# Fruit Notes

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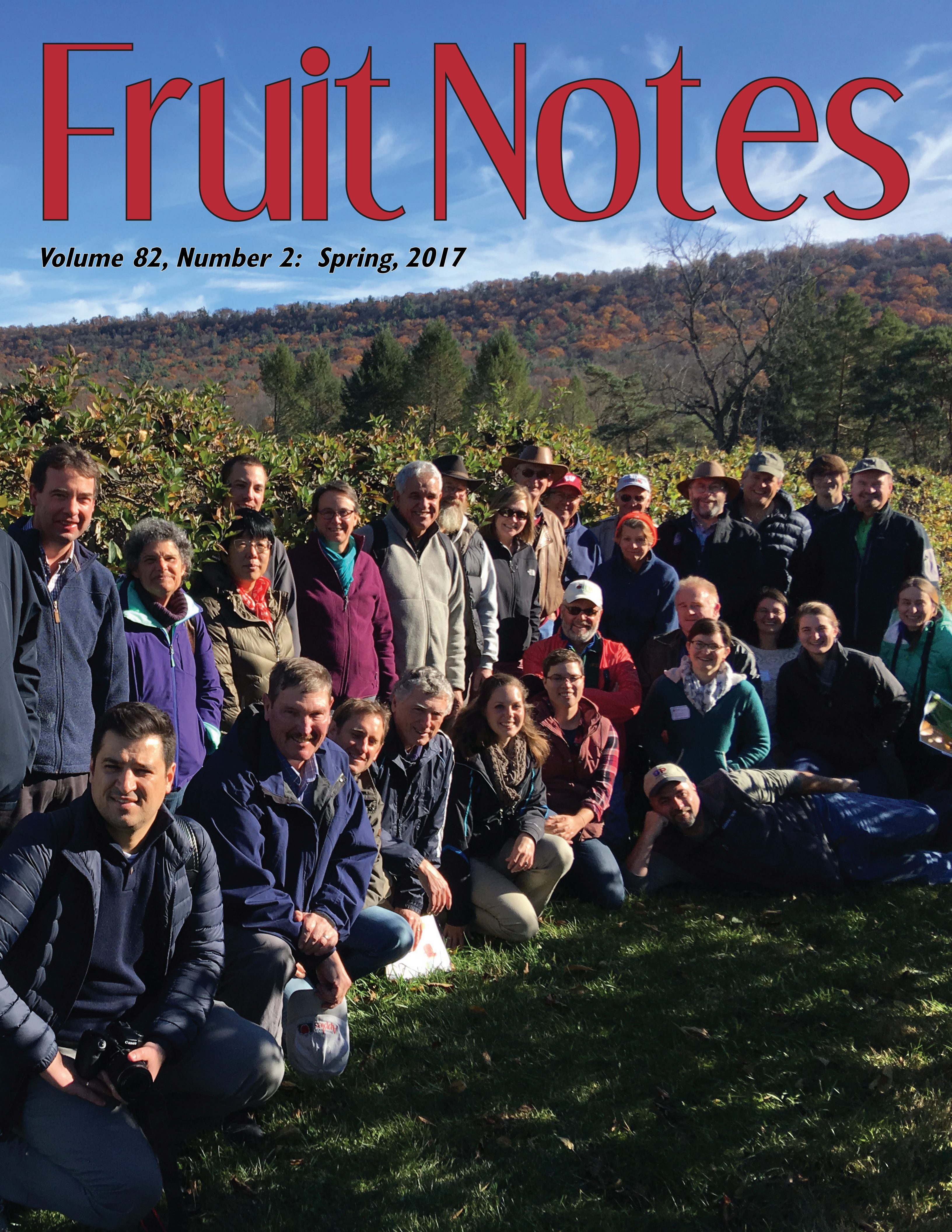

# Fruit Notes

Editors: Wesley R. Autio & Winfred P. Cowgill, Jr.

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## Table of Contents



Cover: NC-140 Multistate Rootstock Research Committee meeting in Pennsylvania in November 2016. Win Cowgill photo.

# Performance of Honeycrisp Apple trees on Several Budagovsky, Cornell-Geneva, and Pillnitz Rootstocks

## *An Update on the Massachusetts Planting of the 2010 NC-140 Apple Rootstock Trial*

**Wesley R. Autio, James S. Krupa, Jon M. Clements, and Winfred P. Cowgill Jr.**
***Stockbridge School of Agriculture, University of Massachusetts***

As part of the 2010 NC-140 Honeycrisp Apple Rootstock Trial, a planting was established at the UMass Cold Spring Orchard Research and Education Center with 31 different rootstocks. These included two named clones from the Budagovsky series (B.9, B.10), seven unreleased Budagovsky clones (B.7-3-150, B.7-20-21, B.64-194, B.67-5-32, B.70-6-8, B.70-20-20, and B.71-7-22), four named Cornell-Geneva clones (G.11, G.41, G.202, and G.935), nine unreleased Cornell-Geneva clones (CG.2034, CG. 3001, CG.4003, CG.4004, CG.4013, CG.4214, CG.4814, CG.5087, and CG.5222), one named clone from the Pillnitz series (Supp.3), two unreleased Pillnitz clones (PiAu 9-90 and PiAu 51-11), and three Malling clones as controls (M.9 NAKBT337, M.9 Pajam 2, and M.26 EMLA). G.41, G.202, and G.935 were represented both by trees propagated from stool-bed liners (labeled as N) and from tissue-cultured liners (labeled as TC).

Budagovsky rootstocks are from the Michurinsk State Agrarian University in Michurinsk, Tambov Region, Russia. The breeding program began with I.V. Budagovsky making crosses in 1938, with the principle goal of developing rootstocks with enhanced winter hardiness. He released one of the best known Budagovsky Rootstocks, B.9, in 1962. The Cornell-Geneva Apple Rootstock Breeding Program is managed jointly by Cornell University and the United States Department of Agriculture. Several rootstocks have been released from this program, most with a high degree of disease resistance, particularly to the fire blight bacterium (*Erwinia amylovora*). The Pillnitz series of rootstocks (PiAu and Supporter) are from the Institut für Obstforschung Dresden-Pillnitz, Germany. The original material for this program came from discontinued breeding programs in Muncheberg and Naumburg. These earlier programs sought better horticultural characteristics and pest resistance.

The trial was planted in May 2010, at a tree spacing of 4'x12', and trees were trained on wire as tall spindles. Trees on B.70-20-20 were deemed too large after five years and were removed from the trial. This article presents data through 2016, the seventh growing season.

The results for 2016 and cumulatively are presented in Table 1. Tree size varied greatly, from the smallest trees on B.71-7-22 and the largest on B.64-194, with more than a ten-fold difference in trunk cross-sectional area between the two. Root suckering varied also, with some rootstocks producing very small amounts (B.64-194, B.10, CG.2034, G.41N, and PiAu 9-90) and others producing moderately large numbers of root suckers (CG.4214, G.202N, CG.4814, and G.202TC). The zonal chlorosis, typical of Honeycrisp, varied with rootstock also. In 2016, the least was seen on trees on B.7-3-150, and the most was seen on trees on G.935TC.

Yield was relatively low in 2016 because of the early spring cold temperatures. Greatest yields were harvested from trees on CG.3001, and the smallest yields were from trees on B.71-7-22. Cumulatively (2013-16), trees on CG.3001 were the highest yielding,

Table 1. Trunk cross-sectional area, cumulative root sucker number, zonal chlorosis, yield per tree, yield efficiency, and fruit weight in 2016 of Honeycrisp apple trees on various rootstocks in the 2010 NC-140 Honeycrisp Apple Rootstock Trial at the UMass Cold Spring Orchard Research & Education Center, Belchertown, MA.

| Rootstock | Trunk cross-sectional area (2016, $cm^2$) | Cumulative root suckers (2010-16, no.) | Zonal chlorosis (2016, %) | Yield per tree (2016, kg) | Cumulative yield per tree (2013-16, kg) | Yield efficiency (2016, $kg/cm^2$ TCA) | Cumulative yield efficiency (2013-16, $kg/cm^2$ TCA) | Fruit weight (2016, g) | Average fruit weight (2013-16, g) |
|---|---|---|---|---|---|---|---|---|---|
| B.9 | 8.6 | 13.7 | 24.2 | 7.6 | 30.4 | 0.9 | 3.5 | 180 | 228 |
| B.10 | 14.5 | 0.6 | 25.0 | 12.9 | 52.2 | 0.9 | 3.7 | 233 | 240 |
| B.7-3-150 | 31.9 | 2.5 | 12.8 | 13.4 | 50.7 | 0.4 | 1.6 | 222 | 264 |
| B.7-20-21 | 27.3 | 6.5 | 29.6 | 9.9 | 55.0 | 0.3 | 2.1 | 193 | 236 |
| B.64-194 | 34.8 | 0.0 | 20.7 | 11.2 | 50.4 | 0.3 | 1.4 | 222 | 248 |
| B.67-5-32 | 33.1 | 1.8 | 18.9 | 9.1 | 46.7 | 0.3 | 1.5 | 217 | 256 |
| B.70-6-8 | 33.2 | 1.2 | 18.2 | 12.5 | 61.6 | 0.4 | 1.9 | 220 | 251 |
| B.71-7-22 | 2.3 | 7.0 | 52.3 | 1.3 | 6.3 | 0.6 | 2.7 | 85 | 163 |
| G.11 | 11.8 | 13.5 | 31.9 | 12.9 | 53.7 | 1.1 | 4.5 | 181 | 238 |
| G.41N | 13.8 | 0.5 | 23.4 | 15.0 | 60.0 | 1.0 | 4.2 | 210 | 246 |
| G.41TC | 12.7 | 14.3 | 26.3 | 13.8 | 45.2 | 1.0 | 3.5 | 214 | 244 |
| G.202N | 27.0 | 40.7 | 50.7 | 11.3 | 88.3 | 0.5 | 3.3 | 205 | 249 |
| G.202TC | 17.7 | 30.0 | 25.7 | 15.2 | 64.6 | 0.8 | 3.6 | 196 | 219 |
| G.935N | 18.1 | 22.4 | 67.5 | 14.2 | 80.4 | 0.8 | 4.4 | 202 | 230 |
| G.935TC | 12.5 | 28.6 | 89.5 | 12.3 | 45.7 | 0.9 | 3.5 | 201 | 223 |
| CG.2034 | 10.1 | 0.1 | 53.7 | 8.2 | 31.6 | 0.7 | 3.0 | 157 | 212 |
| CG.3001 | 28.2 | 3.8 | 23.8 | 19.8 | 106.5 | 0.7 | 3.8 | 223 | 245 |
| CG.4003 | 9.7 | 2.1 | 23.0 | 9.0 | 42.8 | 0.9 | 4.3 | 143 | 195 |
| CG.4004 | 25.5 | 16.0 | 32.5 | 18.0 | 80.6 | 0.7 | 3.2 | 233 | 250 |
| CG.4013 | 19.0 | 28.5 | 40.2 | 19.3 | 70.8 | 0.9 | 3.5 | 191 | 221 |
| CG.4214 | 19.9 | 53.7 | 67.1 | 12.6 | 51.5 | 0.6 | 2.6 | 213 | 238 |
| CG.4814 | 18.1 | 30.3 | 80.6 | 9.5 | 54.4 | 0.5 | 3.1 | 200 | 219 |
| CG.5087 | 17.2 | 8.6 | 69.8 | 16.7 | 59.3 | 1.0 | 3.3 | 160 | 213 |
| CG.5222 | 21.7 | 26.1 | 64.2 | 10.5 | 48.0 | 0.5 | 2.2 | 199 | 223 |
| Supp.3 | 12.1 | 8.7 | 85.0 | 7.7 | 32.8 | 0.6 | 2.7 | 165 | 211 |
| PiAu 9-90 | 24.4 | 1.0 | 66.5 | 6.8 | 20.2 | 0.3 | 0.9 | 168 | 157 |
| PiAu 51-11 | 21.8 | 11.4 | 39.9 | 8.5 | 42.6 | 0.4 | 2.0 | 208 | 247 |
| M.9 NAKBT337 | 13.6 | 25.3 | 69.2 | 12.1 | 51.8 | 0.9 | 3.8 | 197 | 237 |
| M.9 Pajam 2 | 12.4 | 36.9 | 61.7 | 8.6 | 38.5 | 0.7 | 3.3 | 187 | 224 |
| M.26 EMLA | 14.0 | 14.2 | 49.8 | 8.3 | 37.2 | 0.6 | 2.7 | 214 | 231 |
| Est. HSD ($P = 0.05$) | 9.1 | 22.6 | 45.2 | 7.8 | 25.7 | 0.4 | 1.1 | 64 | 41 |

Within a column, mean differences greater than or equal to the Est. HSD are statistically significant (at odds of 19 to 1).

and those on B.71-7-22 were the lowest yielding.

Some of the difference in yield is simply related to tree size, so it often is more instructive to look at yield efficiency, which relates yield to trunk cross-sectional area. The most efficient trees in 2016 were on G.11, and the least efficient were on B.7-20-21, B.64-194, B.67-5-32, and PiAu 9-90. Cumulatively (2013-16), the most efficient trees were on G.11, G.935N, and G.41N, and the least efficient were on PiAu 9-90. Generally, fruit size was not much affected by rootstock, except fruit from trees on B.71-7-22 (the smallest tree) were consistently small (2016 and on average from 2013 through 2016).

Using the data in Table 1 to compare 30 rootstocks is difficult at best. To potentially see differences more easily, trunk cross-sectional area and cumulative yield per tree are presented graphically in Figure 1. Rootstocks are arranged from the most vigorous at the top to the least vigorous at the bottom. It is easy to see that some rootstocks stand out relative to yield within a size

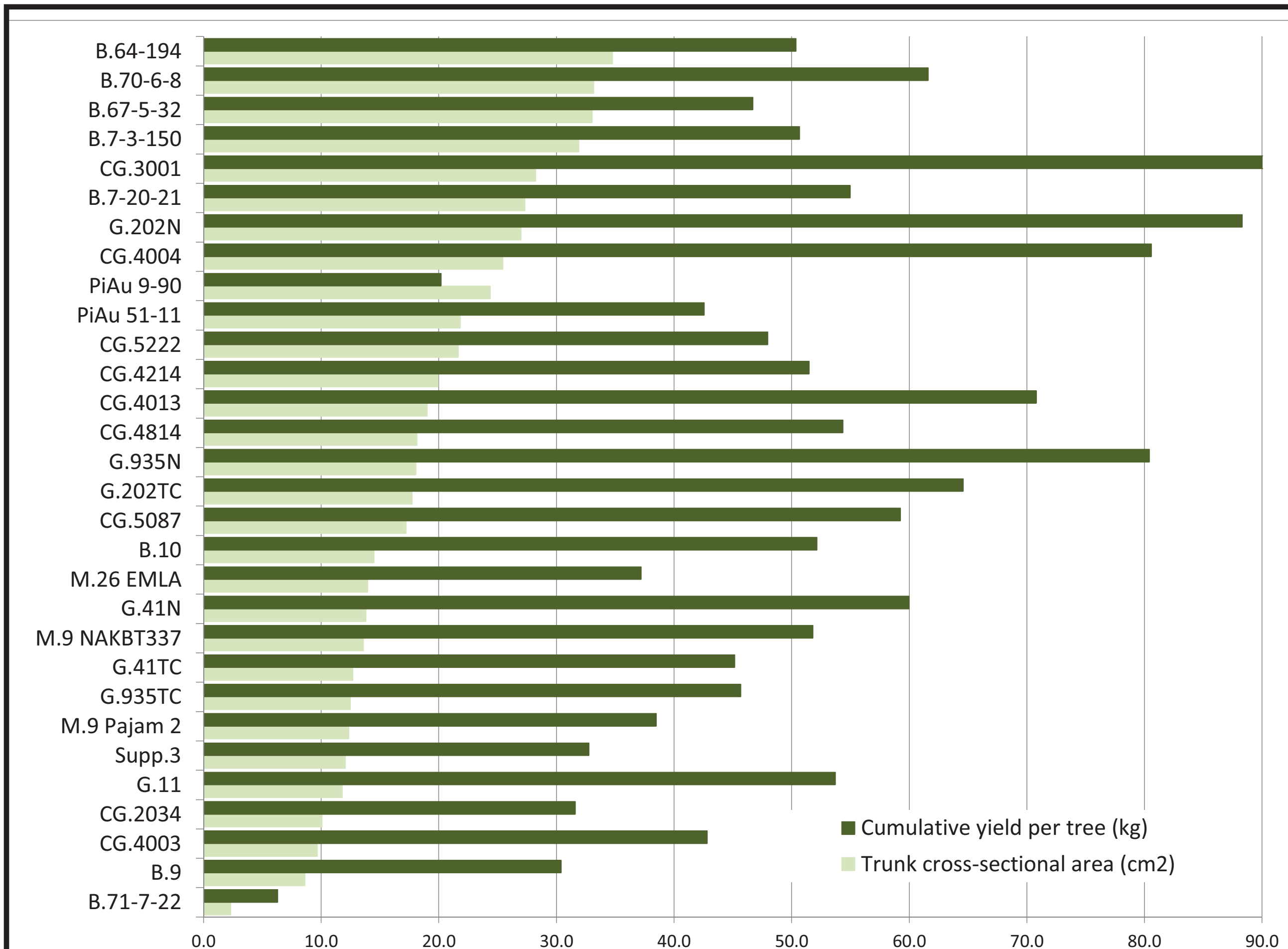


Figure 1. Trunk cross-sectional area and cumulative yield in 2016 of Honeycrisp apple trees on various rootstocks in the 2010 NC-140 Honeycrisp Apple Rootstock Trial.

category.

In Table 2, we have presented the rootstocks by size category (sub-dwarf, small dwarf, moderate dwarf, large dwarf, and semi-dwarf), and within category, we have arranged them from most to least yield efficient. This table gives a much clearer view of these rootstocks. For a semi-dwarf tree, CG.3001, G.202N, and CG.4004 performed the best. Among the large dwarfs, G.935N was the most yield efficient. For the moderate dwarfs, G.11 and G.41N were the best performers, and CG.4003 was the best for the small dwarfs.

This trial has shown that the new Budagovsky rootstocks do not perform particularly well. All, but B.10 and B.71-7-22, are quite vigorous with low yield efficiency. B.10 performed comparably to M.9 NAKBT337, but not as well as G.11 and G.41N. For a very weak rootstock, B.71-7-22 was not very yield efficient and resulted in small fruit.

None of the Pillnitz rootstocks performed well when compared to other rootstocks in their respective size category.

Cornell-Geneva rootstocks performed best in the semi-dwarf, large dwarf, moderate dwarf, and small dwarf categories. The standouts were CG.3001, G.202, CG.4004, G.935, G.11, G.41, and CG.4003. Certainly, the unnamed CG.3001, CG.4004, and CG.4003 are worth of further trial, and the named G.202, G.935, G.11, and G.41 are ready for more significant commercial planting. It is important, however, to note that G.935 is susceptible latent virus that may be in the scionwood. The use of virus indexed scion wood is essential.

Table 2. Rootstocks distributed among five vigor classes based on 2016 trunk cross-sectional area. Within class, rootstocks are ordered highest to lowest based on cumulative (2011-16) yield efficiency. Standouts are highlighted in yellow.

| **HONEYCRISP** | | | |
|---|---|---|---|
| Vigor category | Rootstock | Trunk cross-sectional area (2016, $cm^2$) | Cumulative yield efficiency (2011-16, $kg/cm^2$ TCA) |
| Semi-dwarf | CG.3001 | 28.2 | 3.8 |
| | G.202N | 27.0 | 3.3 |
| | CG.4004 | 25.5 | 3.2 |
| | CG.5222 | 21.7 | 2.2 |
| | B.7-20-21 | 27.3 | 2.1 |
| | PiAu 51-11 | 21.8 | 2.0 |
| | B.70-6-8 | 33.2 | 1.9 |
| | B.7-3-150 | 31.9 | 1.6 |
| | B.67-5-32 | 33.1 | 1.5 |
| | B.64-194 | 34.8 | 1.4 |
| | PiAu 9-90 | 24.4 | 0.9 |
| Large dwarf | G.935N | 18.1 | 4.4 |
| | G.202TC | 17.7 | 3.6 |
| | CG.4013 | 19.0 | 3.5 |
| | CG.5087 | 17.2 | 3.3 |
| | CG.4814 | 18.1 | 3.1 |
| | CG.4214 | 19.9 | 2.6 |
| Moderate dwarf | G.11 | 11.8 | 4.5 |
| | G.41N | 13.8 | 4.2 |
| | M.9 NAKBT337 | 13.6 | 3.8 |
| | B.10 | 14.5 | 3.7 |
| | G.935TC | 12.5 | 3.5 |
| | G.41TC | 12.7 | 3.5 |
| | M.9 Pajam 2 | 12.4 | 3.3 |
| | M.26 EMLA | 14.0 | 2.7 |
| | Supp.3 | 12.1 | 2.7 |
| Small dwarf | CG.4003 | 9.7 | 4.3 |
| | B.9 | 8.6 | 3.5 |
| | CG.2034 | 10.1 | 3.0 |
| Sub-dwarf | B.71-7-22 | 2.3 | 2.7 |


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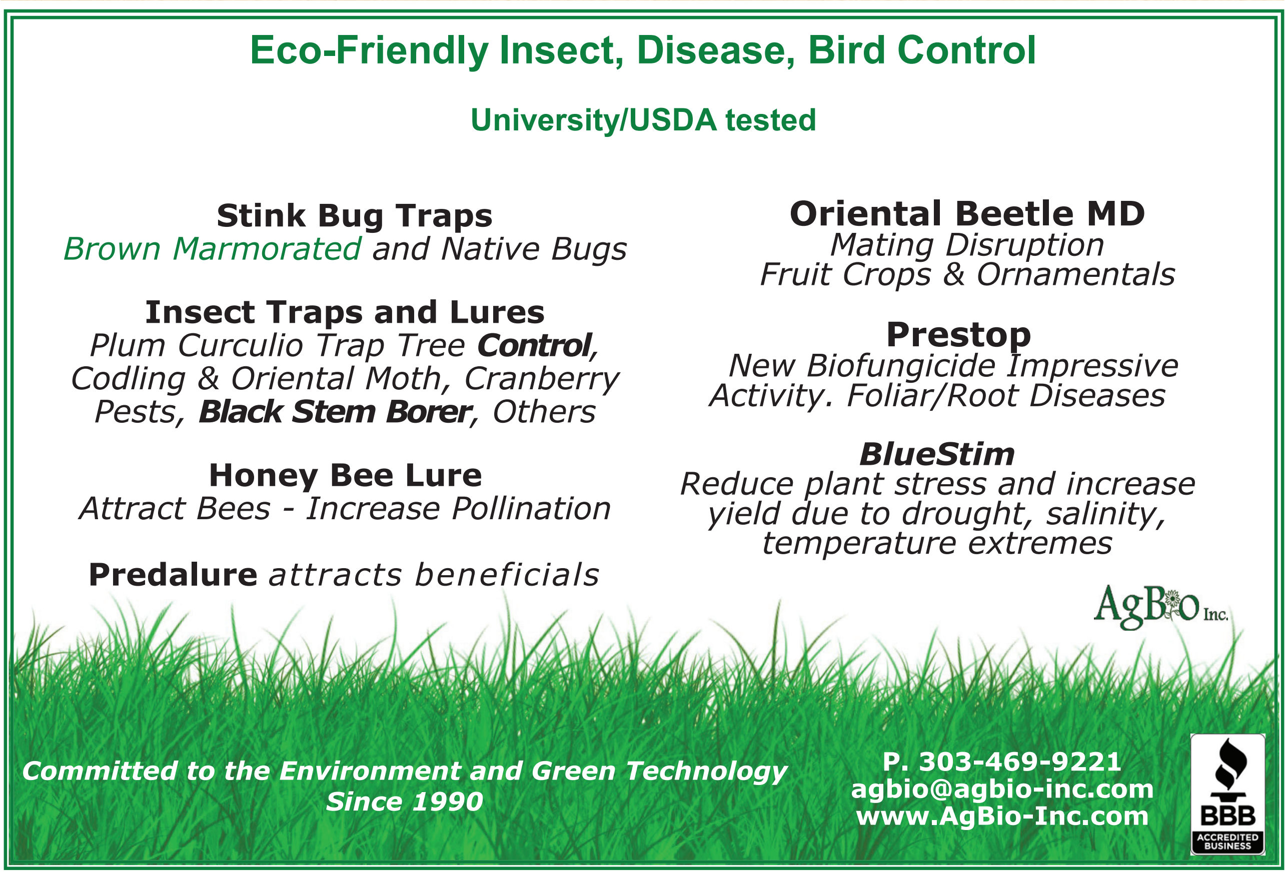
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# Rootstock Influence on Redhaven Peach Performance

## *An Update on the Massachusetts Planting of the 2009 NC-140 Peach Rootstock Trial*

**Wesley R. Autio, James S. Krupa, Jon M. Clements, and Winfred P. Cowgill Jr.**
***Stockbridge School of Agriculture, University of Massachusetts***

In 2009, a planting was established at the UMass Cold Spring Orchard Research and Education Center as part of the 2009 NC-140 Peach Rootstock Trial. Fifteen rootstocks were involved in the experiment, including six based on peach only, two on plum only, and seven that were plum, peach, cherry, and/or almond hybrids (Table 1). Of the peach only rootstocks, one (Guardian) was from USDA/Clemson University, two (HBOK 10 and HBOK 32) were from the University of California Davis, two (KV010-123 and KV010-127) were from USDA Kearneysville, and one was the standard Lovell. The plums were from Bailey's Nursery (*Prunus americana*) and Instituto Sperimentale per la Frutticoltura in Italy (Penta). The three plum hybrids were from the University of California Davis (Controller 5) and the Krymsk Breeding & Research Station in Russia (Krymsk 1 and Krymsk 86). The two almond hybrids were from Bright's Nursery in California (Bright's Hybrid #5) and Agromillora Catalana in Spain (Mirobac). The two peach/almond/plum hybrids (Atlas and Viking) were from Zaiger's Genetics in California.

The trial was planted on May 6, 2009 with eight replications of each rootstock. Trees were spaced 13.1'x16.4' and were trained as open centers. The data

Table 1. Rootstocks included in the 2009 NC-140 Peach Rootstock Trial planted at the UMass Cold Spring Orchard Research & Education Center. All trees are Redhaven and were planted on May 6 with eight replications.

| Rootstock | Genetics | Source | Origin | Projected vigor (relative to Lovell) | Measured vigor (relative to Lovell) |
|---|---|---|---|---|---|
| Lovel | Peach | California (1882 selection drying cultivar) | USA -- CA | 100% | 100% |
| Guardian | Peach | USDA/Clemson University | USA -- SC | 100% | 115% |
| HBOK 10 | Peach | University of California Davis | USA -- CA | 65% | 84% |
| HBOK 32 | Peach | University of California Davis | USA -- CA | 65% | 81% |
| KV010-123 | Peach | Ralph Scorza, USDA Kearneysville | USA -- WV | ? | 89% |
| KV010-127 | Peach | Ralph Scorza, USDA Kearneysville | USA -- WV | ? | 91% |
| *Prunus americana* | American Plum | Bailey's Nurseries | USA -- MN | 70% | 46% |
| Penta | European Plum | Istituto Sperimentale per la Frutticoltura | Italy | 110% | 86% |
| Controller 5 | Japanese Plum x Peach | University of California Davis | USA -- CA | 65% | 35% |
| Krymsk 86 | Myrobolan Plum x Peach | Krymsk Breeding & Research Station | Russia | 100% | 96% |
| Krymsk 1 | Nanking Cherry x Myrobolan Plum | Krymsk Breeding & Research Station | Russia | 60% | 41% |
| Bright's Hybrid #5 | Almond x Peach | Bright's Nursery | USA -- CA | 100% | 83% |
| Mirobac | Myrobolan Plum x Almond | Agromillora Catalana | Spain | ? | 84% |
| Atlas | Peach x Almond x Flowering Plum | Zaiger's Genetics | USA -- CA | 110% | 98% |
| Viking | Peach x Almond x Flowering Plum | Zaiger's Genetics | USA -- CA | 110% | 94% |

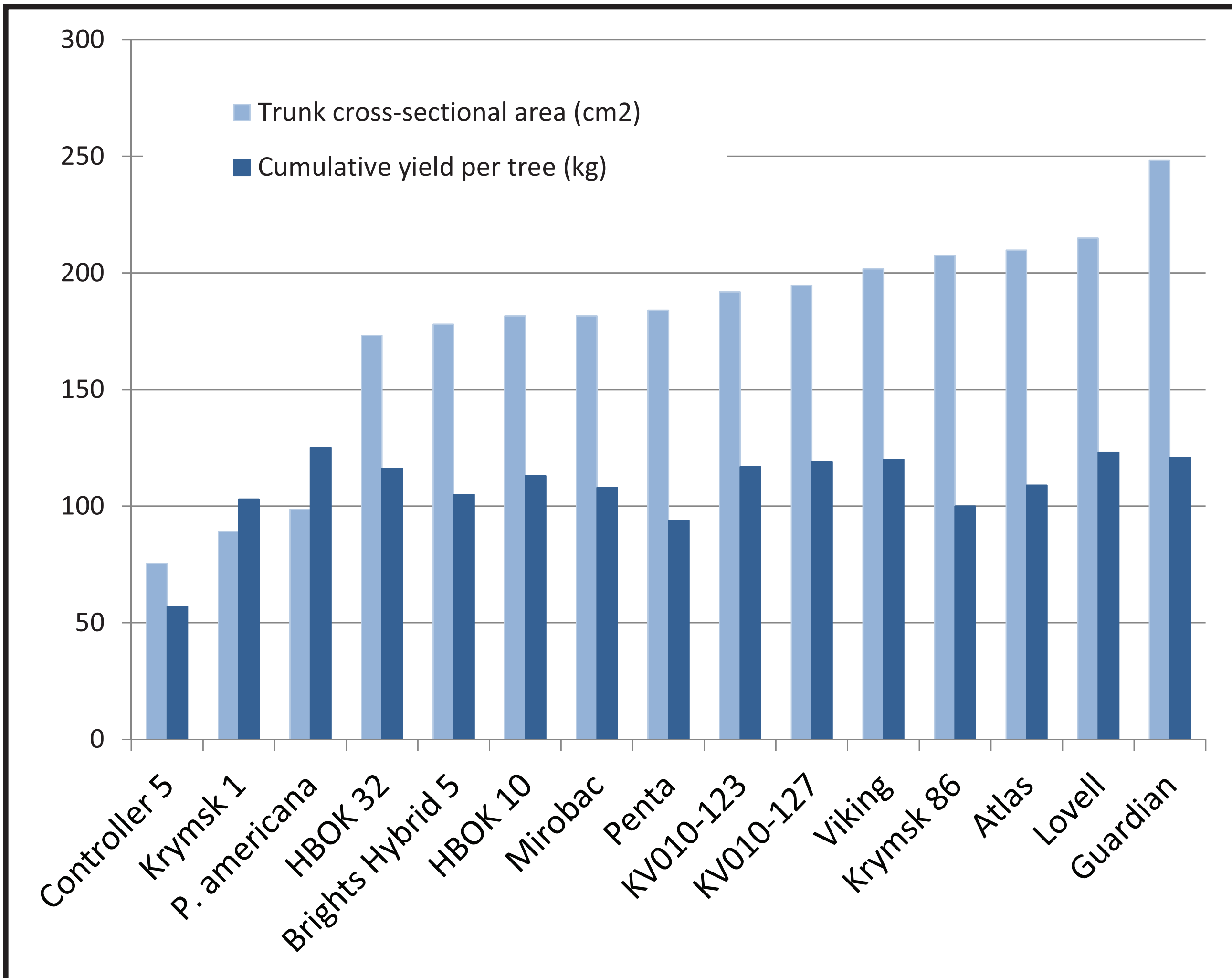



Figure 1. Trunk size and cumulative yield in 2016 of Redhaven peach trees in the 2009 NC-140 Peach Rootstock Trial.

presented in this article were collected through 2016 (the eighth growing season). It should be noted that a winter freeze eliminated the 2016 bloom.

Table 2 presents the cumulative data from this trial. Largest trees were on Guardian, and the smallest trees were on *Prunus americana*, Krymsk 1, and Controller 5. Root suckering was very low and similar for most of the rootstocks, except *Prunus americana*, which developed excessive numbers of root suckers. Cumulative yield (2011-15) was similar for all rootstocks, except Controller 5, which yielded significantly less. Cumulative yield efficiency (2011-15) was greatest for trees on *Prunus americana* and Krymsk 1 and lowest for trees on Atlas, Bright's Hybrid #5, Guardian, Krymsk 86, Lovell and Penta. Average fruit size (2011-15) was not affected by rootstock.

Figure 1 looks more closely at performance by arraying the rootstocks from the least vigorous Controller 5 on the left to the most vigorous Guardian on the right. Cumulative yield per tree is also presented. This graphical presentation makes it clear that trees on Guardian are the largest, and those on Controller 5, Krymsk 1, and *Prunus americana* are the smallest. Trees on the other 11 rootstocks are very similar. It is interesting to note that cumulative yield per tree is very similar across all rootstocks, except Controller 5 (which yielded less per tree).

The two rootstocks which stand out are Krymsk 1 and *Prunus americana*, which result in trees that are about one half the trunk cross-sectional area of the larger trees but with similarly high yields. *Prunus americana* stands out also in its ability to produce root suckers at such a level that makes it commercially unacceptable.

Table 2. Trunk size, root suckering, and canopy spread in 2016 of Redhaven peach trees in the 2009 NC-140 Peach Rootstock Trial at the UMass Cold Spring Orchard Research & Education Center, Belchertown, MA. Note that winter temperatures killed all flower buds for 2016, so cumulative yield and fruit size are based only on data through 2015. All values are least-squares means, adjusted for missing subclasses.

| Rootstock | Trunk cross-sectional area (2016, $cm^2$) | Root suckers (no./tree, 2009-16) | Canopy spread (2016, cm) | Cumulative yield per tree (2011-15, kg) | Cumulative yield efficiency (2011-15, $kg/cm^2$) | Average fruit weight (2011-15, g) |
|---|---|---|---|---|---|---|
| Atlas | 210 ab | 0.1 b | 464 ab | 109 a | 0.62 d | 188 a |
| Brights Hybrid 5 | 178 b | 0.0 b | 441 abc | 105 a | 0.66 d | 181 a |
| Controller 5 | 75 c | 0.0 b | 369 de | 57 b | 1.02 bc | 172 a |
| Guardian | 248 a | 0.6 b | 487 a | 121 a | 0.59 d | 190 a |
| HBOK 10 | 182 b | 0.5 b | 422 bc | 113 a | 0.83 cd | 182 a |
| HBOK 32 | 173 b | 0.9 b | 433 bc | 116 a | 0.81 cd | 179 a |
| KV010-123 | 192 b | 0.0 b | 459 abc | 117 a | 0.78 cd | 181 a |
| KV010-127 | 195 b | 1.5 b | 466 ab | 119 a | 0.71 cd | 184 a |
| Krymsk 1 | 89 c | 7.1 b | 345 e | 103 a | 1.32 ab | 186 a |
| Krymsk 86 | 207 ab | 0.0 b | 459 abc | 100 a | 0.59 d | 180 a |
| Lovell | 215 ab | 0.0 b | 449 abc | 123 a | 0.67 d | 186 a |
| Mirobac | 182 b | 4.9 b | 444 abc | 108 a | 0.74 cd | 176 a |
| *Prunus americana* | 99 c | 187.0 a | 412 cd | 125 a | 1.50 a | 188 a |
| Penta | 184 b | 15.0 b | 411 cd | 94 a | 0.60 d | 186 a |
| Viking | 202 ab | 0.6 b | 454 abc | 120 a | 0.72 cd | 184 a |

Means within a column not followed by a common letter are significantly different at odds of 19 to 1 (Tukey's HSD, P = 0.05).

# Evaluation of Serenade Optimum and Lime-Sulfur for Disease Management in Organic Apple Orchards

**Norman Lalancette, Lorna Blaus, and Peninah Feldman**
***Rutgers Agricultural Research and Extension Center, Bridgeton***

Experimental and currently registered fungicides are evaluated every growing season for management of apple and peach diseases. Many of these materials are reduced-risk conventional fungicides that can be readily incorporated into current IPM programs. The major goal of these trials is to determine the efficacy of these fungicides for controlling the various diseases of importance. Once this information is known, the new material can be deployed at the proper rate and timing for effective management of the target disease.

During the 2016 growing season, two fungicides labeled for use in organic apple orchards were examined along with a variety of conventional materials. The first of these OMRI listed materials, Serenade Optimum, contains the bacterium *Bacillus subtilis* (QST 713 strain) as its active ingredient. The preceding products, Serenade and Serenade MAX contain the same active ingredient, but at lower concentrations. The second OMRI material examined was Lime-Sulfur, an older fungicide that has been replaced by conventional materials, but that may still be useful in organic orchards.

**Overall ratings.** Based on this single year of data, the two organic fungicides provide the following levels of relative efficacy for the indicated apple diseases:

| | | Serenade Optimum | | Lime-Sulfur | |
|---|---|---|---|---|---|
| **Disease** | **Test disease pressure** | **% Control** | **Efficacy rating** | **% Control** | **Efficacy rating** |
| Foliar scab | High | 57-69 | ++ | 55-75 | ++ |
| Fruit scab | High | 46 | ++ | 29 | + |
| Foliar CA rust | Low | 81 | --- | 72 | --- |
| Sooty Blotch | High | 15 | + | 78 | +++ |
| Flyspeck | High | 14 | + | 66 | ++ |
| Bitter rot | Low | 0 | --- | 0 | --- |
| White rot | Low | 67 | --- | 67 | --- |
| All rots | Low | 18 | --- | 18 | --- |
| ++++ = Excellent; +++ = Good; ++ = Fair; + = Poor; --- = inadequate disease pressure | | | | | |

Given these results, Lime-Sulfur may be useful for sooty blotch control in organic orchards. Serenade Optimum provided partial foliar and fruit scab control. However, it would need to be integrated with other more effective materials given its “fair” efficacy rating. Finally, fruit rot control, particularly white rot, needs to be further evaluated under higher disease pressure.

In the 2016 study, both of these organic-approved fungicides were applied full season for evaluation of efficacy against all fungal diseases on apple. Comparisons were made to a standard conventional program. A non-treated control was included for determination of disease pressure.

### *Materials & Methods*

**Orchard Site.** The experiment was conducted during the spring and summer of the 2016 growing season. The test block consisted of 4-year-old 'Cameo' apple trees on M7 semi-dwarf rootstock planted at 15 ft tree x 20 ft row spacing. Ginger Gold and Golden Delicious trees, also on M7 rootstock, were planted as pollinators. The block was 80% Cameo, 10% Ginger Gold, and 10% Golden Delicious.

**Treatments**. Fungicide treatments were replicated four times in a randomized complete block design with two-tree plots. Treatment plots were surrounded on all sides by non-sprayed buffer trees. A Rears Pak-Blast-Plot airblast sprayer calibrated to deliver 100 gal/A at 100 psi traveling at 2.5 mph was used for applications. Insecticides and miticides were applied as needed to the entire block using a commercial airblast sprayer. Treatment application dates and phenological timing were: 30 Mar (1/2" green tip, GT); 8 Apr (tight cluster, TC); 18 Apr (pink, P); 25 Apr (bloom, B); 5 May (petal fall, PF); and 17, 31 May, 14, 27 Jun, 12, 26 Jul, 10, 23 Aug, 6, 20 Sep (first – tenth cover, 1C-10C).

**Assessment.** Early season scab (*Venturia inaequalis*) and other diseases were evaluated on 25 May by examining all leaves on 10 fruit clusters per plot (5 fruit clusters per tree). Mid-season scab, powdery mildew (*Podosphaera leucotricha*), and cedar apple rust (*Gymnosporangium juniper-virginianae*) were evaluated on 29 Jun by examining all leaves on 10 vegetative shoots per plot (5 shoots per tree). Development of scab, powdery mildew, cedar apple rust, sooty blotch (disease complex), flyspeck (*Zygophiala jamaicensis*), bitter rot (*Colletotrichum gloesporoidies*), white rot (*Botryosphaeria dothidea*), and other rots on fruit were evaluated at harvest on 28 Sep by examining 25 fruit per plot.

**Weather Data.** Air temperature and rainfall data were recorded by a Campbell Scientific 23X data logger located at the research station. This weather station is part of the Mesonet Network operated by the Office of the NJ State Climatologist. Observations were taken every two minutes and summarized every hour. Hourly temperature and rainfall data were averaged and summed, respectively, for each day of the growing season.

**Statistical Analysis.** Analyses of variance (ANOVA) and treatment mean comparisons were performed using the General Linear Models (GLM) procedure of SAS v9.4. The Bayesian Waller-Duncan means test was used to compare treatment means. Arcsin and log transformations were performed as needed for propor-

**Table 1. Scab incidence on cluster leaves (May 25).[1]**

| | Treatment | Rate / A | Timing | % Infected Leaves [2] |
|---|---|---|---|---|
| 1 | Non-treated control | -------- | -------- | 34.9 a |
| 2 | **Vangard 75WG**<br>**Indar 2F + Manzate Pro-stik 75DG**<br>**Inspire Super 2.82EW**<br>Captan 80WDG | **5 oz**<br>**8 fl oz + 6 lbs**<br>**12 fl oz**<br>3.5 lb | **½ GT**<br>**TC, P, B, PF**<br>**1C**<br>2C-10C | 9.1 c |
| 3 | **Lime-Sulfur**<br>**Lime-Sulfur** | **2 gal**<br>**1 gal** | **½ GT, TC, P**<br>**B, PF, 1C,** 2C-10C | 15.7 b |
| 4 | **Serenade Optimum 26.2WP**<br>Serenade Optimum 26.2WP | **18 oz**<br>18 oz | **½ GT-1C**<br>2C-10C | 14.9 bc |

[1] Primary apple scab treatments, rates, and application timings in **boldface**.
[2] Means in same column with same letter do not differ significantly according to Waller-Duncan *K*-ratio t-test (α=0.05, *K*=100).

tions and lesion count data, respectively, to correct for departures from the ANOVA assumptions.

***Results & Discussion***

**Environment.** Weather conditions were highly favorable for apple scab development, particularly during the primary scab infection season. From ½" Green Tip (½"GT) through the end of first cover (1C), 22 days with rainfall ≥ 0.10 inches were recorded. Although extended periods of dry weather occurred during the summer, particularly in August and September, occasional rains occurred with a high enough frequency to allow continued secondary scab infection on both vegetative shoots and fruit.

Rainfall frequencies were generally adequate for bitter rot, white rot, sooty blotch, and flyspeck infection during 1C through 4C, although temperatures were initially cool, particularly for the rots. Dryer periods in August and September may have diminished

**Table 2. Scab and cedar apple rust (CAR) on shoots (June 29).**[1]

| | Treatment | Rate / A | Timing | % Infected Leaves[2] Scab | CAR |
|---|---|---|---|---|---|
| 1 | Non-treated control | -------- | -------- | 82.4 a | 2.20 a |
| 2 | **Vangard 75WG**<br>**Indar 2F + Manzate Pro-stik**<br>**Inspire Super 2.82EW**<br>**Captan 80WDG** | **5 oz**<br>**8 fl oz + 6 lbs**<br>**12 fl oz**<br>**3.5 lb** | **½ GT**<br>**TC, P, B, PF**<br>**1C**<br>**2C, 3C**, 4C-10C | 5.1 d | 0.35 b |
| 3 | **Lime-Sulfur**<br>**Lime-Sulfur** | **2 gal**<br>**1 gal** | **½ GT, TC, P**<br>**B, PF, 1C- 3C**,4C-10C | 20.8 c | 0.62 b |
| 4 | **Serenade Optimum 26.2WP**<br>Serenade Optimum 26.2WP | **18 oz**<br>18 oz | **½ GT, - 3C**<br>4C-10C | 25.8 b | 0.41 b |

[1] Scab and cedar apple rust rates and application timings in **boldface**.
[2] Means in same column with same letter do not differ significantly according to Waller-Duncan *K*-ratio t-test (α=0.05, *K*=100).

**Table 3. Scab, sooty blotch, and flyspeck on fruit at harvest (September 28).**

| | Treatment | Rate / A | Timing | % Infected Fruit[1] Scab | Sooty Blotch | Flyspeck |
|---|---|---|---|---|---|---|
| 1 | Non-treated control | -------- | -------- | 80 a | 92 a | 93 a |
| 2 | Vangard 75WG<br>Indar 2F + Manzate Pro-stik<br>Inspire Super 2.82EW<br>Captan 80WDG | 5 oz<br>8 fl oz + 6 lbs<br>12 fl oz<br>3.5 lb | ½ GT<br>TC, P, B, PF<br>1C<br>2C, 3C, 4C-10C | 2 d | 0 d | 2 d |
| 3 | Lime-Sulfur<br>Lime-Sulfur | 2 gal<br>1 gal | ½ GT, TC, P<br>B, PF, 1C-10C | 57 b | 20 c | 32 c |
| 4 | Serenade Optimum 26.2WP | 18 oz | ½ GT-10C | 43 c | 78 b | 80 b |

[1] Means in same column with same letter do not differ significantly according to Waller-Duncan *K*-ratio t-test (α=0.05, *K*=100).

| Table 4. Fruit rots at harvest (September 28). | | | | | | |
|---|---|---|---|---|---|---|
| | | | | % Infected Fruit [1] | | |
| Treatment | | Rate / A | Timing | Bitter Rot | White Rot | All Rots |
| 1 | Non-treated control | -------- | -------- | 7 a | 9 a | 17 a |
| 2 | Vangard 75WG<br>Indar 2F + Manzate Pro-stik<br>Inspire Super 2.82EW<br>Captan 80WDG | 5 oz<br>8 fl oz + 6 lbs<br>12 fl oz<br>3.5 lb | ½ GT<br>TC, P, B, PF<br>1C<br>2C, 3C, 4C-10C | 0 d | 0 b | 0 b |
| 3 | Lime-Sulfur<br>Lime-Sulfur | 2 gal<br>1 gal | ½ GT, TC, P<br>B, PF, 1C-10C | 9 a | 3 b | 14 a |
| 4 | Serenade Optimum 26.2WP | 18 oz | ½ GT-10C | 10 a | 3 b | 14 a |

[1] Means in same column with same letter do not differ significantly according to Waller-Duncan *K*-ratio t-test ($\alpha$=0.05, *K*=100).

infection. Also, since the orchard is young, overwintering inoculum from cankers and other colonized dead tissue was probably minimal. However, nearby wooded areas should have provided some inoculum, particularly for sooty blotch and flyspeck.

Although 'Cameo' is considered moderately susceptible to powdery mildew, the same frequent early season rains that promoted scab probably lessened powdery mildew infection. Only occasional mildew lesions were observed. Overwintering primary mildew shoots were not observed, even on the highly susceptible 'Ginger Gold'.

**Early Season Scab.** Primary scab disease pressure on fruit cluster leaves was moderate. About 35% of non-treated cluster leaves had scab lesions (Table 1). No other diseases, such as powdery mildew or cedar apple rust, were observed in sufficient quantities on the cluster leaves to allow statistical analysis.

All early season treatment programs, whether conventional or organic, significantly reduced primary scab incidence on cluster leaves (Table 1). The major difference among treatments was in the degree of disease control. The Vangard / Indar + Manzate / Inspire Super standard (treatment 2) provided 74% control of primary scab. In comparison, the organic Lime Sulfur and Serenade Optimum programs provided only 55% and 57% control, respectively.

**Scab and Cedar Apple Rust on Shoots.** Foliar scab disease pressure was very high on vegetative shoots. Non-treated shoots had 82% leaves with scab (Table 2). All early season treatments, including cover sprays prior to the assessment in late June, significantly reduced scab incidence. The standard program (treatment 2) yielded 94% control. The Serenade Optimum and Lime-Sulfur treatments yielded 69% and 75% control, respectively.

In contrast to scab, cedar apple rust infection was very low with only 2.2% leaf infection on control trees (Table 2). Nevertheless, all treatments significantly reduced rust incidence. However, no treatment differences were observed under this low disease pressure. Disease control ranged from 84% for the standard to 72% for Lime-Sulfur.

**Scab, Sooty Blotch, and Flyspeck on Fruit.** Disease pressure was very high for development of scab, sooty blotch, and flyspeck on fruit. Disease incidence for these three diseases on control trees were 80%, 92%, and 93% fruit infected, respectively (Table 3). Lesion density, a measure of disease severity, was not assessed but most fruit had multiple numbers of lesions, blotches, or speck colonies.

The standard conventional fungicide treatment (#2) significantly reduced scab, sooty blotch, and flyspeck disease incidence, providing 98 to 100% control (Table 3). The two organic treatments (3 & 4) also significantly reduced disease development relative to the control. Serenade Optimum provided better control of scab while Lime-Sulfur was more effective at controlling sooty blotch and flyspeck. However, the level of disease control was much lower than observed with the conventional standard treatment. Serenade Optimum provided 46%, 15%, and 14% control of scab, sooty blotch, and flyspeck, while Lime-Sulfur provided 29%, 78%, and 66% control of scab, sooty blotch, and flyspeck (both respectively).

**Fruit Rots.** Bitter rot levels were low with only 7% infection of non-treated control fruit (Table 4). Under these low disease pressure conditions, the standard treatment, which used captan for all of its cover sprays, provided 100% control. In stark contrast, both Serenade Optimum and Lime-Sulfur failed to provide any bitter rot control.

White rot disease pressure, at 9% incidence, was slightly higher than bitter rot (Table 4). All three treatments significantly reduced white rot. The captan standard provided 100% control while Lime-Sulfur and Serenade Optimum yielded 67% control.

The category "All Rots" provided a general measure of treatment efficacy against all fruit rots, regardless of whether or not they can be easily identified (Table 4). This category encompasses bitter rot and white rot plus other rots such as black rot and bull's-eye rot. The conventional standard treatment program (captan) once again provided 100% control. The two organic treatments were not effective.

# Perimeter Trap Cropping for Spotted Wing Drosophila Control

**Mary Concklin**
***Visiting Associate Extension Educator, University of Connecticut***

Spotted wing drosophila (SWD) was a new invasive insect pest that was first discovered in the USA in California in 2008 although not identified until 2009. It was discovered in Michigan in 2010 (Isaacs, et al, 2010) and entered CT in mid-season 2011. The arrival of SWD caught CT growers, university and research staff off-guard resulting in almost complete loss of late season blueberries and fall berry crops in 2011. The SWD lays its eggs in berries as they are maturing and the resulting larvae then feed on berries making them unmarketable. This has wreaked havoc with most of the berry growers in CT, particularly with berry crops that are harvested mid-summer through the fall as the SWD populations increase exponentially throughout the growing season. Late season blueberries, late summer blackberries and raspberries, fall brambles and day-neutral strawberries (fall strawberries/everbearing strawberries) are some of the preferred crops that now require pesticide applications once or twice a week in order to maintain close to a SWD-free harvestable product.

A survey was sent to fruit growers in the fall of 2012 to gather information regarding losses and increased costs due to the SWD. Crop losses were reduced, not eliminated, from 2011 to 2012 by many growers due to awareness of the pest and use of available pesticides. Organic growers continue to incur heavy losses because of the limited availability of effective organic insecticides. Survey comments included "the organic pesticide did not work. Tried it since there was a zero day harvest interval and that was very important for brambles." "Have increased from a 10 day spray interval for blueberry maggot to a 3 to 5 day schedule." "Had to take a week off from picking and return to Delegate." "Pest control costs have almost doubled. Modifications made to sprayer to enable spraying blueberries under bird nets." "Damage about the same as last year with our later berries basically a total loss." And, "spraying is a new cost for us directly attributable to SWD."

***History***

In CT, commercial berry growers have had one management tool available to them with varying degrees of success – pesticides. Materials are applied every 3-7 days (Concklin 2012 survey) and growers must rotate between pesticide classes to reduce the potential for resistance development. Organic growers have two pesticides available to them for SWD, spinosad (Entrust) and a pyrethrin (Pyganic). Unfortunately, the pyrethrin has a 0 to 2 day efficacy and the females have been known to be knocked down, bounce back and lay eggs. Non-organic growers have several more chemical options available.

Past pesticide applications have been minimal to non-existent in berry crops in CT. Many blueberry growers had never applied a pesticide to their crops, bramble growers would apply an occasional fungicide for *Botrytis* fruit rot, depending on the season, and with dry summers that was not necessary, day-neutral strawberry growers could skip the usual insecticides that were often needed with June strawberries because of pest life cycles and occasionally applied a fungicide for *Botrytis.* The advent of the SWD has increased costs by the inclusion of insecticide applications, the purchasing of pesticide application equipment and monitoring. It has reduced the number of days many farms are open for pick-your-own to allow for pesticide applications and the required pre-harvest-interval of the particular pesticide material. (Concklin 2012 survey; personal communication with many growers)

In CT and other states impacted by the SWD, a variety of trap colors and styles have been tested to try to determine effectiveness. Red cups with small holes were used in New England and CT in 2012. In 2013 red cups with black tape were used. It had been shown that the SWD were attracted to the black on the cup (April 24, 2013 New England SWD Team meeting, Windsor, CT). Additional trap work was conducted. Baits that are considered to be more appealing to the

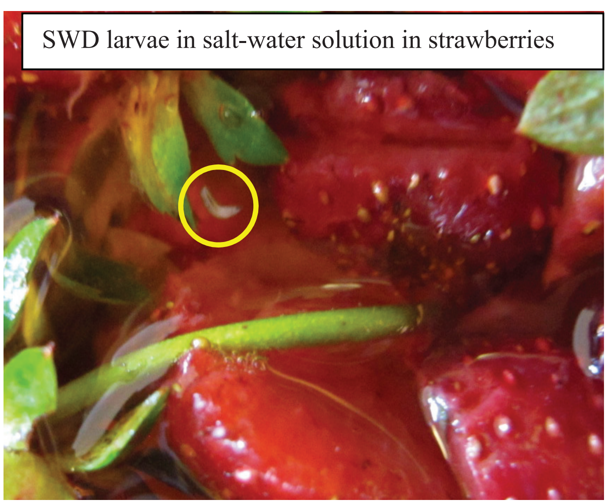
Insects in trap solution prior to counting/identifying.

Male SWD on strawberry

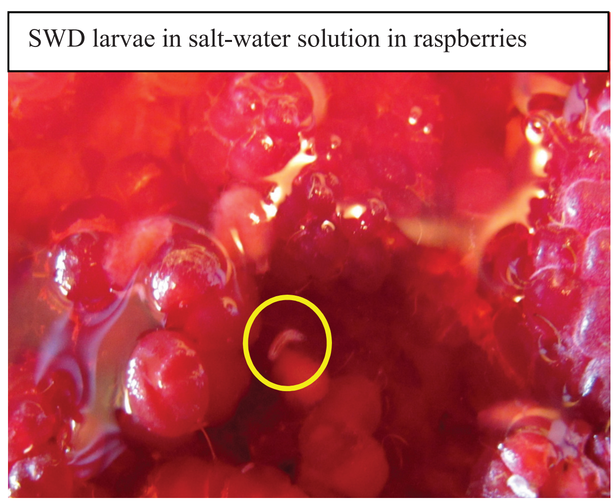
SWD Trece trap in strawberry

SWD Trece trap in raspberry

SWD larvae in salt-water solution in strawberries



SWD larvae in salt-water solution in raspberries



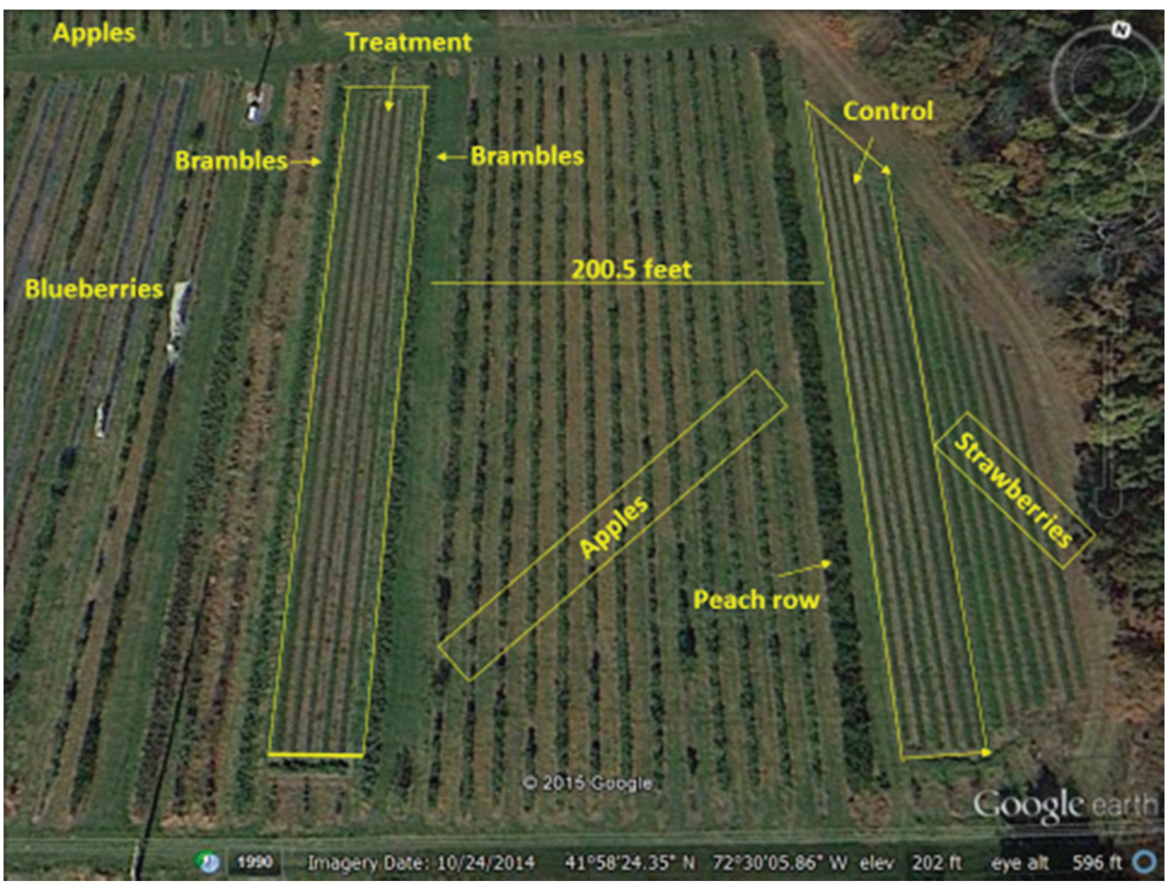
SWD than the ripening fruit have been tried and work is continuing on that. Michigan preferred apple cider vinegar (Isaacs, R, 2010). New England and CT used that same bait in 2012 but found it is not a first indicator of when the SWD have entered a field. In 2013, a yeast-whole wheat flour bait that was found by Dr. Richard Cowles, CAES, to be more effective (http://www.uvm.edu/vtvegandberry/SWD/2013_SWD_Trapping.pdf) was used. In 2013, 'trapping out' was tested in CT, RI and Me using baited traps throughout the planting. It was not successful or cost effective.

***Proposed Solution***

Perimeter trap cropping (PTC) has been successfully utilized in vegetable crops for many years. This project used that concept by using an established planting of fall red raspberries as the trap crop for the SWD, planted around a day-neutral strawberry planting. A separate field of day-neutral strawberries was established without the raspberries planted around them. The raspberries and strawberries were monitored for the presence of SWD with traps and fruit inspections. Insecticide applications were made only to the raspberries, spraying from the inside of the block out, to avoid spraying the day-neutral strawberries. It was expected that the raspberries would either intercept the SWD as they entered the field or the SWD would find the raspberries more appealing than the strawberries, and the pesticide applications would control them before they had a chance to infest the day-neutral strawberries. If successful, PTC would provide another management tool for berry growers to use to control SWD without applying pesticides to the strawberries.

***Procedure***

Seascape day-neutral strawberries were planted May 2014 on black plastic, double rows, 9 inches be-



tween plants, 12 inches between rows; 36 inch aisles. The trap crop plot consisted of five 350 ft. long double rows of Seascape, surrounded by an established 365 foot long row of Caroline fall raspberry 12 feet to the east, and 6 feet to the north and south; and a 365 foot long row of Polana fall raspberry 12 feet to the west of the Seascape. The check plot consisted of five double rows of Seascape strawberries were planted 200.5 feet to the east of the trap crop plot with mature apple and peach trees located between the treatments. Drip irrigation was installed on the strawberries and the north and south end raspberries. Drip irrigation already existed on the east and west raspberry rows. Straw mulch was applied in late fall 2014 to all the strawberries.

The grower applied insecticides plus sugar for SWD to the raspberries, using a speed sprayer, as fruit were ripening by spraying from the inside blowing outward. This reduced the chances of insecticide drift onto the strawberries protected by the raspberry trap crop. In 2014, eight applications were made on a 4-12 day schedule, and in 2015, nine applications were made on a 5-9 day schedule. No insecticides were applied to either the trap crop strawberries or check strawberry plot.

Mature strawberry and raspberry fruit were randomly sampled weekly for the presence of SWD larvae beginning in mid-August and continuing through October in 2014 and through September in 2015. 100 fruit samples from control strawberries, strawberry treatment and raspberries were placed in salt water for approximately 15 minutes. An Optivisor 10X lens was used to detect larvae.

Kumbucha lure trap was initially used but was changed to the commercially developed Trece traps and SWD lures with vinegar as the drowning solution. Traps were set out in the raspberries and strawberries and checked weekly. The drowning solution from the traps was collected weekly and poured through coffee filters. The filters were placed under a microscope for ease of counting SWD adults. New drowning solution was added to the traps weekly.

***Results***

In 2014, larval infestation in the treatment strawberries ranged from 0% to 4% with only a single week, October 2, with any infestation (4%). The raspberry larval infestation occurred during a five week period from September 4 through October 2, and ranged of 2% to 18%. The infestation in the check plot strawberries began September 4 and continued off and on weekly through October 16, with infestations of 2%, 0%, 4%, 0%, 6%, 12%, and 24%.

In the strawberries protected by the trap crop, no SWD were caught in traps the first three weeks although they were present in the raspberries during this interval. Trap captures began in the trap crop plot strawberries September 11, peaked October 2 and continued in lower numbers through October 23. The range was 3 to 44 adult SWD. Raspberry SWD trap captures were immediate and sustained throughout with a range of 3 to 73. Although SWD were present in the trap crop strawberry traps, they appeared to prefer the raspberry fruit over the strawberry fruit. SWD trap captures in the check plot strawberries began August 29 and continued through October 23 ranging from 3 to 97. See Figures 1 and 2 for details.

In 2014, strawberries in both the control and treatment areas were not commercially harvested.

In 2015, larval infestation in the strawberries protected by the trap crop occurred only during two weeks, August 24 and September 8, at 2% each week. The raspberries were infested beginning August 24 and continuing through September 28 with a range of 2% to 14 % with the sole exception of the week ending September 8 which had zero fruit infested. The check plot strawberry infestation was almost identical to the trap crop protected strawberry infestation with two weeks at 2% each, August 31 and September 14, the remainder weeks had 0% infestation. Strawberries in the control and treatment were commercially harvested throughout the season with no impact on the trials under the weeks of September 21 and 28 when they were picked heavily by the picking crew leaving only 22 and 20 fruit for September 21 and 28 respectively to be checked for larval infestation. By September 28 there were very few fruit left in the control block to mature which effectively ended the trial. See Figures 3 and 4 for details.

Although there was a difference between the strawberry fruit infestation in the two plots in 2014, there was no significant difference in 2015. Trap captures as well as fruit infested with SWD larvae were lower in 2015 than 2014 throughout the harvest season.

**Figure 1**

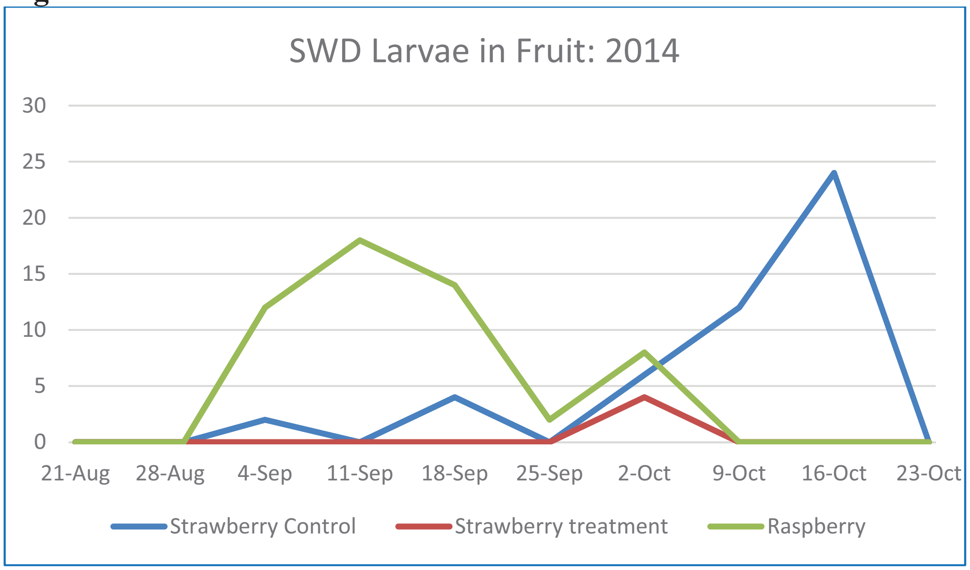
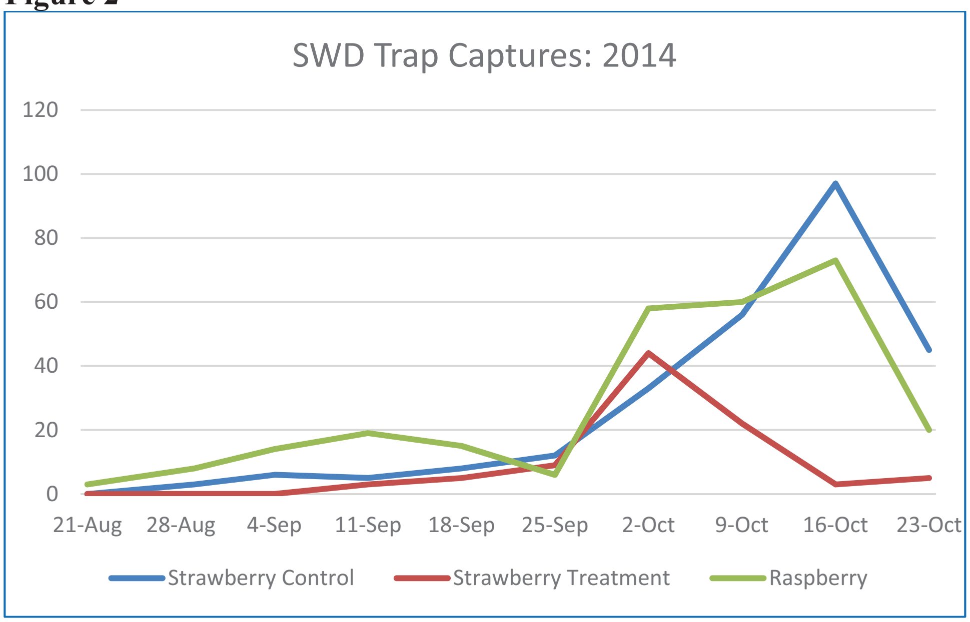



**Figure 2**




out the experiment.

Infestation rates of the check plot strawberries were expected to be very high as no insecticides were applied. However, infestation rates in the check plot were lower than expected and well within the 90% SWD-free goal, with the exception of the weeks of October 8 and 16, 2014. During those two weeks in October, SWD-free fruit dropped to 88% and 76% respectively – an unacceptable level for commercial production. Those two weeks also correspond to the highest SWD trap captures in the check plot.

It is possible the distance between the two plots at 200.5 feet, even with tree fruit between, was not enough to overcome the attractiveness of the raspberries in the trap crop plot, and resulted in low populations in the check plot strawberries..

Data from the two years of this study indicate that raspberry fruit are more attractive to SWD than strawberry fruit and can function as an effective trap crop for strawberries. This pilot study shows promise for the use of PTC for SWD management. Trails are needed at additional farms to discern if the relationship holds in difference environments.

***Conclusions***

The goal for this project was to achieve at least 90% SWD-free fruit in the trap crop protected strawberries. Based on these results, the use of raspberries surrounding the strawberries made a difference in the strawberry fruit infestation of SWD. Trap crop protected strawberries never had less than 96% SWD-free fruit in either year, so fruit were marketable through-

**Figure 3**

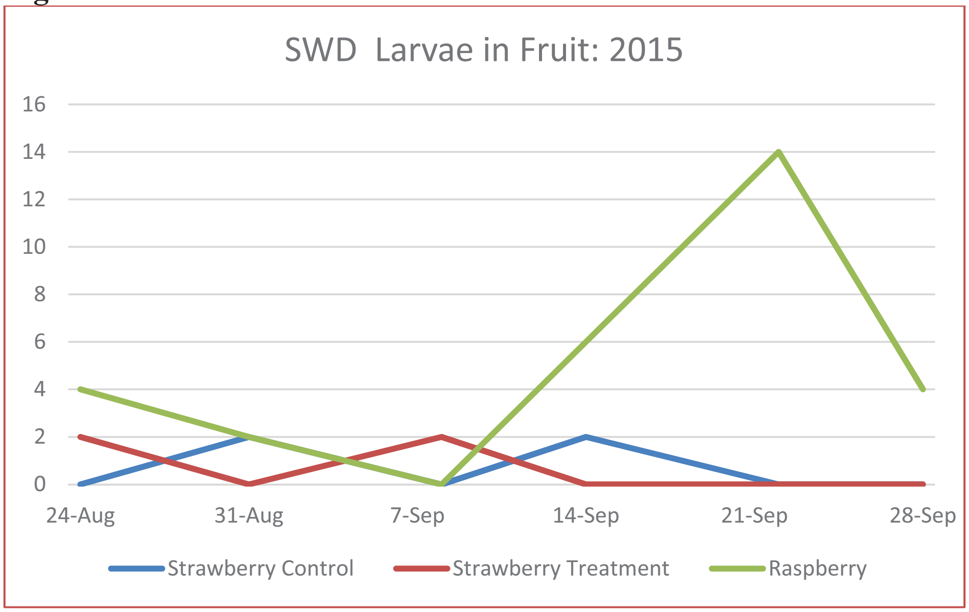
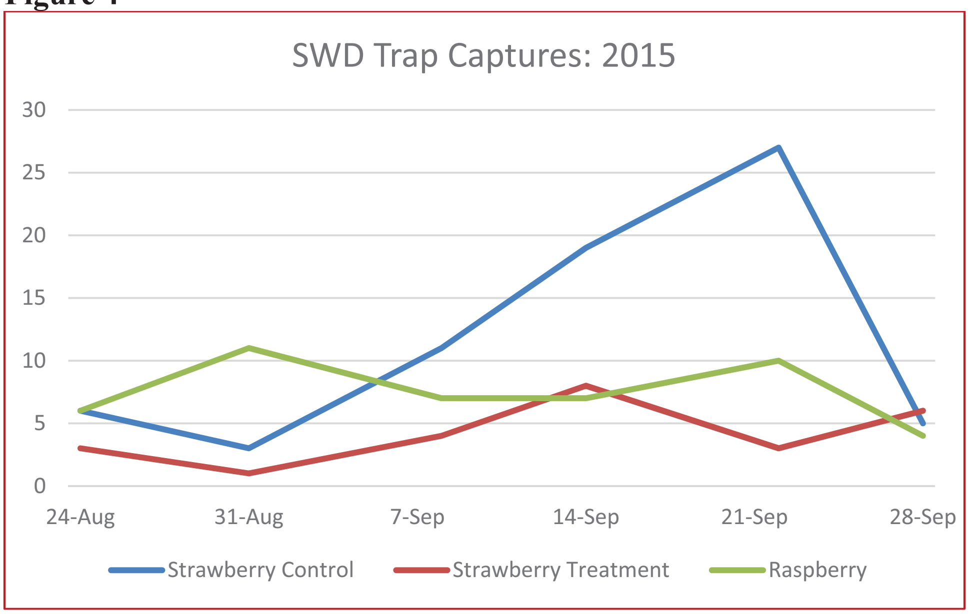



**Figure 4**




***Acknowledgements***

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# Investigating Forage Radish and Compost as a Means of Alleviating Soil Compaction in Post-plant Bramble and Blueberry Fields

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Long-term perennial berry crops (highbush blueberry, brambles) are grown on over two thousand eight hundred acres in New England, of which five hundred eighteen acres are in Connecticut (USDA Census 2012). They generate high value since they are sold almost exclusively to the fresh market. Poor growth leads to reduced production and reduced grower revenue, and is the result of one or several factors including site related issues, soil fertility, soil compaction, plant damage from wildlife, insects and diseases, and abiotic disorders.

One of the factors leading to poor plant performance in established fruit plantings is soil compaction. It is measured as pounds per square inch (psi) using a penetrometer pushed into the soil to a depth of six inches (surface hardness/compaction) and a depth of six to eighteen inches (subsurface hardness/compaction). Root growth is restricted in moderately compact soils with a surface (0– 6 inch depth) penetrometer reading of 125-220 psi, and a subsurface (6 – 18 inches depth) penetrometer reading of 220 to 280 psi. Penetrometer readings greater than 220 psi (surface) and 300 psi (subsurface) are considered severely compacted soils (4).

Compacted soils have reduced pore space which causes a restriction in root growth (2, 15). Blueberry and bramble plants have fibrous root systems that do not easily penetrate compacted soils which can result in reduced plant growth. In addition, compacted soils have been shown to reduce water and nutrient uptake by plants, and in Wisconsin, research has shown potassium uptake is reduced in compacted soils (15), a high demand element that is critical in blueberry and bramble production (9, 10).

As a part of a separate study with Cornell, soils in established berry fields were tested for a number of biological, physical and chemical parameters in 2012. Of the five Connecticut fruit farms participating in that project, four had compacted soils in established berry fields as determined by penetrometer readings, as well as poor production and poor plant growth as determined by the growers.

There is extensive research supporting pre-plant cover crops and incorporation of compost for alleviating soil compaction for annual cropping systems. Research also supports the use of cover crops and incorporating compost in soil to alleviate soil compaction as a pre-plant management tool in perennial crops. Little research has been done using cover crops and compost in a post-plant situation to alleviate soil compaction. (6,7,8,12,15,16)

This study investigated two treatments to alleviate soil compaction in addition to the check: the effectiveness of a forage radish cover crop system; and a surface application of compost. The treatments were applied at three farms: an established raspberry field planted in 2010 on sandy loam soil; and two established blueberry fields, one planted in 2006 on gravelly loam soil, and a certified organic block planted around 1985 on fine sandy loam soil. Treatments were applied within the plant row, and replicated three times at each site, to determine if they would reduce soil compaction. At the raspberry field each rep was 10 feet long for a total of 90 feet. At the two blueberry fields, each rep consisted of 3 bushes for a total of 27 bushes per farm.

There were two requirements for a cover crop for this study – that it winter kill to reduce competition with the berry plants for water and nutrients in the spring as well as the need for herbicide or hand weeding, and that the cover crop be known for alleviating soil compaction. The forage radish, a brassica, is a tender plant that quickly germinates when seeded in the early fall, is killed with low winter temperatures and decomposes in a relatively short time in the spring. It large taproot, often growing to one to two feet, penetrates compacted soils, increases large pore spaces in the soil and decomposes quickly, increasing water and air infiltration and opening soils for greater root penetration. (1,4,11,13,14)

Compost applied to the soil surface will attract soil microbes that decompose the compost and aerate the soil as they move through the soil profile, a process that will increase soil pore space and soil organic matter content over time. (3,5,10) Incorporating compost throughout the root zone provides more immediate results, (7,8) but is not practical in an established berry field due to the shallow root systems of berry plants.

***Procedures***

In early September 2013, compost was evenly spread in a 2'-2.5 wide band in the raspberry row, in a 2.5'-3' wide band in the conventional blueberry row, and in a 2' diameter circle around the organic blueberries (grower mows around each plant) to a depth of 2-3 inches. The forage radish was seeded at the rate of 15 lbs. per acre on bare ground in the raspberry and non-organic blueberry plots and through the sod and weed covered mulch in the organic blueberry plot.

Pre-treatment soil penetrometer readings were taken at each treatment at depths of 0-6 inches and 6-18 inches, 5 locations per rep at each depth. All three locations are pick-your-own operations. Yield data was collected by harvesting all ripe fruit just prior to opening to the public and estimating the remainder.

Soil penetrometer, yield and growth measurements were recorded for each of the next two years. Growth measurements included number of new canes per bush for blueberries and number of canes per ten feet of row for raspberries.

Statistical analysis was conducted looking at differences within and between treatments from years 1 to 3.

**Results**

Each location was analyzed separately.

*Differences among years within treatments*: **Compost** – There were no statistical differences in soil compaction, yield or growth attributed to the compost treatment between years 2013-2015 at any of the three farms.

**Radish** – There were no statistical difference in soil compaction, yield or growth attributed to the forage radish treatment between years 2013-2015, at any of the three farms.

*Differences among years between treatments (comparing the compost to the radish to the check)*: At the **organic blueberry field** and **raspberry field**, there were no statistical differences when comparing the radish to the compost to the check for yield, plant growth and soil penetrometer readings at surface and sub-surface depths.

At the **non-organic blueberry field**, there was no statistical difference for yield or plant growth. However, there was a statistical difference in soil penetrometer readings at the 0-6 inch depth between the check and the radish treatment in years 2014 and 2015. The compost treatment showed a statistical difference between it and the check at the 0-6 inch depth in 2015. There was no statistical difference between the compost and radish treatments. There were no sub-surface differences between the forage radish, compost and the check.

***Conclusions***

The three participating farms had compacted soils prior to the trials based on soil penetrometer readings. Expectations were for reductions in soil compaction after one year with the forage radish treatment, which germinated and grew during the fall before being winter killed. Expectations were for positive impacts on soil compaction from the compost treatment by year two, due to the length of time for it to be broken down by soil microbes.

The lack of differences in soil penetrometer readings between the forage radish treatment and the check plots at the organic blueberry field can be attributed to the difficulty in establishing the radish through the sod and weeds. Although the bushes had wood chips applied around each bush in the spring, by September when the radish was planted, a heavy weed population had taken over the area. Moving the wood chips to get to bare ground for seeding was very difficult. Between the bushes was established sod. Seeding was accomplished by poking holes through the sod and weed cover. Very few radish seeds germinated and

Organic blueberry Non-organic blueberry Raspberry

**Forage Radish Treatment**

Organic blueberry Non-organic blueberry Raspberry

**Compost Treatment**

grew. The difficulty moving the wood chips also made the compost application to bare soil unattainable. The compost was applied as close to the soil as was possible. The difficulty in applying compost close to soil microbes could explain the lack of change in soil compaction. Additional years may be needed for a positive change.

At the non-organic blueberry field, each blueberry row was wood chipped and weeds were kept to a minimum through the use of herbicides. Moving the wood chips allowed for relative ease in radish seeding and establishment, as well as applying compost to the bare soil surface allowing access by soil microbes. Both treatments worked for surface compaction Additional years may be needed for positive change in subsurface soil compaction as well as to see significant differences in growth and yield.

At the raspberry field the weeds were at a minimum within the rows. The radish easily established and grew. Longer time may be needed for positive impacts on sub-surface compaction, yield and growth.

Alternatively, there may not be any changes made in the lifetime of the plantings because physical soil properties are hard to change once plants are established. Prior to planting, growers should check soil compaction levels and take corrective measures if needed.

***References***


1. Bjorkman, T. 2010. Cover Crop Series, Factsheet: Forage Radish. Cornell Cooperative Extension
2. Cox, B. & M. McKellar (eds). 2012. Field Crops Management Guide, Chapter 2.7. Soil Compaction. Cornell University
3. Debasitis, B. 2009. Compost Use Case Study: Weed Abatement and Soil Restoration, The Historic Orchard at Guadalupe River Park and Gar-

dens. www.urbancompost.com
4. Gugino, B., O.J. Idowu, R.R. Schindelbeck, H.M. van Es, D.W. Wolfe, B.N. Moebius-Clune, J.E. Thies, and G.S. Abawi. 2009. Soil Health Assessment Training Manual. Cornell University.
5. Guong, V., N. Hien & D. Minh. 2010. Effect of Fresh and Composted Organic Amendments on Soil Compaction and Soil Biochemical Properties of Citrus Orchards in the Mekong Delta, Vietnam. World Congress of Soil Science. Brisbane, Australia.
6. Hoorman, J. 2009. Using Cover Crops to Improve Soil and Water Quality. Ohio State University.
7. Pritts, M. 2012. Cover Crops for Blueberry Plantings. Cornell University.
8. Pritts, M. 2012. Cover Crops for Raspberry Plantings. Cornell University.
9. Pritts, M & J. Hancock (eds). 1992. Highbush Blueberry Production Guide. NRAES-55. New York
10. Pritts, M. & D. Handley (eds). 1989. Bramble Production Guide. NRAES-35. New York
11. Reeder, R. 2012. Cover Crops Ease Soil Compaction. Ohio State University
12. Sanchez, E. & K. Demchak. 2004. The Organic Way-Use of Compost and Manure in Small Fruit Production. Vegetable and Small Fruit Gazette, Vol. 8, No. 10, October 2004.
13. Weil, R. 2010. Forage Radish: New Multi-Purpose Cover Crop for the Mid-Atlantic. Factsheet 824. Maryland Cooperative Extension.
14. Weil, R. & S. Williams. 2003. Brassica Cover Crops to Alleviate Soil Compaction. U. of Maryland.
15. Wolkowski, R. & B. Lowery. 2008. Soil Compaction: Causes, Concerns, and Cures. U. of Wisconsin Extension A3367.
16. Wortmann, C. 2009. Management to Minimize and Reduce Soil Compaction. U. of Nebraska.

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# Dr. James Moore, World Renown Fruit Breeder, Dies at Age 85

FAYETTEVILLE, Ark. – James N. Moore's handiwork appears on every continent save Antarctica and achieved some of the highest honors in his profession. Yet Moore remained firmly grounded -- almost unassuming -- but could not hide what his students and colleagues called greatness.

Moore was a giant. In 1964, he established the fruit breeding program within the University of Arkansas System Division of Agriculture that quickly became one of the most influential in the world.

Moore passed away on Sunday, aged 85.

"Jim had a passion for horticulture and was a gifted teacher," said Mark Cochran, vice president-agriculture and head of the University of Arkansas System Division of Agriculture. "He leaves a tremendous legacy, not only on farms, orchards and vineyards around the world, but also in the students he taught, who will carry on his work for decades to come."

"Dr. Moore was a giant in his profession, and he laid the foundation of the extremely successful fruit breeding program which is today one of our premier research programs," said Clarence Watson, director of the Arkansas Agricultural Experiment Station.

Born in Vilonia and raised in Plumerville, Moore served in the Air Force following high school and met his wife, Janita "Jan" Fitzgerald of Morrilton, soon after discharge. Encouraged by his mother, Moore attained an associate degree from Arkansas Tech University in 1954, followed in 1956 by a bachelor's degree in horticulture and in 1957, a master's in horticulture, both from the University of Arkansas.

Moore's next step was moving to the Garden State, earning his PhD from Rutgers University in 1961. His time in New Jersey was pivotal. There he worked with Fred Hough, leader of Rutgers' fruit breeding program who had already achieved national renown within horticulture circles for his work on apples, peaches and strawberries. It was in working at Rutgers he met Jules Janick, now the James Troop distinguished professor of horticulture at Purdue. It was the beginning of a collaboration that would last a lifetime.

"Jim was a great horticulturist and a great man and will be sorely missed," Janick said. "I will say that the work he started and is being continued by John Clark will continue to have a tremendous impact on American fruit production."

Clark, a distinguished professor of horticulture for the University of Arkansas System Division of Agriculture, inherited the fruit breeding program from Moore.

From 1961-63, Moore worked for the U.S. Agriculture Department at Beltsville, Maryland, as a fruit breeder.

"Jim loved to tell the story of his choosing to come back to Arkansas, leaving the USDA breeding position. He made his decision, and in late 1963 went in to tell his USDA boss he was moving home," Clark said.

He began his faculty appointment at Arkansas in 1964.

"His boss said, 'Jim, if you go back to Arkansas, you will never be heard from again!' Well, one can say that his coming back to Arkansas was one of the most important moves in small fruit breeding not only in Arkansas, but the region, nationally and internationally," Clark said. "And, he was definitely heard from again!"

### *Moore's Work*

Moore developed a very broad breeding program that encompassed blackberries, strawberries, peaches, and grapes, and added blueberries later in his career. His achievements in fruit breeding were monumental, with more than 50 varieties released from his efforts. Among the most important were Cardinal strawberry, Navaho and Shawnee blackberries, Reliance and Mars grapes, Bonfire peach, and Ozarkblue blueberry.

Although he retired from leadership of the Arkansas fruit breeding program at the end of 1996, his genetic contributions have continued to result in new varieties – with several being named for him including: Prime-Jim® blackberry, Norman blueberry, GoldJim peach, and Amoore Sweet nectarine.

In further use of breeding materials from his career efforts, he and colleague Clark developed a grape with a unique flavor combination and much improved firm texture. This grape selection, although not adapted to the winter cold and summer rains of Arkansas, was used as a mother plant in a hybridization in table grape breeding in California and resulted in the new innovation known as "Cotton Candy ™." Now entering the national and international market, Cotton Candy™ is unlike any other table grape in flavor, with the flavor coming from the Arkansas parent.

"This and many other genetic improvements are clear reflections of Jim's dream of making major contributions to society in his genetic improvements," Clark said.

A prolific writer, Moore had more than 300 professional publications in his career. He was internationally known for his contribution as co-editor of a series of reference books on fruit breeding, including "Advances in Fruit Breeding" in 1975 and the trilogy series "Fruit Breeding" in 1996. Moore was an accomplished speaker, giving hundreds of presentations to grower and professional meetings in his career.

He served as president of the American Society for Horticultural Science and American Pomological Society as well as numerous department, Division of Agriculture and university committees.

Moore received many awards in his career. He was recognized as a distinguished professor at the University of Arkansas, its highest academic appointment. He also received the UA Alumni Association Outstanding Faculty Award, as well as being the first recipient of the University of Arkansas System Division of Agriculture Spitze Land Grant University Faculty Award for Excellence. He was a Fellow of the American Society for Horticultural Science and received the Wilder Medal from the American Pomological Society. He was inducted into the Arkansas Agriculture Hall of Fame as well as the Hall of Fame of the American Society for Horticultural Science.

### *Love of Teaching*

Yet for all his successes in the orchard and vineyard, his real love was in growing students. Moore taught at both the undergraduate and graduate levels, averaging six to 10 graduate students each year. He received high ratings from students, to whom he was both approachable and unassuming. As one outstanding student remarked, "We were being taught by a great man, yet you would never know it from his manner."

"He loved to work with students on their various research projects and inspire them to make a difference in their careers," Clark said. "This inspiration continues today as many of these continue in fruit research and expanding on the ideas he shared as an adviser."

Maria Bassols Raseira, a fruit breeder at Empresa Brasileira de Pesquisa Agropecuária in Brazil, studied with Moore as a master's student in 1972. It was her first time in the United States. "I was shy and scared," she said. Struggling with English and essay tests, she became discouraged. "I wanted to quit, but Dr. Moore wouldn't let me."

This was her first lesson from Moore: "'Never give up anything without a good fight, without trying your best.' And I guess that was also the last lesson he left to us, with his struggle during these last months: "'never giving up without a good fight'."

She would go on to work with Moore on her PhD, and he would become "Uncle Moore" to her growing family, and Moore and his wife Jan would become her American family.

Ed Hellman, professor of viticulture and an extension specialist for Texas A&M AgriLife Extension and Texas Tech, studied at Arkansas from 1980-82. He recalled the many trips from Fayetteville to the Fruit Research Station near Clarksville through the winding roads of the Ozarks. After a day of evaluating fruit, "we then hurried back to Fayetteville for an evening intramural softball game; Jim was our star pitcher," he said. "I learned a lot from Jim on those Clarksville trips; his knowledge and work ethic were incredible. He was a consummate professional and an outstanding mentor."

Patrick Byers, regional horticulture specialist for the University of Missouri Extension Service, said of Moore: "He was an amazing professor, mentor, and supporter over the course of my career. He has also been an example to me as I work in Extension, as I could see his concern for and dedication to the fruit farmers of Arkansas and beyond.

"I'm convinced that his concern for his fellow man was what drove him to the level of excellence that he achieved," Byers said.

His devotion to students may have stemmed from his own experience with a gifted teacher. Daughter Pamela Millican of Arlington, Texas, tells the story of one of his high school teachers who wanted to ensure Moore continued his education after earning his associate's degree.

She told him, "'If you will sell me a cow, I will give you $50.' That's how mom and dad were able to move to Fayetteville for him to get his bachelor's there. That's how poor they were. That $50 made a difference."

Moore is preceded in death by his parents, Jimmy L. and Mittie (Terrell) Moore, brothers Vancil and Billy, sister Geraldine and granddaughter Lauren Millican.

Moore is survived by his wife, Jan Fitzgerald Moore, daughter Pam Millican (Scott) and grandchildren Ryan Tharp (Amy) and Hilary Millican, son David Moore (Diana) and grandchildren Chris Riley and Shawn Riley (Janie), great-grandchildren Elliott Tharp and Ethan Riley and several nieces and nephews, as well as his students, who became a part of his family.

Memorials may be made to the University of Arkansas Foundation for the James N. Moore Fellowship, c/o Department of Horticulture, 316 Plant Sciences Bldg., Fayetteville, AR 72701.

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