ANNUAL REPORT TO NC-140

2014 'Aztec Fuji' Rootstock Trial – Reporting for 2018 data

November 13-14, 2019 – Geneva, NY

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

2018 was the fifth 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 2018 and analyzed by the data coordinator.

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 2019.
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 **2019** (not prior years) and use the correct units using the data template provided for 2019 (see website).
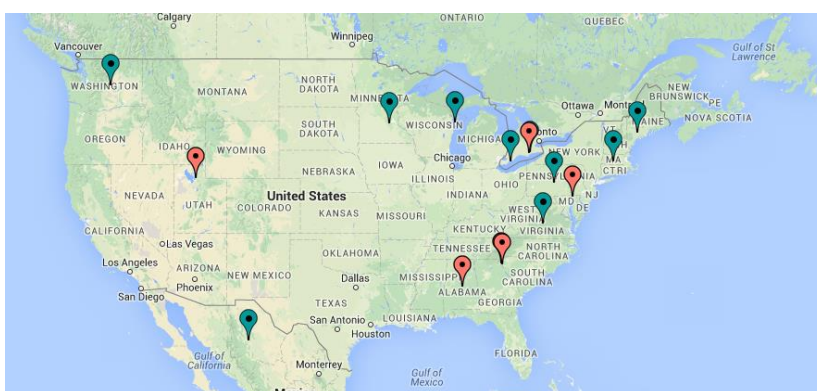
NC 140 Accomplishments Report Statement

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	2019
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	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	X
6) date of full bloom		X	X	X	X	X
7) date of harvest		X	X	X	X	X
8) total yield per tree		X	X	X	X	X
9) flower clusters per tree	X					
10) total number of fruit per tree		X	X	X	X	X
11) total number of rootstock suckers per tree		X	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 2019 NC-140 annual meeting

- Protocol and data to collect in 2020
- Sites not submitting data
- 5-year manuscript (2014-2018 data) – In progress

Table 1. Cooperators in the 2014 NC-140 Fuji apple planting						
Location	Name	Affilitation	Longitude	Latitude	Soil type	Planting irrigated ?
(ON) Simcoe, Ontario	John Cline	University of Guelph	42° 51' 37" N	80° 16' 18" W	Sandy loam	yes
(NJ) Pittstown, New Jersey	Megan F. Muehlbauer	Rutgers University	43° 33' 38" N	74° 57' 24" W	Silt Loam	yes
(AL) Clanton, AL	Elina Coneva	Auburn University	86°40'13" N	32°55'12" W	Loam	yes
(ID) Idaho	Essie Fallahi	University of Idaho				
(GA) Blairsville, GA	Tom Konn	North Carolina State University	83° 55'23"W	34°50'21"N	Fine sandy loam	no
(PA) Rock Springs, PA	Rob Crassweller	PennState University				
(SC) Seneca, SC	Gregory L. Reighard and David R. Ouellette	Clemson University	82° 52'41"W	34°36'70"N	Sandy loam	yes
(UT) Kaysville, UT	Brent Black	Utah State University				

2017 'Aztec Fuji' DATA

Table 1. Growth of 'Aztec Fuji' trees, as indicated by trunk cross-sectional area, as of 2018 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	19.6	e	14.0	e	23.8	cd			23.4	abc			14.4	f	31.2	d	21.1
G.11	27.9	cde	18.8	de	20.3	d	22.5	b	17.0	cde			18.4	ef	33.9	d	22.7
G.202	20.6	e	18.6	de	18.5	d	16.9	b	10.9	e			12.6	f	31.0	d	18.5
G.214	17.8	e	15.3	e	21.6	cd	18.2	b	15.5	de	23.1	bc	16.9	ef	32.3	d	20.1
G.30	35.9	a-d	36.0	bc	34.1	a	61.7	a	30.0	a			30.1	cd	39.9	cd	38.3
G.41	17.8	e	20.4	de	22.1	cd			23.4	abc			16.0	ef	37.9	cd	22.9
G.935	22.6	de	22.8	de	21.5	cd	24.4	b	13.1	e			18.7	ef	33.6	d	22.4
G.969	31.1	b-e	18.8	de	26.9	bc							31.3	bcd	40.5	cd	29.7
M.26 EMLA	37.2	a-d	28.2	cd	28.3	abc	28.1	b	23.9	abc	23.1	bc	21.4	def	41.4	cd	28.9
M.9 T337	28.0	cde	17.1	e			22.0	b	15.5	de	19.1	c	16.3	ef	37.6	cd	22.2
V.1	41.1	abc	37.9	bc	32.6	ab	41.6	ab			28.3	abc	26.5	cde	45.7	bc	36.3
V.5	44.6	ab	36.6	bc			59.9	a	22.2	bcd	32.8	ab	42.2	ab	67.7	a	43.7
V.6	47.6	a	50.1	a			68.7	a	23.2	abc	36.5	a	42.5	a	68.4	a	48.1
V.7	47.5	a	39.2	b			66.3	a	24.5	ab	34.1	a	34.5	abc	55.5	b	43.1
Mean	31.4		26.7		25.0		39.1		20.2		28.1		24.4		42.6		29.9
P-value	<0.0001		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001		<0.0001		

[y] Rootstocks ranked in alphabetical order.

Table 2. Percent survival of 'Aztec Fuji' trees as of 2018 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	100	100	a[z]		100	a		100	a	100	97
G.11	100	80	100	a	100	100	a		100	a	90	96
G.202	90	100	100	a	80	60	b		100	a	100	90
G.214	80	90	100	a	100	90	a	100	100	a	100	95
G.30	100	90	100	a	100	100	a		100	a	100	99
G.41	90	100	100	a		100	a		100	a	100	98
G.935	89	100	90	a	100	100	a		100	a	100	97
G.969	100	100	90	a					100	a	90	96
M.26 EMLA	89	100	70	a	100	100	a	100	90	a	100	94
M.9 T337	80	80			90	100	a	100	60	b	100	87
V.1	100	100	100	a	100			100	100	a	100	100
V.5	100	100			100	100	a	100	100	a	100	100
V.6	90	100			100	100	a	100	90	a	100	97
V.7	100	100			100	100	a	100	100	a	100	100
Mean	92	96	95		97	96		100	96		99	96
P-value	0.5729	0.1568	0.0332		0.1074	<0.0001			0.0001		0.5314	

[y] Rootstocks ranked in alphabetical order.

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	e[z]	0	a	1	a			1	ab		1	b	1	cd	1
G.11	0	e	1	a	0	a	1	a	0	b		0	b	0	d	0
G.202	6	a-e	1	a	1	a	1	a	0	b		5	b	2	bcd	2
G.214	3	cde	0	a	4	a	0	a	1	ab	1	5	b	4	a-d	2
G.30	9	abc	1	a	2	a	1	a	2	ab		7	ab	2	bcd	4
G.41	1	de	0	a	3	a			2	ab		3	b	2	bcd	2
G.935	2	cde	0	a	4	a	0	a	0	b		7	ab	0	d	2
G.969	2	de	0	a	5	a						1	b	4	a-d	2
M.26 EMLA	1	de	1	a	1	a	1	a	0	b	2	1	b	2	bcd	1
M.9 T337	4	b-e	1	a			4	a	1	ab	0	5	b	9	abc	4
V.1	7	a-d	1	a	5	a	5	a			4	14	a	1	d	5
V.5	12	a	3	a			2	a	1	ab	3	6	ab	11	a	6
V.6	8	a-d	3	a			3	a	4	a	5	5	b	6	a-d	5
V.7	11	ab	2	a			2	a	3	ab	9	7	ab	9	ab	6
Mean	5		1		3		2		1		3	5		4		3
P-value	<0.0001		0.0187		0.0161		0.0131		0.0074		0.1473	<0.0001		<0.0001		

[y] Rootstocks ranked in alphabetical order.

Table 4. Cumulative yield (2015-2018; 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
B.10	23.1	abc[z]	19.5	b	58.8	abc			19.7	abc			44.1	cd	52.6	b	36.3
G.11	33.1	abc	36.5	ab	75.4	ab	29.7	abc	17.8	abc			45.0	cd	56.3	b	42.0
G.202	23.5	abc	23.4	b	42.2	bc	23.2	c	10.7	c			48.7	cd	58.5	b	32.9
G.214	26.7	abc	22.3	b	87.0	a	32.0	abc	15.0	abc	52.7	a	60.9	bc	59.2	b	44.5
G.30	42.7	ab	44.5	a	86.7	a	45.5	a	24.5	a			86.8	a	66.0	ab	56.7
G.41	22.6	bc	34.5	ab	60.7	abc			24.2	ab			48.4	cd	64.3	ab	42.4
G.935	33.0	abc	36.1	ab	59.2	abc	44.5	ab	14.6	abc			69.0	ab	59.3	b	45.1
G.969	45.9	a	29.8	ab	71.6	ab							73.4	ab	57.8	b	55.7
M.26 EMLA	20.1	c	28.4	ab	35.1	c	28.7	abc	11.4	bc	30.5	b	45.1	cd	52.8	b	31.5
M.9 T337	28.0	abc	35.4	ab			27.6	bc	20.1	abc	43.6	ab	40.5	d	55.8	b	35.9
V.1	33.1	abc	28.9	ab	63.0	abc	35.1	abc			45.1	ab	60.9	bc	61.9	ab	46.8
V.5	40.6	abc	32.7	ab			27.7	bc	19.5	abc	51.7	a	83.8	a	62.6	ab	45.5
V.6	42.4	abc	36.1	ab			37.5	abc	18.6	abc	53.7	a	84.0	a	59.7	b	47.4
V.7	45.3	a	34.2	ab			34.2	abc	23.6	abc	52.9	a	80.8	a	79.8	a	50.1
Mean	32.9		31.6		64.0		33.2		18.3		47.2		62.2		60.5		43.8
P-value	<0.0001		0.0002		<0.0001		0.0009		0.0020		0.0004		<0.0001		0.0021		

[y] Rootstocks ranked in alphabetical order.

Table 5. Cumulative yield efficiency (2015-2017; kg/tree/cm2 TCSA^x 2018) 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
B.10	1.3	ab	1.5	b-e	2.6	bc			0.8	ab			3.1	abc	1.7	a	1.8
G.11	1.4	ab	2.0	ab	3.7	ab	1.5	a-d	1.1	ab			2.5	bc	1.7	a	2.0
G.202	1.2	ab	1.3	b-e	2.2	c	1.7	abc	1.2	ab			4.0	a	1.9	a	1.9
G.214	1.7	a	1.6	bcd	4.1	a	2.1	a	1.0	ab	2.3	a	3.8	a	1.9	a	2.3
G.30	1.2	ab	1.4	b-e	2.6	bc	1.1	cde	0.8	ab			2.9	abc	1.7	a	1.7
G.41	1.4	ab	1.7	bc	2.8	abc			1.1	ab			3.2	ab	1.7	a	2.0
G.935	1.7	a	1.6	bcd	3.1	abc	1.9	ab	1.1	ab			3.9	a	1.8	a	2.2
G.969	1.5	ab	1.7	bc	2.8	abc							2.4	bc	1.4	abc	2.0
M.26 EMLA	0.8	b	1.1	cde	1.6	c	1.2	b-e	0.5	b	1.3	b	2.5	bc	1.3	abc	1.3
M.9 T337	1.1	ab	2.6	a			1.7	abc	1.3	a	2.3	a	3.2	abc	1.6	a	2.0
V.1	0.9	ab	0.8	e	1.9	c	0.9	de			1.7	b	2.5	bc	1.4	abc	1.4
V.5	0.9	ab	1.0	cde			0.6	e	0.9	ab	1.6	b	2.1	c	0.9	bc	1.1
V.6	1.0	ab	0.7	e			0.6	e	0.8	ab	1.5	b	2.2	bc	0.9	c	1.1
V.7	1.0	ab	0.9	de			0.7	e	1.0	ab	1.6	b	2.4	bc	1.5	ab	1.3
Mean	1.2		1.4		2.7		1.3		1.0		1.7		2.9		1.5		1.7
P-value	0.0023		<0.0001		<0.0001		<0.0001		0.0089		<0.0001		<0.0001		<0.0001		

^{x} Trunk cross-sectional area.

Table 6. Fruit weight (g), averaged over all cropping years (2015-2018) 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
B.10	160	149	d[z]	210	ab		184	a			199	a	196	cd	183
G.11	178	165	a-d	227	ab	180	198	a			216	a	211	bcd	197
G.202	160	154	bcd	201	b	195	138	c			197	a	193	cd	177
G.214	156	153	cd	220	ab	200	169	abc	188	ab	206	a	209	bcd	188
G.30	158	166	a-d	231	ab	208	189	a			211	a	204	bcd	195
G.41	157	172	abc	219	ab		200	a			205	a	191	cd	191
G.935	161	158	a-d	214	ab	185	145	bc			211	a	189	d	180
G.969	171	149	d	212	ab						210	a	213	bcd	191
M.26 EMLA	168	170	abc	239	a	182	204	a	205	a	205	a	212	bcd	198
M.9 T337	173	165	a-d			180	197	a	191	ab	202	a	200	cd	187
V.1	170	171	abc	233	ab	217			181	b	205	a	213	bcd	199
V.5	165	174	ab			198	181	ab	186	ab	203	a	263	a	196
V.6	171	176	a			209	186	a	182	b	207	a	240	ab	196
V.7	176	175	a			202	184	a	189	ab	216	a	230	abc	196
Mean	166	164		220		196	181		189		207		212		191
P-value	0.2644	<0.0001		0.0113		0.0867	<0.0001		0.0276		0.0254		<0.0001		

[x] Trunk cross-sectional area.

Table 7. Tree height (m), as of 2018 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
B.10	2.5	e[z]	3.1	e	3.2	c			1.9	ab			3.4	f	4.1	cd	3.0
G.11	3.3	a-e	3.8	abc	3.4	abc	3.5	abc	1.8	ab			4.3	a-d	4.2	bcd	3.4
G.202	3.1	b-e	3.5	cde	3.2	c	3.2	c	1.3	c			3.6	def	3.9	d	3.1
G.214	2.7	de	3.6	bcd	3.5	abc	3.5	abc	1.9	ab	3.5	ab	4.1	a-e	3.9	d	3.3
G.30	3.4	a-d	4.1	a	3.8	a	3.6	abc	2.0	ab			4.7	a	4.1	cd	3.7
G.41	3.0	b-e	3.5	cde	3.3	bc			2.0	a			3.6	ef	4.1	cd	3.2
G.935	2.8	cde	3.5	cde	3.2	c	3.3	bc	1.6	bc			3.9	b-f	4.0	cd	3.2
G.969	3.6	abc	3.3	de	3.7	ab							4.4	abc	4.1	cd	3.8
M.26 EMLA	3.4	a-e	3.5	cde	3.4	abc	3.3	bc	1.8	ab	3.3	ab	3.7	c-f	4.3	bcd	3.3
M.9 T337	3.1	b-e	3.3	de			3.3	abc	1.8	ab	3.2	b	3.8	b-f	4.0	cd	3.2
V.1	3.5	a-d	3.9	abc	3.5	abc	3.6	abc			3.3	ab	4.0	a-f	4.2	bcd	3.7
V.5	4.0	a	3.9	abc			3.7	a	2.0	ab	3.5	ab	4.3	a-d	4.8	a	3.7
V.6	3.7	abc	4.1	a			3.6	abc	1.9	ab	3.7	a	4.5	ab	4.6	ab	3.7
V.7	3.7	ab	4.0	ab			3.7	ab	1.9	ab	3.5	ab	4.6	ab	4.5	abc	3.7
Mean	3.3		3.6		3.4		3.5		1.8		3.4		4.1		4.2		3.4
P-value	<0.0001		<0.0001		<0.0001		0.0007		<0.0001		0.0225		<0.0001		<0.0001		

[y] Rootstocks ranked in alphabetical order.

[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 6. Tree width (m), as of 2018 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
B.10	1.7	f	2.0	g	1.3			2.9	a		1.5	cd	2.4	c	1.9
G.11	2.2	a-d	2.4	b-g	1.3	1.5	ab	2.7	ab		1.8	ab	2.6	bc	2.0
G.202	1.9	def	2.2	efg	1.2	1.2	b	2.1	c		1.4	d	2.5	c	1.8
G.214	1.7	f	2.0	g	1.2	1.5	ab	2.6	ab	2.5	1.6	bc	2.5	c	2.0
G.30	2.3	abc	2.9	ab	1.5	1.6	a	2.9	a		1.9	a	2.6	bc	2.2
G.41	1.7	ef	2.3	d-g	1.2			2.8	ab		1.6	bc	2.8	abc	2.1
G.935	2.0	c-f	2.4	c-g	1.3	1.5	ab	2.4	bc		1.7	abc	2.4	c	2.0
G.969	2.1	b-e	2.2	fg	1.4						1.8	ab	2.7	abc	2.0
M.26 EMLA	2.2	a-d	2.6	a-f	1.4	1.4	ab	2.7	ab	2.3	1.5	cd	2.5	c	2.1
M.9 T337	2.1	a-e	2.2	efg		1.5	ab	2.7	ab	2.3	1.5	cd	2.4	c	2.1
V.1	2.1	b-e	2.7	a-d	1.4	1.4	ab			2.3	1.7	abc	2.8	abc	2.1
V.5	2.3	abc	2.6	a-e		1.6	a	2.7	ab	2.2	1.9	a	3.0	ab	2.3
V.6	2.5	a	2.9	a		1.7	a	2.8	ab	2.4	1.9	a	3.2	a	2.5
V.7	2.4	ab	2.7	abc		1.7	a	2.8	ab	2.5	1.9	a	3.0	ab	2.5
Mean	2.1		2.4		1.3	1.5		2.7		2.4	1.7		2.7		2.1
P-value	<0.0001		<0.0001		0.0729	0.0014		<0.0001		0.1287	<0.0001		<0.0001		

[y] Rootstocks ranked in alphabetical order.
[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.