CALIFORNIA RESULTS
2003 ANNUAL REPORT OF NC-140
SWEET CHERRY ROOTSTOCK

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PROJECT: NC-140, California
COOPERATING AGENCIES AND PRINCIPAL LEADERS:

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Progress of Work and Principle Accomplishments:

Our first NC-140 sweet cherry rootstock trials initiated in 1987 and 1988 as part of the NC-140 project were terminated in 1994 because of tree decline from stem pitting disease. A final report was submitted at that time. Since then, from the group of new rootstocks tested, growers in California have ordered primarily 148/1 and 148/2 Gisela rootstocks, although *Prunus mahaleb* seedling is the primary rootstock of choice. The sweet cherry industry is rapidly expanding. We have initiated new experiments with grower cooperators.

Introduction:

The major rootstocks used for sweet cherry in California include *Prunus mahaleb* L. (mahaleb), *P. avium* L. (Mazzard), and 'Colt' (*P. avium* x *P. pseudocerasus*). Mahaleb is easy to propagate from seed, but has the disadvantage of susceptibility to root and crown rot fungal diseases generally known as *Phytophthora spp.* Mahaleb is drought tolerant, moderately resistant to bacterial canker and hypersensitive to Western-X. Mahaleb produces few root suckers, but gophers damage trees on Mahaleb. Mazzard is graft compatible with sweet cherry cultivars, but is slow to fruit and imparts vigor to the scion. Cherry fruit size is good on fully mature trees with Mazzard rootstock.

'Bing' cherries trees on 'Colt' rootstock show field resistance to cherry stem pitting (CSP) disease, an apparently soil-borne pathogen suspected to be of viral origin. Use of 'Colt' is presently the only available option for mitigating the risk of CSP. California growers report varied and often poor performance of 'Bing' cherry nursery grafted to 'Colt' rootstock. Tree vigor is variable and seems to be site- and management-dependent. Trees planted on fine-textured soils are generally vigorous, non-precocious, have poor fruit set, and small soft fruit. On coarse-textured soils, tree size and vigor are reduced, trees tend to be more precocious with acceptable fruit size and quality. 'Colt' is sensitive to crown gall and apparently requires higher chilling than mahaleb.

The standard rootstocks for California sweet cherry production listed above do not serve all locations, growing conditions or cultivars of scion. The current rootstocks are increasingly challenged to perform under diverse conditions, particularly as new cultivars are developed as a function of California cherry production expansion into lower chilling and higher heat areas. It is unlikely that a single rootstock will ever be suited to all the environmental conditions and clonal or varietal diversity in which sweet cherry is grown. Field-testing of rootstocks must be used to determine which rootstocks are most appropriate for local growing conditions and management practices. Trials must examine the effects of rootstock on growth habit of the scion, cropping, survival and tolerance for unfavorable climatic conditions, and susceptibility to disease. Characteristics such as vigor, precocity, and compatibility must be evaluated.

To this end, relatively new clonal rootstocks resulting from interspecific hybrid crosses have been tested as part of the ongoing NC-140 Regional Trials. These trials include rootstocks of the 'GM series' (from Belgium), the 'GI series' (Giessen, Germany; 'Gisela'), 'MxM' series (Mazzard x mahaleb from Oregon), and mahaleb clones (originally selected in Bordeaux, France). Our first trial begun in 1987-8 and terminated in 1994, resulted in the following observations:

$ Gi rootstocks induce dwarfing of 'Bing' compared to Colt, mahaleb, mazzard, Stockton morello or MM series.

$ Many Gi rootstocks induce early or precocious bearing in ‘Bing’. This feature is impressive early in the life of the orchard, but as trees get older (5 years or more) there appears to be a tendency for overcropping and reduced fruit size.

$ At present, there is no reliable way to regulate cropping with these rootstocks. Pollination management, extensive renewal pruning, gibberellin use to reduce flowering or other bloom thinners are possible means by which to reduce crop potential, but at present these possibilities are under study.

$ Until 1994, some of the best Gi rootstocks overall (low root suckering, few bacterial canker symptoms, high yielding with good fruit size, dwarfing/improved yield efficiency, and enough vigor) included: Gi 195-2, Gi 148-1 and, possibly, Gi 169-15.

$ Standard mahaleb continues to be a good rootstock. *Phytophthora* root and crown rots can be problematic and partially reduced by careful irrigation.

$ Tree size with Std mahaleb might be controlled through regulated deficit irrigation, summer and selective pruning. ‘

$ Precocity can be induced by tree training.

$ By using mahaleb rootstocks the number of trees per acre will not be as high as with dwarfing rootstocks. More importantly, the level of cropping is easier to control and the level of experience in handling trees growing on mahaleb is greater than with the Gi series rootstocks.

Materials and Methods–1998 to 2003

Planting, Pruning and Training. Rootstocks were propagated by Meadow Lake Nursery in Oregon and were budded with ‘Bing’ in 1997. At least eight replicates of 16 rootstocks were planted on 27 April, 1998 at the University of California, Davis, Pomology Department’s Wolfskill Experimental Orchard in Winters, California. The soil was classified as a Yolo clay-loam. Tree spacing was 10' x 16', planted on berms and irrigated with microsprinkers. Trees were headed at 24" at planting. The experimental design was a randomized complete block with eight individual tree replicates. Rootstocks are listed in Table 1. Pollenizers included ‘Chinook’/MH (mahaleb), ‘Larian’/MH, ‘Black Tartarian’/MH, ‘Early Burlat’/MH, ‘Vista’/MH, and ‘Van’/Maz (Mazzard). Single leader training has limited use and with the long growing season of California we elected to follow the scion growth habit (upright vs spreading) as a function of rootstock. Mahaleb and Mazzard rootstocks were used as controls; ‘Colt’ was added as an additional control in a 1999 planting.

Annual data collection. We began collecting survival data in September, 1998, replanted trees that did not survive (in April, 1999), and again took survival data in July, 1999. We took ‘initial’ TCSA at 30 cm above the ground in April, 1999, and repeated these measurements annually, usually in November-December. In July, 1999 we also measured number of suckers, number of limb breaks, rated tree vigor (3 levels of vigor based on tree height), spreading vs upright, and terminal bud set (see 2002 report). On 31 March, 2000, we counted number of “truss buds” (2 limbs/tree, with density calculated based on branch cross-sectional area at the base and on buds per limb length), bloom rating overall (0 = no bloom, 5 = very high bloom density), average number of flowers per truss bud, and number of branches per TCSA (trunk cross-sectional area; see 2002 report). We collected yield and yield efficiency data in 2001, 2002 and 2003. In Spring, 2002, we visually evaluated individual trees for overall desirability, based on uniform growth habit, enough vigor with dwarfing potential for improved crop efficiency, spur development, branch strength, low root suckering, few bacterial canker symptoms.

Results and Discussion:

Survival: Most rootstock/scion combinations had 100% survival in 1998, five months after planting (Table 1). Those rootstocks that showed a significant decrease in survival during this period include: W 154 (40% survival), W 53 (57% survival), and Mazzard (83%). After replacing some lost trees (mahaleb, Mazzard, Edabriz, W 53, 154 and 158) in
spring of 1999, survival on 25 July, 1999 was 100% for half of the rootstocks planted in 1998 and of those that had been replanted in 1999, Mazzard, W 53 and W 158 maintained 100% survival and W 154 had 88% survival. W 72 reduced both 1998 and 1999 populations to 75%. In 2001, rootstocks that showed losses included Mazzard (11% death, calculated as percentage of those trees surviving in 2000), Weiroot 10 (12%), W72 (50%), W154 (20%) and Colt (67%). In 2002, losses tended to occur with rootstocks that had shown declines in 2001, in addition to a few that showed new losses since 2000. These included: Mazzard (41% loss), mahaleb (12%), Giessen 473-10 (50%), Edabriz (14%), W 10 (11%), W13 (13%), W53 (25%), W72 (50%), W158 (50%). In 2003 few losses occurred; these were single trees of Gi318-17, Gi 473-10, W10 and W154. Based on visual evaluation of trees remaining in Spring, 2002, we scored desirability overall (Table 2). Among these, W154 proved to be the least desirable, in addition to having the lowest survival rate overall.

Vegetative growth, 1999-2003: TCSA on 27 April, 1999 was highest in Gi 148-1 (Table 3). Rootstocks not significantly different from Gi 148-1 included: mahaleb, Gi 148-2, Gi 148-8, Gi 195-20, Gi 209-1, Gi 318-17 and W 13. W 154 showed the least TCSA and the remaining rootstocks were not significantly different from it. In 2000 the same rootstocks were the most vigorous among those planted in 1998, and many of those that had been statistically equivalent to the leaders in 1999 were now significantly less vigorous. Among those planted in 1999, rootstocks 'Colt' and Mazzard were the most vigorous, with most others statistically similar and W53 significantly lower in growth than the 2 leaders (but similar to the mid-range rootstocks). In 2001 there was no significant difference among rootstocks with respect to growth in those planted in 1998, although there was considerable difference numerically. The range of sizes within most rootstocks was such that the variability found in most of the rootstocks was too great to determine statistical differences. Among those rootstocks planted in 1999, W154 showed the greatest growth and all others were statistically less vigorous, but equivalent amongst the lower-range group. Overall, the greatest growth has been in Colt, followed by Standard mahaleb. Of the remaining rootstocks, Gi 148-1, 318-17, W13 and W154 have shown the greatest increase in TCSA. Substantially less vigor was found in Gi 148-2, 148-8, 209-1, 473-10, Edabriz, and the majority of the Weiroot group.

Bloom density and Productivity (Tables 3 and 4):

Flower abundance and full bloom: Flower abundance is an expression of the density of bloom open at a given time, closest to full bloom, so as to evaluate how many flowers are physically present on the tree and are open simultaneously. Earlier in the bloom cycle, abundance may evaluate the number of spurs present along a scaffold limb. In March of 2000, bloom abundance on a whole tree basis was highest in Gi 209-1 and 195-20 for trees planted in 1998; of those planted in 1999, the strongest bloomer was Edabriz. Mazzard was the lowest in flower abundance. On March 25, 2001, of trees planted in 1998, Mazzard was again, the lowest bloomer with W154 and W13equivalent. Gi 148-2, 209-1 and 195-20 were, again, high bloomers. Trees planted in 1999 showed no significant differences in bloom density. Full bloom date for trees in 2001 (both ages combined), was equivalent in all but 148-8, which bloomed earliest, and W72, which bloomed latest. Statistically significant differences were only apparent between these 2 rootstocks. Flower abundance in March, 2002, was highest to date, with most rootstocks showing 30% or more of the tree volume filled. Highest bloomers included mahaleb, 148-2, 473-10 and Colt. Lowest bloomers were Mazzard, 148-8, 318-17, Edabriz, W53, and lowest were W158 and W10 (virtually no flowers). Most rootstocks conferred bloom timing that was at full bloom or petal fall by 28 March, 2002. Those that were significantly late included mahaleb, Gi 148-1, Edabriz and W154.

Fruit production (Table 3) was very low in 2002 and 2003 as low chill conditions prevailed in those dormant seasons.. Cropping had only just begun to show productivity.

Overall, rootstock tends to have a significant to highly significant effect on the parameters of performance represented by the data gathered. In future years we expect to continue to measure vegetative and reproductive vigor, fruit set, yield, fruit size and quality, cropping efficiency, presence of blind wood, early senescence, disease susceptibility, uniformity of growth habit and size, and any other horticultural characteristics that appear to be important.

Table 1. Cherry rootstocks tested for NC140 Regional cherry project; survival.

Rootstock	Species or hybrid	%Survival [Z]							
			7/25/99		4/31/00		11/01[Y]	10/02	6/03
		9/98	Trees planted in						
			1998	1999	1998	1999			
Mazzard	Prunus avium	83b[X]	83b	100a	83b	100a	89a	59bc	59bc
mahaleb	P. mahaleb	88ab	88ab	100a	88ab	100a	100a	88ab	88ab
Giessen (Gi)									
148-1	P. cerasus x P. canescens (Germany)	100a	100a		100a		100a	100a	100a
148-2	P. cerasus x P. canescens (Germany)	100a	100a		100a		100a	100a	100a
148-8	P. cerasus x P. canescens (Germany)	100a	100a		100a		100a	100a	100a
195-20	P. canescens x P. cerasus	100a	100a		100a		100a	100a	100a
209-1	P. canescens x P. cerasus	88ab	88ab		88ab		100a	100a	100a
318-17	P. canescens x P. cerasus	100a	100a		100a		100a	100a	88ab
473-10	P. canescens x P. cerasus	100a	50b		50b		100a	100a	97ab
Edabriz (Tabel)	P. cerasus (Iran, INRA France)	100a	100a	100a	100a	100a	100a	86ab	86ab
Weiroot (W) 10	P. cerasus (Germany)	100a	100a		100a		88a	88ab	82ab
W 13	P. cerasus (Germany)	100a	88b		88b		100a	100	100a
W 53	P. cerasus (Germany)	57bc	57bc	100a	57b	100a	100a	75ab	75ab
W 72	P. cerasus (Germany)	100a	75b	75a	75ab	75b	50b	25c	25cd
W 154	P. cerasus (Germany)	40c	40c	100a	40c	83b	80ab	30c	15d
W 158	P. cerasus (Germany)	100a	100a	100a	100a	100a	100a	50bc	50bc
Colt				100a		100a	33c	33c	33c

[X] Mean separation within columns by Duncan's multiple range test, P = 0.05.

[Y] Survival in 2001and subsequent years was calculated as percentage of trees that survived in 2000.

[Z] Rootstocks were budded to 'Bing' and planted 27 April, 1998; some trees that died in 1998 through spring, 1999 were replanted with the same rootstock. Survival in 1999 and subsequent years represents, therefore a survival figure for both original trees and replants, where applicable.

Table 2. Cherry rootstocks tested for NC140 Regional cherry project; overall evaluation, Spring, 2002.

Rootstock	Species or hybrid (source)	Percentage of trees considered desirable[X]
Mazzard	Prunus avium	100
mahaleb	P. mahaleb	62
Giessen (Gi)		
148-1	P. cerasus x P. canescens (Germany)	75
148-2		62
148-8		83
195-20	P. canescens x P. cerasus	83
209-1		75
318-17		80
473-10		100
Edabriz (Tabel)	P. cerasus (Iran, INRA France)	77
Weiroot (W) 10	P. cerasus (Germany)	75
W 13		67
W 53		100
W 72		100
W 154		25
W 158		100
Colt		67

[X] Of trees surviving in spring, 2002, percentage of surviving evaluated as desirable overall, based on uniform growth habit, enough vigor with dwarfing potential for improved crop efficiency, spur development, branch strength, low root suckering, few bacterial canker symptoms.

Table 3. Cherry rootstocks tested for NC140 Regional cherry project; trunk cross-sectional area (TCSA, cm^2) from 1998-2000; total yield 2001-2003

Rootstock	TCSA 4/27/99 (1998)[Y]	TCSA 11/8/00		TCSA 11/20/01		TCSA 12/12/02
		Planted 1998	Planted1999	Planted 1998	Planted1999	
Mazzard	3.2 cd [X]	18.4 cd	13.2 a	61.6	55.2 b	137.8 bcd
mahaleb	6.1 abc	25.0 abc	7.2 bc	63.6	60.2 b	159.8 b
Giessen (Gi100) 148-1	8.6 a	30.7 a		52.9		134.8 bcd
Gi 148-2	6.6 abc	18.7 bcd		65.0		66.5 efg
Gi 148-8	6.3 abc	21.4 a-d		61.3		78.6 d-g
Gi 195-20	5.8 abc	18.4 cd		92.0		98.6 c-f
Gi 209-1	6.6 abc	16.1 cd		77.6		80.2 d-g
Gi 318-17	6.0 abc	28.4 ab		43.0		152.8 bc
Gi 473-10	4.0 bcd	12.8 d		43.8		47.7 g
Edabriz	2.9 cd	15.1 cd	5.3 cd	89.9	68.3 b	78.0 d-g
Weiroot (W) 10	4.7 bcd	19.6 bcd		77.2		83.8 d-g
W 13	7.0 ab	23.6 abc		83.6		120.8 b-e
W 53	2.4 cd	13.2 d	3.7 d	44.1	29.1 bc	59.1 fg
W 72	4.2 cd	11.9 d		82.6		90.4 d-f
W 154	2.2 d	15.6 cd	5.6 cd	85.6	90.6 a	147.1 bc
W 158	3.5 cd	19.3 bcd		69.6 n.s.	75.4 b	83.5 d-g
Colt			13.2 a		39.4 b	256.0 a

[X] Mean separation within columns by Duncan's multiple range test; P = 0.05 n.s. = non significant.

[Y] Year in parentheses = the year of vegetative growth represented in the column.

Table 4. Rootstock effect on abundance of flowering and bloom date.

Rootstock	Flower abundance on whole tree basis					Full bloom date, March 2001	% Full bloom, 3/28/02
	3/31/00[Z]		3/25/01[Y]		3/28/02, all trees		
	Trees planted in						
	1998	1999	1998	1999			
Mazzard	0.4 f[X]		0.2e	0.3 a	2.8 bc	27 a	80 ab
mahaleb	1.3 c-f		1.3cd	0 a	4.2 ab	25 ab	50 b
Giessen (Gi) 148-1	2.3 abc		1.8bcd		3.8 b	25 ab	35 b
Gi 148-2	1.8 b-e		2.9 a		4.1 ab	26 ab	85 ab
Gi 148-8	0.9 ef		1.6bcd		2.7 bc	24 b	85 ab
Gi 195-20	2.8 ab		2.2abc		3.4 b	26 ab	80 ab
Gi 209-1	3.2 a		2.8 a		3.6 b	26 ab	70 ab
Gi 318-17	1.1 def		1.2 cd		2.4 bc	25 ab	90 ab
Gi 473-10	1.2 c-f		2.5 ab		4.6 a	26 ab	85 ab
Edabriz	1.5 cde	2.6a	2.0 a-d	1.1 a	2.6 bc	26 ab	45 b
Weiroot (W) 10	2.2 a-d		1.4 cd		0.4 d	26 ab	100 a
W 13	1.3 c-f		1.0 de		3.1 b	27 a	80 ab
W 53	1.4 c-f		2.0 a-d	0 a	2.5 bc	27 a	90 ab
W 72	1.2 c-f		1.2 cd		3.5 b	27 a	50 b
W 154	1.0 ef	1.0b	1.0 de	1.0 a	3.6 b	25 ab	70 ab
W 158	1.2 c-f	0.8b	1.2 cd	1.0 a	1.3 cd	25 ab	90 ab
Colt		0c		0 a	4.0 ab	26 ab	80 ab

[X] Mean separation within columns by Tukey's test, $P = 0.05$.
[Y] Flower abundance in 2001 rated as: 0 = no bloom, 1 = 10% of the tree volume blooming, 2 = 20%, ..., 5 = very dense bloom.
[Z] Flower abundance in 2000 rated as: # clusters/30 cm of branch: 0=no flowers, 1 = 1-5 clusters, 2 = 6-10, 3 = 11-20.