Interacting Effects of Waterlogging and Pruning on Leaf Gas Exchange and Biomass of Avocado (*Persea americana* Mill.) Trees in Containers

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INTRODUCTION

Avocado trees are among the most susceptible of fruit tree species to poor soil aeration (Schaffer et al., 1992; Schaffer and Whiley, 2002). In avocado, root hypoxia or anoxia reduces stomatal conductance (*gs*), net CO_2 assimilation (*A*), root and shoot growth and leaf expansion, and causes moderate to severe stem and leaf wilting, leaf abscission, and root necrosis (Ploetz and Schaffer, 1989; Schaffer and Ploetz, 1989; Schaffer et al., 1992; Schaffer and Whiley, 2002). To reduce stress and increase tree survival caused by flooding it has been recommended in Chile and Florida to remove1/2 to 2/3 of the canopy after there is standing water in an orchard. However, this is based on observations and anecdotal evidence. Also, when torrential or extended rains are forecast and flooding is anticipated in Florida, it is often suggested to growers to prune trees prior to the storm for wind protection. This reduction in canopy volume is thought to reduce potential flooding stress due to a reduction of transpirational surface area. To our knowledge, there are no reports of the effects of pruning or the timing of pruning in relation to the flooding period on reducing the susceptibility of avocado trees to flooding stress. The objective of this study was to determine the effects of pruning before or after flooding on physiology and growth of avocado trees in containers.

MATERIALS AND METHODS

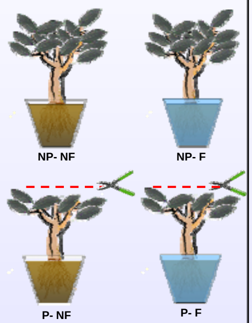
One-year-old 'Choquette' avocado trees on 'Waldin' seedling rootstock were used for this study. Plants were in 11.4-liter plastic containers filled with a potting medium consisting of 50% Canadian peat, 40% pine bark and 10% sand by volume.

Experiment 1. Pruning before flooding. One-half of the number of trees were pruned by cutting the top of the central leader and trimming some of the remaining shoots to remove 1/2-2/3 of the canopy. Two mature leaves, at about the same location in the canopy on each tree, were tagged for subsequent leaf gas exchange and chlorophyll fluorescence measurements. One half the number of pruned and non-pruned trees were each flooded by placing each container in a bucket filled with tap water to 10-cm above the soil surface. Thus there were four treatments: non-flooded, non-pruned (NF-NP); non-flooded, pruned (NF-P); flooded, non-pruned (F-NP); and flooded, pruned (F-P) with at least 5 single-plant replications per treatment. Trees were unflooded one day after there was a significant difference in *A* or *gs* between flooded and non-flooded plants in both pruning treatments.

Experiment 2. Pruning after flooding. This experiment was similar to Experiment 1, except trees were not pruned prior to flooding, but pruned immediately after the flooding period. Twenty four plants were flooded while 12 plants remained non-flooded. Trees were unflooded one day after there was a significant difference in *A* or gs between flooded and non-flooded treatments. After unflooding, 1/2 of the number of plants in each non-flooded and flooded treatment were pruned to remove 1/2 to 2/3 of the canopy, whereas the remaining plants in each flooded and non-flooded treatment were not pruned. There were 6 single-plant replications for each non-flooded treatment (NF-NP and NF-P) and 12 single-plant replications for each flooding treatment (F-P and F-NP).

Measurements. For both experiments, one day prior to flooding and at daily intervals during the flooding period, *A and gs* were measured with a CIRAS-2 portable gas analyzer (PP Systems, Amesbury, Mass.) and variable to maximum chlorophyll fluorescence (*Fv/Fm*) was measured with a chlorophyll fluorescence meter (Opti-Sciences, Hudson, New Hampshire). After plants were unflooded (after 4 days), leaf gas exchange and *Fv/Fm* was measured at 3-4 day intervals for 32 days in Experiment 1 and 56 days in Experiment 2. At the end of the experiments plants in each treatment were harvested and leaf, stem and root dry weights were determined.

Treatments



Experiment 1: Pruning **before** flooding

Experiment 2: Pruning **after** flooding

RESULTS

Experiment 1

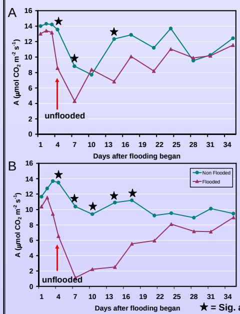


Figure 1. Net CO_2 assimilation in non-pruned (A) and pruned (B) plants.

Table 1. Plant dry weights at the end of the experiment. Means separation between flooding treatments were made by standard T-test within each pruning treatment.

	Flooding treatment	Leaf dry wt. (g)	Root dry wt. (g)	Stem dry wt. (g)	Total plant dry wt. (g)
Non-pruned	Control	29.1	31.4	32.5	93
	Flooded	23	24.7	26.6	74.2
	P	NS	NS	NS	NS
Pruned plants	Control	12.5	24	23.8	60.2
	Flooded	4.1	14.7	19.6	38.4
	P	> 0.01	> 0.05	> 0.05	> 0.01

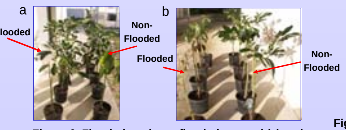


Figure 2. Flooded and non-flooded, pruned (a) and non-pruned (b) plants.

Figure 3. Roots of pruned, non-flooded (P-NF) and pruned, flooded (P-F) plants.

C. gs responses were similar to A responses in both experiments (data not shown).

Experiment 2

Table 2. Plant dry weights at the end of the experiment. Means separation between flooding treatments were made by standard T-test within each pruning treatment.

	Flooding treatment	Leaf dry wt. (g)	Root dry wt. (g)	Stem dry wt. (g)	Total plant dry wt. (g)
Non-pruned	Control	102.3	62.3	62.4	226.9
	Flooded	74.1	35	46.2	155.4
	P	> 0.05	> 0.01	> 0.01	> 0.01
Pruned plants	Control	44.2	23.7	30.4	98.4
	Flooded	31.7	25.3	24.3	81.3
	P	> 0.05	NS	NS	NS

Figure 4. Roots of non-pruned (NP) and pruned (P), non-flooded (NF) and flooded (F) plants.

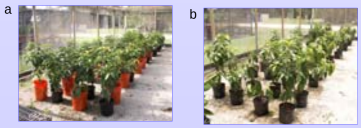


Figure 5. Flooded and non-flooded plants before pruning (a) and after pruning (b).

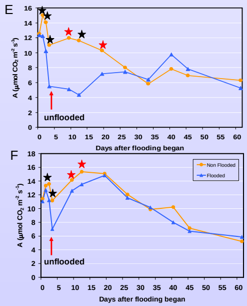


Figure 6. Net CO_2 assimilation in non-pruned (E) and pruned (F) plants.

★ = Sig. at P≤ 0.05

★ = Sig. at P≤ 0.1

D. There was no effect of flooding on *Fv/Fm* in either experiment (data not shown).

CONCLUSIONS

Pruning avocado trees prior to flooding (Experiment 1) actually increased stress compared to non-pruned trees, presumably due to a reduction in leaf area and a subsequent reduction of photosynthates translocated to the roots which limited root respiration during the flooding period. Trees pruned immediately after the flooding period (Experiment 2) tended to recover faster from flooding stress than non-pruned trees as indicated by a more rapid recovery of net CO_2 assimilation and greater dry weights than non-pruned plants. This was presumably due to reduced transpirational demand as a result of a reduction in canopy volume of pruned plants with partial root damage from flooding. The results of this study support the observation that pruning avocado trees immediately after flooding, as it has been suggested, can reduce flooding stress of avocado trees. However, pruning trees shortly before a flooding period can exacerbate flooding stress. This study was conducted with potted trees and additional studies should be conducted in orchard conditions to confirm these observations.

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