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EFFECT OF IRRIGATION DEPTHS ON LEAF PHYSICAL CHARACTERISTICS OF MICROPROPAGATED TORCH GINVER

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1 ABSTRACT

The study aimed to evaluate the effect of five irrigation depths on acclimatization of micropropagated seedlings of Torch Ginger (Etlingera elatior) in a greenhouse. The experiment was conducted in an arch greenhouse. The experimental design was randomized blocks with five treatments and five replicates. The irrigation depths were equivalent to the following percentages of water evaporation in the mini tank (CAE or TE): L25% of CAE (irrigation level corresponding to 25% of CAE), L50% of CAE, L75% of CAE, L100% of CAE, L125% of CAE. The following variables were analyzed: number of leaves (NL), seedling height (SH), shoot dry matter (SDM) and root dry matter (RDM). Data were subjected to ANOVA when significant by the F test at 5% probability level. Quantitative results were subjected to regression analysis. Acclimatization of seedlings of Torch Ginger in a greenhouse should be performed using irrigation water depth corresponding to 100% water evaporation in the mini pan inside the greenhouse.

Keywords: Etlingera elatio, greenhouse, pan evaporation.

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INFLUÊNCIA DE LÂMINAS DE IRRIGAÇÃO NAS CARACTERÍSTICAS FÍSICAS - FOLIARES DO BASTÃO DO IMPERADOR MICROPROPAGADO

2 RESUMO

Este trabalho objetivou testar o efeito de cinco lâminas de irrigação na aclimatização de mudas micropropagadas de bastão do imperador cv. Porcelana, em ambiente protegido. O

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experimento foi conduzido em uma estufa. Os dados relativos à evaporação de água, que serviram de base para a aplicação dos níveis de irrigação, foram obtidos em um mini tanque. O delineamento experimental utilizado foi em blocos ao acaso, composto por cinco tratamentos e cinco repetições. As lâminas testadas foram equivalentes aos seguintes percentuais de evaporação de água no mini tanque (E_{MT}): $L_{25\%}$ da E_{MT} (lâmina a ser aplicada, referente à 25% da evaporação do mini tanque), $L_{50\%}$ da E_{MT}, $L_{75\%}$ da E_{MT}, $L_{100\%}$ da E_{MT}, $L_{125\%}$ da E_{MT}. As variáveis analisadas foram o número de folhas (NF), a altura da muda (AM), a massa seca da parte aérea (MSPA) e a massa seca do sistema radicular (MSSR). Os dados foram submetidos à ANOVA, quando significativo pelo teste F ao nível de 5% de probabilidade. Os resultados quantitativos foram submetidos à análise de regressão. Concluiu-se que a aclimatização de mudas de bastão do imperador cv. Porcelana, em ambiente protegido, deve ser realizada com a lâmina de irrigação correspondente a 100% da evaporação de água do mini tanque instalado no interior do ambiente protegido.

Palavras-chave: *Etlingera elatio.* cultivo protegido, mini tanque.

3 INTRODUCTION

Flower farming has started to spread and expand quickly in the Northeastern region of Brazil, due mainly to incentives to this agronomic production and market expansion. The market for tropical flowers in northeastern Brazil is growing, mainly due to adequate climate, availability of land, water, energy and manpower. There is also that the main consuming regions are in the developed countries, without weather as adequate or land as readily available, making thus possible the Northeastern region of Brazil to produce higher quality at a lower cost, allowing more competitive prices (LOGES et al., 2005). The production of flowers and ornamental plants in the Brazilian Northeast is concentrated mainly in the states of Pernambuco, Bahia, Ceará and Alagoas. The main species of tropical flowers grown in Brazil belong to the family Araceae, Heliconiaceae, Musaceae and Zingiberaceae, which vegetate naturally and are explored in conventional plantations, being characterized by flowers of exotic beauty, colors and shapes, hardiness and post- harvest durability. (ASSIS et al., 2002). The Torch Ginger (*Etlingera elatior*), zingiberaceae family, originally from Malaysia, cultivated for many years in the Northeast region, still not well-known in the market, but with great potential, especially as cut flower. The seedlings are usually obtained by division of clumps or by seed, but this practice can lead to sanitary problems, including the spread of causative agents of diseases each crop cycle, which can be transmitted between successive plantings (BEZERRA; LOGES, 2005). Because of the growing market of ornamental plants, there is a need for improved seedlings, both in quality and quantity, for which micropropagation can be a viable alternative to promote vegetative propagation. This propagation would begin by obtaining plants with high health status and genetic stability, and proceed with preparation of the mother plant, isolation, multiplication, rooting and acclimatization. Acclimatization is the stage at which the plant is transferred from the laboratory (in vitro) for the cultivation environment (ex vitro). The transfer of a totally controlled environment, aseptic, rich in nutrients and with high humidity for an uncontrolled environment, septic and with low humidity, can lead to plant loss, low growth rate and prolonged acclimatization interval. Therefore, acclimatization is a critical step and represents, in many cases, the main obstacle to the micropropagation of many species. In addition, several factors can influence the acclimatization of micropropagated plants, such as irrigation management. In fact, the amount of irrigation water and frequency of irrigation are key factors in the establishment and proper development of seedlings. The observation (of the factors affecting survival and vegetative growth) during the acclimatization of the seedlings, is of fundamental important for the production of seedlings on a large scale, besides serving as a reference for the market for flowers and ornamental plants, which is constantly expanding. Therefore, the aim this work consists in the analysis of the acclimatization of Torch Ginger (Porcelana cultivar) seedlings, in a protected environment under different irrigation levels.

4 MATERIAL AND METHODS

This work was conducted in a protected environment, belonging to the Embrapa Tropical (CNPAT). The area is located in Fortaleza, Ceará, with geographical coordinates corresponding to 3° 44' south latitude, 38° 33' west longitude and 19.5 m high. According to the Köppen climate classification, the climate is type Aw', characterized as tropical rainy climate. Inside the greenhouse, the average monthly temperature and relative humidity, solar radiation and wind speed at 2 m height were 26 °C, 76%, 1.140 Wm^{-2}, and 3,2 ms^{-1}, respectively.

The experiment was conducted in an 'arched ceiling' greenhouse, with east-west orientation, 24 m long, 6,5 m wide and with ceiling 2,5 m high and 4 m high central, covering an area of 156 m². The entire structure was covered with two screens, one shaded to reduce the sunlight by 70% and a clear plastic for protection from weather. Inside the greenhouse, a semi-circular tunnel was built, with a height of 1,80 m, 4,70 m long and 0,92 m wide, covered by a transparent screen to protect the plants, partly against weather, but mainly against pests. The seedlings of the Torch ginger (*Etlingera elatior*) Porcelana cv. were obtained through the micropropagation process, conducted at the Laboratory of Tissue Culture and Plant Genetics of the Embrapa Tropical. The explants (microcuttings) were inoculated in transparent glass vials in laminar flow hood under aseptic conditions, capacity 250 mL, containing 30 mL of MS medium (MURASHIGE; SKOOG, 1962), kept in a growth room under a light intensity of 30 $\mu mol\ m^{-2}s^{-1}$ and with temperature of 24 ± 2 ° C.

The micropropagated Torch ginger seedlings were transplanted to their respective substractes on the 45th day after micropropagation. At the time of transplanting, the seedlings were completely rooted and with heights ranging from 4 to 6 cm. Seedlings from the in vitro material were removed from the vials and their roots washed in running water to remove excess culture medium. After washing, the seedlings were placed in trays with paper towels, where the roots of the seedlings were pruned, with the objective of standardizing the material, facilitate the planting and stimulate the growth of root system. They were then packed in trays with wet paper towel, brought to the greenhouse and planted in a uniform depth, so that the roots were buried up to the neck of the plant. Before transplanting, the containers containing substrates were irrigated in order to promote a favorable environment for seedling growth. After transplanting, water was sprayed to increase relative humidity. After the first week, the seedlings received a mineral supplement containing 5 mL leaf mineral fertilizer (Biofert) per liter of water, with this dosage repeated every 15 days. During the experiment, pesticides were sprayed, as a preventive against pests and diseases, and weeds were cleaned from the area surrounding the experiment. Irrigation was initiated soon after transplanting, being held until the evaporation of water, measured in the mini tank, reached the value greater than or equal to 4 mm, a value reached, on average, every two days (irrigation frequency). Irrigation was performed at 9 am. Data on the evaporation of water, which served as the basis for irrigation levels were obtained in a mini tank with 0,60 m diameter, 0,25 m deep, containing a still well 0,25 m high, with 0,10 m diameter, mounted on a square wooden platform 0,15 m high and with 0,60 m side length. The effects of five irrigation levels in the acclimatization of micropropagated Torch ginger seedlings were tested. The experimental design was randomized blocks (5 blocks), consisting of five treatments and five repetitions. The levels tested (treatments) were equivalent to the following percentages of evaporated water in the Class A Pan (E_{CA}): $L_{25\%}$ of the E_{CA} (Irrigation level, 25% of the evaporation of mini tank), $L_{50\%}$ of the E_{CA}, $L_{75\%}$ of the E_{CA}, $L_{100\%}$ of the E_{CA}, $L_{125\%}$ of the E_{CA}. From the 31th DAT (day after transplanting) the irrigation management was diversified, based the irrigation levels (or treatments) equivalent to 25%, 50%, 75%, 100% and 125% of E_{CA}. The different irrigation levels were applied manually, using a 10 liter plastic watering can and a graduated cylinder.

Each block consisted of five rows of six plants each. For each treatment, 30 functional seedlings were used, plus 12 surrounding seedlings, providing a functional total of 150 seedlings in the experiment. The seedlings were placed in tubes (of 300cm^3) containing the substrate, on the bench. The first data collection was performed on transplanting, considered as the starting point of the experiment. While the study was underway, data were collected on the number of leaves (NL) and seedling height (SH). The number of leaves was counted (visually) all over the plant. All leaves were taken into account, except the dry ones.

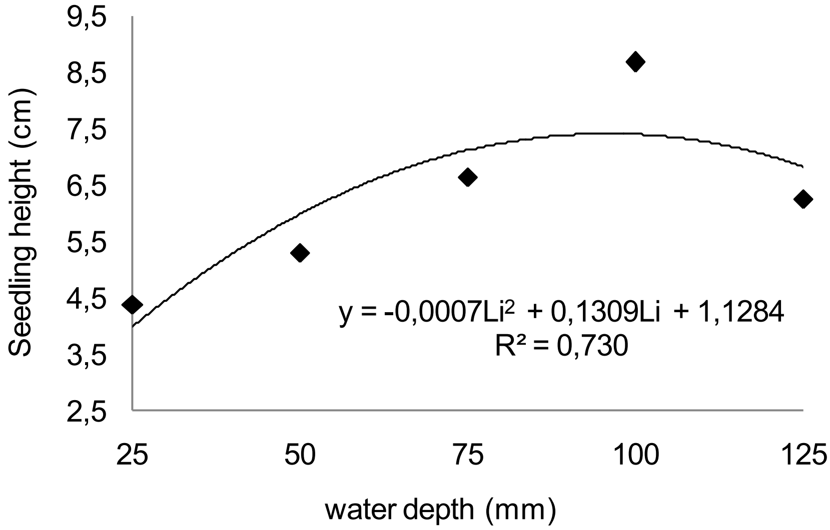
The height of the seedling was measured with the aid of a caliper from the base to the point of insertion of the last leaf. Data for both variables: number of leaves (NL) and seedling height (SH) were also collected on two other occasions: the 31th day after transplanting (DAT) and the 50th DAT. Upon completion of the experiments, the seedlings were taken to the Laboratory of Tissue Culture and Plant Genetics Embrapa Tropical, where they were washed to remove the remaining substrate from the roots. Subsequently, the materials were packed in paper bags, properly identified and taken to a greenhouse with forced air circulation, temperature of 70 °C for 72 hours until their weight stabilized. Then the materials were weighed to obtain dry shoot mass (DSM) and dry root mass (DRM). Then, all data were subjected to analysis of variance and, when found significant, subjected to the F test at 5% level of probability. The results of a quantitative nature (irrigation levels) were submitted to regression analysis. Statistical analysis was performed with the aid of the application SAEG 9.0 - UFV.

5 RESULTS AND DISCUSSION

The total evaporation of water from the mini tank installed inside the greenhouse and from the Class "A" mini pan installed at the Meteorological Station of the Federal University of Ceará, during the 20 days in which the (irrigation level) treatments were tested, were 50,45mm and 134,30 mm, respectively.

During the period of differentiation of treatments, from 31th DAT to 50th DAT, the irrigation treatments corresponding to $L_{25\%}$ of the E_{CA} (Irrigation level, 25% of the evaporation of Class A mini Pan), $L_{50\%}$ of the E_{CA} , $L_{75\%}$ of the E_{CA}, $L_{100\%}$ of the E_{CA}, $L_{125\%}$ of the E_{CA} were 12,61 , 25,23, 37,84, 50,45 and 63,06 mm, respectively. From the regression analysis it was found that the second order polynomial model, with R^2 = 0,73, was the one which best correlated the height of the seedlings with the irrigation level. According to the equation obtained (Figure 1), the irrigation that provided the largest Shoot height (SH) (7,25 cm) corresponded to 93,5% of E_{CA}. Note that the irrigation levels, lower than the level that provided the largest shoot height, did not provide adequate water supply to the seedlings.

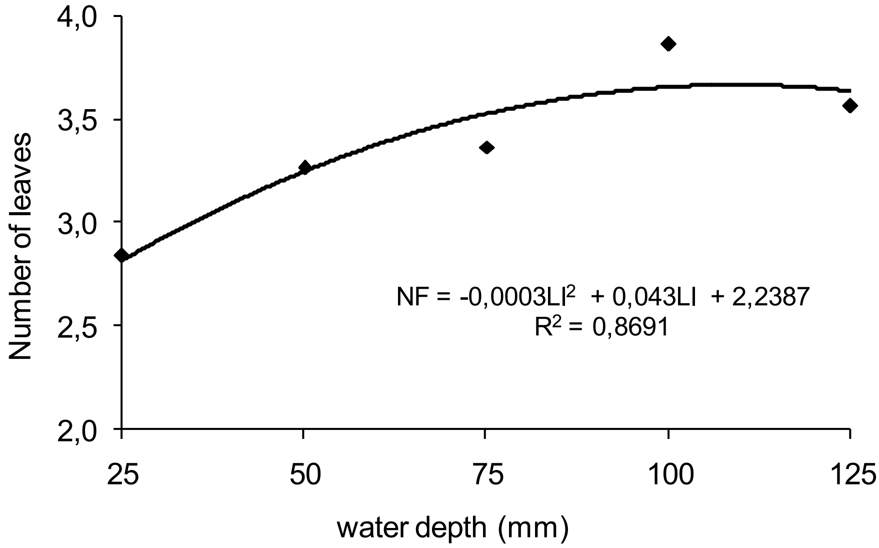
Figure 1. Seedling height (AM) of torch ginger as a function of water depth (Li), postharvest.



Note also that even higher levels, because of applying excessive water, causing a lower aeration, affected adversely the seedling growth. Dobashi et al. (1998) evaluated the effect of different levels of water stress (40, 60, 80 and 100% of water consumed) on the culture of Snapdragon (*Antirrihimum majus*), concluding that the highest irrigation level applied, which corresponded to the full replacement of consumed water (100%), provided the biggest and best inflorescences. From the regression analysis of the NL (number of leaves) as a function of irrigation level, it was found that the model that best fitted the data was the 2nd order polynomial presenting a coefficient of determination (R^2) of 0,87.

According to the regression, equation obtained (Figure 2), the irrigation level that provided the greatest number of leaves (3,67) corresponded to 109,42% E_{CA}.

Figure 2. Number of leaves (NL) seedlings torch ginger as a function of water depth (Li), postharvest.



It is observed that the levels above and below that enhanced growth caused a reduction in the number of leaves, possibly due to deficit and excess water, respectively. According to Raven et al. (2001 apud ROCHA, 2007), the excess water affect the processes of photosynthesis and respiration, decreasing the development of plants, explaining the decrease in growth as the volume of applied water increases beyond the optimum irrigation level (the level that corresponds to the maximum seedling height). Being the water a limiting factor for the development of the plant, both excess and scarcity can affect the growth, health and production of the same plant. According to Miranda e Pires (2001), the correct way to keep an adequate irrigation status of plants is through proper irrigation management.

As shown in Figures 3 and 4, the results of the regression analysis in function of the dry shoot weight (DSW) and Dry Root Mass (DRM), respectively.

Figure 3. Shoot dry mass (SDM) of the torch ginger plants according to water depth (Li).

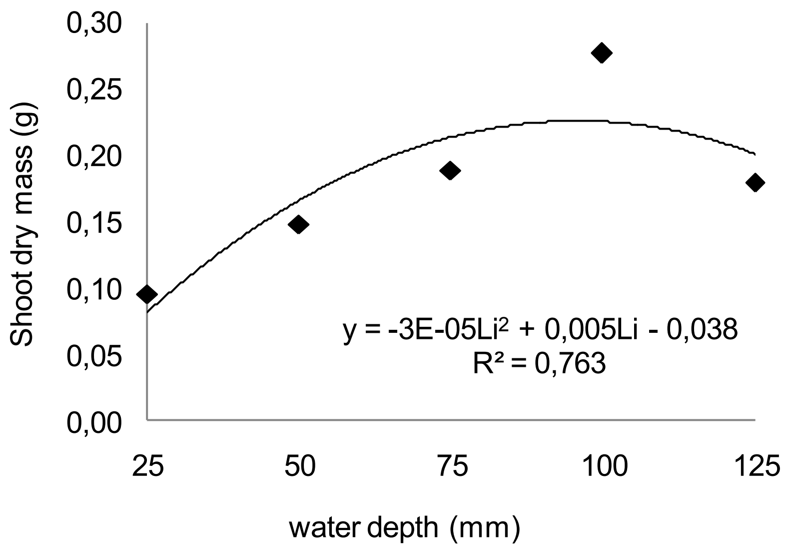
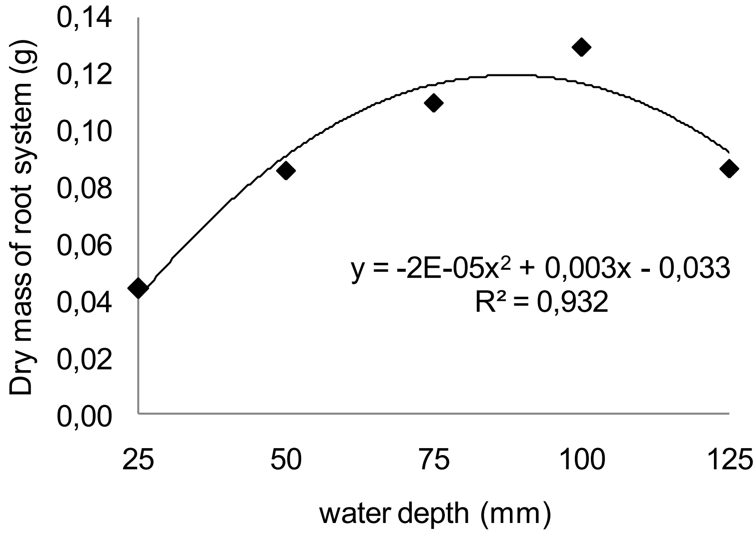


Figure 4. Dry mass of root system (MSSR) seedlings of the torch ginger as a function of water depth (Li).



The 2nd order polynomial model was the one that best fit the data, with R^2 of 0,76 and 0,93 respectively. According to the regression equation obtained, the level corresponding to 91,67% of E_{CA}, was that provided the greatest amount of dry shoot mass (DSM, 0,21 g). As for the DRM, according to the equation obtained, the level equating 87,50% of E_{CA}, corresponded to the highest DRM value (0,12 g). Moreover, until these percentages, the relationship between the variables and the water depth was direct and growing. Azevedo et al. (2005) evaluated the effect of different irrigation when acclimatizing seedlings of ornamental pineapple, found that there was a increasing response of the dry root weight with increasing irrigation level, ie, the greater amount of water applied, the higher the dry root mass of the culture. Similar behavior was observed by Sindeaux et al. (2009), when the seedlings acclimatizing micropropagated Pacovan banana (Musa spp.) seedlings in the coastal region of Ceará (Brazil), testing irrigation levels identical to those evaluated in this experiment, and found a higher growth of both the dry shoot mass and dry root mass with increasing irrigation level. Galbiatti et al. (2005), evaluating the effect of three irrigation levels (50, 100 and 150% of Class A pan evaporation) in the initial growth of seedlings of citrus (Citrus limon and Citrus volkameriana), grown in a greenhouse and under the climatic conditions of Jaboticabal (State of São Paulo, Brazil) also observed that the species Citrus limonia had higher dry root mass and dry shoot mass, when subjected to higher irrigation level.

6 CONCLUSIONS

The acclimatization of seedlings of Torch ginger, (cv Porcelana) in protected environment should be performed with the irrigation level corresponding to 100% of water evaporation measured from the Mini tank installed inside the protected environment.

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