Protocol for Water Needs of Shrubs during Establishment

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INTRODUCTION

Water is a vital part of every aspect of human life, preserving and managing it has become a challenge for every industry, including the landscape industry. It is not clear how much water shrubs need to be established in a landscape, or how long it takes for them to become established. Thus, the goal of this project is to determine how much irrigation is needed to establish and maintain shrubs installed in Florida landscapes. Specific objectives include:

1) Determine how much irrigation is needed to establish shrubs in the landscape
2) Determine the impact of location in the state on irrigation needs
3) Identify the most efficient frequency and rate to apply water to newly planted shrubs
4) Furthermore, the project seeks to correlate location in Florida and irrigation frequency with evapotranspiration to develop models for calculating water budgets for shrub establishment. We hope that this will enable us to predict water needs based on weather data.

PROGRESS

This project has been operating for 21 months. Details of the project procedures are included in the project proposal (FDACS Contract Number 008230). The following working objectives, as well as those included in Progress Report #1, #2 and #3, have been met:

A. Phase one, part 1

Objectives 1 thru 7 have been completed.

Objective 8 thru 11 in progress. In September 2004 and 2005, December 2004 and 2005, March 2005, and June 2005 shrubs were planted in test plots at Balm, Citra, and Fort Lauderdale. Three species of shrubs, *Viburnum odoratissimum* (Viburnum), *Ilex cornuta* 'Burfordii Nana' (Burford Holly), and *Pittosporum tobira* 'Variegata' (Pittosporum) were planted from #3 containers at Balm and Citra. The three species for Fort Lauderdale were Viburnum, *Murraya paniculata* 'Lakeview' (Orange jasmine) and *Acalypha wilkesiana* (Copper Leaf), which replaced Wild Coffee in September 2005. Wild coffee performed poorly under full sun.

On September 2005, the irrigation treatments were modified. For Citra and Balm, the new irrigation treatments were either daily irrigation, or every 2 days, or every 4 days, or every 8 days with 3 L/plant/irrigation event. For Fort Lauderdale, the treatments were

either daily with 9 L/plant/irrigation event, or daily irrigation, or every 2 days, or every 4 days with 3 L/plant/irrigation event. The daily irrigation with 3 L/plant/irrigation event replaces the Mix treatment (daily for 2 weeks, then every 2 days for 2 weeks, then every 4 days for 4 weeks, then once weekly until established).

The experimental design for each site included 4 irrigation treatments X 3 species X 6 replications. A total of 72 plants at each site were planted per planting date, mulched, and maintained using best management practices as outlined in the experimental procedures. To determine when shrubs were established and able to thrive without irrigation, canopy growth indices, the ratio of root spread to canopy spread (called root to shoot ratio), xylem potential (a measurement of plant stress), and visual dieback and plant density ratings on a scale of 1 to 9 (where 9 = excellent quality and 1 = dead plant) were recorded 4, 8, 12, 20, 28 and 52 WAP.

When test plots reach 52 weeks after planting (WAP), 3 replications of each irrigation treatment and species were harvested. The harvested parts were all the above ground material and $1/8^{th}$ of the roots extending beyond the rootball. Dry weights were collected for each and root to shoot ratios calculated based on weight. For the remaining 3 replicates, canopy growth indices and root to shoot ratio will be collected every 4 months to monitor growth until 104 WAP when they will also be harvested.

For all three sites, the first 3 replicates for the September 2004 and December 2004 plots have been harvested. The March 2005 plot has been in the ground for 44 weeks and irrigation discontinued at 12 WAP. The June 2005 plot has been in the ground for 28 weeks and irrigation discontinued 20 WAP. The September 2005 plot has been in the ground for 16 weeks and irrigation discontinued 16 WAP. The December 2005 plot has been in the ground for 4 weeks and continues to be irrigated. Irrigation has been discontinued an average of 18 WAP for all plots.

Results to date

Balm

Growth indices were not affected by irrigation treatments for all species (data not shown). Growth indices were calculated by subtracting initial growth indices from the indices measured 4, 8, 12, 20, 28 and 52 WAP. Comparing the combined effect of the mean of all four irrigation treatments on growth indices of first four plantings (September 2004, December 2004, March 2005, and June 2005), it appears that March planted shrubs grew at a relatively faster rate from 20-WAT to 28-WAT compared with the September 2004 or December 2004 plantings (Figure 1). For March 2004 plantings, the 20-WAT period coincides with the rainy season in the West Central Florida. Burford Holly and Viburnum planted in December 2004 had greater growth indices 52 WAP than shrubs planted in September 2004. In contrast, for Pittosporum the greatest growth had been for September 2004 planted shrubs (Figure 1).

The root to shoot ratios were not affected by irrigation treatments for all species (data not shown). At 20 WAP the root to shoot ratios of all species were above 1.This indicated that the plants were established and the root spread into the landscape was adequate enough to sustain the increased shoot growth observed starting 20 WAP.

For West Central Florida, based on the data collected thus far, shrubs can be established with as little as three liters, of water every 8 days, but more information is needed to make conclusive recommendations and to indicate the most efficient season to plant.

Citra

The irrigation treatments had no effect on plant density and dieback (data not shown). The average plant density was 8.5 (with 9 representing the well established indicator plants) and the average dieback was 8.8 (indicating very little die-back) for all species.

Comparing growth indices of plots planted from September 2004 to June 2005 (first year of experimental plots), all species are growing fastest for March 2005 planted shrubs, while June 2005 shrubs seem to be the slowest from data taken thus far (Figure 2). Pittosporum and Viburnum planted in September 2004 had greater growth indices 52 WAP than shrubs planted in December 2004. In contrast, for Burford Holly the greatest growth had been for December 2004 planted shrubs (Figure 2).

The root to shoot ratios were not affected by irrigation treatments for all species (data not shown). Similar to growth indices, the lowest ratios for all species appear to be for the June 2005 shrubs (Figure 3). In contrast to growth indices, the greatest ratios have not been for March 2005 shrubs. For Burford Holly and Pittosporum, the September 2004 shrubs had the greatest ratios until 28 WAP. At 52 WAP, the greatest ratio for Burford Holly was for December 2004 shrubs. For Pittosporum, September 2004 and December 2004 were similar at 52 WAP. For Viburnum, the December 2004 shrubs had the greatest ratio thus far. Overall, shrubs start actively growing shoots 20 WAP, which is two weeks after irrigation has been discontinued. Roots grew enough into the landscape (indicated by a root to shoot ratio above 1) to sustain shrub growth without supplemental irrigation.

It has been challenging to obtain a complete data set for water potential because it has been raining regularly, but from the data that has been collected we see that as the length of time between irrigation events increased, cumulative water stress also increased, indicating more plant stress. Even though the plants were more stressed, this stress was not significant enough to cause a reduction in plant growth and quality. All three species are recuperating from this mild water stress under all 4 irrigation regimes.

For North Florida, based on the data collected thus far, shrubs can be established with as little as three liters, of water every 8 days, but more information is needed to make conclusive recommendations and to indicate the most efficient season to plant.

Fort Lauderdale

In September 2005, the first three rows of shrubs planted in September 2004 were harvested. Wild Coffee and Viburnum shoot dry weight was greatest for plants watered every 2 days or the Mix treatment, while the greatest Orange Jasmine shoot dry weight was observed in plants watered every 2 or 4 days (Table 1). Wild Coffee and Orange Jasmine watered every 8 days had the least shoot dry weight and Viburnum watered every 4 days had the least shoot dry weight. For all three species, there was no significant difference in root dry weight among the irrigation treatments.

For shrubs in the September 2004, December 2004, March 2005, and June 2005, plots, there is no significant difference in growth indices or root to shoot ration due to irrigation treatment (data not shown). This is probably due to rainfall events during the first 3 months after transplanting. Comparing the amount of water lost due to evapotranspiration versus the amount of rain that fell during 2004 and 2005, more rain fell than was potentially lost from the plants in many cases (Table 2). Because irrigation continued regardless of rain events, it is possible that the rain events negated any effect observed due to irrigation treatment. Hurricane events in 2004 and 2005 also had a lot of rainfall associated with them.

For all plots planted to date, plant growth indices (averaged for irrigation treatment) indicate that plants appear to start to actively grow shoots approximately 20 WAP (Figure 4). Copperleaf shrubs planted in September 2005 are growing significantly better than Wild Coffee planted in earlier plots (Figure 4a). Wild Coffee and Orange Jasmine planted in December 2004 had greater growth indices 52 WAP than shrubs planted in September 2004; while Viburnum growth indices 52 WAP were similar for September and December 2004 plots (Figure 4).

From the data collected to date, it appears that Wild Coffee, Orange Jasmine, and Viburnum plants start to actively grow approximately 20 WAP. However, due to lower temperatures, solar radiation, and potential evapotranspiration, December appears to be a better time of year to plant these shrubs because they grew more than plants installed at other times.

B. Phase one, part 2.

Objectives 1 through 9 have been completed. The lysimeters were built. The irrigation components, percolate collection apparatus, and data collection instrumentation was purchased. The plumbing for the irrigation and electrical components were installed. The backfilling and calibration of the lysimeters was completed. The lysimeters and the companion fields were planted in December 2005. The two species planted in Apopka were Viburnum and Burford Holly. The data being collected is the same as that described on Phase one, part 1.

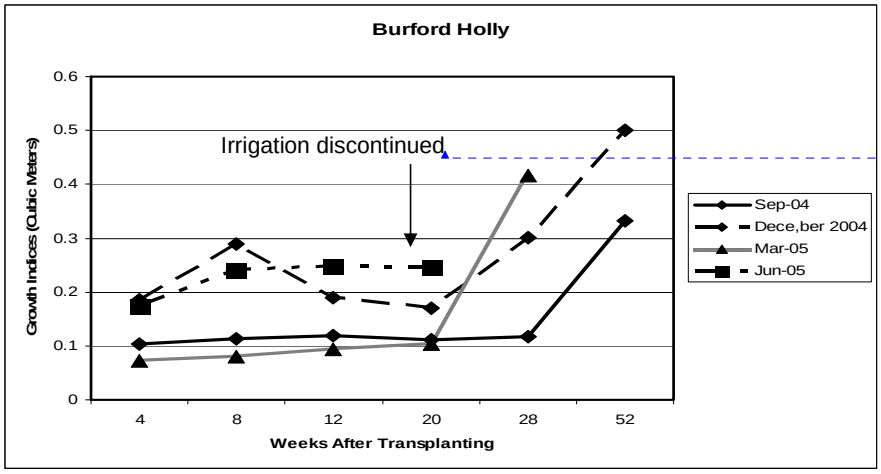
C. Irrigation volume experiment in Citra.

Three irrigation volumes (3, 6, or 9 L), two irrigation frequencies (every 2 or 4 days) and two planting dates (May 2004 and November 2004) were tested on *Viburnum odoratissimum* (Viburnum), *Ilex cornuta* 'Burfordii Nana' (Burford Holly), and *Pittosporum tobira*, 'Variegata' (Pittosporum) to study their impact on shrub establishment and growth. Data collected included plant quality ratings, growth indices and root to shoot ratio. Irrigation for each plot was discontinued 11 WAT. The May 2004 planted plot was harvested 64 WAP in August 2005. The November 2004 planted plot has been in the ground for 60 weeks and will be harvested in February 2006.

Irrigation volume, irrigation frequency, and planting date had no effect on shrub plant quality. For Burford Holly, Pittosporum and Viburnum, the average plant density was 7.9, 8.9, and 9, respectively. The average plant dieback was 8.8, 8.8 and 9, respectively. This indicates that all three shrubs can be established in north Florida and perform well in the landscape by irrigating with 3 L every 4 days for 11 weeks, then no irrigation. That amounts to 57 liters (15 gallons) of water to establish these shrubs from #3 containers.

Irrigation volume, irrigation frequency, and planting date had no effect on shrub growth index. After 52 weeks in the ground, the average shrub index for fall planted shrubs for Burford Holly, Pittosporum and Viburnum was 0.13, 0.47 and 1.84 cubic meters, respectively.

Irrigation frequency and volume had no effect on root to shoot ratio. The average ratio for Burford Holly, Pittosporum and Viburnum was 1.56, 1.8 and 1.46, respectively.



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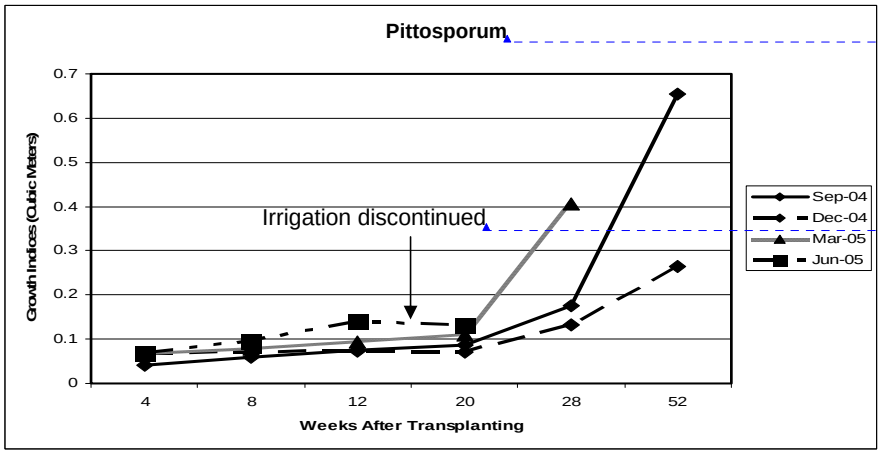

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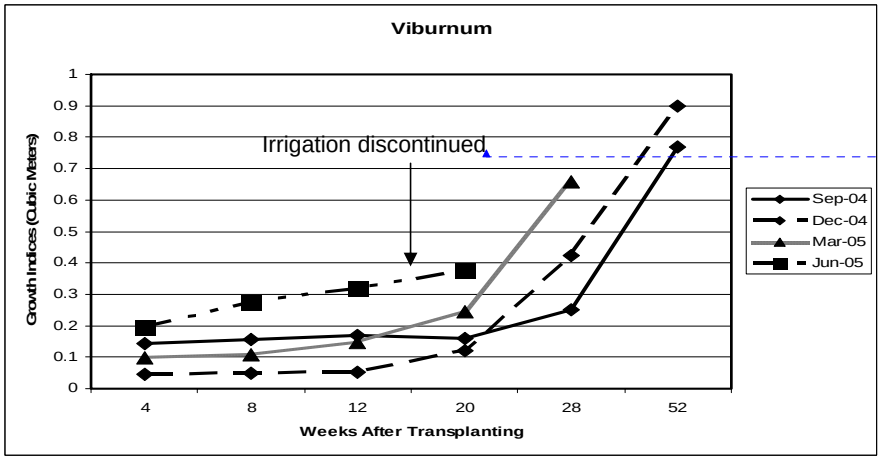

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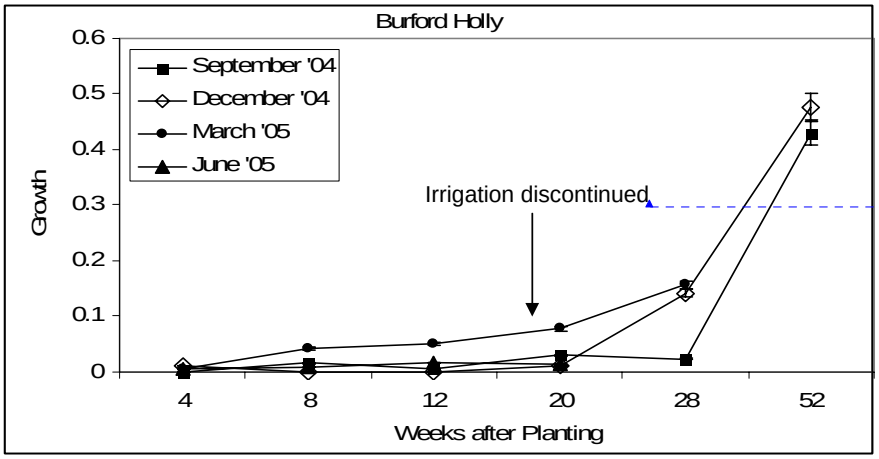
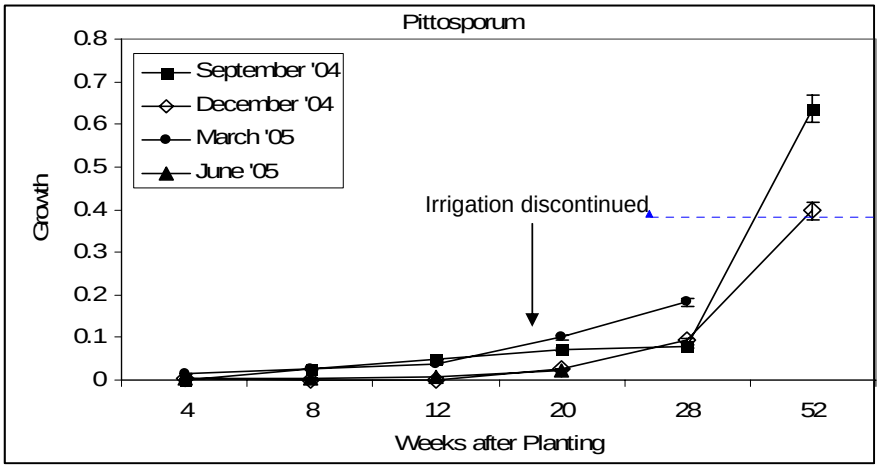
Figure 1. Growth indices (cubic meters) averaged over irrigation treatments for Burford Holly, Pittosporum and Viburnum planted in September 2004, December 2004, March 2005 or June 2005 in Balm, FL.





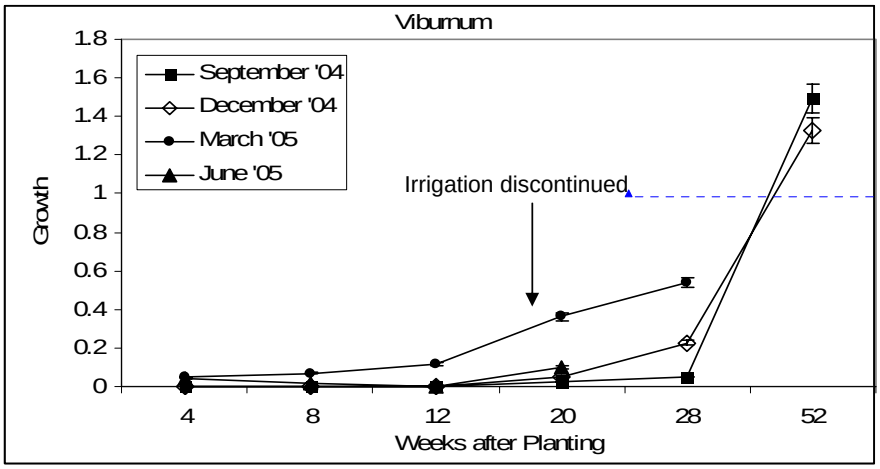


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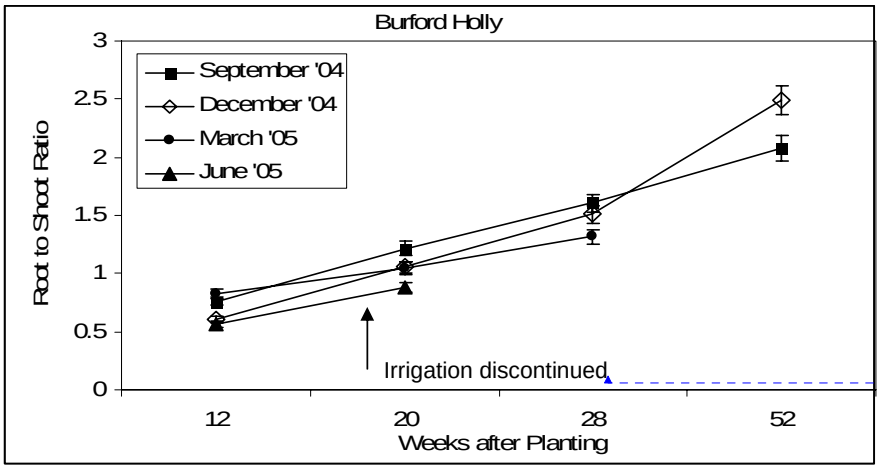
Figure 2. Growth indices (cubic meters) averaged over irrigation treatments for Burford Holly, Pittosporum and Viburnum planted in September 2004, December 2004, March 2005 or June 2005 in Citra, FL. Bars around data point represent standard error.



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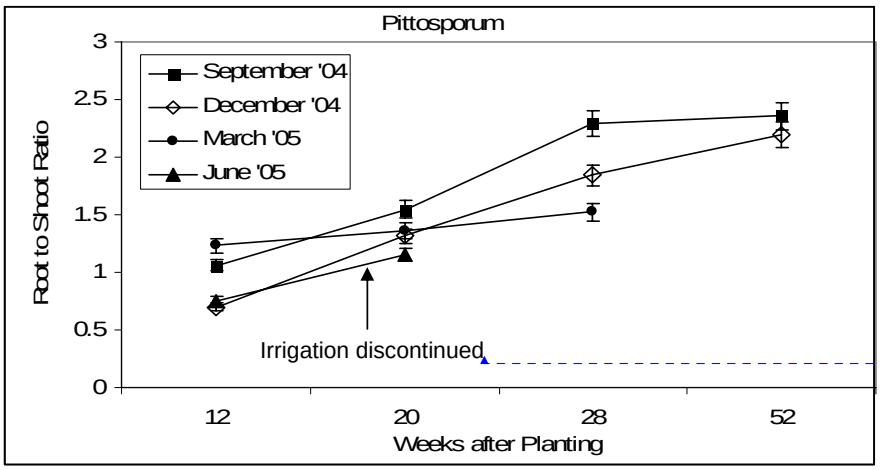

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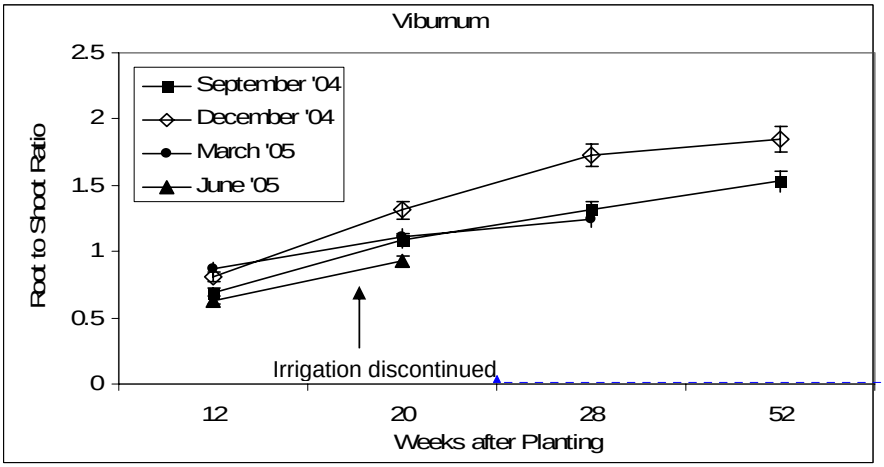

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Figure 3. Root to shoot ratios averaged over irrigation treatments for Burford Holly, Pittosporum and Viburnum planted in September 2004, December 2004, March 2005 or June 2005 in Citra, FL. Bars around data point represent standard error.

Table 1. Final shoot and root dry weight of Wild Coffee, Orange Jasmine, and Viburnum planted in September 2004 and watered every 2 days, 4 days, 8 days or Mix treatment in Fort Lauderdale, FL

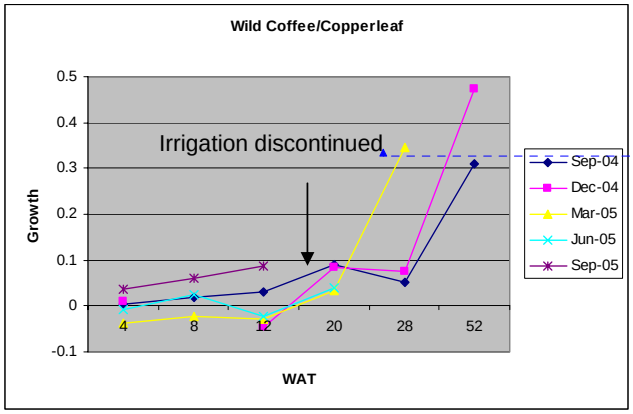
Irrigation Treatment	Shoot dry weight (g)	Root dry weight (g)
	Wild coffee	
2-day	292.8 a*	31.3 a
4-day	162.8 b	25.5 a
8-day	117.5 b	25.2 a
Mix	256.9 a	27.3 a
	Orange jasmine	
2-day	1327.1 a	96.1 a
4-day	1566.2 a	96.1 a
8-day	913.0 b	96.3 a
Mix	1018.0 b	81.4 a
	Viburnum	
2-day	477.4 a	65.9 a
4-day	289.0 b	43.5 b
8-day	430.5 a	51.7 ab
Mix	481.6 a	64.9 a

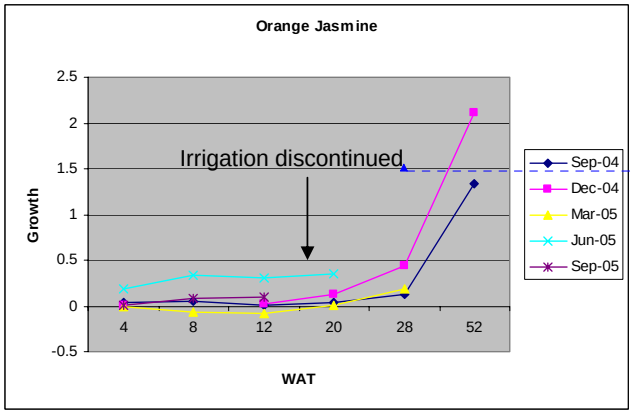
*Means with same letter within a column and species are not significantly different (P<0.05).

Table 2. Average monthly temperature, potential evapotranspiration (ET_p), solar radiation, and rainfall in Fort Lauderdale as recorded by the Florida Automated Weather Network (http://fawn.ifas.ufl.edu/scripts/reportrequest.asp).

Month and year	Temperature Average (°C)	Potential ET_p* (cm/moth)	Solar radiation (W/m^2)	Rainfall (cm)
Sep 2004	26.98	14.2	166	31.90**
Oct 2004	25.09	11.6	181	8.18
Nov 2004	22.83	8.86	151	1.19
Dec 2004	19.40	5.6	129	4.47
Jan 2005	19.18	5.06	149	2.95
Feb 2005	20.8	6.47	161	1.22
Mar 2005	23.0	8.77	216	10.67
Apr 2005	24.7	10.89	261	4.39
May 2005	26.2	13.01	241	11.81
June 2005	26.6	13.62	170	38.23
July 2005	28.8	17.33	236	15.85
Aug 2005	28.6	16.97	210	27.05
Sep 2005	27.7	15.40	193	19.35
Oct 2005	25.6	12.13	160	27.30***
Nov 2005	23.2	9.00	85	11.79
Dec 2005	19.8	5.50	49	5.59

*Potential evapotranspiration was calculated using the Thronthwaite procedure
**Hurricane Frances and Jeanne
***Hurricane Wilma





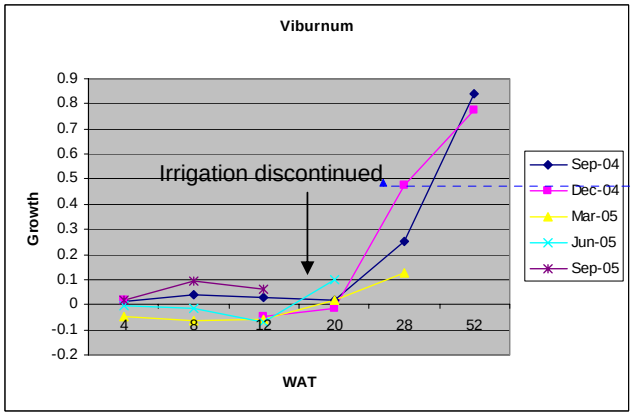


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Figure 4. Growth indices (m^3) averaged over irrigation treatment for Wild Coffee/Copperleaf, Orange Jasmine, and Viburnum planted in September 2004, December 2004, March 2005, June 2005 and September 2005 in Fort Lauderdale, FL. For the September 2005 planting, wild coffee was replaced by copperleaf. (WAT=Weeks after Planting).