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Schinus molle seedlings production: Influence of slow release and conventional fertilizers

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Abstract

The aim of this study was to evaluate the influence of different formulations of slow-release and conventional fertilizer in *Schinus molle* seedlings production. The experiment was conducted at São Paulo State University, School of Engineering, municipality of Ilha Solteira, Brazil, in a Pad & Fan greenhouse type (Average Temp. 26 °C and 55% RH). The seedlings were grown in the same cited environment in polyethylene trays filled with commercial substrate. When seedlings presented 3-4 leaves, 30 days after sowing they were transplanted to 4 L plastic bags, with the following treatments: T1 = Control, T2 = Osmocote® 3M (14-14-14), T3 = Basacote® 3M (15-09-12) and T4 = TecNutri® conventional fertilizer (05-13-13). Mixture of soil + commercial substrate (1:1) formed the substrate and fertilizer at a dosage of 3 g L-1 was used. The experimental design was completely randomized with 4 treatments and 06 replications and evaluations were performed 55 days after planting. The following characteristics were analysed: plant height, stem diameter (mm), plant height and stem diameter ratio and number of leaves. For 55 days seedlings the best treatment was the conventional fertilizer TecNutri®

Keywords: Fertilization; Osmocote®; Basacote®; Aroeira Salsa

1. Introduction

The *Schinus molle* is an evergreen shrub or tree, commonly between 3 and 12 m in height and 15 to 35 cm in diameter at breast height (DBH), reaching exceptionally, 25 m in height [1] and 100 cm in DBH, in adulthood. In Brazil, this species occurs naturally in various plant formations and is also widely used in urban afforestation due to its ornamental value [2]. This species also has great ecological importance, as it is important for the recovery and expansion of forest areas, as it grows even in degraded soils, has a trunk covered by thick and scaly bark, its leaves are composed, without stipules, with 9- 25 linear-lanceolate to linear, subcoreous, glabrous leaflets, 3-8 cm long and with serrated margins [3].

Propagation is done by seeds and care must be taken with substrate and its proper fertilization. This is due to the fact that there is low availability of nutrients from soils or commercial substrates used limiting growth and forest production, making it necessary to supply these nutrients to seedlings [4]. The supply of nutrients to plants through fertilization may decrease the time they stay in nurseries, reducing the expenses with cultural treatments, labour, pesticides, among others [5].

Seedling production is one of the most important stages for any forest stand beginning. Nutrition, in addition to the aspects listed above, also ensures high quality seedlings that, possibly, will have good adaptation and growth after planting [6, 7].

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New technologies are being launched in order to optimize seedlings production and fertilizer efficiency, one of them is the use of nutrition sources with slow or restricted release, which allows gradual release according to each species necessity [8].

This type of fertilizer may synchronize the release of nutrients with plant physiological requirements. However, major obstacle to its greater use is the high cost compared to conventional fertilizers requiring adequate dose or whether species responds satisfactorily to the use of this type of fertilization [9, 8].

It is estimated that, due to the occurrence of losses, the efficiency of Nitrogen use, for example, by plants is only 40% to 50% of the applied amount. In this sense, in order to reduce losses and increase the efficiency of N use, there has been a control of time of application, improvement in application methods, and, more recently, the use of coatings in fertilizers to control the release of nutrients [10], as mention previously.

The encapsulated nutrients by special resins, which are released through porous structure, reach plant root system slower [11]. This characteristic may guarantee the maintenance of a synchronism between the nutrients release over time and the nutritional needs, favouring plants growth and development. In addition, through polymerized fertilizers, there is a decrease in nutrient losses due to leaching, volatilization and fixation, making it possible to reduce the applied dose [12]. In this sense, research has shown promising results in relation to the use of controlled release fertilizers [13, 14, 15, 16].

Thus, the present work objectified to evaluate the influence of different formulations of slow-release and conventional fertilizers in the production of *Schinus molle* seedlings.

2. Material and methods

The experiment was conducted at São Paulo State University, School of Engineering, municipality of Ilha Solteira, Brazil, in a Pad & Fan greenhouse type (Average Temp. 26 ° C and 55% RH).

The seedlings were grown in the same cited environment in polyethylene trays filled with commercial substrate. When seedlings presented 3-4 leaves, 30 days after sowing they were transplanted to 4 L plastic bags, with the following treatments: T1 = Control, T2 = Osmocote® 3M (14-14-14), T3 = Basacote® 3M (15-09-12) and T4 = TecNutri® conventional fertilizer (05-13-13). For all treatment were used the dosage of 3 g L^{-1}.

Mixture of soil + commercial substrate (1:1) formed the substrate. The soil is classified as Dystrophic Red Latosol, sandy loam-clay texture according to the Brazilian Soil Classification System [17] and the commercial substrate was formed by mixture of Sphagnum peat, coconut fibre, rice husk, pine husk and vermiculite.

The experimental design was completely randomized with 4 treatments and 06 replications and evaluations were performed 55 days after planting, analysing the following traits: plant height, using graduated ruler (cm), measuring from the base to the apical bud; stem diameter (mm), measured close to the ground using a digital caliper; plant height and stem diameter ration was calculated by dividing the values of each and the number of leaves.

The data collected were subjected to analysis of variance and means were compared using Tukey test at 5% of significance by computer program: System for Analysis of Variance – SISVAR [18].

3. Results and discussion

Analysing Table 1, it may be seen that there was statistical difference for all evaluated traits.

Table 1 Values of mean square and significance levels for plant height, stem diameter, height/diameter ratio and leaves number of *Schinus molle* under different fertilizers

	Mean Square			
V.F.	**Height (cm)**	**Diameter (mm)**	**Height/diameter ratio**	**Leaves number**
Fertilizers	260.37**	3.99**	23.49*	57.83**
C.V. (%)	14.86	20.36	25.36	21.36

V.F. = Variation factor; C.V.= Coefficient of variation; **(p<0.01); *(p<0.05)

Table 2 shows the mean height of *Schinus molle* seedlings under different fertilizers and control, and there was no significant difference for any fertilization treatment regardless of the release time at 55 days after transplantation, whereas all fertilizer treatments differed statistically from control. It was also possible to observe that numerically all traits evaluated obtained lower averages in relation to control, which shows the necessity to fertilize seedlings to obtain more vigorous plants [19].

Rossa et al., (2014) [20] also found significant difference in height of seedlings of *Cabralea canjerana* when fertilized with slow-release fertilizers (SRF). According to Carneiro (1995) [21], the height of seedlings contributes as an assessment factor for their initial growth at field level.

Table 2 Plant height, stem diameter, height/diameter ratio and leaves number of *Schinus molle* under different slow-release (SRL) and conventional (CF) fertilizers at 55 days after transplant

	Height (cm)	**Diameter (mm)**	**Height/diameter ratio**	**Leaves number**
Control	11.41b	2.97b	3.86c	16.83c
SRL Osmocote®	26.27a	3.23b	8.17a	20.33ab
SRL Basacote®	23.68a	3.53b	7.15ab	21.50ab
CF TecNutri®	22.85a	4.81a	4.92bc	24.33a

Means followed by the same letter in the column do not differ statistically at the level of 5% probability by Tukey test.

Regarding the stem diameter, it may be seen in Table 2 that there was significant difference between CF and other treatments with SRL, including control.

The evaluation of stem diameter is important, as this trait is related to seedlings quality that go to the field. Very high plants with smaller stem diameter may cause them to tip over during their development, which would bring losses, as it would increase production costs with seedlings replanting.

Rossa et al., (2014) [20] found an increment in stem diameter when they submitted Cabralea canjerana seedlings in slow-release fertilizers, unlike the present study in which only the conventional fertilizer responded statistically differently from other treatments. In contrast, Moraes Neto et al., (2003) [22] also did not observe an increase in stem diameter in Guazuma ulmifolia, Peltophorum dubium and Calycophyllum spruceanum seedlings when fertilized with slow-release fertilizers, corroborating the present study. The authors state that this difference may be intrinsic to the species that responds physiologically or not to fertilizers.

The stem diameter is a characteristic that is easy to measure and as it is not destructive it is one of the best characters for estimating the survival of seedlings of different species in the field [23].

The height of seedlings and stem diameter in isolation, according to Gomes et al., (2002) [24], are good characteristics to evaluate its quality, however, the ideal would be to combine these characteristics among them. Thus, the height of the areal part combined with the stem diameter forms one of the main morphological characteristics to evaluate seedlings conditions in nurseries for subsequent transplantation in the field.

In this case, for the height / diameter ratio, Table 2 showed that the SRL Osmocote® differed statistically from the CF TecNutri® and the control, while there was no statistical difference in relation to the SRL Basacote® slow-release fertilizer.

Sturion and Antunes (2000) [25] indicate that the height / stem diameter ratio is one of the parameters used to assess the quality of forest seedlings, as in addition to reflecting the accumulation of reserves, it ensures greater resistance and better fixation in the soil. Work performed by Carneiro (1995) [21] with Pinus taeda seedlings indicates that a good height / diameter ratio to be a good index must be obtained when the values were between 5.4 to 8.1, in this case it is observed that only the treatments with SRF are present in this range. However, Gomes et al., (2002) [22] recommended that, for greater survival and establishment of seedlings in field, less is this index.

In leaves number, it is observed in Table 2 that there was no significant difference among treatments means with fertilizers, while numerically the CF TecNutri® was higher and differed statistically from control.

Mendonça et al. (2004) [26] found similar results such as an increase in the number of leaves when submitting passion fruit (Passiflora edulis) seedlings in slow-release fertilizer treatments, in addition to an increase in plant height and stem diameter, corroborating the present study.

The greater number of leaves in treatments with fertilization may have influenced the greater plant heights and stem diameters in the same treatments. With more leaves, the surface that will make photosynthesis increases, increasing the rate of photoassimilates, making plant grow more.

4. Conclusion

Regarding the development of *Schinus molle* seedlings at 55 days after transplantation, it is possible to notice that it is necessary to fertilize the substrate as the control treatment showed the lowest averages for height and stem diameter.

As there was no statistical difference between fertilization treatments, aiming at economy, the use of conventional TecNutri fertilizer is recommended in the short term.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that they have no conflicts of interest.

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