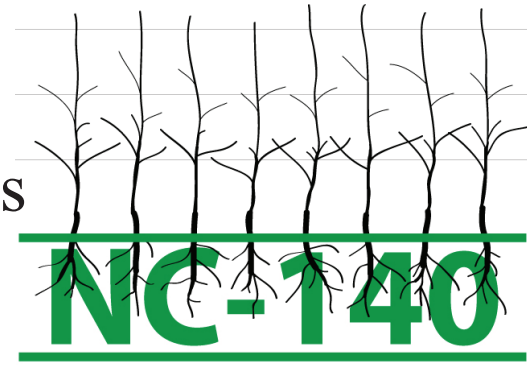
ANNUAL REPORT TO NC-140

2010 Apple Rootstock Trials

November, 2016 -- University Park, PA

Wesley R. Autio



This year was the seventh season of the 2010 NC-140 Apple Rootstock Trials. Data submitted in 2016, however, were for the sixth growing season (2015). All sites, except CO and OH, submitted data, and they were received in an easily read format, but there were a few problems with cooperators following the protocol. **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 (January 15).

The data to be submitted and the format of the data submission are presented in the Data Submission Protocol on Page 3. Submit these data in Excel spreadsheet format, using the rootstock codes described in the protocol, by **January 15, 2017**.

In 2017, follow the Pruning and Training Plan (Page 2) and the Trial Protocol for 2017 (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 3).**

Rootstocks, cultivars, and locations involved in the 2010 NC-140 Apple Rootstock Trial. Honeycrisp plantings are spaced 4'x12', and Fuji plantings are spaced 6'x14'. All trees are trained to the Tall Spindle System.

Rootstocks	Honeycrisp sites	Aztec Fuji sites
B.9	BC	CH
B.10	CH	ID
B.7-3-150	CO**	KY
B.7-20-21	IA	NC
B.64-194	MA	NY**
B.67-5-32	MN	PA
B.70-6-8	MI	UT
B.71-7-22	NJ	
G.11	NS	
G.41 N	NY	
G.41 TC	OH**	
G.202 N	WI	
G.202 TC		
G.935 N		
G.935 TC		
CG.2034		
CG.3001		
CG.4003		
CG.4004		
CG.4013		
CG.4214		
CG.4814		
CG.5087		
CG.5222		
PiAu 9-90		
PiAu 51-11		
Supp.3		
M.26 EMLA		
M.9 Pajam2		
M.9 NAKBT337		

Send 2015 data via email to Wes Autio (autio@umass.edu) by

January 15, 2017

Trial Protocol for 2017

Tree management.

A. Trees must be supported and trained as Tall Spindles (see Pruning & Training Plan, Mature Tree).
B. Adjust crop load as described in the Pruning & Training Plan, Mature Tree.
C. Manage pests, nutrients, and water per local recommendations. Pay attention to weed control in this trial.

Collect the follow data for each tree in 2017.

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. Zonal leaf chlorosis: after Honeycrisp harvest, visually estimate the portion (%) of the canopy exhibiting symptoms.
D. Trunk size: trunk circumference 30 cm above the graft union (mm), October.
E. Status: 0=dead, 1=alive, and 2=missing data, October.

Pruning and Training Plan for the Tall Spindle System

Mature Tree	Dormant	1. Limit tree height to 11.5' (3.6m) by annually cutting leader back to a weak fruitful side branch. 2. Annually, remove at least 2 limbs, including lower tier scaffolds, that are more than ¾" in diameter using a bevel cut. 3. Simplify each remaining branch on the tree so that it is columnar with no major side branches. 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, and then follow up with hand thinning to appropriate levels to ensure regular annual cropping and adequate fruit size. (Target = 120-150 fruits/tree)
	August	Lightly summer prune to encourage light penetration and maintain pyramidal tree shape.

Please note that B.70-20-20 has been removed from the trial. Trees should be removed from the planting.

Data Submission Protocol

Submit data via email (autio@umass.edu) by January 15, 2017.

STATE 2010 Apple Rootstock Trial DATA FOR 2016

Cultivar	Rootstock	Rep	Sub-rep	2010 Status (see below)	Comments regarding trees which died during 2010 (those with status = 0)	2011 Status (0= dead, 1= alive, 2= missing data)	Root sucker (Aug, 2011, no.)	Yield per tree (2011) (kg)	Yield per tree (2011) (no)	Comments regarding trees which died during 2011 (those with status = 0)	2012 Status (0= dead, 1= alive, 2= missing data)	Root sucker (Aug, 2012, no.)	Yield per tree (2012, kg)	Yield per tree (2012, no.)	Zonal chlorosis (2012, %)	Comments regarding trees which died during 2012 (those with status = 0)	2013 Status (0= dead, 1= alive, 2= missing data)	Root sucker (Aug, 2013, no.)	Yield per tree (2013, kg)	Yield per tree (2013, no.)	Zonal chlorosis (2013, %)	Comments regarding trees which died during 2013 (those with status = 0)	2014 Status (0= dead, 1= alive, 2= missing data)	Root sucker (Aug, 2014, no.)	Yield per tree (2014, kg)	Yield per tree (2014, no.)	Zonal chlorosis (2014, %)	Comments regarding trees which died during 2014 (those with status = 0)	2015 Status (0= dead, 1= alive, 2= missing data)	Root sucker (Aug, 2015, no.)	Yield per tree (2015, kg)	Yield per tree (2015, no.)	Zonal chlorosis (2015, %)	Comments regarding trees which died during 2015 (those with status = 0)	**2016 Status (0= dead, 1= alive, 2= missing data)**	**Root sucker (Aug, 2016, no.)**	**Yield per tree (2016, kg)**	**Yield per tree (2016, no.)**	**Zonal chlorosis (2016, %)**	**Tunk circ. (fall, 2016, mm)**	**Comments regarding trees which died during 2016 (those with status = 0)**
Honeycrisp	B.9	1	1	1		1	X	X	X		1	X	X	X	X		1	X	X	X	X		1	X	X	X	X		1	X	X	X	X			**1**	**X**	**X**	**X**	**X**	**X**	
Honeycrisp	B.9	1	2	0	fireblight	0	.	.	.		0	.	.	.	.		0	.	.	.	.		0	.	.	.	.		0	.	.	.	.			**0**	**.**	**.**	**.**	**.**	**.**	
Honeycrisp	B.9	1	3	1		1	X	X	X		1	X	X	X	X		1	X	X	X	X		1	X	X	X	X		1	X	X	X	X			**1**	**X**	**X**	**X**	**X**	**X**	
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Honeycrisp	M.26EMLA	4	1	1		0	X	X	X	Voles	0	X	X	X	X		0	X	X	X	X		0	X	X	X	X		0	X	X	X	X			**0**	**X**	**X**	**X**	**X**	**X**	
Honeycrisp	M.26EMLA	4	2	3		2	.	.	.		2	.	.	.	.		2	.	.	.	.		2	.	.	.	.		2	.	.	.	.			**2**	**.**	**.**	**.**	**.**	**.**	
Honeycrisp	M.26EMLA	4	3	4		2	.	.	.		2	.	.	.	.		2	.	.	.	.		2	.	.	.	.		2	.	.	.	.			**2**	**.**	**.**	**.**	**.**	**.**	

Cultivar	Rootstock	Rep	Sub-rep	2010 Status (see below)	Comments regarding trees which died during 2010 (those with status = 0)	2011 Status (0= dead, 1= alive, 2= missing data)	Root sucker (Aug, 2011, no.)	Yield per tree (2011) (kg)	Yield per tree (2011) (no)	Comments regarding trees which died during 2011 (those with status = 0)	2012 Status (0= dead, 1= alive, 2= missing data)	Root sucker (Aug, 2012, no.)	Yield per tree (2012, kg)	Yield per tree (2012, no.)	Comments regarding trees which died during 2012 (those with status = 0)	2013 Status (0= dead, 1= alive, 2= missing data)	Root sucker (Aug, 2013, no.)	Yield per tree (2013, kg)	Yield per tree (2013, no.)	Comments regarding trees which died during 2013 (those with status = 0)	2014 Status (0= dead, 1= alive, 2= missing data)	Root sucker (Aug, 2014, no.)	Yield per tree (2014, kg)	Yield per tree (2014, no.)	Comments regarding trees which died during 2014 (those with status = 0)	2015 Status (0= dead, 1= alive, 2= missing data)	Root sucker (Aug, 2015, no.)	Yield per tree (2015, kg)	Yield per tree (2015, no.)	Comments regarding trees which died during 2015 (those with status = 0)	**2016 Status (0= dead, 1= alive, 2= missing data)**	**Root sucker (Aug, 2016, no.)**	**Yield per tree (2016, kg)**	**Yield per tree (2016, no.)**	**Tunk circ. (fall, 2016, mm)**	**Comments regarding trees which died during 2016 (those with status = 0)**
Fuji	B.9	1	1	1		1	X	X	X		1	X	X	X		1	X	X	X		1	X	X	X		1	X	X	X		**1**	**X**	**X**	**X**	**X**	
Fuji	B.9	1	2	0	fireblight	0	.	.	.		0	.	.	.		0	.	.	.		0	.	.	.		0	.	.	.		**0**	**.**	**.**	**.**	**.**	
Fuji	B.9	1	3	1		1	X	X	X		1	X	X	X		1	X	X	X		1	X	X	X		1	X	X	X		**1**	**X**	**X**	**X**	**X**	
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Fuji	M.26EMLA	4	1	1		0	X	X	X	Voles	0	X	X	X		0	X	X	X		0	X	X	X		0	X	X	X		**0**	**X**	**X**	**X**	**X**	
Fuji	M.26EMLA	4	2	3		2	.	.	.		2	.	.	.		2	.	.	.		2	.	.	.		2	.	.	.		**2**	**.**	**.**	**.**	**.**	
Fuji	M.26EMLA	4	3	4		2	.	.	.		2	.	.	.		2	.	.	.		2	.	.	.		2	.	.	.		**2**	**.**	**.**	**.**	**.**	

Status 2010:

0 = died after it was clearly growing well
1 = alive
2 = considered to be a non-data tree because of human error (like tractor blight)
3 = planted but broke at the union before it was fully supported
4 = leafed out but quickly shut down
5 = never leafed out and began to grow

When a data point is missing, insert a period in that cell, but do not replace zeros with periods.

DATA FORMAT: Excel

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

B.9	B.7-20-21	B.70-6-8	G.41N	G.202TC	CG.2034	CG.4004	CG.4814	PiAu9-90	M.9Pajam2
B.10	B.64-194	B.71-7-22	G.41TC	G.935N	CG.3001	CG.4013	CG.5087	PiAu51-11	M.9T337
B.7-3-150	B.67-5-32	G.11	G.202N	G.935TC	CG.4003	CG.4214	CG.5222	Supp.3	M.26EMLA

Table 1. Rootstock means for trunk cross-sectional area, root suckers, zonal chlorosis, yield per tree, yield efficiency, and fruit size of Honeycrisp apple trees in the 2010 NC-140 Honeycrisp Apple Rootstock Trial. Means are based on data from BC, CH, IA MA, MI, MN, NJ, NS, NY, and WI. All values are least-squares means, adjusted for missing subclasses.[z]

Rootstock	Trunk cross-sectional area (2015, cm^2)	Cumulative root suckers (2010-15, no./tree)	Zonal chlorosis (% canopy affected)	Yield per tree (2015, kg)	Cumulative yield per tree (2011-15, kg)	Yield efficiency (2015, kg/cm^2 TCA)	Cumulative yield efficiency (2011-15, kg/cm^2 TCA)	Fruit weight (2015, g)	Average Fruit weight (2012-15, g)
B.9	7.2	4.7	25.1	8.0	21.9	1.2	3.1	217	204
B.10	10.9	1.2	20.7	14.4	34.9	1.3	3.2	223	217
B.7-3-150	23.1	1.6	17.1	15.9	38.2	0.7	1.7	250	241
B.7-20-21	24.0	2.2	21.6	15.9	39.6	0.7	1.7	240	227
B.64-194	26.0	1.1	23.9	17.1	40.3	0.6	1.5	250	239
B.67-5-32	23.1	1.4	19.6	14.3	31.5	0.6	1.4	242	235
B.70-6-8	22.5	1.5	20.5	14.3	37.1	0.6	1.6	242	226
B.71-7-22	2.7	2.9	26.5	2.8	7.1	1.0	2.8	201	190
G.11	10.7	3.0	29.9	14.0	36.3	1.3	3.4	232	218
G.41N	11.7	0.6	21.6	14.7	37.7	1.3	3.2	233	226
G.41TC	11.7	2.9	30.5	15.5	36.3	1.3	3.1	227	241
G.202N	20.0	11.7	27.2	17.6	45.3	0.9	2.3	219	216
G.202TC	13.2	9.6	23.7	13.6	35.9	1.1	2.8	225	201
G.935N	14.1	9.5	38.1	15.0	42.4	1.1	3.0	233	213
G.935TC	11.9	10.8	29.0	14.2	36.4	1.2	3.1	221	209
CG.2034	7.4	2.3	37.1	7.2	21.3	1.0	2.8	214	218
CG.4003	9.0	1.1	21.7	10.4	29.2	1.2	3.4	196	199
CG.4004	19.9	6.3	25.3	19.8	54.3	1.0	2.8	242	237
CG.4013	15.8	11.3	32.9	15.4	32.3	1.0	2.2	223	217
CG.4214	13.4	15.4	32.2	16.6	41.9	1.2	3.2	219	217
CG.4814	16.1	9.9	47.1	14.8	42.2	0.9	2.6	220	213
CG.5087	15.6	4.7	40.9	17.6	45.7	1.2	2.9	212	209
Supp.3	10.7	3.2	50.1	9.3	26.5	0.8	2.5	223	208
PiAu 9-90	19.1	2.3	63.4	9.1	22.1	0.5	1.2	191	176
PiAu 51-11	18.3	2.6	25.7	14.1	32.6	0.8	1.9	242	235
M.9 NAKBT337	11.0	6.9	25.3	12.2	33.0	1.1	3.0	235	226
M.9 Pajam 2	12.0	14.4	29.6	12.2	32.3	1.0	2.6	228	216
M.26 EMLA	13.6	4.3	26.3	13.4	32.2	1.0	2.4	236	225
Estimated HSD	2.4	4.0	10.1	3.5	5.7	0.2	0.4	23	16

[z]Mean separation in columns by Tukey's HSD (P = 0.05). HSD was calculated based on the average number of observations per mean.

Table 2. Trunk cross-sectional area (2015, cm^2) of Honeycrisp apple trees at individual planting locations in the 2010 NC-140 Honeycrisp Rootstock Trial. All values are least-squares means, adjusted for missing subclasses.[z]

Rootstock	BC	CH	IA	MA	MI	MN	NJ	NS	NY	WI
B.9	6.2	6.6	4.3	7.6	7.8	8.9	6.5	8.0	7.3	8.8
B.10	9.0	10.7	6.8	12.7	11.0	11.1	11.1	11.4	13.9	11.0
B.7-3-150	14.0	15.5	20.3	26.2	20.4	29.7	34.4	17.8	29.4	23.5
B.7-20-21	17.1	13.0	16.4	22.7	19.5	27.8	37.4	29.6	28.8	28.1
B.64-194	13.9	14.6	17.5	29.6	28.8	26.1	35.7	30.7	31.5	31.8
B.67-5-32	16.3	14.9	18.6	26.9	27.4	26.0	31.3	21.9	24.6	23.3
B.70-6-8	13.5	14.5	18.9	26.9	17.8	25.9	32.2	20.8	31.5	23.1
B.71-7-22	1.7	3.7	2.2	2.1	3.2	3.9	1.8	1.7	3.3	3.1
G.11	7.6	10.1	7.8	10.7	10.9	11.9	14.6	9.7	12.0	11.9
G.41N	10.8	9.2	7.6	11.7	11.3	13.0	13.3	11.6	14.7	13.8
G.41TC	9.6	8.4	8.8	11.1	13.5	15.0	15.5	12.0	11.2	12.0
G.202N	16.1	10.9	12.3	24.3	17.0	22.1	31.0	21.2	21.6	23.4
G.202TC	8.7	8.8	9.2	15.8	10.7	14.2	16.6	11.1	26.3	11.1
G.935N	11.5	8.4	9.2	15.7	13.6	14.6	20.1	13.5	17.9	16.2
G.935TC	8.4	6.4	6.4	11.0	11.1	12.9	19.9	14.5	15.2	13.2
CG.2034	7.7	6.2	5.8	8.1	7.8	7.4	9.1	7.1	6.7	8.3
CG.3001	14.3	---	13.9	24.5	12.4	15.4	26.9	17.8	22.5	12.8
CG.4003	6.6	7.3	6.0	8.8	7.9	8.8	10.8	8.0	15.7	9.7
CG.4004	15.1	12.5	11.0	21.8	18.2	21.8	28.3	26.3	21.1	23.2
CG.4013	8.9	12.6	17.3	15.8	17.2	11.9	27.7	14.6	23.3	8.4
CG.4214	8.0	6.8	9.3	17.6	14.9	14.2	20.4	15.0	16.5	11.6
CG.4814	12.3	10.2	14.8	15.6	15.0	16.1	26.6	16.4	18.6	15.6
CG.5087	13.6	7.7	9.7	15.5	14.5	15.5	28.3	13.9	19.8	17.4
CG.5222	13.6	8.2	---	18.9	15.6	15.5	24.5	19.8	17.8	13.8
Supp.3	8.0	9.6	7.6	10.6	10.2	9.2	17.7	10.2	14.0	9.2
PiAu 9-90	16.5	16.0	9.7	21.4	15.5	14.6	35.1	15.4	29.6	16.7
PiAu 51-11	9.3	13.1	15.5	18.9	20.5	17.7	32.2	14.8	22.7	17.9
M.9 NAKBT337	7.8	8.2	8.4	12.1	10.5	12.0	15.9	10.3	14.6	10.8
M.9 Pajam 2	10.0	8.4	8.3	11.1	13.2	11.7	17.5	11.8	14.2	14.2
M.26 EMLA	10.9	11.6	10.2	12.3	14.1	13.9	20.0	15.5	14.6	12.6
Estimated HSD	4.9	4.4	6.2	7.8	6.8	8.1	6.6	9.3	10.9	8.9

[z]Mean separation in columns by Tukey's HSD (P = 0.05). HSD was calculated based on the average number of observations per mean.

Table 3. Cumulative yield per tree (2011-15, kg) of Honeycrisp apple trees at individual planting locations in the 2010 NC-140 Honeycrisp Rootstock Trial. All values are least-squares means, adjusted for missing subclasses.[z]

Rootstock	BC	CH	IA	MA	MI	MN	NJ	NS	NY	WI
B.9	16.4	5.4	18.5	22.9	27.4	22.6	12.8	24.5	41.0	27.9
B.10	24.5	8.8	26.2	39.3	36.4	36.1	22.8	38.3	71.7	45.3
B.7-3-150	27.4	8.8	29.4	37.3	36.4	47.0	35.7	32.9	76.0	50.7
B.7-20-21	30.5	5.7	30.9	45.1	41.8	39.9	32.3	56.1	71.7	42.0
B.64-194	23.8	9.0	20.3	39.2	38.7	44.8	35.9	62.1	68.7	60.5
B.67-5-32	29.3	6.0	19.2	37.6	38.2	29.5	23.0	37.9	55.0	39.5
B.70-6-8	24.7	7.5	26.1	49.1	31.3	45.3	32.0	35.5	71.1	48.6
B.71-7-22	5.2	1.5	10.3	5.0	8.0	8.6	6.0	3.7	13.2	9.2
G.11	21.3	10.0	35.2	40.8	40.1	47.0	30.9	24.0	63.6	50.6
G.41N	28.1	5.8	31.2	45.0	36.4	45.6	22.3	41.2	68.2	53.1
G.41TC	25.4	6.2	26.0	31.4	33.4	44.7	18.4	71.1	60.4	46.0
G.202N	37.5	7.0	24.4	77.0	43.5	48.6	33.5	60.3	70.5	51.1
G.202TC	25.1	13.1	33.5	49.4	35.5	42.3	30.4	27.0	67.4	35.4
G.935N	36.7	8.5	28.2	66.3	43.9	40.8	31.5	31.7	64.1	72.1
G.935TC	19.8	6.0	25.3	33.4	41.9	36.1	44.7	32.1	64.9	59.5
CG.2034	20.8	3.3	19.2	23.3	20.8	24.9	21.2	15.7	28.0	35.5
CG.3001	35.2	---	48.8	86.7	26.3	44.4	32.6	63.1	90.2	54.2
CG.4003	20.4	13.1	25.5	33.8	26.2	26.6	27.3	26.8	52.8	39.6
CG.4004	46.1	10.6	43.6	62.6	42.1	59.2	50.8	77.2	74.8	76.0
CG.4013	23.3	5.5	22.5	51.5	36.5	38.5	28.2	36.6	60.2	19.6
CG.4214	32.1	8.4	28.2	38.9	45.4	51.1	36.8	51.2	75.6	51.8
CG.4814	41.1	7.3	32.0	44.8	38.7	53.3	40.1	37.5	82.8	44.6
CG.5087	41.2	8.4	34.4	42.6	39.3	53.1	46.5	52.8	76.9	61.4
CG.5222	28.5	6.0	---	37.5	37.1	36.7	32.9	54.3	66.5	48.3
Supp.3	24.3	6.6	11.3	25.1	26.7	25.8	22.4	21.4	64.1	37.6
PiAu 9-90	24.6	7.3	9.8	13.4	18.9	15.8	30.0	22.9	55.4	22.6
PiAu 51-11	19.7	6.2	30.0	34.0	32.5	35.8	28.2	34.2	68.7	37.1
M.9 NAKBT337	23.6	8.0	28.2	39.7	34.9	37.6	34.0	24.4	63.5	36.1
M.9 Pajam 2	24.9	5.6	20.6	29.9	39.2	30.3	34.5	23.3	58.7	56.4
M.26 EMLA	27.3	3.2	33.6	28.9	36.6	31.0	25.5	41.3	53.3	41.1
Estimated HSD	13.2	5.6	13.3	21.7	16.5	16.9	14.2	29.6	23.3	20.8

[z]Mean separation in columns by Tukey's HSD ($P = 0.05$). HSD was calculated based on the average number of observations per mean

Table 4. Cumulative yield efficiency (2011-15, kg/cm^2 trunk cross-sectional area) of Honeycrisp apple trees at individual planting locations in the 2010 NC-140 Honeycrisp Rootstock Trial. All values are least-squares means, adjusted for missing subclasses.[z]

Rootstock	BC	CH	IA	MA	MI	MN	NJ	NS	NY	WI
B.9	2.5	0.9	4.5	3.0	3.6	2.6	1.9	3.3	5.7	3.2
B.10	2.8	0.8	3.9	3.1	3.3	3.3	2.0	3.5	5.2	4.2
B.7-3-150	2.0	0.6	1.5	1.4	1.8	1.6	1.1	1.9	2.6	2.3
B.7-20-21	1.8	0.5	2.0	2.1	2.2	1.5	0.9	1.9	2.5	1.6
B.64-194	1.7	0.6	1.2	1.3	1.4	1.8	1.0	2.0	2.3	1.9
B.67-5-32	1.8	0.5	1.1	1.5	1.4	1.2	0.8	1.7	2.4	1.7
B.70-6-8	1.8	0.5	1.5	1.9	1.8	1.8	1.0	1.7	2.3	2.1
B.71-7-22	2.9	0.4	4.7	2.5	2.5	2.4	2.9	2.0	4.5	3.1
G.11	2.7	1.0	4.6	3.8	3.7	4.1	2.2	2.4	5.3	4.3
G.41N	2.6	0.6	4.2	3.8	3.2	3.6	1.7	3.5	4.7	4.0
G.41TC	2.6	0.7	2.9	2.8	2.5	3.0	1.2	6.4	5.3	3.9
G.202N	2.3	0.7	2.1	3.2	2.5	2.4	1.1	2.8	3.9	2.3
G.202TC	2.8	1.5	3.7	3.1	3.3	3.0	1.8	2.3	3.4	3.2
G.935N	3.2	1.1	3.2	4.2	3.3	2.9	1.6	2.3	3.6	4.5
G.935TC	2.4	0.9	4.1	3.0	3.9	2.8	2.2	2.3	4.4	4.8
CG.2034	2.6	0.6	3.4	2.7	2.6	3.3	2.3	2.3	4.2	4.3
CG.3001	2.4	---	3.6	3.5	2.1	2.9	1.2	3.7	4.0	4.5
CG.4003	3.2	1.8	4.2	3.8	3.2	3.0	2.5	3.3	4.2	4.2
CG.4004	2.9	0.9	4.0	2.9	2.3	2.7	1.8	3.1	3.6	3.4
CG.4013	2.6	0.4	1.5	3.1	2.2	3.3	1.0	2.5	2.8	2.3
CG.4214	4.0	1.2	3.1	2.2	3.1	3.6	1.9	3.4	4.6	4.5
CG.4814	3.3	0.7	2.3	2.9	2.6	3.4	1.5	2.2	4.5	2.9
CG.5087	3.0	1.1	3.6	2.6	2.7	3.4	1.6	3.8	4.1	3.6
CG.5222	2.1	0.7	---	2.0	2.4	2.4	1.3	2.8	3.9	3.6
Supp.3	3.0	0.7	1.5	2.3	2.7	2.8	1.2	1.9	4.5	4.0
PiAu 9-90	1.6	0.5	1.1	0.6	1.2	1.2	0.9	1.2	1.9	1.3
PiAu 51-11	2.1	0.5	2.1	1.8	1.6	2.0	0.9	2.5	3.1	2.2
M.9 NAKBT337	2.9	1.0	3.4	3.3	3.4	3.1	2.1	2.5	4.6	3.4
M.9 Pajam 2	2.5	0.7	2.5	2.9	3.0	2.6	2.0	2.0	4.0	4.1
M.26 EMLA	2.5	0.3	3.3	2.4	2.7	2.2	1.3	2.7	3.7	3.3
Estimated HSD	0.9	0.7	1.8	1.1	1.1	1.1	0.8	1.7	1.6	1.5

[z]Mean separation in columns by Tukey's HSD (P = 0.05). HSD was calculated based on the average number of observations per mean.

Table 5. Average fruit size (2012-15, g) of Honeycrisp apple trees at individual planting locations in the 2010 NC-140 Honeycrisp Rootstock Trial. All values are least-squares means, adjusted for missing subclasses.[z]

Rootstock	BC	CH	IA	MA	MI	MN	NJ	NS	NY	WI
B.9	247	164	154	253	216	158	256	168	218	202
B.10	280	171	170	243	219	160	287	170	245	221
B.7-3-150	291	178	216	283	241	197	304	170	284	242
B.7-20-21	263	185	192	247	210	174	289	178	277	257
B.64-194	270	169	211	259	254	190	297	196	289	253
B.67-5-32	271	184	204	267	245	202	276	190	262	248
B.70-6-8	266	182	204	263	194	184	267	178	280	243
B.71-7-22	217	188	131	213	221	142	266	157	194	169
G.11	253	166	163	265	242	141	300	161	258	225
G.41N	294	180	176	266	241	163	303	169	266	208
G.41TC	290	171	199	259	259	175	300	306	261	189
G.202N	313	172	168	258	207	158	270	154	250	207
G.202TC	227	163	199	228	182	162	292	138	249	174
G.935N	284	171	174	237	217	155	298	163	241	194
G.935TC	274	172	173	232	204	141	290	157	255	191
CG.2034	281	195	184	248	234	156	295	162	239	191
CG.3001	314	---	205	249	190	140	301	180	279	222
CG.4003	273	180	147	216	238	122	284	137	209	181
CG.4004	304	176	196	258	222	180	303	253	253	230
CG.4013	273	171	207	233	215	162	288	167	262	195
CG.4214	272	175	188	250	224	146	297	164	255	201
CG.4814	292	176	213	227	221	141	294	123	254	189
CG.5087	279	161	179	251	222	146	285	155	243	170
CG.5222	294	172	---	231	207	161	268	142	246	207
Supp.3	285	174	157	232	231	141	282	145	253	180
PiAu 9-90	223	161	139	148	183	107	251	121	239	188
PiAu 51-11	257	179	217	259	260	180	289	180	268	261
M.9 NAKBT337	283	167	190	256	226	160	315	171	261	229
M.9 Pajam 2	272	177	175	239	218	163	306	148	242	221
M.26 EMLA	269	180	192	238	268	170	319	148	244	227
Estimated HSD	52	35	37	43	79	42	49	68	38	46

[z]Mean separation in columns by Tukey's HSD (P = 0.05). HSD was calculated based on the average number of observations per mean.

Table 6. Rootstock means for trunk cross-sectional area, root suckers, yield per tree, yield efficiency, and fruit size of Fuji apple trees in the 2010 NC-140 Fuji Apple Rootstock Trial. Means are based on data from ID, KY, NC, and UT. All values are least-squares means, adjusted for missing subclasses.[z]

Rootstock	Trunk cross-sectional area (2015, cm^2)	Cumulative root suckers (2010-15, no./tree)	Yield per tree (2015, kg)	Cumulative yield per tree (2011-15, kg)	Yield efficiency (2015, kg/cm^2 TCA)	Cumulative yield efficiency (2011-15, kg/cm^2 TCA)	Fruit weight (2015, g)	Average Fruit weight (2012-15, g)
B.9	15.3	7.8	11.0	34.7	0.7	2.2	190	181
B.10	30.3	1.7	18.0	45.8	0.6	1.6	215	209
B.7-3-150	59.0	2.0	19.0	52.7	0.4	1.1	209	205
B.7-20-21	7.5	1.2	1.5	5.3	0.2	0.9	126	127
B.64-194	62.4	5.9	21.9	49.5	0.4	0.9	224	208
B.67-5-32	63.2	4.0	19.2	51.6	0.3	0.8	217	208
B.70-6-8	62.7	1.1	21.4	57.0	0.4	1.1	210	204
B.71-7-22	9.1	4.6	5.6	16.6	0.7	2.0	190	183
G.11	33.2	2.8	15.4	54.1	0.5	1.8	229	219
G.41N	34.5	1.9	24.1	66.1	0.6	1.6	234	229
G.41TC	28.8	7.2	20.6	50.6	0.7	1.6	223	226
G.202N	41.0	8.3	23.1	59.2	0.7	1.7	219	207
G.202TC	29.7	10.6	17.4	49.9	0.6	1.8	196	184
G.935N	38.0	5.7	25.2	77.7	0.8	2.3	217	207
G.935TC	35.9	18.3	19.7	58.6	0.6	1.9	202	203
CG.2034	15.7	5.6	13.6	36.4	0.8	2.2	190	198
CG.3001	49.5	5.7	22.6	67.8	0.5	1.3	221	217
CG.4003	18.0	2.3	11.1	35.1	0.7	2.2	183	171
CG.4004	45.9	7.5	24.3	78.1	0.6	1.8	221	222
CG.4214	23.9	9.7	18.0	43.9	0.8	2.0	203	206
CG.4814	38.8	14.1	20.7	53.9	0.6	1.5	202	198
CG.5087	20.9	4.8	15.4	40.8	0.9	2.3	184	195
CG.5222	46.4	11.5	23.2	67.0	0.5	1.5	215	215
Supp.3	29.2	1.2	9.5	37.4	0.4	1.5	188	199
PiAu 9-90	72.7	10.8	11.9	30.3	0.2	0.6	196	187
PiAu 51-11	65.6	1.7	15.2	46.8	0.3	0.8	228	216
M.9 NAKBT337	30.4	9.3	17.6	51.7	0.7	2.0	211	207
M.9 Pajam 2	36.5	15.7	19.3	60.8	0.6	1.9	216	203
M.26 EMLA	52.8	1.0	18.4	59.0	0.4	1.2	233	222
Estimated HSD	10.8	9.6	9.5	14.9	0.3	0.4	31	20

[z]Mean separation in columns by Tukey's HSD (P = 0.05). HSD was calculated based on the average number of observations per mean.

Table 7. Trunk cross-sectional area (2015, cm^2) of Fuji apple trees at individual planting locations in the 2010 NC-140 Fuji Rootstock Trial. All values are least-squares means, adjusted for missing subclasses.[z]

Rootstock	CH	ID	KY	NC	PA	UT
B.9	14.3	21.5	15.1	7.9	16.3	16.7
B.10	20.9	31.9	37.3	20.9	33.2	31.2
B.7-3-150	28.4	42.8	82.4	48.2	59.6	62.3
B.7-20-21	3.6	5.5	14.0	1.8	---	8.6
B.64-194	25.4	55.9	71.3	55.5	---	66.9
B.67-5-32	20.6	61.5	68.4	55.2	57.2	67.6
B.70-6-8	24.6	48.1	78.2	61.4	69.8	63.0
B.71-7-22	5.3	8.2	8.2	7.7	---	12.0
G.11	19.4	28.2	43.3	23.2	21.0	38.2
G.41N	---	50.3	22.2	29.3	---	35.7
G.41TC	20.3	32.2	25.8	21.8	---	33.9
G.202N	23.5	35.5	63.4	28.4	---	36.7
G.202TC	19.7	31.5	42.6	20.7	24.9	23.9
G.935N	14.7	32.9	51.8	25.2	31.8	42.0
G.935TC	17.6	28.9	48.2	21.0	---	45.5
CG.2034	---	14.9	13.0	12.0	---	23.4
CG.3001	---	55.1	48.7	40.9	---	53.4
CG.4003	14.1	12.6	24.8	14.1	---	20.4
CG.4004	18.7	52.3	44.5	28.6	---	58.1
CG.4013	---	---	34.2	20.0	---	26.1
CG.4214	9.7	24.3	34.1	13.7	---	23.3
CG.4814	10.2	34.2	50.4	36.5	---	34.5
CG.5087	9.2	19.3	33.5	6.4	---	24.6
CG.5222	19.6	52.2	56.0	31.8	34.6	45.6
Supp.3	17.2	21.0	39.3	23.5	---	32.8
PiAu 9-90	46.2	36.9	97.7	67.0	---	89.3
PiAu 51-11	25.6	54.9	79.0	55.1	66.1	73.8
M.9 NAKBT337	12.5	24.7	44.8	22.6	30.5	29.5
M.9 Pajam 2	14.9	36.0	47.8	21.1	31.2	41.0
M.26 EMLA	22.8	50.3	64.4	43.9	49.3	52.7
Estimated HSD	13.3	19.3	29.7	19.9	14.2	19.0

[z]Mean separation in columns by Tukey's HSD (P = 0.05). HSD was calculated based on the average number of observations per mean.

Table 8. Cumulative yield per tree (2011-15, kg) of Fuji apple trees at individual planting locations in the 2010 NC-140 Fuji Rootstock Trial. All values are least-squares means, adjusted for missing subclasses.[z]

Rootstock	CH	ID	KY	NC	PA	UT
B.9	8.8	78.4	13.5	19.2	21.3	27.7
B.10	11.9	85.4	21.3	28.4	29.6	48.3
B.7-3-150	13.6	98.7	24.7	28.8	32.6	58.4
B.7-20-21	1.8	5.4	4.4	4.7	---	6.8
B.64-194	11.4	96.2	13.2	33.6	---	55.3
B.67-5-32	10.1	101.3	18.0	30.6	40.3	56.4
B.70-6-8	14.2	113.9	20.8	36.4	37.0	57.1
B.71-7-22	5.8	30.2	5.6	13.7	---	17.1
G.11	19.6	93.4	23.8	43.1	39.0	56.1
G.41N	---	155.4	20.5	41.7	---	46.7
G.41TC	14.6	109.7	21.2	26.0	---	45.3
G.202N	17.5	111.3	25.0	47.4	---	53.0
G.202TC	16.5	96.5	22.2	37.5	38.1	43.5
G.935N	10.7	143.4	28.4	58.0	56.7	81.0
G.935TC	16.0	95.9	17.2	50.0	---	71.3
CG.2034	---	66.4	10.1	20.1	---	50.9
CG.3001	---	148.7	18.9	41.7	---	61.9
CG.4003	12.4	48.1	22.3	34.6	---	35.8
CG.4004	10.7	151.0	35.2	68.4	---	57.8
CG.4013	---	---	16.9	34.1	---	32.4
CG.4214	10.8	102.6	14.3	25.2	---	33.4
CG.4814	8.0	106.0	25.7	33.9	---	49.5
CG.5087	15.0	66.2	26.6	24.9	---	46.1
CG.5222	21.7	121.7	36.2	46.0	38.4	63.9
Supp.3	12.8	59.0	20.0	30.7	---	39.9
PiAu 9-90	12.1	42.6	11.8	20.2	---	46.6
PiAu 51-11	14.0	91.7	16.6	34.1	31.2	44.9
M.9 NAKBT337	10.0	94.5	22.4	45.5	41.3	44.5
M.9 Pajam 2	8.9	102.8	23.3	55.1	43.3	62.4
M.26 EMLA	13.6	105.5	24.9	49.6	43.4	55.8
Estimated HSD	8.3	41.2	15.4	29.4	25.3	27.7

[z]Mean separation in columns by Tukey's HSD (P = 0.05). HSD was calculated based on the average number of observations per mean.

Table 9. Cumulative yield efficiency (2011-15, kg/cm^2 trunk cross-sectional area) of Fuji apple trees at individual planting locations in the 2010 NC-140 Fuji Rootstock Trial. All values are least-squares means, adjusted for missing subclasses.[z]

Rootstock	CH	ID	KY	NC	PA	UT
B.9	0.7	3.7	1.0	2.4	1.3	1.6
B.10	0.6	2.8	0.6	1.3	0.9	1.6
B.7-3-150	0.5	2.4	0.3	0.6	0.5	0.9
B.7-20-21	0.5	1.0	0.3	1.6	---	0.7
B.64-194	0.5	1.7	0.2	0.7	---	0.8
B.67-5-32	0.5	1.7	0.3	0.6	0.7	0.9
B.70-6-8	0.6	2.4	0.3	0.6	0.5	0.9
B.71-7-22	1.2	3.6	0.7	2.1	---	1.5
G.11	1.1	3.3	0.6	1.9	1.8	1.5
G.41N	---	3.0	0.8	1.4	---	1.4
G.41TC	0.8	3.3	0.7	1.2	---	1.3
G.202N	0.8	3.2	0.4	1.8	---	1.6
G.202TC	0.8	3.2	0.5	1.8	1.5	1.8
G.935N	0.8	4.3	0.6	2.3	1.9	1.9
G.935TC	0.9	3.2	0.4	2.4	---	1.6
CG.2034	---	4.2	0.6	1.5	---	2.3
CG.3001	---	2.7	0.3	1.0	---	1.1
CG.4003	1.0	3.7	0.9	2.3	---	1.8
CG.4004	0.5	2.9	0.8	2.4	---	1.0
CG.4013	---	---	0.5	1.9	---	1.3
CG.4214	1.1	4.2	0.4	1.8	---	1.5
CG.4814	0.8	3.1	0.5	0.9	---	1.5
CG.5087	1.7	3.4	0.8	3.0	---	2.0
CG.5222	1.1	2.4	0.7	1.5	1.1	1.5
Supp.3	0.7	2.9	0.5	1.4	---	1.2
PiAu 9-90	0.3	1.1	0.2	0.4	---	0.5
PiAu 51-11	0.6	1.7	0.2	0.7	0.5	0.6
M.9 NAKBT337	0.8	3.9	0.5	2.1	1.4	1.4
M.9 Pajam 2	0.6	2.9	0.5	2.5	1.3	1.6
M.26 EMLA	0.6	2.2	0.4	1.1	0.9	1.1
Estimated HSD	0.5	0.9	0.5	1.2	0.5	0.6

[z]Mean separation in columns by Tukey's HSD (P = 0.05). HSD was calculated based on the average number of observations per mean.

Table 10. Average fruit size (2011-15, g) of Fuji apple trees at individual planting locations in the 2010 NC-140 Fuji Rootstock Trial. All values are least-squares means, adjusted for missing subclasses.[z]

Rootstock	ID	KY	NC	PA	UT
B.9	200	174	192	170	158
B.10	229	194	214	202	198
B.7-3-150	229	167	219	212	207
B.7-20-21	104	131	140	---	135
B.64-194	251	159	213	---	209
B.67-5-32	250	164	220	210	197
B.70-6-8	237	165	210	209	204
B.71-7-22	182	184	173	---	192
G.11	240	184	237	194	218
G.41N	301	189	224	---	204
G.41TC	262	169	259	---	215
G.202N	248	173	211	---	196
G.202TC	204	171	192	168	167
G.935N	243	170	215	212	199
G.935TC	218	173	221	---	201
CG.2034	228	178	189	---	197
CG.3001	281	181	200	---	208
CG.4003	151	178	192	---	163
CG.4004	280	180	207	---	219
CG.4013	---	165	198	---	179
CG.4214	227	186	218	---	194
CG.4814	238	165	204	---	187
CG.5087	256	170	196	---	158
CG.5222	282	170	215	187	194
Supp.3	212	200	184	---	202
PiAu 9-90	192	159	184	---	212
PiAu 51-11	268	163	210	223	224
M.9 NAKBT337	224	185	222	204	198
M.9 Pajam 2	243	163	201	200	207
M.26 EMLA	260	185	231	213	214
Estimated HSD	51	42	37	28	32

[z]Mean separation in columns by Tukey's HSD (P = 0.05). HSD was calculated based on the average number of observations per mean.

Rootstocks distributed among seven vigor classes based on 2015 trunk cross-sectional area. Within class, rootstocks are ordered highest to lowest based on cumulative (2011-15) yield efficiency. Honeycrisp data are from BC, CH, IA, MA, MI, MN, NJ, NS, NY, and WI. Fuji data are from ID, KY, NC, and UT. All values are least-squares means, adjusted for missing subclasses.

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Vigor category	Rootstock	Trunk cross-sectional area (2015, cm^2)	Cumulative yield efficiency (2011-15, kg/cm^2 TCA)
Large semi-dwarf	B.7-20-21	24.0	1.7
	B.64-194	26.0	1.5
Moderate semi-dwarf	CG.4004	19.9	2.8
	G.202N	20.0	2.3
	B.7-3-150	23.1	1.7
	B.70-6-8	22.5	1.6
	B.67-5-32	23.1	1.4
	PiAu 9-90	19.1	1.2
Small semi-dwarf	CG.5087	15.6	2.9
	CG.4814	16.1	2.6
	CG.4013	15.8	2.2
	PiAu 51-11	18.3	1.9
Large dwarf	CG.4214	13.4	3.2
	G.935TC	11.9	3.1
	G.935N	14.1	3.0
	G.202TC	13.2	2.8
	M.9 Pajam 2	12.0	2.6
	M.26 EMLA	13.6	2.4
Moderate dwarf	G.11	10.7	3.4
	B.10	10.9	3.2
	G.41N	11.7	3.2
	G.41TC	11.7	3.1
	M.9 NAKBT337	11.0	3.0
	Supp.3	10.7	2.5
Small dwarf	CG.4003	9.0	3.4
	B.9	7.2	3.1
	CG.2034	7.4	2.8
Sub-dwarf	B.71-7-22	2.7	2.8

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	Rootstock	Trunk cross-sectional area (2015, cm^2)	Cumulative yield efficiency (2011-15, kg/cm^2 TCA)
Large semi-dwarf	PiAu 9-90	72.7	0.6
Moderate semi-dwarf	B.70-6-8	62.7	1.1
	B.64-194	62.4	0.9
	B.67-5-32	63.2	0.8
	PiAu 51-11	65.6	0.8
Small semi-dwarf	CG.4004	45.9	1.8
	CG.5222	46.4	1.5
	CG.3001	49.5	1.3
	M.26 EMLA	52.8	1.2
	B.7-3-150	59.0	1.1
Large dwarf	G.935N	38.0	2.3
	G.935TC	35.9	1.9
	M.9 Pajam 2	36.5	1.9
	G.202N	41.0	1.7
	CG.4814	38.8	1.5
Moderate dwarf	M.9 NAKBT337	30.4	2.0
	G.202TC	29.7	1.8
	G.11	33.2	1.8
	G.41N	34.5	1.6
	G.41TC	28.8	1.6
	B.10	30.3	1.6
	Supp.3	29.2	1.5
Small Dwarf	CG.5087	20.9	2.3
	CG.4003	18.0	2.2
	B.9	15.3	2.2
	CG.2034	15.7	2.2
	CG.4214	23.9	2.0
Sub-dwarf	B.71-7-22	9.1	2.0
	B.7-20-21	7.5	0.9