

Emergence and early seedling growth of *Dilodendron bipinnatum* Radlk in different substrates**Emergência e crescimento inicial de mudas de *Dilodendron bipinnatum* Radlk em diferentes substratos**

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ABSTRACT

Dilodendron bipinnatum Radlk is a Brazilian native woody species, widely used in landscaping and restoration of degraded lands. Due to the lack of native plant material in commercial nurseries, and very little information is available on the propagation of this study species, we investigated the effect of substrates and identified which is most suitable upon the emergence and early seedlings growth of this study species. The experiment was carried out in a greenhouse and the substrates used were: sand, Tropstrato®, chicken manure + red soil (1:1), black soil + red soil (1:1). After 30 days-period, the emergence percentage, emergence speed index, mean emergence time, root and shoot length, and root and shoot dry mass were performed. The most suitable substrates for seedling emergence percentage and emergence speed index were the sand, Tropstrato®, and black soil + red soil substrates. The substrates that added greater dry mass for root and shoot were the black soil + red soil, followed by the Tropstrato®. In conclusion, the Tropstrato® and black soil+ red soil provided the best results for early seedling growth of *D. bipinnatum*. In addition, black soil + red soil substrate can be produced at the nursery, as its components are easily accessible in nature, and for *D. bipinnatum* seedlings, it provides similar results as those obtained using the Tropstrato® substrate, with less costs.

Keywords: Seedling vigor, *Pantanal*, native species, reforestation

RESUMO

Dilodendron bipinnatum Radlk é uma espécie de árvore nativa do Brasil, amplamente utilizada no paisagismo e revegetação de áreas degradadas. Devido a demanda pelo conhecimento sobre produção de plantas nativas em viveiros comerciais e pouca informação é conhecida sobre a propagação dessa espécie, nós investigamos o efeito de diferentes substratos e qual substrato é o mais apropriado na emergência e desenvolvimento de plântulas de *Dilodendron bipinnatum* Radlk. O experimento foi conduzido em casa de vegetação avaliando-se os substratos areia, Tropstrato®, esterco de galinha + terra vermelha (1:1) e terra preta + terra vermelha (1:1) para emergência e produção de mudas. Após 30 dias da semeadura foram determinadas a porcentagem, velocidade e tempo de emergência, o comprimento e a massa seca da raiz e da parte aérea das plântulas. Os substratos areia, Tropstrato® e terra preta + terra vermelha (1:1) foram os melhores para emergência de plântulas. O substrato que agregou maior massa de matéria seca tanto para raiz quanto para a parte aérea foi o substrato terra preta + terra vermelha (1:1), seguida pelo Tropstrato®. Em conclusão, o substrato Tropstrato® e o composto terra preta + terra vermelha (1:1) proporcionaram os melhores resultados, sendo indicados para a produção de mudas de *D. bipinnatum*. Além disso, substrato terra preta + terra vermelha pode ser produzido no viveiro, pois seus componentes são de fácil acesso na natureza, e para mudas de *D. bipinnatum*, proporciona os mesmos resultados obtidos com substrato Tropstrato® mas com menor custo.

Palavras-chave: Vigor, Pantanal, espécie nativa, reflorestamento

1 INTRODUCTION

Dilodendron bipinnatum Radlk, also known as, “mulher pobre”- poor woman, is a native woody species, belonging to the family of Sapindaceae, widely distributed in the Amazon rainforest, Central Brazilian Savanna, and Atlantic rainforest in Brazil and neighboring South American countries such as Peru, Bolivia and North of Paraguay (SOMNER et al., 2016, LORENZI, 2002). It is a tree that can reach 10m height, extensively used in landscaping and revegetation of degraded lands, and its seeds provide an edible oil and its fruit serves as food for birds that consume the aryl surrounding the seeds (LORENZI, 2002).

Seed germination is described physiologically as the primary root protrusion (BEWLEY et al., 2013), however, not only the root protrusion assures that the embryo will be able to establish itself in the field. In this process, several factors may affect germination, seedling emergence, and therefore seedling production (FERREIRA & BORGHETTI, 2004). Substrate is one of the most important external factors for plant survival and seedling growth (HOFFMANN et al., 2001, LIMA et al., 2006), as it is the physical support for germination, root fixation, and where plants draw up water and nutrients (SPURR & BARNES, 1973; SILVA et al., 2001a).

Due to its structure, aeration, water retention capacity, tendency for pathogen infestation among other factors, substrates may either prevent seed germination and seedling development or promote the percentage and speed of emergence, resulting in more vigorous seedlings and reduced production

expenses (CARVALHO & NAKAGAWA, 2012, POPINIGIS, 1985; FIGLIOLIA et al., 1993; SILVA et al., 2001a). Thus, understanding the physiological seed requirements of each species, such as the type of substrate for seed germination and later seedling development, is fundamental for optimizing seedling production.

Several studies have evaluated suitable substrates for early seedling growth of different native species, such as vegetable soil for *Zizyphus joazeiro* (Rhamnaceae) (BRAGA JUNIOR et al., 2010) and *Anadenanthera colubrina* (Fabaceae) (RODRIGUES et al., 2007), sand for *Erythrina velutina* (Fabaceae) (ALVES et al., 2008), and washed sand + humus for *Odorous sicana* (Fabaceae) (LIMA et al., 2010). Each species has requirements regarding substrate that promotes seedling emergence and development, therefore, it is extremely important to study substrates for the propagation of forest species, in order to identify the one that provides the best emergence and early seedling development (ALVES et al., 2017).

Due to the ecological importance of poor woman as a reforestation species and very little information is available on the propagation of this species as well as the lack of native plant material in commercial nurseries, our study aimed to investigate the effect of substrates and identify which is most suitable upon the emergence and early seedlings growth of *D. bipinnatum*.

2 MATERIALS AND METHODS

The experiment was set up in a greenhouse with 50% shade at the Bioscience Institute of the Federal University of Mato Grosso do Sul, Campo Grande, Mato Grosso do Sul state, Brazil.

Dilodendron bipinnatum seeds were collected in a tropical savanna, in the *Pantanal* wetland, located in Aquidauana region, Mato Grosso do Sul state, in the Central-West region of Brazil, (20°28'15 "S, 55 ° 47'13 "W and with average altitude of 149 m). The region's climate is classified by the international Köppen-Geigher system as "Tropical wet-dry "(Aw), with annual average precipitation of 1.250 mm and annual average temperature of 26°C. The soil consists of sandstones with varying fine to coarse grains, with a wide range of colors, from reddish, purplish gray to whitish (SCHIAVO et al., 2010).

The seeds were taken to the laboratory for soaking in water for five minutes, left dry at room temperature, and then stored in paper bags (0.25 mm) at 20 °C until further use. The moisture content was determined at 105°C ± 3°C for 24 h using the oven method (BRASIL, 2009) with four replicates of 25 seeds each and the result was expressed as a percentage on the wet weight basis.

In each treatment, the seeds were sown with one seed per cell distributed in 128 cell polystyrene seed trays using the following four substrates: sand (white, medium-textured river sand), Tropstrato®

(commercial substrate of *Pinnus* bark), chicken manure + red soil (latossolo Vermelho)(1:1), and black soil + red soil (1:1). Watering was done when necessary. Seedlings emergence were recorded daily for 30 days after sowing, considered as an evaluation criterion seedling with hypocotyl, cotyledons, and epicotyl above the substrates (BRAZIL, 2009). Then, the results were expressed in emergence percentage (EP), emergence speed index (ESI) according to MAGUIRE (1962), and mean emergence time (ET) (LABOURIAU, 1983). At the end of the experiment, the shoot length (SL) (mm) of ten seedlings of each treatment were measured from the base to the apical bud by a digital caliper with point zero placed at the base of the plant while the root length (RL)(mm) were measured by millimeter ruler. Thereafter, both shoot and root were placed in paper bags and taken into a forced air circulation oven at 80°C for 24h to determine the shoot and root dry mass (g).

The experimental design was completely randomized, with four treatments (different substrates) for the seedling emergence tests, using four replicates of 40 seeds each. According to the tests of normality and homogeneity of variances, there was no need for data transformations. The data were submitted to analysis of variance, and the means were compared by the Tukey test up to 5% of error probability, carried out through the statistical program Sisvar® 5.3 Build 77 (FERREIRA, 2011).

3 RESULTS AND DISCUSSION

The seed moisture content was 64.02%. The sand, Tropstrato®, and black soil + red soil substrates provided the greatest EP, ESI, and lowest ET and did not differ amongst themselves; however, they were significantly different from the chicken manure + red soil substrate. These results are like those obtained by LOPES et al. (2007) and MEDEIROS & ABREU (2005), which found that the highest emergence speed index and emergence percentage for *Pseudima frutescens* (Sapindaceae) seedlings occurred on sand and black soil substrates, and on sand substrate for *Allophylus edulis* (Sapindaceae), respectively. Similarly, ALVES et al. (2008) recorded that sand enhanced the seedling emergence of *Erythrina velutina* (Fabacea) while CRUZ et al. (2016) pointed out that commercial substrate and the mixture Tropstrato HT® provided higher, faster, and more uniform seedling emergence for *Punica granatum* (Lythracea).

On the other hand, the emergence percentage on sand substrate differed from studies with others sapindaceae species. For instance, *Magonia pubescens* (COELHO et al., 2010) and *Dodonea viscosa* (MEDEIROS & ABREU, 2005) had low emergence percentages on sand substrate. According to BOCCHESI et al. (2008), this fact can be explained by the physical structure of the sand, which promotes water drainage, resulting in decreased seed imbibition.

The chicken manure + red soil substrate delayed the seedling emergence time and percentage (Table 1). The lowest emergence percentage in the manure + red soil substrate may have been caused by the lack or decreased oxygen surrounding the seed, because of high level of moisture in the substrate. According to KIRCHOFF et al. (2003) the addition of organic matter, such as manure to the soil, decreases the bulk density of the soil and increases total porosity of the soil, leading to an increase in water holding capacity. As a result, whether the substrate is not very aerated due to overwatering, this stagnant water causes a typical stress situation by restricting free diffusion of oxygen from air to germinating seeds or even inhibiting germination (NARSAI et al., 2015, MARCOS FILHO, 2005). On the contrary of our findings, OLIVEIRA et al. (2020) found positive effect of a mixture of 45% red soil + 45% sand + 10% chicken manure substrate on seedling growth of *Khaya ivorensis* (Meliaceae). The low amount of chicken manure in this substrate may have influenced positively the aeration of substrate, thus, enhanced the seedling growth of this specie.

Suitable substrate must provide conditions of moisture and aeration that allows movement of water and air in it, which promotes seed germination and seedling emergence. Our findings indicate that *D. bipinnatum* has good plasticity in relation to the substrate, since it adapts its germination to the variation of this factor. There are different levels of water holding capacity according to the physical and chemical characteristics of the substrate or soil (FIGLIOLIA & PIÑA-RODRIGUES, 1995; HUDSON, 1994), hence the seedling emergence can occur in various substrates that provide enough water to promote the germination process (LAVIOLA et al., 2006). Thus, most substrates evaluated may have suitable characteristics, since they improved the seedling emergence and there was no difference in emergence speed index.

Table 1: Emergence percentage (EP), emergence speed index (ESI), and mean emergence time (ET) of *Dilodendron bipinnatum* seedlings on different substrates

Substrates	EP (%)	ESI	ET (days)
Sand	68 a	7.1 a	9.9 a
Tropstrato®	70 a	8.1 a	9.3 a
Black soil + red soil	66 a	8.0 a	8.7 a
Chicken manure +red soil	20 b	1.3 b	15.9 b
C.V. (%)	12.0	13.9	10.7

Means followed by the same letter do not differ significantly by Tukey test at 5% probability

Tropstrato® and black soil + red soil substrates promoted greater root and shoot dry mass and shoot length (Table 2). However, there was no significant difference between them but were different from the other substrates. These findings corroborate with those observed by LOPES et

al. (2007), as the authors pointed out that the black soil promoted the seedling growth of *Pseudima frutesce* (Sapindaceae). Besides that, PAIXAO et al. (2019) recorded that the emergence and early seedling growth of *Euterpe oleracea* (Arecaceae) were enhanced by commercial substrate bioplant. The high nutrient availability for the seedlings, as the black soil and commercial substrates have a large amount of organic matter, increases the soil moisture and aeration, resulting in greater seedling biomass production (BOT & BENITES, 2005).

Regarding the root length, the chicken manure + red soil substrate has provided higher mean and differ statistically from the others. However, the root and shoot dry mass were the lowest among the other substrates, followed by the sand substrate (Table 2). As a result, the seedlings were less vigorous than those in other substrates. According to SILVA et al. (2001b), the limited availability of phosphorus in the soil can reduce the shoot length as a strategy by allocating its resources for root development. Our findings demonstrate the inefficiency of chicken manure + red substrate in promoting vigorous seedlings as it did not contribute substantially to increase the seedling emergence and biomass gain.

Table 2: Root length (RL), root dry mass (RDM), shoot length (SL), and shoot dry mass (SDM) of *Dilodendron bipinnatum* seedlings on different substrates

Substrates	Root		Shoot	
	RL (mm)	RDM (g)	SL (mm)	SDM (g)
Sand	53.8b	0.6bc	87.0bc	4.0bc
Tropstrato®	80.2ab	0.9ab	116.2a	5.5ab
Black soil + red soil	59.8ab	1.2a	103.2ab	5.8a
Chicken manure + red soil	91.3a	0.3c	82.3c	2.6c
C.V. (%)	23,6	23,3	8,9	18,6

Means followed by the same letter do not differ significantly by Tukey test at 5% probability

Additionally, seedlings on the sand substrate were less vigorous than those on Tropstrato® and black soil + red soil substrates. Lower values for dry mass may be caused by nutrient leaching to deeper layers where roots do not reach (SERRAT et al., 2002) since the sand textured materials have large particles that don't hold organic matter resulting in high water drainage capacity (MILLER & NAETH, 2019; HUDSON, 1994). However, as evidenced in this study, the sand substrate improved the seedling emergence percentage, speed and time.

4 CONCLUSION

Overall, the substrates used in this study, except for the chicken manure+ red soil, provided suitable conditions for seedling emergence and early seedling growth.

For producing vigorously seedling, Tropstrato® and black soil + red soil substrates are the most recommended, due to highest emergence percentage and speed index, greater shoot length, and root and shoot dry mass of seedlings.

Besides that, black soil + red soil substrate can be produced at the nursery, as its components are easily accessible in nature, and for *D. bipinnatum* seedlings, it provides the similar results as those obtained using the Tropstrato® substrate with less costs, more affordable.

D. bipinnatum seeds can be sown in sand substrate, however the seedlings must be transplanted to containers with commercial or black soil+ red soil substrates in order to grow vigorously.

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DECLARATION OF CONFLICTING INTERESTS

We have no conflict of interest to declare.

AUTHORS CONTRIBUTION

NVAC, VSSZ and VCS were responsible for the study design, and manuscript preparation. NVAC, VSSZ and VCS were responsible for the data analysis, VCS translated the manuscript into English and all authors reviewed the manuscript.

REFERÊNCIAS

ALVES, E. U et al. Substratos para testes de emergência de plântulas e vigor de sementes de *Erythrina velutina* Willd., Fabaceae. **Semina: Ciências Agrárias**, Londrina. v.29, n 1, p 69-82, 2008.

ALVES, M. M et al. Substrate in the emergence and initial growth of seedlings of *Caesalpinia pulcherrima*. **Ciência Rural**, Santa Maria, v.47, n 3, 2017.

BRAGA JUNIOR, J. M.; ALCÂNTARA BRUNO, R. L.; ALVES, E. U. Emergência de plântulas de *Zizyphus joazeiro* Mart (Rhamnaceae) em função de substratos. **Revista Árvore**, Viçosa-MG, v.34, n.4, p.609-616, 2010.

BRASIL. Ministério da Agricultura, Pecuária e Abastecimento. **Regras para análise de sementes**. Brasília: Mapa/ACS, 2009. 399p.

BEWLEY, J.D.; BRADFORD, K.; HILHORST H E NONOGAKI H. **Seeds: physiology of development, germination and dormancy**. New York: Springer. 2013. 392p.

BOT, A., BENITES, J. The importance of soil organic matter: Key to drought-resistant soil and sustained food production (No. 80). Food & Agriculture Org. 2005.

BOCCHESI, R.A. et al. Efeito de diferentes tipos de solos na germinação de sementes de *Tabebuia heptaphylla* em casa telada. **Cerne**, Lavras, v.14, n.1, p.62-67, 2008.

CARVALHO, N.M.; NAKAGAWA, J. Sementes: ciência, tecnologia e produção. 5.ed. FUNEP: Jaboticabal, 2012. 590p.

COELHO, M. F. B. et al. Substratos para a emergência de plântulas de *Magonia pubescens* St. Hil. **Revista de Ciências Agrárias**, Belém, v.5, n.1, p.80-84, 2010.

CRUZ, M. P. et al. Germination and emergence of pomegranate seeds on different substrates. **International Journal of Current Research** v. 8, n 11, pp.42146-42149, 2016.

FERREIRA, D. F. Sisvar: a computer statistical analysis system. **Ciência e Agrotecnologia**, Lavras, v. 35, n.6, p. 1039-1042, 2011.

FERREIRA, A. G.; BORGHETTI, F. **Germinação: do básico ao aplicado**. Porto Alegre: Artmed, 2004. 323 p.

FIGLIOLIA, M. B.; PIÑA-RODRIGUES, F.C.M. Considerações práticas sobre testes de germinação. In: SILVA, A.; PIÑA-RODRIGUES, F.C.M.; FIGLIOLIA, M.B. **Manual técnico de sementes florestais**. São Paulo: Instituto Florestal, 1995. p.1-12.

FIGLIOLIA, M.B.; OLIVEIRA, E.C.; PIÑA RODRIGUES, F.C.M. Análise de sementes. In: AGUIAR, I.B.; PIÑA RODRIGUES, F.C.M.; FIGLIOLIA, M.B.(Ed). **Sementes florestais tropicais**. Brasília: ABRATES,1993. p. 137-174.

HOFFMANN, A. et al. Efeito de substratos na aclimatização de plantas micropropagadas do porta-enxerto de macieira 'Marubakaido'. **Revista Ciência e Agrotecnologia**, Lavras, v.25, n.2, p.462-467, 2001.

HUDSON, B. D. Soil organic matter and available water capacity. **Journal of Soil and Water Conservation**, v. 49, n. 2, p. 189-194, 1994.

KIRCHOFF, C.J.; MALINA, J. F.; BARRETT, Michael E. **Characteristics of composts: Moisture holding and water quality improvement**. Center for Research in Water Resources, University of Texas at Austin, 2003.

LABOURIAU, L.G. **A germinação das sementes**. Washington: Secretaria geral da Organização dos Estados Americanos, 1983. 174p.

LAVIOLA, B.G. et al. Efeito de diferentes substratos na germinação e no desenvolvimento inicial de jiloeiro (*Solanum gilo* Raddi), cultivar verde claro. **Ciência e Agrotecnologia**, Lavras, v.30, n.3, p.415-421, 2006.

LIMA, J. F. et al. Avaliação de diferentes substratos na qualidade fisiológica de sementes de melão de caroá [*Sicana odorifera* (Vell.) Naudium]. **Revista brasileira de plantas medicinais**. Botucatu, v.12, n.2, p. 163-167, 2010.

LIMA, R. L. S. et al. Substratos para produção de mudas de mamoneira compostos por misturas de cinco fontes de matéria orgânica. **Ciência e Agrotecnologia**, Lavras, v.30, n.3, p.474-479, 2006.

LOPES, I. L. M.; JARDIM, M. A. G.; MEDEIROS, T. D. S. Germinação de sementes e desenvolvimento morfológico de plantas oleaginosas: 1. *Pseudima frutescens* (Aubl.) Radlk.(Sapindaceae). **Revista Brasileira de Farmácia**, Rio de Janeiro, v. 88, n. 3, p.132-134, 2007.

LORENZI, H. **Árvores brasileiras: manual de identificação e cultivo de plantas arbóreas nativas do Brasil**. 4.ed. vol. 01. Nova Odessa: Instituto Plantarum, 2002. 336p.

MAGUIRE, J. D. Speed of germination aid in selection and evaluation for seedling emergence and vigor. **Crop Science**, Madison, v.2, n.2, p.176-177, 1962.

MARCOS FILHO, J. **Fisiologia de sementes de plantas cultivadas**. Piracicaba: Fealq, 2005, 495p.

MEDEIROS, A. C. S.; ABREU, D. C. A. **Instruções para testes de germinação de sementes florestais nativas da Mata Atlântica**. Colombo: Embrapa, 2005.

MILLER, V. S.; NAETH, M. A. Hydrogel and Organic Amendments to Increase Water Retention in Anthrosols for Land Reclamation. **Applied and Environmental Soil Science**, v. 2019, 2019.

NARSAI, R et al. Mechanisms of growth and patterns of gene expression in oxygen-deprived rice coleoptiles. **The Plant Journal**, v. 82, n. 1, p. 25-40, 2015.

OLIVEIRA, H. F. E. et al. Desenvolvimento inicial de mudas de mogno africano em função de subtratos e lâminas de irrigação, **Brazilian Journal of Development**, Curitiba, v. 6, n. 4, p. 20475-20482, 2020.

PAIXÃO, M. V. S et al. Substratos na emergência e desenvolvimento inicial de plântulas da palmeira açai. **Brazilian Journal of Animal and Environmental Research**, Curitiba. v.2, n.3, p. 967-974, 2019.

POPINIGIS, F. **Fisiologia da semente**. 2. ed. Brasília: ABRATES, 1985. 298p.

RODRIGUES, A.C.C. et al. Efeito do substrato e luminosidade na germinação de *Anadenanthera colubrina* (Fabaceae, Mimosoideae). **Revista Árvore**, Viçosa, v.31, n.2, p.187-193, 2007.

SCHIAVO, J. A. et al. Caracterização e classificação de solos desenvolvidos de arenitos da formação Aquidauana-MS. **Revista Brasileira de Ciência do Solo**, Viçosa. v. 34, n. 03, p. 881-889, 2010.

SERRAT, B. M.; DE LIMA, M. R.; GARCIAS, C. E.; FANTIN, E. R.; CARNIERI, I. M. R.S.A. L.; PINTO, S. **Conhecendo o solo**. UFPR/ Setor de Ciências Agrárias/ Departamento de solos e engenharia agrícola, Curitiba, 2002, 27p.

SILVA, M. C.; NAKAGAWA, J.; FIGLIOLIA, M. B. Influência da temperatura, da luz e do teor de água na germinação de sementes de *Schinus terebinthifolius* Raddi Anacardiaceae (aroeira-vermelha). **Revista do Instituto Florestal**, São Paulo, v. 13, n. 2, p. 135-146, 2001a.

SILVA, R. P.; PEIXOTO, J. R.; JUNQUEIRA, N. T. V. Influência de diversos substratos no desenvolvimento de mudas de maracujazeiro azedo (*Passiflora edulis* Sims f. *flavicarpa* DEG). **Revista Brasileira de Fruticultura**, Jaboticabal, v. 23, n. 2, p. 377-381, 2001b.

SOMNER, G.V., FERRUCCI, M.S., ACEVEDO-RODRÍGUEZ, P., *Dilodendron* in Lista de Espécies da Flora do Brasil., Jardim Botânico do Rio de Janeiro, 2016.

SPURR, S. H.; BARNES, B. V. **Forest ecology**. New York: The Ronald Press, 1973. 571p.