EVALUATION OF SIZE CONTROLLING ROOTSTOCKS FOR CALIFORNIA PEACH PRODUCTION

Project Leaders: T.M. DeJong, R.S. Johnson, D. Bryla, and D. Ramming
Cooperators: R.S. Johnson, D. Bryla, and D. Ramming

Over half of the annual production costs for California peaches involve hand labor for pruning, thinning and harvesting which is done on ladders because of the large size of trees. It is widely recognized that production costs could be substantially reduced if the size of the trees could be reduced enough to eliminate the need for ladders in the orchard. The benefit of size-controlling rootstocks has been clearly demonstrated in apples and revolutionized the apple industries in Europe and the U.S.

The primary factor limiting the use of size controlling rootstocks in stone fruit production is the lack of commercial availability of suitable size-controlling rootstocks with a wide range of compatibility among cultivars. From 1986 to 1994 we evaluated 80+ genotypes representing a broad range of genetic backgrounds for their rooting capacity, compatibility with peach (O'Henry) and plum (Santa Rosa), and size controlling characteristics. During 1990 and 1991 in the peach part of this project, we identified 19 potential size controlling rootstock genotypes. In 1993, we selected 8 of the 19 for further testing in a second round of experiments. Most of these sixth leaf trees were 50-80% of the size of trees grown on standard rootstocks. In 1994 we began a project to further evaluate these eight selected rootstocks in replicated field production trials with Flavorcrest and Loadel scion cultivars. In February, 1996 a four-acre experimental rootstock trial was planted at the Kearney Agricultural Center to evaluate the commercial potential of these rootstocks. The main part of this experiment involved ten different rootstocks and two scions. The ten rootstocks were: Alace, Hiawatha, Sapalta (open pollinated seedlings of a *Prunus besseyi* x *P. salicina* hybrid), K-145-5, K-146-43, K-146-44, P-30-135, (*P. salicina* x *P. Persica* hybrids) K-119-50 (*P salicina* x *P. dulcis* hybrid), Citation and Nemaguard. The two main scion cultivars are Loadel (an early clingstone processing cultivar) and Flavorcrest (an early fresh market freestone cultivar). The trial contains thirty-six trees of each rootstock/scion combination. Four replications of 5 trees each were planted and trained to the KAC-V perpendicular V system, and 4 replications of 4 trees each were planted and trained to the standard open vase system. In row tree spacings for each rootstock/scion/training system combination varies according to expectations of final tree size.

A secondary part of this experiment involves up to two trees of each of the eight experimental rootstocks budded with the following scion cultivars: Firebrite, Flamekist, Juneglo, Mayglo, Rose, Sparking June, Carson, Haig Arkalian, Cal Red, Carnival, Elegant Lady, Fay Elberta, Queencrest, Redtop, Spring Lady, Snow Flame, Giant Babcock, and Ross. The cultivars were chosen to represent a broad range of genetic backgrounds to test for scion compatibility and growth characteristics on the various rootstocks. These trees were all planted with four feet between trees in the row and were trained to KAC-perpendicular V system. They are on the margins of the plot and can be removed when compatibility studies are complete without compromising the integrity of the main plot.

Trees on six of the ten rootstocks have grown well during the first seven seasons with size-controlling characteristics of five of the rootstock/scion combinations clearly apparent. Some of the experimental rootstocks appear to produce trees with less dense canopies than Nemaguard. As reported last year, four rootstocks in the trial (Citation, Alace, Sapalta, K145-5) showed clear signs of scion/rootstock incompatibility with both the Loadel and Flavorcrest scions. These incompatibilities caused tree death during 1998 and 1999 in each rootstock/scion combination and consequently trees on these rootstocks were removed from the plot in 2001. Trees on three new rootstocks from Europe, Adesoto (*Prunus insititia*), Pumiselect (*Prunus pumila*) and VSV-1 (*Prunus incane* x P. cerasifera) will be planted in the vacant spots in January 2003.

In order to develop some data on the relative tree size of the various scion/rootstock combinations compared to Nemaguard, trunk circumferences of the trees in each of the 4 or 5 tree replicate subplots were measured after the growing season. Data from January, 2003, are provided in Table 1. Trees on all five size-controlling rootstocks had mean trunk circumferences that were smaller than trees on Nemaguard. However, trees on P-30-135 were not significantly different than trees on Nemaguard. Trees on K-119-50, Hiawatha, K-146-43 and K-146-44 were all clearly smaller than trees on Nemaguard.

The trees were dormant-pruned in December, 2001. Pruning weights varied substantially with various scion/rootstock combinations (Table 2). As observed in previous years the pruning weights of most of the experimental scion/rootstock combinations were substantially less than those of the same scions on Nemaguard. These data indicate that the experimental rootstocks appear to have the capacity to reduce the amount of "excess" vegetative growth of the trees without necessarily having as great of an effect on the structural strength of the trees. Subjectively, the canopies of many of the trees on the experimental rootstocks appear less dense than those on Nemaguard. The trees were not summer pruned in 2002.

The trees produced their fifth significant crop in 2002. Trees in both systems were cropped normally and thinned to commercial expectations by maintaining a separation between fruit to obtain fruit size. As always, there was a strong interaction between crop load and fruit size but generally the trees on the most vigorous rootstocks carried the largest crop load per tree and produced the largest fruit size. However, the disparity in crop load between trees on different rootstocks was much less then in previous years. There was a general trend for fruit sizes on the size-controlling rootstocks to be smaller than fruit sizes on the more vigorous rootstocks however, this was primarily due to the greater crop load relative to tree size as indicated by the fruit #/TCA (trunk cross-sectional area) data presented in Tables 3 and 4. In this calculation, the crop load data were divided by the TCA data collected on the trees at the end of the previous season (2001). This factor normalizes crop load by an indicator of tree size (TCA) and indicates that in all cases the trees on K146-43 and K146-44 were more heavily cropped relative to their tree size. Given these disparities in relative crop loading (as much as twice as high) mean fruit size on the two smallest rootstocks was always within 77% of mean fruit size on the more lightly cropped trees on Nemaguard. These data clearly indicate a higher production efficiency (yield and fruit size relative to tree size) for

trees on the more size controlling rootstocks. When these yield characteristics are considered along with the substantially reduced amounts of brush removed at pruning the size-controlling rootstocks involved in this project appear to have great potential for enhancing the production efficiency peach orchards in California.

Last year we presented leaf tissue nutrient content data for both 2000 and 2001. Although the entire research plot has been fertilized at the same rates for the past several years some interesting differences in leaf nutrient content related to rootstock have become apparent. Trees on most of the experimental rootstocks have significantly lower leaf N concentrations than trees on Nemaguard while leaf concentrations of other nutrients are higher in trees on the experimental rootstocks compared to trees on Nemaguard (ie, calcium, magnesium, manganese). In 2002 a graduate student working with Dr. Scott Johnson conducted an experiment to confirm rootstock differences on scion leaf and fruit tissue calcium content and to investigate effects of these nutrient differences on fruit quality and postharvest storage. Data from this research is still being analyzed but preliminary data appears interesting.

During 2002, the rootstock plot was also used for corollary projects related to peach tree physiology and size-controlling rootstocks. We continued intensive studies of the seasonal behavior of root activity of four of the rootstocks (K-119-50, P-30-135, Hiawatha, K-146-43) in comparison with Nemaguard. This work was carried out collaboratively with Dr. David Bryla (USDA Fresno) and visiting scientists from Italy, Spain and Uruguay. Two research papers have been written and two more are being drafted. These papers will be made available when they are in final form. These studies indicate that the size-controlling mechanism in these peach rootstocks is probably related to differences in how the different rootstocks take up and conduct water in their tissues or at the root-soil interface. In 2003, we plan to continue physiological studies to further characterize these differences and determine if they are likely to have any unanticipated negative consequences on the performance of these rootstocks over time and in different growing conditions.

Table 1: Trunk circumferences (cm) of Flavorcrest and Loadel scion cultivars on six rootstocks and two training systems at the end of the seventh growing season (January 2003). Values represent the mean (∀ SE) of measurements of the four replications in the high density "KAC-V" and standard density "open vase" parts of the trial.

ROOTSTOCK	LOADEL		FLAVORCREST	
	Open Vase	KAC-V	Open Vase	KAC-V
Nemaguard	62 ± 0.4	44 ± 1.0	70 ± 1.1	50 ± 0.9
K-119-50	51 ± 0.8	37 ± 1.8	59 ± 2.2	41 ± 1.5
P-30-135	58 ± 1.6	40 ± 2.3	68 ± 1.8	47 ± 2.8
Hiawatha	50 ± 0.9	37 ± 1.3	55 ± 1.6	40 ± 1.9
K-146-43	40 ± 0.6	29 ± 0.9	46 ± 0.6	30 ± 0.4
K-146-44	39 ± 2.0	31 ± 0.6	47 ± 0.8	32 ± 0.6

Table 2: Dormant pruning weights (kg/tree) of the Flavorcrest and Loadel scion cultivars on six different rootstocks and two training systems after the sixth season of growth in the field (December, 2001).

ROOTSTOCK	LOADEL		FLAVORCREST	
	Open Vase	KAC-V	Open Vase	KAC-V
Nemaguard	28.2 ± 1.74	11.8 ± 0.36	31.8 ± 4.18	14.5 ± 1.91
K-119-50	15.8 ± 1.74	7.1 ± 1.41	21.1 ± 2.8	10.5 ± 1.32
P-30-135	16.3± 1.55	7.5± 1.2	23.7 ± 2.7	11.8 ± 2.20
Hiawatha	9.5 ± 0.61	5.0 ± 0.39	11.6 ± 1.81	7.2 ± 1.20
K-146-43	5.2 ± 0.23	2.6 ± 0.28	7.8 ± 0.63	4.2 ± 0.40
K-146-44	4.7 ± 1.11	3.2 ± 0.26	8.2 ± 0.51	4.6 ± 0.14

Table 3: Fruit harvest data for the KAC-V Loadel and Flavorcrest trees on six different rootstocks in 2002.

ROOTSTOCK	KAC-V							
	LOADEL				FLAVORCREST			
	Mean Crop weight/tree (kg)	Mean Fruit number/tree	Mean fruit weight (g)	Fruit #/TCA (fruit/cm^2)	Mean Crop weight/tree (kg)	Mean Fruit number/tree	Mean fruit weight (g)	Fruit #/TCA (fruit/cm^2)
Nemaguard	48.1	339	142	2.80	41.5	216	192	1.29
K-119-50	46.1	340	135	3.92	44.6	259	172	2.25
P-30-135	43.6	329	132	3.19	46.1	271	169	1.84
Hiawatha	43.2	327	133	3.55	38.7	213	181	1.95
K-146-43	33.7	308	109	5.31	35.2	236	149	4.07
K-146-44	36.2	309	117	4.95	34.8	204	172	3.27

Table 4: Fruit harvest data for the open vase Loadel and Flavorcrest trees on six different rootstocks in 2002.

Rootstock	Open Vase							
	Loadel				Flavorcrest			
	Mean Crop wt/tree (kg)	Mean Fruit Number/tree	Mean fruit wt (g)	Fruit #/TCA (fruit/cm^2)	Mean Crop wt/tree (kg)	Mean Fruit Number/tree	Mean fruit wt (g)	Fruit #/TCA (fruit/cm^2)
Nemaguard	106.5	741	143	2.96	126.4	652	194	1.94
K119-50	117.1	822	142	4.49	126.7	677	187	2.92
P30-135	101.7	739	137	3.44	110.5	624	176	2.03
Hiawatha	95.7	714	134	4.25	104.6	565	185	2.84
K146-43	74.5	629	119	6.11	87.7	538	164	3.83
K146-44	72.0	598	119	6.13	91.3	557	164	3.96