RESPONSE OF YOUNG 'TAHITI' LIME TREES TO DIFFERENT IRRIGATION LEVELS

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ABSTRACT: The aim of this study was to evaluate the effect of different irrigation levels on canopy and root growth, productivity, and fruit quality of young 'Tahiti' acid lime trees. The experiment was installed in Piracicaba, Brazil in a 1.0-ha orchard plot with 'Tahiti' acid lime trees, grafted on 'Swingle' citrumelo rootstock and carried out from August of 2002 to May 2005. Each treatment was assigned to a drip irrigation level, based on *ETc* as follows: T1) non-irrigated, T2) 25%, T3) 50%, T4) 75% and T5) 100% of *ETc* determined by weighing lysimeter presented in the orchard plot. Trunk diameter and tree height were evaluated monthly. The roots were evaluated when the trees were 30 and 48 months old. The yield and fruit quality was evaluated in 2004 and 2005. The results showed that irrigation did not influence root distribution in depth, and trees irrigated with 75% and 100% *ETc* showed horizontal root distribution concentrated until 0.6 m from the trunk. Irrigation did not improve the quality of fruit. Yield increased in all irrigated treatment, but the most efficient yield mean per unit of water applied was the 25% *ETc* treatment.

KEYWORDS: irrigation scheduling, *Citrus latifolia* Tan., evapotranspiration, root distribution.

RESPOSTA DE PLANTAS JOVENS DE LIMEIRA-ÁCIDA 'TAHITI' A DIFERENTES NÍVEIS DE IRRIGAÇÃO

RESUMO: O objetivo deste trabalho foi avaliar o efeito de diferentes níveis de irrigação sobre o crescimento da copa e raízes, produtividade e qualidade de frutos de plantas jovens de limeira-ácida 'Tahiti'. O experimento foi instalado em Piracicaba, em um hectare plantado com limeira-ácida 'Tahiti' enxertadas sobre porta-enxerto citromelo 'Swingle'e irrigadas por gotejamento. O experimento foi conduzido durante o período de agosto de 2002 a maio de 2005. Cada tratamento correspondeu a um nível de irrigação baseado nos valores de evapotranspiração da cultura (*ETc*): T1) não irrigado; T2) 25%; T3) 50%; T4) 75% e T5) 100% da *ETc* determinada por meio de um lisímetro de pesagem, presente na área. O diâmetro e a altura das plantas foram avaliados mensalmente. As raízes foram avaliadas quando as plantas estavam com 30 e 48 meses de idade. A produtividade e a qualidade dos frutos foram avaliadas em 2004 e 2005. Os resultados mostraram que a irrigação não influenciou na distribuição do sistema radicular em profundidade, e que plantas irrigadas com lâminas de água equivalentes a 75 e 100% da *ETc* mostraram uma distribuição horizontal de raízes concentradas a 0,60 m de distância do tronco. Aos 48 meses, a irrigação não influenciou na distribuição do sistema radicular no perfil do solo. A irrigação não melhorou a qualidade dos frutos. A produtividade aumentou em todos os tratamentos irrigados, mas o tratamento correspondente à lâmina de 25% da *ETc* foi o mais eficiente por unidade de água aplicada.

PALAVRAS-CHAVE: manejo de irrigação, evapotranspiração, *Citrus latifolia*, raiz.

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INTRODUCTION

'Tahiti' acid lime [*Citrus latifolia* (Yu. Tanaka) Tanaka] starts to produce an economical yield when trees are 3 years old and contribute substantially to the citrus income (AGRIANUAL, 2007). This species can adapt to different soil types. In the State of São Paulo, acid limes can thrive anywhere, except in areas where temperatures are extreme.

A few years ago, the State of São Paulo was considered the only region in the world with the highest production of citrus under no irrigation. Although the State of São Paulo receives annual rainfall in the range 1,200 to 1,600 mm, about 80% of the rainfall occurs from October to April, and does not coincide with the critical flowering and fruit set stage of the crop. BUSTAN & GOLDSCHMIDT (1998) related that in the reproductive period, 70% of the carbon assimilated by the plant is used to produce flowers and fruits. Studies showed that inadequate rainfall during these periods can significantly reduce yields. Because of the above reasons, the irrigated area in São Paulo under citrus is increasing. Currently, about 15% of the 651 thousand hectares cultivated in São Paulo (USDA, 2005) receive irrigation (PARSONS, 2005).

During the first several years after planting, there is generally a good relationship between increased irrigation and increase in canopy volume and yield (PARSONS et al., 2001). However, as trees reach full size, excessive growth induced by over-irrigation and fertilization can decrease yields because of shading and the need for hedging large amounts of vegetative and reproductive material (WHEATON et al., 1991). Water shortages typically increase concentration of Brix in the juice, while excessive rainfall or irrigation results in dilution of the sugars or total soluble solids in the juice (DAVIES & ALBRIGO, 1994).

Because of their year-round growth and production, lime trees demand about 10% to 20% more irrigation than oranges and trees planted in grass should receive about 20% more water than trees with no grass or ground cover (WRIGHT, 2000).

In addition, many new orchards are using rootstocks that are less tolerant of water stress. These rootstocks are used to control Citrus Sudden Death occurrence in the Northern region of São Paulo, where water shortages are severe.

Despite of benefits of citrus irrigation, the shortage of water and the unavailability of required information for efficient irrigation scheduling is a problem that producers face. Excessive use of irrigation water is wasteful, as it may result in poor fruit quality, leaching of nutrients and increased risk of root rots. Irrigation techniques that guarantee maximum efficiency of water use should be used (BOLLER et al., 2004). Increasing the efficiency of irrigation by reducing water wastage is an important way to save water without affecting productivity. This saved water can be used to expand the area under irrigation.

Information about irrigation of citrus, which was developed in other regions, or with different combinations of rootstock and scion varieties, and different soils and irrigation systems, could be not adequate for São Paulo conditions. Therefore, the objective of this study is to evaluate the effect of irrigation levels (0% to 100% of crop evapotranspiration measured by weighing lysimeter) on 'Tahiti' acid lime young tree canopy and root growth, productivity, and quality of fruit, under drip irrigation in the field.

MATERIAL AND METHODS

The experiment was conducted during a 3-year period (Aug. 2002 to May 2005, totalizing 34 months) in a 1.0-ha plot planted with 'Tahiti' acid lime trees (*Citrus latifolia* Tanaka), grafted on 'Swingle' [*Poncirus trifoliata* (L.) Raf. × *Citrus paradisi* Macf.] citrumelo rootstock. The trees were 1 year old and spaced 7 × 4 m, and were drip-irrigated using 4 pressure compensated drippers of 4 L h^{-1} (uniformity of 95%) per each tree. The closest dripper was 0.5 m from the trunk, and drippers formed 2 wet bulbs in each side of the tree. The orchard was located in Piracicaba, State of São Paulo, Brazil (22º41'58''S, 47º38'42''W; elevation 511 m). Average annual temperature in the area was 21.4 ºC and annual rainfall was 1,257 mm. The soil was a Rhodic Kandiudalf, clay texture, 5% average slope. Plant available soil water was 0.125 m^3 m^{-3}. The average bulk density of the soil measured between 0.2 m and 1 m depth was 1.3 Mg m^{-3}. The orchard floor was kept free of weeds during the experimental period. Ordinary pest control practices were performed and the fertilization was done as recommend by van RAIJ et al. (2000).

In the experimental plot, 50 trees which were identical in size were selected and divided into 5 groups. Each group was assigned to a different irrigation, treatments based on crop evapotranspiration (*ETc*) as follows: T1) non-irrigated, T2) 25%, T3) 50%, T4) 75%, and T5) 100% of *ETc* as determined by a weighting lysimeter.

The weighting lysimeter (2.7-m diameter x 0.8-m depth) was set up in the center of the experimental area with one tree in it. Details about the lysimeter construction and calibration can be obtained in BARBOSA Jr. et al. (2008). The precision of the weight measurements were about 0.268 kg (0.0468 mm). Daily crop evapotranspiration (*ETc*) was calculated from daily weight changes in the lysimeter. The tree in the lysimeter was irrigated and managed like the rest of the trees in the experimental area. The meteorological data (Fig.1C and 3) for the years during the period was collected by an automatic weather station (CR 23X, Campbell Scientific, Logan, USA) located about 70 m away from the orchard.

The frequency of irrigation was of 2 in 2 days by drip irrigation system (Tab. 3). The irrigation level was adjusted using a different number of dripper emitters per tree. In T2 (25% *ETc*) one dripper was used, T3 (50% *ETc*) two drippers, T4 (75% *ETc*) three drippers, and T5 (100% *ETc*) four drippers. The drippers in T2, T3, and T4 were adapted with dividers of flow and microtub (Way Multi - Outlet Dripper) to irrigate all treatments with 4 wet bulbs. Where T2 (25% *ETc*) was irrigated with 4 wet bulbs of 1 Lh^{-1}, T3 (50% *ETc*) with 4 wet bulbs of 2 Lh^{-1}, T4 (75% *ETc*) with 2 wet bulbs of 2 Lh^{-1} and 2 wet bulbs of 4 Lh^{-1}, and T5 (100% *ETc*) with 4 wet bulbs of 4 Lh^{-1}, totalizing 4, 8, 12, and 16 Lh^{-1} $tree^{-1}$, in T2, T3, T4, and T5, respectively. The experimental was a completely randomized design, with 5 treatments (irrigation levels) and 10 replications (one tree each).

The tree growth was evaluated in all 50 trees monthly during the period from August 2002 to April 2005. The trunk diameter was measured 0.05 m above the graft line, and the tree height was measured from the soil surface to the average height of the tallest branches (ALVES JR. et al., 2005).

The roots under irrigation levels were evaluated when the trees were 30-months-old, and again when the trees were 48-months-old, using the method explained by BÖHM (1979). Two trees were used by each treatment (irrigation levels with 0%, 25%, 50%, 75%, and 100% of *ETc*). First sampling was made at 4 horizontal distances from tree trunk (0.3, 0.6, 0.9, and 1.2 m) and 2 depths (0.0 to 0.3 and 0.3 to 0.6 m). For the second, it was made at 5 horizontal distances from the trunk (0.3, 0.6, 0.9, 1.2, and 1.5 m), and 3 depths (0.0 to 0.3, 0.3 to 0.6, and 0.6 to 0.9 m).

Soil cores were collected using a soil auger with a diameter of 0.09 m and height of 0.25 m. Roots were separated from the soil using screens (2 mm opening). Roots were then dried at 65 ^oC for 72 h and weighed. Feeder roots were identified considering them as, all roots with a diameter less than 1.5 mm.

The yield was evaluated by measuring the weight and number of fruits per tree in 2004 and 2005. Harvests were done 4 times during 2004 (February, March, May and August) and 3 times in 2005 (February, May and August), at 18, 19, 21, 24, 32 and 38 months after the experiment had started. All fruit were harvested manually on the basis of coloration of the rind. The fruits were harvested using the Brazilian classification system (HORTBRASIL, 2000). The two rind color intensities used were C3 and C4. From the harvest, a subsample of 10 fruits per replication was randomly selected for quality analysis. The fruits were washed and placed in plastic bags and stored at 10 ^oC for 12 h. The measurement criteria for fruit diameter (equatorial), rind thickness, and percent of juice were as described by ALVES JR. (2006). From the extracted juice, the total soluble solids (^{o}Brix) was measured using a portable refractometer (resolution 0.2), pH using potentiometer (resolution 0.01), and total acidity (%) using titration method as describe by AOAC (1970) cited by ALVES JR. et al. (2006).

RESULTS AND DISCUSSION

The growth of lime trees

In the first nine months, the growth rate of the height tree was very similar in all treatments (Fig.1A). This time coincided with the wet season where the radiation and air temperature were high (Fig. 1C). As there was no water stress during this period, treatments showed similar growth rates for tree height as trunk diameter (Fig. 1B and $1B_1$). Therefore, during this time, the treatments did not show significant differences, although the tree height in 100% *ETc* (T5) compared to the treatments non irrigated (T1) showed higher values at the third month of the experiment, T5 tree height was not significantly greater than T1 until the 12 month (Sept. 2003). Tree height in T5 was about 17% greater than T1 (Fig. 1A and $1A_1$). During the 12 to 18 month (July 2003 to Jan. 2004) these differences were more pronounced, and it could be observed a more intense growth in the treatments irrigated at 75% and 100% of *ETc* as compared to less irrigated (25 and 50% of *ETc*). This time corresponded to a great decrease in pluvial precipitation (Fig 1C and Fig. 3) and then soil water deficit. After 18 month, there was a stabilization of rate of growth in all treatments, however, with lower rate at T1 (non-irrigated trees).

For trunk diameter (Fig. 1B and $1B_1$), the results were similar to trees height but with differences less pronounced, except by the end of the experiment. The results suggested that the water deficits that occurred during July to January of 2004 (Fig. 3) caused a low rate of growth in tree height and trunk diameter. Studies have showed that young citrus tree growth is strongly affected by water deficit especially during the first years after planting (ALVES JR. et al., 2005). CASTEL (1993) found a linear relation between the trunk diameter and the irrigation level. CASTEL (1994) also observed that young ‘Clementine de Nunes’ mandarin trees irrigated at 50% *ETc* showed water stress and lower growth when compared with trees irrigated at 100% of *ETc*. However, GINESTAR & CASTEL (1996) observed reduction on perimeter trunk with water stress but not in a clear way.

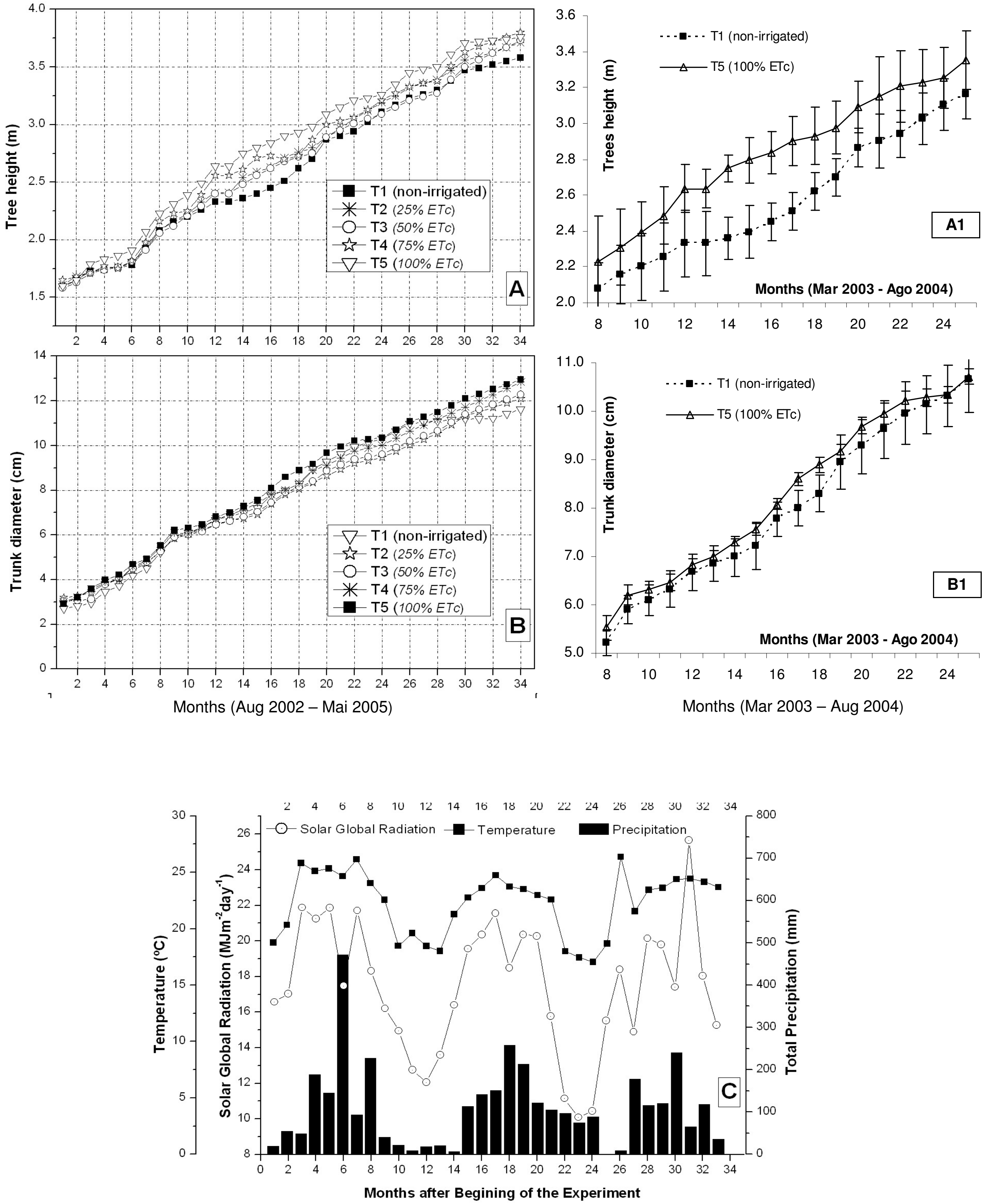

FIGURE 1. Monthly measurement of tree height (A), trunk tree diameter (B) and climatic data throughout the experiment (C). Piracicaba, Brazil. Legend: T1) non-irrigated, T2) 25%, T3) 50%, T4) 75% and T5) 100% of crop evapotranspiration.

Root distribution of lime trees

The results (Tab.1 and Fig.2) from first sampling (after 16 months of the experiment beginning) showed that there was a significant difference in root distribution (in depth and horizontally). About 51.0 kg m^{-3} (69%) of root density was concentrated between 0.0 to 0.6 m from the trunk and about 56.2 kg m^{-3} (78%) of the total roots were found between 0.0 to 0.3 m depth. Similar results were obtained in the second sampling but with a light growth in both horizontal as depth. These results agree with COELHO et al. (2002), MORGAN et al. (2006) and TESTEZLAF et al (2007) which observed that roots of citrus trees normally are concentrated horizontally between 0.5 and 2 m from the stem of the tree and between 0 and 1 m of depth. MATTOS JR. et al. (2003) found also, that roots were concentrated horizontally at a distance of 0.5 m from the trunk in mature ‘Hamlin’ orange on ‘Swingle’ citrumelo rootstock trees (6 years old).

There was more root and feeder root density at high levels of irrigation (T4 and T5) in horizontal root distribution in the first sampling. This was probably due to the wider wetting area (about 0.5 to 0.6 m wet bulb diameter) promoted by drippers of 4 Lh^{-1} in T4 and T5. It showed that there is a trend for roots to be concentrated in the wetted area, due to the higher rate of water application by the irrigation. The results from the second sampling (after 34 months of beginning of experiment in trees with 48 months old) showed that there was no significant difference between irrigation levels and root distribution pattern (*P<0.05*).

TABLE 1. Analysis of variance and ‘F’ test of total root distribution of young tree of acid lime ‘Tahiti’ with ‘Swingle’ citrumelo, irrigated under different irrigation levels in Piracicaba, Brazil.

Variation	Roots at 30 months		Roots at 48 months	
	Characteristics			
	D.F.	F.	D.F.	F
Depth (D)	1	66.06**	2	43.41**
Horizontal distance (H)	3	17.94**	4	34.13**
Irrigation levels x D	4	4.00ns	8	1.08ns
Irrigation levels x H	12	2.99**	16	1.07ns
C.V. (%)		51.2		54.1

** - significant at 5% (P>0.05); ns - non significance by ‘F’ Test; D.F. - degrees of freedom; C.V. - variation coefficient.

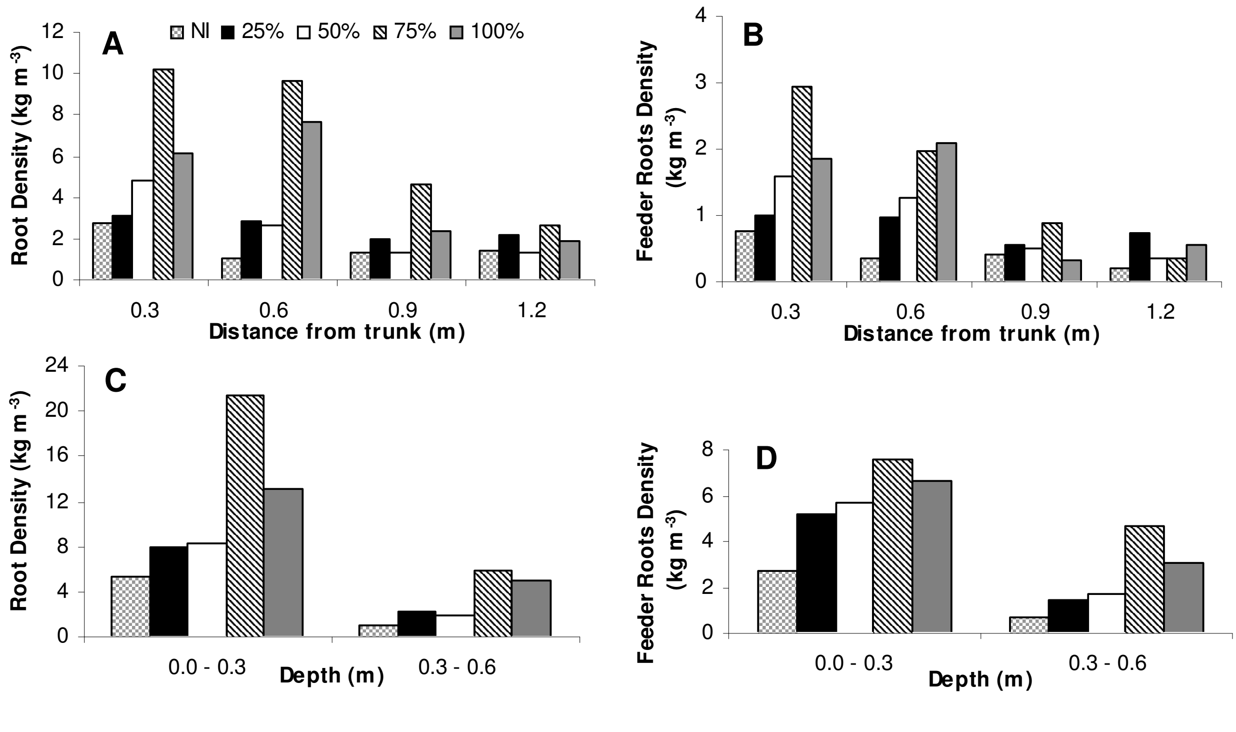

FIGURE 2. Horizontal (A and B) and depth distribution (C and D) of roots and feeder roots at 16 months of beginning of experiment in the treatments of trees with 30 months old, Piracicaba, Brazil.

The root distribution values are in accordance with results reported in literature. SANTOS et al. (2005) verified that the lemon roots grow more with increase in the irrigation intervals and lemon roots extract more water when there is no restriction to the available water in the wetted volume.

CASTLE et al. (1993), who studied root distribution in different rootstocks and observed about 90% of roots within 0.6 m of depth and horizontal distance of 2 m, and about 85% of these roots were feeder roots. SOUZA et al. (2004) and SANTANA et al. (2006) studied citrus roots distribution of ‘Bahia’ orange (*Citrus sinensis* (L.) Osbeck) grafted onto Rangpur lime in a coastal plain soil toposequence in Sapeaçu country, Bahia, Brazil, in soil compact level between 0.3 and 0.5 m, observed about 61% of roots within 0.2 m and 90% within 0.4 m. Some results are different than that observed in our study, probably due these studies evaluated different species, rootstock, age, and grove management, and this may explain the difference.

Yield and quality of lime fruits

The first year the results (Table 2) showed that yields among the different treatments were significant ($P<0.05$). The yield in T2 (25% *ETc*), T4 (75%), and T5 (100% *ETc*) was greater than T1 (no irrigation). The yield in T3 (50% of *ETc*) was intermediate. Although T5 (53 kg tree^{-1}) did not differ significantly from T2 (44 kg tree^{-1}), T3 (39 kg tree^{-1}), and T4 (45 kg tree^{-1}), it was 22% higher. T4 was not significantly different from T3, but its yield was 15% higher. T3 received double the amount of water of T2 (Table 3), it showed a 15% lower yield and T3 did not differ significantly from T1 (24 kg tree^{-1}) but its yield was 62% higher. In all these treatments, the yield reduction was due mostly to fewer fruit as the final fruit size was not significantly affected.

TABLE 2. Yield parameters and fruit quality of ‘Tahiti’ lime under irrigation levels (T1, non-irrigated; T2, 25%; T3, 50%; T4, 75% and T5, 100% of crop evapotranspiration). Analyses of 2004 and 2005. Piracicaba, Brazil.

First year (2004)								
Treatments	Yield kg tree^{-1}	Fruits n°.tree^{-1}	Juice %	Fruit Diameter Mm	Rind Thickness mm	Acidity %	pH	Soluble Solids °Brix
T1	24.1b	332b	41.9a	50.4a	2.7a	6.6a	2.6a	8.0a
T2	44.9a	644a	43.3a	50.6a	2.7a	7.0a	2.5a	8.0a
T3	39.0ab	611a	44.8a	50.0a	2.7a	7.6a	2.5a	8.2a
T4	45.2a	665a	39.1a	50.9a	2.7a	7.3a	2.6a	7.9a
T5	53.6a	761a	39.3a	51.3a	2.7a	7.4a	2.5a	7.9a
Average	41.4	603	41.7	50.6	2.7	7.30	2.5	8.0
LSD	16.2	217.9	18.1	1.9	0.29	1.50	0.14	0.44
C.V.	31.8	29.8	16.1	1.4	8.97	12.4	2.08	2.11
Second year (2005)								
T1	28.4b	373a	56.4a	50.4a	2.7a	6.5a	2.0a	7.6a
T2	40.0a	484a	57.6a	50.4a	2.8a	6.4a	2.0a	7.4a
T3	35.9ab	477a	53.4a	50.3a	2.8a	6.4a	2.0a	7.6a
T4	37.1a	456a	56.8a	50.3a	2.9a	6.4a	2.0a	7.6a
T5	37.4a	453a	54.4a	52.6a	2.8a	6.4a	2.0a	7.7a
Average	35.8	449	55.7	50.8	2.8	6.4	2.0	7.6
LSD	8.4	101.7	9.4	3.5	0.3	0.3	0.1	0.7
C.V.	23.9	22.2	8.9	3.7	6.0	2.4	2.4	4.8

* Means in each column followed by the same letter do not differ statistically at the 0.05 level by Tukey Test; C.V. - variation coefficient; LSD - Least Significant Difference.

The second year yield shows similar results to the first year yield. Irrigated treatments had 30% to 40% more yield than non irrigated trees. The yield in T2, T3, T4, and T5 differed significantly ($P<0.05$) from T1. There was no significant difference among the different irrigation levels.

The results indicate the necessity of scheduling irrigations, because the lime crop did not increase yield proportionally to irrigation levels. Probably, due water stress was lower in second harvest year (Figure 3). Irrigating with at least 25% of *ETc* could significantly increase yield. Trees irrigated at 25% and 100% of *ETc* (3 years old) gave yields that were 86% and 122% higher than non irrigated trees, respectively.

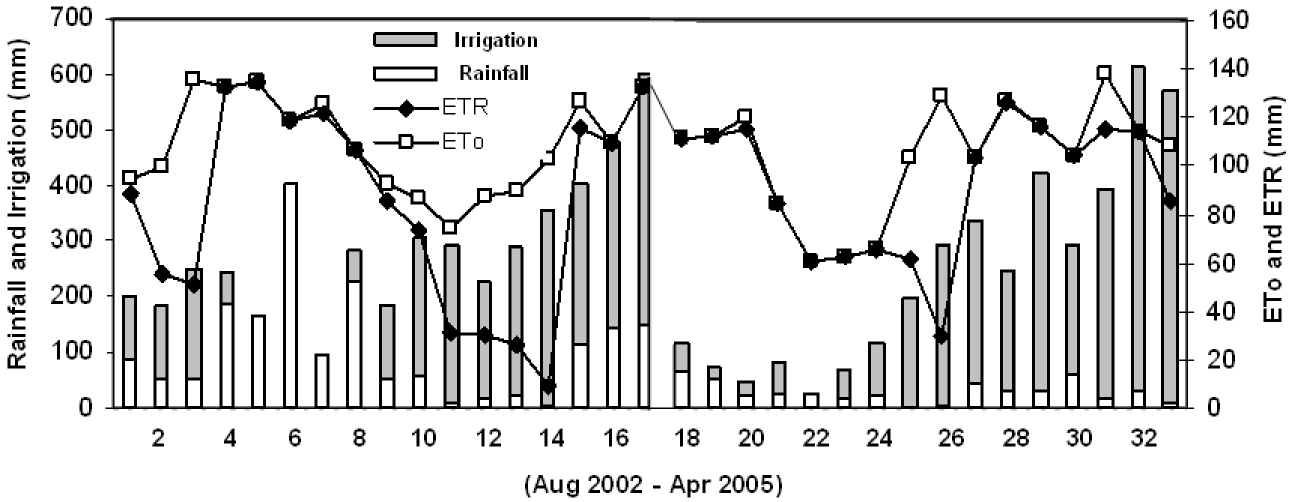

FIGURE 3. Rainfall, irrigation, reference (ETo) and real evapotranspiration (ETR) during experimental time (August of 2002 to September of 2003) in Piracicaba - SP, Brazil.

These results are in according to CASTEL (1994) and SOUZA et al. (2003), who showed that irrigation can increase annual yield of citrus. GAYET et al. (1995) observed that acid lime starts to produce an economical yield when the tree is 3 years old. This study showed that irrigation contributed to earlier yield. Three-year-old irrigated trees produced like 5-year-old trees that are not irrigated, as related by COELHO (1993). He showed that in São Paulo, yield of lime depends on tree age, e.g. 8 to 15 kg per tree at 3 years old, 23 to 37 kg per tree at 4 years old, 64 to 86 kg per tree at 5 years old, and 68 to 141 kg at 6 years old.

With the second year yield (4 years old), trees irrigated with 25% of *ETc* (39.9 kg tree^{-1}) showed 40% higher productivity than non irrigated trees (28.3 kg tree^{-1}). Irrigated trees at 4 years old produced like 4-year-old trees that are not irrigated (COELHO, 1993). This was probably due the characteristic al ternate cropping (biennial bearing) of citrus, as related by FORSYTH (2003).

Table 2 also shows that there was no significant difference ($P<0.05$) among irrigation levels and fruit quality, such as percent of juice, total soluble solid (TSS), pH, total acidity, rind thickness, and fruit diameter. Similar results were obtained by SILVA et al. (2007) in the same experimental area. DOMINGOS et al. (1996) did not verified effect of irrigation on chemical characteristics of Fruits in lemon trees. GINESTAR & CASTEL (1996) observed the effect of water stress on TSS was different in each year of the experiment and presumably be attributed to the differences in air temperature.

Normally, acidity is an important commercialization factor for ‘Tahiti’ acid lime. Average total acidity found in this study was considered acceptable, being between of the interval of 6% to 8% in accordance with GAYET et al. (1995). The results of total soluble solids obtained in this study are between 7 and 8°Brix, which was very similar results obtained by SILVA et al. (2007) and SOUZA et al., (2003) to same variety.

TABLE 3. Amount of used water for irrigation of the 'Tahiti' acid lime trees in the treatments (Irrigation levels 100%, 75%, 50% and 25% of ETc).

Month	Month/year	Irrigatio (liters $tree^{-1}$ day^{-1})			
		100% ETc	75% ETc	50% ETc	25% ETc
1	Aug/2002	4.10	3.08	2.05	1.03
2	Sep/2002	4.80	3.60	2.40	1.20
3	Oct/2002	7.28	5.46	3.64	1.82
4	Nov/2002	2.13	1.60	1.07	0.53
5	Dec/2002	0.00	0.00	0.00	0.00
6	Jan/2003	0.00	0.00	0.00	0.00
7	Feb/2003	0.00	0.00	0.00	0.00
8	Mar/2003	2.06	1.55	1.03	0.52
9	Apr/2003	4.91	3.68	2.46	1.23
10	Mai/2003	9.08	6.81	4.54	2.27
11	Jun/2003	10.74	8.06	5.37	2.69
12	Jul/2003	7.61	5.71	3.81	1.90
13	Aug/2003	9.84	7.38	4.92	2.46
14	Sep/2003	13.06	9.80	6.53	3.27
15	Oct/2003	10.49	7.87	5.25	2.62
16	Nov/2003	12.41	9.31	6.21	3.10
17	Dec/2003	16.40	12.30	8.20	4.10
18	Jan/2004	7.62	5.71	3.81	1.90
19	Feb/2004	3.05	2.29	1.53	0.76
20	Mar/2004	3.70	2.78	1.85	0.93
21	Apr/2004	8.20	6.15	4.10	2.05
22	Mai/2004	0.00	0.00	0.00	0.00
23	Jun/2004	7.41	5.55	3.70	1.85
24	Jul/2004	14.18	10.63	7.09	3.54
25	Aug/2004	28.89	21.66	14.44	7.22
26	Sep/2004	44.42	33.31	22.21	11.10
27	Oct/2004	42.85	32.14	21.43	10.71
28	Nov/2004	32.83	24.62	16.41	8.21
29	Dec/2004	57.77	43.33	28.89	14.44
30	Jan/2005	34.65	25.99	17.33	8.66
31	Feb/2005	61.17	45.88	30.59	15.29
32	Mar/2005	85.70	64.28	42.85	21.43
33	Apr/2005	85.28	63.96	42.64	21.32

Using the Brazilian classification system (HORTBRASIL, 2000), the fruits are classified as Group 'A' when percent juice is between 30% to 35%, group 'B' 42% to 50%, and group 'C' above 55%. Therefore, the average percent juice in this study can be put into the category B and C in the first (41.7%) and second (55.7%) year of yield, respectively.

Fruits are also ideal to harvest when they are between 47 to 65 mm of diameter (GAYET et al., 1995). Using the Brazilian classification system (HORTBRASIL, 2000), the fruits were classified as Class 50 with diameters between 50 to 53 mm.

CONCLUSION

Young trees irrigated with 100% of crop evapotranspiration resulted in greater growth of 'Tahiti' acid lime in field conditions.

With trees that were 33 months old, irrigation did not influence root distribution in depth. However, irrigation influenced root distribution horizontally. Trees irrigated at 75% and 100% of crop evapotranspiration showed horizontal root distribution concentrated between 0.0 to 0.6 m from the trunk.

With 48-month-old trees, irrigation had no effect on root distribution in the soil profile, and the effective (80%) rooting distribution were located to 0.6 m of depth and 0.6 m horizontally.

Irrigation with 25% of crop evapotranspiration induced earlier yield, and increased yield and number of fruits per tree.

Irrigation did not improve the quality of fruit.

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