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Growth, yield and diseases incidence on fruits of guava (*Psidium guajava* L.) under irrigation

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Abstract

Irrigation is the most important activity for crop production in Mara, Zulia State. Growth and yield features of guava trees grown on field in this area were evaluated varying daily water levels: 110, 174, 228 and 273 L per tree. Dry weight (DW), ash content (AC) and organic content (OC) in percentage were determined. Also, increases (in cm) of canopy diameter (ICD), tree height (ITH), canopy height (ICH), stem height (ISH) were measured. Leaf Specific Weight (LSW) in g cm^{-2}, yield and diseases incidence on fruits were assessed. ITH and ICH differed 13 cm between lowest and highest water amount. Significant differences between treatments ($P<0,05$) were detected in LSW, AC and OC. LSW and yield were high and diseases incidence on fruits was low when 228 L day^{-1} per plant were applied without showing differences between treatments. Irrigation level had positive influence on guava growth and yield.
Key words: guava, growth, irrigation, yield, incidence, *Dothiorela* sp.

Introduction

Guava (*Psidium guajava* L.) is one of the main fruit sowed at Zulia state, state reported in 2000 as the most producer area of the country (19). Different characteristics of vegetative and reproductive growth (4, 5, 15, 16, 17) have been evaluated, besides the influence of phytosanitary problems as the apical rot of the fruit caused by *Dothiorella* sp. (7), which has generated lost in the production of even 60% (21), until causing a «regressive death» of trees caused by *Meloidogyne* spp. and *Capulina* sp. of guava (8, 9), which importance and effects as pests on this crop have already been cleared.

Irrigation is a determinant factor in the agricultural production of Maracaibo's plain. The sources of available water are deep wells with a market scarcity in the area, which has incremented costs of production (1). Generally, this crop is irrigated with

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micro-spraying, twice or three times per week (1, 15, 17, 24) where recommendations on daily water levels to be applied have been done, in terms of volume and in function of the shade of the crop (1). These recommendations were accepted by producers of the area, due to the easiness of the handling. Nevertheless, the information provided regarding irrigation handling in fruits under the agro-ecological conditions of the area has been very scarce (1, 3, 24).

Based on the research done by Añez (1), some characteristics of growth and production of guava plants were evaluated, in a farm located at Mara municipality, Zulia state, varying the quantity of applied water during a crop's cycle, including the producer's handling, observing the proportion of healthy and sick fruits.

Materials and methods

The essay was carried out from August 2000 to March 2001, at "San Onofre de las Margaritas" farm, Monte Verde locality, Mara municipality, Zulia state, which belongs to a very dry tropical forest that characterizes by an annual precipitation of 400-700 mm, evaporation of 2000 mm year^{-1} and an average temperature that oscillates in 28°C (11). Using a portable climatologically station installed in the lot of plants were registered precipitation (mm), velocity of wind (Km h^{-1}) average, relative humidity (%), maximum and minimum temperature averaged from August 2000 to January 2001, that allowed to estimate the potential evapotranspiration (ETo) using CROPWAT (10) (table 1).

In a hectare of plants of the farm, 64 plants of Criolla Roja Dominicana guava were selected and pruned, coming from three and a half-year- old seeds of, irrigated by micro-spraying and sowed at a distance of 7 m x 7 m. On table 1, treatments are described, defined as daily volume of water and the irrigation frequency done three times per week and applied during a crop's cycle. For that, volume was determined following Añez (1) recommendation, for the percentage of shade of plants once these were pruned, establishing a lower level (applied by the producer) and two superior levels. The application of daily water levels was based on the variation of station discharge. The experimental design consisted on two randomized plots with four replications and four plants per replication.

From the beginning and with a monthly frequency, increments (cm) of plant's height (AP), stem's height (AT), canopy's height (AC) and canopy's diameter (DC) in cm were measured, obtaining a total value. On the other hand, in leaves were determined dry weights (PSH), percentage of organic matter (%MO) and inorganic or ashes (%MI) taking a sample of 24 leaves per plant following the methodology mentioned by González et al (13). Leaves were

Table 1. Water levels applied in the different treatments at guava plants (*Psidium guajava* L.) and ETo estimated.

Treatament	L day^{-1} per plant	L irrigation	Total water level (mm)	Stimated total ETo
1	110	220	413	819 mm
2	174	348	653	
3	228	456	856	
4	273	546	1025	

washed, and dried at a temperature of 105ºC, and were incinerated (2) in order to obtain the percentage of organic and inorganic matter.

Once plants began the production, the weight of the fruit was measured twice per week. Due to the importance of the apical rot in the area (21) a classification of fruits was done with the same symptoms of illnesses observed in the field, dividing and weighting healthy fruits, fruits with apical rot, fruits with hard rot, fruits with both (hard and apical) and fruits with lateral stain determining its proportion. Likewise, the number of fruits infested with *Capulina* sp. (MBG) was measured.

It is important to mention that the agronomical handling of the crop was reduced to the application of the irrigation and the mechanic control of weed. This factor among to the attack of MBG limited evaluations to a production cycle doing a foliar sampling two months after these ended. These sampling consisted on the collection of 20 leaves per plant, to which the foliar area was measured (cm^2), using an area measurer AT Delta –T-Devices LTD, were dried at a temperature of 65ºC and dried on an electronic balance to obtain the specific weight of the leaf (PEH).

The data was analyzed using the statistical software SAS® (23), applying the Tukey´s mean test of for the detection of differences between means.

Results and discussion

Characteristics of vegetative growth regarding the increment in height and diameter of the plant are presented in table 2. Growth in height was determined by the growth of the canopy that tended to increase at the time that incremented the water level applied. However, there were not significant differences among treatments for variables described on the table mentioned before. These results might be explained considering that these variables tend to show significant changes through 2 years of evaluations (25).

Nevertheless, MO and MI contents (in percentage) in leaves were significantly different between

Table 2. Increments (Δ, in cm) in growth of guava plants (*Psidium guajava* L.) with the application of different water levels.

Treatament	ΔTotal high of the plant (cm)	ΔStem high (cm)	ΔCanopy high (cm)	ΔConopy diameters (cm)
1	22	3	19	17
2	24	4	20	34
3	33	4	29	19
4	35	3	32	29

treatments (P<0.05) observing that the group of mineral or ashes as part of the material accumulated in leaves, increased with the increment of the water volume applied (table 3). This response mentions a positive effect on plants though of the little time of evaluation, due to the irrigation increased on the studied conditions specially when compared to plants submitted to the handling of irrigation offered by the producer (T1).

Growth response in weight obeys to a typical curve for this type of evaluations. PSH and PEH (table 4) reduced when a water volume superior to 228 L per plant was applied, being PEH significantly different (P<0.05). This variable was sensitive to changes on the crops handling in relatively short periods, and it mentions higher photosynthetic tissue per area unit (14), related to variations in water levels.

Water levels favor the growth of the plant, which is related to the determinant role that water has on the physiologic processes (14). A reduction on the application or proportion in the crop might affect the vegetative growth due to the tendency of the plant to reduce in the transpiration (12).

A similar tendency in PSH and PEH was seen on plants yield under irrigation, without observing significant differences between treatments (figure 1). Even though of

Table 3. Dry weight of the leaf, ashes percentage and organic matter in guava plants applying different volume of water levels.

Treatament	Average weight of the leaf (g)	Ashes porcentage	Porcentage of organic matter
1	0.56±0.064[a]	6.19±0.20[bc]	93.81±0.20[ab]
2	0.64±0.048[a]	6.31±0.15[c]	93.69±0.15[a]
3	0.65±0.044[a]	6.43±0..25[a]	93.57±0.26[c]
4	0.60±0.029[a]	6.40±0.27[ab]	93.60±0.27[bc]

Mean ± Standard deviation. Jeans test of Tukey (P<0.05). Means with the same letter do not differ statistically.

Table 4. Weight of the leaf (g) (PSH) at 65ºC foliar area (AF) (cm^2) and specific weight of the leaf (PEH) (g cm^{-2}) of guava plants (*Psidium guajava* L.) applying different volume of water levels

Tratamiento	ÁF (cm^2)	PSH	PEH(g cm^{-2})
1	67,53[a]	0,6345[a]	0,0094[b]
2	67,74[a]	0,6810[a]	0,0101[a]
3	66,85[a]	0,6821[a]	0,0102[a]
4	68,32[a]	0,6648[a]	0,0097[ab]

Means with the same setter do not differ statistically. Mean test by Tukey (P<0.05).

the scarce time of application of treatments, yield increased with the increment of the water levels applied, as is expected on this type of evaluations (3, 12, 18, 20, 22), obtaining a production of the evaluated crop's months (November-January), similar to what Añez reported (1) in guava plants with the same age, irrigated by micro-spraying when the same frequency is employed.

The percentage distribution of healthy and sick fruits with different symptoms found in the field, are seen in figure 2. The high rate of incidence of the apical rot has been related to agroecological conditions of the area influencing the type of soil and quality of water (20). Besides these factors, the absence of phytosanitary controls on the agronomical handling of the plot to reduce the effect of MBG and the fruits rot might influence the high percentage of sick fruits obtained in

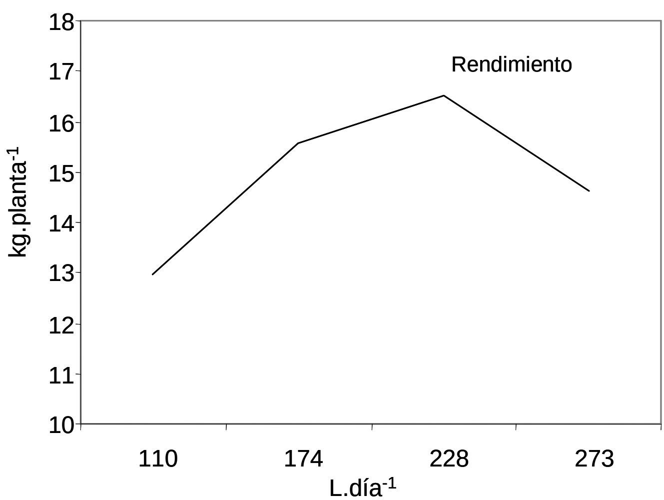

Figura 1. Rendimiento total de plantas de guayabo (kg.planta^{-1}) obtenido variando el volumen de riego.

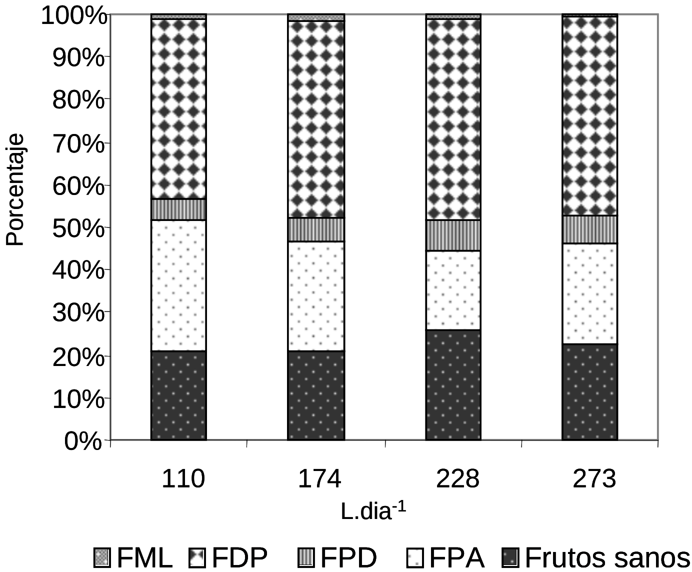

Figura 2. Proporción de frutos sanos y enfermos (FPA: Frutos con pudrición apical; FPD: Frutos con pudrición dura; FDP: Frutos con dos pudriciones, apical y dura; FML: Frutos con mancha lateral) en plantas de guayabo sometidas a la aplicación de diferentes volúmenes de riego

this research. However, the proportion of healthy fruits was slightly higher on treatment 3 agreeing to the behavior observed for some growth variables being studied. It is important to mention that the presence of MBG in fruits indicates an advanced grade of infestation in the plant (8), product, in this case, of lack of controls, a tendency to reduce was observed when increasing the volume of irrigation applied (table 5). When the plant is submitted to stress conditions by any factor, hydrolysis processes are favored which originates a higher availability of proteins, sweets and amino acids of sap (13), from which MBG feeds (8) favoring its development conditions. If the inverse relation were extrapolated to the rest of the plant between magnitude of the phytosanitary affections in fruits and on the water levels, considering that the crop is handled properly, it might be thought that an increased on the application of the latter might contribute to the reduction of these, maybe by disfavoring conditions that propitiated them.

According to the variation of the potential evapotranspiration estimated in the area during the evaluated months, the water levels applied in T3 and T4 is over the net hydric demands estimated of the crop, which offers an explanation to the response observed in plants through the evaluated time and the absence of phytosanitary controls.

Table 5. Total number of fruits per plant (NTF) and of fruits with MBG (NFMBG), in guava plants applying different volumes of water levels

Treatament	NTF	NFMBG
1	146.3	96
2	172.7	85
3	180.0	76
4	174.2	64

Conclusions and recommendations

In most of the studied variables, a curve of typical response was observed for this type of evaluation, even though of the short exposure period to treatments, which suggests that the crop would respond favorably to a remodeling on the irrigation handling employed in the area. Characteristics as PEH, PH and ashes percentage, as well as total yield increased to the application of water, not all showed significant differences though.

It is necessary to keep doing long-term evaluations with the aim of establishing hydric requirements of this crop, which has a huge economical importance in the region, especially by the necessity of the efficient use of available resource as well as the urgent of incrementing the agriculture.

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