment. Tween 20 added to all treatments at 0.1%.
[y]Ethyl hydrogen 1-propylphosphonate. Niagara Chemical Co., Middleport, NY.
[x]Ethyl hydrogen 1-propylphosphonic acid. Niagara Chemical Co., Middleport, NY.
[w]2-dimethylamino-p-menth-8-en-1-ol, hexyl bromide. Amchem Products, Inc., Ambler, PA.
[v]Succinic acid-2,2-dimethylhydrazide. UniRoyal, Inc., Bethany, CT.