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Effect of Osmocote® in the growth and nutrition of *Lecythis lurida* seedlings (Lecythidaceae)

Efeito do Osmocote® no crescimento e nutrição de mudas de Lecythis lurida (Lecythidaceae)

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RESUMO

O sucesso de projetos de reflorestamento para fins comerciais e ambientais depende, dentre outros fatores, da disponibilidade de nutrientes durante a produção de mudas. O fertilizante de liberação controlada é muito empregado porque proporciona menor tempo de formação de mudas com menor perda de nutrientes por lixiviação. O objetivo do estudo foi avaliar a eficiência do fertilizante Osmocote® no crescimento inicial e nutrição de mudas de *Lecythis lurida*. As mudas foram produzidas de sementes, coletadas de árvores matrizes nos municípios de Vitória do Xingu e Altamira, Estado do Pará. A semeadura foi realizada em sacos plásticos de 1 dm^3 de capacidade, previamente preenchidos com substrato de fibra de coco acrescidos com doses de fertilizante Osmocote®. O delineamento experimental adotado foi inteiramente casualizado com único fator (dose de Osmocote®) distribuído em cinco doses: 0,0 (controle); 2,0; 4,0; 6,0 e 8,0 g L^{-1} de fertilizante Osmocote®. Para cada tratamento foram utilizadas 20 repetições. Aos 120 dias após a emergência foram avaliados os parâmetros morfológicos para determinar o crescimento das mudas e análise nutricional das folhas. A dose de Osmocote® que forneceu melhor resposta para às variáveis morfológicas foi 6,0 g L^{-1}. Os teores médios de macros e micronutrientes extraídos e exportados em cada tratamento pela muda de *Lecythis lurida* obedeceram a seguinte ordem: K>N>Mg>S>Ca>P>Fe>Mn>Zn>B>Cu. Conclui-se, que a dose 6,0 g L^{-1} de Osmocote® melhorou a nutrição e a qualidade das mudas de *Lecythis lurida*. O uso de fertilizante Osmocote® possibilita maior crescimento e melhor estado nutricional para as mudas de *Lecythis lurida*.

PALAVRAS-CHAVE: análise nutricional; silvicultura; nutrição de plantas; fertilização.

ABSTRACT

The success of reforestation projects for commercial and environmental purposes depends, among other factors, on the availability of nutrients during seedling production. Controlled-release fertilizer is widely used because it provides shorter seedling formation time with less loss of nutrients through leaching. The objective of the study was to evaluate the efficiency of Osmocote® fertilizer in the initial growth and nutrition of *Lecythis lurida* seedlings. The seedlings were produced from seeds collected from mother trees in the municipalities of Vitória do Xingu and Altamira, State of Pará. Sowing was carried out in plastic bags with a capacity of 1 dm^3, filled with coconut fiber substrate plus dded with doses of Osmocote® fertilizer. The experimental design adopted was completely randomized with a single factor (dose of Osmocote®) distributed into five doses: 0.0 (control); 2.0; 4.0; 6.0 and 8.0 g L^{-1} of Osmocote® fertilizer. For each treatment, 20 replications were used. At 120 days after emergence, morphological parameters were evaluated to determine the growth of the seedling and nutritional analysis of the leaves. The dose of Osmocote® that provided the best response to morphological variables was 6.0 g L^{-1}. The average content of macro and micronutrients extracted and exported in each treatment by the *Lecythis lurida* seedling obeyed the following order: K>N>Mg>S>Ca>P>Fe>Mn>Zn>B>Cu. It is concluded that dose 6.0 g L^{-1} of Osmocote® improved the nutrition and quality of *Lecythis lurida* seedlings. The use of Osmocote® fertilizer allows greater growth and better nutritional status for *Lecythis lurida* seedlings.

KEYWORDS: nutritional analysis; forestry; plant nutrition; fertilization.

INTRODUCTION

Lecythis lurida (Miers) S. A. Mori is a species of the Lecythidaceae family, popularly known as Jarana or Inhaíba. This species belongs to the late secondary canopy ecological group and is endemic to Brazil, occurring in terra firme forests within the Amazon and Atlantic Forest phytogeographic domains (DUARTE et al. 2020). The wood of *Lecythis lurida* is mainly used in heavy internal civil construction as beams, rafters, planks and boards in roof structures (CORRÊA et al. 2018). Although this species shows considerable economic and environmental potential, technical information regarding its nutritional and silvicultural aspects remains limited. Among silvicultural practices, forest seedling production represents a crucial initial phase in the sequence of operations aimed at establishing forest stands.

However, during the seedling production stage, several factors such as fertilization, light, temperature, substrate, water, and seed quality can affect the development of forest species seedlings (BRACHTVOGEL & MALAVASI 2010) and, consequently, their subsequent field performance and growth. Fertilization is a crucial aspect directly linked to seedling quality, yet remains poorly understood for native species (ROSSA et al. 2013). Furthermore, the high diversity of existing species poses another problem, due to the lack of details on nutritional recommendations and requirements (SILVA et al. 2022). Thus, during seedling production, the nutritional status must be considered, so that the seedlings do not suffer losses in growth due to deficiency or excess of nutrients (CUNHA et al. 2021).

In forest nurseries, seedling production relies on two main fertilization techniques: conventional immediate-release and controlled-release fertilizers. One of the advantages of conventional fertilization is the immediate supply of readily available nutrients for plants. However, it has some disadvantages, such as nutrient leaching and economic waste due to the drop in nutrient use efficiency (VEJAN et al. 2021, ARAÚJO et al. 2023). Controlled release fertilization (CRF) provides nutrients to target plants slowly over months, increasing the symmetry between nutrient availability and plant nutritional demand, in order to reduce nutrient loss and increase crop yield (ABDULLAH et al. 2023). Greater efficiency in the use of nutrients promotes increases in photosynthesis and consequently in the production of biomass and seedling quality (ROSSA et al. 2013, SILVA et al. 2019, JARDIM et al. 2023). Thus, the use of CRF can reduce the time for seedling formation compared to conventional fertilizer (OLIVEIRA et al. 2021).

One of the first FLC lines launched on the market was Osmocote®, featuring a polymeric coating that covers fertilizer salt granules (ABDULLAH et al. 2023). The diffusion process ensures the quantity of nutrients according to the plants' needs, reducing losses due to leaching and the negative effects of high salinity in the soil solution (GOMES et al. 2017). In addition to the primary macronutrients nitrogen (N), phosphorus (P), and potassium (K), Osmocote® granules also contain magnesium (Mg), sulfur (S), iron (Fe), boron (B), zinc (Zn), copper (Cu), and molybdenum (Mo). The durability of Osmocote® varies from 3 to 16 months (ABDULLAH et al. 2023).

Therefore, understanding species-specific nutritional requirements is crucial for developing effective fertilization protocols. In this sense, the following question was raised: Does Osmocote® influence growth rates and nutrient concentrations for obtaining *Lecythis lurida* seedlings? Therefore, we hypothesized that Osmocote® fertilizer would promote healthy seedling growth of *Lecythis lurida* under greenhouse conditions. To clarify this topic, CRF can be used to produce *Lecythis lurida* seedlings and then make them available for commercialization.

Therefore, this study aimed to evaluate the efficiency of Osmocote® fertilizer on early growth and nutrition of *Lecythis lurida* seedlings under greenhouse conditions.

MATERIAL AND METHODS

The experiment was conducted in a greenhouse at the Federal University of Pará (UFPA), Altamira, Pará State, Brazil. The climate of Altamira, according to Köppen, is of the equatorial type Am and Aw, with an average temperature of 26 ºC, an average annual rainfall of 1,700 mm and a relative humidity of 80% (ALVARES et al. 2013).

Lecythis lurida seeds were collected from native plants in legal reserve areas owned by ELETRONORTE S/A in Vitória do Xingu and Altamira municipalities. Selected seeds were sown in 1 dm^3 plastic bags containing coconut fiber substrate (AMAFIBRA®) supplemented with Osmocote® fertilizer at the planned rates. The Osmocote® formulation used is 15-09-12 in NPK plus 1.3% Mg and 2.3% S. It also has the following composition in relation to micronutrients: Cu (0.05%), Fe (0.45%), Mn (0.06%) and Mo (0.02%). The complete nutrient release period ranges from 3 to 4 months. O delineamento experimental adotado foi inteiramente casualizado com único fator (dose de Osmocote®) distribuído em cinco doses: 0,0 (controle); 2,0; 4,0; 6,0 e 8,0 g L^{-1} de fertilizante Osmocote®. Twenty replicates (one plant per replicate) were used for each treatment. The seedlings were maintained for 120 days in a greenhouse under 50% shade cloth with daily irrigation.

Plants were harvested at 120 days for evaluation. Plant height (H) was measured from the substrate surface to the apical meristem using a millimeter ruler. Stem diameter (SD) was measured at the root collar using a digital caliper (mm). The number of leaves (NL) was determined by direct counting. Plant samples were separated into shoots and roots and oven-dried at 70 °C until constant weight. After drying, dry mass of the aerial part (g) (DMAP) and dry mass of the root system (g) (DMRS) were determined. These parameters were transformed into the following indices: ratio between stem height and diameter (H/SD), total dry mass (TDM = DMAP + RDM) and the Dickson Quality Index (DQI), according to equation (1).

$$IQD = \frac{MST}{\frac{H}{DC} + \frac{MSPA}{MSR}} \quad (1)$$

Where: DQI – Dickson Quality Index; TDM – total dry mass (g); H – height (cm); SD – Stem diameter (mm); DMAP – Dry mass of the aerial part (g); DMRS – Dry mass of the root system (g).

Determination of macronutrient levels: N (Kjeldahl method), P, K, Ca, Mg, S, Cu, Zn, Fe, Mn (wet nitroperchloric digestion) and B (dry digestion), using the ICP-OES equipment. All analyses were performed in the Leaf Analysis laboratory of the Soil Institute of the Federal University of Lavras, MG.

Data normality and homogeneity were assessed using Shapiro-Wilk and Bartlett's tests, respectively. Analysis of variance (ANOVA) was performed, and when significant differences were detected by F-test, means were compared using Scott-Knott test ($p<0.05$). Polynomial regression analysis was performed to evaluate the effects of Osmocote® rates. The maximum technical efficiency dose (MTED) was estimated when the quadratic equation showed significant effects. Data were analyzed using SISVAR software (FERREIRA 2011).

RESULTS AND DISCUSSION

Morphological variables of *Lecythis lurida* seedlings

The information generated in the ANOVA is summarized in Table 1. The morphological variables exhibited quadratic behavior in the regression equations as a function of different Osmocote® fertilizer rates, except for the H/SD ratio (Figures 1 and 2). The quadratic behavior proves that plant growth variables increase up to the maximum technical efficiency dose (MTED), with a decrease occurring at higher doses of fertilizer (MENEGATTI et al. 2020). The coefficients of variation (CV) ranged from 9.90 to 21.76%, which are considered moderate values for greenhouse experiments (PIMENTEL-GOMES 2009).

The highest mean number of leaves per plant (6.7) was achieved at the estimated maximum economic technical dose (METD) of 5.9 g L^{-1} for plants grown under greenhouse conditions (Figure 1A). A 68% increase in leaf number was observed compared to non-fertilized seedlings (control). Result ratified by SANTOS et al. (2020), who noticed a greater number of leaves at 120 days at the estimated dose of 6.44 kg m^{-3} of controlled-release fertilizer Basacote®.

Table 1. Summary of ANOVA of the measurements of growth parameters of the species *Lecythis lurida* as a function of the doses of Osmocote®, after 120 days of cultivation.

Table 1. Summary of the ANOVA of the measurements of the growth parameters of the species Lecythis lurida as a function of the doses of Osmocote®, at 120 days of cultivation .

SV	DF	Mean Square							
		NL	H	SD	H/SD	DMAP	DMSR	TDM	DQI
Doses	4	0.89**	288.39**	8.78**	0.200^{ns}	12.44**	4.77**	32.38**	0.63**
CV (%)		12.10	21.76	18.13	14.73	20.45	17.39	20.46	9.900
GM		5.500	22.10	4.320	5.120	2.600	1.740	4,.20	0.640

SV: source of variation; DF: degrees of freedom; CV: coefficient of variation; GM: general mean. (**) significant at the 1% level of probability of error; (^{ns}) non-significant.

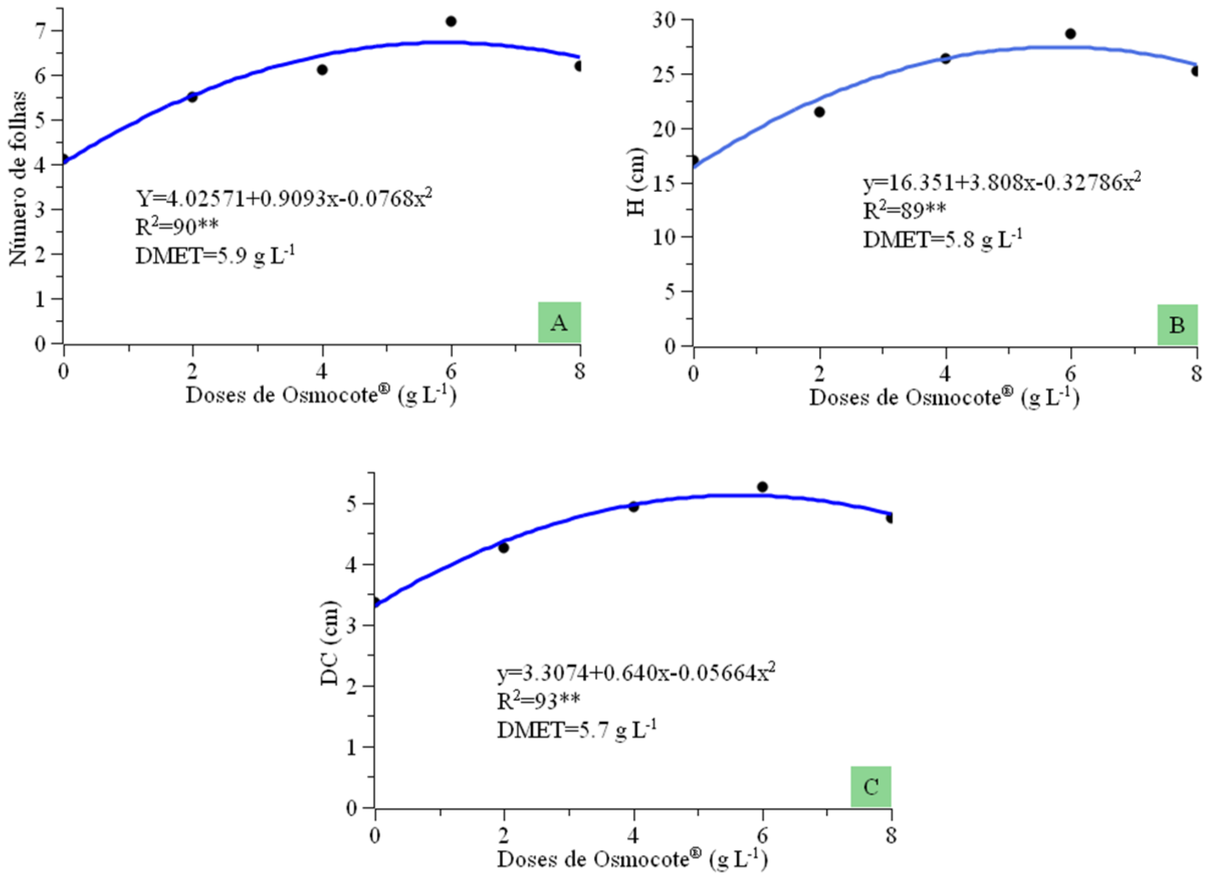

Figure 1. Average results of the number of leaves (A), height (B) and stem diameter (C) of *Lecythis lurida* seedlings subjected to different doses of Osmocote® at 120 days after sowing.

Lecythis lurida seedlings reached a higher average height (27.4 cm) with the estimated MTED of 5.8 g L^{-1} of Osmocote® fertilizer (Figure 1B). Resulting in an 11 cm increase in height compared to control seedlings. This increase demonstrates better plant development under greater nutrient availability, a fact confirmed in other studies (SILVA et al. 2019, MADRID-AISPURO et al. 2020). However, Osmocote® doses exceeding the MTED resulted in reduced height, indicating that nutrient excess is detrimental to seedling development.

Height is a key parameter for screening suitable seedlings for commercialization or field cultivation. However, management techniques and seedling production processes can modify the standard planting size. Therefore, selecting seedlings based solely on height is a serious mistake, as the selected batch may contain etiolated seedlings.

At MTED, the mean diameter was estimated at 5.1 mm, representing a 55% growth increment compared to the stem diameter of control seedlings (Figure 1C). A similar result was observed by SILVA et al. (2019) using Osmocote® for *Acacia mangium* seedlings, in which the best dose for diameter growth was 7.77 kg m^{-3} of substrate.

Height and diameter are key parameters used by forestry companies in selecting seedlings for field cultivation. Seedlings considered suitable have a height between 15 and 25 cm and SD of 2.5 mm (FREITAS et al. 2021). Therefore, *Lecythis lurida* seedlings at all tested doses are suitable for forestry operations.

For the H/SD ratio, different Osmocote® doses showed no significant differences ($p>0.05$), with a mean value of 5.1 (Table 1). This result is within the range of values attributed in the literature for forest species (DANTAS et al. 2018). These authors suggest a maximum H/SD ratio of 10 for forest seedlings. For greater chances of seedling survival in the field, lower values for the H/SD index should be (COSTA et al. 2022).

The seedling dry mass of *Lecythis lurida* was significantly affected by increasing doses of Osmocote® fertilizer. The DMAP was estimated at 3.52 g with the estimated DMET of 5.9 g L^{-1} of Osmocote® fertilizer (Figure 2A). Comparing with the DMAP obtained in the control plants, an increase of 138% was observed. JARDIM et al. (2023) observed similar behavior in *Calophyllum brasiliense* Cambess seedlings in response to Osmocote® application, with optimal results achieved at 4.2 g L^{-1} of substrate.

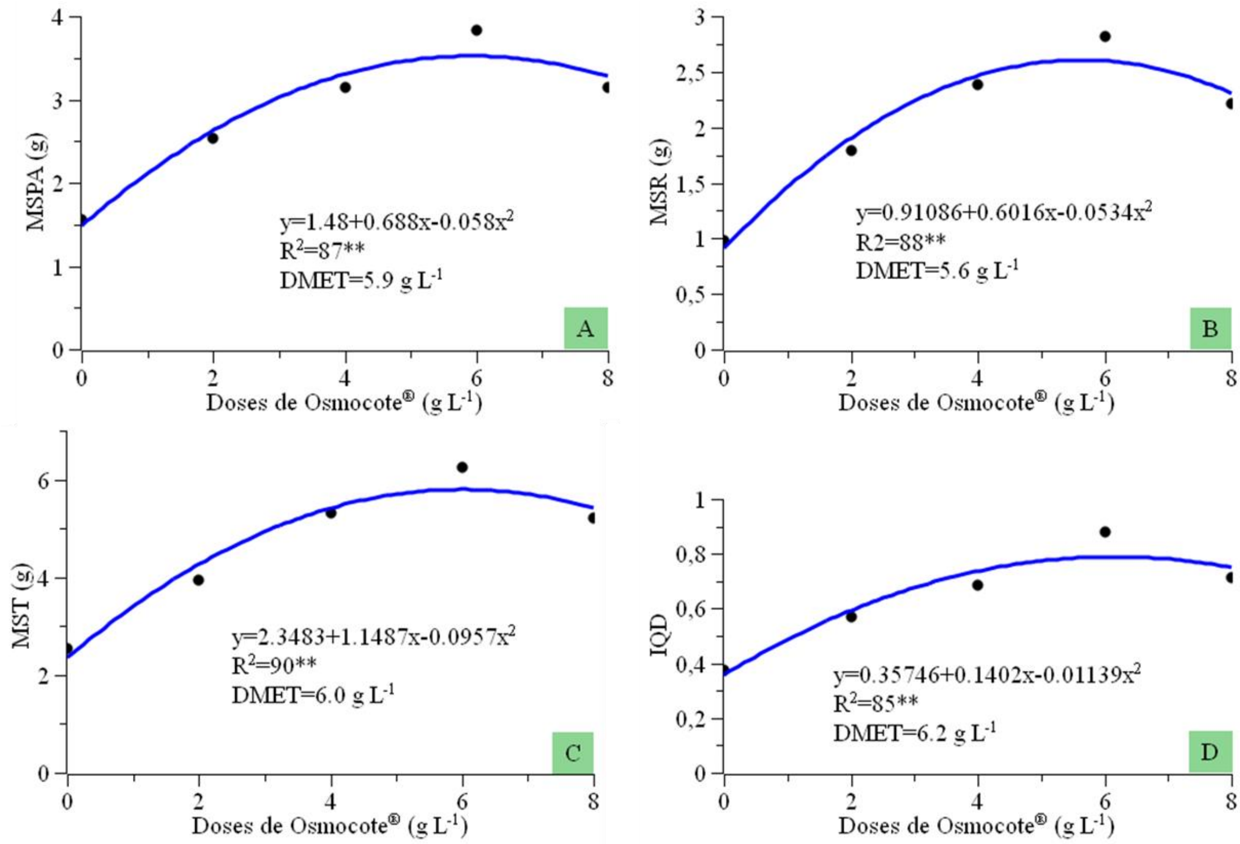

Figure 2. Average results of dry mass of the aerial part (A), root (B), total (C) and Dickson Quality Index (D) of *Lecythis lurida* seedlings subjected to different doses of Osmocote® at 120 days after sowing.

The DMAP measurement is an alternative method of measuring the development and quality of seedlings; this variable expresses the rusticity of the seedling (SMIDERLE et al. 2018). Seedlings with high shoot dry matter content tend to be more lignified and hardy, resulting in thicker and harder tissues that enhance their resistance and durability. This enhanced resilience enables seedlings to better withstand adverse conditions, including drought periods, strong winds, pest and disease attacks, and other environmental stressors.

Root dry matter (RDM) was significantly affected by different rates of Osmocote® fertilizer. At MTED, the root dry mass (RDM) reached 2.6 g, representing a 186% increase compared to the control (Figure 2B). Behavior similar to that observed by JARDIM et al. (2023) in research conducted *on Calophyllum brasiliense* Cambess seedlings subjected to increasing doses of Osmocote® and by ROSSA et al. (2013) working with slow-release fertilization in *Schinus terebinthifolius and Sebastiania commersoniana* seedlings.

The value of 5.8 g for the TDM of *Lecythis lurida* plants was estimated in MTED (Figure 2C). Compared to the control seedlings, dry matter increased by 147%. According to SANTOS et al. (2020) the accumulated TDM in the seedling results from net photosynthetic production plus the mass of mineral nutrients absorbed by the plant.

The highest DQI value (0.9) was obtained with the estimated MTED (6.2 g L^{-1}) for *Lecythis lurida* plants grown under greenhouse conditions (Figure 2D). The higher the DQI value, the better seedlings produced to be cultivated in the field (FREITAS et al. 2017). According to the authors, the DQI is a balanced index, as it combines other parameters such as TDM, H/SD and DMAP/DMSR. This index is widely employed in forest species assessment, particularly in academic research.

Morphological analyses revealed that a 6.0 g L^{-1} dose of Osmocote® fertilizer was sufficient to achieve the desired quality parameters. Other studies corroborate average doses (6 g L^{-1}), similar to that of the present study, generating adequate growth of forest species. MARTÍNEZ-NEVÁREZ et al. (2023) found that a dose of 6 g L^{-1} of CRF enhanced growth and nutrition of *Pinus cooperi* seedlings under nursery conditions. In turn, JARDIM & SILVA (2023) recommended applying 6.0 g L^{-1} of Osmocote® during the initial growth stage of *Theobroma cacao* seedlings in nursery conditions.

Nutritional analysis of *Lecythis lurida* leaves

To date, there are no references in the literature establishing optimal levels of macro and micronutrients for *Lecythis lurida*. In this case, best practice involves careful monitoring of plant development and adjusting fertilization according to nutritional requirements. Seeking to maintain an adequate nutritional balance to promote good growth and health of *Lecythis lurida* seedlings.

Table 2 presents the leaf analysis data of macro and micronutrients in *Lecythis lurida* seedlings. The Osmocote® doses influenced the concentration of most nutrients in the shoot dry matter. The macronutrient content in seedlings followed the decreasing order K>N>Mg>S>Ca>P during the initial growth phase of *Lecythis lurida*. The average content of each micronutrient in each treatment follows the order Fe>Mn>Zn>B>Cu. In the literature it is common to find orders for nutrient contents different from those presented here (WALTER et al. 2022, MADRID-AISPURO et al. 2020). These nutrients are required by plants in quantities that vary according to the species and stage of development (NEVES & FIOR 2020), and the origin and progeny can also be added (SILVA et al. 2022, SANTOS et al. 2020).

The Osmocote® fertilizer had no significant effect ($p>0.05$) on the N concentration in the aerial part of *Lecythis lurida* seedlings (Table 2). It should be noted that the values found in the study remain within the range of 12 to 35 g kg^{-1} considered adequate for N by MALAVOLTA et al. (1997). Nitrogen is an essential macronutrient for plant growth and development. N is part of cellular components, such as amino acids, nucleic acids and is related to important physiological processes, such as photosynthesis and cell division (MARTÍNEZ-NEVÁREZ et al. 2023).

Leaf P content in control plants was significantly lower compared to CRF treatments, suggesting high P availability from controlled-release fertilizer in the substrate (Table 2). The highest concentration of P (3.93 g kg^{-1}) was obtained at the highest dose of Osmocote® , considered normal according to KOPINGA & VAN DEN BURG (1995). The P contents obtained from the 4.0 g L^{-1} dose fall within the range of 1.2 to 4.0 g kg^{-1} established for most tropical plants (MALAVOLTA et al. 1997). P performs essential functions in the plant's cellular energy metabolism and in the photosynthesis process, which are directly related to growth (MARTÍNEZ-NEVÁREZ et al. 2023).

Table 2. Average macro and micronutrient contents in the dry mass of *Lecythis lurida* leaves according to Osmocote® doses, after 120 days of cultivation.

Dose (g L^{-1})	Macronutrients (g $kg^{-1)}$						Micronutrients (mg kg^{-1})				
	N	P	K	Ca	Mg	S	Ass	Zn	Fe	Mn	B
0.0 (controle)	20.4 a	0.83 c	10.98 b	1.72 d	3.65 c	3.31 b	6.43 b	22.93 b	103.0 a	44.67 a	17.4 b
2.0	19.7 a	1.05 c	19.29 a	2.34 c	4.11 b	3.92 a	8.04 a	32.66 a	110.9 a	67.11 a	16.3 b
4.0	19.5 a	1.24 c	20.65 a	2.41 c	4.29 b	4.02 a	7.24 a	30.71 a	88.75 b	52.13 a	24.2 a
6.0	19.7 a	2.18 b	22.44 a	3.23 b	4.65 a	4.20 a	7.80 a	33.99 a	76.81 b	57.40 a	23.6 a
8.0	19.5 a	3.93 a	23.07 to	4.44 a	5.15 a	3.63 b	7.50 a	35.16 a	93.67 b	62.89 a	29.7 a

Means followed by the same letter in the column do not differ from each other by the Scott-Knott test ($p<0.05$).

Regarding K, there was a substantial 76% increase in nutrient concentration between the control and the 2.0 g L^{-1} Osmocote® treatment (Table 2). This marked increase highlights the critical role of this nutrient during this developmental stage. This finding aligns with EPSTEIN & BLOOM (2004), who established that a K content of 10 g kg^{-1} in plant dry matter is suitable across species. Among the cations present in plants, K stands out for being the most abundant (HANSEL et al. 2021). K acts directly on photosynthetic activity, on maintaining water in plant tissues, increases N absorption and protein synthesis (MEURER et al. 2018).

Calcium content increased with higher doses of Osmocote® in the substrate (Table 2). At the 8.0 g L^{-1} Osmocote® rate, calcium content was 4.4 g kg^{-1}. EPSTEIN & BLOOM (2004) present 5 g kg^{-1} as a reference for the Ca content in the dry matter of plants. On the other hand, Larcher (2004) reported calcium concentrations in plants ranging from 3 to 15 g kg^{-1}. Therefore, the calcium content found in the present study falls within the acceptable range reported in previous studies. According to MALAVOLTA et al. According to research conducted in 1997, N and P supplementation promotes calcium accumulation in leaves. Therefore, the increase in Ca levels correlates with P content as Osmocote® rates increase.

Similarly to Ca, Mg content increased with increasing rates of Osmocote® fertilizer (Table 2). At a dose of 8.0 g L^{-1} of Osmocote® , the Mg content in the aerial part of *Lecythis lurida* seedlings was 5.15 g kg^{-1} . This result is corroborated by MALAVOLTA et al. (1997), who establish values in the range of 1.5 to 5.0 g kg^{-1} as adequate levels for Mg in forest species. The SBCS-CQFS (2004) also establishes that for forest species, suitable values for Mg are in the range between 2 and 8 g kg^{-1}. Therefore, in all treatments, including control plants, magnesium content remained within acceptable ranges according to established literature.

Regarding S, the highest content (4.2 g kg^{-1}) in *Lecythis lurida* seedling leaves was observed at the 6.0 g L^{-1} Osmocote® rate (Table 2). EPSTEIN & BLOOM (2004) reported that 1.0 g kg^{-1} is adequate for plant S content, while SBCS-CQFS (2004) established a range between 1.0 and 2.0 g kg^{-1}.

The Fe content in *Lecythis lurida* leaves started high at the 2.0 g L^{-1} dose, decreased at intermediate doses, and then increased again at the highest Osmocote® dose (Table 2). A plausible explanation may be attributed to the dilution effect, as the substantial increase in leaf dry biomass (Figure 2) leads to decreased concentrations of certain elements. The quadratic response to Osmocote® rates aligns with a decrease and subsequent increase in nutrient levels at the highest Osmocote® rate. However, the Fe concentration in *Lecythis lurida* leaves ranged from 76.81 to 110.91 g kg^{-1}. In this interval, the Fe content is in the adequate range, considering that the Fe content in plant tissues varies between 25 and 200 mg kg^{-1} (VIEIRA et al. 2020).

The Mn content found in the leaves of *Lecythis lurida* showed a similar behavior to that of iron. In the leaf dry biomass of *Lecythis lurida*, Mn content ranged from 44.67 to 67.11 g kg^{-1} (Table 2). According to Dechen and Nachtigall (2006), optimal Mn concentrations for plant growth and development range from 20 to 500 mg kg^{-1}, with lower values potentially causing deficiency and higher values leading to toxicity. Mn plays a crucial role in activating enzymes in the shikimate pathway, which is responsible for coumarin biosynthesis (MARSCHNER 2012), highlighting the importance of proper nutrient uptake.

Zinc content increased with higher doses of Osmocote® (Table 2). At the 8.0 g L^{-1} Osmocote® rate, Zn content reached 35.16 g kg^{-1}. FAQUIN (2005) classified Zn concentrations in plants into three categories: optimal range (20-120 mg kg^{-1}), deficiency symptoms (<20 mg kg^{-1}), and toxicity (>400 mg kg^{-1}). The species *Lecythis lurida* in this work presented levels within the range considered optimal. It should be noted that Zn is essential for the healthy growth of plants, however, when present in high concentrations, it can become toxic and cause damage to plants. Zn is involved in the structure and function of over 300 enzymes, auxin synthesis, and forms part of the structural proteins that bind to form DNA molecules (SABOOR et al. 2021).

Copper concentrations showed minimal variation among treatments, ranging from 6.43 to 8.04 g kg^{-1} (Table 2). The literature has reported data on Cu contents in different variations in plant tissue. For example, RUSSO et al. (2022) found values ranging from 3.5 to 9.8 mg kg^{-1} when quantifying nutrient contents in *Copaifera langsdorffii* Desf. leaves across different phytophysiognomies. Cu is not only a component of various enzymes, but also closely related to carbon assimilation, N metabolism, uptake and redox processes in plants (LIU et al. 2022).

B content increased with Osmocote® fertilization (Table 2). The B levels found in the dry matter of the aerial part of *Lecythis lurida* vary between 16.3-29.7 mg kg^{-1}. According to EPSTEIN & BLOOM (2004), the reference value for B content is approximately 20 mg kg^{-1} in plant dry matter. However, SBCS-SQFS (2004) expanded the adequate B content range to between 10 and 50 mg kg^{-1} for certain forest species. Finally, DECHEN & NACHTIGALL (2006) suggested that plants with levels below 15 mg kg^{-1} are deficient in this micronutrient. The role of B in plants is related to better growth, development, productivity and quality of crops (KOHLI et al. 2023). Dicotyledonous species, such as *Lecythis lurida*, require medium levels of B, however, at high concentrations the plants are severely affected (KOHLI et al. 2023). Therefore, our findings regarding B are fully consistent with optimal plant standards reported in the literature.

Overall, results confirmed that Osmocote® fertilizer enhances growth and nutritional status of *Lecythis lurida* seedlings. Controlled release fertilizers reduce nutrient loss through leaching, due to the supply of nutrients in synchrony with the plant's needs (GOMES et al. 2017) and in this study the plant responses, expressed in morphological and nutritional quality indices, confirmed these effects (Figures 1 and 2 and Table 2). Finally, field trials are recommended to assess the economic trade-offs between controlled-release and conventional fertilizers.

CONCLUSION

Based on the results, the 6.0 g L^{-1} dose of Osmocote® fertilizer proved optimal for promoting seedling growth and vigor in *Lecythis lurida*. This rate promotes enhanced morphological parameters, indicating superior seedling development. The optimal dose promotes adequate nutritional status in *Lecythis lurida* seedlings, enhancing the production of high-quality seedlings under greenhouse conditions.

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