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Incisions on cladode the Pitaya Red of white pulp to promote the rooting

Incisões em cladódios de Pitaia Vermelha de polpa branca para promover o enraizamento

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Abstract
The objective of this work was to study different types of incisions in white pulp pitaya cladodes to promote and anticipate rooting in the formation of seedlings. The collection of cladodes was carried out in clones of pitaya matrix plants. The treatments were: T1 = incision perpendicular to cut (control), T2 = incision bevel, 45º, T3 = removal of 1/3 until reaching the main axis of the cladode (pericycle), T4 = perpendicular incision of 1/3 on three sides of the cladode, T5 = without incision. The different incisions made at the base of the cladode provide a high percentage of rooting. Incisions can be used to obtain a more efficient root system.

Keywords: Vegetative propagation; cutting; *Hylocereus undatus*.

Resumo
O objetivo deste trabalho foi estudar diferentes tipos de incisões em cladódios de pitaia de polpa branca para promover e antecipar o enraizamento na formação de mudas. A coleta de cladódios foi realizada em clones de plantas matrizes de pitaia. Sendo os tratamentos: T1 = incisão perpendicular ao corte (controle), T2 = bisel incisão, 45º, T3 = remoção de 1/3 até atingir o eixo principal do cladódio (periciclo), T4 = incisão perpendicular de 1/3 nos três lados do cladódio, T5 = sem incisão. As diferentes incisões feitas na base do cladódio fornecem alta porcentagem de enraizamento. Incisões podem ser usadas para obter um sistema radicular mais eficiente.

Palavras-chave: propagação vegetativa, estaquia, *Hylocereus undatus*

Introduction

The white pulp pitaya [*Hylocereus undatus* (Haworth) Britton & Rose] is a native cactus from Latin America, probably from Mexico and Colombia, and is now widely distributed in tropical and subtropical regions (LE BELLEC *et al*., 2006).

Among the main existing species, the white pulp pitaya [*Hylocereus undatus* (Haw.) Britton & Rose] and Costa Rican pitaya (*Hylocereus polyrhizus and [Hylocereus costaricensis (F. A. C. Weber)* Britton & Rose] are those that stand out commercially (GALVÃO, 2015). Its expansion in the exotic fruit market has been increasing due to its appearance as well as its organoleptic characteristics (MORAES, 2015).

The propagation and formation of pitaya plants are done mostly using cuttings. This propagation method allows using whole cladodes or segments and has as advantages: earliness in the production, practicality, uniformity in its cultivation and its flowering occurs one or two years after planting (GALVÃO, 2015).

Typically, cladodes from 25 to 40 cm long are used for the formation of seedlings (MIZRAHI *et al*., 2002). Some factors may influence this propagation method, such as genotype, plant physiological conditions, cutting type and environmental conditions (FRANCO *et al*., 2007).

For Hartmann *et al*., (2002), some techniques can be used in the rooting of cladodes, including the mechanical injury, which consists of incisions (wounds) at the cladode base. Several studies report the influence of basal incisions in the rooting of cuttings, semi-woody, and herbaceous. Some studies report divergent results, showing absent or positive interactions between incision at the base of cuttings and rooting (CAMOLESI *et al*., 2007; ALMEIDA *et al*., 2008; TREVISAN *et al*., 2008; BASTOS *et al*., 2009).

However, regarding the rooting of cladodes of pitayas, there are scarce studies, especially those related to the several types of incision that can be performed to promote and anticipate the rooting. Therefore, the aim of this study was to study different types of incisions in cladodes of white pulp pitaya in order to promote and anticipate rooting in the formation of seedlings.

Material and methods

The collection of cladodes (cuttings) was performed with the aid of pruning shears, which were collected in clones of white pulp pitayas, from a planting already installed in the Fruit-growing of the Federal University of Lavras (UFLA) at the age of eight. The cladodes were selected, sectioned at every 25 cm long, and their apex was removed in all of them with the aid of pruning shears. The experimental design was completely randomized design (CRD) with four replicates, five cladodes per plot and five treatments, which were characterized according to the type of incision at the cladode base (Figure 1). T1 = perpendicular incision (control), T2 = bevel incision, 45°, T3 = removal of 1/3 until reaching the main axis of the cladode, T4 = perpendicular incision of 1/3 on the three sides, T5 = cladode without incision.

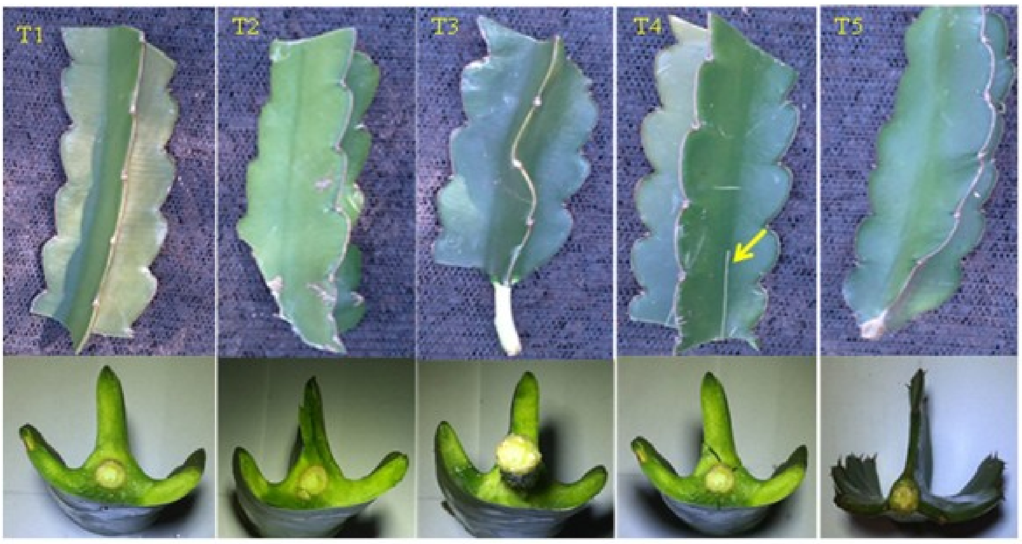


Figure 1 - Different types of incisions in cladode base of white pulp pitaya, T1 = perpendicular incision (control), T2 = bevel incision, 45°, T3 = removal of 1/3 until reaching the main axis of the cladode, T4 = perpendicular incision of 1/3 on the three sides, T5 = cladode without incision.

All incisions were performed with pruning shears, and in treatment 4, the performed incision reached the main axis. After the different types of incisions at the cladode base, they were immediately placed to root at a depth of 10 cm in black polyethylene bags with 3.5 L capacity, filled with substrate composed of subsoil from the second layer and sand at 1:1 ratio, both sieved. The containers were placed on benches screened with 50% luminosity. During the conduction of the experiment, manual irrigations were performed with a graduated beaker, with 450 ml of water per cladode, three times a week.

After 20 days, when the first sprouts emerged, the first evaluation of sprout percentage (%S) and length of the highest sprout (LS) was performed, being the others with 25-day interval. In order to measure the characteristics, a manual counting of Sprouts was performed and the first sprout of cutting was marked with a string, so that its length was then measured with a measuring tape. After reached four months of age, the plants were removed from the containers for evaluations of rooting percentage (%RT), root length (RL), root volume (RV), Sprout fresh biomass (SFB) and Sprout dry biomass (SDB), and root fresh biomass (RFB) and root dry biomass (RDB). The roots were properly separated from the substrate in running water over a sieve with a mesh of 2.75 mm and 60 cm diameter. The root volume was obtained by the difference in the volume of water displaced inside a graduated beaker after the placement of fresh roots. Root and Sprout fresh biomass were obtained by weighing at digital scale. In order to obtain the plant dry biomass, the material was sectioned and then placed in a convection oven (65 °C) for 72 h and then weighed on a digital scale until reaching constant weight.

The results were submitted to analysis of variance and regression, the qualitative averages were compared by the Tukey test at 5% probability. The used software was SISVAR® software (Ferreira, 2014).

Results and Discussion

The different incisions at the pitaya cladode base did not influence the rooting percentage (Figure 2).

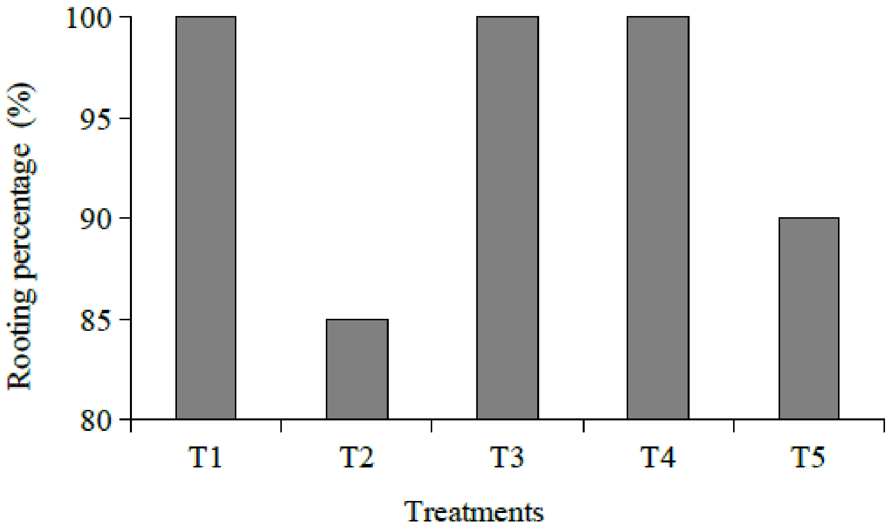


Figure 2 - Rooting percentage in pitaya cladodes under different incisions: T1 = perpendicular incision (control), T2 = bevel incision, 45°, T3 = removal of 1/3 until reaching the main axis of the cladode, T4 = perpendicular incision of 1/3 on the three sides, T5 = cladode without incision.

The T2 treatment, formed by incision in the cladode in a 45° bevel, provided lower rooting (85%) than the control (T1), not differentiating from the other treatments. However, wounds at the cladode base are beneficial, since they showed high rooting percentage. This may be related to the fact that the studied species is a cactus, with specialized structures that reduce water loss and favor good rooting. Moreover, mature cladodes of pitaya can store water, nutrients and carbohydrates in their tissues, which are transported to their new drains, contributing to root formation. The cladodes have the photosynthesizing function and have axillary buds in the areolas, which produce substances that aid in the root formation.

According to Biasi *et al*., (2000), the cellular activity in the lesioned area is stimulated by the increase of respiratory rate, increase in the auxin, carbohydrate and ethylene contents, resulting in the formation of roots in the lesion margins. The presence of gems on the cuttings, for Taiz & Zeiger (2013), has an important role for the formation of the new root system, being responsible for the production of assimilates and substances as auxins, being the latter synthesized in these locations.

Different incisions were studied in the rooting of *Eucalyptus* cuttings, and the results indicated that the best treatments were the perpendicular cuts and the basal incision, with 52% and

61%, respectively (BATISTA *et al*., 2014). However, Bastos *et al*., (2009) verified that the technique of etiolation and wounding on the base of starfruit woody cuttings harmed the rooting.

For the root length characteristic, there was no statistical difference among the used treatments (Figure 3).

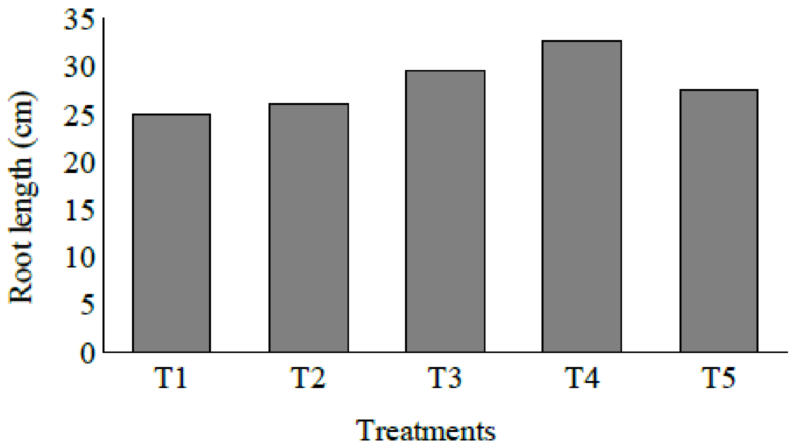


Figure 3 - Root length in pitaya cladodes under different incisions: T1 = perpendicular incision of cladodes (control), T2 = bevel incision, 45°, T3 = removal of 1/3 until reaching the main axis of cladodes, T4 = perpendicular incision of 1/3 on the three sides, T5 = cladodes without incision.

The different incisions did not influence the root length. These results are also indicative that the conditions related to the used substrate were similar for a uniform development of roots and mainly the main root, since the evaluated length refers to that from the main root.

In the present study, there was no change for supplied water. This may have contributed to the physical and chemical characteristics of the substrate for a better use of cladodes during the root system development, with drainage being the limiting factor, since the used substrate is rich in macropores and easily drains water, avoiding excessive water retention and possible root problems. Gunasena *et al.,* (2007) state that the pitaya requires well-drained soils, slightly acidic and with enough organic matter and, for Santos *et al*., (2010), the substrates that contain sand are the most suitable for the formation of vigorous and good quality seedlings.

In the production of plants in commercial scale, the emission of roots in higher number and length is a prevalent factor for the success of orchards, because the well-formed root system favors the absorption of nutrients and water, thus providing a better seedling development (CARVALHO JUNIOR *et al*., 2009).

It is observed in Figure 4 that the results for the root volume characteristic were similar, without significant difference, with values of 11.8 ml (T2) and higher value for treatment 4 of 11.65 ml. In the formation of pitaya plants, this characteristic is considered as one of the most important because plants with higher secondary root volume provide a larger area to be explored for water and mineral absorption when placed in the field.

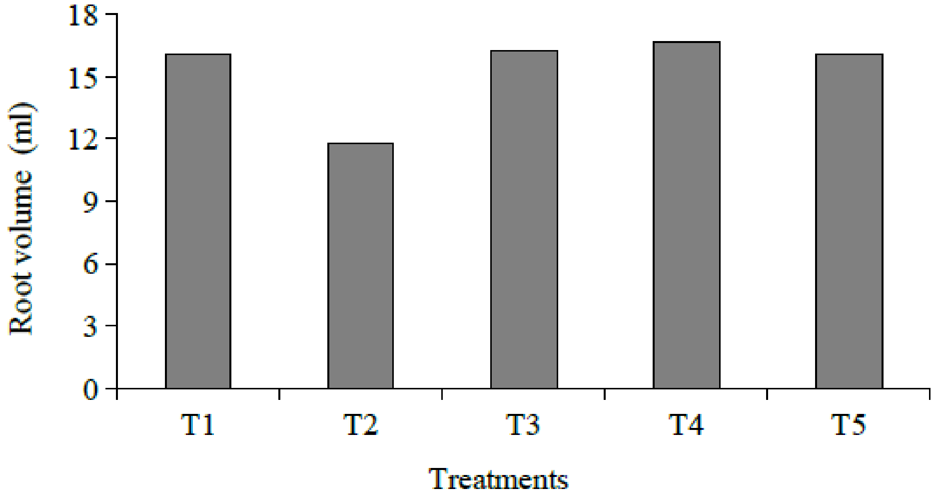


Figure 4 - Root volume in pitaya cladodes under different incisions: T1 = perpendicular incision of cladodes (control), T2 = bevel incision, 45°, T3 = removal of 1/3 until reaching the main axis of cladodes, T4 = perpendicular incision of 1/3 on the three sides, T5 = cladodes without incision.

The substrate used in the present study provided uniform root volume, not interfering with the studied characteristic. Similar results to that from Silva (2014), who despite having used different substrates in the production of pitaya plants, did not obtain difference for the volume. It is observed that pitaya cladodes show easiness to form secondary roots.

According to the results, the different incisions performed in cladodes influenced the sprout percentage during the evaluated period (Figure 5).

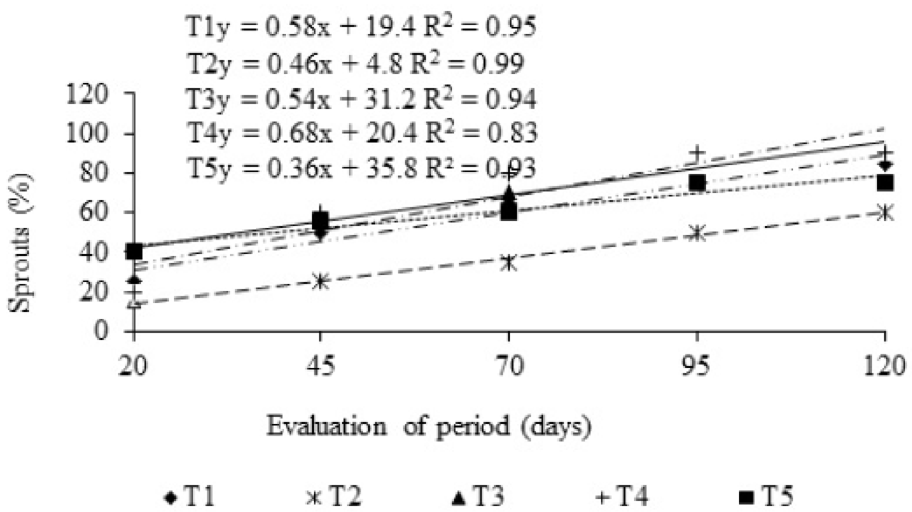


Figure 5 - Sprout percentage of pitaya cladodes under different incisions: T1 = perpendicular incision in cladode (control), T2 = bevel incision, 45°, T3 = removal of 1/3 until reaching the main axis of the cladode, T4 = perpendicular incision of 1/3 on the three sides, T5 = cladode without incision.

However, it was verified that the treatment formed by cladodes that received the bevel incision at 45° (T2) provided a lower Sprout percentage compared to the other treatments, showing only 60% at 120 days, being 25% lower than control (T1). At 120 days, the treatments 3 and 4 showed the best Sprout percentages, with 90% and only 5% more than the control. Similar results were found by Lima et al., (2013) in *Camellia sinensis,* in which the presence of cut at the cutting base did not influence the cladode mortality, as well as the percentage of living cladodes with root and Sprout. Silva (2014) did not find a significant difference in the number of Sprouts using fishery residues and saw dust in the rooting of pitaya cladodes.

For the Sprout length (Figure 6), it was verified that the T2 showed a smaller Sprout length, being 4.92 cm lower than the control treatment (T1), with 16.17 cm at 120 days.

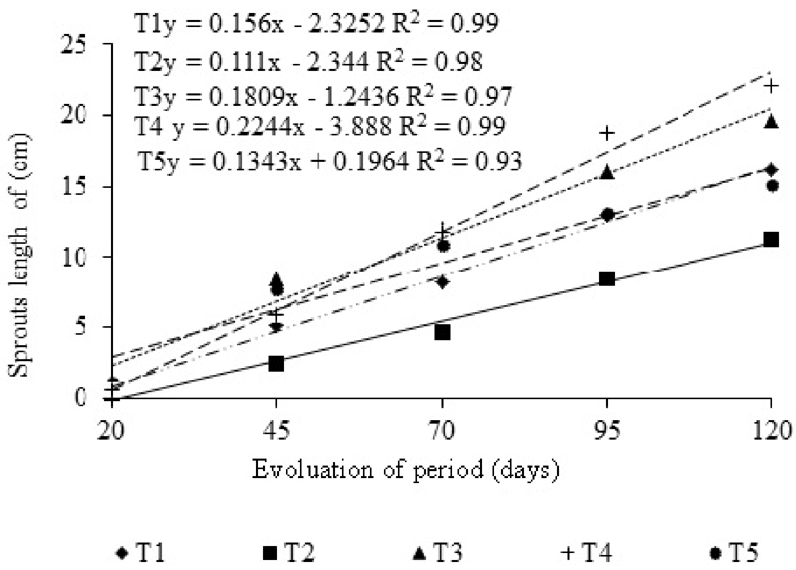


Figure 6 - Sprouts length in pitaya cladodes under different incisions: T1 = perpendicular incision (control), T2 = bevel incision, 45°, T3 = removal of 1/3 until reaching the main axis of the cladode, T4 = perpendicular incision of 1/3 on the three sides of cutting, T5 = cladode without incision.

According to the results, the sprouts length of the treatment in which the plants underwent a perpendicular incision of 1/3 (T4) showed higher Sprout length at 120 days, being 5.93 cm higher than the control (T1) and almost twice than T2. Sprout growth can be an important factor, since larger cladodes may indicate the formation of earlier plants, which can establish earlier in the field, anticipating production and bringing rapid economic returns. Furthermore, plants with larger sprouts have a higher capacity to perform photosynthesis and to accumulate larger amounts of carbohydrates, hormones and nutrients in their tissues. Thereby, it can favor a good root development and the emergence of new Sprouts in the plant.

For Taiz & Zeiger (2013), Sprout growth occurs either by direct action of auxins or by the increase generated in gibberellin biosynthesis, since these two hormones have cell elongation as physiological effect, resulting in a longer stem length. In contrast, López *et al*., (2000), report that cladode size, among other factors, also has an influence on the rooting power in cacti, mainly in pitaya, due to the production and translocation of hormones and carbohydrates necessary for the root formation.

Regarding the characteristics Sprout fresh and dry biomass, there was no statistical difference among the different incisions at the cladode base (Figure 7).

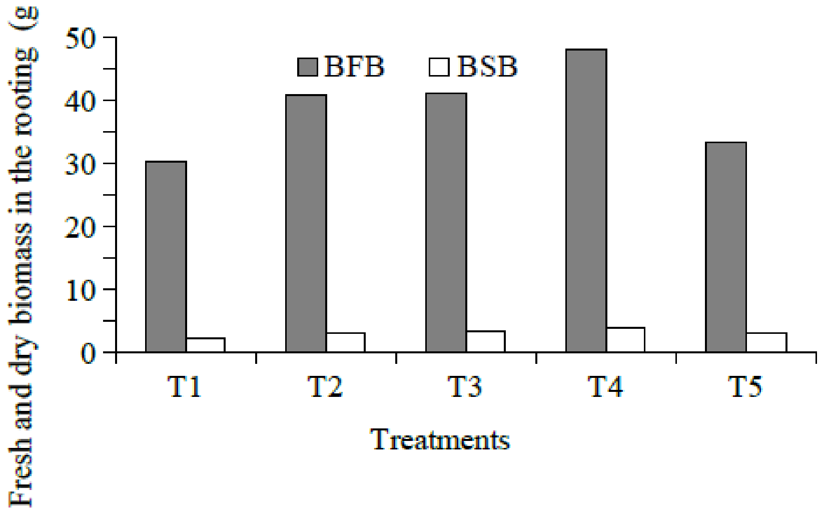
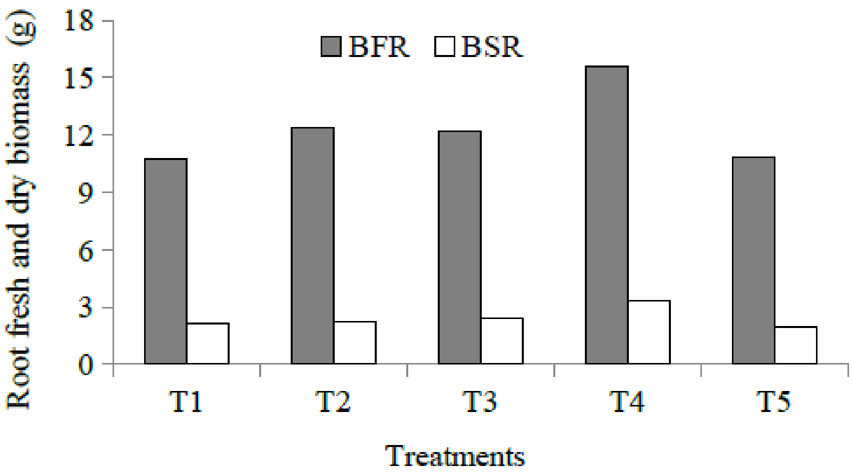


Figure 7 - Fresh and dry biomass in the rooting of pitaya cladodes under different incisions: T1 = perpendicular incision in cladode (control), T2 = bevel incision, 45º, T3 = removal of 1/3 until reaching the main axis of the cladode, T4 = perpendicular incision of 1/3 on the three sides, T5 = cladode without incision.

However, the perpendicular incision on the three faces (T4) indicated higher biomass, both for fresh and dry sprouts, standing out with 48.19 g and 3.90 g, respectively. This result was already expected, since both the percentage and Sprout length were higher for this treatment. In the formation of pitaya plants, sprouting of cladodes is extremely important, since the higher number of Sprouts indicate the quality of seedlings, because plants with greater vigor in the Sprout can capture more light and produce more photoassimilates, which will be transported to its younger drains, such as Sprouts and roots.

According to (Figure 8), there was a significant difference for the characteristics root dry and fresh biomass.



*Averages followed in the same letter on the column do not differ among themselves by Tukey test at 5% probability.

Figure 8 - Root fresh and dry biomass in pitaya cladodes under different incisions: T1 = perpendicular incision in the cladode base, T2 = bevel incision, 45°, T3 = removal of 1/3 until reaching the main axis of the cladode, T4 = perpendicular incision of 1/3 on the three sides, T5 = cladode without incision.

It was verified that the treatment of perpendicular incision on the three faces (T4) showed higher fresh biomass, with 15.6 g, not statistically differing from T2 and T3. Treatment 4 also obtained higher root dry biomass (3.35 g). The other treatments were similar.

This result can be attributed to the higher number of secondary roots emitted by these cladodes, which is a desirable characteristic in plant formation, since these roots provide higher capacity for plants to absorb water and minerals present in the soil and, therefore, can show better adaptation and rapid development when transplanted into the field. The higher root dry mass is also attributed to the cutting size by some authors (MARQUES *et al*., 2011).

Conclusions

The different incisions made at the cladode base of white pulp pitaya provide high percentage of rooting in the formation of plants.

The treatment in which a 1/3 perpendicular incision on the three sides (T4) was performed can be used to obtain a more efficient root system in the formation of pitaya plants. It is not recommended to use the bevel incision at 45°.

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