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Effect of different container volumes and concentration of the controlled release fertilizer in the production of *Eugenia involucrata* DC. seedlings

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Eugenia involucrata **DC. (Myrtaceae) stands out by its ecological potential, and it is indicated in planting in degraded areas and permanent preserved areas. Because of its importance, the work aimed to evaluate the effect of different container volumes and concentrations of controlled release fertilizer (CRF) in the seedlings emergence and the seedlings growth of *E. involucrata* in nursery. The experiment was conducted in Laboratory of Silviculture and Forest Nursery, Santa Maria, RS, Brazil. The fruits of *E. involucrata* were collected from eight trees in a fragment of Subtropical Seasonal Forest. For installation of the experiment, substrate which constituted of a mixture of 80% of commercial substrate mixed to 20% of carbonized rice husk was used. In this study, two container volumes (tubes with 110 and 180 cm^3 of capacity) and five doses of CRF (0, 3, 6, 9 and 12 g L^{-1}), were evaluated with four repetitions, using completely randomized design. The emergence variables, the emergence speed index and average time of emergence were analyzed, besides the height, stem diameter and relation height/diameter of the stem. The seedlings emergence had the beginning at 77 days after sowing, and it was established at 126 days. For production of seedlings indicated the use of container of 180 cm^3, allied to the dose of 12 g L^{-1} of CRF. Nevertheless, considering the long time necessary to the emergence and the slow species growth, the topdressing will be necessary since this fertilizer presents determined time of efficiency.**

Key words: Native species, fertilizing, forest nursery.

INTRODUCTION

Eugenia involucrata DC., belongs to the Myrtaceae family, occurs naturally in Argentina, Paraguay, Uruguay and Brazil (Carvalho, 2008). The species has antiulcer, anti-diarrheic and digestive medicinal potential (Sausen et al., 2009), antioxidant (Marin et al., 2008) and, according to Franzon and Raseira (2006), it has *in natura* or processed food utilization. Besides that, *E. involucrata* presents great ecological importance because it presents honey

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flowers and attractive fruit to the wild fauna, and it is indicated to the planting in areas of permanent preservation (Backes and Irgang, 2009).

In this way, considering the potentialities highlighted for *E. involucrata,* mainly in relation to its use in projects of riparian forest restoration, it becomes essential carrying out studies that focus on the quality of the seedlings, in special address of factors linked to its propagation, which according to Mendonça et al. (2009) and Alegretti et al. (2015) still lack information. In obtaining qualified seedlings, one should consider the different characteristics of growth of forest species, which can be partially controlled by silviculture, by means of adequate techniques of production, which consider the different types of containers and substrates, nutritional and hydric demands, among other aspects (Saidelles et al., 2009).

The choice of container to be used is very important for the seedlings production, implying additional costs with substrate when using containers that are bigger than the recommended ones (Viana et al., 2008). Besides, this influences the quantity of water and available nutrients for the seedling growth (Brachtvogel and Malavasi, 2010). The ideal size of the container depends on the characteristics of the species growth, on the substrate used and on the climate conditions, and it has influence on the development not only of the root but also the aerial part of the seedlings (Viana et al., 2008).

However, the use of containers with limited dimensions makes the root system subject to physical restrictions (Danner et al., 2007), mainly when associated with a long permanence of the seedlings in these containers, so it is necessary for specific studies on the distinct forest species as a way of subsidizing practical information to the nurserymen. In this sense, Souza et al. (2015) and Dutra et al. (2016) reported that the search for alternative components, ecologically viable and of low cost are of extreme importance for the seedlings propagation, as for example, the carbonized rice husk mixed to the substrate.

Besides the size of the container, the fertilization used is also considered a relevant factor for the good development of seedlings (Rossa et al., 2013). One of the fertilizers used for the seedlings production in nursery is denominated controlled release fertilizer (CRF), which, due to the slow and continuous release of nutrients, offers practicality to the seedlings production in containers, reducing the possibility of losses by leaching and maintaining the plant with available nutrients during determined period (Jacobs and Landis, 2009). Nevertheless, because of the elevated acquisition cost, it becomes fundamental to determine the adequate concentration for each species and systems of production (Rossa et al., 2013).

In this way, the aim of this work was to evaluate the effect of different volumes of container and concentrations of controlled release fertilizer in the seedlings production of *Eugenia involucrata* DC. in nursery.

MATERIALS AND METHODS

The experiment was conducted in Laboratory of Silviculture and Forest Nursery (latitude 29°43'14.3" South and longitude 53°43'17.5" West), at Universidade Federal de Santa Maria (UFSM), Santa Maria, RS, Brazil. According to the classification of Köppen, the Santa Maria climate is subtropical, with rains during all year, presenting annual average precipitation of 1700 mm, average temperature of the hottest month superior to 22°C, and of the coldest month superior to 3°C (Alvares et al., 2013).

The fruits of *E. involucrata* were collected from eight trees in a fragment of Subtropical Seasonal Forest (latitude 29°39'13.3" South and longitude 53°28'43.7" West), in the municipality of São João do Polêsine, RS, Brazil. The extraction of seeds was carried out manually by removing the pulp from the fruits, in running water, with the help of a sieve and after this process, it was performed the natural drying of the seeds under the shadow, under environmental temperature and humidity (Carvalho, 2008). After the processing, the seeds remained stored in cold chamber, with temperature of ± 8°C and relative humidity around 80%, in paper bags inside barrels of Kraft paper, during 14 days (Figure 1).

For installation of the experiment, conical tubes of polypropylene, with capacity of 110 cm^3 (6 stripes, internal diameter of 35 mm and height of 13.5 cm) and 180 cm^3 (8 stripes, internal diameter of 52 mm and height of 13 cm), accommodated on plastic trays suspended to 16 cm over the ground surface was used. The substrate used was constituted of a mixture of 80% of commercial substrate (composed of *Sphagnum* peat, expanded vermiculite, dolomitic limestone, agricultural plaster and NPK fertilizer) mixed to 20% of carbonized rice husk (CRH) (Figure 1). The physical and chemical analysis of the substrate (Table 1) was performed by Laboratory of Analysis of Substrates for Plants (Laboratório de Análises de Substratos para Plantas - LASPP), State Foundation of Agriculture and Cattle Raising Research (Fundação Estadual de Pesquisas Agropecuárias).

The sowing was carried out directly in the tubes putting three seeds by container. Approximately 150 days after sowing (DAS), it was performed the thinning, eliminating the exceeding seedlings, leaving only one by container, the most central and vigorous. The experimental design used was entirely randomized, in factorial scheme 2 × 5, and the factor A was represented by two volumes of container (tubes of 110 and 180 cm^3), the factor B by five concentrations of controlled release fertilizer miniprill (NPK 18:05:09) (0, 3, 6, 9 and 12 g L^{-1}), with four repetitions per treatment. The useful parcel for assessment of seedlings emergence was composed by 24 seedlings, and at the 150 DAS it was the alternation of the same was performed, remaining 13 interleaved seedlings. The assessment of emergence was performed every seven days, from the date of experiment installation, by means of visual observation and registration of the emerged seedlings. From these results, it was possible to determine the Emergence (E), Emergence Speed Index (ESI) and Average Time of Emergence (ATE). After the period of emergence, at the 180 DAS, it was the beginning of the assessment of the growth by means of height (H) and stem diameter (SD) measurement, every 30 days, with the help of a millimeter ruler and digital calliper (precision of 0,001 mm), respectively, which allowed the obtaining of the relation height/stem diameter (H/SD).

In the data analysis, the test of Shapiro-Wilk was used to verify the normality of residues and of Barlett to homogeneity among the variances. Besides that, the data was submitted to variance analysis, aiming to verify the existence of interaction, and subsequently submitted to the regression analysis. In the case of significant effect of quadratic equations, the dose of maximum

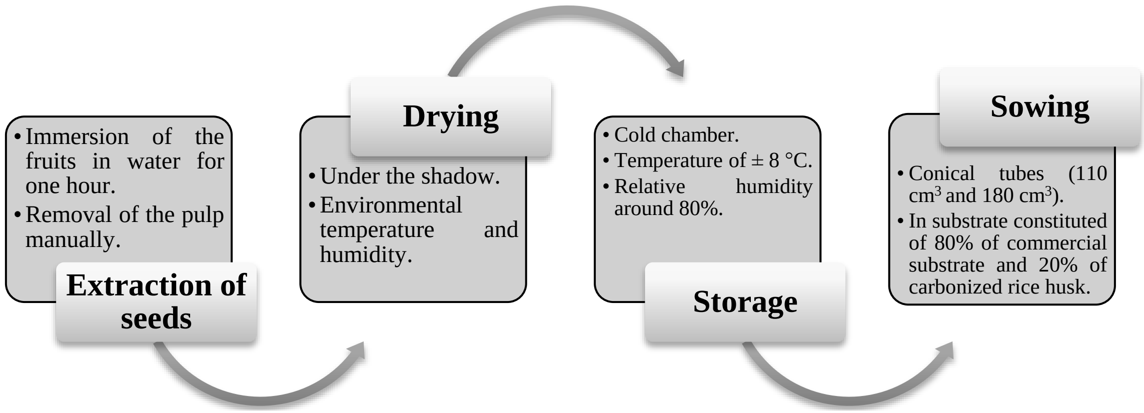

Figure 1. Diagram of the steps involved in the processing, storage and sowing of *Eugenia involucrata* seeds.

Table 1. Physical and chemical properties of the substrate used for the production of *Eugenia involucrata* seedlings.

Parameter	HD (kg m^{-3})	SA (%)[1]	WEA (%)[1]	EC (dS m^{-1})	Classification (EC)[2]	pH	Classification (pH)[2]
Substrate	278	30.6	23.7	0.41	Normal	6.1	Adequate

In which: Substrate: 80% commercial substrate and 20% carbonized rice husk; HD: Humid Density; SA: Space of aeration; AFD: Water Easily Available; EC: Electrical Conductivity. [1]Schmitz; Souza; Kämpf (2002) quoted SA ideal = 30% and WEA = 24 at 40%; [2] Regan (2014).

technical efficiency (DMTE) was determined. For the analysis, the statistical software SISVAR was used (Ferreira, 2014).

RESULTS AND DISCUSSIONS

The emergence of *E. involucrata* seedlings had the beginning at the 77 days after sowing, establishing itself at the 126th day. Carvalho (2008) related that the emergence of seedlings of this species can be observed initially at the 30 to 40 days after sowing, generally, it is associated to the low germinal performance, diverging from the results obtained in this work, which presented slow emergence, but with elevated values. Prado (2009) studying the self-ecological and silvicultural aspects of this same species verified that despite a small number of seeds answered fast, emerging at the 25 days after installation of the experiment, the majority presented emergence until the second month after sowing, and the emergence could be observed until the 150 days, confirming the slow species emergence.

Analyzing the emergence (E), emergence speed index (ESI) and average time of emergence (ATE) in *E. involucrata* seedlings submitted to different concentrations of CRF, we determined significant difference for emergence (E%) and emergence speed index (ESI). The species presented greater averages not only in E (%) (91.2%) (Figure 2A), but also in ESI (0.19) (Figure 2B), when produced with 12 g L^{-1} de CRF (Figure 2).

In this way, the greatest dose of fertilizer used did not compromise the initial phase of the seedlings emergence, and it does not provide an elevated salinity in the initial phase of development. Besides that, associating to the recalcitrant characteristic of seeds from this species (Wielewicki et al., 2006), as well as the slow emergence and growth, can infer that the availability of seedlings for commercialization and/or using in programs of areas recovery depends on the immediate sowing after collection, maintaining a seedling bank in the nursery, to be handled for seedlings expedition in field.

According to the variance analysis, the triple interaction (volumes of container × doses of CRF × time) was not significant for any of the analyzed morphological variables (H, SD and H/SD). There was significant interaction between the container × doses of CRF for H, SD and relation H/SD of seedlings (Figure 3).

Seedlings of *E. involucrata* presented greater averages both in H and SD, when produced in tubes of 180 cm^3, with 12 and 9 g L^{-1} of CRF, respectively. Gasparin et al. (2015) highlighted in *Parapiptadenia rigida* (Benth.) Brenan that the tube of 180 cm^3 combined with the dose of 9 g L^{-1} of CRF, obtained the best results for the analyzed morphological variables (H, SD and H/SD), allowing seedlings of quality for planting in field. In a similar way, Stüpp et al. (2015) evaluating different sizes of tubes and doses of CRF for the seedlings production

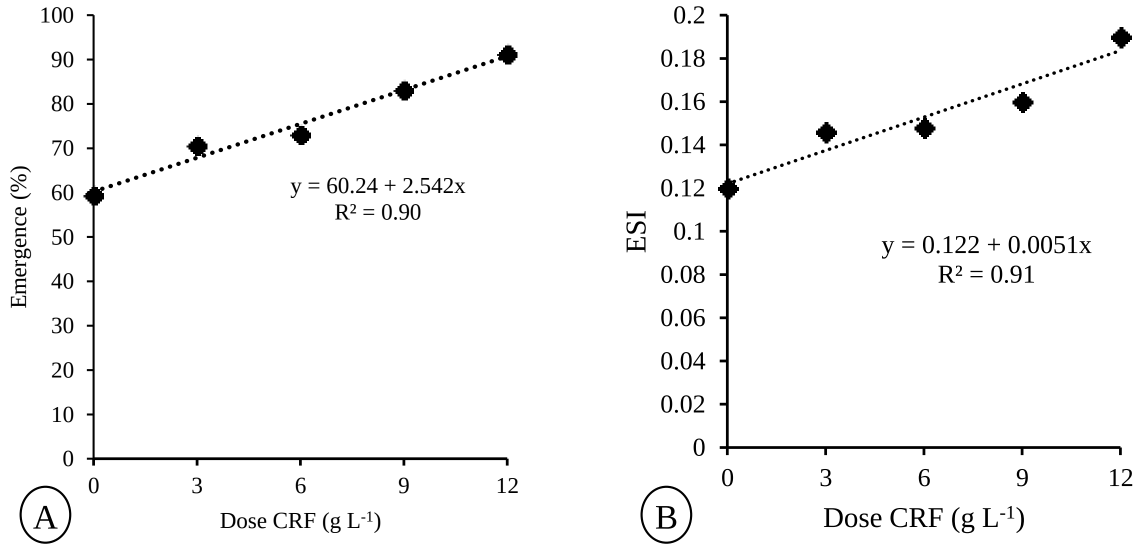

Figure 2. Percentage of Emergence (A) and emergence speed index (ESI) (B) of *Eugenia involucrata* seedlings in controlled release fertilizer doses (CRF).

of *Mimosa scabrella* Benth. concluded that the doses of fertilizer influenced on the initial growth of seedlings, and the greatest growth was obtained with the use of tubes of 180 cm³ and 6 g L^{-1} of CRF. In both studies, the best results both in H and in SD were obtained with the use of bigger containers, in the case the tube with 180 cm^3, which can be attributed to the greatest volume of available substrate and the smallest restriction for the root growth of seedlings.

Berghetti et al. (2016) highlighting that *Cordia trichotoma* is responsive to fertilization, and that bigger increments can be obtained under the greatest volume of substrate and doses of CRF, when we maintain the waiting nursery. Besides that, the positive result of the use of CRF can be explained by the fact that this fertilizer releases the nutrients gradually as the resin that involves the granules of the same is dissolved, maintaining the availability of the essential elements during the period of seedlings growth (José et al., 2009). Mendonça et al. (2008) affirmed that the use of CRF provides, through a single application, the continuous supply of nutrients throughout the development of the plant, reducing the occurrence of nutritional disability symptoms, dispensing the parceled applications of other sources (topdressing), since that it is considered the release period of the fertilizer, which is informed by the manufacturer.

The greatest growth in H and SD in *E. involucrata* seedlings when produced in tubes of 180 cm^3 of capacity, with 12 and 9 g L^{-1} of CRF, respectively, deserves highlight. The answer provided by both morphological variables is considered as one of the main parameters for selection of seedlings for planting (Ritchie et al., 2010), because they provide an estimate of initial potential growth and survival of seedlings in field (Wendling and Dutra, 2010). According to these authors, seedlings that are able to be planted should present SD of 2 mm, and values superior to the related by these authors are found, in the conditions described.

The maximum dose of technical efficiency (MDTE) estimated for height was of 9.14 g L^{-1} for the tube of 110 cm³ and 13.9 g L^{-1} for the tube of 180 cm³ (Figure 3A). For stem diameter, the MDTE was of 25.9 g L^{-1} for the tube 110 cm³ and 8.8 g L^{-1} for the tube 180 cm³ (Figure 3B). For the variables height and stem diameter the interaction between the doses of CRF and the time of assessment (Figure 4) was also verified. At the end of the 180 days the greatest averages in height in the seedlings submitted to the greatest dose of CRF (Figure 4A) was found, since for the stem diameter the greatest averages used were 9 g L^{-1} (Figure 4B).

Because it presents slow growth, this species needs some greater time of permanence in nursery, which elevates the cost of seedlings production, because it increases the necessity of labour as well as the successive applications of fertilizers and defensives. Additionally, with the use of containers as tubes, although the quantity of substrate used is lower, the frequent irrigation tends to provide the leaching of nutrients (Guareschi et al., 2015), highlighting thus the necessity of performing adequate fertilizations for the good development of the seedlings in nursery. In this sense, it is recommend that in the seedlings production of *E. involucrata*, concomitant to the use of 12 g L^{-1} of CRF, the topdressing is performed, which will be necessary, considering the low species growth and the determined time of the efficiency of the fertilizer.

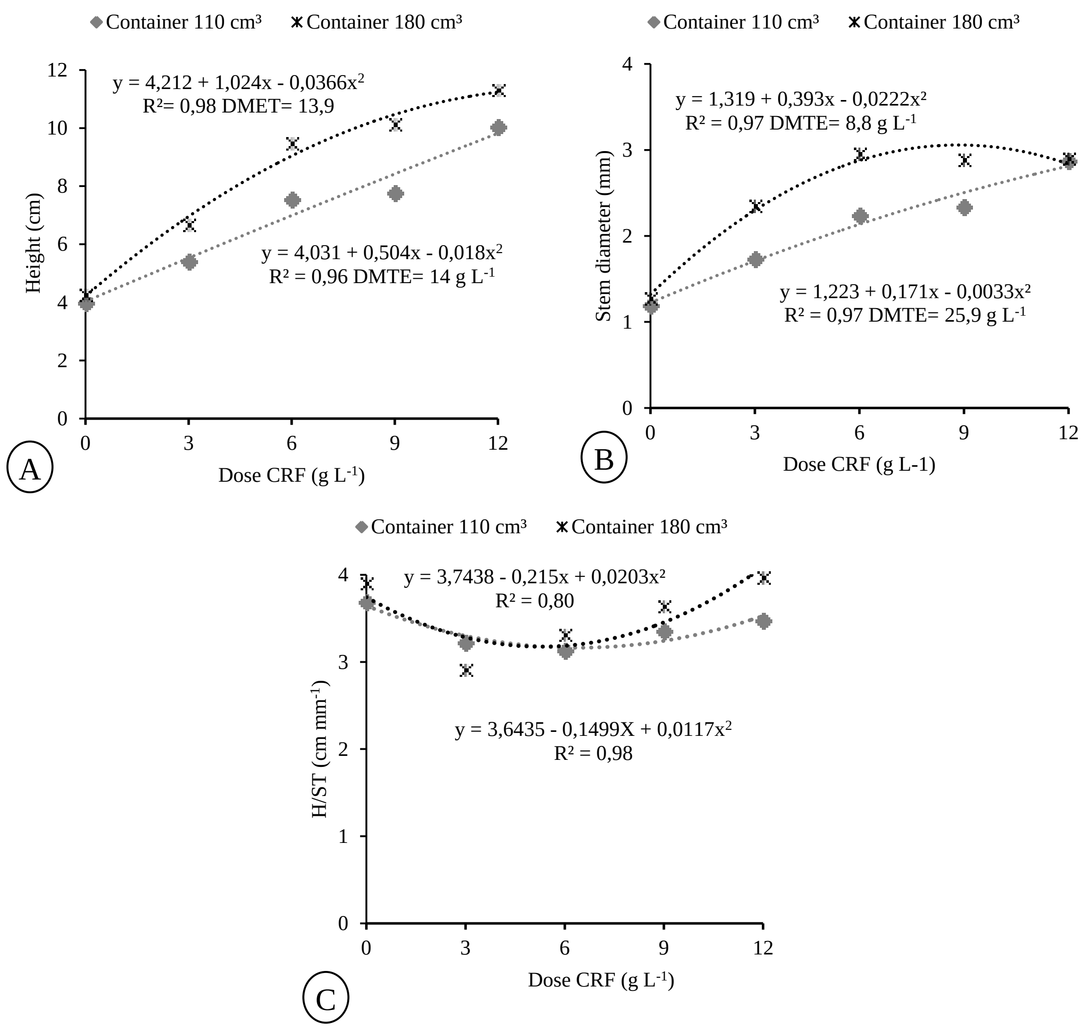

Figure 3. Effect of the container volumes and concentration of the controlled release fertilizer on Height (A) and stem diameter (B) and H/SD (C) of *Eugenia involucrata* seedlings.

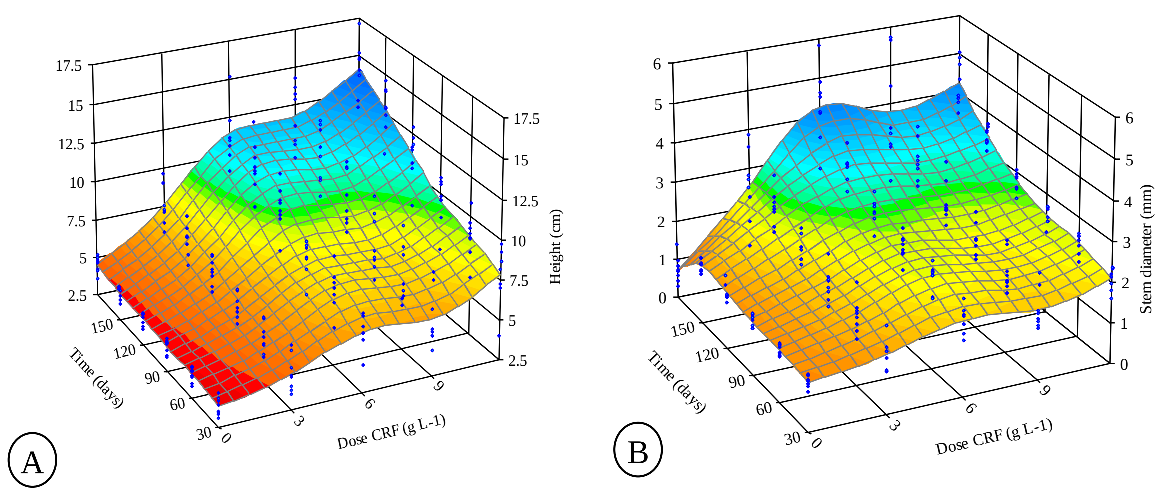

Figure 4. Contour graphs representing the effect of the time and the concentration of the controlled release fertilizer on height (A) and stem diameter (B) of *Eugenia involucrata* seedlings.

Conclusion

The emergence of *Eugenia involucrata* had the beginning at the 77 days after sowing, and it was finished at the 126 days. For the production of seedlings in nursery, the container of 180 cm^3, allied to the dose of 12 g L^{-1} of controlled release fertilizer is necessary. However, considering the long time necessary to the emergence and the slow species growth, the topdressing will be necessary since this fertilizer presents determined time of efficiency.

Conflict of interests

The authors have not declared any conflict of interests.

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