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Effect of NPK fertilizers on the initial growth of transplanted seedlings of *Butia eriospatha*

Efeito de fertilizantes NPK no crescimento inicial de mudas transplantadas de Butia eriospatha

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RESUMO

Butia eriospatha (Martius ex Drude) Beccari é uma palmeira endêmica da região sul do Brasil, de valor econômico e cultural. Atualmente, a espécie está classificada como ameaçada de extinção, devido à expansão agrícola, urbanização e dificuldades de propagação da espécie. O objetivo deste trabalho foi de avaliar o efeito de fertilizantes NPK no crescimento inicial de mudas transplantadas de *B. eriospatha*. As mudas foram obtidas de área de regeneração natural no município de Curitibanos (SC), e transplantadas para vasos de 2,6 L contendo substrato comercial Carolina Soil®. O experimento foi conduzido em casa de vegetação, em delineamento inteiramente casualizado. Para a análise do efeito dos fertilizantes, foram utilizados sete tratamentos, sendo eles a aplicação de nitrogênio (N), fósforo (P), potássio (K), nitrogênio, fósforo e potássio (NPK), fósforo e nitrogênio (PN), nitrogênio e potássio (NK) e fósforo e potássio (PK), contendo 20 repetições cada e totalizando 140 plântulas. Os fertilizantes utilizados no experimento foram ureia, superfosfato triplo e cloreto de potássio, aplicados em períodos quinzenais. A cada bimestre foi avaliado o diâmetro de colo e altura de estipe, durante 22 meses. O melhor tratamento para o crescimento biométrico de mudas de *B. eriospatha* transplantadas para substrato comercial Carolina Soil® foi a associação de fósforo e nitrogênio.

PALAVRAS-CHAVE: biometria; arecaceae; produção de mudas.

ABSTRACT

Butia eriospatha (Martius ex Drude) Beccari is a palm tree endemic to the southern region of Brazil, of economic and cultural value. Currently, the species is classified as endangered, due to agricultural expansion, urbanization and difficulties in propagating the species. The objective of this study was to evaluate the effect of NPK fertilizers on the initial growth of transplanted seedlings of *B. eriospatha*. The seedlings were obtained from a natural regeneration area in the municipality of Curitibanos (SC), and transplanted to 2.6 L pots containing Carolina Soil® commercial substrate. The experiment was carried out in a greenhouse in a completely randomized design. To analyze the effect of fertilizers, seven treatments were used, namely the application of nitrogen (N), phosphorus (P), potassium (K), nitrogen, phosphorus and potassium (NPK), phosphorus and nitrogen (PN), nitrogen and potassium (NK) and phosphorus and potassium (PK), containing 20 replicates each and totaling 140 seedlings. The fertilizers used in the experiment were urea, triple superphosphate and potassium chloride, applied every two weeks. Every two months, the neck diameter and stem height were evaluated for 22 months. The best treatment for the biometric growth of *B. eriospatha* seedlings transplanted to Carolina Soil® commercial substrate was the association of phosphorus and nitrogen.

KEYWORDS: biometry; arecaceae; seedling production.

INTRODUCTION

The genus *Butia* (Arecaceae) encompasses 22 palm species native to South America, commonly referred to as jelly palms or pindo palms. They hold significant economic, cultural, and environmental value in their native regions, despite being underutilized and neglected species. *Butia eriospatha* (Martius ex Drude) Beccari, commonly called mountain butiá, is a species endemic to the southern Brazilian states, with a marked occurrence in the Mixed Ombrophilous Forest (BARBIERI et al. 2022, HEIDEN & SANT'ANNA-SANTOS 2023, CARVALHO 2014).

The species faces extinction risk due to severe habitat loss from agricultural and urban expansion in recent decades. It is currently classified as Vulnerable on the IUCN Red List of Threatened Species, Vulnerable in Brazil's Red Book of Threatened Flora, and Critically Endangered on Rio Grande do Sul's Threatened Species List (NOBLICK 1998, CNCFLORA 2013, RIO GRANDE DO SUL 2014).

Seedling production of B. *eriospatha* is hindered by low and slow germination rates, coupled with seed dormancy. Thus, rescuing plants from anthropogenically disturbed areas is a viable alternative for seedling production of this species. However, to ensure plants withstand field climate variations, it is crucial to produce high-quality seedlings with robust aerial parts and substantial leaf mass production (GOETEN et al. 2023, GUARDIA et al. 2021, WENDLING et al. 2020).

To optimize plant growth and vigor in the field, it is crucial to ensure the presence of essential nutrients in the soil for root absorption, as their absence can significantly impact growth and productivity. These elements are categorized based on their proportion in plant dry matter, with primary macronutrients comprising Nitrogen, a structural component of organic matter and enzymatic complexes; Phosphorus, responsible for cellular energy transfer; and Potassium, crucial for osmotic regulation and enzymatic activity. Fertilizers containing these macronutrients, known as NPK, enhance seedling growth in the early stages. Thus, it is possible to reduce production costs, since the transfer of plants to the field can be carried out in a shorter time (ROSA et al. 2021, PRADO 2020, EMER et al. 2019).

According to CARVALHO (2014), *B. eriospatha* exhibits slow growth, necessitating research into seedling production techniques, particularly those that accelerate initial plant growth, to meet demands for commercial cultivation and environmental restoration. Therefore, this study aimed to assess the impact of NPK fertilizers on the early growth of transplanted B. *eriospatha* seedlings.

MATERIAL AND METHODS

The seedlings were collected from a natural regeneration area within the urban zone of Curitibanos, Santa Catarina. The seedlings with a height of between 1.0 and 3.0 cm were selected and transplanted into 2.6 L pots. The substrate used was Carolina Soil®, which is made up of 70% Sphagnum peat, 10% perlite and 20% roasted rice straw, and has a pH of 5.65±0.25, a density of 220 kg m_3 and an electrical conductivity of 1.5±0.1 dS m^{-1} (PRADELA et al. 2018).

The experiment was carried out in a greenhouse at the Curitibanos Campus of the Federal University of Santa Catarina, using a completely randomized design. The seedlings were irrigated using an automated sprinkler system, delivering 0.9 to 1.0 L/min^{-1}, activated twice daily for two minutes throughout the experiment. This irrigation regimen was designed to simulate the average annual rainfall of the municipality, which ranges from 1,400 to 1,500 mm per year (WREGE et al. 2012).

To analyze the effect of fertilizers, seven treatments were established: nitrogen (N), phosphorus (P), potassium (K), nitrogen-phosphorus-potassium (NPK), phosphorus-nitrogen (PN), nitrogen-potassium (NK), and phosphorus-potassium (PK). Each treatment consisted of 20 replicates, totaling 140 seedlings. Fertilizers were manually applied biweekly using urea (45% nitrogen), triple superphosphate (46% P_2O_5), and potassium chloride (60% K_2O). For each application, 20 $mg.L^{-1}$ of nitrogen, phosphorus, and potassium were added to the substrate according to the respective treatment.

Biometric assessments were conducted bimonthly, measuring seedling collar diameter and stipe height using a digital caliper and ruler. Only non-destructive methods were employed, as the seedlings were pre-allocated for commercial planting. The assumptions of analysis of variance were not met due to non-normal data distribution. Therefore, the non-parametric Kruskal-Wallis test was employed for statistical analysis, with a significance level of α=0.05 and a probability of 5%, using RStudio software version 4.2.1.

RESULTS AND DISCUSSION

The results indicate that stem height in B*. eriospatha* seedlings was not significantly affected by the various treatments tested. Significant differences in stem diameter were observed among treatments, with the highest mean recorded for the combined application of phosphorus and nitrogen (PN) (Table 1).

Table 1. Collar diameter (mm) and stem height (cm) of *Butia eriospatha* seedlings in response to fertilization after 22 months.

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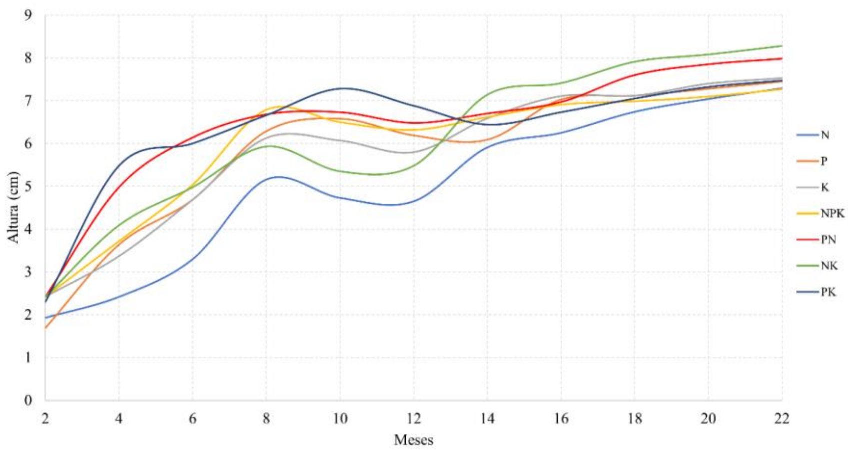
Treatment	Stem height (cm)	±S	Collar diameter (mm)	±S
N	7.29 a	±2.26	50.86 d	±19.25
P	7.45 a	±1.28	47.44 and	±11.30
K	7.53 a	±1.37	51.10 d	±21.42
NPK	7.27 a	±1.16	61.26 cm	±14.90
PN	7.98 a	±1.07	70.88 a	±14.93
NK	8.28 a	±1.45	60.19 cm	±15.52
PK	7.47 a	±0.82	67.52 b	±15.82

N: Nitrogen; P: Phosphorus; K: Potássio; NPK: Nitrogen; Phosphorus and Potassium; PN: Phosphorus and Nitrogen; NK: Nitrogen and Potassium; PK: Phosphorus and Potassium. Source: the Authors (2023). *Averages followed by different letters in the columns differ from each other, using the Kruskal-Wallis test at 5% probability.

Examining Figure 01, it is evident that at four and ten months of evaluation, there was a difference of approximately three centimeters in stipe height between the mean values of PK and N treatments. However, after ten months, stipe height growth stagnated, and treatments that had initially shown slow growth in height managed to achieve mean values comparable to other treatments. Thus, at the conclusion of the experiment, the variation in means between treatments was less than 1 cm. FERRAZ et al. (2022) also noted a plateau in height growth for *Dypsis lutescens* H. Wendl seedlings after an 11-month evaluation period.



N: Nitrogen; P: Phosphorus; K: Potássio; NPK: Nitrogen; Phosphorus and Potassium; PN: Phosphorus and Nitrogen; NK: Nitrogen and Potassium; PK: Phosphorus and Potassium.

Figure 1. Growth of *Butia eriospatha* seedlings in relation to stem height (cm) over 22 months.

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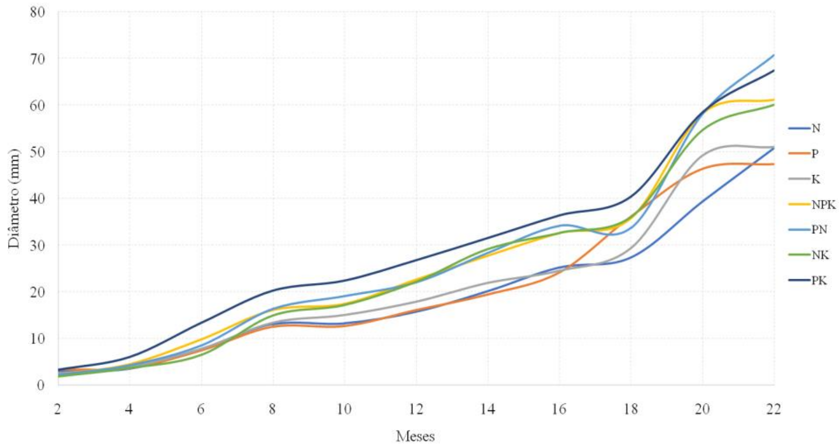
The container volume is a critical factor influencing plant development during the nursery phase, as it constrains root growth, limits vertical growth, reduces leaf area, and decreases biomass production (OLIVEIRA et al. 2008). NASCIMENTO & GATTI (2020), assessing the impact of container size on *Euterpe oleracea* Mart., found that larger containers (1.9 L) produced taller seedlings. They recommended smaller containers only for short-term nursery use, as growth stagnation in these containers increases seedling production costs. Thus, the observed growth stagnation in B. *eriospatha* seedlings is likely attributed to the container volume (2.6 L) used in this experiment.

Despite the stagnation in stem height growth of seedlings, the initial months revealed that treatments with Phosphorus and Potassium (PK) and Phosphorus and Nitrogen (PN) yielded the most favorable responses. Phosphorus fertilizers have demonstrated positive results for the growth of other species of the botanical family Aceraceae, such as *Rhapis excelsa* (Thunb.) Henry, who shows high stipe growth when phosphate fertilization is applied (LUZ et al. 2006).

Assessing the early development of *Butia capitata* (Mart.) Becc. in the north of Minas Gerais, AQUINO et al. (2007) noted that fertilizer additions did not influence seedling growth, attributing this to the high fertility of the experimental area and the species' adaptability to low-fertility environments. According to FIOR (2011), Butia seedlings thrive in moderately dense organic substrates without stringent fertilization or pH requirements. In addition, there is no recommendation for fertilization for adult butiás plants (LOPES et al. 2015). However, Table 1 reveals significant differences among treatments for stem diameter, and Figure 2 illustrates the seedlings' growth in this parameter throughout the experimental period.



N: Nitrogen; P: Phosphorus; K: Potássio; NPK: Nitrogen; Phosphorus and Potassium; PN: Phosphorus and Nitrogen; NK: Nitrogen and Potassium; PK: Phosphorus and Potassium.

Figure 2. Growth of *Butia eriospatha* seedlings in relation to stem diameter (mm) over 22 months.
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Unlike stem height, fertilizer applications did not yield visually discernible differences in collar diameter during the initial 10 months of the experiment. Only after the tenth month was there a marked increase in stem diameter, ultimately differentiating all treatments. For this variable, the application of Phosphorus and Nitrogen (PN) yielded superior results compared to other treatments. This finding aligns with Araújo's (2021) observations, which demonstrated that nitrogen and phosphorus fertilization synergistically enhances seedling growth and aerial dry mass accumulation in *Euterpe precatoria* Mart. In addition to positively influencing foliar levels of other elements, such as sulfur, calcium, zinc, and iron.

In general, plants exhibit diverse responses to phosphate fertilization, with pioneer species demonstrating the highest phosphorus uptake for dry matter accumulation (SANTOS et al. 2008). Even climatic species from the Arecaceae family have demonstrated positive results with phosphate fertilization, such as E*. precatória*, which, as observed by QUEIROZ NETO (2019), the increase in phosphorus doses contributes to the growth of seedlings. In addition, SOPRANO et al. *(2016),* observed an increase in dry matter due to the addition of phosphorus to the substrate in *Archontophoenix H*.Wendl seedlings. & Drude spp.

Evaluating the early development of B. *odorata* seedlings (Barb. Rodr.) Noblick, FIOR (2011) noted that the species tends to prioritize stem thickness development during periods of lower temperatures (winter). During warmer periods, it allocates its energy to various vegetative growth functions. Similarly, B. *eriospatha* seedlings in this study exhibited accelerated collar diameter growth from the eighth month of evaluation, coinciding with the onset of autumn in April 2020, when temperatures in the Curitibanos (SC) region decrease, enabling differentiation among treatment means.

The results of this study demonstrate the importance of phosphate fertilization for *B*. *eriospatha* seedling production, as the two best treatments for stem diameter included phosphorus in their composition. Phosphorus plays essential roles in plant cells, including energy capture and transfer, formation of new meristematic tissues, and composition of genetic materials (REETZ 2017). However, in this experiment, the application of phosphorus alone did not yield beneficial responses, suggesting the need for further studies evaluating different phosphorus concentrations to determine the optimal fertilizer formulation for B. *eriospatha* seedlings.

Nitrogen was correlated with potassium and phosphorus in treatments exhibiting the greatest stem heights. Stem diameter was positively correlated with phosphorus levels, with higher values observed in treatments with increased phosphorus application. Highlighting the importance of nitrogen fertilization for B. *eriospatha* seedling production. Nitrogen is a structural nutrient essential for organic matter composition, enzymatic biochemical reactions, and redox processes (PRADO 2020). BEZERRA et al. (2018), evaluating nitrogen sources and rates in *Euterpe oleracea* seedling production, observed through the Dickson Quality Index (DQI) that urea application promotes the production of higher-quality seedlings. However, no significant responses were observed for seedling height and stem diameter.

For stem diameter growth, studies with other palm species have shown a positive correlation with increased potassium fertilization rates, as observed in E. *precatoria* (BUTZKE et al. 2023) and E. *oleracea* (OLIVEIRA et al. 2011). However, potassium fertilization did not yield positive results for stem diameter in B. *eriospatha* seedlings. Only when combined with triple superphosphate did it reach 67.52 mm, which was statistically different from the best treatment but superior to the others. Potassium is a highly leachable element in soil, as noted by GOMES et al. (2002), long-term positive outcomes for forest species are not anticipated. Consequently, the applied potassium chloride (KCl) dosage may have been insufficient to compensate for fertilizer losses due to leaching.

CONCLUSION

It was concluded that for the production of *Butia eriospatha* seedlings in Carolina Soil ® commercial substrate, the biweekly application of 20 mg.L^{-1} of Phosphorus and Nitrogen provides a better collar diameter. Further research utilizing diverse substrates and fertilizer concentrations is recommended to establish optimal fertilization protocols for seedling production of this species.

REFERENCES

ARAÚJO JC. 2021. Adubação nitrogenada e fosfatada para produção de mudas de Açaizeiro Solteiro (*Euterpe precatoria* Mart.). Tese (Doutorado em Agronomia). Rio Branco: UFAC. 113p.

AQUINO CF et al. 2007. Resposta do coquinho-azedo à adubação mineral e orgânica em fase de desenvolvimento inicial. Revista Brasileira de Agroecologia 2: 1374-1377.

BARBIERI RL et al. 2022. *Butia odorata*: a palmeira dos butiazais em Tapes e na Fazenda São Miguel. In: TOZETTI AM et al. (Orgs.). Patrimônio natural dos butiazais da Fazenda São Miguel. Porto Alegre: Editora Fi. p.15-37.

BEZERRA JLS et al. 2018. Fontes e doses de nitrogênio na produção de mudas de açaizeiro (*Euterpe oleracea* Mart). Enciclopédia Biosfera 15: 541-553.

BUTZKE AG et al. 2023. Production of *Euterpe precatoria* Mart. seedlings in response to different dosages of nitrogen and potassium. Comunicate Scientia Horticultural Journal 14: 1-6.

CARVALHO PER. 2014. Espécies arbóreas brasileiras. 5vol. Brasília: Embrapa.

CNCFLORA. 2013. CENTRO NACIONAL DE CONSERVAÇÃO DA FLORA. Lista vermelha da flora ameaçada do Brasil. Rio de Janeiro: Instituto de Pesquisas do Jardim Botânico do Rio de Janeiro, 2013. Disponível em: http://cncflora.jbrj.gov.br/portal/ptbr/listavermelha/ARECACEAE. Acesso em: 18 maio 2023.

EMER AA et al. 2019. Controlled release fertilizer used for the growth of *Campomanesia aurea* seedlings. Ornamental horticulture 26: 35-44.

FERRAZ MV et al. 2022. Controlled release, organic or organomineral fertilizers for areca palm production. Ornamental Horticulture 28: 332-339.

FIOR CS. 2011. Propagação de *Butia odorata* (Barb. Rodr.) Noblick & Lorenzi. Tese (Doutorado em Fitotecnia). Porto Alegre: UFRGS. 202p.

GOETEN D et al. 2023. Effect of water content and biochemical cell state on the germination rate of cryopreserved *Butia eriospatha* embryos (Arecaceae). Plant Cell, Tissue and Organ Culture 152: 339-356.

GOMES JM et al. 2002. Parâmetros morfológicos na avaliação da qualidade de mudas de *Eucalyptus grandis*. Revista Árvore 26: 655-664.

GUARDIA MC et al. 2021. Crescimento de *Syagrus romanzoffiana* (Cham.) Glassman após resgate e realocação em unidade de conservação urbana. Ciência Florestal 31: 290-309.

HEIDEN G & SANT'ANNA-SANTOS BF. 2023. Butia in Flora e Fungo do Brasil. Jardim Botânico do Rio de Janeiro. Disponível em: https://www.floradobrasil.jbrj.gov.br/FB15703. Acesso em: 27 abr. 2023.

LOPES R et al. 2015. Palmeiras nativas do Brasil. Brasília: Embrapa.

LUZ PB et al. 2006. Efeitos de nitrogênio, fósforo e potássio no crescimento de *Raphis excelsa* (Thunberg) Henry ex. Rehder (Palmeira-Ráfia). Ciência e Agrotecnologia 30: 429-434.

NASCIMENTO WMO & GATTI LAP. 2020. Produção de mudas de Açaizeiro em recipientes de diferentes volumes. Belém: Embrapa Amazônia Oriental. 24p. (Boletim de Pesquisa e Desenvolvimento 143).

NOBLICK L. 1998. The IUCN red list of threatened species IUCN, 1998. Disponível em: https://www.iucnredlist.org/species/38462/10114794. Acesso em: 08 maio 2023.

OLIVEIRA CJ et al. 2011. Crescimento inicial de mudas de açaizeiro em resposta a doses de nitrogênio e potássio. Revista Verde 6: 227-237.

OLIVEIRA JP et al. 2008. Crescimento de mudas micropropagadas de bananeira aclimatizadas nas condições da Amazônia sul ocidental sob a influência de diferentes substratos e recipientes. Revista Brasileira de Fruticultura 30: 459-465.

PRADELA VA et al 2018. Fertilização com boro em plântulas de *Corymbia citriodora*. Brazilian Journal of Biosystems Engineering 12: 361-367.

PRADO RM. 2020. Nutrição de plantas. 2.ed. São Paulo: Editora Unesp Digital.

QUEIROZ NETO JC. 2019. Efeito das diferentes concentrações de nutrientes no crescimento do Açaizeiro (*Euterpe precatoria* Mart.). Trabalho de Conclusão de Curso (Graduação em Ciências Biológicas). Manaus: UFAM. 48p.

REETZ HF. 2017. Fertilizantes e o seu uso eficiente. Tradução: Alfredo Scheid Lopes. São Paulo: ANDA.

RIO GRANDE DO SUL. 2014. Decreto nº 52.109, de 1º de dezembro de 2014. Declara as espécies da flora nativa ameaçadas de extinção no Estado do Rio Grande do Sul. Porto Alegre: Diário Oficial do Estado.

ROSA DP et al. 2021 Liming and macronutrient on early growth of *Eucalyptus benthamii*. Ciência Rural 51: 1-10.

SANTOS JZL et al. 2008. Crescimento, acúmulo de fósforo e frações fosfatadas em mudas de sete espécies arbóreas nativas. Revista Árvore 32: 799-807.

SOPRANO E et al. 2016. Efeito de diferentes tratamentos no crescimento de mudas de Palmeira-Real-Australiana. Revista de Agricultura 91: 265-273.

WENDLING I et al. 2020. Manual de produção de mudas clonais de erva-mate. Colombo: Embrapa Florestas. 47p. (Documento 336).

WREGE MS et al (Ed). 2012. Atlas climático da região Sul do Brasil. 2.ed. Brasília: Embrapa.