Research Funding for 2001 and Research Progress Reports for 2000

2001 PROJECT FUNDING

The following research projects were funded by the IDFTA Rootstock Research Committee for 2001.

Project Leader	Project Title	Funding Awarded
Barritt, B. and T. Robinson	Early intermediate level testing of new CG. apple rootstocks in the Pacific Northwest	$6,000
Marini, R. (for NC-140 committee)	NC-140 data summarization	$10,800
Robinson, T. and NC-140 Technical Committee	National evaluation of the new Cornell-Geneva rootstocks and other promising rootstocks from around the world	$8,000
Robinson, T., H.T. Holleran and H.S. Aldwinckle	Differential susceptibility of apple rootstocks to four strains of fire blight and three latent viruses	$6,000
Kappel, F.	Sweet cherry rootstock evaluation	$4,500
Neilsen, D. and G.H. Neilsen	Nutrient and water management in high-density sweet cherry	$4,500
Robinson, T.L., R. Andersen and S. Hoying	High-density planting systems for sweet cherries in the Northeast	$5,500
Lang, G.A. and R.L. Perry	Fundamental rootstock influence on flowering affects training and management decisions for cherry crop load and fruit quality	$5,500
	Total	**$50,800**

TABLE 1

Performance in year 3 of rootstocks in the 1998 trial of Cornell-Geneva rootstocks with Gala and Jonagold.

Gala					Jonagold				
Rootstock	TCA (cm^2)	Yield (kg/tree)	Yield efficiency (kg/cm^2 TCA)	Mean fruit weight (g)	Rootstock	TCA (cm^2)	Yield (kg/tree)	Yield efficiency (kg/cm^2 TCA)	Mean fruit weight (g)
G.65	3.5	2.3	0.7	233	M.9 EMLA	6.4	46	0.7	219
CG.757	3.5	3.6	1.0	183	G.16	6.6	4.9	0.8	212
M.9 EMLA	4.5	4.2	0.9	160	CG.41	7.4	5.9	0.8	259
CG.995	5.2	4.3	0.8	173					
CG.12	5.3	3.7	0.7	138	LSD .05	1.9	2	0.3	31
CG.602	5.3	4.3	0.8	175					
CG.93	5.5	3.6	0.7	180					
M.26	7 3	8 0	6	164					
M.9 (WAF)	6.0	5.6	1.0	178					
G.16	7.2	5.8	0.9	168					
CG.910	9.3	3.3	0.4	164					
P.14	9.9	4.3	0.5	180					
LSD .05	2.5	2.2	0.4	43					

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

Project Leader: Bruce Barritt; Cooperator, Bill Johnson, USDA/ARS-Cornell University

Intermediate level trials were established at the Tree Fruit Research and Extension Center in 1998 and 1999. Preliminary tree size, yield and fruit size data for the 1998 trial are presented in Table 1. On such young trees the data are preliminary and may not be reliable estimates of future performance.

SWEET CHERRY ROOTSTOCK EVALUATION

Project Leader: Frank Kappel

1. Edabriz/Maxma 14 rootstock trial: Maxma 14 has been the most productive rootstock in the trial. Edabriz has been the only truly dwarfing stock, however the trees appear to be stunted. The trees on Edabriz suffered from replant problems and non-virusfree budwood used for propagating the scion cultivars. Fruit size of cherries grown on Maxma 14 has not decreased even though yields have increased significantly. Sweetheart has been very precocious and productive without a decrease in fruit size. The trial was removed in 2000.

2. J rootstock trial: Rootstock J was about 20% smaller (trunk cross-sectional area) than F12/1; however, it had only about one-half the cumulative yield of F12/1. There was no difference in yield efficiency (cumulative yield/trunk cross-sectional area). The trial was removed in 2000.

3. A, J, M rootstock second test: The rootstock A is the only rootstock that appears to be dwarfing with trees about 65% the size of F12/1. To date rootstock has not had an effect on yield. In 2000 Lapins was more productive than Bing and had larger fruit.

4. Weiroot rootstocks: Trees on W53 and Gi 196/4 have been the most productive since the first fruit in 1998. The most efficient trees have been those on W53 and W72. To this point, fruit size has not been affected by rootstocks. Suckering has been an extremely difficult problem for W154. The most dwarfing trees are those on W53, W72 and W154.

5. Sweetheart rootstock trial: Trees on G5 are the smallest, followed by G6 and J, whereas the trees on P50 and mazzard are the largest. The trees on both the Gisela rootstocks had the highest yields in the first year of fruiting.

6. NC-140—Summerland: The smallest trees were on the rootstocks W53, Gi 209/1 and W154, followed by Gi 473/10, Edabriz and W72. The largest trees were on the rootstocks mahaleb and Gi 318/17. There were some fruits on some of the rootstocks but it is too early to report. Gi 473/10 and W154 and W13 had severe suckering problems.

NC-140 DATA SUMMARIZATION

Project Leader: Richard Marini

Last year's funds were used by coordinators of 7 rootstock plantings to summarize data from the 1999 growing season. Annual reports for each planting, including means with statistical analyses, were presented to the NC-140 Technical Committee in Wooster, Ohio, in November 2000. Manuscripts summarizing the first 5 years of the dwarf and semi-dwarf Gala plantings established in 1994 were published in the *Journal of the American Pomological Society*. A paper summarizing the 1988 pear rootstock planting was presented at an international symposium and a manuscript is being prepared for publication in the *Journal of the American Pomological Society*. A 10-year summary of the 1990 apple cultivar/rootstock planting was presented at the annual meeting of the American Society for Horticultural Science and a companion manuscript has been written and is being reviewed for publication in the *Journal of the American Pomological Society*. Below are some of the most important results presented in the 2000 summary reports.

1. In the 1994 peach rootstock planting, tree survival was highest on Stark Redleaf, GF 305, S.2729 and H7338013, and lowest on Myran, Ta Tao 5 interstem and Lovell. Trunks are largest for Lovell and Guardian and smallest for Ishtara and Tzim Pee Tao. Cumulative yield was highest for Lovell and GF 305 and lowest for Ishtara and Ta Tao 5 interstem.
2. In the 1990 cultivar/rootstock planting there is not a strong interaction between cultivar and rootstock, so results from rootstock trials with one cultivar likely can be extrapolated to other cultivars not in the trial. Averaged over all cultivars, tree size was greatest for M.26 EMLA, followed by O.3, M.9 EMLA, B.9 and Mark. Cumulative yield efficiency was greatest for B.9 and Mark and lowest for M.26 EMLA.
3. In the 1990 systems trial, central leader trees on M.26 or Mark rootstock tended to be least productive, whereas slender spindle trees on M.9, Mark and B.9 rootstocks were the most productive. Vertical axe/M.9 was the most productive of the vertical axe systems and at some locations it was as productive as slender spindle. Yield was greatly influenced by location but, relative to other systems, vertical axe/M.9 trees produced higher yields at the high-producing locations than at the low-producing locations.
4. The 1990 rootstock trial with Gala was terminated and included MAC.39, P.1, O.3, M.27, B.9, Mark, M.9 EMLA and M.26 EMLA. P.1 produced trees with the largest trunks, lowest yield and yield efficiency, and smallest fruit. O.3, B.9 and M.26 EMLA produced trees with similar trunk size, but M.26 EMLA was the least productive. Mark, MAC.39 and M.9 EMLA produced trees with similar trunk size, yields and yield efficiencies. M.27 produced the smallest trees and had relatively low yields.
5. The six M.9 clones in the 1994 trial are quite different. RN29 and Pajam 2 are nearly as large as M.26 EMLA, followed by M.9 EMLA and Pajam 1. NAKBT 337 and Fleuren 56 are the smallest of the M.9 clones. Rootstock significantly influenced yield efficiency at 19 of 25 locations. Yield efficiency was highest for P.16 in the most dwarfing size class, and O.3, Mark and M.9 NAKBT 337 in the intermediate size class. M.26 EMLA had lower yield efficiency than V.1, M.9, RN29 and M.9 Pajam 2.
6. In the 1994 semi-dwarf trial, four rootstocks (M.26 EMLA, P.1, V.2 and G.30) are being compared. Tree losses were greatest for G.30; less than 60% tree survival was reported for five of the 26 locations and there was 100% tree loss at one location. P.1 produced the largest trees and G.30 produced the smallest trees. Yield and yield efficiency tended to be highest

TABLE 2

Nutrient and water management in high-density sweet cherry.

Treatment*	Tree height (cm)	Leaf nutrients N (% dw)	Leaf nutrients P (% dw)	Yield (kg/tree)	Size (g)	Fruit quality SS (%)	Fruit quality All splits (%)
1. Low N	306ab	2.53ab	0.29a	1.81bc	12.6	19.3	18
2. Med. N	306ab	2.76a	0.25b	1.97bc	12.0	19.0	18
3. High N	285bc	2.89a	0.21c	3.01abc	12.3	18.9	12
4. Med. N + P	322a	2.56ab	0.25b	1.68c	12.5	18.7	18
5. Med. N + K	304ab	2.88a	0.25b	1.90bc	12.0	19.8	12
6. Broadcast N	289bc	2.72ab	0.24bc	3.37ab	12.6	19.5	15
7. Broadcast N + postharvest fertigation	287bc	2.74ab	0.23bc	3.35ab	12.0	19.1	15
8. Medium N drip	279c	2.38b	0.25b	3.55a	12.2	19.6	15

*All treatments except 8 irrigated with micro-sprinkler; means with same letter or no letter in columns not significantly different.

for G.30 (13 of 21 locations) and lowest for P.1.

7. Graphical techniques were used to compare cumulative yield at 5 years with cumulative yield at 10 years. There was a poor relationship at most locations, indicating that rootstock trials should be continued for at least 10 years.

NUTRIENT AND WATER MANAGEMENT IN HIGH-DENSITY SWEET CHERRY

Project Leaders: D. Neilsen and G.H. Neilsen

Treatments were applied during the 2000 growing season as detailed in the experimental outline. This year was the third growing and second fruiting season for the planting. The 1999 crop consisted of a small number of fruit on most trees. This year's crop was larger but still relatively small. Selected data are presented below.

Drip irrigated trees were smaller (height) than trees irrigated by micro-sprinkler (Table 2). Interestingly, applying more N via micro-sprinkler also reduced tree height. Leaf N concentration increased linearly with N application rate. Lowest N concentration was observed for drip irrigated trees, even though soil solution N concentrations (data not shown) were higher for drip irrigated trees. Leaf P was affected by N fertigation, decreasing as N rate increased, but was less affected by P fertigation. The most surprising result has been the higher yields for the trees receiving drip irrigation when compared with the trees receiving micro-sprinkler irrigation. In general, fruit quality has been little affected by treatments. Fruit size was excellent for all treatments. Percentage of splits was higher than would occur commercially, since the slightest indication of cracking was counted as a split. It will be useful to continue this experiment for several more years to see if these preliminary findings persist. It would be extremely useful if atmometer scheduled drip irrigation could induce dwarfing whilst maintaining good yields and fruit size.

NC-140 PEACH ROOTSTOCK TRIAL FOR 2001

Project Leader: Gregory L. Reighard

Funding: One-time grant for $3,500 for shipping costs

The objective of this grant is to help pay the shipping charges for the 2001 NC-140 Peach Rootstock Trial. Cooperators pay the tree and establishment costs. The objectives of this trial are as follows: 1) to evaluate the adaptability of new rootstock selections and cultivars with Lovell as the control under field conditions in 16-20 states and provinces; 2) to quantify tree growth, disease resistance, fruit production and fruit quality on these rootstocks; and 3) to evaluate soil disease and nematode tolerance of these rootstocks.

Rootstock propagation and/or bud take were not high on many of these vegetatively propagated (i.e., clonal) rootstocks. At the NC-140 meeting in November 2000, it was decided to go forward and plant the 2001 trial which will contain 14 rootstocks having enough trees of 3 cultivars (Redhaven, Cresthaven and Redtop) in 15 states and in Ontario. The locations for the 2001 trial are in AR, CA, CO, GA, IL, IN, MD, MI, MO, NJ, NY, ONT, SC, TX, UT, and WA. The rootstock cultivars and their species pedigree that will be tested are as follows: Pumiselect (*P. pumila*), Jaspi (*P. domestica x P. spinosa*), Julior (*P. insititia* x *P. domestica*), Cadaman (*P. persica* x *P. davidiana*), SLAP and BH-4 (*P. persica* x *P. dulcis*), VVA-1 (*P. cerasifera* x *P. tomentosa*), P30-135 (*P. salicina* x *P. persica*), K146-43 and K146-43 (*P. salicina* x *P. dulcis*), Hiawatha (*P. besseyi* x *P. salicina*), Lovell, Bailey and SC-17 (*P. persica*). Of this group the size controlling rootstocks are Jaspi, Pumiselect, VVA-1, P30-135, K146-43, K146-44 and Hiawatha. Cold hardy rootstocks are Pumiselect, Bailey and VVA-1.

Due to the unexpected problems encountered this past year, the NC-140 group decided to also plan a 2002 peach rootstock trial with rootstocks that did not have sufficient numbers for the 2001 test as well as adding another 8 new rootstocks that are currently being propagated after going through quarantine this past year. There are 18 states (AR, CA, CO, IL, KY, MA, MD, MI, MO (2), NJ, NY, OH, ONT, PA, SC, TX, UT, and WA) signed on for this test which will have about 15 rootstocks.

Data for the 2001 test will be collected annually by each cooperator, summarized and then written up in the NC-140 annual report. At the end of the 5- and 10-year evaluation periods, the data (results) will be published in an appropriate journal and available to all stakeholders.

If any funds for shipping charges are left over from the 2001 trial, they will be applied to the 2002 NC-140 peach rootstock trial.

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

Project Leader: Terence Robinson and NC-140 Technical Committee

The new series of Cornell-Geneva (CG) rootstocks have the potential to replace existing rootstocks because they have resistance to fire blight and phytophthora root rot. Four CG stocks have now been released (G.16, G.30, G.65 and G.11) and are being commercialized. About a dozen more elite selections are in the pipeline. As these new stocks become available to fruit growers, orchard tests in several climatic areas on a variety of soils are needed. We have established a series of trials within NY state and nationally through NC-140 to further evaluate their commercial potential. The NC-140 trials also compare other rootstocks from around the world. Data from these trials will give growers unbiased information about the potential not only of the CG stocks, but also for the Vineland, Supporter, Morioka and JTE stocks. A short summary of several of our rootstock plots follows.

NY 1992 CG-Liberty Rootstock Trial: The 1992 CG rootstock trial has now completed 9 years and is being terminated this winter. Among dwarf stocks CG.6737, CG.3029, CG.50 and G.11 continued to have the highest cumulative yield efficiency and also had good fruit size. They all exceeded the performance of M.9. G.65 had significantly lower cumulative yield efficiency than CG.11 and also had significantly smaller fruit size. Among semi-dwarf stocks, G.30, CG.6210, CG.67, CG.222, CG.6143, CG.517, CG.5179 and CG.222 were top performers. They exceeded the performance of M.7. Among vigorous stocks CG.8189 and CG.6239, CG.4 and CG.2 were top performers. These stocks exceeded the performance of MM.111.

TABLE 3

Performance of rootstocks in the NY-Geneva 1994 NC-140 Gala rootstock trial (semi-dwarf plot).

Rootstock	TCA 2000 (cm^2)	No. of suckers 2000	Cumulative yield (kg/tree)	Cumulative yield efficiency (kg/cm^2 TCA)
G.30	59.6	4.7	252	4.3
V.2	68.3	0.9	243	3.6
M.26 EMLA	69.0	0.1	214	3.6
P.1	91.8	1.0	200	2.2
LSD 0.05	11.6	4.6	25	0.9

1993 CG-Liberty Rootstock Trial: The 1993 Liberty plot has completed 8 years and will be concluded at the end of 2001. The highest yield efficiencies among dwarf stocks were with CG.26, CG.4247, CG.3041, CG.3902, CG.3007, CG.4003, and CG.38. All performed significantly better than M.9 or M.26. Among this group CG.3041 has been tested on several growers' farms where it has been a top performer in the dwarf class and will likely be introduced in 2003. Among the semi-dwarf stocks top performers were G.30, CG.6874, CG.5012, CG.6210, CG.5046, CG.222, CG.756, CG.5202 and CG.7760. All performed significantly better than M.7. Among vigorous stocks, CG.6239, CG.6253, CG.6723, CG.7707, and CG.8189 were top performers. These stocks exceeded the performance of MM.111.

1994 Apple Rootstock Trial-Geneva (Table 3): The 1994 Gala trees have completed 7 years and have attained their mature size. In the semi-dwarf rootstock plot, G.30 and V.2 have had the highest yield and the highest yield efficiency. M.26 had lower yield but not significantly lower yield efficiency. P.1 was the largest stock and had the lowest yield and the lowest yield efficiency. G.30 was the smallest tree while V.2 and M.26 EMLA were similar in size.

In the dwarf rootstock plot the greatest cumulative yield efficiency was with P.16 followed by M.9 T337, M.9 EMLA, Mark, B.491, M.9 Pajam 2 and P.22. All of the other M.9 clones had lower efficiency as well as B.9 and O.3. Among very dwarfing stocks which were similar in tree size to M.27, but had greater yield efficiency and fruit size than M.27, were P.16, and B.491. There were significant differences in tree size among M.9 clones. The smallest clones were M.9 Fleuren 56 and M.9 T337 which were similar in size to Mark. M.9 EMLA was intermediate in size while the Pajam 1, Pajam 2 and Nic29 clones were significantly more vigorous. The three vigorous clones were similar in size to M.26. B.9 was similar in size to M.9 EMLA. The lowest yield efficiency was with M.26, V.1 and P.2. V.3 rootstock gave a tree size similar to M.9 T337 and B.9 and had similar yield efficiency.

1998 NC-140 Gala- Jonagold/G.16 Trial (Tables 4, 5 and 6): Three plantings of G.16 with Gala and Jonagold were established in NY in 1998 (Geneva, Hudson Valley and Champlain Valley). The Jonagold trees were propagated on stool bed propagated (non-tissue cultured) liners;

TABLE 4

Performance of rootstocks in the NY-Geneva 1998 NC-140 Gala/G.16 trial.

Rootstock	TCA 2000 (cm^2)	Fruit number/tree 2000	Yield 2000 (kg/tree)	Fruit size (g)	Yield efficiency 2000 (kg/cm^2 TCA)
G.65	8.6	9	1.7	162	0.21
G.11	10.4	14	2.6	157	0.23
CG.5935	10.5	8	1.7	133	0.15
B.9	10.6	9	1.7	156	0.16
M.9	10.9	8	1.3	166	0.13
M.9 EMLA	12.4	13	2.2	155	0.18
M.26	13.4	7	1.1	152	0.09
G16TC	16.5	17	2.9	152	0.18
P.14	17.4	14	2.7	161	0.15
LSD P<0.05	2.8	9	1.9	27	0.17

TABLE 5

Performance of rootstocks in the NY-Geneva 1998 NC-140 Jonagold/G.16 trial.

Rootstock	TCA 2000 (cm^2)	Fruit number/tree 2000	Yield 2000 (kg/tree)	Fruit size (g)	Yield efficiency 2000 (kg/cm^2 TCA)
M.9 EMLA	8.7	22	5.7	261	0.69
CG.3041	9.6	20	5.2	234	0.47
G.16	9.7	39	8.2	220	0.85
G.16TC	9.9	51	9.4	191	0.94
LSD P<0.05	1.5	19	4.0	34	0.44

TABLE 7

Performance of rootstocks in the NY-Geneva 1999 NC-140 McIntosh trial.

Trial	Rootstock	TCA 2000 (cm^2)	No. of suckers/tree 2000	Fruit No./tree 2000
Dwarf	M.9 T337	2.3	0	0.0
	M.26 EMLA	4.3	0	0.0
	CG.5179	4.8	0	0.0
	CG.3041	5.6	0	0.0
	Supporter 1	5.6	0	0.0
	CG.5202	5.7	0	0.0
	G.16T	6.2	0	0.0
	G.16N	6.5	0	0.2
	Supporter 3	6.6	0	0.0
	Supporter 2	6.8	0	2.0
	CG.4013	7.0	0	0.2
	CG.5935	8.3	0	0.0
	LSD P<0.05	1.9	0	0.9
Semi-dwarf	M.26 EMLA	3.6	0	0.0
	CG.6814	4.5	0	0.0
	CG.6210	5.2	0	0.0
	CG.7707	5.2	0	0.0
	CG.30T	6.3	0	0.0
	Supporter 4	6.6	0	0.0
	CG.30N	8.0	0	0.0
	M.7 EMLA	9.9	2	0.0
	LSD P<0.05	2.3	1	0.0

TABLE 6

Performance of rootstocks in the NY-Hudson Valley 1998 NC-140 Jonagold, Gala/G.16 trial.

Variety	Rootstock	TCA 2000 (cm^2)
Gala	M.9 EMLA	11.9
	M.9 T337	11.9
	G.16	17.2
	LSD P<0.05	2.4
Jonagold	M.9 EMLA	11.2
	CG.3041	13.2
	G.16	13.7
	LSD P<0.05	2.6

however due to limited numbers of lines we propagated the Gala trees on tissue cultured G.16 plants. The tissue cultured Gala/G.16 trees grew very well in the nursery and have continued to grow larger than the Gala/M.9 trees in both the Geneva and the Hudson Valley plots. However with Jonagold there was no significant difference in tree size between the G.16 and M.9 trees. With the Jonagold trees CG.3041 was included and was similar in tree size to the G.16 and M.9 trees. G.16 had the highest yield efficiency with Jonagold but had intermediate yield efficiency with Gala. This indicates that tissue culturing of G.16 induces considerable vigor and a reduction in yield efficiency in the early years of the trees' growth. Without tissue culture G.16 appears to be slightly larger than M.9 EMLA. It probably is similar in size to a vigorous M.9 clone.

1999 NC-140 McIntosh Fuji Rootstock Trial (Table 7): Two plantings were established in NY in 1999 on growers' farms in western New York and in the Champlain Valley of New York. These trees have grown very well. After 2 years the smallest trees are on M.9 T337 and the largest trees are on CG.5935. Trees on G.16, CG.3041 and CG.4202 are intermediate in size. In the semi-dwarf plot, trees on M.26 were the smallest and trees on M.7 and G.30 were the largest.

Conclusions: Based on the relatively young national trials with G.16 we continue to be optimistic that this stock will be an alternative to M.9 for North American apple growers. It has excellent production and good fire blight survivability. We continue to recommend it only for trial since long-term production experiments are not yet complete and its ultimate tree size is unclear at this time. As a tissue cultured plant G.16 appears to be considerably more vigorous than M.9 and probably closer to M.26. However, as a stoolbed liner it appears to produce a tree the same size as a vigorous M.9 clone. Since all commercially produced trees are from stoolbed liners, apple growers should expect G.16 to be similar in size as M.9 trees. Other work we are doing with G.16 is helping us understand better its virus sensitivity. We have emphasized to nurserymen that only virus free scion wood should be used with G.16 since it is susceptible to one or more viruses. 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 while results with apple chlorotic leaf spot virus were ambiguous. Since some reputed virus free wood may have a low titer of viruses, nurserymen will need to test bud 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. Although we continue to give this stock only a tentative recommendation, the serious tree losses in the eastern US due to fire blight in 2000 mean that G.16 may be the best practical alternative for successful high density plantings in the east.

Within M.9, the more vigorous clones (Pajam 2 or Nic29) which are only slightly smaller than M.26 in size should be used in weaker soils or with weak scions while the weaker scions should be used in virgin ground or with vigorous rootstock clones. Both M.9 EMLA and M.9 T337 are intermediate in size and similar in performance. There does not seem to be any justification for choosing one over the other. B.9 and O.3 are specifically recommended over M.9 for the cold climate areas of North America.

Among semi-dwarf stocks, G.30 which is M.7 size continues to perform much better than M.7 and in some cases better than M.26. It should not be used as a rootstock for Gala since the graft union is brittle. The difficulties in stool bed propagation of G.30 due to spines have limited the production of this stock. Despite its problems, G.30's yield performance is spectacular and is recommended for planting.

HIGH-DENSITY PLANTING SYSTEMS FOR SWEET CHERRIES IN THE NORTHEAST

Project Leaders: Terence L. Robinson, Robert Andersen and Steve Hoying

Sweet cherries offer an opportunity for diversification for many apple growers in the northeastern U.S. However, the production difficulties of rain cracking, large trees, non-precocious rootstocks and relatively soft small-fruited cultivars have limited the extent of new plantings. 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. New varieties offer the possibility of firmer, larger cherries. This project seeks to develop successful high-density production systems for sweet cherries and to help growers successfully make the transition to high-density cherry orchards.

In 1999 we established a replicated cherry systems trial at Geneva, NY, (Table 8) with 3 cultivars (Hedelfingen, Lapins and Sweetheart) and 3 rootstocks (Gi.5, 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 6 systems:

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.

Training Principles of the Central Leader System

First year

- head leader at 36 inches at planting.
- remove large diameter feathers.
- remove buds below the new leader bud along 8 inches of the leader.
- attach clothespins to lateral branches when 4 inches long to improve crotch angle.

Second year

- head leader at bud swell removing 1/3 of last year's growth.
- remove large diameter upright shoots at bud swell.
- remove 5 buds below the new leader bud on the leader at bud swell.
- attach clothespins to lateral branches when 4 inches long to improve crotch angle.
- tie down four primary scaffold branches to 15° above horizontal in early June.

TABLE 8

High-density planting systems for sweet cherries in the Northeast.

System	Spacing (ft.)	Density (trees/acre)
Modified Central Leader	16 X 20	136
Spanish Bush	10 X 16	272
Vogel Slender Spindle	8 X 15	363
Free Standing V	6 X 18	403
Marchant Trellis	8 X 13	418
Zahn Vertical Axis	6 X 15	484

Training Principles for the Spanish Bush System

First year

- head leader at 15 inches.
- attach clothespins to lateral branches when 4 inches long to improve crotch angle.
- head lateral shoots in early July to multiply number of shoots.
- fertilize trees with Nitrogen in early July to force new growth.
- seed cover crop of rye in early August to use up excess Nitrogen to prevent winter injury.

Second year

- head each leader branch at bud swell removing 1/2 of last year's growth.
- re-head each lateral shoot by about 1/2 in early July to multiply number of shoots.
- fertilize trees with Nitrogen in early July to force new growth.
- allow weeds to grow in herbicide strip in August to reduce tree growth and assist in cold acclimation.

Training Principles for the Vogel Slender Spindle System

First year

- head leader at 36 inches.
- remove all feathers.
- remove buds below the new leader bud along 8 inches of the leader.
- attach clothespins to lateral branches when 4 inches long to improve crotch angle.
- attach weighted clothespins to the ends of lateral branches to maintain horizontal branch angle.

Second year

- head leader at bud swell removing 1/3 of last year's growth.
- remove 5 buds below the new leader bud on the leader at bud swell.
- remove large diameter upright shoots at bud swell.
- attach clothespins to lateral branches when 4 inches long to improve crotch angle.
- attach weighted clothespins or cement weights to the ends of all primary lateral branches to maintain horizontal branch angle. Move clothespins or weights regularly to maintain flat branches.

Training Principles for the Free Standing 'V' System

First year

- head leader at 12 inches.
- attach clothespins to 2 lateral branches that were oriented toward the tractor alleys when 4 inches long to improve crotch angle.
- keep central leader shoot for first year but suppress growth with pinching in mid-summer.

Second year

- select 2 primary scaffold branches to serve as arms of the 'V' and tie to training stake at 60˚ above horizontal at bud swell.
- remove leader shoot and other extra scaffold branches at bud swell.
- induce lateral branching along 'V' scaffold arms by removing 60% of buds along branch at bud swell.

Training Principles for the Marchant System

First year

- plant trees at 45˚ angle down the row.
- head leader at 40 inches.
- remove all side branches.
- remove buds on underside of the leader.
- thin remaining buds to an 8-inch spacing.
- train leader to a 60˚ angle along the row utilizing a 4 wire trellis and an inclined bamboo pole at each tree.

Second year

- train lateral branches arising off the inclined leader in the opposite direction down the row by tying to trellis at 45˚ above horizontal at bud swell.
- remove large diameter vigorous shoots at bud swell.
- train leader to a 60˚ angle along the row utilizing inclined bamboo training pole in early July.

Training Principles for the Zahn Vertical Axis System

First year

- head leader at 48 inches.
- remove large diameter feathers (larger than 2/3 diameter of leader).
- induce lateral branching along leader by removing 60% of buds along branch at bud swell (remove 2 buds and leave 1 bud along the entire length of the leader).
- attach clothespins to lateral branches when 4 inches long to improve crotch angle.

Second year

- do not head leader.
- stub back large diameter lateral branches that are larger than 2/3 diameter of leader to 6 inches long at bud swell.
- induce lateral branching along leader by removing 60% of buds along branch at bud swell.
- attach cement weights to the ends of second year lateral branches to maintain horizontal branch angle.

Lateral Branching Experiment

In the second year we compared 3 methods of stimulating lateral branch growth along the leaders of the Zahn, Vogel, Vee and Central Leader Systems. The 3 treatments were:

1. Promalin (5,000 ppm) mixed with diluted white paint (1:1 ratio of paint and water) sprayed on the leader at bud swell.
2. Notching above every 3rd bud along the leader with a hacksaw blade at bud swell.
3. Bud removal of 2/3 of the buds along the leader (every third bud was left and the others were rubbed out at bud swell).

At the end of the season the number of lateral branches on the lower middle and upper sections of each leader was counted (Table 9). The Promalin and notching treatments were not very effective in stimulating lateral branch development in the lower and middle sections of the leader. However, the bud removal treatment was very effective and gave a relatively uniform distribution of lateral branches along the shoot

TABLE 9

Effect of branching treatments on side branching of the leader of three sweet cherry varieties.

Variety	Branching treatment	Number of side shoots produced on: bottom third of leader	middle third of leader	top third of leader
Hedelfingen	Promalin	0.5 c	2.2 b	10.3 a
Hedelfingen	Notching	1.2 b	1.7 b	9.3 a
Hedelfingen	Bud removal	2.9 a	4.2 a	4.7 b
	LSD p<0.05	0.7	0.7	1.1
Lapins	Promalin	0.2 b	0.2 b	7.5 a
Lapins	Notching	0.1 b	0.1 b	6.4 b
Lapins	Bud removal	0.9 a	2.6 a	5.0 c
	LSD p<0.05	0.4	0.4	0.7
Sweetheart	Promalin	0.1 c	0.4 b	10.5 a
Sweetheart	Notching	0.6 b	0.3 b	9.1 b
Sweetheart	Bud removal	1.5 a	3.3 a	5.3 c
	LSD p<0.05	0.4	0.5	1.1

(Table 9). The bud removal treatment gave the greatest number of lateral branches with Hedelfingen and the least with Lapins. Sweetheart was intermediate.

The bud removal treatment should prove to be very useful for sweet cherry growers. It allowed good lateral branch development without heading the leader. This should allow more rapid development of the canopy and earlier production. We are recommending this practice only where the threat of bacterial canker infection is low or where copper sprays are applied immediately after the buds are removed.

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

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There have been contradictory reports about the sensitivity of various apple rootstocks to fire blight. One possible explanation for these observations is that rootstocks have differential susceptibility to certain strains of the fire blight pathogen. For example, strain E4001A has been shown to cause moderate levels of infection in Robusta 5 although it is completely resistant to most strains. Robusta 5 has been used heavily as a parent in the Geneva rootstock breeding program as a source of resistance to fire blight. In another case, strain E2017P caused infection of G.16 rootstock which is highly resistant to fire blight. The reported resistance of B.9 has also been variable. This experiment is designed to verify the resistance of various apple rootstock genotypes to the 4 commonly encountered strains of fire blight bacteria. The extent to which specific strain by genotype interactions are occurring will be an important indicator of the eventual durability of the resistance of these genotypes. The results may elucidate why observations of fire blight have proven contradictory and may offer guidelines for avoiding the rootstock phase of fire blight in future plantings.

In the spring of 2000 rooted apple rootstock liners of many current and new rootstocks were planted in bullet tubes in the greenhouse at the Geneva Experiment Station and trained to a single vigorously growing shoot. Plants were grown in groups of 12, and each multiple of 12 was inoculated with one of four strains of the fire blight bacteria. The strains used were: Ea273 (standard strain for fire blight inoculations in New York); E2002A (a highly aggressive strain); E4001A (Canadian strain with differential virulence to Robusta 5); E2017P (Ontario strain reportedly virulent on G.16). With some rootstock genotypes we had only enough liners to inoculate with 3 or 2 or 1 strain(s). In midsummer liners were inoculated (scissors method) on two young, rapidly expanding leaves, and symptoms were recorded 10 to 30 days later, after the development of necrosis had stopped. Reaction to the infection was measured as the proportion of the current season's growth exhibiting necrosis. In addition, the regrowth reaction of the plant to the inoculation was recorded. With this second measure of resistance, if shoot growth was uninterrupted by the inoculation it was given a rating of 1. If the inoculation caused only a terminal bud to set, it was rated a 2. If the inoculation caused some death of the shoot but infection was stopped by the plant and a side shoot began to grow, it was rated a 3. If the inoculation caused some death of the shoot and no new regrowth was observed, it was rated a 4. If the inoculation caused the death of the plant, it was rated a 5.

Inoculation with the standard NY strain (Ea273) showed that most of the CG clones were highly resistant to this strain. The most tolerant clones were G.65, GG.3041, and CG.5179 which had none of the shoot infected and had a growth reaction of 1. Other CG clones with essentially no shoot infection but with some growth reaction rating were: G.11, G.16, G.30, and CG clones 4003, 4814, 5046, 5757, 5935, 5890, 6006, 6589, 6969 and 7707. Among current commercial clones M.7 had intermediate resistance but less than the CG clones listed above. M.9, M.26, M.27, MM.106, O.3 and Mark showed high susceptibility. CG clones that showed only moderate levels of resistance were: 3007, 5202, 4023, 6874, 6253, 6879, and 6210. Other rootstocks that showed a moderate level of resistance were Marubakaido, and B.490. CG stocks that were high susceptibility were 5087.

Among the Vineland series rootstocks, V.1, 2, 3, 4 and 7 all showed moderate resistance but less than M.7. The three Morioka series stocks we tested (JM 2, 4 and 10) all showed moderate susceptibility. All of the JTE series stocks we tested (JTE-B, C, D and G) showed high levels of susceptibility. Other stocks which were highly susceptible were B.9, Supporter 4, B. 118, and B.491.

Inoculation with any of the 3 more virulent strains of fire blight showed some level of infection with almost all rootstocks.Nevertheless, CG.3041 and G.11 exhibited the best resistance. There were some rootstocks that were more resistant to one strain over another but most stocks were ranked similarly to their rankings with the standard fire blight strain. When averaged over all strains the CG rootstocks were clearly the most tolerant to fire blight. They were followed by M.7, the Vineland series and the Morioka series. The most susceptible stocks were the other Malling stocks, the JTE series, B.9 and Supporter 4.

The high susceptibility of B.9 to direct inoculation with any of the 4 strains is contrary to field studies with grafted trees at Geneva and Pennsylvania. In addition anecdotal evidence from Ohio indicates that B.9 as a rootstock tolerated field epidemics of fire blight. It appears that the rootstock itself is highly susceptible but that, when used as a rootstock, it has field tolerance. This contradiction in susceptibility and field survivability indicates that all rootstocks should also be tested in the field as grafted trees to determine field tolerance. Objective 2 of this project incorporates such field testing of grafted trees.