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Shading levels in the development of dragon fruit (pitaya) nurseries

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ABSTRACT

The objective of this work was to evaluate the rooting and sprouting of pitaya (*Hylocereus undatus*) cuttings under different shading levels. Shades obtained by screen were: 37.8%, 49.6%, 86.3%, and under the sun. The following characteristics were analyzed: cuttings survival (%), shooting (%), number of shoots, shoots average length (cm), shoots dry matter (g), rooted cuttings (%), root average length (cm), root volume (mL), root dry matter (g), and chlorophyll concentration a and b (mg g^{-1}). Survival percentage means were between 90 and 100%. Responses for shooting and shoots dry matter were quadratic, with maximum point at 23.48% and 42.7 % of shading, respectively. In regards to cuttings rooting, means were between 80 and 95%. Root volume and root dry matter showed linear reduction according to shading level. Chlorophyll contents a and b showed linear increase in function o shading level. Partial shading (between 23 and 42%) increased the percentage of cuttings with shoots, the accumulation of dry matter on them, and affected volume and dry matter accumulation on roots in pitaya nurseries propagated by cuttings.

Key words: Cactaceae, chlorophyll, *Hylocereus undatus*, cutting.

INTRODUCTION

Article

The pitaya or dragon fruit is a perennial plant that presents epiphytic habit with adventitious roots that help nutrients acquisition and fixing. Cladodes are triangular, juicy and constituted of small thorns of 2 to 4 mm wide. The flower is hermaphrodite, white and nocturnal anthesis (Donadio 2009; Silva et al., 2011). Some fruit of pitaya species have been well accepted for commercialization, especially the *Hylocereus undatus*, an oblong fruit; red peel; white pulp; nice flavor, slightly sweet, with lots of tiny black seeds (Donadio 2009; Mizrahi et al., 1997).

The propagation of this species can be done in a vegetative way or by seeds, being the latter more convenient for genetic breeding programs (Andrade et al., 2008) and to collect materials with distinct genetic characteristics that can be explored in new hybridizations or selection processes. However, when orchards of superior quality is desired, pitaya propagation is commonly done by cuttings of previously selected materials.

Seedlings production from cuttings is one of the most important cloning methods used in fruit culture, since it promotes the fixation **of** selected genotypes, population uniformity, easy propagation, flowering period anticipation, juvenile stadia reduction and greater control of the development phases (Franco et al., 2007). Pitaya plants originated from this method start flowering one or two years after the cuttings rooting. In addition to early production, propagation by cuttings of whole or segmented cladodes has been the most recommended from a practical standpoint (Andrade et al., 2007; Marques et al., 2012).

It is known that cutting rooting is influenced by internal factors such as physiological condition, mother plant age, type of cutting and hormonal balance plus external factors such as temperature, substrate type, humidity and luminosity (Fachinello et al., 2005; Hartmann et al., 2011). According to Bir and Bilderback (2013), plants formed by cuttings are commonly produced under shades that vary from 25 to 70%, being 50% the most common level, since the direct exposure to the sun can damage the cuttings, affecting their rooting.

The presence of light during cutting rooting may favor the emission and development of the root system due to the photosynthesis realized in the period. However, the light can degrade the plants’ pre-existing auxins, being these auxins hormones with greater effect on the development of cutting roots (Fachinello et al., 2005; Hartmann et al., 2011).

Considering that light and its intensities affect the rooting process of cuttings, it is important to determine the best shading conditions to obtain best quality seedlings. Therefore, the objective of this work was to evaluate pitaya cuttings rooting and shooting under different shading levels.

MATERIALS AND METHODS

The work was carried out between the months of May and September, 2013, at the Londrina State University (UEL) Plant Science sector, located at 23º 23' S and 51º 11' W, average altitude of 560 m and climate of the Cfa type, humid subtropical, according to the Köppen classification.

Cuttings originated from intermediate segments of cladodes of pitaya (*Hylocereus undatus*) mother plants from the UEL school farm. They were 20 cm long and treated with indolebutyric acid (IBA), 3000 mg L^{-1}, under fast immersion (10 seconds), and then placed in 1.5 L plastic pots, using vermiculite of average granulation as substrate.

Pots were displayed on a 4 x 1 m worktop, divided into four regions, each one covered with a commercial black plastic screen (Sombrite®), with 25, 50 and 75% of light retention and an area without coverage (Figure 1). The worktop was installed in the north-south position, in relation to the greater axis, to prevent auto-shading interference between treatments. Watering took place whenever the substrate saturation was lower than 70%, irrigating it until reaching 80%. The methodology described by Kämpf et al. (2006) was used to determine saturation.

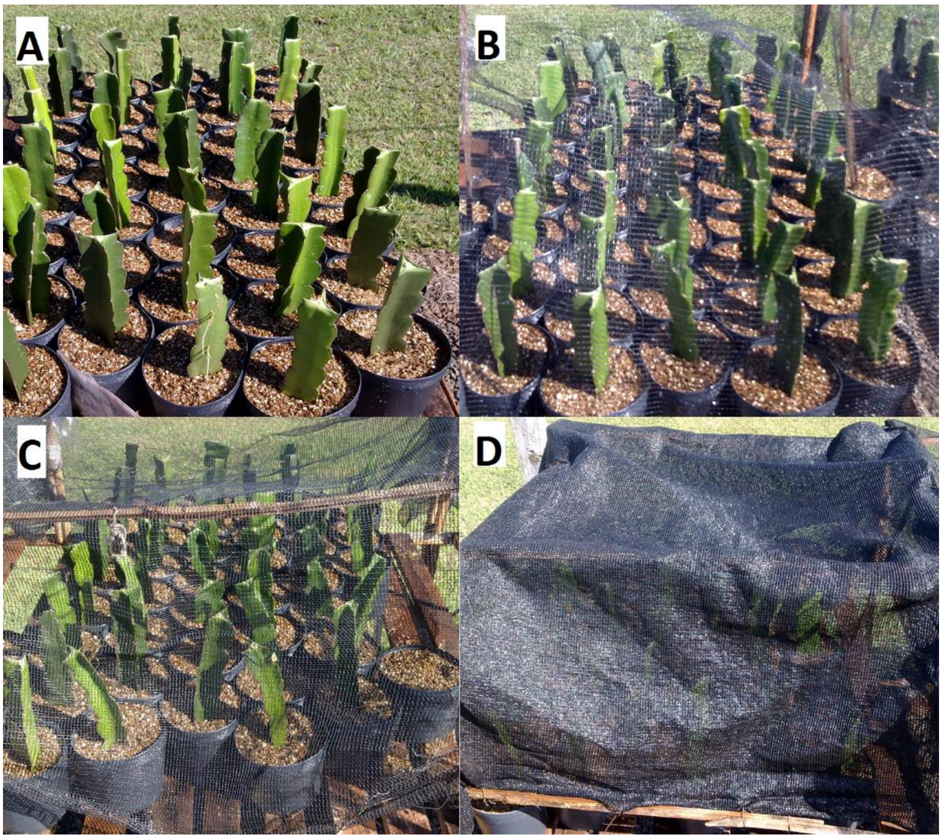

Figure 1. Pitaya (*Hylocereus undatus*) cuttings under different shading levels: A- 0%; B- 37.8%; C- 49.6%; and D- 86.3%, obtained with the use of plastic screens (Sombrite®).

Shading real level was evaluated in tem randomized points from each studied region with the help of a luximeter (light meter) (Instrutherm, model LD-240). Shading average values obtained under screens of 25, 50 and 75% of light retention were 37.8 $\pm$3.0; 49.6 $\pm$5.2; 86.3 $\pm$3.7%, respectively. Average, minimum, maximum and air relative humidity were registered by digital gauge (Data logger HT500), installed in each region which delimited treatments. Rain registration was obtained by a graded pluviometer (Figure 2).

An entirely randomized design was adopted, with 4 replications and 10 cuttings per plot. The following characteristics were evaluated: cuttings survival (%); shooting (%); number of shoots; shoots average length (cm); shoot dry matter (g); rooted cuttings (%); roots average length (cm); root volume (mL), using the test tube/beaker method; roots dry matter(g) and chlorophyll concentration *a* and *b* (mg g^{-1}).

Chlorophyll determination was built on four disks of 0.9 cm of diameter, from each replication of randomized plants. Chlorophyll extraction and its determination were realized according to Arnon (1949) and Dere et al. (1998). The following formulas were used: for chlorophyll *a*:

$Ca = 11.75\ A_{662} – 2.350\ A_{645}$;

For chlorophyll *b*:

$Cb = 18.61\ A_{645} – 3.960\ A_{662}$,

where: A_{645} is the absorbance value in 645 nm and A_{662} is the absorbance value in 662 nm.

Data were submitted to an analysis of variance followed by a regression analysis in function of the shading average values obtained from the luximeter (light meter) measurements.

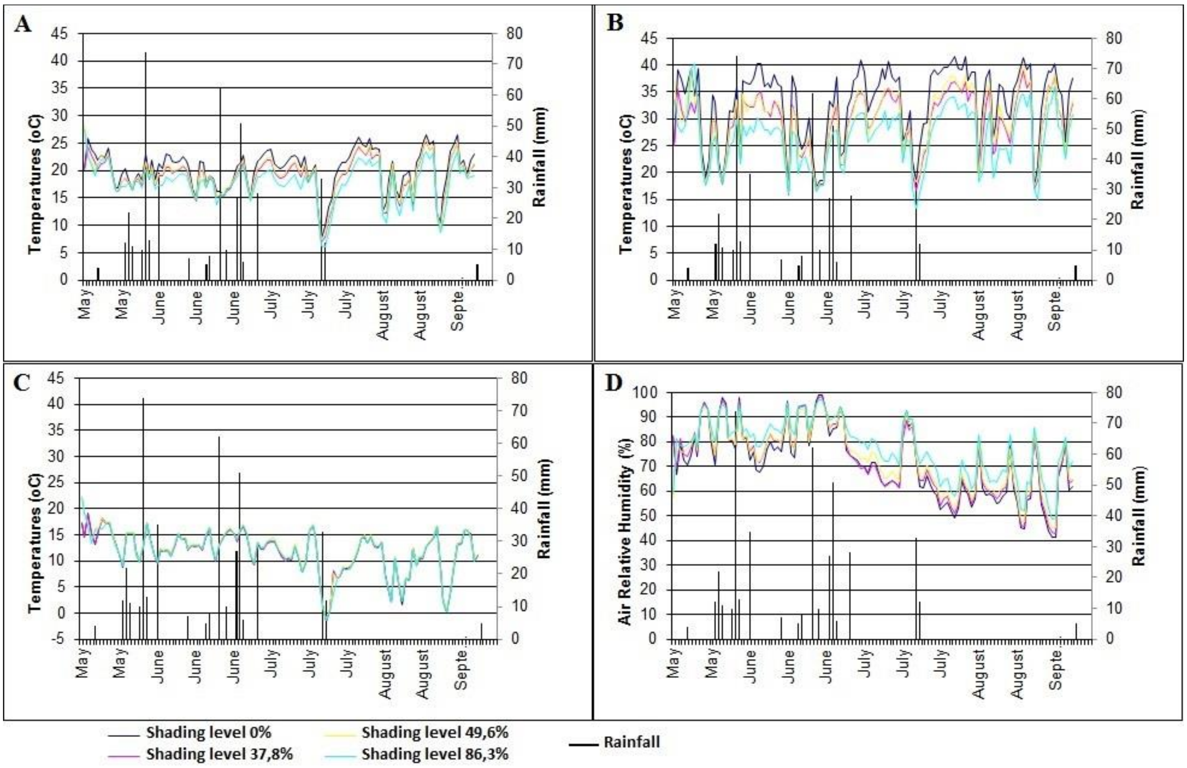

Figure 2. Average (A), maximum (B) and minimum (C) temperatures, (D) air relative humidity and rainfall (mm) under different shading levels (0; 37.8; 49.6; 86.3%), from May 10 to September 7, 2013. Londrina, PR, Brazil.

RESULTS AND DISCUSSION

Survival percentage means were between 90 and 100% among the different shading levels; however, there was no significant difference for this variable (Figure 3).

Shading at 86.3% promoted inferior maximum and minimum temperatures than the other levels, being the highest levels observed for under the sun direct exposition. However, for the minimum temperature, there was low interference of the shading screen. Shading at 86.3% maintained the highest humidity, mainly in relation to under the sun (Figure 2). Highest humidity level can prevent cutting dehydration and death thus helping its development. According to Fachinello et al. (2005), water loss is one of the main causes of fruit tree cuttings death. However, the present work showed no significant difference in relation to survival among the different shading levels. This finding could be related to the fact that the studied species is a cactus, with great resistance to dehydration, due to the high water content stored in its parenchymal tissue, reduced evapotranspiration surface and CAM (Crassulacean Acid Metabolism) photosynthetic system. According to Taiz and Zeiger (2009), plants with the CAM system show stomatal opening at night, when temperatures are milder, losing less water. The CO_2 enters through the stomatal opening and is fixed in organic acid to be reconverted into CO_2 during the day. As for shoots percentage, the answer was quadratic with the maximum point at 23.48% of shading. In regards to shoots dry matter, the quadratic answer with the maximum point was at 42.7% of shading. However, for number of shoots, there was a linear reduction according to the increase in shading level and no significant difference for shoot length (Figure 3). These results show no shoots etiolation even in higher shading (86.3%), with more accumulation of dry matter with partial shading. According to Barber and Anderson (1992), excessive light, above the photosynthesis use capacity, may result in a stress condition known as photosynthesis photoinhibition, reducing the efficiency of this process and, consequently, the matter incorporation by plants.

According to Taiz and Zeiger (2009), the light may degrade the auxin, reducing its concentration in the vegetal tissue. Thus, in shaded environments, the tissue may present higher auxin concentration, which inhibits the development of lateral buds, explaining the linear reduction in shoots according to the increase in shading level.

In regards to cuttings rooting, means were between 80 and 95%; however, there was no significant difference among values. As for root average length, there was an increase in values according to the increase in shading level. However, this increase did not reflect on the increase in root volume and root dry matter characteristics values, which showed linear reduction according to the increase in shading level (Figure 4). Lone et al. (2009) also observed less accumulation of root dry matter and aerial part at 75% of shading, in relation to under the sun and 20% for the cactus species *Melocactus bahiensis*. According to Grime (1977) and Carvalho (1996), plants, reacting to little light, produce less dry matter and retain photoassimilates in the aerial part, with less accumulation in the root

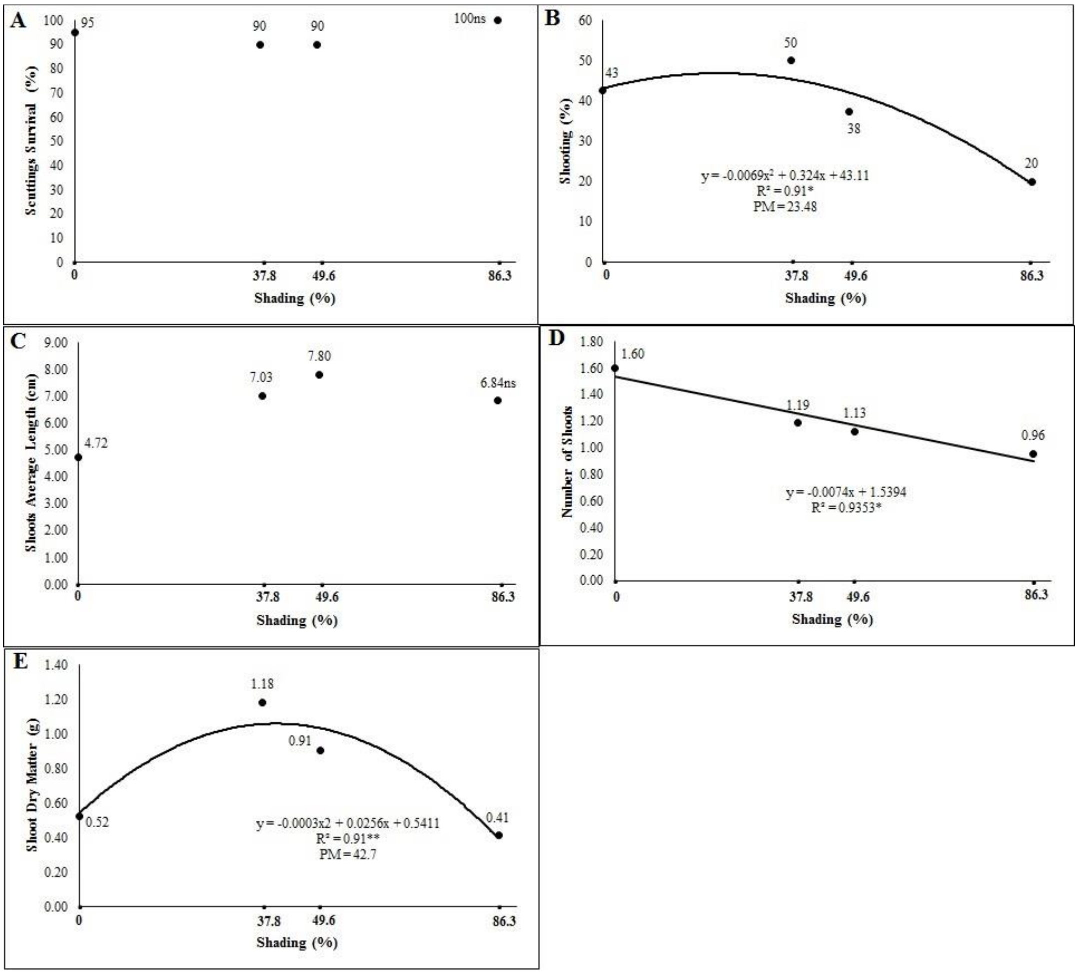

Figure 3. (A) cuttings survival (%), (B) shooting (%), (C) shoot length (cm), (D) number of shoots and (E) shoot dry matter (g) of pitaya (*Hylocereus undatus*) under different shading levels (0; 37.8; 49.6; 86.3%). ** Significant at 1%. *Significant at 5%. Ns: non-significant. PM: Maximum point. Londrina, PR, Brazil (2013).

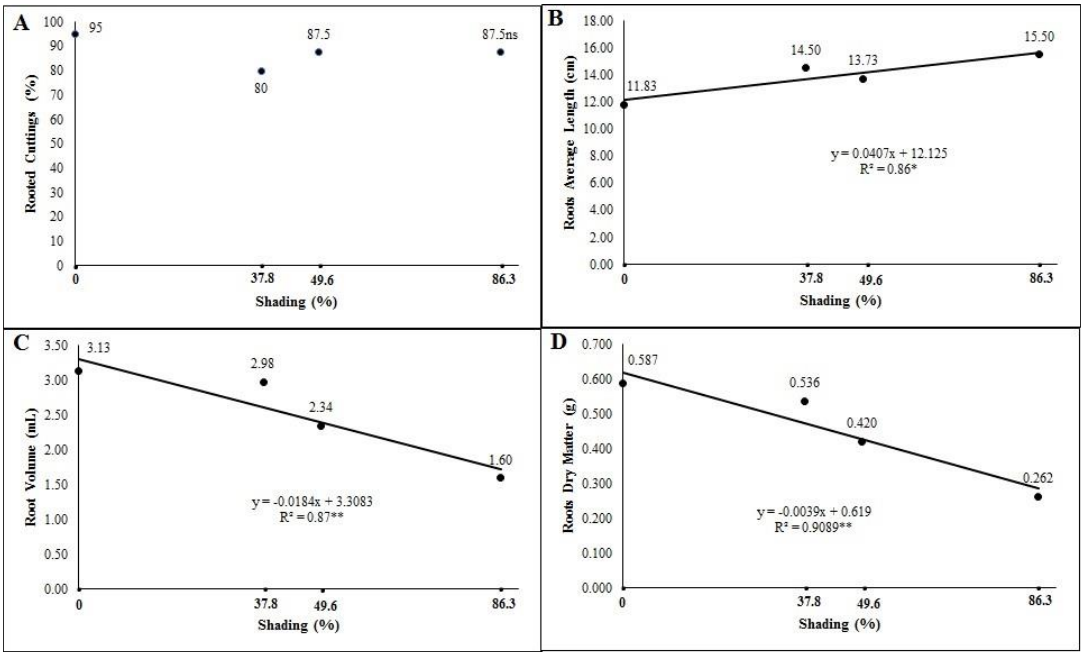

Figure 4. (A) Rooted cuttings (%), (B) average root length (cm), (C) root volume (mL) and (D) root dry matter (g) of pitaya (*Hylocereus undatus*) under different shading levels (0; 37.8; 49.6; 86.3%). ** Significant at 1%. *Significant at 5%. Ns: non - significant. Londrina, PR, Brazil (2013).

Chlorophyll contents *a* and *b* showed a linear increase in function of shading level (Figure 5). Similar result was found by Engel and Poggiane (1991) in cherry tree (*Amburana cearensis*), ipê-felpudo (*Zeyhera tuberculosa*), purple poui (*Tabebuia avellanedae*) and suinã (*Erythrina speciosa*) and por Zanella et al. (2006) in passion fruit (*Passiflora edulis*). The increase of chlorophyll in a shaded environment takes place to maximize the capture of light for the photosynthetic process

Although shading reduces the number of shoots per cutting and root average length, partial shading (between 23 and 42%) increases the percentage of cuttings with shoots, the accumulation of dry matter in them and affects volume and the accumulation of dry matter in the roots.

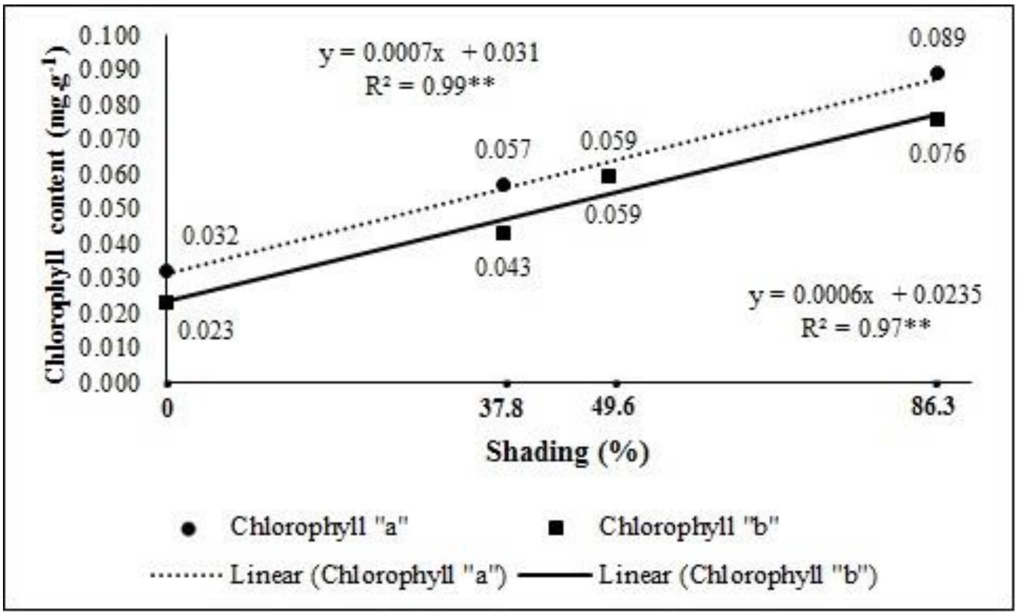

Figure 5. Chlorophyll content *a* and *b* ($mg.g^{-1}$) in pitaya (*Hylocereus undatus*) under different shading levels (0; 37.8; 49.6; 86.3%). ** Significant at 1%. Londrina, PR, Brazil (2013).

CONCLUSION

Partial shading (between 23 and 42%) increases the percentage of cuttings with shoots, the accumulation of dry matter in them, and affects the volume and the accumulation of dry matter in the roots of pitaya nurseries (*Hylocereus undatus*) propagated by cutting.

REFERENCES

Andrade RA, Martins ABG and Silva MTH (2007) Influência da fonte e do tempo de cura na propagação vegetativa da pitaia vermelha (*Hylocereus undatus* Haw.). Revista Brasileira de Fruticultura 29: 183-186.

Andrade RA, Oliveira IVM, Silva MTH and Martins ABG (2008) Germinação de pitaya em diferentes substratos. Revista Caatinga 21: 71-75.

Arnon DI (1949) Copper enzymes in isolated chloroplasts - polyphenoloxidase in *Beta vulgaris*. Plant Physiology 24: 1-15.

Barber J and Anderson B (1992) Too much of a good thing: light can be bad for photosynthesis. Trends in Biochemical Sciences 17: 61-66.

Bir D and Bilderback T (2013) Rooting for you: plant propagation with stem cuttings. http://plantpropagationmistingsystem.com/Members_area_PDFs/rooting_4_you.pdf. Accessed 15 november 2016.

Carvalho PER (1996) Influência da intensidade luminosa e do substrato no crescimento, no conteúdo de clorofila e na fotossíntese de *Cabralea canjerana* (Vell.) Mart. subsp. canjerana, *Calophyllum brasiliense* Amb. e *Centrolobium robustum* (Vell.) Mart. Ex Benth. Tese, Universidade Federal do Paraná.

Dere S, Günes T and Sivaci R (1998) Spectrophotometric determination of chlorophyll - A, B and total carotenoid contents of some algae species using different solvents. Journal of Botany 22: 13-17.

Donadio LC (2009) Pitaya. Revista Brasileira de Fruticultura 31(3): 637.

Engel VL and Poggiani F (1991) Estudo da concentração de clorofila nas folhas e seu espectro de absorção de luz em função do sombreamento em mudas de quatro espécies florestais nativas. Revista Brasileira de Fisiologia Vegetal 3: 39-45.

Fachinello JC, Hoffmann A and Nachtigal JC (2005) Propagação de plantas frutíferas. EMBRAPA, Brasília, 221p.

Franco D, Oliveira IVM, Cavalcante ÍHL, Cerri PE and Martins ABG (2007) Estaquia como processo de clonagem do Bacuri (*Redhia garderiana* Miers ex Planch e Triana). Revista Brasileira de Fruticultura 29: 176-178.

Grime JP (1977) Evidence for the existence of three primary strategies and plants and its relevance to ecological and evolutionary theory. The American Naturalist 111: 1169-1194.

Hartmann HT, Kester DE, Davies Júnior FT and Geneve RL (2011) Plant propagation: principles and practices. Prentice Hall, New Jersey, 915p.

Kämpf NA, Takane RJ and Siqueira PTV (2006) Floricultura: Técnicas de preparo de substratos. LK Editora, Brasília, 132p.

Lone AB, Takahashi LSA, Faria RT and Destro D (2009) Desenvolvimento vegetativo de *Melocactus bahiensis* (Cactaceae) sob diferentes níveis de sombreamento. Revista Ceres 56: 199-203.

Marques VB, Moreira RA, Ramos JD, Araújo NA and Cruz MCM (2012) Porções de cladódios e substratos na produção de mudas de pitaia vermelha. Revista Agrarian 5(17): 193-197.

Mizrahi YA, Nerd A and Nobel PS (1997) Cacti as crops. Horticultural Review 18: 291-320.

Silva ACC, Martins ABG and Cavallari LL (2011) Qualidade de frutos de pitaya em função da época de polinização, da fonte de pólen e da coloração da cobertura. Revista Brasileira de Fruticultura 33(4): 1162-1168.

Taiz L and Zeiger E (2009) Fisiologia vegetal. 4. ed. Artmed, Porto Alegre, 819p.

Zanella F, Soncela R and Lima ALS (2006) Formação de mudas de Maracujazeiro "amarelo" sob níveis de sombreamento em Ji-Paparná/RO. Ciência e Agrotecnologia 30: 880-884.

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