ANNUAL REPORT TO NC-140

2010 Apple Rootstock Trials

November, 2017 -- Wenatchee, WA

Wesley R. Autio

This year is the eighth season of the 2010 NC-140 Apple Rootstock Trials. Data submitt ed in 2017, however, were for the seventh growing season (2016). All sites submitt ed data, and they were received in an easily read format. All data should be submitt ed in the format and units requested and by the submis-sion deadline (**January 15, 2018**). An Excel template was dis-tributed in March to aid with the organizati on of the data for submission.

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.**
4. **Make sure that all data make sense -- proofread your data set.**
5. **For rootstock and replication designations, follow the protocol exactly -- rootstock names should appear as they are listed in the Data Submission Protocol (Page 2).**

Rootstocks, cultivars, and locations involved in the 2010 NC-140 Apple Rootstock Trials. 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	IL	NY
B.67-5-32	MA	PA
B.70-6-8	MN	UT
B.71-7-22	MI	
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		
Supp.3		
PiAu 9-90		
PiAu 51-11		
M.9 NAKBT337		
M.9 Pajam 2		
M.26 EMLA		

Send 2017 data via email to Wes Autio (autio@umass.edu) by

January 15, 2018

Trial Protocol for 2017

Collect and submit 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. Tree height from the soil surface (cm).
F. Canopy spread as the average of in-row and across-row canopy width (cm).
G. Status: 0=dead, 1=alive, and 2=missing data, October.

Data Submission Protocol

Submit data via email (autio@umass.edu) by January 15, 2018.

STATE 2010 Apple Rootstock Trial DATA FOR 2016

Location	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, %)	Comments regarding trees which died during 2016 (those with status = 0)	**2017 Status (0= dead, 1= alive, 2= missing data)**	**Root sucker (Aug, 2017, no.)**	**Yield per tree (2017, kg)**	**Yield per tree (2017, no.)**	**Zonal chlorosis (2017, %)**	**Tunk circ. (fall, 2017, mm)**	**Tree height (fall, 2017, cm)**	**Canopy spread (fall, 2017, cm)**	**Comments regarding trees which died during 2017 (those with status = 0)**
XY	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		**1**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	
XY	Honeycrisp	B.9	1	2	0	fireblight	0	.	.	.		0	.	.	.	.		0	.	.	.	.		0	.	.	.	.		0	.	.	.	.		0	.	.	.	.		**0**	**.**	**.**	**.**	**.**	**.**	**.**	**.**	
XY	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		**1**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	
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XY	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		**0**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	
XY	Honeycrisp	M.26EMLA	4	2	3		2	.	.	.		2	.	.	.	.		2	.	.	.	.		2	.	.	.	.		2	.	.	.	.		2	.	.	.	.		**2**	**.**	**.**	**.**	**.**	**.**	**.**	**.**	
XY	Honeycrisp	M.26EMLA	4	3	4		2	.	.	.		2	.	.	.	.		2	.	.	.	.		2	.	.	.	.		2	.	.	.	.		2	.	.	.	.		**2**	**.**	**.**	**.**	**.**	**.**	**.**	**.**	

Location	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.)	Comments regarding trees which died during 2016 (those with status = 0)	**2017 Status (0= dead, 1= alive, 2= missing data)**	**Root sucker (Aug, 2017, no.)**	**Yield per tree (2017, kg)**	**Yield per tree (2017, no.)**	**Tunk circ. (fall, 2017, mm)**	**Tree height (fall, 2017, cm)**	**Canopy spread (fall, 2017, cm)**	**Comments regarding trees which died during 2017 (those with status = 0)**
XY	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		**1**	**X**	**X**	**X**	**X**	**X**	**X**	
XY	Fuji	B.9	1	2	0	fireblight	0	.	.	.		0	.	.	.		0	.	.	.		0	.	.	.		0	.	.	.		0	.	.	.		**0**	**.**	**.**	**.**	**.**	**.**	**.**	
XY	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		**1**	**X**	**X**	**X**	**X**	**X**	**X**	
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XY	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		**0**	**X**	**X**	**X**	**X**	**X**	**X**	
XY	Fuji	M.26EMLA	4	2	3		2	.	.	.		2	.	.	.		2	.	.	.		2	.	.	.		2	.	.	.		2	.	.	.		**2**	**.**	**.**	**.**	**.**	**.**	**.**	
XY	Fuji	M.26EMLA	4	3	4		2	.	.	.		2	.	.	.		2	.	.	.		2	.	.	.		2	.	.	.		2	.	.	.		**2**	**.**	**.**	**.**	**.**	**.**	**.**	

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, MA, MI, MN, NJ, NS, NY, OH, and WI. All values are least-squares means, adjusted for missing subclasses.[z]

Rootstock	Trunk cross-sectional area (2016, cm^2)	Cumulative root suckers (2010-16, no./tree)	Zonal chlorosis (2016, % canopy affected)	Yield per tree (2016, kg)	Cumulative yield per tree (2011-16, kg)	Yield efficiency (2016, kg/cm^2 TCA)	Cumulative yield efficiency (2011-16, kg/cm^2 TCA)	Fruit weight (2016, g)	Average Fruit weight (2012-16, g)
B.9	9.0	6.9	16.9	10.4	34.7	1.1	3.9	217	215
B.10	13.6	1.7	18.9	14.2	53.0	1.1	4.0	236	226
B.7-3-150	30.1	2.1	16.1	21.3	61.5	0.8	2.2	236	243
B.7-20-21	30.7	2.9	23.9	19.8	62.4	0.6	2.2	221	232
B.64-194	34.0	0.6	19.0	21.8	65.5	0.7	2.0	251	254
B.67-5-32	30.8	1.9	20.6	15.3	50.2	0.5	1.8	237	248
B.70-6-8	28.9	0.9	20.2	19.0	58.8	0.7	2.2	228	232
B.71-7-22	3.0	4.4	30.8	2.6	9.7	0.8	3.2	212	196
G.11	11.9	3.8	25.9	16.1	54.5	1.3	4.5	219	223
G.41N	14.6	1.3	14.7	18.2	59.7	1.3	4.1	228	227
G.41TC	13.2	3.8	24.9	14.8	51.2	1.1	3.8	215	223
G.202N	23.9	17.1	28.8	19.0	70.2	0.9	3.1	212	225
G.202TC	15.0	10.1	27.2	13.7	50.8	1.0	3.5	252	211
G.935N	16.6	12.7	29.1	21.0	68.6	1.3	4.1	211	215
G.935TC	14.9	15.7	31.6	17.7	56.3	1.1	3.8	221	216
CG.2034	9.0	3.1	39.4	9.5	32.3	1.0	3.7	225	215
CG.3001	19.8	2.0	30.2	17.5	70.5	1.0	3.6	221	226
CG.4003	10.4	1.4	17.9	9.7	39.1	1.0	3.9	190	196
CG.4004	24.6	9.0	25.2	27.9	84.3	1.1	3.5	225	233
CG.4013	18.6	14.2	36.9	18.5	53.8	1.1	3.2	212	218
CG.4214	15.6	24.5	46.6	17.3	63.5	1.2	4.3	213	215
CG.4814	17.5	13.7	46.7	17.0	62.7	1.0	3.6	208	206
CG.5087	17.5	6.1	42.0	18.4	68.8	1.1	4.0	182	201
CG.5222	19.9	17.6	36.3	17.9	58.7	0.9	3.1	225	222
Supp.3	11.9	4.2	44.5	12.8	42.3	1.1	3.5	194	202
PiAu 9-90	21.8	2.7	65.1	8.4	32.7	0.4	1.5	185	184
PiAu 51-11	21.2	2.8	32.8	14.1	48.9	0.7	2.4	235	243
M.9 NAKBT337	13.3	8.4	27.4	15.4	50.2	1.2	3.9	217	222
M.9 Pajam 2	14.4	17.3	27.2	14.7	49.5	1.0	3.5	224	218
M.26 EMLA	16.0	6.0	24.7	15.0	49.0	1.0	3.1	219	223
Estimated HSD	4.1	7.4	15.4	5.2	10.0	0.3	0.5	36	30

[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 (2016, 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	CO	IA	IL	MA	MI	MN	NS	NY	OH	WI
B.9	7.3	6.7	7.4	6.9	11.2	8.6	9.7	10.2	8.6	8.5	9.3	9.9
B.10	10.5	11.3	17.3	11.0	21.4	14.5	12.3	13.2	12.8	15.6	15.9	13.7
B.7-3-150	18.1	17.1	34.5	39.2	79.2	31.9	29.6	39.4	19.7	35.2	38.2	28.7
B.7-20-21	20.4	13.5	39.3	29.9	75.6	27.3	28.3	33.4	30.4	33.4	38.9	33.6
B.64-194	17.9	16.6	48.2	32.9	82.8	34.8	38.8	32.2	33.8	37.6	37.9	39.2
B.67-5-32	20.1	15.4	41.1	35.7	70.8	33.1	40.1	34.4	24.7	28.3	36.7	29.1
B.70-6-8	16.7	15.8	39.8	35.6	80.9	33.2	24.7	33.8	21.5	36.1	36.5	28.5
B.71-7-22	1.9	3.7	4.1	3.9	4.7	2.3	3.9	4.5	1.6	3.5	3.1	3.4
G.11	8.4	10.5	16.5	13.0	23.7	11.8	12.9	13.1	10.4	13.6	11.6	13.6
G.41N	12.2	9.8	22.0	12.4	19.9	13.8	13.8	15.8	12.4	17.0	15.0	16.4
G.41TC	10.9	8.7	19.9	15.4	26.1	12.7	15.7	16.5	13.3	13.3	9.3	14.1
G.202N	19.4	10.7	18.3	19.1	45.4	27.0	19.4	26.1	21.1	25.5	26.8	25.9
G.202TC	9.7	8.5	18.4	17.0	33.9	17.7	13.3	15.6	11.0	22.5	15.2	14.7
G.935N	12.8	8.4	.	14.9	27.6	18.1	16.0	17.4	13.5	19.8	17.3	17.9
G.935TC	10.7	7.7	19.5	11.1	32.4	12.5	13.3	15.0	16.6	17.8	18.1	15.7
CG.2034	8.9	8.6	11.9	10.0	14.2	10.1	9.1	9.9	10.3	6.8	7.2	9.5
CG.3001	16.5	.	27.4	23.0	.	28.2	13.4	18.4	19.3	25.7	22.2	14.9
CG.4003	7.5	7.2	12.9	8.9	14.6	9.7	8.7	12.4	8.3	17.1	8.4	11.4
CG.4004	18.5	13.4	25.3	18.3	43.7	25.5	22.4	26.7	27.6	23.1	27.6	25.6
CG.4013	10.3	13.1	.	27.2	45.5	19.0	22.0	14.4	14.6	26.2	31.8	10.9
CG.4214	9.2	6.7	15.3	15.3	26.6	19.9	16.4	16.7	14.9	18.2	16.4	13.2
CG.4814	13.9	10.9	20.3	24.9	26.4	18.1	16.4	18.6	16.5	20.8	17.2	18.0
CG.5087	16.3	8.9	19.3	16.3	33.7	17.2	15.6	17.0	14.1	21.6	18.5	19.4
CG.5222	15.1	9.0	26.2	.	27.5	21.7	19.0	17.0	20.0	20.6	29.4	16.2
Supp.3	9.1	9.9	22.1	.	13.9	12.1	12.3	11.6	10.4	16.4	12.6	10.8
PiAu 9-90	22.0	17.2	33.9	16.4	37.8	24.4	19.8	15.3	15.9	33.7	23.1	20.1
PiAu 51-11	10.6	13.5	27.7	27.9	78.4	21.8	28.0	21.4	17.6	26.1	22.1	21.6
M.9 NAKBT337	9.0	8.3	17.6	12.7	24.7	13.6	13.2	15.1	11.0	16.8	15.7	12.3
M.9 Pajam 2	11.0	8.2	20.9	14.2	27.4	12.4	15.9	14.3	12.3	16.4	17.3	16.1
M.26 EMLA	12.3	13.6	20.2	17.4	34.2	14.0	18.9	16.0	16.6	16.8	18.5	15.2
Estimated HSD	8.1	6.0	22.6	13.1	26.4	11.0	11.7	13.3	12.3	13.3	12.6	13.3

[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 (2011-16, 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	CO	IA	IL	MA	MI	MN	NS	NY	OH	WI
B.9	21.8	6.2	7.9	21.3	18.1	30.4	39.6	32.5	34.5	44.1	25.9	48.8
B.10	30.3	10.0	11.4	31.1	37.0	52.2	53.6	45.7	49.8	75.4	42.6	74.6
B.7-3-150	37.2	14.6	15.5	45.3	31.4	50.7	54.9	74.4	48.3	81.8	40.4	104.6
B.7-20-21	38.5	7.9	13.0	40.6	31.2	55.0	56.4	58.4	77.4	77.7	45.9	89.8
B.64-194	34.0	14.8	9.5	43.5	32.3	50.4	58.1	76.5	79.0	78.0	41.7	105.9
B.67-5-32	37.3	8.5	6.8	39.1	25.3	46.7	57.2	41.4	47.2	59.6	35.5	77.1
B.70-6-8	35.4	12.3	9.9	36.0	36.6	61.6	42.6	66.7	52.8	77.6	39.2	94.4
B.71-7-22	7.6	2.2	1.7	11.7	10.7	6.3	12.6	11.5	5.0	12.7	7.5	14.1
G.11	29.0	13.5	13.4	40.4	43.5	53.7	64.2	56.8	38.5	70.8	38.6	84.3
G.41N	39.9	7.7	17.2	38.4	39.4	60.0	60.6	61.0	57.1	77.3	34.3	87.2
G.41TC	32.1	8.2	21.4	38.2	31.7	45.2	53.6	61.0	47.2	72.0	21.8	76.5
G.202N	48.1	11.3	12.4	28.8	54.2	88.3	60.7	60.8	76.5	79.6	55.1	92.6
G.202TC	31.0	18.6	12.3	44.1	36.0	64.6	49.7	57.2	38.6	71.5	41.6	52.3
G.935N	49.6	10.0	.	38.6	54.9	80.4	69.9	62.8	48.2	74.1	47.7	116.0
G.935TC	27.6	8.0	14.4	31.1	53.9	45.7	61.5	45.9	50.4	71.8	53.3	94.6
CG.2034	25.9	6.4	6.1	22.5	24.4	31.6	32.9	33.5	24.5	30.1	23.3	56.5
CG.3001	43.8	.	9.0	59.3	.	106.5	47.4	53.1	74.9	96.2	54.6	87.3
CG.4003	28.0	14.0	6.4	28.6	22.0	42.8	36.2	33.7	33.2	59.8	19.3	60.1
CG.4004	57.1	16.6	15.2	56.1	55.6	80.6	69.4	84.2	82.1	90.2	72.6	138.5
CG.4013	30.4	9.0	.	36.7	33.5	70.8	59.2	54.4	51.7	64.1	50.9	49.3
CG.4214	43.8	11.0	20.0	37.3	41.5	51.5	71.5	63.4	63.9	80.8	50.1	82.5
CG.4814	47.0	10.7	18.6	51.3	54.3	54.4	63.9	62.6	52.4	92.7	46.1	82.6
CG.5087	49.8	9.7	10.3	42.8	29.8	59.3	60.7	68.4	63.8	87.4	62.5	98.5
CG.5222	40.7	7.1	12.9	.	62.9	48.0	55.5	53.3	62.8	71.9	58.3	78.9
Supp.3	35.3	6.9	6.5	.	10.4	32.8	43.0	37.1	32.6	69.1	29.3	59.5
PiAu 9-90	27.3	10.5	8.6	18.4	13.2	20.2	24.0	22.2	25.3	60.2	33.2	49.6
PiAu 51-11	24.1	9.1	12.8	37.2	30.6	42.6	51.2	45.8	41.0	73.3	43.8	69.6
M.9 NAKBT337	31.4	9.9	20.8	35.7	43.8	51.8	55.0	51.2	35.8	69.5	44.7	62.3
M.9 Pajam 2	33.4	6.5	20.6	28.8	39.8	38.5	55.8	46.4	35.3	63.9	38.4	84.5
M.26 EMLA	38.3	3.3	12.8	41.9	51.9	37.2	52.8	47.7	46.5	59.5	37.1	72.6
Estimated HSD	18.3	7.8	15.7	17.1	30.1	31.0	27.6	29.4	34.2	32.0	23.4	35.3

[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 (2011-16, 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	CO	IA	IL	MA	MI	MN	NS	NY	OH	WI
B.9	3.0	1.0	1.4	3.1	1.8	3.6	4.2	3.2	4.1	5.2	2.8	5.0
B.10	2.9	0.9	0.7	2.8	1.8	3.7	4.4	3.6	4.0	4.9	2.7	5.5
B.7-3-150	2.2	0.9	0.5	1.2	0.4	1.6	2.0	2.0	2.5	2.4	1.1	3.8
B.7-20-21	2.0	0.6	0.4	1.5	0.4	2.1	2.1	1.9	2.8	2.4	1.2	2.9
B.64-194	2.0	0.8	0.2	1.3	0.4	1.4	1.5	2.8	2.4	2.1	1.1	2.7
B.67-5-32	2.0	0.6	0.2	1.1	0.4	1.5	1.4	1.3	1.9	2.2	1.0	2.8
B.70-6-8	2.3	0.8	0.3	1.1	0.6	1.9	1.8	2.0	2.5	2.2	1.1	3.4
B.71-7-22	3.5	0.6	0.5	3.1	2.4	2.7	3.0	2.7	2.8	4.1	2.6	4.3
G.11	3.3	1.3	0.8	3.2	2.0	4.5	5.0	4.4	3.6	5.3	3.3	6.4
G.41N	3.3	0.8	0.8	3.2	2.1	4.2	4.5	3.9	4.6	4.6	2.3	5.4
G.41TC	2.9	0.9	1.2	2.4	1.3	3.5	3.4	3.7	3.7	5.3	2.6	5.5
G.202N	2.5	1.1	0.7	2.0	1.2	3.3	3.1	2.7	3.6	3.9	2.3	3.7
G.202TC	3.1	2.2	0.8	2.7	1.1	3.6	3.8	4.1	3.3	3.7	2.8	3.6
G.935N	3.9	1.3	.	2.7	2.2	4.4	4.4	3.7	3.5	3.8	2.8	6.6
G.935TC	2.7	1.1	0.7	3.0	1.6	3.5	4.6	3.0	3.1	4.2	3.0	6.5
CG.2034	2.9	0.7	0.6	2.3	1.7	3.0	3.7	3.5	3.0	4.4	3.1	6.0
CG.3001	2.6	.	0.3	2.7	.	3.7	3.4	2.9	4.0	3.8	2.4	6.3
CG.4003	3.8	1.9	0.6	3.1	1.4	4.4	4.1	2.9	4.0	4.3	2.3	5.3
CG.4004	3.1	1.3	0.6	3.1	1.3	3.2	3.2	3.2	3.0	3.9	2.7	5.6
CG.4013	3.0	0.7	.	1.4	0.8	3.5	3.0	3.8	3.5	2.6	1.6	4.6
CG.4214	4.8	1.6	1.3	2.5	1.7	2.6	4.4	3.8	4.4	4.5	3.2	6.3
CG.4814	3.4	1.0	0.9	2.2	2.1	3.1	3.9	3.4	3.3	4.5	2.7	4.6
CG.5087	3.1	1.1	0.4	2.7	1.0	3.3	3.9	4.2	4.5	4.3	3.3	5.2
CG.5222	2.7	0.8	0.5	.	2.3	2.3	2.9	3.1	3.3	3.6	2.0	4.9
Supp.3	3.8	0.8	0.3	.	1.1	2.7	3.7	3.3	2.8	4.3	2.2	5.5
PiAu 9-90	1.4	0.6	0.3	1.1	0.4	0.9	1.2	1.5	1.4	1.8	1.5	2.5
PiAu 51-11	2.4	0.7	0.5	1.4	0.5	2.0	1.8	2.2	2.4	2.9	2.0	3.4
M.9 NAKBT337	3.5	1.2	1.2	2.8	1.7	3.8	4.2	3.7	3.4	4.4	2.9	5.1
M.9 Pajam 2	3.1	0.8	1.0	2.1	1.5	3.3	3.6	3.2	2.9	3.8	2.3	5.4
M.26 EMLA	3.1	0.2	0.8	2.4	1.6	2.7	3.0	3.0	2.7	3.6	2.0	4.8
Estimated HSD	1.3	0.8	1.1	1.3	1.3	1.4	1.5	1.6	1.6	1.9	1.6	1.6

[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 5. Average fruit size (2012-16, 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	CO	IA	IL	MA	MI	MN	NS	NY	OH	WI
B.9	258	166	143	154	166	228	282	156	155	220	208	214
B.10	286	175	194	167	207	240	283	163	159	246	197	231
B.7-3-150	296	176	198	209	208	264	318	197	148	282	195	240
B.7-20-21	264	182	195	190	223	236	290	171	165	275	202	257
B.64-194	283	164	207	192	246	248	365	187	183	285	212	268
B.67-5-32	275	185	212	196	219	256	343	201	181	260	204	261
B.70-6-8	282	178	207	194	233	251	270	181	156	277	196	246
B.71-7-22	227	201	151	124	217	163	284	143	139	194	205	210
G.11	262	170	200	163	192	238	297	143	155	257	218	215
G.41N	294	184	217	171	211	246	290	159	165	265	180	215
G.41TC	289	180	223	192	232	244	273	173	169	262	172	201
G.202N	312	184	234	157	200	249	273	158	148	249	212	203
G.202TC	234	167	195	189	188	219	273	167	137	249	193	214
G.935N	285	175	.	166	179	230	269	146	156	244	197	192
G.935TC	282	170	179	170	174	223	269	138	160	256	196	204
CG.2034	292	195	178	181	217	212	305	170	141	235	177	192
CG.3001	317	.	175	199	.	245	252	143	187	279	196	188
CG.4003	274	184	167	144	183	195	279	130	131	210	154	193
CG.4004	303	173	213	186	225	250	312	178	169	245	191	214
CG.4013	266	175	.	199	202	221	266	159	159	261	206	207
CG.4214	280	175	215	173	217	238	275	151	155	255	173	196
CG.4814	293	177	219	189	171	219	279	143	131	254	141	183
CG.5087	277	157	192	164	248	213	265	135	151	236	157	178
CG.5222	294	176	217	.	196	223	283	156	136	245	225	219
Supp.3	289	177	195	.	186	211	234	135	129	250	166	203
PiAu 9-90	225	168	193	121	136	157	263	101	115	237	168	202
PiAu 51-11	259	180	193	206	264	247	337	192	177	267	199	262
M.9 NAKBT337	288	172	212	180	214	237	276	159	157	262	189	211
M.9 Pajam 2	274	180	221	169	200	224	288	157	143	242	189	225
M.26 EMLA	273	195	191	188	219	231	323	160	147	245	198	212
Estimated HSD	60	36	75	39	90	49	93	49	52	43	59	44

[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, NY, PA, and UT. All values are least-squares means, adjusted for missing subclasses.[z]

Rootstock	Trunk cross-sectional area (2016, cm^2)	Cumulative root suckers (2010-16, no./tree)	Yield per tree (2016, kg)	Cumulative yield per tree (2011-16, kg)	Yield efficiency (2016, kg/cm^2 TCA)	Cumulative yield efficiency (2011-16, kg/cm^2 TCA)	Fruit weight (2016, g)	Average Fruit weight (2012-16, g)
B.9	16.5	12.9	15.9	47.0	0.9	2.8	170	173
B.10	34.1	1.7	27.4	70.8	0.8	2.2	201	202
B.7-3-150	70.4	4.0	30.4	82.1	0.5	1.3	211	207
B.7-20-21	7.0	1.4	2.6	8.1	0.2	1.0	162	135
B.64-194	71.5	9.4	34.3	81.5	0.5	1.2	220	217
B.67-5-32	69.0	4.0	35.7	83.8	0.5	1.2	204	204
B.70-6-8	76.2	2.4	35.1	89.7	0.5	1.4	201	203
B.71-7-22	9.6	6.0	6.9	20.6	1.0	3.0	184	179
G.11	34.5	3.4	34.8	87.9	1.1	2.8	204	208
G.41N	40.7	4.5	37.9	96.2	1.0	2.3	200	208
G.41TC	36.0	6.6	27.2	77.9	0.8	2.2	215	216
G.202N	48.6	12.1	34.0	91.7	0.7	2.1	207	204
G.202TC	32.3	16.2	27.4	76.8	0.9	2.5	182	180
G.935N	41.2	9.0	33.3	107.2	0.9	2.8	201	204
G.935TC	37.6	18.9	25.7	83.1	0.7	2.6	193	203
CG.2034	18.1	7.0	16.6	49.2	1.1	3.1	171	184
CG.3001	53.5	7.7	36.9	106.6	0.7	1.9	205	215
CG.4003	19.4	2.8	17.1	52.0	0.8	2.8	156	160
CG.4004	51.6	10.5	46.1	122.3	0.9	2.4	219	218
CG.4214	25.1	10.1	23.0	64.3	0.9	2.7	194	197
CG.4814	40.6	15.7	32.7	82.1	0.9	2.2	174	188
CG.5222	51.1	19.2	34.0	95.8	0.7	1.9	214	208
Supp.3	32.6	3.3	16.4	51.1	0.5	1.8	174	183
PiAu 9-90	70.5	13.8	18.1	43.8	0.4	1.0	196	181
PiAu 51-11	72.9	2.4	35.0	80.8	0.5	1.2	214	220
M.9 NAKBT337	34.2	11.4	28.2	78.8	0.9	2.6	191	198
M.9 Pajam 2	41.1	16.4	30.0	86.5	0.7	2.2	202	204
M.26 EMLA	60.2	2.4	38.2	95.8	0.7	1.7	204	215
Estimated HSD	10.9	11.6	12.2	19.8	0.3	0.5	31	19

[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 (2016, 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	NY	PA	UT
B.9	10.0	24.0	15.3	9.3	11.6	18.8	18.5
B.10	21.3	35.0	40.4	26.8	22.7	40.9	36.8
B.7-3-150	34.3	49.5	99.3	61.7	54.6	77.9	79.7
B.7-20-21	3.3	5.8	15.3	1.9	3.2	7.3	10.0
B.64-194	31.8	67.4	86.7	73.7	43.7	76.2	83.6
B.67-5-32	24.0	71.6	77.5	66.8	48.2	71.4	79.1
B.70-6-8	27.9	54.0	95.2	82.6	61.0	89.7	76.4
B.71-7-22	4.7	9.6	9.5	9.1	5.7	8.8	13.8
G.11	21.3	32.0	48.4	29.7	25.5	26.4	42.8
G.41N	.	59.1	25.6	36.8	32.6	77.9	43.0
G.41TC	22.1	42.3	34.8	28.4	28.7	38.2	40.9
G.202N	27.0	43.4	69.6	35.3	49.7	53.5	42.9
G.202TC	25.0	35.3	46.3	25.3	26.6	29.7	30.7
G.935N	15.4	38.4	57.0	31.8	32.0	39.1	47.8
G.935TC	19.8	33.0	55.1	26.9	24.2	36.4	52.5
CG.2034	.	16.3	15.6	15.3	14.1	12.8	26.7
CG.3001	.	61.9	54.8	49.3	46.2	36.1	62.6
CG.4003	14.1	14.0	27.2	17.8	18.3	16.9	23.1
CG.4004	19.1	60.7	50.4	37.1	40.1	.	68.3
CG.4013	.	.	40.5	28.5	13.3	26.0	27.6
CG.4214	10.3	28.0	38.1	17.7	17.0	18.1	28.3
CG.4814	11.3	37.7	55.3	46.7	27.5	35.7	37.9
CG.5087	12.0	21.5	38.1	6.8	.	.	30.0
CG.5222	24.7	60.4	61.6	43.8	41.9	42.8	54.7
Supp.3	18.8	25.0	46.1	29.5	23.2	32.4	40.1
PiAu 9-90	47.8	42.2	117.3	99.0	14.6	37.6	111.7
PiAu 51-11	26.5	61.5	90.7	67.3	50.9	83.9	86.3
M.9 NAKBT337	12.9	29.1	48.7	28.4	27.5	37.9	34.5
M.9 Pajam 2	14.1	40.9	52.9	26.5	32.9	40.1	47.3
M.26 EMLA	24.4	56.3	78.7	55.9	48.2	61.9	63.5
Estimated HSD	16.0	24.1	37.7	28.4	14.9	25.9	26.5

[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 8. Cumulative yield per tree (2011-16, 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	NY	PA	UT
B.9	9.4	110.7	28.3	21.2	43.2	36.6	44.7
B.10	12.8	135.8	53.3	28.1	80.0	49.4	76.6
B.7-3-150	17.8	145.6	61.7	33.4	111.6	55.3	84.7
B.7-20-21	1.6	6.3	9.5	4.7	6.7	1.4	11.2
B.64-194	11.6	165.3	50.5	35.3	88.3	63.3	81.6
B.67-5-32	11.2	166.7	53.0	35.6	85.9	63.3	98.1
B.70-6-8	15.1	168.9	54.8	38.6	114.9	66.3	92.8
B.71-7-22	5.8	38.1	16.7	14.6	33.8	16.4	30.0
G.11	20.0	146.1	61.6	44.2	110.2	66.6	99.1
G.41N	.	242.4	67.8	45.7	99.6	67.8	78.9
G.41TC	14.2	136.1	43.9	32.3	103.0	71.0	69.3
G.202N	17.8	165.8	73.4	48.0	106.9	86.9	81.3
G.202TC	16.2	133.9	65.2	38.5	91.7	62.1	69.7
G.935N	10.8	198.1	65.8	61.4	111.7	83.3	124.8
G.935TC	16.0	132.9	51.5	50.9	99.6	64.8	103.9
CG.2034	.	90.6	44.5	20.6	58.6	38.0	69.2
CG.3001	.	234.2	47.3	44.5	119.0	71.4	104.9
CG.4003	12.4	59.0	50.7	37.9	81.4	27.3	57.2
CG.4004	12.9	240.6	85.1	68.7	136.0	.	102.2
CG.4013	.	.	40.6	37.0	72.3	34.7	59.7
CG.4214	10.7	131.0	55.7	28.8	81.0	29.1	57.4
CG.4814	8.1	155.3	71.9	37.2	93.6	54.7	82.3
CG.5087	14.6	117.7	61.3	24.7	.	.	60.7
CG.5222	21.8	191.7	77.0	52.2	99.4	60.4	91.0
Supp.3	12.6	79.7	44.8	33.4	47.0	50.6	72.7
PiAu 9-90	12.0	68.0	46.2	25.3	35.2	22.2	70.1
PiAu 51-11	14.4	161.9	55.6	35.2	95.1	48.2	83.0
M.9 NAKBT337	10.1	128.4	50.5	46.3	100.9	69.0	78.0
M.9 Pajam 2	9.1	149.4	66.3	55.7	88.6	64.2	98.2
M.26 EMLA	14.1	173.8	56.9	51.8	114.5	70.2	95.8
Estimated HSD	19.9	69.9	43.3	32.7	45.6	43.0	40.6

[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 9. Cumulative yield efficiency (2011-16, 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	NY	PA	UT
B.9	0.9	4.6	1.9	2.2	3.7	1.9	2.4
B.10	0.6	4.0	1.3	1.0	3.6	1.2	2.1
B.7-3-150	0.5	3.0	0.6	0.5	2.1	0.7	1.1
B.7-20-21	0.5	1.1	0.6	1.4	2.0	0.8	1.1
B.64-194	0.4	2.4	0.6	0.5	2.1	0.9	1.0
B.67-5-32	0.5	2.4	0.7	0.5	1.8	0.9	1.3
B.70-6-8	0.6	3.1	0.6	0.5	1.9	0.8	1.2
B.71-7-22	1.3	4.0	1.7	1.9	5.9	2.2	2.3
G.11	1.0	4.6	1.3	1.5	4.3	2.5	2.3
G.41N	.	4.0	2.4	1.3	2.9	0.9	2.0
G.41TC	0.7	3.1	1.2	1.1	3.6	1.7	1.7
G.202N	0.7	3.7	1.2	1.4	2.2	1.6	2.1
G.202TC	0.7	3.9	1.5	1.5	3.5	2.1	2.4
G.935N	0.7	5.2	1.2	2.0	3.7	2.2	2.6
G.935TC	0.8	3.9	1.0	1.9	4.5	1.7	2.0
CG.2034	.	5.5	2.0	1.2	4.2	2.2	2.7
CG.3001	.	3.8	0.9	0.9	2.6	2.1	1.7
CG.4003	1.0	4.1	1.8	2.1	4.5	1.4	2.5
CG.4004	0.7	4.0	1.8	1.8	3.4	.	1.5
CG.4013	.	.	1.0	1.4	5.1	1.3	2.0
CG.4214	1.1	4.6	1.4	1.6	4.9	1.7	2.2
CG.4814	0.8	4.1	1.3	0.8	3.4	1.5	2.3
CG.5087	1.3	5.4	1.6	2.7	.	.	2.1
CG.5222	0.9	3.2	1.3	1.2	2.4	1.4	1.7
Supp.3	0.7	3.3	1.0	1.1	1.9	1.4	1.9
PiAu 9-90	0.2	1.5	0.5	0.4	2.3	0.6	0.6
PiAu 51-11	0.6	2.7	0.7	0.6	1.9	0.6	1.0
M.9 NAKBT337	0.8	4.4	1.1	1.7	3.8	1.9	2.2
M.9 Pajam 2	0.6	3.7	1.3	2.1	2.7	1.6	2.1
M.26 EMLA	0.6	3.2	0.8	0.9	2.4	1.1	1.5
Estimated HSD	0.5	1.4	1.0	1.1	1.9	0.8	0.7

[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 10. Average fruit size (2011-16, 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	CH	ID	KY	NC	NY	PA	UT
B.9	137	210	130	187	154	188	167
B.10	136	227	172	213	173	217	210
B.7-3-150	137	233	169	211	188	218	220
B.7-20-21	136	100	131	138	122	88	186
B.64-194	128	247	170	212	218	215	229
B.67-5-32	135	251	165	210	175	213	212
B.70-6-8	127	235	169	206	184	209	217
B.71-7-22	150	179	169	172	169	181	204
G.11	131	240	166	235	172	211	221
G.41N	.	299	154	222	178	202	209
G.41TC	145	271	172	247	177	234	210
G.202N	124	248	163	210	174	228	212
G.202TC	111	205	154	191	170	182	177
G.935N	141	245	170	210	179	217	206
G.935TC	127	217	172	220	194	207	210
CG.2034	.	216	154	183	159	184	207
CG.3001	.	277	169	199	199	232	212
CG.4003	140	151	144	191	155	140	172
CG.4004	143	280	173	206	196	.	229
CG.4013	.	.	164	195	172	185	194
CG.4214	138	231	161	210	175	191	206
CG.4814	150	231	149	200	167	193	190
CG.5087	147	274	162	195	.	.	171
CG.5222	122	274	159	210	188	210	205
Supp.3	124	215	163	182	166	157	205
PiAu 9-90	116	213	165	177	128	158	235
PiAu 51-11	129	269	165	207	203	228	240
M.9 NAKBT337	134	228	161	220	177	215	197
M.9 Pajam 2	128	247	152	198	183	211	216
M.26 EMLA	125	256	182	228	181	221	221
Estimated HSD	32	59	35	41	49	37	39

[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 2016 trunk cross-sectional area. Within class, rootstocks are ordered highest to lowest based on cumulative (2011-16) yield efficiency. Honeycrisp data are from BC, MA, MI, MN, NS, NY, OH, and WI. Fuji data are from ID, KY, NC, NY, PA, and UT. All values are least-squares means, adjusted for missing subclasses. Distribution among categories were made relative to the size of trees on M.9 NAKBT337: 0-40% sub-dwarf, 40-80% small dwarf, 80-110% moderate dwarf, 110-130% large dwarf, 130-150% small semi-dwarf, 150-200% moderate semidwarf, and 200+% large semidwarf.

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Vigor category	Rootstock	Trunk cross-sectional area (2016, cm^2)	Cumulative yield efficiency (2011-16, kg/cm^2 TCA)
Large semi-dwarf	B.7-3-150	30.1	2.2
	B.7-20-21	30.7	2.2
	B.70-6-8	28.9	2.2
	B.64-194	34.0	2.0
	B.67-5-32	30.8	1.8
Moderate semi-dwarf	CG.4004	24.6	3.5
	G.202N	23.9	3.1
	PiAu 51-11	21.2	2.4
	PiAu 9-90	21.8	1.5
Small semi-dwarf	CG.5087	17.5	4.0
	CG.3001	19.8	3.6
	CG.4814	17.5	3.6
	CG.4013	18.6	3.2
	CG.5222	19.9	3.1
Large dwarf	CG.4214	15.6	4.3
	G.935N	16.6	4.1
	G.935TC	14.9	3.8
	G.202TC	15.0	3.5
	M.26 EMLA	16.0	3.1
Moderate dwarf	G.11	11.9	4.5
	G.41N	14.6	4.1
	B.10	13.6	4.0
	M.9 NAKBT337	13.3	3.9
	G.41TC	13.2	3.8
	Supp.3	11.9	3.5
	M.9 Pajam 2	14.4	3.5
Small dwarf	CG.4003	10.4	3.9
	B.9	9.0	3.9
	CG.2034	9.0	3.7
Sub-dwarf	B.71-7-22	3.0	3.2

FUJI

	Rootstock	Trunk cross-sectional area (2016, cm^2)	Cumulative yield efficiency (2011-16, kg/cm^2 TCA)
Large semi-dwarf	B.70-6-8	76.2	1.4
	B.7-3-150	70.4	1.3
	B.67-5-32	69.0	1.2
	PiAu 51-11	72.9	1.2
	B.64-194	71.5	1.2
	PiAu 9-90	70.5	1.0
Moderate semi-dwarf	CG.4004	51.6	2.4
	CG.3001	53.5	1.9
	M.26 EMLA	60.2	1.7
Small semi-dwarf	G.202N	48.6	2.1
	CG.5222	51.1	1.9
Large dwarf	G.935N	41.2	2.8
	G.41N	40.7	2.3
	CG.4814	40.6	2.2
	M.9 Pajam 2	41.1	2.2
Moderate dwarf	G.11	34.5	2.8
	M.9 NAKBT337	34.2	2.6
	G.935TC	37.6	2.6
	G.202TC	32.3	2.5
	B.10	34.1	2.2
	G.41TC	36.0	2.2
	Supp.3	32.6	1.8
Small dwarf	CG.2034	18.1	3.1
	B.9	16.5	2.8
	CG.4003	19.4	2.8
	CG.4214	25.1	2.7
Sub-dwarf	B.71-7-22	9.6	3.0
	B.7-20-21	7.0	1.0