ANNUAL REPORT TO NC-140

# 2015 Organic Apple Rootstock Trial

November, 2019 -- Geneva, NY


## Wesley R. Autio


This year is the fifth season of the 2015 NC-140 Organic Apple Rootstock Trials.

I hope that tree management was reasonably easy. Data collection should occur per the protocol distributed last November. For submission of those data, **everyone is encouraged to review their data and make sure that all measurements are the unit requested. Further, include only those data requested in the protocol, with the same columns in the spreadsheet, and in the same order**. All data should be submitted in the format and units requested and by the submission deadline.

The data to be submitted for 2019 and the format of the data are presented in the Data Submission Protocol on Page 2. Submit these data in an Excel spreadsheet, using the rootstock codes described in the protocol, by **January 15, 2020**. Please note that a 5-year report will be written based on all data through 2019.

In 2020, follow the Pruning and Training Plan (Page 2) and the Trial Protocol for 2020 (Page 2).

*To avoid problems during the compilation of the data, please pay particular attention to the following points:*

1. **Submit only the data requested.**
2. **Use the correct units.**
3. **Columns must be consistent with the protocol.**
3. **Make sure that all data make sense -- proofread your data set.**
4. **For rootstock and replication designations, follow the protocol exactly -- rootstock names should appear as they are listed in the Data Submission Protocol (Page 2) -- please note that there are no spaces in any of these names.**

Rootstocks, cultivars, and locations involved in the 2015 NC-140 Organic Apple Rootstock Trial. Modi trees are spaced 1x3.5m, and all trees are trained to the Tall Spindle System. Each site includes 12 replications in a randomized, complete-block design, with a single tree of each rootstock treatment per replication. Liberty/G.935 is included as a pollinizer.

| Rootstocks | Sites |
|---|---|
| G.11 | CA |
| G.16 | CO |
| G.41 | ID |
| G.202 | MA |
| G.214 | MI* |
| G.222 | NM |
| G.890 | NS |
| G.935 | NY – Ithaca |
| G.969 | NY – Geneva |
| M.9 NAKBT337 | VT |
| | WI |

* Data for 2018 not submitted.

### *Explanation of Tree Loss*

Tree loss has been relatively low. CA has lost approximately 10% of the trees in the trial, including one tree on G.11, two on G.214, three on G.30, one on G.890, two on G.969, and two on M.9 NAKBT337. All were lost due to excessive week competition, with the exception of one tree on G.969 that suffered wind damage.

In VT, about 6% of the trees have died. Thse include one tree on G.202, one on G.214, one on G.30

Send 2018 data via email to Wes Autio (autio@umass.edu) by

***January 15, 2020***

and one on G.890 that were severely damaged by voles. Additionally, two trees on G.30 were killed by winter damage, and one on G.30 was lost to severe dogwood borer infestation.

MA lost about 5% of the trees (two on G.11 and one each on G.214, G.41, G.969, and M.9 NAKBT337) to undertermined causes.

Three percent or less died at other locations. Reasons for this loss included fireblight (one G.11 in NYG, one M.9 NAKBT337 in NM, and two M.9 NAKBT337 in NS. Voles killed one tree on G.890 and two on G.935 in CO. Graft union failure took one G.214 in ID, and unknown causes took one G.935 and one G.41 in ID and one G.969 in NYI.

# Trial Protocol for 2020

***Tree management.***

A. Trees must be supported and trained as Tall Spindles (see Pruning & Training Plan for the Tall Spindle System).
B. Thin fruit as described in Pruning and Training Plan for the Tall Spindle System.
B. Manage pests, nutrients, and water per local organic recommendations.

***Collect the follow data for each tree in 2020.***

A. Root suckers: the number removed and counted, August.
B. Yield: count all fruit per tree and weigh (to the nearest 0.1 kg).
C. Trunk size: trunk circumference 30 cm above the graft union (mm), October.
D. Status: 0=dead, 1=alive, and 2=missing data, October.

## *Pruning and Training Plan for the Tall Spindle System*

| | |
|---|---|
| Dormant | 1. Limit tree height to 11.5' (3.6m) by annually cutting leader back to a weak fruitful side branch.<br>2. Annually, remove at least 2 limbs, including lower tier scaffolds, that are more than ¾" in diameter using a bevel cut.<br>3. Simplify each remaining branch on the tree so that it is columnar with no major side branches.<br>4. Shorten branches that extend into the row to facilitate movement of equipment and preserve fruit quality on the lower limbs. |
| Late May | Chemically thin with 2 applications of lime sulfur and fish oil during bloom (30% and 60%), and then follow up with hand thinning to appropriate levels to ensure regular annual cropping and adequate fruit size (target = 120 fruit per tree). |
| August | Lightly summer prune to encourage light penetration and maintain pyramidal tree shape. |

**Data Submission Protocol**

Submit data via email (autio@umass.edu) by **January 15, 2020.**

| Location | ROOT | REP | 2015 STATUS (see below) | Trunk circ. at planting (mm) | Side branches (>10cm) after pruning (no.) | Height of the graft union above the soil at planting (mm) | Fall trunk circ. 2015 (mm) | Comments regarding trees which died during 2015 (those with status = 0) | 2016 STATUS (0=dead, 1=alive, 2=missing data) | 2016 Root sucker (no./ tree) | 2016 Trunk circ. (mm) | 2016 Yield (no./ tree) | 2016 Yield (kg/ tree) | Comments regarding trees which died during 2016 (those with status = 0) | 2017 STATUS (0=dead, 1=alive, 2=missing data) | 2017 Root sucker (no./ tree) | 2017 Trunk circ. (mm) | 2017 Yield (no./ tree) | 2017 Yield (kg/ tree) | Comments regarding trees which died during 2017 (those with status = 0) | 2018 STATUS (0=dead, 1=alive, 2=missing data) | 2018 Root sucker (no./tree) | 2018 Trunk circ. (mm) | 2018 Yield (no./ tree) | 2018 Yield (kg/ tree) | Comments regarding trees which died during 2018 (those with status = 0) | 2019 STATUS (0=dead, 1=alive, 2=missing data) | 2019 Root sucker (no./ tree) | 2019 Trunk circ. (mm) | 2019 Tree height (cm) | 2019 Canopy width (cm) | 2019 Yield (no./ tree) | 2019 Yield (kg/ tree) | Comments regarding trees which died during 2019 (those with status = 0) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| IA | G.11 | 1 | 1 | X | X | X | X | | 1 | X | X | X | | | 1 | X | X | X | | | 1 | X | X | X | | | 1 | X | X | X | X | X | X | |
| IA | G.11 | 2 | 0 | X | X | X | . | fireblight | 0 | . | . | . | | | 0 | . | . | . | | | 0 | . | . | . | | | 0 | . | . | . | . | . | . | |
| IA | G.11 | 3 | 1 | X | X | X | X | | 1 | X | X | X | | | 1 | X | X | X | | | 1 | X | X | X | | | 1 | X | X | X | X | X | X | |
| . | . | . | . | . | . | . | . | | . | . | . | . | | | . | . | . | . | | | . | . | . | . | | | . | . | . | . | . | . | . | |
| . | . | . | . | . | . | . | . | | . | . | . | . | | | . | . | . | . | | | . | . | . | . | | | . | . | . | . | . | . | . | |
| . | . | . | . | . | . | . | . | | . | . | . | . | | | . | . | . | . | | | . | . | . | . | | | . | . | . | . | . | . | . | |
| IA | M.9T337 | 10 | 1 | X | X | X | | | 0 | . | . | . | | fireblight | 0 | . | . | . | | | 0 | . | . | . | | | 0 | . | . | . | . | . | . | |
| IA | M.9T337 | 11 | 3 | X | X | X | . | | 3 | . | . | . | | | 3 | . | . | . | | | 3 | . | . | . | | | 3 | . | . | . | . | . | . | |
| IA | M.9T337 | 12 | 4 | X | X | X | . | | 4 | . | . | . | | | 4 | . | . | . | | | 4 | . | . | . | | | 4 | . | . | . | . | . | . | |

**Special requirements for the 2015 status assessment:**
0 = died after it was clearly growing well
1 = alive
2 = considered to be a non-data tree because of human error
3 = planted but broke at the union before it was fully supported
4 = leafed out but quickly shut down
5 = never leafed and began to grow

**Appropriate Rootstock Codes (do not include spaces in the rootstock name):**

| | | | |
|---|---|---|---|
| G.11 | G.41 | G.222 | G.969 |
| G.16 | G.202 | G.890 | M.9T337 |
| G.30 | G.214 | G.935 | |

When a data point is missing, insert a period in that cell.
Do not replace zeros with periods.
Required data format: Excel

Table 1. Tree and fruiting characteristics (2018) of Modi trees in the 2015 NC-140 Organic Apple Rootstock Trial. All data are least-squares means adjusted for missing subclasses.

| Location and rootstock | Suvival (%, 2015-18) | Trunk cross-sectional area ($cm^2$, 2018) | Root suckers (no./tree, 2015-18) | Yield per tree (kg, 2018) | Cumulative yield per tree (kg, 2016-18) | Yield efficiency ($kg/cm^2$ TCA, 2018) | Cumulative yield efficiency ($kg/cm^2$ TCA, 2016-18) | Fruit weight (g, 2018) | Average fruit weight (g, 2016-18) |
|---|---|---|---|---|---|---|---|---|---|
| G.11 | 97 a | 5.7 e | 0.7 d | 4.1 cd | 5.3 bc | 0.62 ab | 0.80 bc | 125 ab | 134 a |
| G.30 | 94 a | 7.1 cd | 1.2 cd | 4.4 c | 5.8 b | 0.57 ab | 0.77 c | 131 a | 135 a |
| G.41 | 98 a | 7.4 c | 0.5 d | 5.3 b | 7.0 a | 0.59 ab | 0.80 bc | 128 ab | 135 a |
| G.202 | 99 a | 8.1 b | 2.0 ab | 3.8 cd | 4.9 c | 0.41 d | 0.53 e | 116 b | 124 a |
| G.214 | 96 a | 4.9 f | 0.6 d | 3.7 cd | 4.6 c | 0.67 a | 0.84 abc | 124 ab | 132 a |
| G.222 | 100 a | 3.8 g | 2.6 a | 2.3 e | 2.5 d | 0.43 cd | 0.51 e | 127 ab | 136 a |
| G.890 | 97 a | 11.1 a | 2.1 ab | 6.8 a | 7.9 a | 0.52 bc | 0.62 de | 127 ab | 134 a |
| G.935 | 97 a | 6.7 d | 1.6 bc | 5.3 b | 7.2 a | 0.67 a | 0.94 a | 124 ab | 127 a |
| G.969 | 97 a | 5.4 ef | 0.7 d | 3.8 cd | 5.4 bc | 0.63 ab | 0.91 ab | 121 ab | 132 a |
| M.9 NAKBT337 | 94 a | 5.5 ef | 0.5 d | 3.4 d | 4.5 c | 0.53 bc | 0.73 cd | 129 ab | 134 a |
| CA | 90 b | 3.1 d | 1.7 b | 0.8 d | 1.1 e | 0.22 d | 0.31 d | 63 e | 84 e |
| CO | 97 ab | 5.2 c | 0.7 c | 1.0 d | 1.1 e | 0.19 d | 0.22 d | 144 b | 143 b |
| ID | 97 ab | 8.1 b | 3.7 a | 0.4 d | 2.4 de | 0.05 ef | 0.29 d | 143 b | 166 a |
| MA | 95 ab | 5.7 c | 0.7 c | 0.0 d | 1.1 e | 0.00 f | 0.21 d | --- | 128 d |
| NM | 98 ab | 7.5 b | 2.1 b | 6.3 b | 6.7 b | 0.83 b | 0.88 bc | 79 d | 79 e |
| NS | 98 ab | 5.2 c | 0.7 c | 3.2 c | 3.6 cd | 0.61 c | 0.70 c | 140 b | 142 bc |
| NYG | 99 a | 7.2 b | 2.0 b | 5.6 b | 6.3 b | 0.82 b | 0.94 b | 132 b | 134 bcd |
| NYI | 99 a | 5.9 c | 0.5 c | 5.2 b | 6.0 b | 0.92 b | 1.05 b | 178 a | 172 a |
| VT | 94 ab | 5.5 c | 0.3 c | 2.7 c | 5.7 bc | 0.50 c | 1.06 b | 108 c | 130 cd |
| WI | 100 a | 12.3 a | 0.1 c | 17.7 a | 21.1 a | 1.49 a | 1.79 a | 138 b | 144 b |

Mean separation within columns for location or rootstock by Tukey's HSD ($P$ = 0.05).

Table 2. Survival (%, 2015-18) of Modi trees in the 2015 NC-140 Organic Apple Rootstock Trial.

| Rootstock | CA | CO | ID | MA | NM | NS | NYG | NYI | VT | WI |
|---|---|---|---|---|---|---|---|---|---|---|
| G.11 | 92 a | 100 a | 100 a | 83 a | 100 a | 100 a | 92 a | 100 a | 100 a | 100 a |
| G.16 | --- | 100 a | 100 a | 100 a | 100 a | --- | 100 a | 100 a | 100 a | 100 a |
| G.30 | 75 a | 100 a | 100 a | 100 a | 100 a | 100 a | 100 a | 100 a | 64 b | 100 a |
| G.41 | 100 a | 100 a | 92 a | 92 a | 100 a | 100 a | 100 a | 100 a | 100 a | 100 a |
| G.202 | 100 a | 100 a | 100 a | 100 a | 100 a | 100 a | 100 a | 100 a | 92 a | 100 a |
| G.214 | 83 a | 100 a | 92 a | 92 a | 100 a | 100 a | 100 a | 100 a | 92 a | 100 a |
| G.222 | 100 a | 100 a | 100 a | 100 a | 100 a | 100 a | 100 a | 100 a | 100 a | 100 a |
| G.890 | 92 a | 92 a | 100 a | 100 a | 92 a | 100 a | 100 a | 100 a | 92 a | 100 a |
| G.935 | 100 a | 83 a | 92 a | 100 a | 100 a | 100 a | 100 a | 100 a | 100 a | 100 a |
| G.969 | 83 a | 100 a | 100 a | 92 a | 100 a | 100 a | 100 a | 92 a | 100 a | 100 a |
| M.9 NAKBT337 | 83 a | 100 a | 100 a | 89 a | 89 a | 78 b | 100 a | 100 a | 100 a | 100 a |

Mean separation within columns by Tukey's HSD ($P$ = 0.05).

Table 3. Trunk cross-sectional area ($cm^2$, 2018) of Modi trees in the 2015 NC-140 Organic Apple Rootstock Trial.

| Rootstock | CA | CO | ID | MA | NM | NS | NYG | NYI | VT | WI |
|---|---|---|---|---|---|---|---|---|---|---|
| G.11 | 2.7 bcd | 5.6 bc | 7.6 de | 5.0 cdef | 5.9 de | 4.7 cde | 6.1 cde | 5.0 bcd | 4.6 cde | 9.9 de |
| G.16 | --- | 1.1 e | 4.1 f | 2.2 g | 4.0 e | --- | 2.9 f | 3.5 d | 2.6 e | 8.7 de |
| G.30 | 3.2 abc | 5.4 bc | 10.3 ab | 6.1 bcd | 8.7 b | 5.3 cd | 9.3 b | 5.7 bcd | 5.6 bcd | 11.3 cd |
| G.41 | 4.2 a | 5.1 bcd | 8.9 bcd | 6.4 bc | 8.1 bc | 5.8 bc | 7.5 bc | 7.2 b | 6.6 b | 14.3 bc |
| G.202 | 4.2 a | 6.6 ab | 9.9 abc | 7.3 b | 8.4 b | 6.9 b | 9.2 b | 6.9 bc | 6.6 b | 15.3 b |
| G.214 | 2.5 cd | 2.9 de | 6.4 ef | 5.2 cde | 5.1 de | 3.9 e | 5.2 def | 4.5 cd | 4.6 cde | 8.6 e |
| G.222 | 1.6 d | 1.9 de | 3.6 f | 3.0 fg | 4.3 e | 3.5 e | 3.7 ef | 3.5 d | 2.9 e | 9.8 de |
| G.890 | 3.8 ab | 8.9 a | 11.3 a | 10.8 a | 12.9 a | 8.3 a | 13.1 a | 11.1 a | 9.7 a | 21.3 a |
| G.935 | 3.4 abc | 5.7 bc | 7.9 cde | 4.6 def | 8.3 b | 5.6 cd | 6.1 cde | 7.1 b | 6.2 bc | 12.6 bcd |
| G.969 | 2.8 bcd | 4.3 cd | 7.8 cde | 4.9 cdef | 6.6 cd | 4.4 de | 5.7 cdef | 4.3 cd | 4.0 de | 9.7 de |
| M.9 NAKBT337 | 2.7 bcd | 5.2 bcd | 7.4 de | 3.7 efg | 6.6 cd | 4.1 de | 6.5 cd | 4.2 cd | 3.9 de | 10.4 de |

Mean separation within columns by Tukey's HSD ($P$ = 0.05).

Table 4. Cumulative yield per tree (kg, 2016-18) of Modi trees in the 2015 NC-140 Organic Apple Rootstock Trial.

| Rootstock | CA | CO | ID | MA | NM | NS | NYG | NYI | VT | WI |
|---|---|---|---|---|---|---|---|---|---|---|
| G.11 | 0.9 ab | 1.1 abc | 3.7 a | 0.7 ab | 5.9 cde | 2.6 b | 6.5 bc | 6.1 abc | 4.3 bcd | 21.1 bc |
| G.16 | --- | 0.0 c | 0.8 bc | 0.1 b | 3.5 de | --- | 2.7 d | 2.0 c | 1.3 d | 8.4 e |
| G.30 | 1.2 ab | 1.6 ab | 2.3 abc | 1.1 ab | 8.2 bc | 3.6 ab | 7.5 abc | 5.1 abc | 7.3 ab | 20.3 c |
| G.41 | 1.3 ab | 0.5 bc | 2.1 abc | 1.3 ab | 6.0 cd | 4.7 ab | 8.6 ab | 7.5 ab | 7.9 a | 30.3 a |
| G.202 | 1.3 ab | 1.3 abc | 3.5 a | 1.2 ab | 4.4 de | 3.3 ab | 5.6 cd | 5.5 abc | 4.3 bcd | 18.3 cd |
| G.214 | 1.3 ab | 0.6 bc | 1.1 bc | 0.9 ab | 6.2 bcd | 2.5 b | 5.2 cd | 4.8 bc | 6.6 ab | 16.7 cd |
| G.222 | 0.2 b | 0.0 c | 0.3 c | 0.8 ab | 2.8 e | 1.6 b | 2.9 d | 2.1 c | 2.6 cd | 11.7 de |
| G.890 | 0.9 ab | 1.6 ab | 2.9 a | 1.0 ab | 13.1 a | 6.2 a | 9.3 a | 8.0 ab | 7.1 ab | 28.8 a |
| G.935 | 2.0 a | 1.4 abc | 3.0 a | 1.5 ab | 8.7 b | 4.8 ab | 6.5 bc | 8.8 a | 9.1 a | 26.3 ab |
| G.969 | 1.2 ab | 2.1 a | 2.6 ab | 1.7 a | 6.2 bcd | 3.3 ab | 6.1 c | 6.5 abc | 4.7 bc | 19.2 c |
| M.9 NAKBT337 | 0.5 b | 1.6 ab | 2.2 abc | 0.5 ab | 5.6 cde | 3.2 ab | 5.2 cd | 5.1 abc | 3.5 cd | 18.1 cd |

Mean separation within columns by Tukey's HSD ($P$ = 0.05).

Table 5. Cumulative yield efficiency (kg/cm$^2$, 2016-18) of Modi trees in the 2015 NC-140 Organic Apple Rootstock Trial.

| Rootstock | CA | CO | ID | MA | NM | NS | NYG | NYI | VT | WI |
|---|---|---|---|---|---|---|---|---|---|---|
| G.11 | 0.31 ab | 0.20 bc | 0.48 a | 0.15 ab | 0.96 abcd | 0.58 a | 1.07 ab | 1.21 ab | 0.94 abc | 2.14 a |
| G.16 | --- | 0.05 bc | 0.28 ab | 0.04 b | 0.87 abcde | --- | 0.97 abc | 0.50 b | 0.72 bc | 0.99 c |
| G.30 | 0.38 ab | 0.31 ab | 0.23 b | 0.23 ab | 0.94 abcd | 0.67 a | 0.85 abc | 0.97 ab | 1.33 ab | 1.83 a |
| G.41 | 0.32 ab | 0.09 bc | 0.20 b | 0.20 ab | 0.74 cde | 0.88 a | 1.18 a | 1.06 ab | 1.20 ab | 2.16 a |
| G.202 | 0.29 ab | 0.21 bc | 0.35 ab | 0.18 ab | 0.51 e | 0.50 a | 0.61 c | 0.77 b | 0.63 c | 1.20 c |
| G.214 | 0.42 ab | 0.17 bc | 0.17 b | 0.17 ab | 1.21 a | 0.67 a | 1.05 ab | 1.15 ab | 1.38 a | 1.98 a |
| G.222 | 0.06 b | 0.00 c | 0.15 b | 0.25 ab | 0.64 de | 0.46 a | 0.85 abc | 0.56 b | 0.87 abc | 1.24 c |
| G.890 | 0.20 b | 0.24 abc | 0.26 b | 0.10 b | 1.03 abc | 0.78 a | 0.73 bc | 0.73 b | 0.74 bc | 1.38 bc |
| G.935 | 0.59 a | 0.25 abc | 0.37 ab | 0.32 a | 1.05 ab | 0.92 a | 1.11 ab | 1.26 ab | 1.45 a | 2.09 a |
| G.969 | 0.38 ab | 0.47 a | 0.33 ab | 0.37 a | 0.92 abcd | 0.76 a | 1.08 ab | 1.54 a | 1.24 ab | 2.06 a |
| M.9 NAKBT337 | 0.18 b | 0.28 abc | 0.32 ab | 0.15 ab | 0.85 bcde | 0.72 a | 0.87 abc | 1.24 ab | 0.88 abc | 1.79 ab |

Mean separation within columns by Tukey's HSD ($P$ = 0.05).

Table 6. Average fruit weight (g, 2016-18) of Modi trees in the 2015 NC-140 Organic Apple Rootstock Trial.

| Rootstock | CA | CO | ID | MA | NM | NS | NYG | NYI | VT | WI |
|---|---|---|---|---|---|---|---|---|---|---|
| G.11 | 85 ab | 146 a | 172 a | 144 a | 73 de | 140 a | 136 ab | 178 a | 124 ab | 141 ab |
| G.16 | --- | 179 a | 156 a | 134 a | 71 de | --- | 133 ab | 144 a | 141 a | 147 ab |
| G.30 | 75 ab | 141 a | 169 a | 131 a | 84 abc | 146 a | 134 ab | 173 a | 136 ab | 164 a |
| G.41 | 85 ab | 154 a | 162 a | 118 a | 82 abcd | 148 a | 147 a | 161 a | 138 a | 151 ab |
| G.202 | 71 ab | 128 a | 165 a | 133 a | 66 e | 137 a | 128 b | 153 a | 116 b | 142 ab |
| G.214 | 54 b | 150 a | 165 a | 137 a | 79 bcd | 146 a | 133 ab | 185 a | 139 a | 131 b |
| G.222 | 155 a | 154 a | 140 a | 125 a | 78 bcde | 135 a | 127 b | 166 a | 129 ab | 152 ab |
| G.890 | 81 ab | 138 a | 173 a | 139 a | 86 ab | 142 a | 134 ab | 185 a | 131 ab | 130 b |
| G.935 | 74 ab | 125 a | 174 a | 109 a | 90 a | 145 a | 128 b | 168 a | 121 ab | 132 b |
| G.969 | 100 ab | 137 a | 169 a | 128 a | 75 cde | 138 a | 132 ab | 166 a | 131 ab | 144 ab |
| M.9 NAKBT337 | 62 ab | 158 a | 176 a | 113 a | 74 cde | 141 a | 143 ab | 185 a | 135 ab | 155 ab |

Mean separation within columns by Tukey's HSD ($P$ = 0.05).