

# 2010 Apple Rootstock Trials

November, 2011 -- Grand Rapids, MI

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## Data Collection & Transmission

This year was the second season of the 2010 NC-140 Apple Rootstock Trials. Data submitted in 2011, however, were for the first growing season (2010). All submitted data were received in an easily read format, but there appears to be a few problems with units. Everyone is encouraged to review their data and make sure that all measurements are the unit requested. Union height from 2010 may have been submitted in inches from some locations. Another problem with the 2010 data submission was the lack of submission by 45% of the planting locations. This situation is completely unacceptable. All data should be submitted in the format and units requested and by the submission deadline (January 15).

The 2010 data also pointed out an additional concern. In this trial, we have multiple trees of the same rootstocks in each replication. Since we need to keep the data together for each individual tree throughout the trial, we need to add an addition-

*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. **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 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	IL	NC
B.64-194	IN	NY
B.67-5-32	IA	PA
B.70-6-8	MA	UT
B.70-20-20	MN	
B.71-7-22	MI	
G.11	NJ	
G.41 N	NS	
G.41 TC	NY	
G.202 N	OH	
G.202 TC	UT	
G.935 N	WI	
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		

Highlighted locations did not submit 2010 data!

Send 2010 data via email to Wes Autio (autio@pssci.umass.edu) by

**January 15, 2012**

# Trial Protocol for 2012

## *Tree management.*

- A. Trees must be supported and trained as Tall Spindles (see Pruning & Training Plan, 3<sup>rd</sup> Leaf).
- B. Adjust crop load as described in the Pruning & Training Plan, 3<sup>rd</sup> Leaf.
- C. For Honeycrisp, apply naphthalene acetic acid (NAA) as described in the Pruning & Training Plan, 3<sup>rd</sup> Leaf.
- D. Manage pests, nutrients, and water per local recommendations. Pay attention to weed control in this trial.

## *Collect the follow data for each tree in 2012.*

- 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.

## Data Submission Protocol

Submit data via email (autio@pssci.umass.edu) by **January 15, 2012**.

		STATE				2010 Apple Rootstock Trial				DATA FOR 2011					
Cultivar	Rootstock	Rep	Sub-rep	2010 Status (see below)	Trunk circ. (spring, 2010, mm)	Side branches (spring, 2010, no.>10cm)	Height of the graft union (spring, 2010, mm)	Trunk circ. (fall, 2010, mm)	Comments regarding trees which died during 2010 (those with status = 0)	2011 Status (0=dead, 1=alive, 2=missing data)	Flower clusters (no.)	Root sucker (Aug, 2011, no.)	Yield per tree (if fruited) (kg)	Trunk circ. (fall, 2011, mm)	Comments regarding trees which died during 2011 (those with status = 0)
Honeycrisp	B.9	1	2	0	X	X	X		fireblight	0	.	.	.	.	
Honeycrisp	B.9	1	3	1	X	X	X	X		1	X	X	X	X	
.	.	.	.	.	.	.	.	.		.	.	.	.	.	
.	.	.	.	.	.	.	.	.		.	.	.	.	.	
Honeycrisp	M.26EMLA	4	1	1	X	X	X	X		0	X	X	X	X	Voles
Honeycrisp	M.26EMLA	4	2	3	.	.	.	.		2	.	.	.	.	
Honeycrisp	M.26EMLA	4	3	4	.	.	.	.		2	.	.	.	.	

### Special requirements for 2010's status assessment:

- 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.

REQUIRED DATA FORMAT: Excel or Quatro Pro

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

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

al designation per tree. Another column has been added to the data submission protocol (Page 2) requesting a sub-replication number. Simply number each tree of the same rootstock within a replication in sequence from 1 to 3, and maintain that number consistently through the trial. Additionally, all data from the beginning of the trial will be requested each year (see Page 2). Delinquent cooperators need not submit 2010 data, but must include these data in the 2011 submission.

Data submitted for 2011 should include cultivar, rootstock, replication, sub-replication, 2010 status, spring 2010 trunk circumference (mm), spring 2010 side branches (no. > 10cm), spring 2010 graft union

height (mm), fall 2010 trunk circumference (mm), comments on 2010 tree death, 2011 status, 2011 root suckers (no.), fall 2011 trunk circumference (mm), and comments on 2011 tree death. The format of the data submission is presented in the Data Submission Protocol on Page 2. Submit these data in spreadsheet format (Excel preferred), using the rootstock codes described in the protocol, by **January 15, 2012**.

In 2012, follow the Pruning and Training Plan (Page 3) and the Trial Protocol for 2012 (Page 2). In August, count and cut root suckers, and measure trunk circumference (mm) 30 cm above the graft union in October. Measure yield by counting and weighing all fruit from each tree.

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

<b>1<sup>st</sup> Leaf</b>	At Planting	Adjust graft union to 6" (15 cm) above the soil level. Remove all feathers below 24" (60 cm) using a flush cut. Do not head the leader or feathers. Remove any feathers that are larger than 2/3 the diameter of the leader leaving a stub.
	3-4" Growth	Rub off 2 <sup>nd</sup> and 3 <sup>rd</sup> buds below the new leader bud to eliminate competitors to the leader shoot.
	May	Install a 3- or 4-wire tree support system that will allow tree to be supported to 3 m. Attach trees to support system with a permanent tree tie above the 1 <sup>st</sup> tier of scaffolds, leaving a 2-inch diameter loop to allow for trunk growth.
	Early June	Tie down each feather that is longer than 10" (25 cm) to a pendant position below horizontal.
<b>2<sup>nd</sup> Leaf</b>	Dormant	Do not head the leader or prune the tree.
	3-4" Growth	Rub off 2 <sup>nd</sup> and 3 <sup>rd</sup> buds below the new leader bud to eliminate competitors to the leader shoot.
	Early June	Defruit trees in this trial.
<b>3<sup>rd</sup> Leaf</b>	Mid June	Tie the developing leader to the support system with a permanent tie.
	Dormant	Do not head the leader. Using a bevel cut, remove any overly vigorous limbs that are more than ½ the diameter of the leader.
	Late May	Hand thin <b>within 3-4 weeks after petal fall</b> to appropriate levels of crop load ( <b>Honeycrisp – 4 fruit/cm<sup>2</sup>, Fuji -- 5 fruit/cm<sup>2</sup></b> ) to ensure regular annual cropping and adequate fruit size. Calculate a crop-load target for each tree based on the previous fall's trunk cross-sectional area.
	June	Tie the developing leader to the support system with a permanent tie.
<b>4<sup>th</sup> Leaf</b>	June-July	For Honeycrisp, apply four 5-ppm naphthalene acetic acid applications at 1-week to 10-day intervals beginning when fruit reach an average of 30 mm in diameter.
	Dormant	Do not head the leader. Using a bevel cut, remove any overly vigorous limbs that are more than ½ the diameter of the leader.
	Late May	Chemically thin, and then follow up with hand thinning to appropriate levels to ensure regular annual cropping and adequate fruit size. (Target = 100 fruits/tree)
<b>Mature Tree</b>	June	Tie the developing leader to the support system with a permanent tie.
	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.

Table 1. Trunk cross-sectional area, number of branches (>10cm), and union height at planting of Honeycrisp apple trees in the 2010 NC-140 Honeycrisp Apple Rootstock Trial.<sup>z</sup>

Rootstock	Trunk cross sectional area at planting (cm <sup>2</sup> )	Branches at planting (no. > 10cm)	Graft union height at planting (cm)	Trunk cross-sectional area (cm <sup>2</sup> , 2010)
B.9	1.2 gh	6.1 fg	11.5 efg	1.8 g
B.10	1.4 fg	6.6 fg	10.9 fgh	2.2 ef
B.7-3-150	1.4 fg	5.0 g	12.3 bcdef	2.2 ef
B.7-20-21	2.1 c	9.9 e	12.3 bcdef	3.2 b
B.64-194	1.8 de	8.1 ef	13.1 abcd	2.8 bc
B.67-5-32	1.6 ef	6.3 fg	10.9 fgh	2.4 de
B.70-6-8	1.7 ef	7.2 fg	11.4 efg	2.6 cd
B.70-20-20	2.5 b	13.0 d	13.3 abc	3.9 a
B.71-7-22	0.6 i	0.3 h	11.8 cdefg	0.9 h
G.11	1.4 fg	12.7 d	11.6 defg	2.2 ef
G.41N	1.3 gh	6.9 fg	11.0 efg	1.9 g
G.41TC	1.0 h	6.9 fg	6.9 i	1.7 g
G.202N	2.0 cd	14.3 cd	10.6 fgh	3.1 bc
G.202TC	1.7 ef	14.2 cd	10.0 gh	2.6 cd
G.935N	1.6 ef	13.2 cd	11.5 efg	2.4 de
G.935TC	1.3 gh	11.2 de	9.6 gh	2.0 fg
CG.2034	1.1 h	7.6 ef	9.3 h	1.7 g
CG.3001	1.7 ef	12.7 d	10.7 fgh	2.7 cd
CG.4003	1.1 h	6.8 fg	12.3 bcdef	1.8 g
CG.4004	1.7 ef	18.7 ab	11.0 efg	2.7 cd
CG.4013	1.4 fg	11.4 de	9.7 gh	2.0 fg
CG.4214	1.4 fg	15.4 c	11.6 defg	2.1 fg
CG.4814	1.8 de	15.8 bc	11.2 efg	2.7 cd
CG.5087	1.6 ef	15.8 bc	11.8 cdefg	2.3 def
Supp.3	1.1 h	5.0 g	10.4 fgh	1.7 g
PiAu 9-90	2.8 a	19.8 a	14.4 a	3.8 a
PiAu 51-11	2.0 cd	10.0 e	13.6 ab	2.9 bc
M.9 NAKBT337	1.4 fg	9.5 e	12.1 cdef	2.2 ef
M.9 Pajam 2	1.6 ef	9.1 e	12.6 bcde	2.4 de
M.26 EMLA	1.3 gh	6.1 fg	12.0 cdef	2.2 ef

<sup>z</sup> Least-squares mean separation within column by Tukey's HSD ( $P = 0.05$ ).

Table 2. Tree number and status in the 2010 NC-140 Honeycrisp Apple Rootstock Trial.

Rootstock	Total number of trees	Died after growing well (% , 0)	Alive at the end of the growing season (% , 1)	Non data trees due to human error (% , 2)	Planted but broke at union before supported (% , 3)	Leafed out but quickly shut down (% , 4)	Never leafed out (% , 5)
B.9	84	0	100	0	0	0	0
B.10	61	0	100	0	0	0	0
B.7-3-150	69	0	100	0	0	0	0
B.7-20-21	84	0	100	0	0	0	0
B.64-194	47	0	100	0	0	0	0
B.67-5-32	69	0	100	0	0	0	0
B.70-6-8	84	0	100	0	0	0	0
B.70-20-20	84	0	100	0	0	0	0
B.71-7-22	39	10	85	3	0	3	0
G.11	74	0	100	0	0	0	0
G.41N	75	5	95	0	0	0	0
G.41TC	26	8	92	0	0	0	0
G.202N	41	10	78	0	0	5	7
G.202TC	38	3	92	5	0	0	0
G.935N	67	3	94	0	0	1	1
G.935TC	19	0	100	0	0	0	0
CG.2034	33	3	91	0	0	0	6
CG.3001	17	0	94	0	0	6	0
CG.4003	32	3	97	0	0	0	0
CG.4004	30	3	97	0	0	0	0
CG.4013	24	4	96	0	0	0	0
CG.4214	53	0	100	0	0	0	0
CG.4814	54	9	87	0	2	2	0
CG.5087	23	0	96	0	0	0	4
CG.5222	48	17	69	2	8	4	0
Supp.3	40	0	100	0	0	0	0
PiAu 9-90	46	0	98	0	0	0	2
PiAu 51-11	75	0	100	0	0	0	0
M.9 NAKBT337	83	0	100	0	0	0	0
M.9 Pajam 2	84	0	100	0	0	0	0
M.26 EMLA	56	7	88	0	2	2	2

Table 3. Trunk cross-sectional area (cm<sup>2</sup>) at planting of Honeycrisp apple trees on various rootstocks in the 2010 NC-140 Honeycrisp Apple Rootstock Trial.

Rootstock	IA	MA	MN	NJ	NY	UT
B.9	1.1	1.3	1.4	1.5	1.0	1.1
B.10	1.2	1.7	1.3	1.7	1.6	1.2
B.7-3-150	1.5	1.2	1.8	1.8	1.0	1.0
B.7-20-21	1.8	2.0	2.6	2.9	1.7	1.8
B.64-194	1.9	1.7	2.1	2.2	1.1	2.0
B.67-5-32	1.7	1.7	1.8	1.8	1.2	1.4
B.70-6-8	1.5	1.8	1.9	2.2	1.4	1.3
B.70-20-20	2.6	2.4	2.9	3.2	1.8	2.0
B.71-7-22	0.6	0.5	0.6	0.9	0.5	0.3
G.11	1.3	1.4	1.5	1.6	1.1	1.2
G.41N	1.4	1.2	1.4	1.4	1.2	1.0
G.41TC	1.1	1.1	1.3	1.1	0.3	1.2
G.202N	2.2	2.4	1.9	2.5	1.7	1.6
G.202TC	1.6	1.7	1.6	1.9	1.8	1.6
G.935N	1.4	2.0	1.7	1.7	1.5	1.4
G.935TC	1.1	1.1	1.4	2.1	0.9	1.1
CG.2034	0.9	1.0	1.2	1.5	0.9	1.2
CG.3001	1.6	1.9	1.7	2.2	1.6	1.3
CG.4003	1.1	1.2	0.9	1.4	0.9	0.9
CG.4004	1.5	1.9	2.0	1.8	1.4	1.4
CG.4013	1.4	1.0	1.6	1.7	1.5	1.4
CG.4214	1.3	1.4	1.6	1.7	1.3	1.1
CG.4814	1.7	1.7	2.2	2.4	1.5	1.5
CG.5087	1.3	1.4	1.9	2.0	1.7	1.5
CG.5222	–	2.0	1.8	2.3	1.5	1.6
Supp.3	0.9	1.1	1.1	1.6	0.9	0.9
PiAu 9-90	2.5	3.1	3.3	3.4	2.1	2.3
PiAu 51-11	1.9	2.0	2.3	2.4	1.9	1.6
M.9 NAKBT337	1.2	1.6	1.7	1.7	1.0	1.2
M.9 Pajam 2	1.6	1.5	1.9	1.8	1.3	1.3
M.26 EMLA	1.4	1.3	1.4	1.5	1.2	1.0
Approximated LSD	0.3	0.3	0.4	0.2	0.2	0.3

Table 4. Lateral branches (no.) at planting of Honeycrisp apple trees on various rootstocks in the 2010 NC-140 Honeycrisp Apple Rootstock Trial.

Rootstock	CH	IA	MA	MN	NJ	NY	UT
B.9	7.8	7.6	7.7	5.3	4.8	5.7	3.7
B.10	4.7	6.4	8.9	7.4	6.8	7.5	4.4
B.7-3-150	4.5	7.8	4.7	7.7	5.6	2.2	2.5
B.7-20-21	7.9	11.5	8.9	9.6	14.3	10.3	6.9
B.64-194	8.6	8.8	7.1	10.2	9.4	3.6	8.6
B.67-5-32	6.2	9.6	6.1	7.2	5.3	5.7	4.1
B.70-6-8	7.1	7.8	9.7	9.0	6.3	6.8	3.8
B.70-20-20	12.3	15.4	11.7	14.9	17.1	10.8	9.1
B.71-7-22	0.0	0.0	0.1	0.0	0.0	4.1	0.0
G.11	12.8	16.8	13.5	13.5	12.6	11.8	7.7
G.41N	8.8	9.5	5.2	7.8	8.3	5.8	2.6
G.41TC	11.5	12.6	6.5	9.5	4.8	0.0	5.0
G.202N	15.4	16.4	17.6	12.3	14.4	15.3	8.7
G.202TC	13.2	16.4	13.3	13.3	15.0	15.6	12.2
G.935N	15.7	16.2	16.1	10.1	13.0	12.0	9.1
G.935TC	7.4	19.2	8.3	11.6	14.6	11.1	5.7
CG.2034	8.9	10.7	7.7	3.6	8.0	7.3	6.8
CG.3001	9.2	17.9	15.8	10.6	18.6	8.4	7.7
CG.4003	8.7	7.8	7.3	6.2	10.8	4.4	2.5
CG.4004	19.5	23.0	19.5	17.4	22.0	18.8	10.5
CG.4013	9.3	16.9	8.6	7.3	17.1	13.3	6.8
CG.4214	14.3	19.4	19.5	14.4	20.1	13.9	6.4
CG.4814	18.2	15.3	16.9	14.6	20.6	14.4	10.4
CG.5087	20.8	13.9	16.2	13.8	18.8	17.1	9.7
CG.5222	7.8	–	15.9	8.7	12.8	11.4	7.7
Supp.3	1.4	8.6	9.1	4.7	5.1	4.0	1.7
PiAu 9-90	19.1	23.9	22.8	16.8	26.2	15.7	13.9
PiAu 51-11	9.0	13.4	11.2	10.3	10.6	9.2	5.8
M.9 NAKBT337	8.4	12.4	12.8	10.1	11.4	6.5	4.9
M.9 Pajam 2	6.9	10.6	11.7	9.5	11.0	8.8	5.3
M.26 EMLA	6.3	10.9	6.6	7.4	3.8	4.6	3.1
Approximated LSD	4.0	4.3	4.2	3.1	3.9	4.4	2.5

Table 5. Graft union height (cm) at planting of Honeycrisp apple trees on various rootstocks in the 2010 NC-140 Honeycrisp Apple Rootstock Trial.

Rootstock	CH	IA	MA	MN	NJ	NY	UT
B.9	11.8	8.8	13.9	7.3	15.6	12.6	10.6
B.10	10.1	7.6	13.3	6.0	16.9	12.3	9.7
B.7-3-150	12.4	9.8	16.3	6.7	16.7	11.3	12.4
B.7-20-21	12.2	7.8	16.4	8.0	17.9	11.9	11.7
B.64-194	13.4	10.9	16.3	8.0	19.8	12.1	10.9
B.67-5-32	11.4	8.0	12.7	5.7	17.1	12.1	9.6
B.70-6-8	12.7	9.2	14.4	6.8	16.2	10.3	10.5
B.70-20-20	13.4	9.3	16.3	7.4	19.8	14.6	12.2
B.71-7-22	12.5	10.6	15.2	5.5	15.7	13.7	9.4
G.11	10.3	8.5	16.1	7.4	16.7	12.0	10.4
G.41N	11.4	9.0	13.0	6.6	14.6	12.3	9.6
G.41TC	9.5	3.6	6.3	3.3	5.0	15.0	5.5
G.202N	12.2	5.0	17.0	6.2	16.7	9.3	7.9
G.202TC	13.1	6.4	12.8	4.6	15.1	7.0	10.5
G.935N	11.7	10.8	15.8	7.4	16.2	10.6	7.7
G.935TC	10.8	6.5	12.5	5.7	14.0	8.6	9.0
CG.2034	10.2	5.8	12.7	4.6	11.9	11.3	8.8
CG.3001	9.1	6.7	16.0	6.0	15.0	10.3	11.0
CG.4003	10.6	12.6	15.8	7.6	16.5	10.8	12.3
CG.4004	10.3	7.3	14.3	6.8	17.6	12.3	8.3
CG.4013	10.8	5.2	10.9	4.9	16.2	9.5	10.5
CG.4214	11.9	8.1	15.8	7.0	17.0	10.8	10.4
CG.4814	12.5	7.3	16.8	6.7	16.2	9.9	9.1
CG.5087	12.6	10.8	15.3	6.3	14.4	13.3	10.0
CG.5222	10.2	–	13.5	5.5	13.0	9.7	7.0
Supp.3	10.0	7.7	13.6	5.9	15.4	10.3	9.8
PiAu 9-90	12.7	12.5	18.0	8.2	19.4	15.6	14.4
PiAu 51-11	12.7	10.0	16.8	9.2	20.6	14.5	11.6
M.9 NAKBT337	11.8	9.3	16.8	7.2	18.0	9.0	12.4
M.9 Pajam 2	12.2	9.3	15.8	7.4	19.6	12.2	11.5
M.26 EMLA	11.6	9.3	16.8	7.6	16.4	12.1	10.3
Approximated LSD	2.1	2.5	2.5	1.9	2.6	2.2	2.4



Table 6. Trunk cross-sectional area (cm<sup>2</sup>) at the end of the 2010 growing season of Honeycrisp apple trees on various rootstocks in the 2010 NC-140 Honeycrisp Apple Rootstock Trial.

Rootstock	CH	IA	MA	MN	NJ	NY	UT
B.9	2.6	1.4	1.3	2.2	2.1	1.3	1.6
B.10	3.6	1.6	1.8	2.0	2.7	2.2	1.7
B.7-3-150	3.0	2.1	1.3	2.9	3.0	1.6	1.6
B.7-20-21	4.0	2.6	2.1	4.1	4.8	2.5	2.6
B.64-194	3.9	2.5	1.8	3.4	3.7	1.8	2.8
B.67-5-32	3.4	2.2	1.7	2.9	3.0	1.9	2.0
B.70-6-8	3.7	2.2	1.8	3.3	3.3	2.2	2.0
B.70-20-20	4.4	3.2	2.6	4.6	6.3	2.9	3.2
B.71-7-22	2.0	0.8	0.5	0.9	1.0	0.7	0.6
G.11	3.3	1.9	1.4	2.6	2.6	1.7	1.9
G.41N	2.5	1.7	1.2	2.3	2.4	1.5	1.4
G.41TC	2.6	1.6	1.2	2.0	2.1	0.5	1.6
G.202N	4.1	3.0	2.6	3.3	4.1	2.3	2.2
G.202TC	3.1	2.2	1.9	2.5	3.2	2.6	2.8
G.935N	3.3	2.0	2.1	2.6	2.9	2.3	1.9
G.935TC	2.1	1.7	1.1	2.5	3.3	1.6	1.6
CG.2034	2.5	1.3	1.1	1.7	2.5	1.4	1.7
CG.3001	2.8	2.8	2.0	2.9	3.6	2.4	2.1
CG.4003	3.1	1.4	1.3	1.8	2.3	1.3	1.6
CG.4004	3.5	2.3	1.9	3.2	3.8	2.2	1.9
CG.4013	3.2	1.9	0.9	1.9	2.5	2.1	1.9
CG.4214	2.6	1.8	1.5	2.3	2.8	1.8	1.7
CG.4814	3.9	2.0	1.8	3.0	3.6	2.2	2.3
CG.5087	3.1	1.6	1.6	2.5	3.1	2.4	1.9
CG.5222	3.5	–	2.1	2.7	3.6	2.2	2.0
Supp.3	2.7	1.4	1.1	1.6	2.5	1.3	1.3
PiAu 9-90	4.4	3.2	3.1	4.3	5.6	3.0	3.2
PiAu 51-11	3.6	2.4	2.0	3.6	3.8	2.5	2.3
M.9 NAKBT337	3.1	1.7	1.7	2.6	2.9	1.6	1.8
M.9 Pajam 2	3.0	2.1	1.5	3.0	3.2	1.9	1.9
M.26 EMLA	3.2	2.0	1.4	2.6	2.7	2.0	1.6
Approximated LSD	0.7	0.4	0.3	0.6	0.4	0.4	0.4

Table 7. Trunk cross-sectional area, number of branches (>10cm), and union height at planting of Fuji apple trees in the 2010 NC-140 Fuji Apple Rootstock Trial.<sup>z</sup>

Rootstock	Trunk cross sectional area at planting (cm <sup>2</sup> )	Branches at planting (no. > 10cm)	Graft union height at planting (cm)	Trunk cross-sectional area (cm <sup>2</sup> , 2010)
B.9	1.5 fg	2.6 de	9.4 abc	3.2 ghi
B.10	2.0 d	5.2 c	9.5 abc	3.9 defg
B.7-3-150	2.3 c	4.5 cd	9.6 abc	4.6 bc
B.7-20-21	1.1 hi	1.5 ef	10.9 a	1.7 j
B.64-194	1.6 efg	3.9 cde	9.8 abc	3.5 fgh
B.67-5-32	1.6 efg	2.2 ef	10.1 a	3.8 efg
B.70-6-8	2.4 b	4.6 cd	10.1 a	4.4 cd
B.70-20-20	2.5 b	9.1 b	8.6 bc	5.7 a
B.71-7-22	0.8 i	0.3 f	8.5 bc	1.6 j
G.11	1.6 efg	5.8 bc	10.1 a	3.7 efg
G.202N	2.8 a	10.5 ab	9.8 abc	4.9 bc
G.202TC	2.3 c	10.0 ab	9.1 abc	4.7 bc
G.935N	2.8 a	11.0 a	9.9 ab	4.3 cde
G.935TC	2.3 c	9.3 ab	8.2 c	3.6 efg
CG.3001	2.2 cd	9.0 b	9.1 abc	5.2 b
CG.4003	1.5 fg	4.7 c	9.8 abc	2.9 hi
CG.4004	2.0 d	10.6 ab	9.7 abc	4.0 cdefg
CG.4214	1.3 gh	3.9 cde	10.8 a	2.6 i
CG.4814	2.4 b	9.1 b	9.2 abc	4.1 cdef
CG.5087	1.1 hi	2.8 cde	9.6 abc	2.0 ij
CG.5222	2.6 a	7.7 b	8.4 c	4.7 bc
Supp.3	1.6 efg	4.0 cd	9.8 abc	3.3 ghi
PiAu 9-90	2.6 a	9.9 ab	11.0 a	5.4 b
PiAu 51-11	2.7 a	7.5 b	9.4 abc	5.2 b
M.9 NAKBT337	1.7 ef	4.7 c	9.9 ab	3.8 efg
M.9 Pajam 2	1.9 de	4.9 c	10.6 a	4.1 cdef
M.26 EMLA	2.1 d	7.7 b	9.8 abc	4.4 cd

<sup>z</sup> Least-squares mean separation within column by Tukey's HSD ( $P = 0.05$ ).

Table 8. Tree number and status in the 2010 NC-140 Fuji Apple Rootstock Trial.

Rootstock	Total number of trees	Died after growing well (% , 0)	Alive at the end of the 2010 growing season (% , 1)	Non data trees due to human error (% , 2)	Planted but broke at union before supported (% , 3)	Leafed out but quickly shut down (% , 4)	Never leafed out (% , 5)
B.9	59	0	100	0	0	0	0
B.10	60	0	98	0	0	2	0
B.7-3-150	60	0	100	0	0	0	0
B.7-20-21	60	0	100	0	0	0	0
B.64-194	40	0	93	0	0	5	3
B.67-5-32	57	0	100	0	0	0	0
B.70-6-8	60	0	100	0	0	0	0
B.70-20-20	60	0	92	0	0	7	2
B.71-7-22	49	0	96	0	2	2	0
G.11	43	0	91	0	0	7	2
G.41N	31	3	32	0	0	26	39
G.41TC	5	0	100	0	0	0	0
G.202N	41	0	76	0	0	7	17
G.202TC	50	0	100	0	0	0	0
G.935N	57	2	79	0	0	12	7
G.935TC	25	0	88	0	0	4	8
CG.2034	13	0	46	0	0	8	46
CG.3001	17	0	82	0	0	6	12
CG.4003	34	0	97	0	0	3	0
CG.4004	18	0	89	0	0	6	6
CG.4013	24	0	25	0	0	17	58
CG.4214	27	0	89	0	0	4	7
CG.4814	42	2	62	0	0	21	14
CG.5087	10	0	70	0	0	20	10
CG.5222	42	0	100	0	0	0	0
Supp.3	28	0	89	0	0	0	11
PiAu 9-90	37	0	51	0	0	22	27
PiAu 51-11	59	0	100	0	0	0	0
M.9 NAKBT337	59	0	98	0	0	2	0
M.9 Pajam 2	49	0	94	2	0	4	0
M.26 EMLA	60	0	98	2	0	0	0

Table 9. Trunk cross-sectional area (cm<sup>2</sup>) at planting of Fuji apple trees on various rootstocks in the 2010 NC-140 Fuji Apple Rootstock Trial.

Rootstock	ID	KY	PA	UT
B.9	1.5	1.6	1.8	1.2
B.10	1.7	2.0	2.6	1.6
B.7-3-150	2.1	2.1	3.2	1.9
B.7-20-21	1.2	1.1	1.3	0.9
B.64-194	1.5	1.6	2.2	1.3
B.67-5-32	1.4	1.6	2.1	1.4
B.70-6-8	2.4	2.0	2.5	2.0
B.70-20-20	2.5	1.9	2.7	2.7
B.71-7-22	0.8	0.7	0.9	0.8
G.11	1.6	1.5	1.8	1.5
G.41N	3.4	1.8	3.1	2.0
G.41TC	0.5	0.6	–	0.6
G.202N	3.0	2.6	3.4	2.4
G.202TC	2.4	2.3	2.5	2.0
G.935N	2.9	2.6	3.3	2.3
G.935TC	2.9	2.0	2.7	1.4
CG.2034	1.5	1.1	1.6	1.2
CG.3001	2.8	1.2	2.7	2.2
CG.4003	1.5	1.6	1.6	1.4
CG.4004	2.1	1.7	2.1	2.0
CG.4013	–	1.0	1.7	1.2
CG.4214	1.7	1.3	1.2	1.0
CG.4814	2.5	2.2	2.7	2.1
CG.5087	0.9	1.3	0.7	1.6
CG.5222	2.7	2.5	3.1	2.3
Supp.3	1.5	1.5	1.8	1.5
PiAu 9-90	3.1	2.9	2.0	2.5
PiAu 51-11	2.3	2.5	3.6	2.3
M.9 NAKBT337	1.5	1.5	2.4	1.4
M.9 Pajam 2	1.9	1.8	2.4	1.6
M.26 EMLA	2.2	1.8	2.2	2.1
Approximated LSD	0.3	0.3	0.5	0.4

Table 10. Lateral branches (no.) at planting of Fuji apple trees on various rootstocks in the 2010 NC-140 Fuji Apple Rootstock Trial.

Rootstock	CH	ID	KY	PA	UT
B.9	3.1	5.8	2.1	0.0	2.2
B.10	6.0	7.5	4.4	4.4	3.5
B.7-3-150	5.7	5.5	3.8	3.5	3.9
B.7-20-21	2.8	2.6	0.9	0.0	1.4
B.64-194	4.3	5.4	3.0	4.3	2.6
B.67-5-32	2.3	4.7	1.5	1.4	1.1
B.70-6-8	5.5	7.5	4.0	3.2	3.0
B.70-20-20	14.9	8.1	7.2	6.9	8.5
B.71-7-22	0.0	2.1	0.0	0.0	0.1
G.11	7.8	7.1	4.6	3.8	5.6
G.41N	–	10.6	2.6	15.8	4.8
G.41TC	4.1	2.2	0.0	–	0.0
G.202N	12.4	8.1	10.3	12.2	9.8
G.202TC	11.6	10.5	7.6	12.2	8.1
G.935N	10.0	8.9	11.0	14.7	10.5
G.935TC	12.6	8.7	8.0	12.3	4.5
CG.2034	–	4.4	0.0	5.3	2.3
CG.3001	10.6	10.0	5.2	11.9	7.1
CG.4003	5.3	4.4	5.1	2.6	5.9
CG.4004	11.8	13.0	9.5	6.3	12.5
CG.4013	–	–	2.1	0.0	0.5
CG.4214	6.6	5.0	3.3	1.9	2.3
CG.4814	11.4	6.6	10.0	7.9	9.4
CG.5087	0.7	0.9	1.5	4.3	6.4
CG.5222	10.1	8.0	6.0	6.4	7.9
Supp.3	4.8	5.2	3.0	3.3	4.0
PiAu 9-90	17.2	8.5	10.3	3.4	10.3
PiAu 51-11	9.5	7.3	6.6	6.5	7.5
M.9 NAKBT337	5.8	6.1	3.5	5.6	2.6
M.9 Pajam 2	6.6	6.3	3.8	3.9	3.6
M.26 EMLA	9.8	9.9	6.6	4.6	7.3
Approximated LSD	3.2	2.3	2.2	3.9	2.5

Table 11. Graft union height (cm) at planting of Fuji apple trees on various rootstocks in the 2010 NC-140 Fuji Apple Rootstock Trial.

Rootstock	CH	ID	KY	PA	UT
B.9	10.3	5.3	12.7	13.1	5.6
B.10	10.3	5.3	12.5	12.8	6.4
B.7-3-150	10.9	5.1	13.1	13.1	5.7
B.7-20-21	13.9	8.0	13.2	13.2	6.1
B.64-194	11.6	5.9	13.8	12.8	5.0
B.67-5-32	10.8	7.4	13.6	12.7	6.2
B.70-6-8	12.3	6.6	12.6	13.3	5.8
B.70-20-20	9.8	4.7	10.9	13.5	4.4
B.71-7-22	8.8	4.9	11.5	12.8	4.7
G.11	11.2	6.8	13.2	13.0	6.4
G.41N	—	5.5	12.0	11.3	4.9
G.41TC	7.9	4.2	5.3	—	1.6
G.202N	11.5	5.8	13.0	13.5	5.3
G.202TC	8.4	5.3	11.9	14.2	5.5
G.935N	11.2	6.1	13.9	12.7	5.8
G.935TC	8.2	5.5	11.3	12.5	3.3
CG.2034	—	2.8	12.7	11.8	6.9
CG.3001	10.3	5.2	12.4	12.4	5.0
CG.4003	10.4	6.1	13.5	12.9	6.0
CG.4004	10.9	5.9	13.6	13.8	4.5
CG.4013	—	—	12.8	13.6	2.6
CG.4214	11.7	7.7	14.0	13.8	6.9
CG.4814	9.8	5.9	12.1	12.8	5.3
CG.5087	16.4	3.4	11.8	11.3	4.7
CG.5222	9.7	5.2	11.5	11.3	4.4
Supp.3	10.8	6.8	12.0	12.9	6.4
PiAu 9-90	14.1	8.0	13.7	11.9	7.3
PiAu 51-11	10.2	5.6	12.3	12.5	6.4
M.9 NAKBT337	11.4	5.3	13.4	13.9	5.3
M.9 Pajam 2	12.6	7.2	13.7	12.9	6.6
M.26 EMLA	10.9	5.9	12.7	13.0	6.3
Approximated LSD	2.2	1.9	1.9	1.7	1.7

Table 12. Trunk cross-sectional area (cm<sup>2</sup>) at the end of the 2010 growing season of Fuji apple trees on various rootstocks in the 2010 NC-140 Fuji Apple Rootstock Trial.

Rootstock	CH	ID	KY	PA	UT
B.9	2.8	4.6	3.0	2.0	3.6
B.10	3.2	5.8	4.0	2.8	4.0
B.7-3-150	3.7	6.8	4.7	3.4	4.3
B.7-20-21	1.6	2.2	1.7	1.4	1.6
B.64-194	2.9	5.9	3.4	2.4	3.2
B.67-5-32	2.5	5.6	4.5	2.5	4.1
B.70-6-8	3.3	7.0	4.5	2.8	4.5
B.70-20-20	4.4	8.9	5.7	3.1	6.4
B.71-7-22	1.6	2.3	1.2	1.0	1.9
G.11	3.4	5.4	4.0	1.9	3.8
G.41N	–	6.4	2.0	3.4	3.3
G.41TC	2.0	5.4	2.3	–	2.5
G.202N	3.4	7.4	5.8	3.5	4.4
G.202TC	4.7	7.5	4.3	2.9	4.4
G.935N	3.3	5.1	5.0	3.2	4.6
G.935TC	3.0	5.4	2.9	2.8	4.0
CG.2034	–	3.6	1.9	1.7	1.9
CG.3001	4.5	8.6	4.7	3.1	5.1
CG.4003	3.0	3.9	2.8	1.9	2.9
CG.4004	3.2	7.1	3.4	2.5	4.1
CG.4013	–	–	2.4	1.8	1.5
CG.4214	2.8	4.3	2.4	1.3	2.4
CG.4814	3.3	5.9	4.7	2.7	3.9
CG.5087	3.2	1.1	2.2	0.6	2.7
CG.5222	4.5	6.1	5.2	3.5	4.5
Supp.3	2.5	4.2	3.6	2.1	3.9
PiAu 9-90	5.2	6.4	7.2	2.0	6.1
PiAu 51-11	3.7	7.6	5.5	3.9	5.3
M.9 NAKBT337	3.1	5.6	4.0	2.6	3.5
M.9 Pajam 2	3.1	6.1	4.7	2.7	4.0
M.26 EMLA	3.7	6.8	4.6	2.8	4.2
Approximated LSD	0.7	1.0	0.9	0.6	0.7