Development and Testing of Pedestrian Orchard Concepts

Project Leader: Kevin R. Day

Cooperators: Dr. Theodore DeJong
Dr. R. Scott Johnson
Becky Phene

ABSTRACT

Economic pressures are forcing growers to reevaluate all farming practices. For production practices, labor costs dominate all others. Over the past few years, much has been learned about the relationship between tree height, production potential, and labor cost savings. Both dwarfing and standard rootstocks have been studied, but never within a comparison as part of an overall system.

Furthermore, while we have demonstrated that orchard height can be significantly and successfully reduced, even while using vigorous rootstocks such as Nemaguard, we still do not know if a true pedestrian orchard, i.e. one in which no ladders are at all necessary, is economically feasible over the long-term.

To understand these issues better, we have begun several trials that will explore the relationships between tree from, orchard density and rootstock vigor. Our overall goal will be to maintain tree height at about 7-8' thus establishing a pedestrian orchard. Within those constraints we will investigate how successful and how suitable such a strategy is.

METHODS

1. **Trial 1 - "Owen T" Plum**

   In March 2007 a block of "Owen T" plums growing on the semi-dwarfing rootstock Citation (about 75-80% of the vigor of Nemaguard) were planted at Kearney. Two row spacings/tree height configurations are used: 1) standard 18 foot wide rows in which the trees will be grown to standard height (12-14 feet tall); and 2) 15 foot wide rows in which the tree will be kept at a pedestrian height (7-9 feet tall). Tree conformation within each includes three training systems: 1) 6-leader Hex-V trees, 2) 4-leader Quad-V trees, and 3) 2-leader Kearney V trees planted at 12, 8, and 4 feet apart respectively. This design will allow us to make comparisons between tree height, tree density, and per acre scaffold count, (Table1).

Table 1. Per acre tree and scaffold counts for "Owen T" plums on "Citation" rootstock, growing at differing densities and conformations and planted at the Kearney Ag Center in March 2007.

Row Spacing	Tree Form	Trees/acre		Scaffolds/acre	
		15' row	18' row	15' row	18' row
4'	Kearney-V	726	605	1452	1212
8'	Quad-V	363	303	1452	1212
12'	Hex-V	242	202	1452	1212

One of our primary goals was to achieve full production in 2010, the fourth leaf. To do this, we performed virtually no pruning during the first and second growing season (2007 and 2008); instead relying upon very minor in-season shoot tipping to induce branching and spur formation. Some scaffold orientation was performed in August 2008 by limb tying and/or bending. As a consequence, and especially in the most closely planted treatments, we were able to develop large fruiting areas and quickly fill the allotted tree space. Full tree size was achieved during the 2009 growing season, and trees were mechanically topped to their ultimate heights in mid-October 2009.

The trees were harvested on 2 July 2009 in a single pick. Yields are presented below in Table 2. Note that the trees were not topped to their ultimate heights until after harvest, so these yields are not indicative of that portion of the experiment. Yields were greater than we expected and were primarily related to tree density, with the 2-leader KAC-V trees having the greatest yields. Per tree fruit set was similar for each of the tree conformations – except for the HEX-V trees – and yields were greater in trees planted to a 15' row spacing as a consequence of their additional crop load per acre. It was somewhat surprising to observe such high yields in the third leaf. This response demonstrates the benefit of minimal pruning and illustrates the role of tree density in achieving early yields. We suspect that the KAC-V trees have already achieved full production and are curious if the other conformations will reach similar production levels in 2010. However, of greatest importance in the next few years, will be observing the effect of the different tree heights on fruit yield and quality.

Table 2. Yield, crop load and fruit size of third-leaf Owen T plums trained to various tree conformations/densities and growing at the Kearney Agricultural Center. Trees harvested July 2, 2009.

Treatment	Yield (tons/ac)	Yield (boxes/ac)	Fruit Size (grams)	Crop Load (fruit/tree)	Crop Load (fruit/acre)
KAC-V 15' row	22.16	1165	135	212	154,000
KAC-V 18' row	21.11	1111	131	247	149,000
QUAD-V 15' row	10.71	564	142	189	69,000
QUAD-V 18' row	9.26	487	144	193	58,000
HEX-V 15'row	9.36	493	130	270	65,000
HEX-V 18'row	5.62	296	143	177	36,000

2. Trial 2 - "Springcrest"/"O'Henry" Height and Rootstock Comparison

In order to derive yield data in 2008 and 2009, an established block of five year old "Springcrest" and "O'Henry" peaches was differentially topped in the fall of 2007 prior to dormant pruning. One-half of the orchard was mechanically topped at 8' and the other at 11'. The shorter trees were then hand-topped even lower during dormant pruning to no higher than 7' – with the primary purpose of making them into true pedestrian trees. Within each height, there are four rootstocks, Nemaguard, UC Controller 9, Hiawatha, and UC Controller 5 (listed from greatest to lowest vigor).

2009 yield data for Nemaguard and Controller 5 is presented below in Tables 3 & 4 for Springcrest and O'Henry respectively. In 2009 there were no significant yield or fruit quality differences between short and tall trees for a given rootstock for either Springcrest or O'Henry. This reinforces the premise that pedestrian orchards are possible under California growing conditions, even with our current rootstock options. We had no trouble keeping trees on Nemaguard limited to 7' tall, but we carefully monitor water and fertilizer applications in the block to assist in this. Springcrest trees were summer pruned twice, in early-May and again in September; O'Henry trees were summer pruned once, in mid-July.

Fruit size on Controller 5 continues to be smaller than on Nemaguard. To better understand this condition we performed shoot "mapping" during fruit development of Controller 5 and Nemaguard trees in 2008. Results of this mapping indicated that Controller 5 develops more flowers per shoot and per unit shoot length, and also sets more fruit per flower. This results in a condition that limits fruit growth potential. Additional work led by Dr. T.M. DeJong demonstrated that C-5 rootstock has "limited" ability to transport water through its vascular system – also limiting fruit size. In 2009 we tested a severe dormant pruning/shoot tipping strategy that somewhat alleviated this problem (data not presented). One of the additional benefits of this was the development of fruit wood more similar to that of trees growing on Nemaguard. We plan to further study this in 2010 in the hope that these shoots will have flower densities and fruit sets more like those growing on Nemaguard.

Table 3. Yield, crop load and fruit size of Springcrest peach pruned to two heights and growing on two rootstocks at the Kearney Agricultural Center, 2009. Values are means ± standard errors.

Rootstock Height	Yield (kg/tree)	Yield (tons/ac)	Crop Load (fruit/tree)	Crop Load (fruit/ac)	Fruit Size (g/fruit)
Nemaguard					
7' Tall	13.7 ± 1.8	6.8 ± 0.9	104 ± 12	47,000	131 ± 2
11' Tall	13.6 ± 1.5	6.8 ± 0.7	110 ± 12	50,000	123 ±1
Controller 5					
7' Tall	11.6 ± 1.5	7.0 ± 0.9	116 ± 14	63,000	99 ± 3
11' Tall	11.3 ± 0.8	6.8 ± 0.5	110 ± 13	60,000	106 ± 9

Table 4. Yield, crop load and fruit size of O'Henry peach pruned to two heights and growing on two rootstocks at the Kearney Agricultural Center, 2009. Values are means ± standard errors.

Rootstock Height	Yield (kg/tree)	Yield (tons/ac)	Crop Load (fruit/tree)	Crop Load (fruit/ac)	Fruit Size (g/fruit)
Nemaguard					
7' Tall	42.3 ± 5.5	21.1 ± 2.7	231 ± 43	105,000	189 ± 11
11' Tall	42.0 ± 1.0	21.0 ± 0.5	235 ± 14	107,000	180 ± 9
Controller 5					
7' Tall	33.9 ± 5.5	20.3 ± 3.3	221 ± 32	120,000	154 ± 11
11' Tall	28.9 ± 3.2	17.3 ± 1.9	186 ± 18	101,000	154 ± 4

3. Trial 3 - Tree Form and Rootstock for Peach and Nectarine

An orchard block is being established at the Kearney Agricultural Center to study the relationship between tree form, rootstock vigor and season of ripening. The orchard was planted as rootstock on May 28, 2008 to the following treatments; and in February 2009 Zee Fire nectarine and Summer Flame 32 peach were grafted onto the rootstocks:

Rootstock	Spacing	Density (tree/acre)	Scaffolds per acre	Form
Nemaguard	12'x16'	227	1362	6-leader Hex V - tall
Nemaguard	12'x16'	227	1362	6-leader Hex V
UC Controller 9	12'x16'	227	1362	6-leader Hex V
UC Controller 9	7' x 14'	445	1780	4-leader Quad V
UC Controller 5 (removed May 2009)	7' x 14'	445	1780	4-leader Quad V
UC Controller 5 (removed May 2009)	5' x 14'	622	1244	2-Leader Kearney V

Given our frustrating experience with reduced fruit size for trees growing on Controller 5, and in consultation with the CTFA Research Subcommittee, we removed the C-5 portion of this block in May 2009 so that we could use this portion of the land within the experiment to focus on more promising rootstock choices. In the late summer of 2008 we discovered that Controller 5 has promise as an inter-stem, which when grafted onto Nemaguard rootstock imposes about 25% dwarfing but with no apparent reduction in fruit size. These trees continued to perform so well in 2009 that we had nursery trees made for January 2010 planting. This is of particular interest because it may provide growers with an immediate size-controlling option. We will also plant trees from the UC HBOK breeding line developed by DeJong et al, and which reduce tree vigor by a similar and approximate 25%. Both of these treatments will be planted within this block in January 2010 at a 7'x14'spacing, trained to a 4-leader Quad-V and limited to a height of 7' tall.