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Growth of *Pinus elliottii* in an area of copper tailings

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Workshop Information

I Workshop of Plant Biology (I Workshop de Biologia Vegetal) was held in the Bioscience Institute – UNESP, campus of Rio Claro, Brazil, during August 20 and 21, 2012. Workshop was a scientific event organized by Post-graduate students from that Institute aiming to integrate Post-graduate and Graduate students from different areas related to Plant Biology (Anatomy, Ecology, Evolution, Morphology, Physiology, and transitional areas) from different Universities. Workshop Organization offered a large number of speaking activities, scientific discussions, and extra short-courses to improve the knowledge and formation of students in Plant Biology.

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INTRODUCTION

The land reclamation of an area explored ensures a continued sustainability of any production system, because it is responsible for the establishment of vegetation, its development, and production of satisfactory settlement. The recovery of impacted areas with forest species provides a good economic returns, with production of firewood, charcoal, wood, pulp, fodder, honey, and tannin (Andrade 1997).

To proceed with the recovery of a degraded soil, according to Nolla (1982), it is necessary to implement reforestation with native or exotic species, in order to replenish the soil. In natural forest ecosystems, when there are declines in the availability of growth factors such as decline of soil fertility, the forest community adapts to new environmental conditions through the replacement of species. Already in forest plantations, the trees respond to environmental changes through productivity (Gonçalves et al. 2005).

Thus, this study aimed to evaluate the root and shoot development of *Pinus elliottii* at the age of three years, planted in an area of deposition of tailings from the copper mining.

MATERIAL AND METHODS

This study was conducted in an area belonging to the former CBC, located in Minas Camaquã in Caçapava do Sul - RS. The study area is from a large deposit of waste soil and rock from copper mining.

Seedlings were used in laminate, purchased from a nursery in the region. There were applied two treatments: T1-planting seedlings directly in the mining waste; T2 - planting seedlings in furrows cut into the tailings area with dimensions of 0.25 x 0.25 x 0.50 m (L x W x D). There were placed in each furrow about 6 kg of argisoil from an area far from the study area. Both treatments were fertilized with NPK (20-10-20).

The experimental design was randomized blocks with two treatments and four replicates per treatment with 16 plants per plot. The plots had double border, totaling 36 plants per treatment.

At three years after planting proceeded the data collection. There were measured the plant height, diameter and length of lateral and tap roots with the use of a pocket strip tape. After the measurement, 15 specimens were stripped by treatment for measuring the length and depth of the roots.

The results were processed with SAS 9.1 statistical software for Windows. To evaluate the effect of treatments (independent variables) on the dependent variables, the results were submitted to ANOVA and mean comparisons by Tukey test, adopting a significance level of 5% (Storck et al. 2000).

RESULTS AND DISCUSSION

Growth of pine height and diameter

Plants showed better development in height and diameter, comparing to planting done directly in the area of mining waste, where there was addition of the planting pit argisoil (Table 1).

Table 1. Development in *Pinus elliottii* plantation with and without addition of the planting hole argisoil assessed at three years old.

Treatments	Parameters evaluated		
	Diameter (cm)	Height(m)	Mortality %
T1	1.6	0.50	26.87
T2	2.7	2.16	1.87

T1 - Pine to reject without adding argisoil; T2 - Pinus in tailings with the addition of Ultisol.

In the study area, there were observed high concentrations of copper which, as Santos et al. (2007) explains the poor development of the pine shoot because the Cu inhibits the growth of vegetation. As an example, oats and other native species that have grown weak, with chlorosis and death of plants in areas with high concentrations of copper (Santos et al. 2004).

Although plants showed a greater development with addition Ultisol at planting (Table 1), this development has not been satisfactory over the years, because the soil in the region have nutritional deficiencies.

The percentage of losses was much higher in seedlings planting made directly in the mining waste. This can be explained by the fact that the waste be formed by crushed rocks sandstore like with high porosity. Giving poor nutrition and water stress. Since this region shows harsh and rainy winters and hot dry summer, the seedlings planted without added argisoil suffered more with the high climate variability. In winter, due to the large amount of rain, the seedlings were with a blade of water for long periods. In the summer the problem faced was the lack of water and overheating of the exposed soil due to lack of vegetation.

Length of roots at depth and lateral

In Figure 1, are the comparative figures for height growth, root growth in depth and lateral root growth of pine trees in planting and planting directly into the tailings with the addition of Ultisol in the pit.

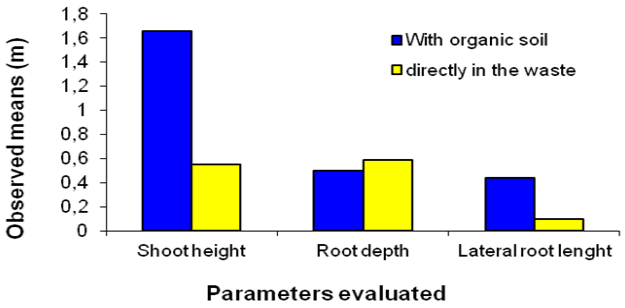

Figure 1. Development of shoots and roots of *P. elliottii* planted in the area of waste with and without addition of Ultisol Ultisol addition, the three-year-old.

Due to a large amount of heavy metals from copper mining, there was a wide variation in the pine root development in both lengths lateral and depth. The addition of Ultisol in the pit showed a better height growth in relation to treatment without Ultisol in the pit (Figure 1). This development was about three times lower compared to T2 to T1. This is because the plant had a certain amount of nutrients in argisoil added to the pit in the early stages of development.

When assessing the root growth with depth can be seen that the treatment without argisoil in the pit generated seedlings with roots a little deeper than the seedlings planted in the pit with the addition of Ultisol. According to Silva and Valcarcel (2000), the roots tend to develop in depth when they are subjected to adverse conditions, looking for ways to remedy their deficiencies.

The same was not observed for the lateral growth of roots. The root systems of seedlings without added argisoil was restricted to the pit. This is due to the adverse conditions of toxicity, which resulted in slower growth compared with seedlings with added Ultisol with the pit where the roots have gained strength and expanded after finding in the early stages of development, a more favorable condition.

The length of the roots that develops in each environmental condition is directly related to physical and chemical characteristics of soil, plant genetic factors, with the balance of the relationship between the shoot and the root with soil management and the orchard management (Silva and Valcarcel 2000).

CONCLUSION

There was a better development in height and diameter in seedlings of *P. elliottii* treatment with added Ultisol in the pit. However, pine planted directly into the mining tailings had greater root length in depth.

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