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Eucalypt coppices behavior under application of plant growth regulators

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ABSTRACT

This study aimed to evaluate the influence of TDZ; calciocianamide, and thiourea in the emission and development of eucalyptus shoots. The study was conducted in clonal sprouts of an *Eucalyptus urophylla x E. grandis* clone, located in the city of Mogi Guaçu, Northeastern State of São Paulo. The climate was Cwa. Harvesting was performed in the stand at age of 6.5 years. The diameter of the shoots at the twelfth month, the height of the shoots at six, twelve, and eighteen months of age and the number of shoots by coppice at three, six and twelve months post-harvesting. The thinning of coppices occurred at the twelfth month, and left two shoot/stump. There were used the following treatments: T2: complete fertilization; T10: complete fertilization + calciocianamide; T11: complete fertilization + TDZ; T12: complete fertilization + thiourea. TDZ and calciocianamida affected the shoot height up to 12 months after post-harvesting. Doses of TDZ, thioureia, and calciocianamida applied onto the strains show no effect on the shoot height, shoot stem diameter, and number of sprouts of that eucalypt clone after 18 months after post-harvesting.

Keywords: Management, second rotation, TDZ, calciocianide, thiourea.

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INTRODUCTION

Much emphasis has been given to the clonal eucalypts as a way to reach higher yield in a shorter period of time and to get a well-response to climatic and soil variations due to different external (fertilization) and internal (hormonal) stimulation. However, there are few studies on the use of plant growth regulators in field conditions aiming to stimulate the bud emission.

Plant growth regulator is a synthetic substance, exogenously applied onto plants, having similar actions to groups of known plant hormones (auxins, gibberellins, cytokinins, retardants, inhibitors, and ethylene) (Davies 2004). These substances may act directly on different cell structures, causing physical, chemical, and biological changes (Castro and Vieira 2001). Trials have shown that nutrients are transported and accumulated preferentially in tissues treated with cytokinins, suggesting this hormone stimulates the mobilization of nutrients, creating a new source-sink ratio (Taiz and Zeiger 2009).

One of the major nutrients that interact with cytokinins is the nitrogen. Deficiency of this nutrient associated with low levels of cytokinin causes chlorosis as well as the acceleration of leaf senescence (Kerbauy 2008). In the culture of shoot tips, this plant growth regulator is used mainly for axillary bud proliferation through the ability to modify apical dominance (Bhojwani and Razdan 1996). The rapid development and differentiation of buds can be related to the high level of cytokinin accumulated after harvesting (Phillips 1969, Leopold and Kriedmann 1975). When sprouts arise, this hormone also exerts the function of nutrients and other hormones carried to the apex of the plant. According to Caldas et al. (1990), the composition and concentration of hormones are determinants for growth and development pattern of most systems. Among the synthetic plant regulators with cytokinin function are calciocianamide, thidiazuron (TDZ), and thiourea.

The calciocianamide stimulates the cell division and budding due to leading the bud breaking earlier and more evenly, increasing the total percentage of shoots in buds (Perussi 2009), also serving to break the dormancy of buds of various species of deciduous plants such as apple, almond, fig, grape, peach, persimmon, and plum (Camili 2007).

The TDZ is used in cotton crop to cause defoliation and in tissue culture to induce sprouting in vitro (Petri et al. 1992), producing high cytokinin activity when used in small concentrations (Mok et al. 1982). In most cases, TDZ has shown better results when compared to other cytokines and to induce shoot multiplication of many species (Salgado et al. 2001).

Another regulator that has been studied is the thiourea. Substances are not specific as nitrates, nitrites, and urea derivatives, being named as promoters of germination (Delatorre et al. 1997). Thiourea acts on: the entry of potassium in the embryonic axis, altering the respiratory mechanism; the remobilization of reserves, inhibiting the application of light (Hernandez-Nistal et al. 1983); the interaction with ABA (abscisic acid), reducing its inhibitory effects (Mayer and Poljakoff-Mayber 1984). Thiourea also has an effect similar to cytokinin but it can also inference on the ethylene synthesis, as observed on seeds of *Xanthium pensylvanicum* (Delatorre et al. 1997).

Highest number of shoots per plant helps to increase the survival rate of the coppice. So if parts of shoots suffer some form of injury (the action of winds, attack of pests and diseases or natural death), there is a higher chance of surviving, at least of buds (Paula Neto et al. 1982). Based on that, this study aimed to evaluate the effect of use of growth regulators, in field conditions, in a clone of eucalipts (*Eucalyptus urophylla x E. grandis*) in order to find a plant growth regulator presenting the highest efficiency on the development in height, diameter, and number of sprouts.

MATERIAL AND METHODS

The study was conducted in a population of an *E. urophylla x E. grandis* clone, managed by coppice. The study area was located in the city of Mogi Guaçu (latitude 22° 22' 20" S, longitude 46° 56' 32" WGr., and average altitude of 591 m), in the Northeast of the São Paulo State of Brazil. The soil was classified as Typic Distrofic medium texture soft-wavy relief (Demattê, 2000).

Stocks were planted in the field at a spacing of 3.00 m x 2.75 m. In May 2010, an experiment was done with the harvest Feller-Buncher when the population had the age of 6.8 years. The experiment consisted of an application of plant growth regulators on the addition of these coppices to induce sprouting after forest harvesting. We used the randomized blocks design, with 4 treatments and 4 replicates per treatment, with 16 plants per plot. The plots had double border, making a total of 36 plants per treatment.

To manage the coppicing with added plant growth regulators, we used the following treatments: T2 – complete fertilization; T10 – complete fertilization with calciocianamide application; T11 – complete fertilization with TDZ application; T12 – complete fertilization with thiourea application. The application of plant growth regulators was performed by brushing immediately after harvesting of the forest in the morning, on the outside of the stump, covering the

cambial regions and close to the bark, where there epicormic shoot. There were applied 200 mL solutions with concentration of 0.5 mg L^{-1} of each growth regulator on the stumps, according to results found by Ribeiro et al. (2006). The experimental plots were kept free of weeds by applying post-emergence herbicides around the stumps in a distance of 30 cm to avoid spraying onto them.

The diameter of the shoots, the height of shoots, and number of sprouts were evaluated. The diameter measurements occurred after thinning of the coppices, at the twelfth month after application, using a pocket measuring tape. The height was measured semiannually, beginning at six months post-harvest, in June and December, covering two seasons (winter and summer). The measurements were extended until the 18th month post-harvest and were made with the use of a graduated ruler. Counting the number of sprouts per stump was done manually, at the 3rd, 6th and 12th month post-harvesting, according to the procedure adopted by the company.

After evaluations, the results were processed using statistical software SAS 9.1 for Windows (SAS Institute, USA). To assess the effect of treatments (independent variables) on the dependent variables, the results were submitted to analysis of variance (ANOVA) and mean comparisons by the Tukey test, adopting a significance level of 5% (Storck et al . 2000).

RESULTS AND DISCUSSION

There was difference between treatments for height at six and twelve months as well as the number of shoots at six months age (Table 1). The application of TDZ on the stumps showed greater interference in the height, providing the less height growth when comparing to other treatments. However, Petri et al. (2001), in studies with use of TDZ on apple trees, found that this application was 20 times more effective than a natural cytokinin to break the dormancy apple lateral buds.

The use of TDZ to induce sprouting negatively influenced the growth in height and diameter and the number of shoots, during evaluations. Studies made by Graça et al. (2001) found that TDZ at lower concentrations (0.5 mg L^{-1}), as used in this experiment, promoted the multiplication of shoots of *Eucalyptus dunnii* also increasing callous productions, being detrimental to the development of shoots.

Unlike TDZ, calciocianamide application on the stumps at six months showed a greater height development. However, at twelve months the control, treatment gave better results. While there is no significant effect at eighteen months, the greatest heights were obtained again in the treatment with calciocianamide application.

There was no significant effect on the treatments and the diameter of the shoots in both ages evaluation. However it is clear that there was a significant increase in six-month evaluation with an average diameter of 1.2 cm to 7.8 cm for twelve months to eighteen months. From six months, the effect of plant growth regulators was not significant for the number of shoots. Fransozi et al. (2010), in studies using calciocianamide, found that the application of this led to an increase in the number of shoots.

Leão and Silva (2005) studied the use of calciocianamide to break bud dormancy in grapevine and they found a substantial increase in the percentage of budding and bud fertility, bunch number and yield per plant. The thiourea showed no significant effect on the height and diameter of the shoots. However, studies by Delatorre et al. (1997) found that the thiourea stimulates germination of estylosanthes, especially through the production of ethylene.

The lack of response on the part of the shoots may have been influenced by external or environmental factors such as temperature, time of year, age of application, species less responsive, plant vigor, rainfall and so on., Which can interfere significantly in the preparation of secondary metabolites (Pasqual and Petri 1985, Stefanini et al. 2002, Leão and Silva 2005, Costa 2010). Such metabolites could inhibit the action of plant growth regulators as stimulators emission shoots. Although there were no answers in the field up to a year, studies by Florentino et al. (2011), with the use of benzylaminopurine (BAP) in explants of *Tectona grandis* growing *in vitro*, found that plant development was directly proportional to the increased concentration of plant hormones.

Table 1. Mean values of shoot height at 6, 12, and 18 months, shoot stem diameter at 12 and 18 months, and number of sprouts at 3, 6 and 12 months after post-harvesting, in an *Eucalyptus urophylla x E. grandis* clone under application of plant growth regulators. Mogi Guaçu, SP.

Treatments		Height			Diameter		Number of sprouts		
		6 m.	12 m.	18 m.	12 m.	18 m.	3 m.	6 m.	12 m.
		m			cm		unit		
T2	Control	1.8 ab	9.2 a	9.6	1.1	7.7	2.5 b	3.8	4.3
T10	Calciocianamide	1.9 a	8.7 bc	10.1	1.0	8.1	4.4 a	3.5	4.1
T11	TDZ	1.7 b	8.4 c	9.6	1.3	7.7	4.4 a	3.3	4.1
T12	Thiourea	1.8 ab	8.8 ab	9.8	1.4	7.8	5.0 a	3.6	4.0
Average Data		1.8	8.8	9.8	1.2	7.8	4.1	3.6	4.1

Obs.: means followed by the same letter in the column do not differ by Tukey test at 5% of probability.

CONCLUSION

Solutions of 200 mL with a concentration of 0.5 mg per liter of three plant growth regulators, TDZ, thioureia, and calciocianamida, applied onto the strains of an eucalypt (*E. urophylla x E. grandis*) clone, show no effect on shoot height, shoot stem diameter, and number of sprouts at 18 months after post-harvesting.

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