Progress Reports from Rootstock Research Proposals

EARLY INTERMEDIATE LEVEL TESTING OF NEW CG. APPLE ROOTSTOCKS IN THE PACIFIC NORTHWEST

Bruce Barritt, Washington State University, Tree Fruit Research and Extension Center

Data from all trials must be considered preliminary because the trials are young with only 2 or 3 years of production data.

1998 Cornell-Geneva Gala Trial. In 2002 (year 5) the most yield efficient of 12 rootstocks were CG.12 and CG.757 and the least efficient were CG.910 and P.14. On a cumulative basis, M.9 WAF, CG.12 and CG.757 were the most efficient and P.14 and CG.910 the least efficient.

1998 Cornell-Geneva Jonagold Trial. In year 5 (2002), there were no significant differences in yield efficiency among the rootstocks CG.41, G.16 and M.9E. There were also no differences on a cumulative basis.

1999 Cornell-Geneva Fuji Dwarf Trial. In 2002 (year 4), the most yield efficient of 10 rootstocks were CG.5179, Supporter 2 and M.9 and the least efficient were Supporter 4 and CG.4013. On a cumulative basis, the most efficient rootstocks were CG.5179, CG.16TC and CG.16N and the least efficient were Supporter 4 and CG.4013.

1999 Cornell-Geneva Fuji Semi-dwarf Trial. In 2002 (year 4), the most yield efficient of seven rootstocks were CG.4814 and CG.30N although none was significantly different from M.26 or M.7. On a cumulative basis, the most efficient rootstocks were CG.4814 and CG.30N and the least efficient were CG.4210 and M.7.

1999 Cornell-Geneva Gala Dwarf and Semi-dwarf Trials. In 2002 (year 4) the three dwarfing CG rootstocks fell between M.9 and M.26 in tree size (TCA). In year 4 yield efficiency for the dwarf rootstocks was highest for CG.4214 and lowest for M.26. On a cumulative basis, yield efficiency was high and similar for CG.4213, CG.4214 and M.9. Of four semi-dwarf rootstocks, all were similar to MM.106 in tree size (TCA) except CG.6210 which was larger. In year 4 yield efficiency was highest for CG.5046. One rootstock, CG.5046, had higher cumulative yield than MM.106.

DIFFERENTIAL SUSCEPTIBILITY OF APPLE ROOTSTOCKS TO FOUR STRAINS OF FIRE BLIGHT AND THREE LATENT VIRUSES

Gennaro Fazio, Terence Robinson, H.T. Holleran, H.S. Aldwinckle, New York State Agricultural Experiment Station, Cornell University

Resistance of Apple Rootstocks to Three Latent Viruses

A virus-testing experiment was performed to test sensitivity of Cornell and other commercial rootstocks for apple stem grooving virus, apple stem pitting virus and chlorotic leaf spot virus. Apple rootstock liners were planted in a field nursery in the spring of 2001. In late August the liners were budded with virus-infected budwood obtained from NRSP-5. The genotypes used were M.9, 5046, G.16, G.30, 6874, 7707, 5935, 5179, 6210, Maruba, 4214, 4013, 4011, 4003, 4814 and 3041. Three replications (5 rootstocks per rep.) for each virus were budded, for a total of 45 rootstocks to be tested for each genotype. Data were taken for "bud take" in early spring of 2002 and for bud survival and tree growth during the growing season. Dead rootstocks were also noted. When the scion shoots were approximately 18 inches long, the graft strength was tested by applying pressure to the scion. This spring the trees will be planted in an orchard and survival will be recorded for 2 years. The preliminary data taken from the nursery in 2002 show the most susceptible rootstocks to be G.16, 5179 and 6210. The three rootstocks showing the most resistance are Marubakaido, 5935 and 5046. Data are still being analyzed from the nursery that was removed this fall.

FIRST GRAFTED EVALUATION OF MSU'S SWEET CHERRY ROOTSTOCK SELECTIONS

Amy Iezzoni, Ron Perry, Matt Whiting, Michigan State University and Washington State University

Objective The objective was to evaluate the MSU sweet cherry rootstock candidates for their suitability as commercial rootstocks for sweet cherry. The goal is to identify rootstock candidates that are easily propagated by softwood cuttings, virus tolerant and induce dwarfing and precocity without a reduction in fruit size.

Significant Findings in Year 2002

- Twelve out of the 50 MSU rootstock selections that were screened for virus tolerance in 2002 were found to be sensitive to Prune Dwarf Virus (PDV) and *Prunus* Necrotic Ringspot Virus (PNRSV). These susceptible selections were discontinued.
- 25 additional MSU rootstock selections were planted in the test plot at MSU's Clarksville Horticultural Experiment Station (CHES) with Hedelfingen scion. This represents an additional 119 trees.
- 19 MSU rootstock selections were planted in the first planting of the test plot at WSU-Prosser. This represents 102 trees.
- It is projected from nursery counts that year 2003 and 2004 plantings will result in the evaluation of 93 MSU rootstock selections totaling 667 and 519 trees, respectively, at CHES and Prosser.
- All but one of the 20 MSU rootstock selections planted at CHES in 2001 induced flowering on Hedelfingen and Bing scions. In general, the MSU rootstock selections induced similar or fewer flowers per tree than the GI 6 rootstock.

Results and Discussion

Twenty-four percent (12/50) of the MSU selections that were screened for PDV and PNRSV sensitivity by Bill Howell were found to be susceptible. These 12 selections were discarded. The decision to include the virus screen prior to plot testing has proven to be a valuable strategy due to the large number of selections discarded.

There are currently 45 MSU rootstock selections, totaling 273 trees, under test in the plot at CHES (Figs. 1 and 2). The control is GI 6. The majority of the scions are Hedelfingen. However, because a decision was made to delay the planting of the Prosser plot until 2002, some of the rootstock selections planted in 2001 have Bing scions. The pollinator is Ulster/GI 6.

There are currently 19 MSU rootstock selections, totaling 102 trees, planted at the test plot in Prosser (Figs. 3 and 4). The control rootstock is GI 6 and the scion is Bing with Tieton/GI 6 as the pollinator.

At Meadow Lake Nursery there are 32 Bing/MSU rootstock and 60 Hedelfingen/MSU rootstock selections available for spring planting in the WSU and MSU plots, respectively.

Since 2001 was the last propagation year, propagation of some of the selections from previous years was repeated in an attempt to move forward with complete rootstock sets at both MSU and WSU. Assuming 50% bud take from August 2002 budding, we anticipate that the final planting in 2004 will bring the number of MSU test selections at MSU and WSU to 93 and 70, respectively (Figs. 1 and 3). The projected final tree numbers will be 677 and 519 for MSU and Prosser, respectively (Figs. 2 and 4).

In spring 2002, all the MSU rootstock selections except one induced flowering on Hedelfingen and Bing in the CHES plot that was planted in spring 2001 (Fig. 5). GI 6 resulted in a mean of 49 flowers per tree. The majority of the MSU rootstock selections resulted in a mean of 7 to 50 flowers per tree. Therefore, it appears as if selection for precocious flowering may be relatively easy. Unfortunately freeze damage to the flowers during bloom resulted in no fruit set. Based on this data, we anticipate that there will be flowering data and possibly fruiting data from the vast majority of the selections planted at the Prosser and CHES plots in 2003.

Mean cross-sectional area measurements of the MSU test rootstock selections planted in spring 2002 ranged from 20 to 35 mm (Fig. 6). GI 6 was in the group with the smallest measurement.

SUMMARY

The MSU cherry rootstock selection project is on target to complete planting of the first grafted trials at MSU and WSU by spring 2004. The abundance of bloom induced by the MSU rootstock selections planted a year ago in the MSU test plot indicate that precocious flowering is easy to achieve. This will allow us to begin to access productivity and fruit size at a young tree age.

SWEET CHERRY ROOTSTOCK EVALUATION

Frank Kappel, Pacific Agri-Food Research Centre

A, J, M Rootstock Second Test

This trial was planted in 1996. Tree size was significantly affected by rootstock but not by scion cultivar (Table 1). Largest trees were on F12/1 rootstock (the control), followed by M and J (about 85% the size of F12/1) and the smallest trees were on rootstock A (67% of F12/1). In 2002 trees on A had the highest yields (28 kg/tree) and trees on J and F12/1 had the least (19 kg/tree). Trees on M were intermediate (24 kg/tree). There was no difference in yield between Bing and Lapins in 2002. Fruit size was not affected by rootstock in 2002, however Lapins fruit were larger than Bing fruit again for the third year. Results for rootstock A are encouraging, therefore further trials are being contemplated.

Weiroot Rootstocks

This trial was planted in 1996. Compared to the control, the smallest trees were W72 (37% of F12/1) followed by W53 (53% of F12/1) and W158 and W154 (76% and 66%, respectively, of F12/1) (Table 1). Gi196/4 was not significantly different from F12/1 in trunk cross-sectional area. Trees on Gi196/4 had the highest yields in 2002 and trees on F12/1 and W72 had the lowest with the others intermediate. There were no significant differences in fruit size. Trees on W154 had a substantial number of root suckers ruling this rootstock out as having

FIGURE 1

The cumulative number of MSU rootstock selections currently planted and projected to be planted at Clarksville, MI. The majority of the rootstock selections have Hedelfingen scions while some of the selections also have Bing scions.

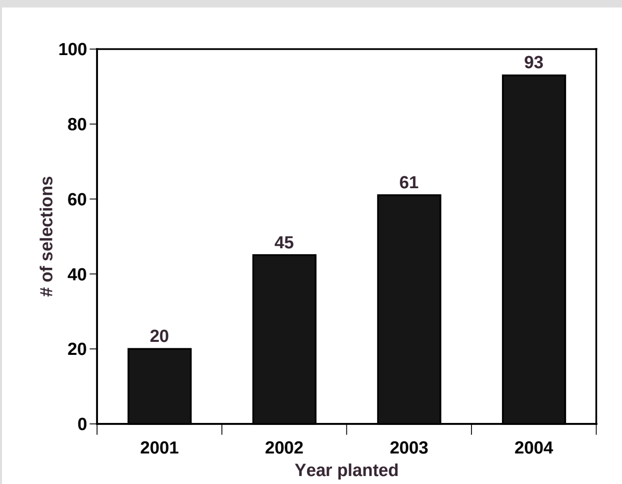


FIGURE 2

The cumulative number of trees currently planted and projected to be planted in the MSU rootstock selection test block at Clarksville, MI.

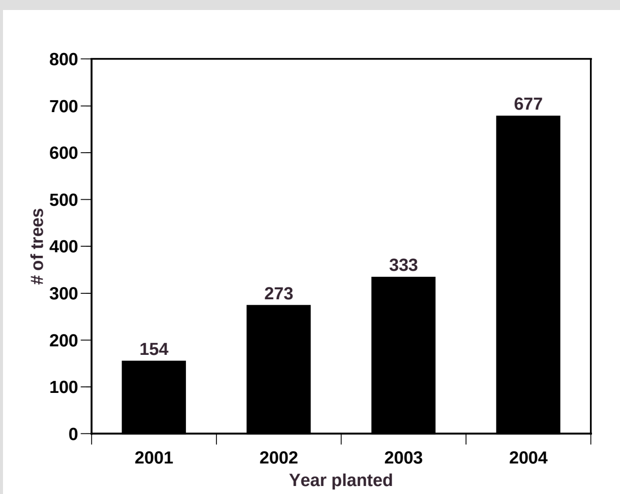


FIGURE 3

The cumulative number of MSU rootstock selections currently planted and projected to be planted in Prosser, WA. All of the rootstock selections have Bing scions.

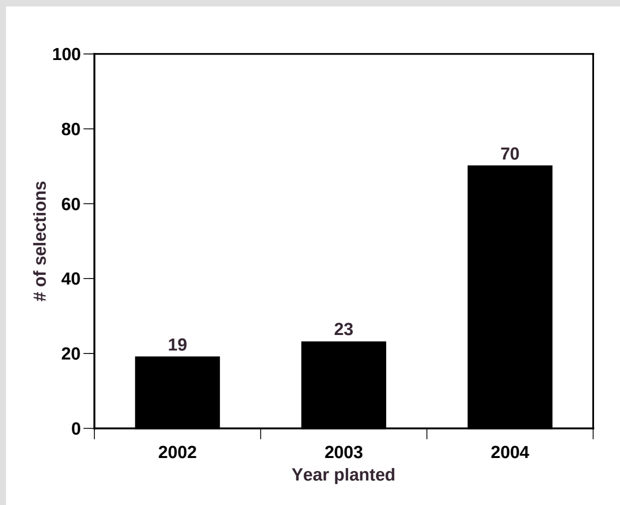
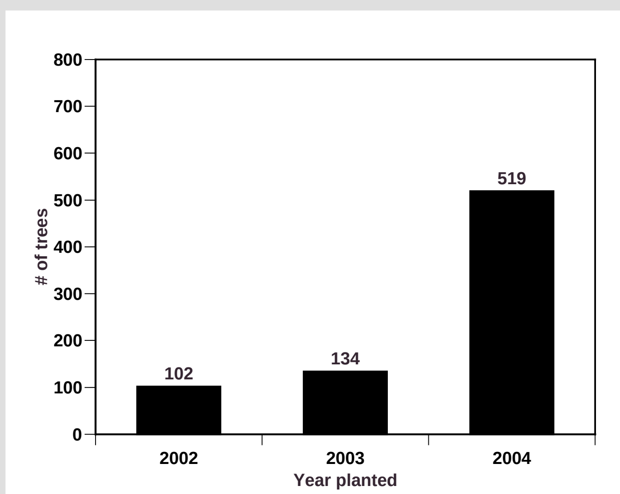


FIGURE 4

The cumulative number of trees currently planted and projected to be planted in the MSU rootstock selection test block at Prosser, WA.



any potential. This trial will likely be terminated after the 2003 season. The rootstock Gi196/4 warrants further investigation.

Sweetheart Rootstock Trial

This trial was planted in 1998. Largest trees were on the control rootstock mazzard, followed by trees on P50 (Table 1). Smallest trees were on G5, about 28% of the control. Trees on G6 were about two-thirds the size of trees on mazzard. Highest yields in 2002 were on G6 and lowest on P50. Yields of mazzard, G5 and J were intermediate. G6 had the highest cumulative yield and P50 the lowest. There was no effect by rootstock on fruit size. G5 may be too small a rootstock for self-fertile cultivars, vigor of the tree is being affected.

NC-140—Summerland

This trial was planted in 1998. Tree size continues to fall into 3 broad categories: standard size trees (mahaleb, mazzard, Gi318/17, G6, W13, G7 and W10); intermediate (Gi195/20, W158, G5 and W72); and dwarfing (edabriz, W154, Gi209/1, Gi473/10 and W53) (Table 1). Intermediate trees range in size from 79% of standard to 62% of standard. The dwarfing trees are between 59% of standard to 47%. Yields began improving with Gi473/10, G5, Gi195/20, G7, Gi209/1, W53 and edabriz having per-tree yields between 9.5 and 7.3 kg. Trees on W72, G6, Gi318/17, W154, W10 and W158 had yields between 5 to 3.4 kg. Trees on mahaleb, W13 and mazzard had yields of 2.2, 1.0 and 0.4, respectively. Average fruit weight was generally good for most rootstocks except for W53, Gi473/10 and mazzard.

Variety/Rootstock Interaction

This trial was planted in 1998. Again, trees on G5 were smaller than trees on mazzard (61% of standard) (Table 1). Smallest trees were Staccato, Celeste, Sonata, 13S-21-01 and Sweetheart, whereas the largest trees were 13N-07-39, Symphony, Sandra Rose, Samba, Skeena and Summit. Trees on G5 had 8 times the yield of trees on mazzard. Average fruit weight was not affected by rootstock in 2002.

TABLE 1

vTrunk cross-sectional area (TCA), yield and average fruit weight (AFW) in 2002, cumulative yield and yield efficiency of rootstocks in four trials. LS-means adjusted for missing values and mean separation within trial at P>0.05.

Rootstock	2002 TCA	2002 yield	2002 AFW	Cumulative yield	Yield efficiency
A, J, M Rootstock Second Test (Lapins and Bing, planted 1996)					
F12/1	206.6a	19.6b	10.2a	33.7a	0.17c
M	176.4b	23.9ab	9.6a	40.4a	0.24b
J	172.8b	19.0b	10.2a	33.6a	0.21bc
A	138.2c	27.6a	9.5a	43.7a	0.34a
Weiroot Rootstock Trial (Bing, planted in 1996)					
F12/1	161.9a	8.5c	9.5a	10.5c	0.064c
Gi196/4	148.2a	31.0a	9.8a	63.8a	0.428a
W158	122.3b	22.5ab	9.9a	46.3a	0.376ab
W154	106.9b	15.0bc	10.1a	22.0bc	0.202bc
W72	59.6d	6.4c	9.7a	18.5c	0.321ab
W53	85.2c	16.7bc	9.3a	45.2ab	0.495a
Rootstocks for Sweetheart (planted 1998)					
mazzard	94.5a	8.5b	9.0a	9.6c	0.11cd
G5	26.2d	9.2b	8.3a	14.5b	0.56a
G6	63.5c	17.7a	9.0a	21.8a	0.34b
J	70.3bc	11.0b	9.2a	12.4bc	0.18c
P50	90.9ab	4.1c	8.4a	4.4d	0.05d
NC-140 Rootstock Trial (Bing, planted 1998)					
mazzard	116.3ab	0.4f	7.5e	0.4f	0.004g
mahaleb	130.7a	2.2def	10.1abc	2.4ef	0.019g
G5	79.0efg	9.1a	10.3ab	11.8a	0.149abc
G6	110.2bc	4.6cd	10.4a	5.7cd	0.055efg
G7	96.6bcd	9.0a	10.2abc	11.6ab	0.126bcd
edabriz	69.1gh	7.3ab	9.2abcd	8.5bc	0.122bcd
Gi195/20	92.3de	9.0a	9.8abc	11.7a	0.141abc
Gi209/1	61.7gh	7.6a	9.3abcd	10.1ab	0.168ab
Gi318/10	114.3ab	4.6cd	10.2abc	5.7cde	0.059efg
Gi473/10	60.4h	9.5a	7.8e	11.5ab	0.189a
W10	95.0cde	3.8cd	9.5abcd	4.3de	0.051efg
W13	100.0bcd	1.0ef	9.2cd	1.1f	0.010g
W154	65.1gh	4.1cd	9.3abcd	4.5de	0.080def
W158	88.5def	3.4cde	9.7abc	3.7def	0.042fg
W53	54.8h	7.6a	8.4de	10.0ab	0.215a
W72	71.6fgh	5.0bc	9.4abcd	6.8cd	0.101cde

PHYSIOLOGICAL DETERMINATION OF THE MOST EFFICIENT PRUNING CUTS FOR BALANCING SWEET CHERRY CROPPING AND SHOOT RENEWAL ON GISELA ROOTSTOCKS

Gregory A. Lang and Marlene Ayala, Michigan State University

The 2002 growing season in Michigan was extremely challenging, following the worst spring frost damage in more than 60 years across nearly all of the cherry growing regions. Our initial research experiments for this project, utilizing branch and cropping treatments established on trees at MSU's Clarksville research station, were severely damaged by spring frost and set no crop. However, an alternative experiment was established several weeks later that allowed the development of the baseline relationships for photosynthetic activity of the major canopy leaf populations, i.e., leaves on

FIGURE 5

Mean flower numbers for GI 6(*) and 20 MSU rootstock selections that were planted at Clarksville, MI, in spring 2001. The mean values are summed over both Hedelfingen and Bing scions.

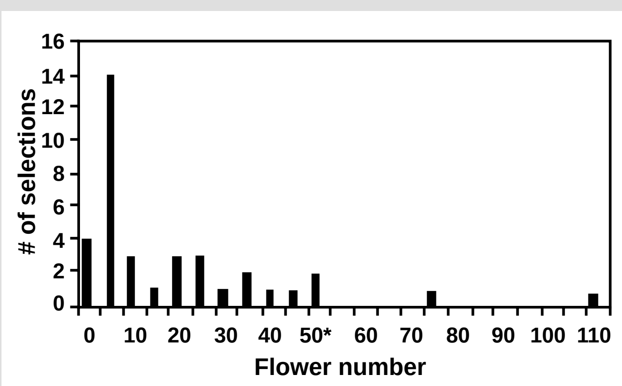
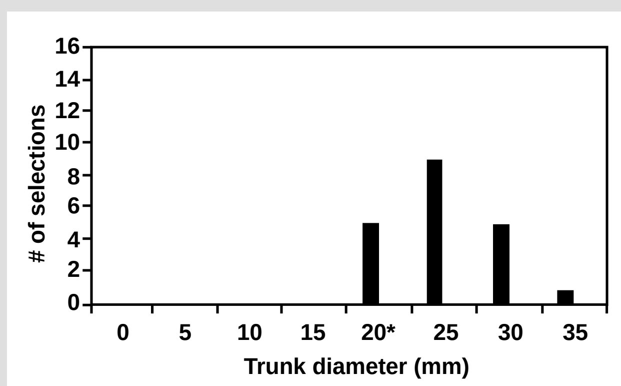


FIGURE 6

Mean trunk cross-sectional area for GI 6 (*) and 20 MSU rootstock selections that were planted at Clarksville, MI, in spring 2001. The mean values are summed over both Hedelfingen and Bing scions.



fruiting spurs (2- and 3-year-old shoots), on non-fruiting spurs (1-year-old shoots) and on current shoot growth, using a commercial orchard of Sam on the highly productive, dwarfing rootstock Gisela 5. The partitioning of carbohydrates, as determined via movement of photosynthetically fixed $^{13}CO_2$ from specific "pulsed" leaf populations to new vegetative growth and/or fruiting spurs, was sampled several times during Stage III fruit growth. At the time of this report, all of the tissue samples have been prepared and analysis via mass spectroscopy is ongoing. Preliminary results have detected a considerable supply of carbon from the non-fruiting spur leaves to developing spur fruits, as well as some to concurrent new shoot growth. There may be a "proximity" factor for supply to fruits which our further analyses may or may not confirm. If such a relationship can be confirmed and characterized, it would have important ramifications for the limiting (e.g., via pruning) of fruiting shoot lengths to optimize fruit growth potential. Work in 2002 will attempt to compare any "proximity" effect

FIGURE 7

Illustration of a 2-year-old (and associated 1-year-old) cherry shoot. Dark lines indicate the different sections by which the shoot was analyzed.

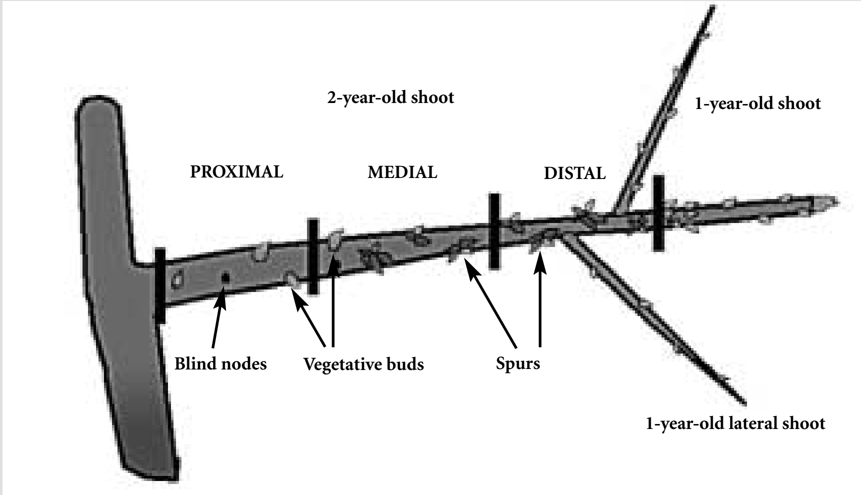
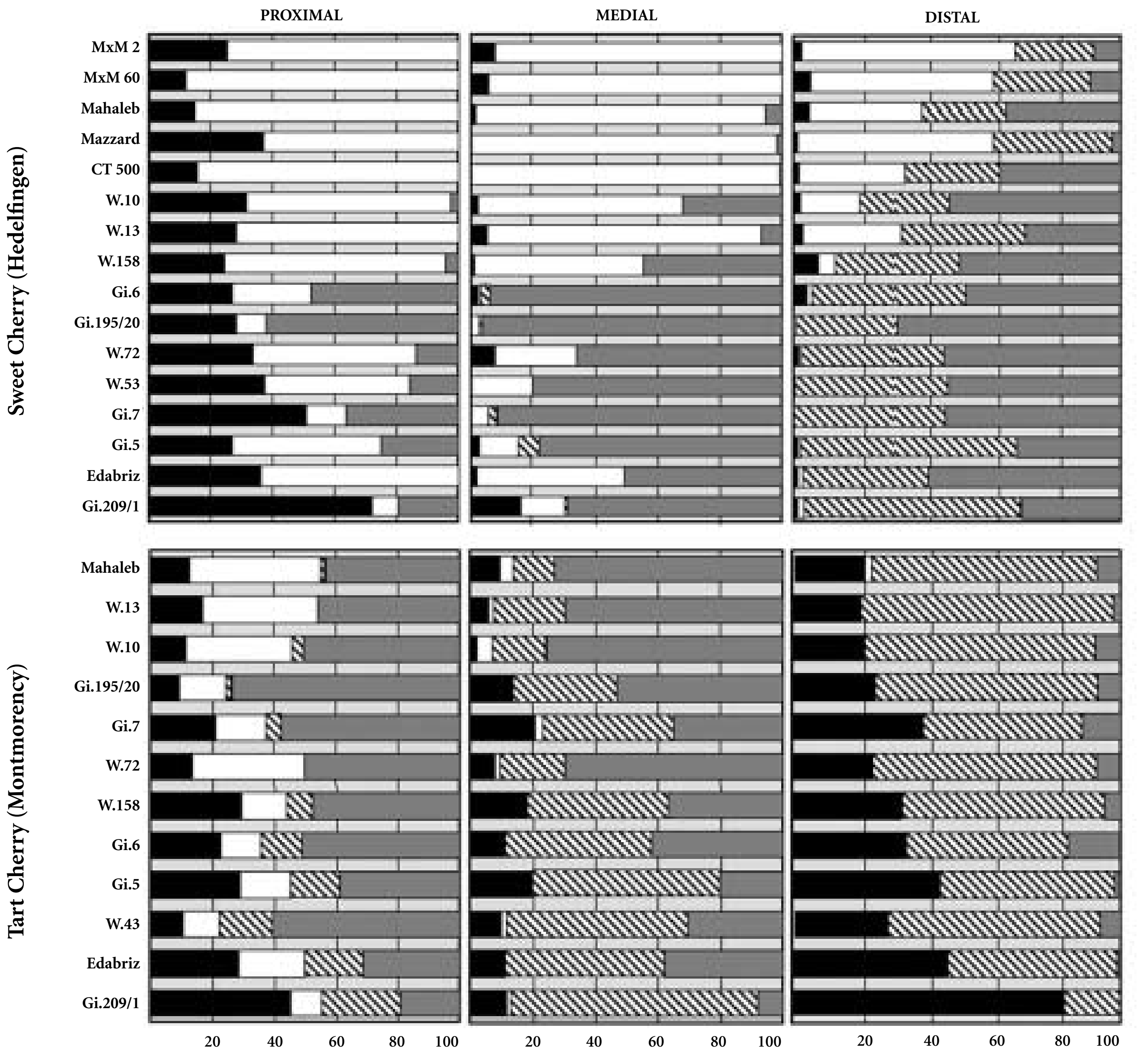


FIGURE 8

Percentage of nodes within each section (proximal, medial, distal) of a 2-year-old sweet cherry shoot having no buds (black), only vegetative axillary buds (white), lateral shoots (white/black stripe) or spurs (gray). Rootstocks are listed in order of decreasing vigor for sweet cherry (top) and tart cherry (bottom).



(which may be a key component of "balanced pruning") with the simple variability that may arise from different crop loads per standard total leaf area (a component of "spur extinction").

A second major experiment was imposed in late summer 2002 to pulse young orchard trees of Regina with $^{13}CO_2$ for partitioning into storage reserves. Subsequently we will be able to track the mobilization of carbohydrate reserves into spring flowers, fruits and new shoots and thereby estimate the point at which, during the spring, the importance of reserves is exceeded by the current season (photosynthetically fixed) carbohydrate supply. This will have important ramifications for cultural practices that optimize spring leaf area and activity, such as nitrogen and soil moisture availability.

FUNDAMENTAL ROOTSTOCK INFLUENCE ON FLOWERING AFFECTS TRAINING AND MANAGEMENT DECISIONS FOR CHERRY CROP LOAD AND FRUIT QUALITY

Gregory A. Lang and Ron L. Perry, Michigan State University

The 2002 growing season in Michigan was extremely challenging, following the worst spring frost damage in more than 60 years across nearly all of the cherry growing regions. The 1998 NC-140 cherry rootstock trial plots at Traverse City were severely damaged by spring frost and set no crops for either Hedelfingen sweet cherry or Montmorency tart cherry. Consequently, follow-up data (to 2001) were minimal. Instead, the analysis of the node-by-node data from 2001 was finished (see Figs. 7 and 8), revealing some interesting rootstock trends across tart and sweet cherries. Blind node formation was greatest on Gi.209/1 across both species, though to a much greater extent in tart cherries. As the vigor imparted by rootstocks decreased, the proportion of blind nodes increased in the proximal (lower) sections of annual branch growth for both species and, for tart cherries, there was also a similar trend in the distal (upper) section.

Lateral branching was much less in sweet cherries than in tart cherries, occurring almost exclusively in the distal section of the 2-year-old branch and generally occurring to a greater extent on the most dwarfing rootstocks than on those that were most vigorous (Fig. 8). This indicates that no rootstock within this trial significantly improved the formation of lateral

TABLE 2

New York 1993 NC-140 Liberty/CG rootstock trial.

Vigor class	Rootstock	TCA (cm^2) 2002	Fruit no. 2002	Yield 2002 (kg)	Yield eff. (kg/cm^2) 2002	Fruit size (g) 2002	No. suckers 2002	Cum. fruit no.	Cum. yield (kg)	Average fruit size (g)	Cum. yield efficiency (kg/cm^2)
D	CG.26	17.0	161	17.1	0.58	119	-	989	136.0	136	8.09
D	CG.3902	23.2	114	12.6	0.35	105	-	1078	152.7	142	5.26
D	CG.4247	33.0	320	32.5	0.84	102	-	1919	246.8	129	7.31
D	G.65	34.7	210	23.3	0.57	111	-	1217	161.2	132	4.63
D	CG.3041	43.8	301	37.7	0.75	129	-	1500	216.9	146	4.93
D	CG.3007	46.0	259	30.5	0.53	124	-	1636	227.2	139	4.94
D	CG.5179	51.2	246	33.9	0.60	138	-	1524	227.3	149	4.69
D	CG.11	61.5	323	38.3	0.57	119	-	1349	196.8	146	3.28
D	M.26	63.4	341	43.7	0.64	128	-	1656	250.2	151	4.05
D	M.9A	66.5	413	53.0	0.85	128	-	1853	273.0	147	4.83
D	M.9Emla	69.6	360	48.7	0.60	136	-	1673	258.7	155	3.77
D	CG.5701	103.4	336	85.0	0.61	247	-	2038	349.5	169	3.29
D	GG.3029	110.1	348	50.9	0.40	148	-	1650	266.2	161	2.49
D	CG.8	112.6	476	58.5	0.47	124	-	1892	286.8	152	2.54
LSD P<0.05		26.4	129	49.5	0.39	138		413	85.0	28	2.00
SD	CG.38	24.6	121	14.9	0.49	125	0.8	999	128.7	129	5.44
SD	CG.4003	49.5	191	25.7	0.66	135	0.3	1085	152.8	141	4.76
SD	CG.5202	81.4	329	47.6	0.57	145	3.7	1719	276.4	160	3.85
SD	CG.222	78.2	367	47.3	0.53	129	1.7	1990	296.4	149	3.94
SD	M.7A	86.9	375	47.5	0.50	125	4.5	1767	250.5	141	3.17
SD	G.30	78.8	407	59.9	0.68	149	2.8	2506	375.8	153	4.90
SD	CG.5156	90.1	410	57.2	0.58	140	4.8	2185	342.3	156	3.86
SD	CG.5046	56.9	412	51.6	0.87	126	13.5	1959	274.9	142	5.18
SD	CG.6874	67.7	414	48.6	0.64	117	0.5	2464	324.8	132	4.89
SD	CG.2	90.7	452	59.9	0.60	134	1.2	2018	314.4	156	3.53
SD	CG.6210	82.6	457	60.2	0.67	133	5.5	2366	353.7	149	4.35
SD	CG.7570	115.0	459	63.6	0.55	139	4.0	1986	324.7	164	2.99
SD	CG.6723	121.6	477	62.6	0.47	132	0.5	2216	347.0	158	2.93
SD	CG.103	100.1	488	58.6	0.45	120	0.7	2172	319.8	147	2.69
SD	CG.5012	81.1	495	62.2	0.70	127	0.0	2672	385.1	145	4.86
SD	CG.5	201.8	522	73.7	0.35	141	-	2402	388.2	162	1.96
SD	M.7Emla	144.1	533	68.1	0.42	133	1.0	1926	300.1	156	2.22
SD	LB-OR	203.7	540	70.6	0.32	132	0.0	2435	376.3	155	1.85
SD	CG.4013	157.5	657	89.4	0.51	137	20.0	2631	408.8	155	2.61
SD	CG.134	143.7	707	89.7	0.56	128	0.0	3045	469.4	154	3.21
LSD P<0.05		36.3	126	15.0	0.22	15	11.2	334	55.8	11	1.53
V	CG.756	73.4	158	30.0	0.37	180	1.3	1558	246.1	155	4.03
V	CG.6143	76.9	215	30.3	0.38	142	3.6	1303	199.6	153	2.97
V	CG.7760	79.2	238	33.4	0.38	142	4.1	1882	287.0	153	3.64
V	CG.6253	91.6	314	42.9	0.43	137	0.5	2005	304.5	152	3.35
V	CG.6239	105.1	286	42.9	0.36	152	3.6	1981	314.4	159	3.01
V	CG.8189	109.9	392	53.9	0.44	139	2.3	2160	334.7	155	3.03
V	CG.96	121.6	248	33.4	0.26	135	1.3	1472	215.6	146	1.85
V	CG.7707	127.1	360	49.8	0.36	142	4.1	2012	315.9	158	2.57
V	CG.4	127.2	414	55.9	0.40	136	1.5	1870	301.3	161	2.36
V	CG.93	128.4	485	61.5	0.44	129	11.4	2038	297.7	148	2.38
V	MM.111	135.2	351	48.0	0.38	133	3.8	1886	302.3	162	2.33
V	CG.8228	138.2	611	81.3	0.53	133	2.5	2340	368.3	157	2.65
V	CG.934	177.2	523	69.9	0.38	134	1.9	2177	326.3	151	1.96
LSD P<0.05		38.8	135	18.0	1.71	17	4.9	352	56.8	14	0.88

*Rootstocks within each vigor class ranked by trunk cross-sectional area.

branching across the length of the entire branch, illustrating the need for pruning to distribute such branches more uniformly. Tart cherry showed a clear trend for increased lateral branching in the medial (middle) branch section as rootstock vigor decreased. This trait illustrates the potential production combination of greater cropping in a more compact canopy, provided light distribution is not impacted adversely. The dwarfing to moderately dwarfing rootstocks Gi.5, Gi.6, Edabriz and W.53 had the best distribution of lateral branching across all branch sections.

Flowering spur formation was apparent in tart cherry across all rootstocks, with no rootstock clearly promoting a higher proportion of flowering spurs than the industry standard, Mahaleb (Fig. 8). In fact, spur formation was significantly less on the most dwarfing rootstocks such as Gi.5, Edabriz and Gi.209/1 (largely due to the higher proportions of blind nodes). It was of interest to confirm that flowering spur formation on young tart cherries can be significant, as these flowering sites become fewer with age. It is worth considering cultural practices, such as removal of the most distal branch section that has few flowering spurs, to perhaps promote the retention of these flowering spur sites as the branch and tree ages. Flowering spur formation in sweet cherry was strongly influenced by rootstock but not in a manner related to vigor.

The project's subsequent focus on development of an integrative, computer-based model of cherry tree growth to incorporate rootstock-specific and site-specific inputs that will predict cropping behavior was begun with the hiring of a computer programmer in 2002. Creation of the fundamental growth model took much of the summer (and the research budget), achieving a preliminary quantitative and illustrative model that could predict crop yields on a year-by-year basis, given the flower density data developed above. The propensity for blind nodes and for lateral branching created significant differences in the model tree architecture and fruit placement within the canopy. The model was developed to the extent that, while preliminary, it was well received at the 26th International Horticultural Congress in August. However, the unexpected complexities of developing such a model mean that more remains, at this time, for full integration of the diverse data from this experiment into a fully interactive and dynamic model for orchard planning and decision making.

NATIONAL EVALUATION OF THE CORNELL-GENEVA ROOTSTOCKS AND OTHER PROMISING ROOTSTOCKS FROM AROUND THE WORLD

Terence Robinson and the NC-140 Committee, New York State Agricultural Experiment Station

The new series of Cornell-Geneva (CG) rootstocks has the potential to replace existing rootstocks because they have resistance to fire blight and phytophthora root rot. Five clones are currently being commercialized and about a dozen elite selections are in the pipeline. As these new rootstocks become available to fruit growers, orchard tests in several climatic areas on a variety of soils are needed. We have established a series of intermediate stage trials in NY, MI and WA to select the most promising clones from the dozens of candidates. We have also begun testing the most promising selections through the national NC-140 group to further

TABLE 3

New York-Geneva 1998 NC-140 Jonagold/G.16 trial.

Rootstock	TCA 2002 (cm²)	Fruit No. 2002	Yield 2002 (kg)	Fruit size 2002 (g)	Cropload '02 (fruit no./cm² TCA)	Yield eff. '02 (kg/cm² TCA)	No. of root suckers 2002	Cumulative yield (kg)	Average fruit size (g)	Cumulative yield eff (kg/cm² TCA)
M.9 EMLA	21.2	66.4	18.0	278	4.5	0.85	0.0	30.9	267	1.45
G.16N	22.0	68.5	17.5	262	4.7	0.80	0.2	33.8	240	1.57
CG.3041	22.4	117.6	28.9	271	7.4	1.34	0.0	48.6	258	2.21
G16T	23.4	60.1	15.5	266	3.6	0.65	0.0	29.2	222	1.26
LSD p<0.05	3.3	35.6	7.8	28	2.1	0.39	0.2	9.1	20	0.48

*Rootstocks ranked by trunk cross-sectional area.

TABLE 4

New York-Geneva 1999 NC-140 McIntosh trial.

Plot	Rootstock	TCA Nov. 2002	Fruit no. 2002	Yield 2001 (kg)	Fruit size 2001 (g)	Cropload 2002 (kg/cm² TCA)	Yield eff. 2002 (kg/cm² TCA)	Number of root suckers 2002	Cumulative fruit no.	Cumulative yield (g)	Cumulative yield eff. (kg/cm² TCA)	Average fruit size (g)
Dwarf	M.9T337	13.0	29.0	7.7	266.1	4.5	0.59	0.0	35.3	8.7	0.66	233.6
Dwarf	CG.5179	17.5	49.5	12.1	246.4	5.1	0.72	0.2	82.8	17.6	0.93	226.9
Dwarf	CG.3041	18.4	54.2	16.2	297.2	4.6	0.84	0.0	120.0	28.4	1.50	240.1
Dwarf	G.16T	18.9	60.0	15.2	263.8	5.0	0.79	0.0	121.0	24.1	1.25	206.1
Dwarf	Supporter 1	19.2	40.2	10.7	266.7	3.4	0.54	0.2	94.5	19.6	0.98	218.0
Dwarf	Supporter 3	20.2	45.6	11.3	248.5	3.4	0.53	0.0	100.0	20.0	0.94	213.7
Dwarf	Supporter 2	21.1	54.2	15.3	273.6	4.1	0.68	0.0	123.0	27.2	1.26	221.5
Dwarf	M.26EMLA	21.5	45.7	12.6	283.5	3.6	0.59	0.0	46.3	12.7	0.59	275.7
Dwarf	G.16N	21.5	45.7	11.9	250.0	3.9	0.62	0.0	111.0	22.7	1.18	208.6
Dwarf	CG.5202	25.0	25.2	7.1	265.2	1.7	0.26	0.0	60.2	13.6	0.48	233.8
Dwarf	CG.5935	29.8	91.2	27.4	293.2	5.3	0.91	0.6	184.0	42.6	1.40	227.9
Dwarf	CG.4013	33.4	52.7	15.2	283.2	3.1	0.44	0.7	92.0	22.2	0.61	238.2
	LSD p<0.05	7.0	35.5	10.1	38.4	2.7	0.45	0.6	53.4	12.7	0.52	31.3
Semi-dwarf	CG.6814	17.9	23.8	5.6	237.2	2.4	0.32	1.0	36.8	8.5	0.49	230.2
Semi-dwarf	M26EMLA	17.9	14.6	4.8	321.1	1.3	0.23	0.2	15.2	5.9	0.28	296.3
Semi-dwarf	CG.6210	20.3	23.3	5.4	230.9	1.9	0.28	0.5	23.8	5.5	0.28	225.9
Semi-dwarf	CG.7707	22.7	11.0	2.8	241.5	0.9	0.13	1.0	24.3	5.3	0.25	232.3
Semi-dwarf	G.30T	25.5	20.6	5.4	284.4	1.5	0.21	0.6	66.8	13.7	0.48	251.1
Semi-dwarf	G.30N	29.9	29.8	7.2	248.2	1.9	0.25	0.0	92.2	18.8	0.65	217.4
Semi-dwarf	Supporter 4	31.3	13.0	3.5	272.0	0.9	0.12	0.2	19.3	4.5	0.15	196.0
Semi-dwarf	M.7EMLA	37.0	27.8	8.6	307.2	1.3	0.23	2.0	46.0	12.1	0.33	266.0
	LSD p<0.05	7.1	19.8	5.4	54.8	1.3	0.20	2.0	46.1	9.9	0.36	64.5

*Rootstocks ranked by trunk cross-sectional area.

evaluate their commercial potential. The NC-140 trials also are comparing other rootstocks from around the world, including the Vineland, Supporter, Morioka, Pillnitz-Dresden, Poland, Budagovsky and JTE rootstocks.

In 2002 we planted three new intermediate stage testing blocks of CG rootstocks in NY and WA. We also propagated trees for three new intermediate stage trials in NY, WA and MI. Through the NC-140 group we planted a comparison of B.9 clones in 9 states or provinces in 2002. Also in 2002, two smaller 3- to 4-state plantings of several Japan Morioka (JM) rootstocks and Pillnitz (PiAu) rootstocks were planted by NC-140 cooperators. We are continuing to work with commercial nursery people to gain access to other new rootstocks from eastern Europe and Japan.

In 1993 we planted a comparison of many CG rootstocks with Liberty as the scion. Data over 10 years have shown that the highest yield efficiency among dwarfing rootstocks was with CG.26, CG.3902 and CG.4247, but CG.26 and CG.4247 had small fruit size (Table 2). CG.3041 had high yield efficiency and excellent fruit size. The tree is slightly smaller than M.9. CG.3007 also performed well. G.11 was larger than expected and had slightly poorer performance than M.26. G.65 had high yield efficiency but small fruit size. Among semi-dwarf rootstocks, G.30 was among the most productive with good fruit size. Other high performing rootstocks were CG.38, CG.4003, CG.5046, CG.6874, CG.6210 and CG.5012. Among vigorous rootstocks, CG.756 and CG.7760 were the top performers. These top-performing rootstocks are being further evaluated by the NC-140 national rootstock testing group.

From our other trials in NY planted from 1991 to 1998, we have identified CG.3041, CG.3902, CG.3007, CG.4003, CG.4202, CG.4247, CG.5757, CG.6737, CG.3029, CG.50, CG.26, CG.995, CG.12.3 and CG.38 as promising dwarfing rootstocks that have exceeded the performance of M.9 or M.26. Among semi-dwarf rootstocks, CG.5935, CG.5012, CG.5046, CG.5202, CG.5179, CG.6210, CG.6874, CG.756 and CG.7760 exceeded the performance of M.7. Among vigorous rootstocks CG.6239, CG.6253, CG.6723, CG.7707 and CG.8189 exceeded the performance of MM.111.

In 1998 we planted a comparison of C.16, CG.3041 and M.9 using Jonagold. Over the first 5 years, trees on G.16 and CG.3041 have produced trees similar in size as M.9 (Table 3). G.16 has had similar yield efficiency as M.9 while CG.3041 has had significantly higher yield and yield efficiency than either M.9 or G.16. Although G.16 continues to perform well in commercial plantings, its virus sensitivity in the nursery has limited its commercial acceptance by nurserymen. CG.3041 may prove to be a good alternative to G.16 when released in 2004.

A rootstock plot planted in 1999 has shown that trees on C.16, CG.3041 and CG.202 are larger than trees on M.9T337 and trees on CG.5935 are larger than trees on M.26 (Table 4). The most efficient rootstocks were CG.3041, G.16, Supporter 2 and Supporter 1. Among semi-dwarf rootstocks, the most efficient rootstock was G.30.

We continue to be optimistic about G.30 and G.16 as excellent alternatives to M.26 and M.9, respectively, for North American apple growers. Both have excellent production and good fire blight survivability. The primary weaknesses of G.30 are its spines in the nursery and the relatively brittle graft union with Gala, Honeycrisp, Greening, Golden and Jonagold. It must be trellised with these varieties. We recommend a steel pole and a trellis for all plantings of G.30. The biggest problem with G.16 is its virus sensitivity. We have now learned that it is highly susceptible to apple stem pitting. It does not appear to be susceptible to apple stem grooving virus or apple chlorotic leaf spot virus. Since some reputed virus-free wood may have a low titer of viruses, nurserymen will need to test budwood source trees by budding test quantities of G.16 liners with buds from each potential scion wood tree to determine if it is virus free. This characteristic of G.16 will limit the use of scion wood from some of the newest varieties or strains where virus-free wood is unavailable or the virus status of the wood is not known. We believe G.16 with its high fire blight resistance may be the best practical alternative to M.9 for successful high density plantings in the east. In December 2004 we plan to release both CG.3041 as an M.9 alternative and CG.5935 as an M.26/M.7 alternative.

The current status of CG rootstocks is:

1. G.16 and G.30 are being sold commercially by most U.S. nurseries.
2. Stoolbeds of G.11 are being planted by commercial nurserymen in 2002.
3. We have released G.202 in New Zealand in May 2002. We also intend to release this rootstock in the U.S. in 2003.
4. We have announced to our licensees our intention to release CG.3041 and CG.5935 in 2003. Nurseries are beginning to bulk up these rootstocks for commercial sale.

HIGH DENSITY PLANTING SYSTEMS FOR SWEET CHERRIES IN THE NORTHEAST

Terence Robinson, Robert Andersen and Steve Hoying
New York State Agricultural Experiment Station, Cornell University

Sweet cherries offer an opportunity for diversification for many apple growers in the northeastern U.S. The introduction of dwarfing cherry rootstocks and newer varieties has allowed new possibilities for developing high density cherry orchards with smaller trees that will be more precocious and productive and can either be covered with rain exclusion shelters or treated with $CaCl_2$ to prevent rain cracking. This project seeks to compare high density production systems and dwarfing rootstocks for sweet cherries and to help growers successfully adapt the best systems for commercial orchards.

In 1999 we established a replicated cherry systems trial at Geneva, NY, with three cultivars (Hedelfingen, Lapins and Sweetheart) and three rootstocks (Gi.unknown, Gi.6 and MXM.2). The purpose of this trial is to compare high density training systems that utilize precocious rootstocks and new pruning and training strategies. We chose to compare six systems (Table 5).

All trees were planted on 12-inch high berms to control winter damage associated with excessive soil moisture. In addition, a subsurface tile line was installed in the center of each tractor alley to remove excess moisture in the spring and during heavy rainfall before harvest.

In 2000 (the second year) we compared three methods of stimulating lateral branching along the leader. Spraying at bud swell with 5000 ppm Promalin mixed with diluted white paint or notching above every third bud along the leader with a hacksaw blade at bud swell were not very effective in stimulating lateral branching in the lower and middle sections of the leader. Removal of two-thirds of the buds along the leader (every third bud was left) was very effective and gave a relatively uniform distribution of lateral branches along the shoot. Hedelfingen had the greatest number of lateral branches. Sweetheart had an intermediate number and Lapins the least. The bud removal treatment should prove very useful for sweet cherry growers in the Northeast to allow more rapid development of the canopy and earlier production. To reduce the risk of bacterial canker infection from the wounds left by the bud removal technique we recommend the application of a copper spray immediately before or after the buds are removed.

In 2002 we installed a rain shield over one-third of the experiment to evaluate rain crack control methods. However, no significant rain events occurred during the fruit ripening in 2002.

In the third year (2001) the trees had their first crop and the Gi.unknown rootstock had the highest yield, followed by Gi.6. The MXM tree had almost no yield. In 2002 the trees had a commercially significant yield (Table 6). Among rootstocks, cumulative yield per tree of the Gi.unknown rootstock was highest (10.3 kg/tree) followed by Gi.6 (6.6 kg/tree). Trees on MXM.2 had the lowest cumulative yield (0.6 kg/tree). Among systems, the Zahn system had the highest cumulative yield per tree (13.2 kg/tree), followed by the Vogel (6.6 kg/tree), Spanish bush (5.9 kg/tree), central leader (5.8 kg/tree), the perpendicular V system (4.4 kg/tree) and Marchant with the lowest cumulative yield per tree (4.1 kg/tree). On an acre basis the Zahn system had the highest cumulative yield (7.0 tons/acre), followed by the Vogel system (2.6 tons/acre), the perpendicular V system (2.0 tons/acre), the Marchant system (1.9 tons/acre), the Spanish bush system (1.8 tons/acre) and the central leader system (0.9 tons/acre). The cumulative yields largely

TABLE 5

High density planting systems trial treatments for sweet cherries in the Northeast.

System	Spacing (ft)	Tree density/acre
Modified central leader	16 x 20	136
Spanish bush	10 x 16	272
Vogel slender spindle	8 x 15	363
Freestanding V	6 x 18	403
Marchant trellis	8 x 13	418
Zahn vertical axis	6 x 15	484

reflected density. However, the Zahn system, because of its high yield per tree and the highest tree density, produced more than double the cumulative yield per acre of any other system. In 2002 fruit size was largest on Gi.6 (7.5 g), intermediate on Gi.unknown (7.3 g) and smallest on MXM.2 (6.8 g). Among systems, fruit size was largest with the perpendicular V system (7.9 g), followed by central leader (7.6 g), the Vogel and Marchant systems (7.5 g), the Zahn system (7.3 g) and the Spanish bush (7.1 g). Fruit soluble solids was highest with the perpendicular V system (17.6%), followed by the central leader and Vogel systems (17%), the Marchant system (16.6%), the Spanish bush system (16.2%), and lowest with the Zahn system (16.0%). This likely reflects heavier crops with the Zahn system and shade within the Spanish bush canopy.

Our results so far show the value of the precocious Gisela rootstocks and the value of high tree densities for early yields. Among the pruning systems, the Zahn system had the least pruning in the first 4 years and has had the highest yield per tree and the highest yield per acre. The yields achieved by the Zahn system over the first 4 years are very impressive. Its only drawback is that its tree height is now 4 m.

TABLE 6

Performance of 6 orchard training systems for sweet cherries in the fourth leaf at Geneva, NY (2002).

Variety	System	Rootstock	Tree density/ acre	Fruit number/ tree 2002	Yield/ tree 2002 (kg)	Yield/ acre 2002 (tons/ acre)	Fruit size 2002 (g)	Fruit soluble solids 2002 (%)	Cum. yield (kg/ tree)	Cum. yield (tons/ acre)
Hedelfingen	Modified central leader	Gi.unknown	136	928	8.1	1.2	5.7	14.1	8.5	1.3
		Gi.6		392	3.4	0.5	-	-	3.4	0.5
		MXM.2		32	0.2	0.0	-	-	0.2	0.0
	Spanish bush	Gi.unknown	272	1342	11.2	3.4	5.8	14.1	11.4	3.4
		Gi.6		919	7.9	2.4	6.9	18.1	8.1	2.4
		MXM.2		62	0.5	0.1	5.5	14.2	0.5	0.1
	Vogel slender spindle	Gi.unknown	363	1516	12.3	4.9	6.1	14.5	13.6	5.4
		Gi.6		1387	12.5	5.0	6.8	16.0	12.9	5.2
		MXM.2		20	0.2	0.1	6.6	16.9	0.2	0.1
	Perpendicular V	Gi.unknown	403	1109	9.4	4.2	7.0	16.1	9.4	4.2
		Gi.6		588	5.3	2.3	7.4	17.5	5.3	2.4
		MXM.2		36	0.3	0.1	-	-	0.3	0.1
	Marchant trellis	Gi.unknown	419	703	5.3	2.5	5.7	13.2	5.5	2.6
		Gi.6		753	6.2	2.9	7.7	17.3	6.3	2.9
		MXM.2		72	0.5	0.2	7.4	16.9	0.6	0.3
	Zahn vertical axis	Gi.unknown	484	2792	19.2	10.3	5.9	13.7	19.7	10.5
		Gi.6		1674	13.2	7.1	6.7	15.4	13.6	7.3
		MXM.2		256	1.9	1.0	-	-	1.9	1.0
		LSD p<0.05		465	3.3	1.5	0.4	1.0	3.3	1.5
		Anova		**	**	**	**	**	**	**
Lapins	Modified central leader	Gi.unknown	136	1786	13.6	2.0	8.2	15.7	15.0	2.3
		Gi.6		765	5.9	0.9	7.7	16.5	6.2	0.9
	Marchant trellis	Gi.unknown	419	1001	6.8	3.1	8.1	16.1	7.8	3.6
		Gi.6		777	5.7	2.6	7.9	16.8	6.5	3.0
	Spanish bush	Gi.unknown	272	1421	10.5	3.2	7.6	16.1	11.6	3.5
		Gi.6		622	4.7	1.4	7.9	17.1	5.2	1.5
	Perpendicular V	Gi.unknown	403	485	4.0	1.8	8.5	16.2	4.4	1.9
		Gi.6		228	1.9	0.8	8.7	15.9	2.4	1.1
	Vogel slender spindle	Gi.unknown	363	740	6.1	2.4	9.2	17.8	8.0	3.2
		Gi.6		301	2.5	1.0	8.0	16.0	2.9	1.2
	Zahn vertical axis	Gi.unknown	484	2398	17.3	9.2	8.2	15.7	20.0	10.7
		Gi.6		1622	11.8	6.3	8.0	16.2	13.6	7.3
		LSD p<0.05		542	3.8	1.7	0.9	1.4	4.0	1.7
		Anova		**	**	**	**	**	**	**
Sweetheart	Modified central leader	Gi.unknown	136	1154	7.0	1.0	7.8	17.2	8.6	1.3
		Gi.6		359	2.2	0.3	7.6	19.0	2.4	0.4
	Marchant trellis	Gi.unknown	419	320	1.9	0.9	7.4	16.8	2.9	1.3
		Gi.6		310	2.0	0.9	7.5	17.3	2.7	1.3
	Spanish bush	Gi.unknown	272	767	5.1	1.5	6.9	15.7	7.9	2.4
		Gi.6		480	2.8	0.9	7.0	16.3	3.9	1.2
	Perpendicular V	Gi.unknown	403	730	4.4	2.0	7.5	19.4	4.7	2.1
		Gi.6		842	5.2	2.3	7.9	19.7	6.0	2.7
	Vogel slender spindle	Gi.unknown	363	764	4.8	1.9	7.7	17.9	6.9	2.8
		Gi.6		691	4.4	1.8	7.4	16.9	5.9	2.4
	Zahn vertical axis	Gi.unknown	484	2143	13.9	7.4	7.3	17.0	15.5	8.3
		Gi.6		1076	7.1	3.8	7.1	16.4	8.6	4.6
		LSD p<0.05		280	1.7	0.7	0.4	1.1	1.9	0.9
		Anova		**	**	**	**	**	**	**