2007 Woolly Apple Aphid Control on Apple Roots
Utah Agricultural Experiment Station, Kaysville, UT

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Objective and Brief Background:

As a follow-up to a spring and summer insecticide efficacy trial for suppression of woolly apple aphid, aphid colonies and root galls were evaluated on apple roots in the fall. The objective was to determine if the systemic insecticide, spirotetramat (Movento® 150SC or Ultor® 150SC), reduced aphid colonies and root galls following spring and summer applications to apple tree canopies.

Methods:

Experimental design and treatments

The study was conducted in an 18-year-old 2-acre apple orchard of mixed cultivars at the Utah Agricultural Experiment Farm in Kaysville, UT. A total of 16 trees were selected for root sampling from the original treatment plots. The orchard was slated for removal following completion of the 2007 woolly apple aphid insecticide trial. Four trees from each of four previous trial treatments were selected: 1) untreated control, 5) Movento 150SC @ 12 oz/acre + 1% v/v horticultural mineral oil (HMO) applied on May 9 only, 6) Movento 150SC @ 8 oz/acre + 1% v/v HMO applied on May 9 and June 11, and 7) Movento 150SC @ 12 oz/acre + 1% v/v HMO applied on May 9 and June 11. The May 9 application targeted the petal fall timing and the June 11 application was 33 days later. Refer to the Alston and Lindstrom (2007) report for full descriptions of the treatments, plot design, and application methodologies.

Root and aphid sampling

Root sampling was conducted on 15 'Delicious' (Red strains) trees and on one 'Mutzu' tree. One 'Mutzu' tree was selected because there were not enough 'Delicious' trees available in the untreated control plots. All limbs were removed from the sample trees prior to root sampling. Heavy rainfall thoroughly soaked the orchard soil prior to sampling and facilitated tree removal. On October 10, 2007, a tractor with a large hinged bucket was used to lift the trunks of trees from the ground and shake them to remove soil. Root systems of root suckers attached to the main apple tree roots were removed, the stems pruned off, and the roots placed in a gallon-sized Ziplock® plastic bag. Root suckers are small apple tree sprouts that grow off of the main tree roots. They were smaller and easier to sample than main tree roots. Woolly apple aphids utilize root suckers as a prime feeding site and apple root suckers have been observed to serve as a primary source of woolly apple aphids in orchards. Enough roots were collected from each tree to fill a gallon-sized bag. The roots were visually inspected for woolly apple aphid colonies. Some aphids could be seen (gray, waxy covering of aphids was evident), but it seemed that root galling was a more effective measure of aphid feeding than attempting to extract aphids from the roots for quantification.

The roots were returned to the laboratory and soil washed from the roots by soaking them in a tub of water and running water from the facet over the roots. The roots from the whole sample were patted dry with paper towels, weighed, and a visual root gall rating assessed. The rating scale was as follows: 0 = no galls, 1 = 1-10% of the roots galled, 2 = 11-20% of the roots galled, …, 10 = 91-100% of the roots galled. Then two sub-samples of two to three root systems each were selected from each of the whole samples, weighed, the number of galls counted, and the location of galls on the roots recorded. Each spherical structure was counted as a gall. In some cases, galls were stacked on top of each other. Each gall was counted separately. Gall location was divided into three types of roots: 1) the main tap root, 2) mid diameter lateral roots (roots growing directly out from main tap root), and 3) fine secondary roots (roots growing out from mid sized lateral roots). See photos at the end of this report for visual aids of trial methodologies.

Statistical analyses

Gall ratings of whole root samples (one sample from each of 16 trees, N = 16) and location of galls on roots in sub-samples (two sub-samples per tree, N = 32) were analyzed with frequency tests (Proc Freq, SAS Institute). Chi-square and Fisher's Exact Test were included in the analysis. The frequency of gall rating categories and location of galls on roots were compared among the four treatments. The number of galls on root sub-samples was compared among treatments with analysis of variance (Proc Mixed, SAS Institute). When significantly different, means were separated with the Tukey-Kramer pairwise-mean comparisons method.

Results and Discussion:

Root gall ratings

The mean wet weight of root samples collected from apple tree root suckers of each tree ranged from 228 to 692 g. There was no difference in whole root sample weights among treatments [410.5 $\pm$ 98.9, 505.5 $\pm$ 33.1, 450.0 $\pm$ 46.7, and 471.5 $\pm$ 40.7 g (mean $\pm$ SE), for Treatments 1, 5, 6, and 7, respectively). There were statistically significant differences among treatments in root gall ratings (χ^2, $p = 0.05$; Fisher's Exact Test, $p = 0.04$). A greater frequency of higher gall ratings occurred in the untreated control and Movento 8 oz treatment (applied twice) than in either of the Movento 12 oz treatments (applied once and twice) (Fig. 1).

Densities of galls on roots

The number of galls on roots was compared among treatments on a per gram of wet-weight-basis. Significantly more galls were present on roots from untreated trees than from any of the three Movento treatments ($p = 0.001$) (Fig. 2).

Location of galls on roots

All treatments had roots with galls on the main tap root, but only the untreated control and Movento 8 oz treatment had galls on mid-sized and fine roots (Fig. 3). There was a greater frequency of galls on mid-sized roots in the untreated than in any Movento treatment and a greater frequency in Movento 8 oz than in either Movento 12 oz

treatments (χ^2 and Fisher's Exact Test, $p < 0.001$). There was a greater frequency of galls on fine roots in both the untreated and Movento 8 oz treatments than in either of the Movento 12 oz treatments (χ^2, $p = 0.007$; Fisher's Exact Test, $p = 0.006$) (Fig. 3).

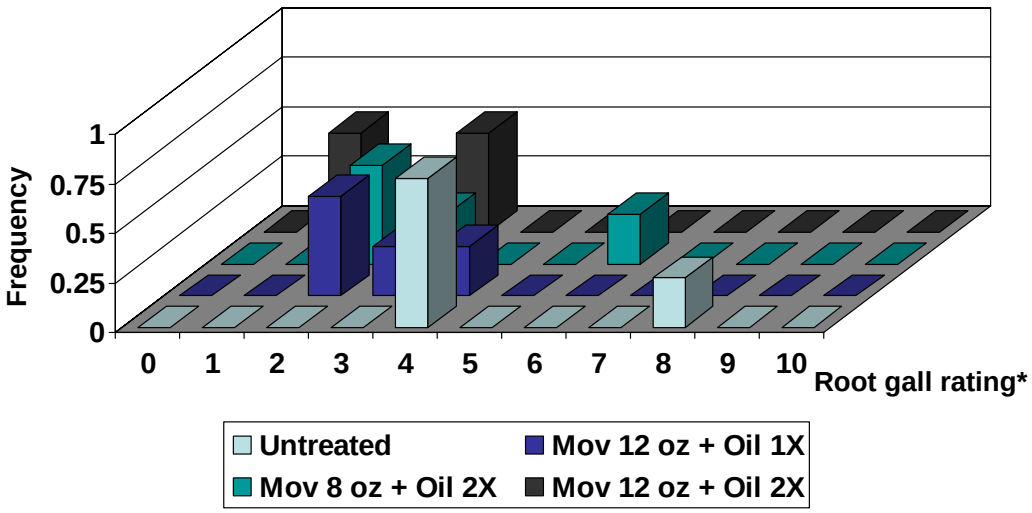
Summary and conclusions

Movento applications made at the 12 oz/acre rate either only once at petal fall (on May 9) or two times (a second application 33 days later on June 11) were the most effective in suppressing galls formed by woolly apple aphids on apple root sucker root systems. The Movento 8 oz/acre rate (applied twice) was not as effective as the higher rate in suppressing root galls based on visual ratings and location of galls on roots. More galls were present on the fine and mid-diameter roots in the Movento 8 oz rate than in the 12 oz rate. All of the Movento treatments were more effective at reducing galls formed by woolly apple aphids than the untreated control. Based on visual observations, it was evident that some of the galls were older than others. Woolly apple aphids had been present in this research orchard for more than five years; therefore, galls had likely accumulated on roots over time. So Movento applications made in the spring and summer of 2007 significantly reduced new gall formation, but would not have had an effect on galls formed before 2007. It is likely that most of the older galls would have been present on the main tap root and perhaps on the mid-diameter lateral roots. The fine secondary roots are likely younger and so suppression of aphids during 2007 would have the most effect on preventing galls on the fine roots especially, and on mid-sized roots to some extent. The summer aphid count data suggested that both the low and high rate of Movento and one and two applications were similar in their suppression of woolly apple aphid incidence and densities on tree limbs. The lower 8 oz rate of Movento didn't provide as great of root gall prevention within one season following multiple years of woolly apple aphid infestation as did the 12 oz rate.

Report Cited:

Alston, D. and T. Lindstrom. 2007. Woolly and green apple aphid control trial in apples. Utah Agricultural Research Station Report (12 pp).

Fig. 1. Influence of Movento treatments on frequency of root gall ratings.



*0 = no galls, 1 = 1-10% of roots galled, …. 10 = 91-100% of roots galled

Fig. 2. Influence of Movento treatments on number of root galls.

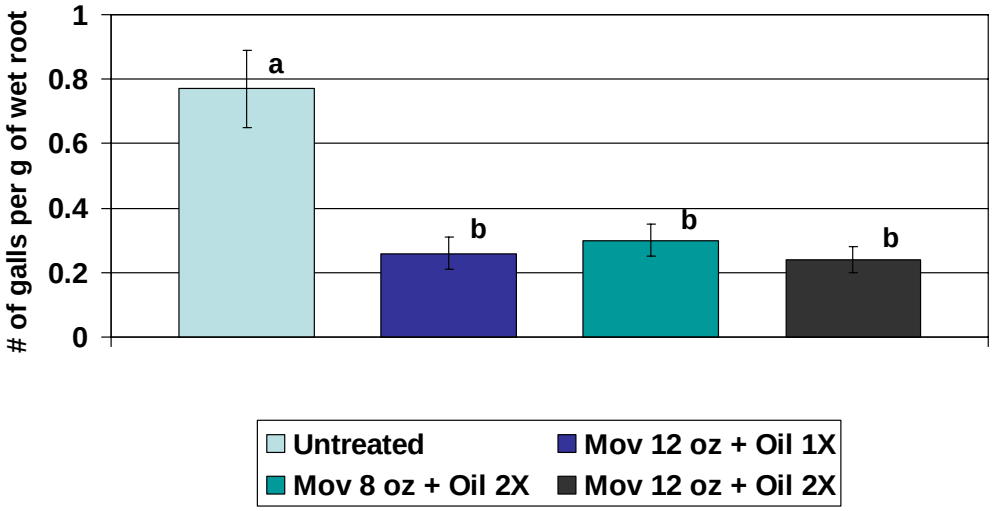
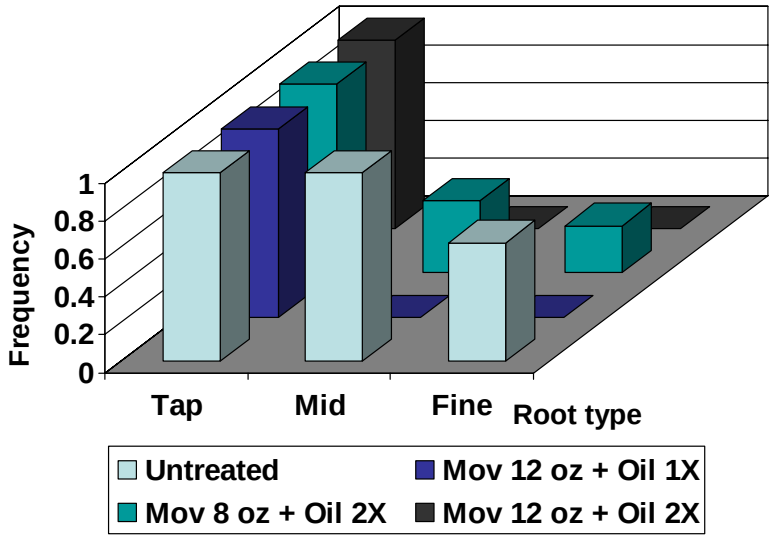


Fig. 3. Influence of Movento treatments on location of galls on roots.

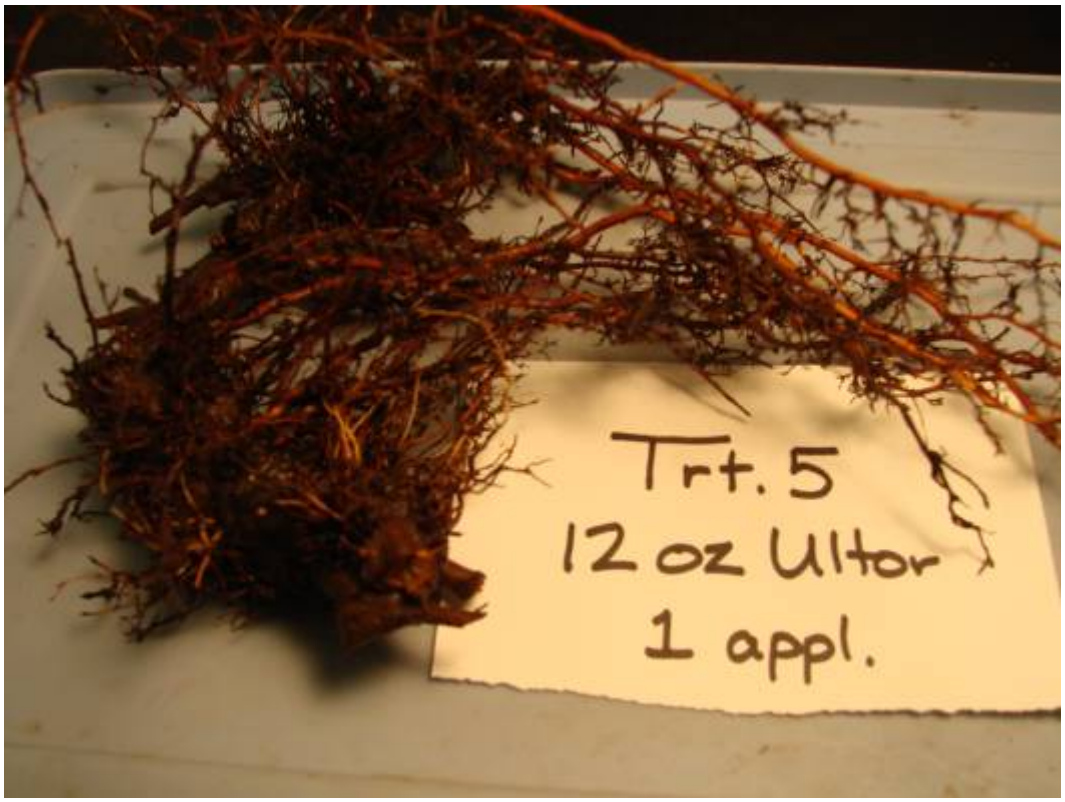


Tractor with hinged-bucket pulled tree trunks from the ground and shook off soil.

Root suckers clustered at base of apple tree trunk.

Woolly apple aphids (gray, waxy structures) and galls on apple sucker roots.

Root system from an untreated tree (note the large galls on the tap and secondary roots.



Root system from Treatment 5, Movento @ 12 oz per acre applied once.

Root system from Treatment 6, Movento @ 8 oz per acre applied twice.

Root system from Treatment 7, Movento @ 12 oz per acre applied twice.