Developing Pedestrian Orchard Systems

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Abstract

Owen T Plums: This block was planted in March 2007 and compares 8' and 12' tall trees growing in three tree forms. Fourth-leaf yields ranged from ~800 to 1250 boxes per acre, and were primarily related to tree density, with the 2-leader KAC-V trees having the greatest yields. Short trees tended to have greater fruit size, and tall trees greater yield – regression analysis indicates that these differences were a function of crop load rather than system potential.

Springcrest/O'Henry: In 2008 and 2009 there were no significant yield or fruit quality differences between short (7') and tall (12') trees for a given rootstock for either Springcrest or O'Henry. In 2010, we could not summer prune the Springcrest block and tall trees had slightly greater size potential than short trees, but short and tall O'Henry trees had similar yield potential. After three years of work, we have demonstrated that pedestrian orchards are possible under California growing conditions, even with our current rootstock options, and we had no trouble keeping trees on Nemaguard limited to 7' tall. While not studied in this portion of the experiment, our previous results and grower experiences indicate that labor savings of 20-35% or more, can be realized in pedestrian systems. However, care must be taken to manage light through proper pruning, summer pruning, irrigation and fertility programs.

Zee Fire/Summer Flame 34: Development of this block continues. Nemaguard and Controller 9 (C-9) rootstocks were grafted to these selected varieties in 2009. The Controller 5 sections were removed and those areas were replanted in January 2010 with HBOK 28 and the Nemaguard/Controller 5 interstem combination – both of which reduce vigor by 25-35% – since these rootstocks appear to be much more promising than C-5 as a stand-alone rootstock. The Summer Flame crop was poor and inconsistent and was physically aborted for 2010. Zee Fire yields ranged from approximately 250 to 450 boxes per acre. The greatest yields were obtained using C-9 rootstock grown as a 6-7' tall Quad-V tree spaced at 7'x14'. Fruit size was significantly larger using the C-9 rootstock and it supported crop loads equal or superior to that of Nemaguard.

Background Information

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 conducted several trials to explore the relationships between tree form, 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

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 were 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, (table 1).

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

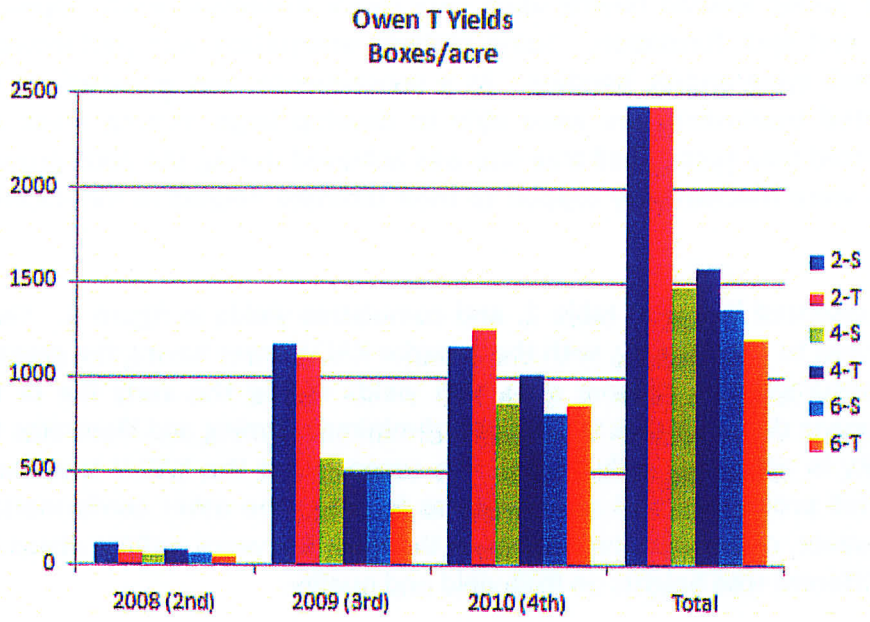
One of our primary goals was to try to achieve full production in 2010, the fourth leaf. To do this, we performed virtually no pruning during the first and second growing season (2007 and 2008); instead relying upon very minor in-season shoot tipping to induce branching and spur formation. Some scaffold 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.

2010 yields are presented below in table 2, and cumulative yields in figure 1. Yields were primarily related to tree density, with the 2-leader KAC-V trees having the greatest yields. It was encouraging to observe such high yields during the early life of the orchard. 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 as to when the other conformations will catch up. 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 fourth-leaf Owen T plums trained to various tree conformations/densities and growing at the Kearney Agricultural Center. Trees harvested 7 July 2010. (Boxes per acre calculated at 28.5 lbs/box @ 75% packout.)

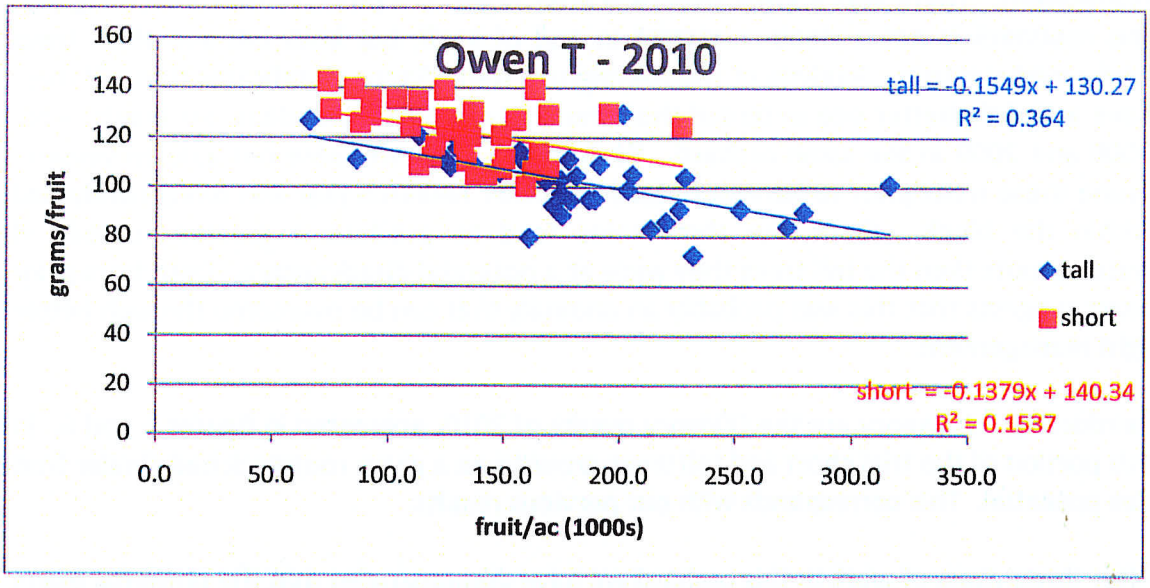
	15' Row Width				18' Row Width			
Tree spacing	boxes/ac	g/fruit	fruit/tree	fruit/ac	boxes/ac	g/fruit	fruit/tree	fruit/ac
4'	1155	124	222	161,000	1258	94	383	232,000
8'	858	121	340	124,000	1014	101	572	173,000
12'	803	121	479	116,000	854	112	665	134,000

Figure 1. Cumulative yield in boxes per acre equivalents of Owen T plums through fourth leaf. (Treatment legend: 2, 4, and 6 represent Kearney, Quad, and Hex V forms respectively; and "S" and "T" represent short and tall trees.)



In general, short tree tended to have greater fruit size and tall trees greater yield. This appears to have been primarily related to crop load. Regression analysis (figure 2) of the fourth leaf production data indicated that fruit size potential was similar between tree height treatments, with short trees showing excellent performance but over a smaller range of crop loads. In 2011 we will perform similar and more extensive measurements of this relationship.

Figure 2. Adjusted crop load and size potential of Owen T plums growing at the UC Kearney Ag Center.



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

In order to derive yield data in 2008, 2009, and 2010 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 (C-5), listed from greatest to lowest vigor.

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 monitored 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.

In 2010, we performed differential thinning across the C-5 and Nemaguard trees, of both Springcrest and O'Henry, to obtain a range of crop loads. Trees were thinned to

approximately 67%, 100% and 133% of "normal" crop fruit-counts. Fruits were harvested multiple times and data analyzed using regression analysis.

Springcrest results are presented in figures 3 and 4 for Controller 5 and Nemaguard respectively. There was a great deal of scatter in the C-5 plots, further indicating that this rootstock is not a viable rootstock in and of itself, but both tall and short trees performed similarly. Analysis of the Nemaguard data (figure 4) indicates that tall trees have a slightly better size potential than short trees. This contradicts our results from 2008 and 2009 in the same orchard. However, in 2010 we were not able to summer prune these trees prior to harvest because of other research that was being conducted within the block. Since the short trees tend to produce a greater number of watersprouts than the tall trees they were at a potential disadvantage. Data from prior years suggests that this was probably an anomaly that can be overcome through better light management.

Reinforcing this theory are the O'Henry results of 2010, presented in figures 5 and 6. In this portion of the trial short and tall trees growing on a given rootstock had similar fruit size potential. This corresponds with our pervious results.

After three years of work in this orchard we have demonstrated that the potential exists to successfully grow and manage short trees under southern San Joaquin Valley growing conditions. While not studied in this portion of the experiment, our previous results and grower experiences indicate that labor savings of 20-35% or more exist. However, care must be taken to manage light through proper pruning, summer pruning, irrigation and fertility programs.

Figure 3. Fruit size potential of Springcrest peach growing on UC Controller 5 rootstock at the Kearney Ag Center. Short trees are ~ 7' tall and tall trees are 12' tall.

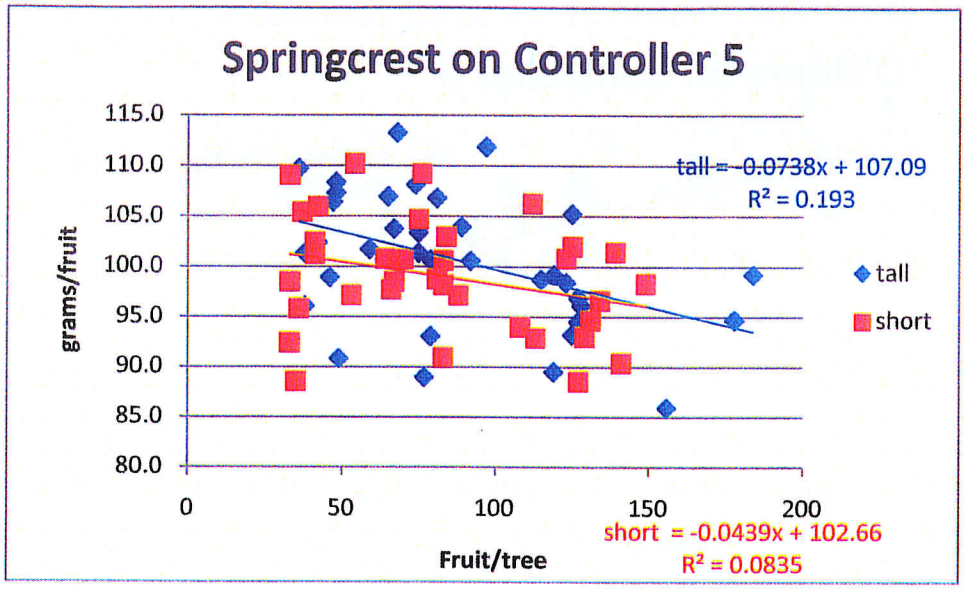


Figure 4. Fruit size potential of Springcrest peach growing on Nemaguard rootstock at the Kearney Ag Center. Short trees are ~ 7' tall and tall trees are 12' tall.

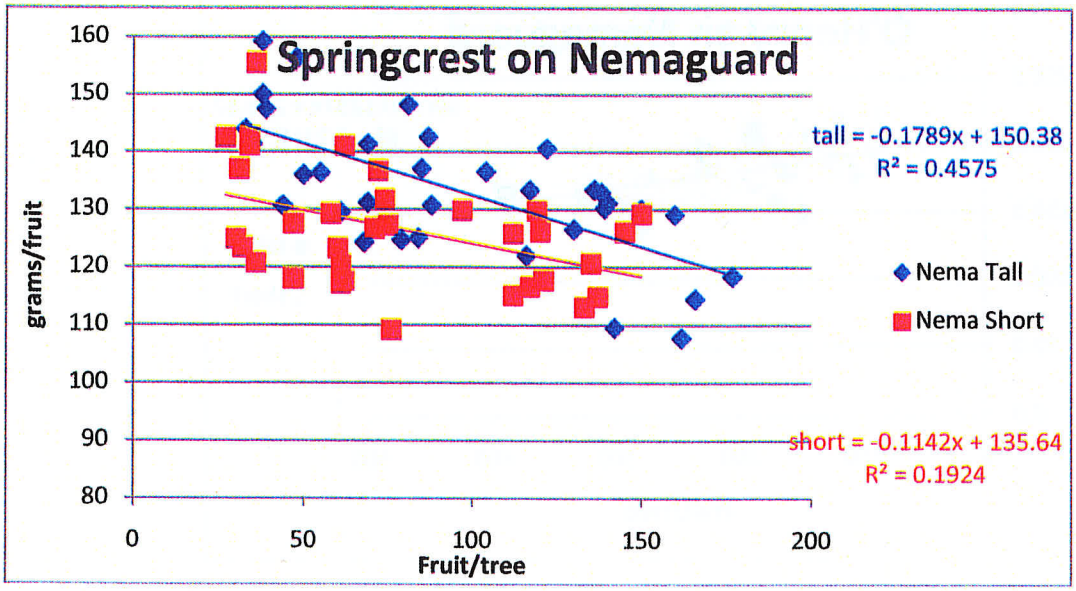


Figure 5. Fruit size potential of O'Henry peach growing on UC Controller 5 rootstock at the Kearney Ag Center. Short trees are ~ 7' tall and tall trees are 12' tall.

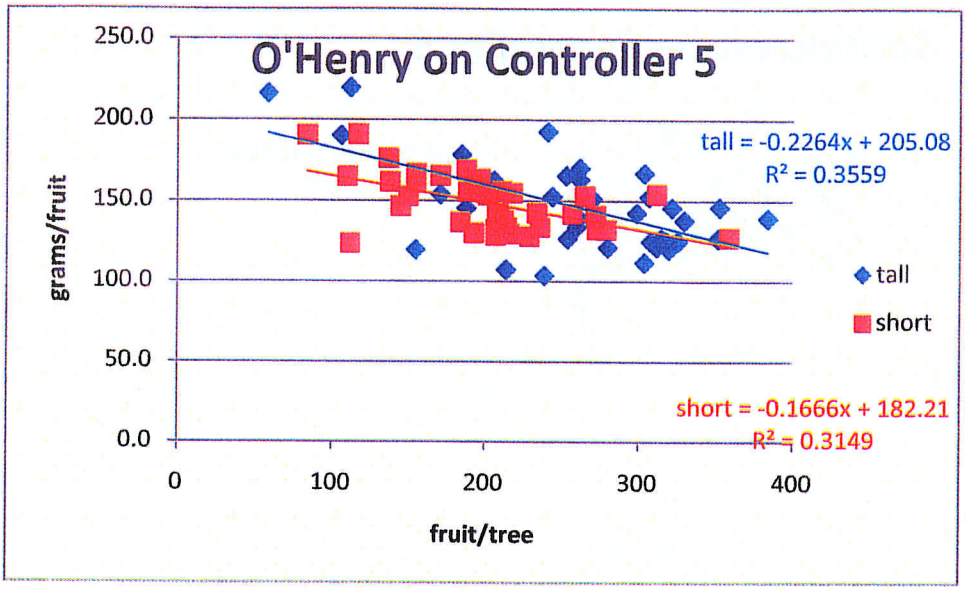
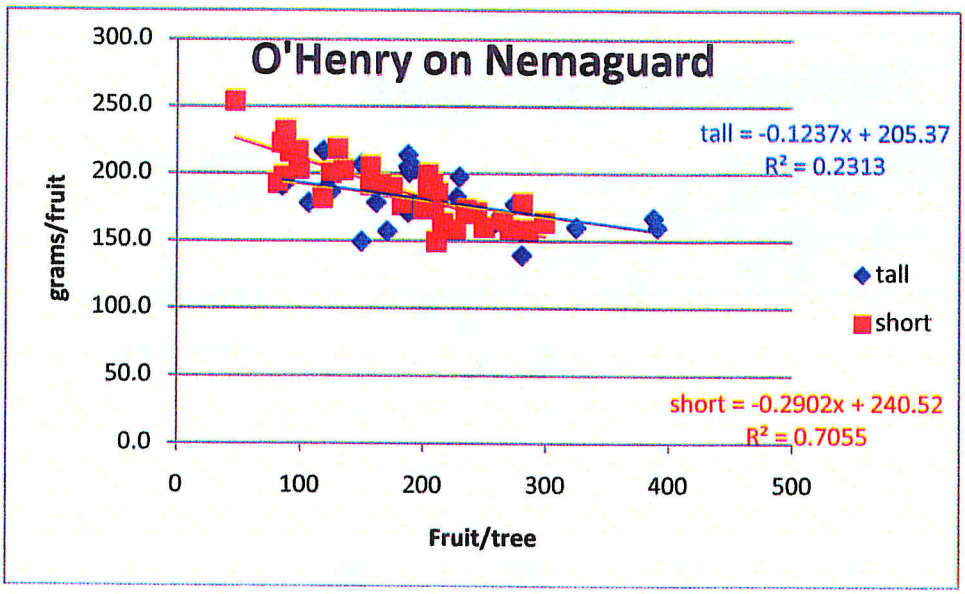


Figure 6. Fruit size potential of O'Henry peach growing on Nemaguard rootstock at the Kearney Ag Center. Short trees are ~ 7' tall and tall trees are 12' tall.



Trial 3: Tree Form and Rootstock for Peach and Nectarine, Zee Fire/Summer Flame 34: 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, and in February 2009 Zee Fire nectarine and Summer Flame 34 peach were grafted onto the rootstocks. In consultation with the CTFA Research Subcommittee, the initial Controller 5 sections of the block were

removed in 2009 and those areas were replanted in January 2010 with HBOK 28 and the Nemaguard/Controller 5 interstem combination – both of which reduce vigor by 25-35% – since these options appear to be much more promising than C-5 as a stand-alone rootstock. Development of the block continues.

A summary of the various treatments follows; treatments 1-4 are 2008 plantings and treatments 5-6 are 2010 plantings:

1. Hex-V/Nemaguard @ 12'x16' (tall trees ~12-13')
2. Hex-V/Nemaguard @ 12'x16' (short trees ~7-8')
3. Hex-V/Controller 9 @ 12'x16' (short trees)
4. Quad-V/Controller 9 @ 7'x 14' (short trees)
5. Quad-V/UC HBOK 28 @ 7'x 14' (short trees)
6. Quad-V/Nemaguard/Controller 5 interstem @ 7'x14' (short trees)

The Summer Flame crop was poor and inconsistent and was physically aborted for 2010. Preliminary analysis of Zee Fire data showed that yields ranged from approximately 250 to 450 boxes per acre. The greatest yields were obtained using C-9 rootstock grown as a 6-7' tall Quad-V tree spaced at 7'x14'. Fruit size was significantly larger using the C-9 rootstock and it supported crop loads equal or superior to that of Nemaguard.

Table 3. 2010 Yields, Zee Fire Nectarine; harvest 1 June 2010. Data are means ± standard error.

Rootstock	Lbs/tree	Lbs/acre	Fruit/tree	Fruit/acre	Grams/fruit
Nema – tall Hex	25.1 ± 2.0	5698 ± 464	126 ± 10	28,600 ± 2300	90 ± 2
Nema – short Hex	29.8 ± 3.6	6767 ± 809	139 ± 16	31,600 ± 3600	98 ± 4
C-9 – Hex	27.0 ± 3.2	6128 ± 729	113 ± 15	25,700 ± 3400	110 ± 3
C-9 - Quad	19.4 ± 1.8	8635 ± 803	74 ± 7	32,900 ± 3100	119 ± 2