ANNUAL REPORT TO NC-140

2014 'Aztec Fuji' Rootstock Trial – Reporting for 2017 data

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John A. Cline, University of Guelph jcline@uoguelph.ca

2017 was the fourth year of the 2014 NC-140 Apple Rootstock Trials. Rootstocks included in this experiment are listed below. All data presented in this report were collected in 2017 and analyzed by the data coordinator. All cooperators submitted data except two sites: ON-Ridgetown, Michigan.

An Excel data template worksheet was provided to all cooperators to submit data. This generally worked well, however there were some data issues at some sites. Please use the Excel data template when submitting data -- a new worksheet template will be provided each year. Participants are encouraged to review their data and make sure that all measurements are in the units requested. Include only those data requested in the protocol – which is provided in addition to the data template.

Summary of Data Submission for 2019
1. Review the data protocol located on the NC-140 website
2. Be sure to correct any errors in the data structure (treatments, reps) communicated by the data coordinator to you in 2018.
3. Submit only the data requested using the Excel data template worksheet, which can be found on the NC-140 website
4. Submit only data collected in **2018** (not prior years) and use the correct units using the data template provided for 2018 (see website).

Rootstocks, cultivars and locations involved in the 2014 NC-140 'Aztec Fuji' Rootstock Trial. Plantings are spaced 5'×13' (1.52m×3.96m). All trees are trained to the tall spindle orchard system.

Rootstocks	Aztec Fuji sites
B.10	AL
G.11	ID
G.202	GA
G.214	**NJ***
G.30	ON (Simcoe)
G.41	PA
G.935	SC
G.969	UT
M.26 EMLA	
M.9 T337	
V.1	
V.5	
V.6	
V.7	

*** No data were submitted for 2016.

NC 140 Accomplishments Report Statement

2014 NC-140 Apple Rootstock Planting – 'Aztec Fuji'

The 2014 Apple rootstock (Fuji) planting was established in 7 locations in the United States (AL, ID, GA, NJ, NY, PA, SC, UT), and in Ontario, Canada http://bit.ly/1zv3wCc). The trial consists of the following rootstocks: B.10, G.11, G.202, G.214, G.30, G.41, G.935, G.969, M.26 EMLA, M.9 T337, V.1, V.5, V.6, and V.7. Trial coordination and data analyses are being coordinated by John Cline. Trees were planted to a 'tall spindle' systems at a 5 x13 ft spacing. Trees are planted in a completely randomized design with single trees serving as experimental units. There are 10 replicates of each treatment. Each site selected their own pollinizer varieties. The trees were propagated by Willow Drive Nursery, WA and planted in the spring of 2014.

Data protocols have been established for 2014-2018 and data that was collected is summarized below

Measurement	2014	2015	2016	2017	2018
1) initial trunk diameter measured at planting 30cm above graft union	X				
2) number of side branches >10 cm at planting	X				
3) trunk circumference in the fall	X	X	X	X	X
4) height of the graft union above soil;	X				
5) tree status at the end of the growing season	X	X	X	X	X
6) date of full bloom		X	X	X	X
7) date of harvest		X	X	X	X
8) total yield per tree		X	X	X	X
9) flower clusters per tree	X				
10) total number of fruit per tree		X	X	X	X
11) total number of rootstock suckers per tree		X	X	X	X
12) tree height in the fall					X
13) tree spread in the fall (in-row and perpendicular to the row)					X

Figure 1. Location of participants of the 2014 NC-140 Apple rootstock planting evaluation of 'Aztec Fuji' (red) and 'Honeycrisp' (teal) in Canada, the United States, and Mexico. Map updated as of Nov 10, 2014 (not all participants provided gps coordinates). For an updated interactive map visit http://bit.ly/1zv3wCc
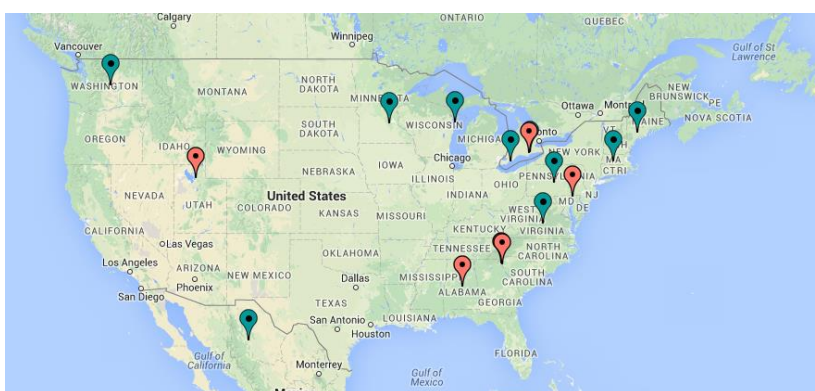
Important points to discuss at the 2018 NC-140 annual meeting

- Protocol and data to collect in 2019
- Sites not submitting data
- Any concerns raised by study participants
- When to terminate the experiment
- 5-year manuscript (2014-2018 data)

Summary of Results for the 2014 NC-140 Aztec Fuji Trial

General comments
- Response variables were greatly affected by both rootstock and location
- Rootstock by location interactions were highly significant
- There were no statistically significant differences in TCA between M.9 T337 and M.26 EMLA making it difficult to separate rootstocks into different vigor categories
- Based on TCA, rootstocks were broadly classified into 3 vigor categories: those similar to M.9 T337, those similar to M.26 EMLA and those more vigorous than M.26 EMLA

Rootstocks in the M.9 T337 size class
- G.935, G.41, G.11, B.10, G.214 and G.202 were generally similar in vigor to M.9 T337 based on the TCA. Albeit non-significant, G.214 and G.202 tended to have the smallest TCA across sites. (Table 1)
- Tree survival was 100% for most rootstocks and sites. Survival was 90% for B.10 at GA, G.11 at ID, NJ and UT, G.202 at AL, G.214 at AL, GA, ON-S, G.41 at AL, G.935 at AL. The lowest survival was observed for B.10 at AL (80%), G.11 at GA (80%), G.202 at NJ (60%) and ON-S (70%). Averaged across sites, mean tree survival was lowest for G.202 and G.11 for this class of rootstock. (Table 2)
- Overall, all the rootstocks produced few suckers (Table 3)
- Cumulative yield (CY) of these rootstocks were generally similar to M.9 T337 except for G.935 at SC and G.214 at PA which produced significantly higher CY than M.9 T337. (Table 4)
- Cumulative yield efficiency (CYE) was generally similar to M.9 T337. CYE of G.214 at UT, and G.202 at SC and UT was significantly higher than M.9 T337. Although not statistically significant, CYE of G.935 and G.969 at AL was double the CYE of M.9 T337. CYE of B.10 at GA was significantly lower than M.9 T337. (Table 5)
- Fruit weight on all rootstocks was similar to M.9 T337. (Table 6)

Rootstocks in the M.26 EMLA size class
- G.969 and V.1 were generally similar in vigor to M.26 EMLA, based on the TCA (Table 1)
- Tree survival of V.1 was 100% at all sites. Survival of G.969 was slightly reduced at the SC and UT sites. (Table 2)
- These rootstocks produced few rootstock suckers. Only V.1 at SC produced more than 5 suckers. (Table 3)

- Cumulative yield (CY) of these two rootstocks was generally similar to M.26 EMLA except for G.969 at AL and SC and V.1 at SC which produced significantly higher CY than M.26 EMLA. (Table 4)
- Cumulative yield efficiency of these rootstocks was not significantly different than M.26 EMLA. (Table 5)
- Fruit weight was similar to M.26 EMLA except for G.969 at GA which had significantly lighter fruit than M.26 EMLA.

Rootstocks more vigorous than M.26 EMLA
- V.5, V.6, V.7, and G.30 were generally more vigorous than M.26 EMLA, based on mean TCA. At some sites TCA of these rootstocks was not statistically different than M.26 EMLA (Table 1).
- Tree survival was 100% for most of these rootstocks. Survival of G.30 at GA, V.5 at SC and V.6 at AL was 90%. Survival of V.7 was 100% at all sites (Table 2)
- These rootstocks produced few rootstock suckers. Only V.5 at AL, and V.7 at SC produced more than 5 suckers. (Table 3)
- Cumulative yield of G.30 at GA, NJ, ON-S, SC and UT, V.6 at AL, GA, PA, SC, UT, V.7 at AL, PA, SC, and UT, V.5 at PA, SC and UT was significantly higher than M.26 EMLA. (Table 4)
- Cumulative yield efficiency and fruit weight of these rootstocks was similar to M.26 EMLA at all sites. (Tables 5, 6)

2017 'Aztec Fuji' DATA

Table 1. Growth of 'Aztec Fuji' trees, as indicated by trunk cross-sectional area (cm^2), as of 2017 from the NC-140 apple rootstock trial planted in 2014 at 8 locations.

Rootstock[y]	AL		GA		ID		NJ		ON-S		PA		SC		UT		Mean
V.6	37.8	a[z]	32.1	a			68.7	a	15.2	abc	28.9	a	33.1	a	52.7	a	38.4
V.7	32.7	abc	25.3	ab			69.9	a	16.7	ab	26.6	ab	28.6	ab	44.0	b	34.8
V.5	35.1	ab	22.4	b			59.9	a	14.3	b-e	25.9	abc	33.8	a	50.6	ab	34.6
G.30	30.0	a-d	25.0	ab	29.6	a	61.7	a	19.6	a			26.0	abc	32.6	cd	32.1
V.1	29.8	a-d	24.4	b	27.1	ab	41.6	ab			22.4	a-d	22.6	bcd	34.8	c	29.0
G.969	24.0	cde	11.8	cd	22.3	bc							26.1	abc	32.1	cde	23.3
M.26 EMLA	23.9	b-e	18.6	bc	21.6	bcd	26.1	b	14.7	bcd	17.6	cd	18.7	cde	28.6	c-f	21.2
G.935	20.1	de	14.2	cd	17.7	cd	24.0	b	8.6	f			17.2	de	28.8	c-f	18.7
M.9 T337	20.4	de	13.3	cd			20.0	b	10.4	def	15.4	d	15.5	de	30.8	c-f	18.0
G.41	15.4	e	14.3	cd	19.0	cd			14.7	bcd			14.3	e	29.6	c-f	17.9
G.11	18.5	e	12.8	cd	18.1	cd	20.7	b	11.0	c-f			15.0	de	27.9	c-f	17.7
B.10	17.4	e	10.4	d	20.6	cd			15.2	abc			13.3	e	24.5	f	16.9
G.214	14.4	e	8.7	d	19.2	cd	15.7	b	9.4	ef	18.3	bcd	14.5	de	26.7	def	15.9
G.202	17.2	e	11.1	d	16.3	d	13.7	b	6.4	f			11.1	e	25.3	ef	14.4
Mean	24.1		17.5		21.1		38.4		13.0		22.2		20.7		33.5		23.8
P-value	<0.0001		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001		

[y] Rootstocks ranked by decreasing mean trunk cross-sectional area.

[z] Mean values with the same letter within a given column are not significantly different according to the Tukey-Kramer test at

Table 2. Percent survival of 'Aztec Fuji' trees as of 2017 from the NC-140 apple rootstock trial planted in 2014 at 8 locations.

Rootstock[y]	AL	GA	ID	NJ	ON-S	PA	SC	UT	Mean
B.10	80	90	100		100		100	100	95
G.11	100	80	90	90	100		100	90	93
G.202	90	100	100	60	70		100	100	89
G.214	90	90	100	100	90	100	100	100	96
G.30	100	90	100	100	100		100	100	99
G.41	90	100	100		100		100	100	98
G.935	90	100	100	100	100		100	100	99
G.969	100	100	100				90	90	96
M.26 EMLA	80	100	80	100	100	100	90	100	94
M.9 T337	90	80		90	100	100	70	100	90
V.1	100	100	100	100		100	100	100	100
V.5	100	100		100	100	100	90	100	99
V.6	90	100		100	100	100	100	100	99
V.7	100	100		100	100	100	100	100	100
Mean	93	95	97	95	97	100	96	99	96
P-value[z]	-	-	-	-	-	-	-	-	-

[y] Rootstocks ranked in alphabetical order.

[z] Data did not correspond to the assumptions of the ANOVA. Data is not normally distributed.

Table 3. Cumulative number of rootstock suckers (2015-2017) from 'Aztec Fuji' trees from the NC-140 apple rootstock trial planted at 8 locations.

Rootstock[y]	AL	GA	ID	NJ	ON-S	PA	SC	UT	Mean
B.10	0	1	1		0		1	0	1
G.11	0	2	0	1	0		0	0	1
G.202	3	2	1	0	0		3	1	1
G.214	2	1	3	0	0	0	3	2	1
G.30	5	2	2	0	1		5	1	2
G.41	0	1	2		1		2	1	1
G.935	1	2	3	0	0		5	0	2
G.969	0	1	3				1	2	2
M.26 EMLA	1	2	1	0	0	1	0	1	1
M.9 T337	2	2		1	0	0	3	5	2
V.1	3	1	3	2		2	8	0	3
V.5	7	2		0	0	1	4	5	3
V.6	3	1		1	0	3	3	3	2
V.7	5	2		0	1	4	6	4	3
Mean	2	2	2	1	0	2	3	2	2
P-value[z]	-	-	-	-	-	-	-	-	-

[y] Rootstocks ranked in alphabetical order.

[z] Data did not correspond to the assumptions of the ANOVA. Data is not normally distributed.

Table 4. Cumulative yield (2015-2017; kg/tree) of 'Aztec Fuji' trees from the NC-140 apple rootstock trial planted in 2014 at 8 locations.

Rootstock[y]	AL		GA		ID		NJ		ON-S		PA		SC		UT		Mean
G.969	18.3	a[z]	20.0	abc	43.9	ab							40.2	a-d	20.7	de	28.6
G.30	13.5	a-d	27.8	a	41.6	ab	22.8	a	14.7	a			45.8	abc	31.2	abc	28.2
V.6	15.8	abc	25.9	ab			18.4	ab	8.6	a-d	21.3	a	49.7	a	32.1	abc	24.5
V.7	17.1	ab	24.2	abc			16.3	ab	10.6	a-d	21.3	a	43.8	abc	36.3	a	24.2
V.5	13.6	a-d	24.6	abc			14.5	ab	8.1	a-d	22.3	a	48.9	ab	32.6	ab	23.5
G.935	15.1	a-d	26.4	ab	32.5	ab	17.8	ab	10.5	a-d			38.0	bcd	24.2	cde	23.5
G.214	7.9	bcd	16.9	bcd	52.3	a	13.7	ab	9.0	a-d	21.2	a	35.8	c-f	26.0	b-e	22.8
G.41	8.4	bcd	20.9	abc	35.3	ab			13.7	ab			31.6	d-g	24.6	b-e	22.4
V.1	11.4	a-d	19.2	a-d	29.6	ab	17.7	ab			16.7	ab	36.7	cde	22.4	de	22.0
G.11	12.1	a-d	21.1	abc	44.5	ab	8.2	b	7.5	bcd			24.6	g	21.4	de	19.9
G.202	8.4	a-d	17.3	a-d	24.9	b	9.0	b	6.1	cd			30.9	d-g	26.4	bcd	17.6
B.10	6.9	cd	9.0	d	31.4	ab			12.3	abc			25.3	fg	17.7	e	17.1
M.9 T337	7.6	bcd	18.1	a-d			8.4	b	8.8	a-d	13.7	b	26.3	efg	19.6	de	14.6
M.26 EMLA	5.2	d	14.6	cd	20.3	b	8.6	b	4.7	d	10.7	b	24.9	fg	18.6	de	13.5
Mean	11.5		20.4		35.6		14.1		9.5		18.2		35.9		25.3		21.6
P-value	<0.0001		<0.0001		0.0010		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001		

[y] Rootstocks ranked by decreasing mean cumulative yield.

[z] Mean values with the same letter within a given column are not significantly different according to the Tukey-Kramer test at P=0.05.

Table 5. Cumulative yield efficiency (2015-2017; kg/tree/cm2 TCSA^x 2017) of 'Aztec Fuji' trees from the NC-140 apple rootstock trial planted in 2014 at 8 locations.

Rootstock[y]	AL	GA		ID		NJ		ON-S		PA		SC		UT		Mean
G.214	0.6	2.1	a^z	2.8	a	1.1	a	1.0	ab	1.2	a	2.6	ab	1.0	a	1.5
G.935	0.8	1.9	a	1.7	abc	0.8	ab	1.2	a			2.3	abc	0.9	abc	1.4
G.41	0.6	1.5	a-d	1.9	abc			1.0	ab			2.3	abc	0.8	abc	1.3
G.969	0.8	1.7	ab	2.0	abc							1.6	cd	0.6	bc	1.3
G.202	0.5	1.6	abc	1.5	bc	0.7	ab	0.9	ab			2.9	a	1.1	a	1.3
G.11	0.7	1.7	ab	2.5	ab	0.4	ab	0.7	abc			1.7	cd	0.8	abc	1.2
B.10	0.5	0.9	de	1.6	abc			0.8	abc			2.0	bcd	0.7	abc	1.1
G.30	0.5	1.2	b-e	1.4	bc	0.5	ab	0.8	abc			1.8	cd	1.0	ab	1.0
M.9 T337	0.4	1.7	ab			0.5	ab	0.8	abc	0.9	ab	2.0	bcd	0.7	bc	1.0
V.1	0.4	0.8	e	1.1	c	0.4	b			0.8	ab	1.8	cd	0.6	bc	0.8
V.7	0.5	1.0	cde			0.3	b	0.7	bc	0.8	ab	1.6	cd	0.8	abc	0.8
V.5	0.5	1.2	b-e			0.3	b	0.6	bc	0.9	ab	1.5	d	0.6	bc	0.8
V.6	0.5	0.8	e			0.3	b	0.6	bc	0.8	ab	1.6	cd	0.6	c	0.7
M.26 EMLA	0.3	0.8	e	1.0	c	0.5	ab	0.3	c	0.6	b	1.5	d	0.7	bc	0.7
Mean	0.5	1.4		1.7		0.5		0.8		0.9		1.9		0.8		1.1
P-value	0.0240	<0.0001		0.0001		0.0014		<0.0001		0.0073		<0.0001		<0.0001		

[x] Trunk cross-sectional area.

[y] Rootstocks ranked by decreasing mean cumulative yield efficiency.

[z] Mean values with the same letter within a given column are not significantly different according to the Tukey-Kramer test at P=0.05. There were no significant differences for AL according to the Tukey-Kramer test.

Table 6. Fruit weight (g), averaged over all cropping years (2015-2017) for 'Aztec Fuji' trees from the NC-140 apple rootstock trial planted in 2014 at 8 locations.

Rootstock[y]	AL	GA		ID	NJ	ON-S		PA	SC	UT		Mean
V.1	145	174	a-d[z]	232	209			206	197	249	a-d	202
G.11	152	167	a-e	237	210	167	ab		198	247	a-d	197
V.7	148	182	a		207	156	abc	212	201	271	ab	197
M.26 EMLA	143	177	abc	233	176	159	abc	224	193	256	abc	195
V.6	136	179	ab		213	161	abc	209	195	272	a	195
G.30	128	170	a-e	220	234	178	a		197	235	cd	194
V.5	142	179	abc		221	141	abc	207	190	274	a	194
G.214	130	150	de	232	215	142	abc	218	197	244	bcd	191
M.9 T337	138	172	a-d		199	160	abc	227	195	242	cd	190
G.969	156	148	e	218					194	236	cd	190
G.41	138	176	abc	219		171	a		195	235	cd	189
B.10	141	154	b-e	202		171	a		185	239	cd	182
G.935	146	158	a-e	212	194	131	bc		201	224	d	181
G.202	124	154	cde	202	193	119	c		186	238	cd	174
Mean	140	167		221	206	155		215	195	247		191
P-value	0.3275	<0.0001		0.0169	0.2010	<0.0001		0.1077	0.0780	<0.0001		

[x] Trunk cross-sectional area.

[y] Rootstocks ranked by decreasing mean fruit weight.

[z] Mean values with the same letter within a given column are not significantly different according to the Tukey-Kramer test at P=0.05. There were no significant differences for ID according to the Tukey-Kramer test.