ANNUAL REPORT TO NC – 140
2003 DWARF APPLE ROOTSTOCK TRIAL SUMMARY FOR THE 2010 SEASON

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The 2003 Dwarf rootstock trial was established in the spring of 2003 with 15 cooperators. During the past several years four cooperators have dropped out for various reasons and no data were received from WI for 2010. Nine core states received trees on 18 rootstocks and four of these states received an additional five rootstocks. Five states received a partial planting of 11 rootstocks. The scion cultivar is 'Gibson Golden Delicious'. Each cooperator received 8 trees per rootstock for most rootstocks, but most states got only 7 trees of 5 rootstocks and three states got only 6 trees of one rootstock.

At each location the experimental design is a generalized randomized complete block design. There are two trees (referred to as "tree 1" and "tree 2") of each rootstock randomized within each of four blocks per location. Trees are being trained to the Vertical Axis system following Terence Robinson's "simplified pruning and training plan for the Vertical Axis system."

The letter "X" has been placed in boxes in the table below to indicate cooperators who have submitted data for the first 8 years of this trial.

Year	AR	BC	CA	CHIH	GA	IA	KY	ME	NY	OH	PA	UT	WI
2003		X	X	X		X	X	X	X		X	X	X
2004	X	X	X	X	X	X	X	X	X		X	X	X
2005	X	X	X	X	X	X	X	X	X		X	X	X
2006	X	X	X	X	X	X	X	X	X		X	X	X
2007	X	X	X	X	X	X	X	X	X	X	X	X	X
2008		X	X	X	X	X	X	X	X		X	X	X
2009		X	X	X		X	X	X	X		X	X	X
2010		X	X	X		X	X	X	X		X	X	

<u>Collection and Transmission of data for the 2010 growing season</u>

Although reporting is improving, some cooperators still did not follow instructions for coding the data or sending data for the response variables I requested. The most common problems included:

1. Using the wrong code for the rootstocks and for the subsamples ("tree 1" and "tree 2"). There are not 8 blocks in this experiment; there are 4 blocks and each block has 1 or 2 trees for each rootstock.
2. Including variables that I don't request – "such as row number" or "rootsuckers" or "number of blossoms".
3. Placing columns in the wrong order

4. Remember that there are two trees for each rootstock in each block; unless you received less than 8 trees for a rootstock, in each block there should be a tree coded as "1" and one tree coded as "2". Some cooperators numbered them differently.

Before sending data next year, please look at the data set to confirm that it follows the format outlined below.

1. E-mail is the preferred method of receiving data sets. Use spread sheets that can be read in Windows 2010.

2. ***Avoid the newest versions of any spreadsheet***.

3. ***Please proof data sets before sending them to me***.

- Make sure that you have the appropriate number of blocks for each rootstock and the appropriate number of rootstocks for each block.
- Make sure the units are correct.
- Make sure the values seem realistic.
- Make sure the rootstock codes are correct and in the correct column.
- If the data are sorted in a spreadsheet, make sure *all* columns are sorted correctly.

4. If values are calculated in spreadsheets, please send only the values and not the formulas.

5. Report "tree status" as 0 = dead, 1 = living, or 2 = missing. Missing trees are those that are dead or severely injured by mechanical injury, wildlife, or herbicides. If a 0 or a 2 is recorded for status, then all other columns for that tree should have dots.

6. Include "dots" or "periods" in all cells where data are missing, but enter a zero where zero is the appropriate value.

7. When a tree dies, continue to report status for that tree. Do not eliminate the tree from the data set and enter dots for all response variables except "status".

8. Please put the entire data set on one sheet. Some cooperators put data for different blocks on different sheets within an Excel notebook. This increases the time to proof and consolidate the data set.

PLEASE, PLEASE, PLEASE – Do not simply copy spread sheets from last year until you have first looked it over to make sure the rootstock codes are correct and columns are in the correct order. A few cooperators submit the same incorrect codes each year.

An example of the spreadsheet for data collected in 2010 is provided below.

STATE _____. Data for the 2003 Dwarf Rootstock Planting for the 2011 season

Additional information about your planting: Select one response per question.

1. Was irrigation provided? (yes or no)
2. Replant history: Was this planting preceeded by apple trees, fruit trees other than fruit trees, no fruit trees.
3. Site preparation. This site was not fumigated before this planting, this site was fumigated before planting

1 Year	2 site	3 Block	4 Tree	5 Rootstock code	6 Status	7 TCSA	8 Fruit wt. (g)	9 Yield (Kg/tree)
2011	MI	1	1	JM1	1	xx.x	xxx	xx.x
2011	MI	1	2	JM1	1	xx.x	xxx	xx.x
2011	MI	2	1	JTEG	1	xx.x	xxx	xx.x
2011	MI	2	2	JTEG	0	.	.	.
2011	MI	2	1	B9	1	xx.x	xxx	xx.x
2011	MI	2	2	B9	1	xx.x	xxx	xx.x
2011	MI	2	1	T337	2	.	.	.
2011	MI	2	2	T337	1	xx.x	xxx	xx.x

Column 1: year is 2011
Column 2: site should be in capital letters, use same abbreviation as in the annual report.
Column 3: Block (1, 2, 3, or 4)
Column 4: Tree number (1 or 2)
Column 5: Rootstock – use the codes listed in the table below ("code to report"). Use all capital letters and no spaces.
Column 6: Tree status (0=dead, 1=live, or 2=missing)
Column 7: Trunk cross-sectional area (cm^2 measured fall 2011)
Column 8: Fruit weight (grams per fruit)
Column 9: Yield (kg/tree)

Preferred Format: Excel.

Use rootstock codes in the following table for the 2003 Dwarf rootstock trial. All letters must be capitalized and there must be no spaces or periods between characters. The shaded columns are the rootstock names. The non-

shaded columns are the codes to use in your spread sheets. The reason for the codes is to shorten the names.

Code to Report	Rootstock Name		Code to Report	Rootstock Name
CG3041	CG.3041		PI5683	PiAu 56-83
CG5935	CG.5935		B9	B.9
CG6210	CG.6210		Pajam2	M.9Pajam2
JTEG	J-TE-G		M26	M.26
JTEH	J-TE-H		T337	M.9T337
JM1	JM.1		G16	G.16
JM2	JM.2		JM4	JM.4
JM7	JM.7		JM5	JM.5
JM8	JM.8		JM10	JM.10
PI5111	PiAu 51-11		PI362	PiAU 36-2
PI514	PiAU 51-4		CG5179	CG.5179
B62396	Bud.62-396			

Summary of the data collected in 2010 for the 2003 rootstock trial.

Tree Survival. Tree survival was greatly influenced by location (Table 1). Tree survival was so poor in CA that they were not included in the statistical analysis. All trees survived in IA and survival was greater than 90% in BC, ME, NY, and PA, whereas survival was less than 80% of the trees in the core group of rootstocks survived in KY and UT. In the core group, rootstocks with less than 90% survival included G.16, M.26, and M.9Pajam2. The standard rootstocks, B.9, M.26 and the M.9 clones all had less than 40% survival in CA, but trees on B.62396, CG.5935 and J-TE-H had good survival. Of the rootstocks not in the core group, JM2, JM4, CG.6210, had good survival at all locations.

Trunk cross-sectional area. The most vigorous trees were reported for KY, slightly less vigorous were trees at UT and PA and trees in CA were least vigorous (Table 2). In the core group of rootstocks, the two PI rootstocks are more than twice as large as any of the others. B.9 is about half the size of CG3041, which is the next smallest. Rootstocks with similar TCA to M.9 NAKBT337 include G.16, CG.3041, and B.62396, whereas CG.5935, and J-TE-H were similar to M.9 Pajam2. Of the non-core rootstocks, PI151-11, PI36-2, JM.2 and JM.8 were considerably more vigorous than M.26. Trees on JM.7, CG.6210, CG.5179 and JM.1 were similar in size to M.9Pajam2 at some locations, but were considerably larger than M.9 Pajam2 at other locations. JM.7 and CG.6210 were similar to M.26 in vigor at some locations.

Cumulative Yield Efficiency.

Since a single season's data can be misleading due to alternate bearing, cumulative yield efficiency (CYE) is presented in Table 3. CYE is highest in BC and NY and lowest in CHIH, but rootstock means did not differ significantly at CHIH. Averaged across the eight locations, CYE was highest for trees on B.9, CG.3041 and CG.5935, followed by B.62396 and M.9 NAKBT337. Trees on the two PI rootstocks had the lowest CYE. Of the non-core rootstocks, J-TE-G had extremely high CYE at most locations.

Table 1. Survival (%) of 'golden Delicious' apple trees in 2010 on 23 rootstocks planted in 2003.[z]

[z] Lsmeans and p-values (obtained with the slice option) for location are calculated from the 11 core rootstocks.

Stock	BC	CA	CHIH	IA	KY	ME	NY	PA	UT	WI	Mean	Slice
B62396	88	88	100	100	100	100	100	100	62		95	0.026
B9	100	25	100	100	50	100	100	88	100		92	0.001
CG3041	88	50	75	100	88	100	100	100	75		91	0.136
CG5935	100	88	86	100	25	100	100	100	88		87	0.001
G16	62	75	62	100	50	88	88	100	88		80	0.001
JTEH	100	100	52	100	100	100	100	100	100		95	0.025
M26	100	12	88	100	75	100	100	100	25		85	0.001
M9P2	100	12	100	100	88	100	100	100	25		89	0.001
PI 51-4	100	-	83	100	100	100	100	100	86		96	0.790
PI 56-83	88	---	88	100	100	100	100	100	100		98	0.970
T337	88	38	88	100	88	100	100	100	62		91	0.033
Mean	94	---	85	100	78	98	98	98	74			
Slice	0.089	---	0.019	1.000	0.001	0.997	0.997	0.997	0.001			
CG5179	---	88	---	88	---	---	88	---	---			
CG6210	87	71	---	87	---	100	100	100	86			
JM1	44	88	---	100	---	100	100	83	68			
JM2	88	0	---	100	---	100	100	100	100			
JM4	---	88	---	100	---	---	100	---	---			
JM5	---	40	---	100	---	---	100	---	---			
JM7	73	57	---	75	---	86	100	85	72			
JM8	41	71	---	100	---	100	100	100	68			
JM10	---	75	---	100	---	---	100	---	---			
J-TE-G	87	71	---	85	---	100	100	100	12			
PI36-2	---	0	---	100	---	---	100	---	---			
PI51-11	88	75	---	88	---	100	100	100	43			

Table 2. Trunk cross-sectional area (cm2) of 'Golden Delicious' apple trees in 2010 on 23 rootstocks planted in 2003.[z]

Stock	BC	CA	CHIH	IA	KY	ME	NY	PA	UT	WI	Mean	Slice
B62396	29.9	19.2	45.3	61.5	72.4	40.6	30.7	49.3	48.3		47.2	0.001
B9	17.2	4.7	19.6	23.4	19.4	24.5	15.1	34.2	20.2		21.7	0.161
CG3041	36.0	38.8	43.0	42.8	68.9	34.2	30.3	41.5	44.4		42.6	0.001
CG5935	40.9	68.1	51.0	65.2	61.5	49.3	28.9	49.3	56.8		50.4	0.001
G16	33.5	64.3	46.7	44.6	78.5	37.4	25.6	47.4	48.0		45.2	0.001
JTEH	44.6	48.7	39.0	64.6	85.4	40.4	44.5	70.5	76.1		58.1	0.001
M26	42.9	81.5	48.9	64.0	88.9	47.0	35.5	74.9	88.8		61.4	0.001
PI 51-4	97.2	---	86.9	135.8	188.6	60.9	96.0	127.8	176.8		121.2	0.001
PI 56-83	110.1	---	124.3	136.0	219.7	83.4	89.1	134.3	182.2		134.9	0.001
M9P2	30.7	41.0	28.9	55.5	100.1	31.3	36.9	62.4	73.3		52.4	0.001
T337	26.3	32.9	21.3	55.5	74.8	26.4	30.0	56.5	58.1		43.6	0.001
Mean	46.3	---	50.4	68.1	96.2	43.2	42.1	68.0	79.4			0.001
Slice	0.001	---	0.001	0.001	0.001	0.001	0.001	0.001	0.001			
CG5179	---	55.6	---	56.5	---	---	34.5	---	---			
CG6210	44.4	126.0	---	73.1	---	51.6	51.4	72.7	68.5			
JM1	10.4	129.0	---	41.2	---	45.6	71.7	63.1	71.2			
JM2	102.6	---	---	72.9	---	67.8	51.5	147.6	153.3			
JM4	---	213.0	---	115.1	---	---	117.7	---	---			
JM5	---	203.4	---	90.7	---	---	64.6	---	---			
JM7	37.6	150.5	---	127.7	---	50.1	114.0	61.8	69.1			
JM8	33.5	135.2	---	57.7	---	55.3	38.1	99.8	143.8			
JM10	---	204.0	---	70.7	---	---	44.4	---	---			
J-TE-G	11.7	10.6	---	24.7	---	13.6	9.0	24.9	19.2			
PI36-2	---	---	---	120.3	---	---	90.7	---	---			
PI51-11	39.9	66.1	---	68.3	---	39.2	54.6	76.9	162.1			

[z] Lsmeans and p-values (obtained with the slice option) for location are calculated from the 11 core rootstocks.

Table 3. Cumulative yield efficiency ($kg \cdot cm^{-2}$ TCA) of 'Golden Delicious' apple trees in 2010 on 23 rootstocks planted in 2003.[z]

Stock	BC	CA	CHIH	IA	KY	ME	NY	PA	UT	WI	Mean	Slice
B62396	4.6		0.5	1.5	3.1	2.3	4.6	2.8	2.1		2.7	0.001
B9	5.3		0.2	2.4	2.2	2.4	5.7	2.9	3.0		3.0	0.001
CG3041	4.6		0.5	2.4	2.7	3.1	4.6	2.8	2.4		2.9	0.001
CG5935	4.8		0.5	2.0	2.4	2.6	5.1	2.7	2.7		2.9	0.001
G16	3.7		0.5	2.0	2.2	2.4	3.6	2.9	2.5		2.5	0.001
JTEH	3.5		0.3	1.5	2.9	1.9	3.4	1.6	2.0		2.1	0.001
M26	3.8		0.5	1.5	2.1	1.9	4.1	1.7	1.2		2.1	0.001
M9P2	4.4		0.2	1.8	2.4	2.7	4.1	2.3	1.6		2.4	0.001
PI 51-4	2.1	---	0.3	0.6	1.6	1.7	2.3	1.6	0.9		1.4	0.001
PI 56-83	2.5	---	0.4	0.4	1.4	1.6	2.3	1.2	0.9		1.4	0.001
T337	4.1		0.3	1.7	2.2	3.1	4.4	2.2	2.5		2.6	0.001
Mean	4.0	---	0.4	1.6	2.3	2.3	4.0	2.5	2.0			
Slice	0.001	---	0.929	0.001	0.001	0.001	0.001	0.001	0.001			
CG5179	---		---	1.7	---	---	4.0	---	---			
CG6210	3.7		---	1.9	---	2.3	4.5	2.4	2.0			
JM1	3.0		---	1.5	---	2.7	1.9	2.0	1.6			
JM2	1.9	---	---	0.7	---	1.7	2.4	0.7	0.8			
JM4	---		---	1.1	---	---	1.2	---	---			
JM5	---		---	0.5	---	---	2.5	---	---			
JM7	4.0		---	0.3	---	2.5	1.6	2.3	1.9			
JM8	2.2		---	0.9	---	2.3	4.2	1.6	1.2			
JM10	---		---	1.6	---	---	3.6	---	---			
J-TE-G	6.4		---	2.5	---	3.9	5.3	3.5	1.6			
PI36-2	---	---	---	0.7	---	---	2.5	---	---			
PI51-11	3.2		---	1.3	---	1.8	2.9	1.5	0.9			

z Lsmeans and p-values (obtained with the slice option) for location are calculated from the 11 core rootstocks

Effect of crop density on fruit weight:

Since CG.3041 and CG.5935 are slightly more productive than M.9 and M.26, we need to know if these rootstocks produce smaller fruit. Analysis of covariance was used to adjust average fruit weight (FW) for differences in crop density (CD). A number of assumptions are required for a valid analysis of covariance, such as all rootstocks in the analysis should have a similar range of CDs and there should be a non-significant rootstock x CD interaction.

When all 11 rootstocks were evaluated, the ranges of CD did not overlap adequately at any site to perform a normal analysis of covariance. There was adequate overlap for the four rootstocks of most interest (CG.3041, CG5935, M.26 and M.9 NAKBT337), so only those four rootstocks were included in the analysis. Only four sites (BC, KY, NY, and PARS) had CDs in the range of a full crop and with similar ranges in 2010. Since past experience shows that the site x rootstock x CD interaction is always significant, and the

ranges for CD did not overlap very well for all locations, each location was analyzed separately. At all locations the rootstock x CD interaction was not significant at the 5% level, so a normal analysis of covariance was performed by location. At all locations except KY, the covariate was significant at the 5% level; even at KY the covariate was significant at the 0.059 level.

Table 4. Minimum and maximum values for crop density (CD) and means and LSmeans for fruit weight (FW) adjusted for CD for four rootstocks at four locations in 2010.

			CD (fruit/cm^2 TCA)		FW (g)	
Site	Rootstock	N	Minimum	Maximum	Mean	LSmean [z]
BC	CG.3041	7	4.01	6.79	216	215 a
	CG.5935	7	4.20	6.72	203	206 a
	M.26	8	3.20	5.89	217	200 a
	T337	7	4.14	8.45	202	219 a
KY	CG.3041	7	4.19	5.94	209	212 a
	CG.5935	1	5.52	5.52	196	202 a
	M.26	6	3.02	5.37	203	198 a
	T337	5	4.07	6.40	212	213 a
NY	CG.3041	8	4.16	8.94	202	205 ab
	CG.5935	8	4.05	9.93	191	193 b
	M.26	8	3.10	7.82	214	208 a
	T337	8	4.48	8.57	211	212 a
PARS	CG.3041	8	2.68	5.07	192	197 bc
	CG.5935	8	1.67	3.77	192	192 c
	M.26	8	1.12	3.21	215	208 ab
	T337	8	1.70	3.53	210	210 a

[z] LSmeans for fruit weight , adjusted for crop density, followed by common letters within location do not differ at the 5% level of significance, by DIFF.

In BC and KY fruit weight was not influenced by rootstock. NY had the highest crop densities and fruit weight was slightly lower for trees on CG.5935 than for trees on M.26 and M.9 NAKBT337. Crop densities were lower in PA than the other locations and trees on CG.3041 had slightly higher CDs. In PA FW was highest for trees on M.9 NAKBT337 and lowest for trees on CG.5935. In both NY and PA, FW was lowest for trees on CG.5935, but those trees also had the highest CD and the analysis of covariance may not have adequately accounted for this difference in CD. I plan to evaluate FW for these four rootstocks for several years to confirm that the effect of rootstock on FW is not very consistent.