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# Scion/Rootstock Interactions Determine Tree Size of Ten Asian Pear Scion Cultivars on Five Old Home x Farmingdale Rootstocks

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## Abstract

The influence of five Old Home x Farmingdale (OHF) clonal rootstocks, OHF 51, OHF 97, OHF 217, OHF 282 and OHF 333 on tree size with Asian pear scion cultivars, '20th Century,' 'Chojuro,' 'Hosui,' 'Kikusui,' 'Niitaka,' 'Okusankichi,' 'Seigyoku,' 'Shinko,' 'Shinseiki' and 'Tse Li' was examined after 10 years in an experimental orchard in central Washington state. The effect of rootstock on tree size varied among scion cultivars. Within the cultivars, 'Chojuro,' 'Hosui,' 'Niitaka' and 'Seigyoku,' trunk cross-sectional areas (TCA) were similar regardless of rootstock, but 'Hosui' trees were significantly larger than 'Niitaka' and 'Seigyoku' trees, which were significantly larger than 'Chojuro.' Within 'Tse Li,' which had the largest TCAs, OHF 333 produced larger trees than OHF 282 and OHF 217. 'Okusankichi' trees, which were generally the same size as 'Hosui,' were significantly larger on OHF 217 and OHF 97 than on OHF 333. 'Kikusui' trees, which were generally similar in size to 'Niitaka' and 'Seigyoku,' were larger on OHF 217, OHF 97 and OHF 282 than on OHF 333. '20th Century,' which was similar in size to 'Chojuro' and 'Shinseiki,' appeared to be the cultivar most sensitive to rootstock. '20th Century'/OHF 217 were significantly larger than trees on OHF 97 and OHF 282, which were larger than trees on OHF 51. 'Shinseiki'/OHF 97 were larger than trees on OHF 333. Contrary to research with some European pear scions, consistent trends did not emerge from this research that would allow a general prediction of the relative influence of these 5 OHF clonal rootstocks on Asian pear tree size.


## Introduction

Pear rootstocks influence numerous characteristics of tree performance including susceptibility to pesticide damage (5), root suckering (6), fruit quality (2), mineral status (3), yield (7, 9, 13, 15, 20), drought tolerance (8, 19), disease and pest resistance (14, 18), and tree size. A prediction of the tree size that may be affected by pear rootstocks is of critical importance during the design phase of orchard development, if tree density is to be optimal for the site. Given the plethora of rootstocks available, evaluation of rootstock effects on tree performance continues to be important.

This report details the affect on tree size, as measured by TCA, of 5 Old Home x Farmingdale (OHF) clonal rootstocks budded to 10 Asian pear scion cultivars after 10 years of growth. Additionally, we examine the effect of Asian pear scion cultivar on tree size.

## Materials and Methods

Descriptive details of our experimental planting have been reported previously (8, 9, 10, 11). The orchard was planted in April, 1985 in a fine sandy-loam soil on a uniform south-facing slope at the Washington State University Royal Slope Research Unit near Othello, Washington. Scion cultivars (main plots) were '20th Century,' 'Chojuro,' 'Hosui,' 'Kikusui,' 'Niitaka,' 'Okusankichi,' 'Seigyoku,' 'Shinko,' 'Shinseiki' and 'Tse Li' (which we and others erroneously reported in earlier publications as 'Tsu Li'). Rootstocks (sub-plots) were OHF 51, OHF 97, OHF 217, OHF 282 and OHF 333. Trees for the study were supplied by Carlton Nursery, Dayton, Oregon through the efforts of Brandt Nursery, Parker, WA. 'Hosui'/OHF 97 was unavailable at planting, and the only 'Tse Li'/OHF 51 tree that survived the first year (8) succumbed prior to the tenth year.

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The orchard was laid out as a split plot experiment in a randomized complete block design containing 4 blocks. Within each block, a row contained a single scion cultivar (main plot) that had been assigned at random. Within rows, each rootstock (sub-plot) was assigned at random to a three-tree plot. Spacing was 3.0 x 5.1 m in rows oriented north-south on a uniform south-facing slope. The western- and easternmost rows of the orchard were guard rows, as were the northern- and southernmost trees in each row. Trees were free-standing and were trained to a central leader. Irrigation was from overhead sprinklers and totaled about 130 cm during the growing season. Thirty-year (1961-1990) average annual rainfall at Othello, Washington, was 20.75 cm, with 8.51 cm falling from April through October (16, 17).

Tree loss was significant during the first year (8), but only trees that appeared healthy in the first and all subsequent years were used for analysis. For each tree, scion trunk diameter at approximately 30 cm above the ground was measured with a diameter tape in December, 1995. These data were converted to TCA under the assumption that the trunk was circular in cross-section.

*Statistical Analysis* — TCAs were initially analyzed as a split plot experiment in a randomized complete block design with scion cultivar in the main plots and with rootstocks in the subplots in each of 4 blocks. Scion and rootstock were considered fixed effects and block was considered a random effect. Analysis under this design led to empty cells due to mortality in the first year of the study. Since the block effect was not significant ($P = 0.1521$), the missing cell problem was minimized by doing the analysis as a split plot experiment in a completely randomized design. Differences among scion cultivars (main effect) were assessed using Duncan's multiple range test; pairwise differences among rootstocks within scion cultivar were assessed at the 5% level using the *pdiff* option in the *lsmeans* statement of PROC GLM (12).

## Results

Statistical analysis revealed a significant interaction between rootstock and scion ($P = 0.0022$), indicating that the effect of rootstock on tree size after 10 years in the orchard varied among scion cultivars. The nature of the interaction between rootstock and scion was complex, although the magnitude of significant differences among rootstocks within scion was generally not large. 'Hosui,' 'Niitaka,' 'Seigyoku' and 'Chojuro' showed no significant effect of rootstock on tree size (Fig. 1). 'Tse Li' trees were larger on OHF 333 than on OHF 282 and OHF 217, while 'Okusankichi' trees were larger on OHF 217 and OHF 97 than on OHF 333 (Fig. 1). 'Kikusui' trees on OHF 217, OHF 97 and OHF 282 were significantly larger than on OHF 333. The largest '20th Century' trees were on OHF 217 and the smallest were on OHF 51. 'Shinko'/OHF 282 were significantly smaller than all other 'Shinko' trees (Fig. 1).

Significant differences among scion cultivars were obvious in the orchard, so even though the interaction between rootstock and scion was significant, we decided that examination of the main effect of scion cultivar on tree size was of interest. The effect was highly significant ($P \leq 0.0001$) with 'Tse Li' producing the largest trees and 'Shinko' producing the smallest (Fig. 2).

## Discussion

Prediction of Asian pear tree size on the basis of rootstock appears to be unreliable. For example, OHF 333 produced the largest 'Tse Li' trees, but the same rootstock produced the smallest 'Kikusui' trees. Westwood et al. (20) reported the TCAs of 12-year-old 'Bartlett' trees on these OHF clonal

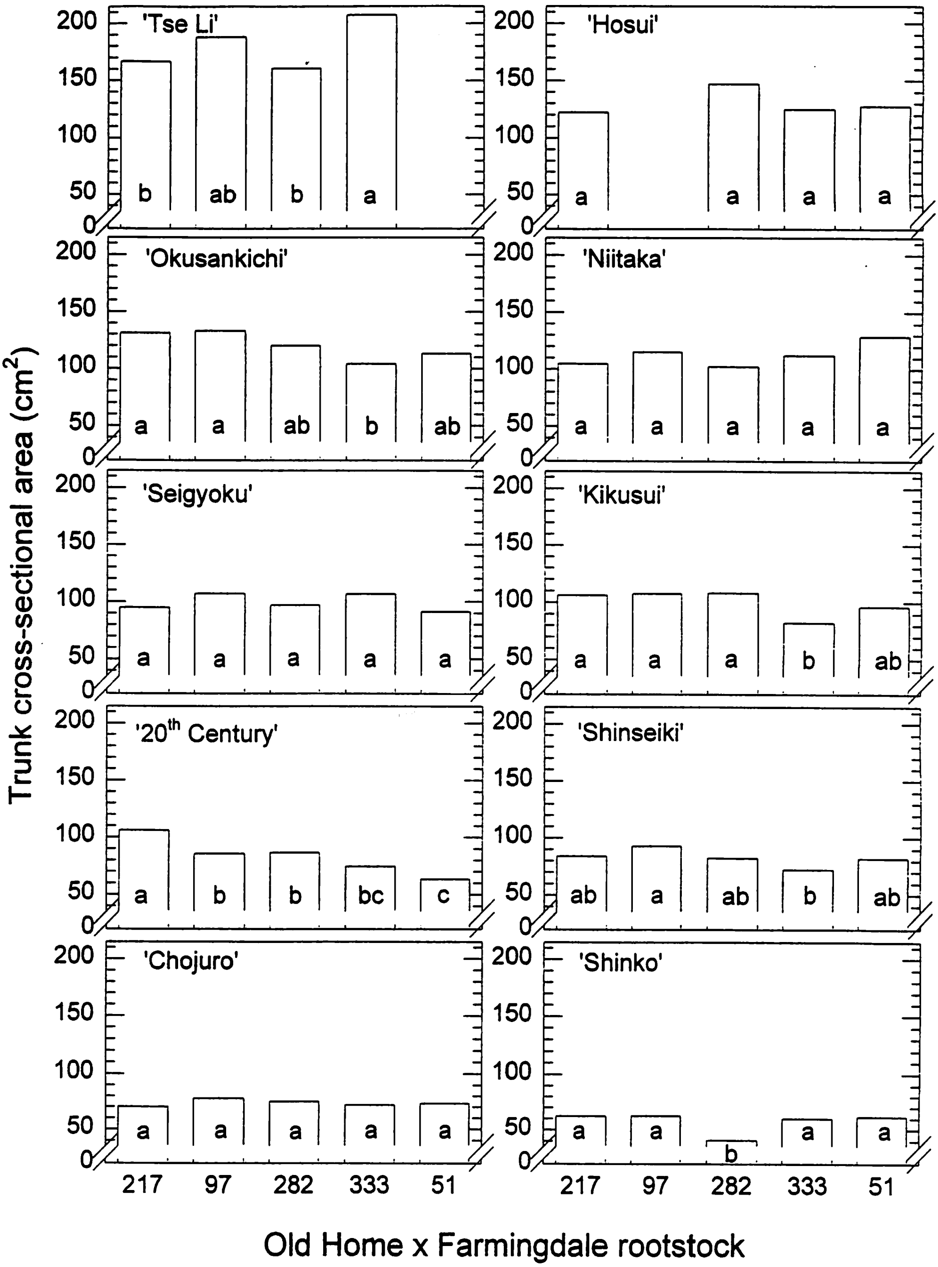


**Figure 1.** Mean trunk cross-sectional area of 10 Asian pear scion cultivars on 5 Old Home x Farmingdale rootstocks. The orchard was 10 years old and was located in central Washington state. Within a scion cultivar, bars having the same letter at their base represent means that are not significantly different ($P \leq 0.05$). The order of rootstocks along the horizontal axis reflects their main-effect ranking from largest to smallest.

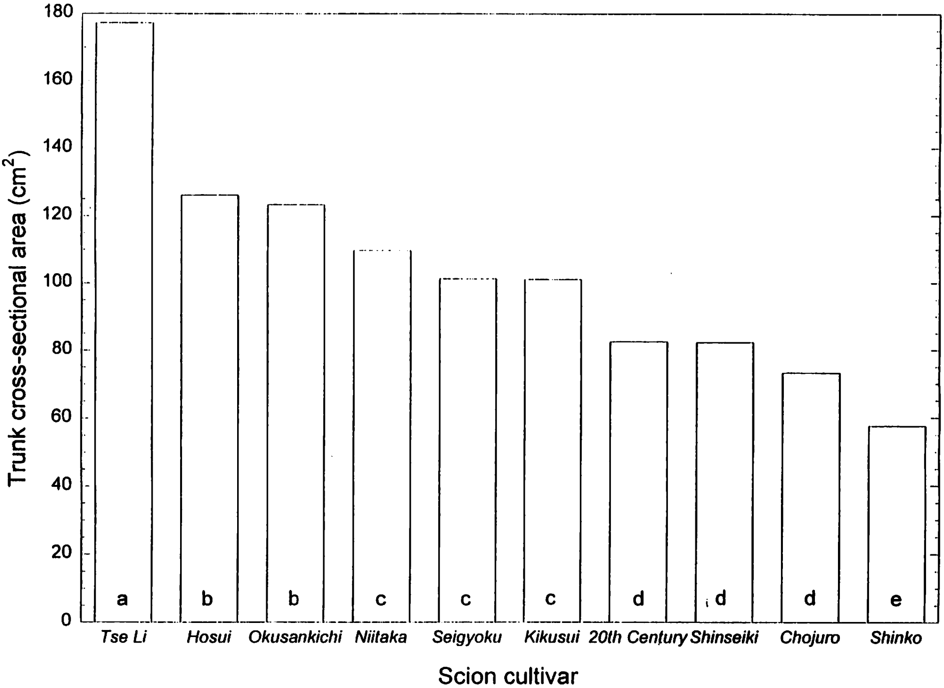


**Figure 2. Mean trunk cross-sectional area of 10 Asian pear scion cultivars, without regard to rootstock. The orchard was 10 years old and was located in central Washington state. Bars with the same letter at their base represent means that are not significantly different (Duncan's multiple range test, $P \leq 0.05$).**

rootstocks as OHF 97 = 138 $cm^2$, OHF 282 = 119 $cm^2$, OHF 217 = 103 $cm^2$, OHF 333 = 84 $cm^2$ and OHF 51 = 68 $cm^2$, with an LSD at the 5% level of 20 $cm^2$. We did not observe this same ranking with any of the Asian pear cultivars used in our study. Lombard and Westwood (14) reported tree sizes, as a percentage of a standard size tree, of 60, 70, 80 and 100 for OHF 51, OHF 333, OHF 217 and OHF 97 respectively (OHF 282 was not included in their report). This ranking was not observed for any of the 10 Asian pear cultivars in our research.

'20th' Century' appeared to be the scion cultivar most sensitive to a rootstock influence on size. Trees on OHF 217 were larger than trees on OHF 97 and OHF 282, which were in turn significantly larger than trees on OHF 51. No other scion cultivar showed as many clear distinctions among rootstocks.

The large difference in tree size between 'Tse Li' and all other cultivars may be due to a difference in species. Some authorities included 'Tse Li' in *Pyrus bretschneideri* Rehder, but others were unable to distinguish 'Tse Li' from the various Japanese cultivars included in *P. serotina* Rehder (1, 4). Even if two species are represented, we saw significant effects of cultivar on tree size even within the Japanese pears studied. This observation leads us to question the assumption that all Asian pears are generally slow-growing and should be budded to vigorous rootstocks as is done by some nurseries (18). We pose this question because our results show that the effect of rootstock on Asian pear tree size cannot be confidently predicted, and that not all Asian pears are particularly slow growing. In an Oregon study, a rough estimate of the TCA of 'Bartlett,' averaged over the same rootstocks that we used, was 102 cm$^2$ the 12th year (our calculation from the data reported by Westwood et al., (20)). After the 10th year in central Washington, only four of the 10 Asian pear cultivars we studied were substantially smaller in cross-section than 'Bartlett' in Oregon; these four cultivars were '20th' Century,' 'Shinseiki,' 'Chojuro' and 'Shinko' (Fig. 2). Part of the difference noted between our results and those of Westwood et al. (20) were probably due to differences in macroclimate and soil. Larsen and Fritts (7), however, reported tree size of 'Bartlett' on unselected, un-numbered Old Home x Farmingdale rootstocks as 175 cm$^2$ after 15 years of growth. Their report was based on trees grown in plots immediately adjacent to the Asian pear orchard reported herein. Ten-year-old 'Tse Li' surpassed the tree size of the 15-year-old 'Bartlett' trees of the earlier report (7).

We should note that the original experimental design also included all 10 cultivars on Provence quince rootstock. Survival in the nursery was poor for several of the scion cultivars on Provence quince (9). Any trees that survived 10 years in the orchard were so weak and undersized that they would represent a liability to commercial growers. Provence quince is an unacceptable rootstock for these Asian pear cultivars.

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