EVALUATION OF SIZE CONTROLLING ROOTSTOCKS FOR CALIFORNIA PEACH PRODUCTION

PROJECT LEADER: T.M. DeJong
COOPERATORS: R. Scott Johnson, David 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 the current 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 (Controller 5), K-146-44, P-30-135 (Controller 9), (*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 contained 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 nine seasons with size-controlling characteristics of five of the rootstock/scion combinations clearly apparent. 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) were planted in the vacant spots in January, 2003, but several of these have not grown very well. It is not clear if the spotty performance of these replants is characteristic of the rootstocks or simply a problem with the irregular condition of the replant sites.

The best indicator of differences in relative tree size among the various scion/rootstock combinations compared to Nemaguard is the data on trunk circumferences. Trees in each of the 4 or 5 tree replicate subplots were measured after the growing season. Data from January, 2005, are provided in Table 1. Trees on all five or the remaining size-controlling rootstocks had mean trunk circumferences that were smaller than trees on Nemaguard. However, trees on P-30-135 (Controller 9) were not significantly different than trees on Nemaguard. Trees on K-119-50, Hiawatha, K-146-43 (Controller 5) and K-146-44 were all clearly smaller than trees on Nemaguard.

Prior to the summer of 2003 all of the trees were allowed to attain a tree height that appeared to be in balance with the relative vigor of the rootstocks. Thus, by 2003 post-dormant season pruning heights of trees on the most vigorous trees (Nemaguard, K119-50, P30-135-Controller 9) approached more that fourteen feet. Since the real value of size-controlling rootstocks is foreseen to be in their ability to help manage trees height, in September, 2003, the management strategy was changed and the trees were severely topped at 11 ft. This topping was repeated in September, 2004. Unfortunately, it was impossible to record the amount of wood that was removed in each topping because of the type of machine that was used but the yields and the dormant pruning weights in December 2004 are a good indication of how the trees on the various rootstocks responded to the altered management strategy and give an indication of how efficiently trees on the different rootstocks can be with lowered canopies.

The trees were dormant-pruned in December, 2004. Pruning weights varied substantially among the 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 the trees on the experimental rootstocks have appeared less dense than those on Nemaguard and this years pruning weights are a good quantification of this since the dormant pruning weights represent only the fine pruning that was done subsequent to the late summer topping. Clearly there is a pruning advantage to using size-controlling rootstocks if a grower is interested in developing an orchard management strategy that involves arbitrarily limiting tree height to less than 11 ft.

Trees in both the KAC-V and the open vase systems were cropped normally and thinned to commercial expectations by maintaining a separation between fruit to obtain fruit size. Interestingly in 2004 crop loads tended to be lower in the trees on Nemaguard that the other rootstocks. This is different than in all previous years of this trial and most likely reflects the negative effects of arbitrarily reducing tree heights on very vigorous trees. Apparently the excessively shaded conditions in the lower parts of the Nemaguard canopies caused those canopies to have less high quality fruitwood than trees on the other rootstocks, resulting in fewer fruiting sites and less crop load at harvest. As always though, there was an interaction between crop load and mean fruit size but this was most apparent on the most size controlling rootstocks. With the exception of the trees on Nemaguard, the disparity in crop load between trees on the different rootstocks was much less then in previous years. There was a general trend for fruit sizes on the most size-controlling rootstocks to be smaller than fruit sizes on the intermediate vigor rootstocks however, this was probably primarily due to the greater crop load relative to tree size as indicated by the fruit weight/TCA (trunk cross-sectional area, 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 season (January, 2005). 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 (more than twice as high) mean fruit size on the two smallest rootstocks was always within 80% of mean fruit size on the more lightly cropped trees on Nemaguard. These data clearly indicate higher production efficiency (yield and fruit size relative to tree size) for trees on the more size controlling rootstocks.

The 2004 yield data subsequent to severe topping indicate the importance of these increased yield efficiencies when tree heights are limited to less than the natural balance of the tree. For the first time, this year trees on the intermediate vigor rootstocks clearly out-performed trees on Nemaguard with regard to tree yields and fruit size. Next year we are proposing to reduce the height of half of the replications in each system to 8 ft. to see if the most size-controlling stocks will then have an advantage over trees on both the Nemaguard and the intermediate vigor rootstocks.

During 2004, the rootstock plot was also used for corollary projects related to peach tree physiology and size-controlling rootstocks. These corollary projects have clearly documented that at least part of tree size-controlling mechanism involves differences in root hydraulic conductivity and daily water relations among the different rootstocks. We are currently also investigating if there are differences in the root carbohydrate storage capacity among the rootstocks. We plan to continue physiological studies to further characterize rootstock 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 eighth growing season (January 2005). 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	70 ± 0.4	49 ± 1.0	80 ± 1.8	56 ± 0.7
K-119-50	57 ± 1.1	41 ± 2.6	65 ± 2.9	46 ± 1.7
P-30-135	65 ± 2.0	46 ± 2.3	78 ± 2.4	55 ± 3.2
Hiawatha	56 ± 0.9	42 ± 1.5	62 ± 2.1	45 ± 2.1
K-146-43	46 ± 0.4	33 ± 1.4	53 ± 0.9	35 ± 0.7
K-146-44	45 ± 2.7	35 ± 0.8	56 ± 1.3	38 ± 0.5

Table 2: Dormant pruning weights (kg/tree) of the Flavorcrest and Loadel scion cultivars on six different rootstocks and two training systems after the ninth season of growth in the field (December, 2004).

ROOTSTOCK	LOADEL		FLAVORCREST	
	Open Vase	KAC-V	Open Vase	KAC-V
Nemaguard	16.7 ± 1.10	8.6 ± 0.42	18.3 ± 0.63	12.3 ± 1.45
K-119-50	7.5 ± 0.30	4.8 ± 0.47	12.0 ± 0.71	8.3 ± 1.24
P-30-135	6.6 ± 0.31	4.1 ± 0.52	10.2 ± 0.58	9.9 ± 1.27
Hiawatha	6.2 ± 0.52	3.5 ± 0.52	8.3 ± 1.21	4.9 ± 0.57
K-146-43	4.0 ± 0.25	2.6 ± 0.58	6.0 ± 0.56	3.8 ± 0.36
K-146-44	4.3 ± 0.58	2.5 ± 0.19	7.2 ± 0.31	5.3 ± 0.48

Table 3: Fruit harvest data for the KAC-V Loadel and Flavorcrest trees on six different rootstocks in 2004. (TCA is trunk cross sectional area)

ROOTSTOCK	KAC-V							
	LOADEL				FLAVORCREST			
	Mean crop weight/tree (kg)	Mean fruit weight (gm)	Mean crop load (#fruit/tree)	Fruit weight/TCA (kg/cm^2)	Mean Crop weight/tree (kg)	Mean fruit weight (gm)	Mean crop load (#fruit/tree)	Fruit weight/TCA (kg/cm^2)
Nemaguard	44.2±3.2	142±6.3	311	0.23	26.4±1.7	151±9.5	175	0.11
K-119-50	47.4±2.0	142±2.5	334	0.35	38.0±3.4	160±4.9	237	0.22
P-30-135	47.4±6.7	130±4.1	365	0.28	37.2±3.4	159±3.8	234	0.15
Hiawatha	38.9±2.2	127±2.5	306	0.28	38.5±6.7	154±2.9	250	0.23
K-146-43	36.0±3.2	117±2.5	308	0.42	34.2±1.9	152±6.6	225	0.35
K-146-44	41.2±4.7	125±2.9	330	0.41	39.4±2.2	156±8.9	252	0.34

Table 4: Fruit harvest data for the open vase Loadel and Flavorcrest trees on six different rootstocks in 2004. (TCA is trunk cross sectional area)

ROOTSTOCK	OPEN VASE							
	LOADEL				FLAVORCREST			
	Mean crop weight/tree (kg)	Mean fruit weight (gm)	Mean crop load (#fruit/tree)	Fruit weight/TCA (kg/cm^2)	Mean Crop weight/tree (kg)	Mean fruit weight (gm)	Mean crop load (#fruit/tree)	Fruit weight/TCA (kg/cm^2)
Nemaguard	85.8±7.1	151±4.0	568	0.22	76.6±4.0	165±5.3	464	0.15
K-119-50	111.2±6.2	141±3.5	787	0.43	91.8±5.3	164±4.8	600	0.27
P-30-135	99.0±7.4	137±2.5	723	0.29	87.2±6.8	164±1.8	532	0.18
Hiawatha	89.5±6.1	145±2.7	617	0.36	96.1±5.6	161±2.7	597	0.31
K-146-43	86.7±4.1	125±1.9	694	0.51	84.2±3.8	150±4.7	561	0.37
K-146-44	95.1±9.1	122±3.7	779	0.59	89.8±3.5	154±4.6	583	0.36