EFFECTS OF IRRIGATION AND NITROGEN LEVELS ON QUALITATIVE AND NUTRITIONAL ASPECTS OF FIG-TREES (*Ficus carica* L.)[1]

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ABSTRACT: In order to evaluate qualitative and nutritional aspects of fig-trees with respect to six irrigation and six nitrogen levels, at Ilha Solteira, SP, Brazil, an experiment was carried out in randomized blocks, with subdivided plots, and four replications. Results showed that in four dates during harvest, only the first analysis (January 2, 1991) showed influence of nitrogen fertilization on fruit soluble solids (brix). There was no significant effect of treatments on pulp/peel relation for the four harvestings. In relation to leaf macronutrient concentration at flowering, water supply influenced N, P and Ca concentrations, and nitrogen influenced only Ca concentration. For an average of 10 $t.ha^{-1}$ of mature fruit and 1.3 $t.ha^{-1}$ of immature fruit production, there was a nutrient export of about 65 $kg.ha^{-1}$ of N; 10 $kg.ha^{-1}$ of P_2O_5; 44 $kg.ha^{-1}$ of K_2O; 35 $kg.ha^{-1}$ of Ca and 9 $kg.ha^{-1}$ of Mg.
Key Words: fig-trees, irrigation, nitrogen.

EFEITOS DA IRRIGAÇÃO E DE NÍVEIS DE NITROGÊNIO EM ASPECTOS QUALITATIVOS E NUTRICIONAIS DA FIGUEIRA (*Ficus carica* L.)

RESUMO: Para avaliar aspectos qualitativos e nutricionais da figueira em relação a seis níveis de irrigação e de nitrogênio, desenvolveu-se um experimento em blocos ao acaso, com parcelas subdivididas e com quatro repetições, em Ilha Solteira, SP. Os resultados mostraram que em quatro datas de colheita, apenas a primeira análise (2 de janeiro de 91) mostrou influência da fertilização nitrogenada sobre os sólidos solúveis (brix) dos frutos. Não houve efeito significativo dos tratamentos sobre a relação polpa/casca, nas quatro colheitas. Com relação à concentração de macronutrientes nas folhas na época de florescimento, o suprimento de água influenciou as concentrações de N, P e Ca e a aplicação de nitrogênio influenciou apenas a concentração de Ca. Para uma produção média de 10 $t.ha^{-1}$ de frutos maduros e de 1,3 $t.ha^{-1}$ de frutos verdes, observou-se uma exportação de aproximadamente 65 $kg.ha^{-1}$ de N; 10 $kg.ha^{-1}$ de P_2O_5; 44 $kg.ha^{-1}$ de K_2O; 35 $kg.ha^{-1}$ de Ca e 9 $kg.ha^{-1}$ de Mg.
Descritores: figueira, irrigação, nitrogênio.

INTRODUCTION

Fig-tree cultivation in Brazil can be found in the states of São Paulo, Rio Grande do Sul and Minas Gerais, which are the largest producers. In the State of São Paulo its production is practically restricted to the microregion of Campinas, especially in the county of Valinhos. Due to the large scale of manual work involved and to its financial return fig-tree cultivation is extremely interesting from the social point of view.

Among the new agricultural areas, the region of Ilha Solteira has opened great perspectives for the crop, because of its suitable climate, its relatively fertile soil and the great availability of water and electric energy. On the other hand, being a non-traditional crop in the region, accurate studies are needed in order to assist fertilization effects upon nutritional and qualitative aspects for commercial fig crop production.

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Literature concerning fig-tree cultivation is scarce. FACHINELLO *et al.* (1979) reports that from a practical viewpoint there are no special rules on this subject. PROEBSTING & TATE (1952) observed that foliar concentration of net and total nitrogen decreased during the growing season. Similar results were obtained by PROEBSTING & WARNER (1954) who noted the decrease of nitrogen and phosphorus contents, while potassium content increased up to half of the growth season and calcium and magnesium contents increased gradually from the beginning to the end of growth season.

BATAGLIA *et al.* (1985) report that nitrogen fertilization may play an important role not only because of the concentration of nitrogen metabolits, but also because it affects the incorporation of assimilates through the increase of the photosynthetic capacity of the tree.

EL-KASSAS (1975) working with three irrigation levels and three levels of N fertilization, observed that fig-tree retained 50%, 65% and 80% available soil water, and presented 1.25%, 1.25% and 1.17% N in the leaves, respectively. The author suggests that the decrease in the concentration and the corresponding increase of water availability in the soil may be related to the large growth of the trees or nitrate leaching in the soil.

Studies developed by HAAG *et al.* (1979) revealed that fig-trees well supplied with nutrients showed in the leaves: N = 3.39%; P = 0.17% to 0,20%; K = 2.86 to 2.83%; Ca = 1.67 to 1.91%; Mg = 0.63 to 0.66%; and B = 162 to 219 ppm. Other authors working with four irrigation levels (12.5%, 25.0%, 37.5% and 50.0% of Class A pan evaporation) observed that there was no variation of N, P, Ca and Mg contents in the leaves, at several seasons in which samples were collected.

HIROCE *et al.* (1979) observed that for the production of only 20 $t.ha^{-1}$ of fresh fruit, fig-trees extracted 68.8 kg of N, 9.4 kg of P_2O_5, 79.3 kg of K_2O, 21.9 kg of Ca and 6,1 kg of Mg. It should be noted that due to the drastic pruning, when about 10 $t.ha^{-1}$ of branches are exported, nutrients are carrying along.

This work aims the evaluation of the effect of six water levels, based on the Class A pan evaporation, and six nitrogen levels upon the quality of figs and their nutritional aspects related to crop management.

MATERIAL AND METHODS

The experiment was carried out at Ilha Solteira, 335 m above sea level, in the county of Selviria (20°22'S, 51°22'W), MS, Brazil. According to Köppen's classification the climate type is Aw, presenting an average yearly temperature of 25° and precipitation of 1330 mm (CENTURION, 1982).

The soil is a dark-red loamy latosol and a previous chemical analysis indicated: pH ($CaCl_2$) = 4.8; MO = 2.8 %; P(H_2SO_4) = 30 $\mu g/cm^3$; K, Ca, Mg, H+Al, S, T, respectively 0.37, 2.7, 1.1, 3.9, 4.17, 8.07 $meq/100cm^3$ and base saturation (V) = 52%.

Fig trees of the variety "Roxo-de-Valinhos" were obtained through asexual propagation by means of commercial cuttings. This variety is the only one cultivated in the State of São Paulo. The tree is strong, productive and suits quite well to the system of drastic pruning. It is suitable for the production of ripe figs for *in natura* consumption and immature or not yet fully ripe figs for the industry (FRANCO & PENTEADO, 1986). Yield is high and fruit is of good quality, both for *in natura* consumption and industrial processing (RIGITANO & OJIMA, 1963; SIMÃO, 1971; GOMES, 1975).

Transplant of the rooted cuttings to the experimental plots was done on May 19, 1988, using a 3.0 x 2.0 m spacing (3.0 m between the rows and 2.0 m between the trees). Fertilizer was applied to holes, using 1 kg of dolomitic lime, 500 g of simple superphosphate, 100 g of KCl and 20 liters of fresh manure. After planting the rooted cuttings were managed according to PEREIRA (1981). The experiment started when trees had twelve branches and were in their second commercial harvest.

A mulch of bean straw (*Phaseolus vulgaris* L.) was used to cover soil surface. Occasional sprouts along the branches were eliminated to keep trees without side sprouting.

Irrigation was performed using microsprinklers, applying water to two plants simultaneously, three times a week. The average precipitation of each microsprinkler was 2.5 mm/h, tested before the beginning of the experiment. Fertilization was done on August, 20 and October, 10, 1990, with simple superphosphate and potassium chloride in full dosage of 222 and 120 g per tree, respectively, applied around the plant.

Six main water treatments were chosen, related to Classe A Pan Evaporation (CAPE), being Wo = non-irrigated, W1 = 0.25 CAPE, W2 = 0.50 CAPE, W3 = 0.75 CAPE, W4 = CAPE, W5 = 1.25 CAPE, and six secondary fertilizer treatments, with nitrogen doses: No = O, N1 = 150, N2 = 300, N3 = 450, N4 = 600 and N5 = 750 g/plant, applied monthly, from August to December 1990, using ammonium sulphate.

During the experiment (July, 1990 to March, 1991), the total CAPE was 1590.3 mm. In January and February, irrigations were little frequent due rain excess and in March, they were not provided for the same reason.

The experimental design is a split plot statistical scheme, with six main and six secondary treatments and four replicates. The useful area of each sub-plot was of 12 m^2, including two plants. According to this scheme, each row had 6 subplots, each one with 3 trees, two of them used for sampling and one considered as border plant.

During harvest, the pulp/peel ratio and soluble solid content of fruits were analysed four times. The content of soluble solids (Brix) was obtained through the reading in a refractometer with fully ripe figs. Each replicate of these parameters represents the average of aleatorilly picked fruits in each sub-plot. Measurements were made the day after harvest.

For nutritional analysis, leaves were picked on October 18, 1990. Sampling was made at the beginning of fruit season, choosing the first fully expanded leaf from the apex of five branches. Laboratory analysis was made according to SARRUGE (1974).

Along the harvesting season four samplings of ripe fruit were made for nutrient analysis, aiming to determine their export.

RESULTS AND DISCUSSION

TABLE 1 shows that according to the F test the treatments present no differences. Nevertheless, the regression analysis made on data of January 2, shows a 5% significance of probability. Increase in nitrogen level also increased the Brix content of the ripe fruit, the fruit presenting a sweeter flavour. The average Brix content of the three later seasons was not more than 11°. This fact shows that to the end of harvest season, leaf fall increases. Consequently, there is a decrease in photosynthastes transferred to the fruit. At the beginning of the harvest the fruit presents best flavor (sweeter), since at a later stage the quantity of leaves tends to be reduced due to physiological features of the species.

CONDIT (1947) reports that ripe fruit presented differences in soluble solid contents, varying from 12° to 19°, in the first season. Nevertheless this difference may be related to the region of cultivation and to the stage of maturation of the fruit at harvesting time. The high precipitation which occured in Summer induced a major incidence of rust, which caused greater leave fall. This fact may have influenced the quality of the fruits.

With respect to the pulp/peel relation for January samples, there was a significant interaction between doses of N and water supply. Data were adjusted to a quadratic function, but the regression deviation was also significant. Average values for the pulp/peel relation were found ranging from 89 to 92% of pulp and 8 to 11% of peel. CONDIT (1947) found values of 84% in the pulp and 16% in the peel. In the current experiment fruits have presented a larger percentage of pulp comparing to the cited author, corresponding to thin peel fruits, more suitable for consumption *in natura*. On the other hand, such thin peel fruits have a shorter market life.

With respect to nutrient analysis, there was significance for phosphorus and calcium contents, due to the different water supply. Nitrogen dosage influenced calcium content. By regression analysis it was observed that water supply influenced N and Ca contents in the leaves of fig-trees (Figure 1). Water has increased the absorption of N and Ca by the plants. The same did not happen in relation to phosphorus, whose value was reduced when water supply increased. Data here presented differ from those presented by EL-KASSAS (1975), since the water supply did not decrease nutrient content. On the contrary, it increased the content of nutrients in the leaves.

N doses influenced only Ca contents (Figure 2). In this case N may have an antagonistic influence. Comparing HAAG *et al.* (1979) results with the average values of this experiment, N and P contents were higher, while K, Ca and Mg contents were of the same order.

From the nutritional point of view, analysis made on ripe fruit, at four different stages along the harvest, it was possible to calculate the average export of nutrients by fresh fruit: 20.5 kg N, 2.2 kg P_2O_5, 26.7 kg K_2O, 4.6 kg Ca and 1.8 kg Mg, for an average production of 10 $t.ha^{-1}$.

TABLE 1 - Averages, F test values and coefficients of variation (C.V.), of soluble solid (Brix) content, Pulp/Peel (P/P) ratio in ripe fruits in different seasons and nutrient content within fig leaves on October 18, 1990.

Source of Variation	DF	SEASONS JAN/02/1991		JAN/16/1991		FEB/13/1991		NUTRIENTS N	P	K	Ca	Mg
		BRIX	P/P	BRIX	P/P	BRIX	P/P	%				
W	5	0.70ns	0.35ns	0.58ns	2.38ns	0.87ns	1.60ns	1.33ns(2)	4.05*(3)	0.72ns	4.79**(4)	0.89ns
N	5	2.06ns(1)	1.17ns	0.16ns	0.72ns	2.07ns	0.64ns	0.52ns	0.79ns	0.91ns	3.14* (5)	1.91ns
W X N	25	1.21ns	0.75ns	1.50ns	1.93*	1.10ns	1.38ns	0 92ns	0.90	1.00ns	0.87ns	1.42ns
C.V.% (W)		13.58	25.61	11.14	10.48	12.22	33 60	15.92	8.42	11.63	9.46	17 11
C.V.% (N)		10.86	21.07	8.01	19.33	8.14	16.80	8.52	4.85	8.72	7.19	10.02
W0 = 1119mm		14.55	9.76	10.11	10.37	10.19	8.37	3.45	0.50	2.29	1.29	0 43
W1 = 1371mm		14.30	10.08	10.65	10.86	10.49	10.36	3.65	0.50	2.24	1.28	0.40
W2 = 1617mm		14.29	9.78	10.35	10.38	10.63	8.57	3.76	0 47	2.29	1.30	0 40
W3 = 1871mm		14.65	9.59	10 42	11 46	10.60	9.47	3.79	0.49	2.23	1.31	0.42
W4 = 2121mm		14 88	10.45	10.32	10 70	10.40	9.64	3.76	0.47	2.17	1.39	0.40
W5 = 2371mm		13.92	10.06	10.30	11.42	10.04	10.19	3.83	0.46	2.24	1.41	0.43
N0 = 0		14.29	10.71	10.25	10.86	10.41	9.74	3.65	0.48	2.26	1.37	0 40
N1 = 150g		13.89	9 68	10.39	10.74	10.16	9.26	3.70	0.48	2.26	1.36	0.40
N2 = 300g		14.12	9.66	10.36	11.58	10.52	9.27	3.70	0.48	2.25	1.34	0.42
N3 = 450g		14.55	10.28	10.33	10.78	10.22	9.39	3.66	0 48	2.19	1.32	0.42
N4 = 600g		15.23	9.47	10.34	10.59	10.22	9.77	3.76	0.49	2.21	1.31	0.43
N5 = 750g		14.52	9 92	10.45	10 64	10.81	9.18	3.76	0 49	2.26	1.27	0.41

W = Total Water supply (irrigation + rain)
N = Nitrogen
D.F. = Degrees of freedom
ns = non significant
* = significant at P=0.05
** = significant at P=0.01

(1) $Y = 14.0391 + 0.0011 X$ $R^2 = 0.41$ * (X = nitrogen dose, g)
(2) $Y = 3.5444 + 0.2585 X$ R2 = 0.76 * (X = % CAPE)
(3) $Y = 0.5012 - 0.0304 X$ R2 = 0.73 ** (X = % CAPE)
(4) $Y = 1.2602 + 0.1090 X$ R2 = 0.82 ** (X = % CAPE)
(5) $Y = 1.3733 - 0.0001 X$ R2 = 0.95 ** (X = nitrogen dose, g)

Nutrient export related to the production of 1,300 $kg.ha^{-1}$ of green fruit was of about 11.6 kg N, 1.2 kg P_2O_5, 11.0 kg K_20, 4.4 kg Ca and 1.7 kg Mg and the export of nutrients through the branches of the plants (5.6 kg/plant) was about 32.9 kg N, 6.6 kg P_2O_5, 31.1 kg K_2O, 25.9 kg Ca and 5.6 kg Mg per hectare of fig-tree plantation, totalizing an export of 65 kg of N, 10 kg P_2O_5, 44 kg K_2O, 35 kg Ca, 9 kg Mg in an hectare of fig-orchard.

Values presented above were calculated from nutrient concentration in non-irrigated trees, which have received 300 g of N/tree. The results are not in accordance with HIROCE *et al.* (1979) who indicate a larger export.

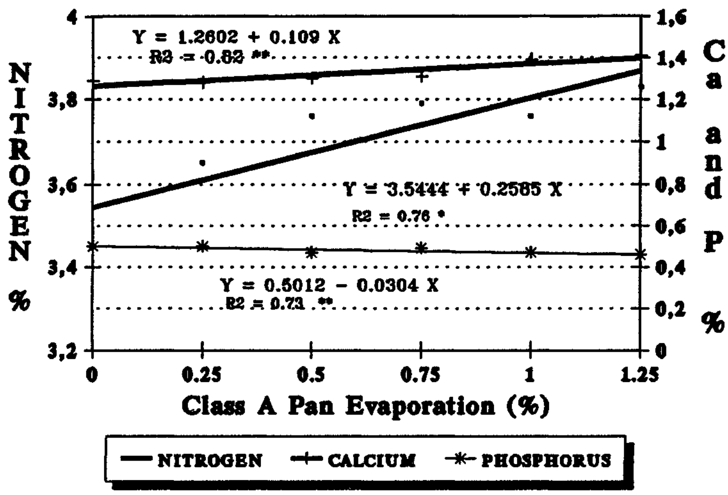

Figure 1 - Nitrogen, phosphorus and calcium leaf levels related to water supply - Harvest 1990/1991.

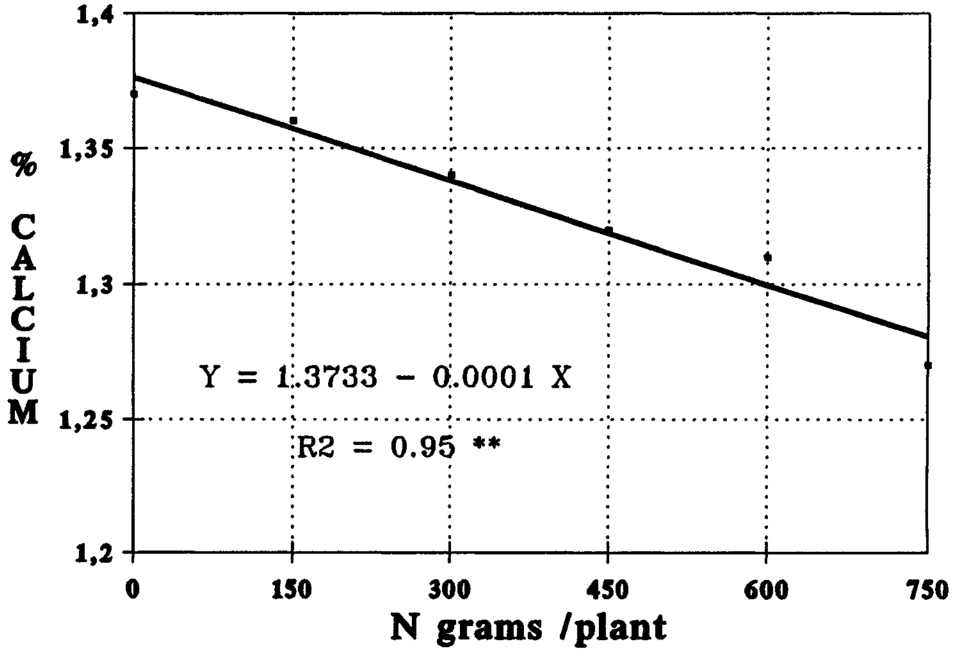

Figure 2 - Calcium leaf level related to nitrogen doses. Harvest 1990/1991.

CONCLUSION

It is concluded that:

- only nitrogen has shown positive effect on the Brix, for only one analysed period;

- considering leaf analysis, irrigation increased leaf N and Ca contents and decreased P_2O_5 contents. N has caused a reduction in Ca content. P and Mg were not influenced by treatments;

- the total export of nutrients for the production of 10 t of ripe fruit and 1.3 t of green fruit was of about 65 kg of N, 10 kg of P_2O_5, 44 kg of K_2O, 35 kg of Ca, 9 kg of Mg in one hectare of fig-trees; and,

- fig-tree crop is well adapted to the new region, producing fruit of good quality even if non-irrigated, but mulch must be present.

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