COMPARISON OF GROWTH AND PRODUCTIVITY OF PRUNED AND UNPRUNED YOUNG 'HOWARD' WALNUT TREES AS IMPACTED BY CROP LOAD

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ABSTRACT

Terminal shoot growth in 'Howard' walnut trees has been significantly greater in pruned than in unpruned trees. However, because the pruned trees need to regrow the amount of shoot that was pruned off during the dormant season, overall tree height has not been significantly different in the pruned versus unpruned trees. Unpruned trees had significantly more shoots that broke below the terminal than pruned trees. Analysis of shoot growth data for the 2007 season was not completed at the time of reporting.

In 2005, 2006 and 2007, there were significantly more shoots growing in the pruned treatment trees compared to the unpruned. Unpruned trees tended to be shorter at the end of the growing season, except for the unpruned with fruit removal treatment. However, this relationship changes after pruned treatment trees are pruned during the winter. In 2005, the greatest number of nuts was on the treatment that was pruned in 2004 but not pruned in 2005, but in 2006, there were no significant differences in the numbers of nuts on pruned versus unpruned trees. In 2007, number of nuts per tree was similar except there were significantly more nuts on the unpruned treatment that had nuts removed in all years until 2007.

Trees formed by pruning have a different structure than unpruned trees. In pruned trees, less shoots break below the terminal but those that do, grow more aggressively than the shoots that break below the terminal in unpruned trees. This tends to give a more dense canopy with more branches crossing over and intertwining than in the unpruned trees. This also leads to dieback of interior limbs at an earlier age in pruned versus unpruned trees.

Midday stem water potential was similar in all treatments early and late in season when trees were fully watered. However, during midseason when all treatments became somewhat stressed, the level of stress tended to be greater in pruned trees compared to unpruned trees in 2005. In 2006, late in the season, trees with fruit removed tended to be more stressed than those with fruit left on the tree. In 2007, midday stem water potentials were generally similar among all treatments.

Four years after initiating pruned and unpruned treatments, tree size, midday canopy light interception, and yields have been similar in unpruned versus pruned trees. Fruit removal has increased growth but it is not clear if yields in the next few years will make up for lost early yields due to fruit removal.

INTRODUCTION

A study was set up on two-year-old Howard walnut trees at the Nickels Soil Lab in Colusa County to look at the impact of the following pruning and fruit removal treatments

Treatment 1- unpruned, no fruit removal
Treatment 2- unpruned, with fruit removal
Treatment 3- pruned (1/3 of previous years growth removed each year until tree fills allotted space, no fruit removal)
Treatment 4- pruned as in treatment 3 with fruit removal.
Treatment 5- pruned as treatment 3 in winter 2003-4, otherwise, unpruned

PROCEDURES

In the spring of 2004, 2005 and 2006, all nuts were removed from Treatments 2 and 4 when they were approximately ¼" in diameter. Nuts were not removed from these treatments in 2007. Terminal shoot growth was measured approximately every 2-3 weeks during the growing season in 2004 and at the end of the growing season in 2005, 2006 and 2007 (not yet completed). The number (in 2004-2007) and timing (in 2004) of in-season branching points formed (sylleptic shoots) were assessed as well. The number and length of preformed and neoformed leaves were measured late in the season in all years. Preformed leaves are leaves that are formed in the bud during the previous summer. Neoformed leaves are formed during the current growing season. The number of shoots that broke below each terminal were counted late in the season in 2004 and 2005. The number and the percentage of minor and major sunburned nuts on each tree were counted in early September in 2004, 2005 and 2006. In 2007, only major sunburned nuts were counted. Midday stem water potential was measured approximately every other week on 10 trees per treatment. Leaves were bagged at least 15 minutes before measurements were taken with a plant pressure chamber at midday. In 2004, nuts were counted on the tree. In 2005 and 2006, trees were harvested by hand shaking and all nuts were collected, counted and weighed. In 2007, nuts were removed by mechanical shaking, run through a small hand pulled harvester to remove debris and weighed in the field. Sub-samples were taken for drying from each tree in all years. Samples for leaf nitrogen analysis were collected in mid-July in 2005. Samples were analyzed for quality from each monitored tree in 2005-2006 and from each replication (two trees combined) in 2007.

RESULTS AND DISCUSSION

Shoots that are growing in June consist of secondary growth (i.e. the leaves were formed during the current growing season. Pruning resulted in significantly more actively growing shoots per tree in 2004 (data not shown) and in 2005, 2006 and 2007 (Fig. 1). In general, shoots on the pruned trees tended to stop growing earlier in the summer than did those on the unpruned trees in 2005 and 2006 (Fig. 1). Fruit removal led to more growing shoots and a tendency towards longer growth, although the effect was not significant in 2006 (Fig. 1). Fruit removal also tended to result in higher weight of pruning removed in 2005, 2006 and 2007 but the effect was not significant (Fig. 2).

There were no treatment impacts on June midday canopy light interception in any year (Fig. 3). Since midday canopy light interception limits overall potential productivity, we would not expect major yield differences among treatments once fruit removal ceases.

All treatments tended to become more stressed as the season progressed (Fig. 4). Pruning and fruit removal treatments had only small impacts on midday stem water potential. In 2005, the pruned treatments tended to be slightly more water stressed in mid to late summer compared to the unpruned treatments (Fig. 4). In 2006, the treatments that had their fruit removed tended to be slightly more stressed than the unthinned treatments in mid to late summer (Fig. 4). In 2007, midday stem water potentials were similar among all treatments except on 2 dates in July when the pruned treatment that had fruit removed until 2007 was significantly more stressed (Fig. 4). This may have been due to their larger crop (Table 1).

In 2004, the unpruned treatment had significantly higher yields than the pruned treatment (Fig. 5). However, after 2005 these early differences no longer resulted in a significantly higher cumulative yield compared to the pruned treatment (Table 1, Fig. 5). In 2007, T2 which had fruit removed in 2003 through 2006 but not in 2007, had a significantly higher yield than any other treatment (Table 1, Fig. 5). By the end of the 2007 season, cumulative yield for T1, T3 and T5 were all similar. Cumulative yields for T2 and T4 were significantly less with T4 having significantly lower yield than T2 (Table 1). However, the yield for T2 was significantly higher in 2007 than any other treatment (Table 1). When the yield data from this trial is plotted with a much larger data set from a number of other trials, it can be seen that yields in this trial tended to be somewhat below their maximum potential (based on their midday light interception) for all treatments (Fig. 6). The only exception was T2 in 2007, which is indicated in Figure 6. This treatment was right on the maximum yield line. The fact that all other treatments are below the line suggest there are limitations due to some factor(s) which could include the moderate stress that has occurred in all years as the season progresses (Fig. 4).

There were no significant treatment impacts on any quality attributes in any year (data not shown).

PRELIMINARY CONCLUSIONS

Four years after initiating pruned and unpruned treatments, it appears that in terms of tree size (data not shown) midday canopy light interception (Fig. 3) and yield (Table 1, Fig 5), the unpruned trees are performing similarly to the pruned trees. Unpruned trees tended to have more fruit the first two years of the study but by the third year, fruit load (Table 1) and cumulative yields were similar for all treatments with fruit left on tree (Table 1, Fig. 5). Fruit removal had little effect on overall vegetative growth in the first and second year of the trial when numbers of fruit per tree were few, but by the third year, growth tended to be more extensive on trees with fruit removed, both in terms of number and length of shoots. It is not clear if yields in the next few years will make up for lost early yields due to fruit removal. Impacts of the pruning treatments on midday stem water potential deserve further investigation.

None of the pruning treatments has had a significant impact on either major sunburn or fruit quality except a slight increase in T5 in 2005 (the year after it had been pruned).

Tree structure for pruned versus unpruned trees is quite different with the unpruned trees tending to have a more open canopy structure while the pruned trees tend to be bushier. There has been more shading related lower canopy dieback in the pruned treatments compared to the unpruned. Fruit removal treatments exacerbated these differences.

Acknowledgements

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Table 1. Effects of treatments on number of fruit, yield and sunburn in 2004-2007. Letters indicate significant differences among treatments within a year.

Treatment	*#nuts per tree*	*Yield (lbs/acre)*	*Cumula-tive yield (lbs/acre)*	*Percent minor sunburn*	*Percent major sunburn*
2004					
1 (unpruned)	78 a	418 a	728 a	4.6 a	2.1 a
2 (unpruned w/fruit removed)					
3 (pruned)	48 b	256 b	262 b	2.9 a	3.1 a
4 (pruned w/fruit removed)					
5 (pruned 2004, unpruned 2005)	44 b	280 ab	309 ab	1.0 a	0.1 a
2005					
1 (unpruned)	266 b	1221 b	1948 a	6.4 b	1.9 b
2 (unpruned w/fruit removed)		39 c	39 c		
3 (pruned)	237 b	1050 b	1313 b	6.3 b	2.6 b
4 (pruned w/fruit removed)		37 c	100 c		
5 (pruned 2004, unpruned 2005)	350 a	1528 a	1837 ab	15.7 a	4.7 a
2006					
1 (unpruned)	848 a	3040 a	4988 a	0.7 a	1.3 a
2 (unpruned w/fruit removed)			39 b		
3 (pruned)	879 a	3190 a	4502 a	0.6 a	0.8 a
4 (pruned w/fruit removed)			100 b		
5 (pruned 2004, unpruned 2005)	796 a	2866 a	4703 a	0.6 a	0.7 a
2007					
1 (unpruned)	990 b	4011b	8999 a	*	3.4 a
2 (unpruned w/fruit removed until 2007)	1866 a	6718 a	6756 b	*	4.3 a
3 (pruned)	946 b	4155 b	8657 a	*	3.8 a
4 (pruned w/fruit removed until 2007)	1175b	4630 b	4730 c	*	2.9 a
5 (pruned 2004, unpruned 2005)	944 b	3929 b	8632 a	*	4.4 a

*minor sunburn not measured in 2007

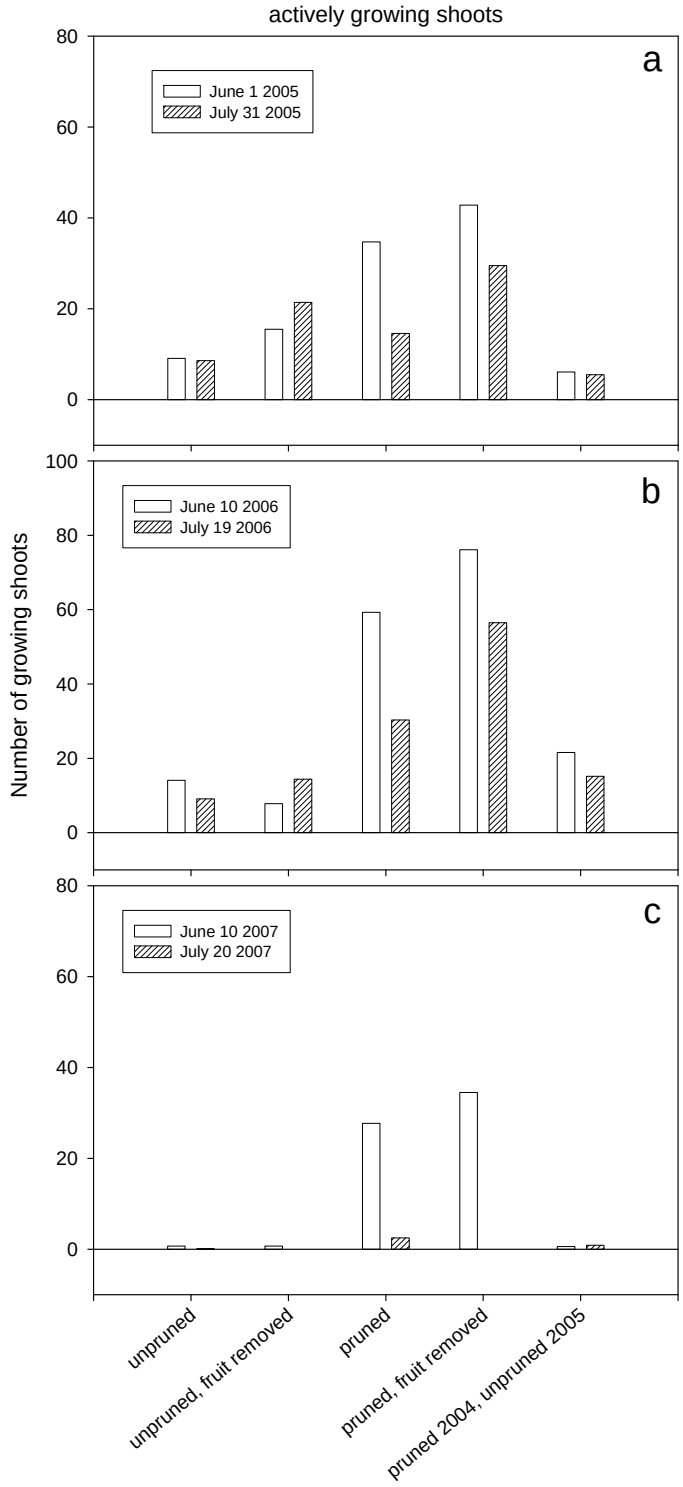

Fig. 1. Growing shoots per tree on a) June 1 & July 31, 2005, b) June 10 & July 19, 2006 and c) June 10 and July 20 2007 by treatment.

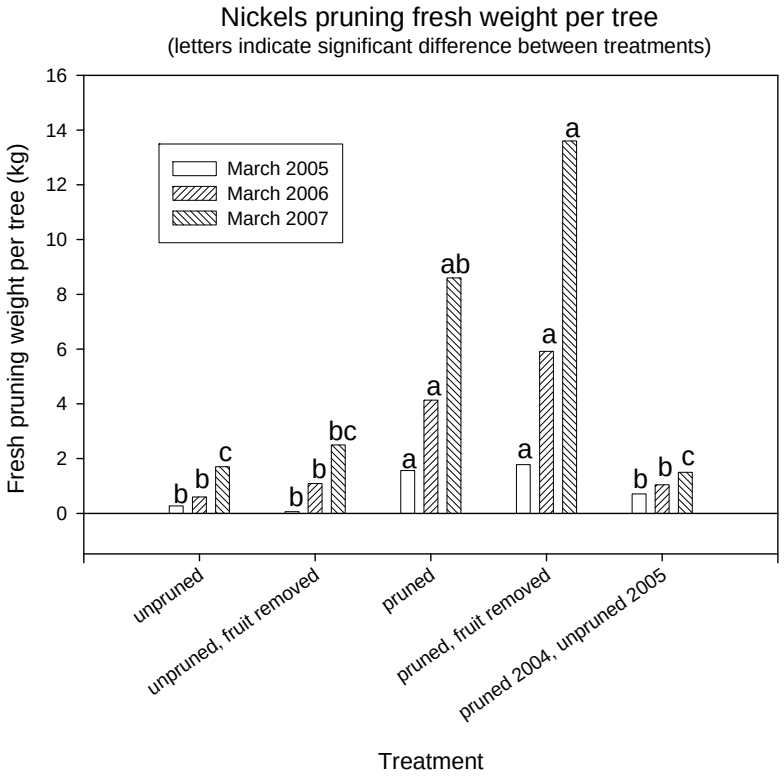

Fig. 2. Fresh pruning weight by treatment and year. Letters indicate significant difference between treatments within a year. Pruning weights for unpruned treatments are branches that either broke off or were removed because they were too close to the ground or in the way of the shaker.

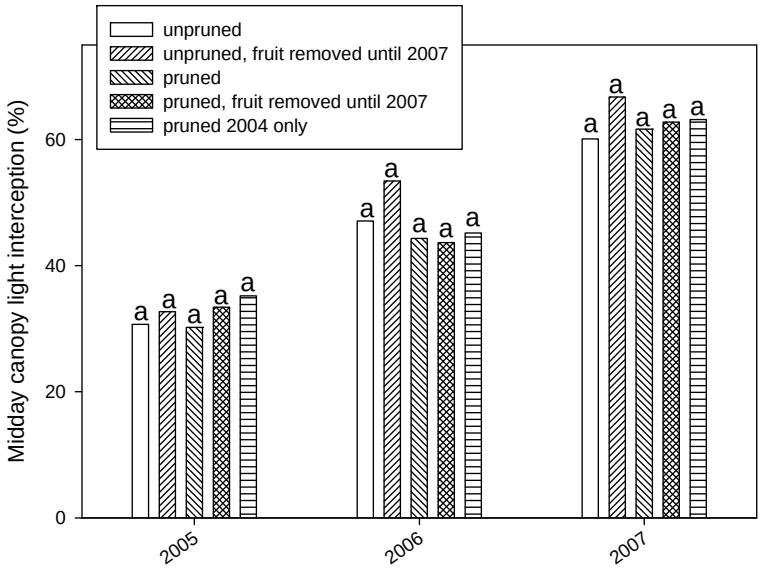

Fig. 3. Midday light interception measured on June 22, 2005, June 15, 2006 and June 18 2007. Letters indicate significant difference among treatments within a given year.

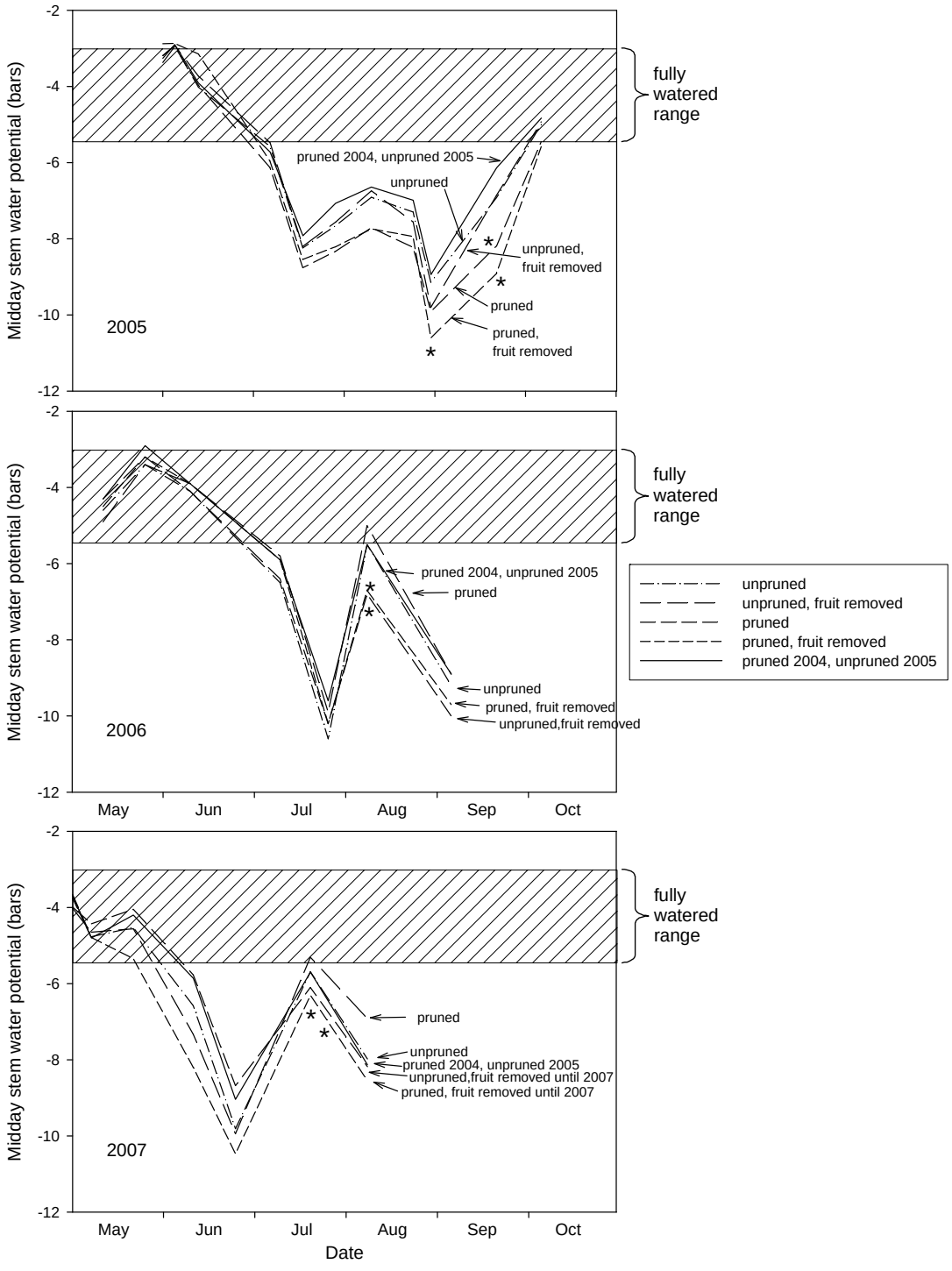

Fig. 4. Midday stem water potential by treatment for 2005-2007 seasons. Cross-hatched area marks approximate range for fully watered tree.

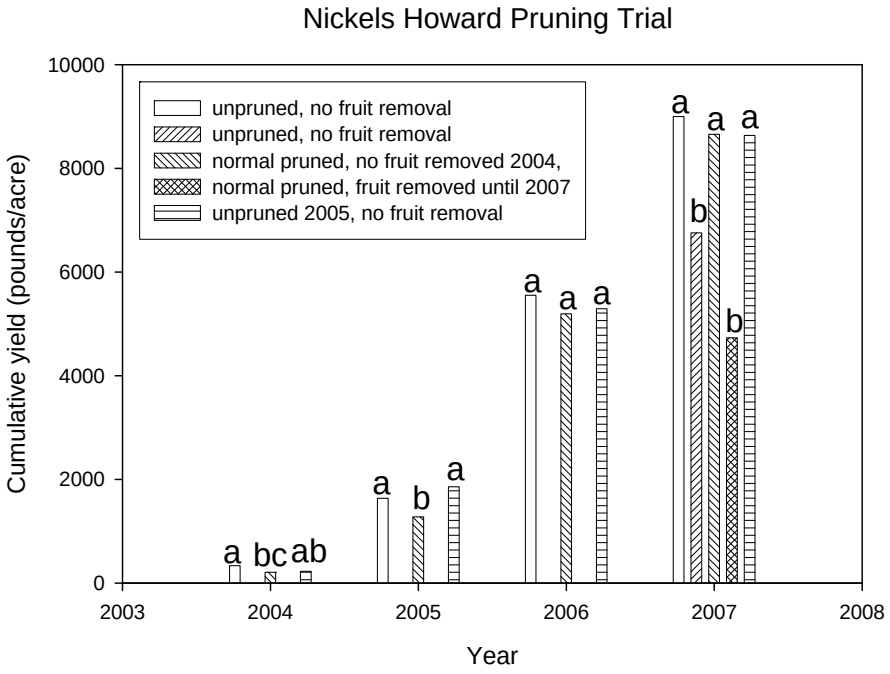

Fig. 5. Cumulative yield by year and treatment.

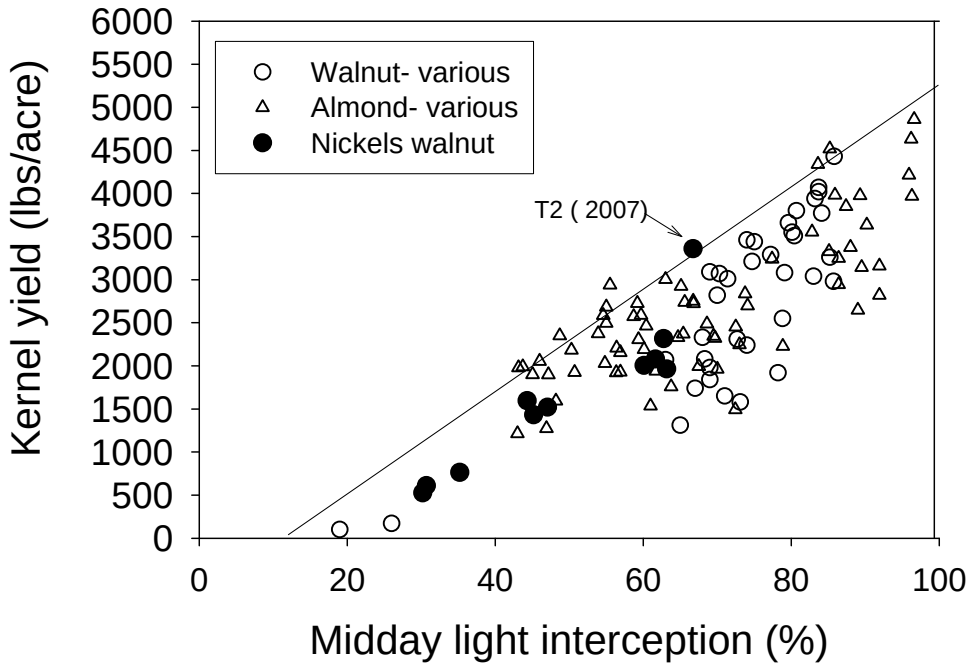

Fig. 6. Kernel yield as related to midday canopy light interception as measured in June. Data for almonds is for the Nonpareil variety from various trials and walnut data is from Chandler and Howard varieties from various trials