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RENEWABLE SOURCE HYDROGEL AS A SUBSTRATE OF CONTROLLED-RELEASE NPK FERTILIZER FOR SUSTAINABLE MANAGEMENT OF *Eucalyptus urograndis*: FIELD STUDY

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ABSTRACT

In this work a biodegradable, amphoteric and renewable source hydrogel, called HEDTA, was employed as a substrate of controlled-release NPK fertilizer (nitrogen, phosphorus and potassium) in a field study of Eucalyputs urogradis seedlings. In the field study four treatments with different hydrogels and NPK fertilizer were compared. The treatments were: HEDTA without NPK fertilizer (HEDTA); HEDTA with NPK fertilizer (10-10-10) (HEDTA+NPK); commercial potassium polyacrylate hydrogel without NPK fertilizer (PAP); and solid NPK fertilizer (7-31-13) (NPK). The influence of each of these treatments on seedling development was monitored by measurements of neck circumference (nc), growth of mean Diameter at Breast Height (DBH) and height (ht). In addition, the amount of nutrients presents in the leaves of the seedlings that received each of the four treatments were also evaluated. The results showed that the eucalyptus seedlings developed faster with the use of the HEDTA+NPK treatment. Effectively, HEDTA proved to be an excellent substrate for slow release and water retention in the soil, reducing fertilizer leaching, as well as being non-toxic, biodegradable in soil, and environmentally friendly.

Keywords: *Hydrogel, Eucalyptus urograndis, Controlled-release, Water-retention, NPK compound fertilizer.*

INTRODUCTION

Agricultural activity is fundamental to humanity and currently has great challenges due to the growing number of the world's population. (1) In various segments of the consumer goods industry was a need for greater agricultural production including of various technological advances, such as increased fertilizer application. The use of fertilizers has increased significantly, resulting in concerns related to economic and

environmental impact such as the eutrophication of estuaries and coastal regions, and in water reservoirs intended for consumption in several parts of the world. [2-4]

The use of hydrogels in agriculture has a growing demand worldwide, due to its ability to minimize nutrient losses to the environment, controlled release of fertilizers and soil water retention. When mixed into the soil, the hydrogel is able to absorb large amounts of water, from rainfall or irrigation, serving as a water reserve in dry periods. The need for new technologies that present greater efficiency in the use of water and nutrients by plants has been growing, as well as the study of the applications of hydrogels in agriculture. [5-8]

To address the problem of fertilizer leaching, Senna et al. [6] developed an amphoteric hydrogel (HEDTA). Based on the literature in the area, HEDTA has been widely encouraged to be applied in *Eucalyptus urograndis* seedling plantations, due to its excellent results in controlled release of water and fertilizers into the soil, and the low leaching of these macronutrients. [6,9,10] The study employed four different treatments on *Eucalyptus urograndis* seedlings to evaluate the efficiency of HEDTA as a substrate for controlled-release of NPK fertilizer, comparing it mainly with commercially available hydrogel PAP. The field study aimed to follow the development of the seedlings by measurements of average Neck Circumference (nc), growth of mean Diameter at Breast Height (DBH) and Height (ht), in addition to determining the content of NPK ions in plant tissues of the studied seedlings.

MATERIALS AND METHODS

Synthesis of cellulose acetate derived hydrogel (HEDTA)

The hydrogel was synthesized according to the methodology developed by Senna et al.13, where the CA and ethylenediaminetetraacetic dianhydride (EDTAD) were solubilized in dimethylformamide, as reaction catalyst was used triethylamine for esterification and cross-linking between the free hydroxyl groups of CA and EDTAD. After the curing period, the hydrogel was neutralized, milled and sieved to obtain uniformity in particle size. The hydrogel was given the nomenclature HEDTA.

Site location and experimental conditions

The experiment was conducted about 6 kilometers from the center of the municipality of Salto de Pirapora, in the State of São Paulo, Brazil (23° 41′29.1″ S and 47° 34′ 38.96″ W). Planting with *Eucalyptus urograndis* seedlings was done following all the recommended steps: application of herbicide, ant control, subsoiling and liming, carried out throughout the study area.

The treatment applied to each seedling was performed as follows: 30 seedlings were planted with HEDTA without NPK fertilizer absorbed (HEDTA); 30 seedlings were planted with HEDTA with NPK fertilizer absorbed (10-10-10) (HEDTA+NPK); 30 seedlings were planted with PAP® without NPK fertilizer absorbed (PAP); 30 seedlings were planted with solid NPK fertilizer (7-31-13) (NPK).

Physical characteristics of seedlings and statistical analysis

After planting, monthly measurements of ht, nc and DBH were carried out. The results obtained by the physical characterizations and the NPK ion concentration of the seedlings were statistically analyzed.

RESULTS AND DISCUSSION

The numerical values obtained in the analyzes of nc, DBH and ht for the four types of treatments (HEDTA, HEDTA+NPK, PAP and NPK) were analyzed by ANOVA test with a single factor and alpha value equal to 0.05. The values obtained for the four types of treatments were compared with each other (Figure 1).

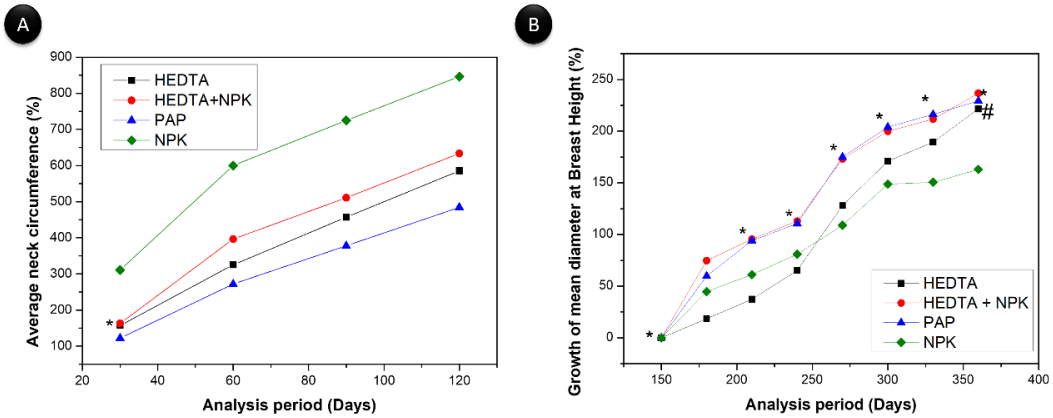

Figure 1: Average neck circumference (A) and Growth of mean diameter at breast height (B) of *Eucalyptus urograndis* seedlings.

It was possible to observe that the seedlings that received the NPK treatment showed the greatest increase in nc (Figure 1 A), with a significant difference in relation to the other treatments. This result was related to the requirement of *Eucalyptus* seedlings for phosphorus, which was supplied using NPK fertilizer (07-31-13) with a high concentration of this nutrient. The HEDTA+NPK treatment, also showed a positive and increasing response regarding nc.

The results related to the DBH of the seedlings (Figure 1 B), prove the theory that the HEDTA+NPK treatment performs the slow release of the fertilizer according to the plant's needs. In the last measurements, the results showed that the NPK treatment proved to be the least efficient in relation to the measured parameter.

The crucial parameter for pruning *Eucalyptus* seedlings is the average height growth (ht), figure 2. The statistical analysis showed similar results in the first 30 days of the experiment and this fact was highlighted in figure 2 by the letter "a".

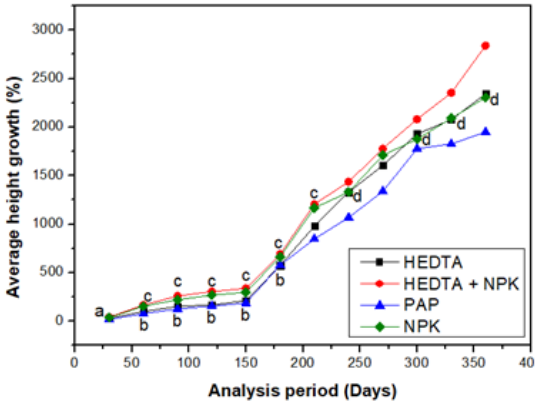

Figure 2: Average height growth of *Eucalyptus urograndis* seedlings.

In the follow-up period between 60 and 180 days, it was possible to observe lower and statically similar ht values for the clones treated with HEDTA and PAP (highlighted by the letter "b" in figure 2), however after this period the PAP presented the worst performance among all treatments. The treatments with HEDTA+NPK and NPK, on the other hand, presented the best results with respect to the ht of seedlings, with no statistically significant differences between them in measurements taken until 210 days, as highlighted by the letter "c" in figure 2. After this period, a decrease in the efficiency of the NPK treatment can be observed, which in some points is statistically equal to HEDTA (highlighted by the letter "d" in figure 2).

CONCLUSIONS

The present work showed that the HEDTA+NPK treatment can be efficiently used as a substrate for controlled nutrient release in *Eucalyptus urograndis* plantations. It was concluded that the high leaching rate of the NPK treatment impaired the development of the seedlings and in contrast the HEDTA+NPK released in a controlled way all the nutrients. Thus, HEDTA+NPK was able to effectively reduce the leaching rate of fertilizers and improve the performance of *Eucalyptus* seedlings, providing water and nutrients in a controlled manner to the plants.

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