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Rooting Platanus (*Platanus acerifolia* (Aiton) Willd.) cuttings in Marechal Cândido Rondon - PR, Brazil: Influence of lesions at cutting bases and depth of planting

Enraizamento de estacas de platanus (*Platanus acerifolia* (Aiton) Willd.) no Marechal Cândido Rondon – PR: influência da lesão na base da estaca e da profundidade de plantio

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Abstract

Platanus, an arboreal and deciduous plant, is widely adapted and can be used for several purposes. Despite producing viable seeds, production of platanus seedlings usually occurs through vegetative propagation; cuttings are the best and most efficient source for obtaining seedlings. Although cuttings offer a practical and easy method to obtain seedlings in different vegetable species, they are influenced by several factors, both external and internal. The present study aimed to analyze the behavior of plantain cuttings planted in sand subjected to damage or no damage at the cuttings base, and planted at depths of 20 and 40 cm. Experiment was carried out at the experimental station of horticulture and protected cultivation of UNIOESTE-Brazil, in a randomized 2×2 factorial design, which comprises both, planted at 20 cm and 40 cm depths, with 5 replicates and 5 cuttings per replicate. After 170 days of incubation, injured and non- injured cuttings, were evaluated for rooting percentage and cuttings sprouted, length of roots and medium length of stems, stem diameter, number of leaves per stem, and dry mass of roots and shoots. No significant differences were observed in cutting injury. All variables analyzed presented higher values when cuttings were planted at 20 cm depth. Results indicate that planting of platanus cuttings at 20 cm depth leads to better rooting rates and vegetative development.

Key words: Plant propagation, propagation by cuttings, propagation materials, rooting potential, rhizogenesis, vegetative development.

Resumo

O plátano, planta arbórea e caducifólia, possui ampla adaptabilidade, podendo ser utilizada para diversas finalidades. Apesar de produzir sementes viáveis, a produção de mudas geralmente se dá através da propagação vegetativa, sendo a estaquia o melhor e mais eficiente método para obtenção de mudas da espécie. A estaquia, apesar de ser um método prático e fácil para obtenção de mudas de diferentes espécies vegetais, sofre influencia de inúmeros fatores, tanto externos quanto internos ao vegetal. Com isso, o presente trabalho buscou analisar o comportamento de estacas de plátano plantadas em leito de areia, submetidas a lesão da base da estaca ou não e profundidades de plantio de 20 e 40 cm. Para isso, montou-se um experimento na Estação Experimental de Horticultura e Cultivo Protegido da UNIOESTE, em delineamento de blocos inteiramente casualizado e esquema fatorial 2x2, constituído de estacas lesionadas e não lesionadas, estaqueadas a 20cm e 40cm de profundidade, contendo 5 repetições com 5 estacas por repetição. Passados 170 dias do plantio, avaliou-se o percentual de estacas enraizadas e brotadas; comprimento da maior raiz e comprimento médio de haste; diâmetro de haste; número de folhas por haste e massa seca de raiz e de parte aérea. Quanto à lesão nas estacas, não observou-se diferenças significativas. No entanto, para as profundidades de plantio, todas as variáveis analisadas apresentaram maiores valores quando as estacas foram plantadas a 20 cm de profundidade, concluindo-se, assim, que tal profundidade de plantio proporciona melhores índices de enraizamento e desenvolvimento vegetativo para as estacas de plátano.

Palavras-chave: Estaquia, potencial de enraizamento, propagação por estacas, materiais de propagação, rizogênese.

Introduction

Platanus (*Platanus acerifolia* (Aiton) Willd.) is an arboreal plant species with large, deciduous leaves and is the sole cultivated representative of Platanaceae family in Brazil. It occurs in Brazil and other South American countries, and used as an ornamental plant, for afforestation, for breaking wind in plantations, and in carpentry, for furniture and floor production owing to its high quality wood (Merino, 1991; Ono, de Barros & Rodrigues, 1994).

This plant can also be used for shading pigpens, corrals, coops, stables, and other rural facilities, providing greater thermal comfort to animals during hot summer conditions. On the other hand, because is a deciduous plant, also allows sunlight into facilities during winter, providing heating and disinfection of the environment by sunlight action.

In Serra Gaucha region of the state of Rio Grande do Sul-Brazil, this plant is widely used by winemakers to support grapevines through its use as living fence posts, to break winds in orchards, and as a vegetable fuel in production of pastries and homemade jams. In this region, this species is propagated by winegrowers who use hardwood cuttings of approximately 2 m long, derived from pruning of mature plants, which is performed between fall and winter.

Use of plants as living fence posts for the support of wire fences that delimit land, for delimitation of roads, and for general delimitation in urban or rural areas has been described in some literature citations by various authors (Lamônica & Guerra, 2008). Considering sustainable vision for the use of plants as living fences, platanus appears as an excellent candidate since this plant can be propagated through cuttings, living fences or hedge posts can be easily obtained due to its high propagation rate to form mature plants, and propagated plants are identical to mother plants (Lamônica & Guerra, 2008).

Vegetative propagation of platanus is the most preferred method for winegrowers in Serra Gaucha region, with satisfactory results; root-inducing products or other methods that require greater attention during the seedling production process are not preferred.

Nevertheless, adult plants produce seeds that are dispersed randomly during winter and early spring; however, germination percentage is very low (Leonardis, 1977). Therefore, vegetative propagation of this species by cuttings, an ancient practice, is widely used and recommended by several authors (Hartman & Kester, 1971; Dias, Franco & Dias, 1999) and is the most efficient method for platanus seedlings production.

Plant rooting and development by cuttings can be influenced by genotype and time of collection of plant material (Silva, Oliveira, Pio, Zambon & Oliveira, 2012). Physiological conditions of the mother plant and environment, are also influential, especially with respect to endogenous levels of auxin, size and number of nodes in cuttings, temperature, humidity of the environment, and substrate used in rooting (Oliveira, Pasqual, Chalfun, Regina & Rincón, 2003).

However, for some species, use of cuttings can often be a slow and impractical method (Ono, de Barros & Rodrigues, 1994) and is dependent on endogenous levels of tryptophan. This amino acid is the precursor of indole-3-acetic acid (IAA), the plant hormone belonging to the auxins, is most abundant in plants, and is responsible for the formation of adventitious roots and formation of plant organs such as leaves and stems in higher plants (Rossal, Kersten & Conter, 1997; Mercier, 2008).

Lesions in cutting base may also influence the rooting ratio. Lesions favor water absorption and plant growth regulator when treated, although the use of this technique may also lead to unsatisfactory results (Trevisan & Boldrini, 2008). Planting depth is another factor that may cause variation in rooting rates of cuttings and subsequent development in different species, as reported by Ojima & Regitano (1969), Pio, Ramos, Chalfun, Almeida, Carrijo, Mendonça, Alvarenga & Abrahão (2005), and Marques, Moreira, Ramos, Araújo & Cruz (2012), in pitahaya tree, quince, and fig tree, respectively.

Considering numerous benefits, possibilities of use, and influence on platanus cuttings, studies on their adaptation to tropical and subtropical conditions, as well as the rhizogenic potential of this species are required for the development of simple and easy techniques to propagate this plant. Results of these studies may be beneficial for cultivation of this species, especially for small Brazilian farmers.

This study aimed to evaluate the behavior of platanus (*Platanus acerifolia* (Aiton) Willd.) cuttings, comprising injured and non-injured cuttings, planted at different depths in the municipality of Marechal Cândido Rondon-PR, Brazil.

Material and methods

Study area

An experiment was carried out at the Experimental Station of Horticulture and Protected Cultivation “Professor Mário César Lopes”, Universidade Estadual do Oeste do Paraná-Unioeste, campus Marechal Cândido Rondon, Brazil.

Plant material

For the experiment, were used platanus (*P. acerifolia*) cuttings) of 2 meters in length, obtained from cuttings of mature plants located in Santa Tereza-RS, Brazil, collected on June 1st, 2013 and transported to Marechal Cândido Rondon–PR, Brazil. Therefore, hardwood cuttings were accommodated in sand bed in way that their bases stayed buried about 30-cm. Manual daily watering with hose aid to keep the moisture in the substrate around the cuttings until the time they were in uniform for experiment implementation, was carried out.

Plant cuttings

With the aid of hacksaw, were planted on June 8, 2013. Each cutting section (approximately 50 cm long) had 3 vegetative shoots, with a diameter of 3.0–4.0 cm. Cuttings were cut close to lower shoots of the plant; cuttings were subsequently inserted into sand bed for rooting.

To perform the injury, a knife with a 30-cm flat blade was used to cut at 10 cm from basal part of the cutting, causing small cuts in the skin (Figure 1).

Figure 1. Injured *P. acerifolia* cuttings

Subsequently, cuttings were planted 10 cm apart in a 100-cm-deep sand bed covered with 50% shade mesh.

Base of cuttings were abundantly watered to the top level of sand bed after planting to eliminate possible spaces or air pockets between sand and cuttings, which have allowed an intimate contact between both components.

Throughout trial period, cuttings received regular irrigation sprays that were activated 20 times per day. Irrigation system was programmed via timer that turned on at 7:00 A.M. and off at 6:00 P.M. From 7:00 A.M. to 9:00 A.M. and 5:00 P.M to 6:00 P.M, system was activated every hour for 3 min. During other periods of the day, system was activated every 30 min for 3 min.

After 170 days of plant growth, plants were evaluated for rooting and sprouting percentage. Maximum root length and average length of stems were measured with a measuring tape and values were expressed in centimeters. Stem diameter was measured with a digital caliper, 1 cm above insertion between stem and shoot, values were expressed in millimeters. Number of leaves per stem was recorded. Dry mass of roots and shoots, after drying in an oven with air circulation at 65°C for 72 h, were weighed using a semi-analytical balance, and results were expressed in grams.

Statistic analysis

Experimental design was a 2 x 2 completely randomized factorial design, comprising a total of 100 injured and non-injured cuttings, staked 20 cm and 40 cm depth, with 5 replicates and 5 cuttings per replicate.

Once tabulated, data were subjected to analysis of variance (ANOVA) to identify significant difference among treatments and statistical significance for all comparisons was made at $p<0.05$. Tukey's multiple range test was used to compare the mean values of treatments.

Results

ANOVA results of significant differences among planting depths for all variables are shown in Table 1.

Table 1. Percentage of rooted cuttings (R) and sprouting (S), root length (CL), medium stem length (MSL), stem diameter (SD), number of leaves per stem (NLS), root dry mass (RDM) shoot dry weight (SDW) of *P. acerifolia* cuttings at two depth plantings (20 and 40 cm)

Depth -- cm --	R. -- % --	S. -- % --	C.L. -- cm --	M.S.L. -- cm --	S.D. - mm -	N.L.S.	R.D.M. -- g --	S.D.W. -- g --
20	100 a*	100a	36.32a	52.95a	8.48a	30.94a	1.52a	25.03a
40	88b	84b	16.58b	43.44a	6.55b	18.20b	0.51b	11.76b
SAD	11.66	10.96	4.68	12.27	1.27	8.44	0.51	7.53
CV%	12.74	12.23	18.15	26.13	17.32	35.26	51.11	42.03

* Averages followed by different lowercase letters in the column differ statistically by Tukey test at 5% probability of error.

Injuries made at base cuttings, in the present study did not activate significant physiological changes involving ethylene and auxin accumulation; however, it appears that the current base cutting served as a physical barrier against basipetal flow and auxin accumulation in the base cutting area, thereby promoting roots development in this region (Figure 2).

Figure 2. *P. acerifolia* cuttings. In sand bed on planting day (a); sprouted cuttings (119 days after planting) (b).

Figure 3, shows lower number of roots in cuttings planted at 40 cm depth compared to those buried at 20 cm depth.

Figure 3. *P. acerifolia* roots in cuttings at 20 and 40 cm planting depth. a) not injured cuttings subjected to a planting depth of 40 cm; b) cuttings subjected to a planting depth of 20 cm.

In the present study, water was sprayed intermittently during experiment, providing good moisture soil conditions to platanus cuttings planted at evaluated planting depths (20 and 40 cm). However, those buried at greater depths, were damaged by excessive moisture contained in the substrate, thus reducing rooting percentage and consequently, damaging the vegetative growth of cuttings.

Discussion

For injured cuttings, there were no significant differences in the analyzed variables. Similarly, no significant differences between planting depth and injury in base cutting, were observed.

It was observed that percentage of rooted cuttings, results were not consistent with previous work carried out by Dias, Franco & Dias (1999), who obtained rooting percentages ranged from 60 and 75% when compared platanus cuttings of 0.94–2.75 cm diameter. However, in the present study, cuttings were collected in August, 2013 which may explain differences in results between two studies. However, these results are comparable in variability to the report by Ono, de Barros & Rodrigues (1994), and Nicoloso, Lazzari & Fortunato (1999), who observed that best cuttings rates were obtained when cuttings were collected during fall season.

According to Fachinello, Hoffmann, Nachtigal, Kersten & Fortes (1995), and Kersten, Lucchesi & Gutierrez (1993), time of cuttings collection is very important and should be taken into account when collecting cuttings for vegetative propagation purposes. A possible explanation for this is that during certain periods of the year, formation and accumulation of rooting inhibitors can occur (Muñoz & Valenzuela, 1978) or synthesis of phytohormones precursor, such as tryptophan, may occur (Rossal, Kersten & Conter, 1997). This provides more accurate and reliable estimates of injury at base cutting, which was expected that injured cuttings would have higher rooting percentages and rooting and occur in the injured area. According to Mercier (2008), root formation process (for either inducing formation of lateral roots or for inducing root formation on stems) is regulated by ethylene (among other phytohormones) action, which can be synthesized by plant after suffering any injury. Ethylene is the hormone responsible for auxin accumulation (indolyl-3-acetic acid - EIA) in certain plant regions and, consequently, initiate the process of root formation.

In fact, in a previous work on planting depth, Pio *et al.* (2005), using quince cuttings of 20 cm length, observed that cuttings totally buried presented lower rooting percentage than those buried to 2/3 of their length. They also observed that sprouting percentage and number of leaves per cutting were reduced when cuttings were completely buried, attributing these results to the presence of excess moisture in the substrate.

Results of the present study corroborate these previous studies; platanus cuttings planted at greater depths showed lower rooting percentage, fewer and smaller sprouted cuttings, and lower number of leaves produced on each stem (Table 1).

According to Fachinello *et al.* (1995), appropriate moisture in the rooting substrate is essential to obtain satisfactory results in the rooting of different plant cuttings. Substrates with high moisture content may affect emergence and development of roots and lack of moisture can also damage plant development.

This can be related to planting depth; cuttings buried deeper tend to reach regions with higher moisture content, hindering emergence of roots and thus affecting the cuttings and their initial plant growth.

Ojima & Reginato (1969) and Munõz & Valenzuela (1978), using fig tree cuttings, verified that those staked to 4/5 of their length showed a higher rooting percentage than those staked to 1/2 of their length. These results justify the fact that cuttings buried deeper benefit from greater protection against dryness, thus favoring rooting.

Root and vegetative development in the cuttings planted at greater depths can also be related to aeration present at lesser depths (Munõz & Valenzuela, 1978). Pio *et al.* (2005), highlighted the need to keep rooting substrate fully aerated for best rooting rates and cuttings.

On the result basis from present study and those of previous studies, can be inferred that depending on the substrate used, a substrate can have a moisture gradient throughout its profile and water holding capacity, particle size, texture of each type of substrate and planting depth of cuttings, influence the optimum humidity required for rooting of platanus cuttings.

Conclusion

P. acerifolia cuttings buried to 20 cm deep show highest rates of rooting and vegetative development. The injury on base cutting not allowed an improvement in the rooting and vegetative development.

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