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Effects of Hydrogels on Soil Moisture and Growth of Leucaena Pallida in Semi Arid Zone of Kongelai, West Pokot County

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Abstract:

Studies on the effects of hydrogels on soil amendments, moisture conservation and growth of *Leucaena pallida* in arid and semi-arid lands was carried out. Seedlings of *L. pallida* were established both in the nursery and in the field with and without hydrogels. Field experiment was carried out with three replications and three concentration hydrogels levels (7g, 11g and 15 g) and control seedlings established in soils without hydrogels. In the nursery, root collar diameter and heights were measured every two weeks upto eight weeks. Seedlings established without hydrogels in the nursery were transplanted into field soils with none, 7g, 11g and 15g of hydrogels. Root collar diameter and height were again measured every month for three months. In addition, soil was collected randomly once every month from the base of each seedling and analyzed for soil moisture using standard laboratory procedures. All data were subjected to analysis of variance. Results show that there was a significant difference in the height and root collar diameter growth of the species and at different level of hydrogels. This suggests that use of hydrogels in the nursery soils retards plant growth but improves growth in the field. Hydrogels increased soil moisture volume from 8.3% to 10% in H_{15g} level of hydrogels under *L. pallida* after transplanting. It was concluded that hydrogels does not contribute to growth of seedlings in the nursery but it does so after transplanting. Hydrogels increase soil moisture in the soil therefore recommended for use in semi arid lands to boost the survival and growth of seedlings.

Keywords:

Hydrogels; Moisture; Nutrients; Growth; Semi Arid Lands

1. INTRODUCTION

Kenya is a developing country striving to achieve vision 2030 [1], 2009). One way of achieving such goals is to improve the livelihood of people living in arid and semi arid lands through introduction of appropriate agroforestry technologies and practices to mitigate aridity [2]. The forest cover in Kenya is currently standing at 1.7% way far below the internationally accepted minimum of 10% (IPCC, 2008),

therefor a need to support the development of forestry practices to increase forest cover towards the required minimum percentage. On the basis of moisture availability for plant growth, Kenya is classified as 88% arid and semi-arid with a population over of 10 million many of whom are pastoralists and agro-pastoralists [3]. Similarly moisture retention in the soil is fundamental in the growth of agroforestry tree species. Soil water affects plant growth directly because it influences aeration, temperature, nutrient transport, uptake and transformation [4].

Hydrogels are networks of polymer chains that are hydrophilic and highly absorbent to water molecules [5]. The addition of hydrogels to soil can improve water holding capacity, decrease evapotranspiration and allow plants to mitigate the drought stress (Leciejewski, 2008).

This study therefore aims at investigating the effects of hydrogels on soil water availability and growth of *L. pallida* seedlings in the nursery and their early establishment in the arid and semi arid lands of Kongelai.

2. MATERIALS AND METHODS

2.1 Location and climate of study area

This study project was carried out at Kongelai, West Pokot County Latitude: $1.47^{0}71$'S; Longitude: $35.02^{0}07$'E. The study area lies between 1500 to 2100 metres above sea level, characterized by bimodal type of rainfall with the long rains between April to August and short rains between October and February. The study area is characterized by great variations in temperature with 30 ˚C in the lowlands and 15 ˚C the highlands. Soils in the study area are developed from sedimentary rocks. The soils are generally eutric cambisols partly with lithic phase, while some are eutric regosols and in some places have rock outcrops. The soils are shallow and well drained, hence retain optimum amounts of soil water for plant growth after rain. Natural fertility is moderate, while erosion susceptibility is high. The top soil is harden and sealed while infiltration rate is low hence runoff accompanied by severe erosion on the gentle slope.

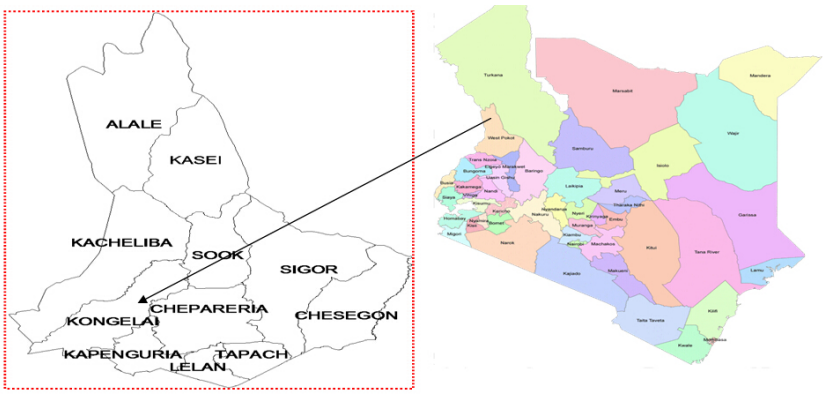

Figure 1. Map of Study Area, West Pokot County (County Commissioners Office, 2013)

Hydrogels used was called Belsap manufactured by Bell Industries limited in Nairobi Kenya.

Potting soil was obtained from Kapolet Forest Station.

2.2 Procedures in nursery

Seeds of *L. pallida* was directly sown into polythene tubes measuring (4 × 6 inches) containing 800g of forest soil and at different levels with hydrogels others without hydrogels. A total of 4 treatments were prepared. Each treatment consisted of 42 seedlings at 0, 7, 11 and 15g hydrogels levels replicated thrice. Treatments were randomized within the blocks. All polythene tubes were labeled for identification purposes. Once germinated, root collar diameter and height were measured every two weeks for two months. Randomized block design was used in this experiment.

2.3 Procedures in Field

After three months, control seedlings in the nursery were de-potted and transplanted into pre-tested soil samples in a field within the same region. All seedlings treated with hydrogels in the nursery were not transplanted. In the field, the same levels of as in the nursery were applied in the planting holes mixed with soil. Thirty seedlings were used for each treatment. Once a month for two months, RCD and height of seedlings were measured. In addition soil samples were collected from the base of each growing seedling for moisture analysis.

2.4 Determination of soil moisture

50g soil from 0-10cm horizons was collected in the field using a soil auger under*Leucaena pallida* seedlings. Initial weight was determined and the sample oven dried at 100 ˚C. Oven dry weight was determined and soil moisture content determined using the formulae below.

$$\text{Moisture content (MC)} = \frac{Initialsoilmoisturecontent - finalweight(ovendryweight)}{Initialsoilmoisturecontent} \times 100$$

The data collected were analyzed using Microsoft Excel; Analysis Toolpak, a computer package for data analysis. F-Test was used to test the level of significance.

3. RESULTS AND DISCUSSION

3.1 Effects of hydrogels on height of seedlings in the nursery

Leucaena pallida established in soils with no hydrogels gave higher height growth than those in soils treated with hydrogels. Soils treated with the higher amount of hydrogels (H15g) gave the least growth in height of seedlings. Analysis of variance for the height of *Leucaena pallida* shows that $\{F_{0.05}(1) = 3.4967 > \text{F critical } (3.1903)\}$. This implies that hydrogels application has a significant difference on the height growth.

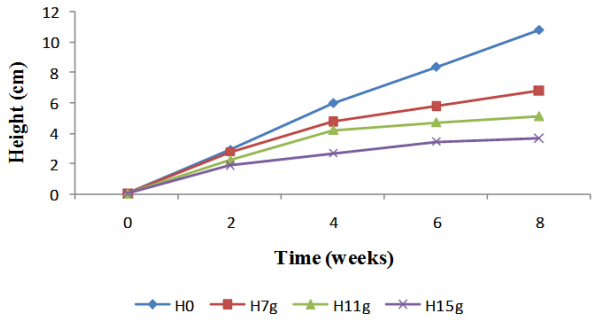

Figure 2. Effects of hydrogels on height of Leucaena pallida seedlings in the nursery.

3.2 Effects of hydrogels on root collar diameter of seedlings in the nursery

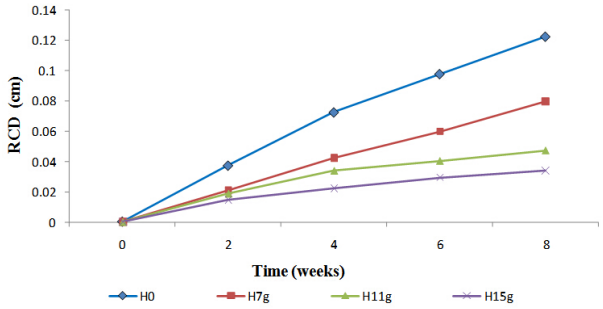

Figure 3. Effects of hydrogels on RCD of Leucaena pallida seedlings in the nursery.

Leucaena pallida seedlings established in soils with no hydrogels gave higher RCD growth as compared to seedlings established in soils treated with hydrogels. Analysis of variance shows that $F_{0.05}(1) = 4.6504 > F$ critical (3.4903). This implies that hydrogels application has a significant difference on the root collar diameter growth.

Increasing levels of hydrogels has a negative effect on the growth of seedlings in the nursery both in RCD and height. Hydrogels also absorbs water and fills the soil pores causing flooding in the polythene tubes therefore retards the growth of seedlings. This finding was in total agreement with [6, 7].

3.3 Effects of hydrogels on height of seedlings in the field

Leucaena pallida seedlings grown in soils with no hydrogels gained least growth in height than those in soils treated with hydrogels. Analysis of variance for the height of *Leucaena pallida* shows that $F_{0.05}(1)$ [15, 3] = 91.6573 > F critical (3.4903). This shows that hydrogels has a significant difference on the growth of transplanted seedlings hence use of hydrogels in the soil in the field has a positive impact on height growth.

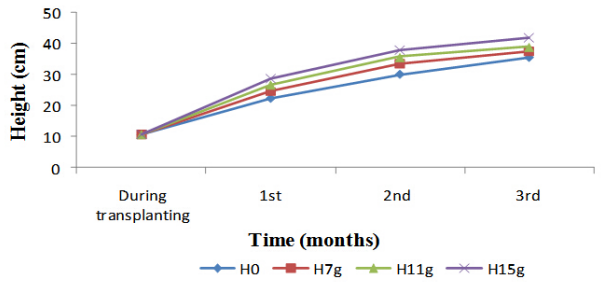

Figure 4. Effects of hydrogels on height of Leucaena pallida seedlings after transplanting.

3.4 Effects of hydrogels on RCD after transplanting

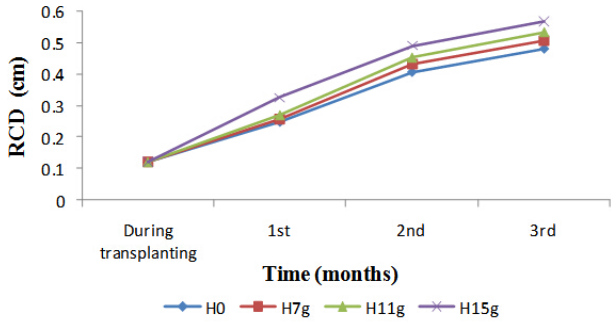

Figure 5. Effects of hydrogels on RCD of transplanted seedlings after 3 months.

Hydrogels is used in arid and semiarid areas to improve the growth of agroforestry tree species Michael, [8] reported that hydrogels absorbs water which can improve the growth of seedlings after transplanting in arid environment. Their results of the study confirm that changes in the nutrient status of the soil were influenced by the application of hydrogels which resulted to the increase in soil fertility hence the differences in growth rate.

3.5 Effects of hydrogels on soil moisture

Soil moisture content was determined in the subplots under the three species and the results were presented in the **Figure 6**.

Hydrogels had an impact on soil moisture content in the soil after transplanting in arid and semi arid climate. Analysis of variance shows that; $F_{0.05}(1) = 5.2690 > F$ critical (4.0662). Hydrogels has a significant difference on the growth of transplanted seedlings in the field.

Landis [9] reported that hydrogels improve soil moisture content in the soil and provide water to the plants during dry season. This was experienced in soils treated with hydrogels gained more soil moisture content as compared to controls.

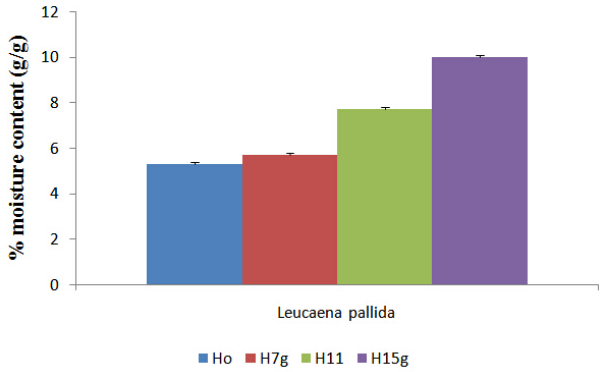

Figure 6. Effects of hydrogels on soil moisture after transplanting.

4. CONCLUSION

Analysis of variance on the growth of *Leucaena pallida* shows that $F_{0.05}(1)$ [15, 3] = 91.6573 > F critical (3.4903). This implies that hydrogels has an impact on the growth of seedlings. It retards growth of seedlings in the nursery but it has positive impacts after transplanting.

Analysis of variance on soil moisture shows that $F_{0.05}(1) = 5.2690 >$ F critical (4.0662) implying that hydrogels has a significant difference on the growth of transplanted seedlings in the field. Hydrogels when incorporated into growing media or soil absorbs moisture in the environment and retain water therefore it is used in arid and semi arid areas to increase plants survival after transplanting.

Further studies to be done to compare hydrogels effects on a range of soil types using a wide range of tree species.

References

[1] M. Muchiri, B. Kamondo, D. Ochieng, P. Tuwei, and J. Wanjiku, "Kenya Forestry Research Institute Proceedings of the 4th KEFRI Scientific Conference. Recent advances in Forestry Research for Environmental Conservation, Improved livelihood and Economic Development," 2009.

[2] F. Okorie, "Studies on Drought in the Sub-Saharan Region of Nigeria using Satelite Remote Sensing and Precipitation Data," 2003.

[3] GoK, "National Climate Change Response Strategy," 2010.

[4] Z. Luo, E. Wang, O. J. Sun, C. J. Smith, and M. E. Probert, "Modeling long-term soil carbon dynamics and sequestration potential in semi-arid agro-ecosystems," *Agricultural and Forest Meteorology*, vol. 151, no. 12, pp. 1529–1544, 2011.

[5] J. Abedi-Koupai, F. Sohrab, and G. Swarbrick, "Evaluation of Hydrogels Application on Soil Water Retention Characteristics," *Journal of plant nutrition*, vol. 31, no. 2, pp. 317–331, 2008.

[6] A. D. Del Campo, J. Hermoso, J. Flors, A. Lidón, and R. M. Navarro-Cerrillo, "Nursery location and potassium enrichment in Aleppo pine stock 2. Performance under real and hydrogels-mediated drought conditions," *Forestry*, vol. 84, no. 3, pp. 235–245, 2011.

[7] A. Korsaeth, "N, P, and K Budgets and Changes in Selected Topsoil Nutrients over 10 Years in a Long-Term Experiment with Conventional and Organic Crop Rotations," *Applied and Environmental*

Soil Science, vol. 2012, 2012.

[8] M. S. Chen, Y. Huang, J. Zou, Q. Shen, Z. Hua, Y. Qin, H. Chen, and G. Pan, "Modeling Inter-annual Variability of Global Soil Respiration from Climate and Soil Properties," 2010.

[9] T. Landis, D. L. Haase, *et al.*, "Applications of hydrogels in the nursery and during out planting," in *National Proceedings: Forest and Conservation Nursery Associations*, pp. 53–58, 2011.

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