*Journal of Research in Forestry, Wildlife & Environment Vol. 12(3) September, 2020*
*E-mail: jrfwe2019@gmail.com; jfewr@yahoo.com*
*http://www.ajol.info/index.php/jrfwe*


*ISBN: 2141 – 1778*
*Alex et al., 2020*



# EFFECTS OF GROWTH MEDIA AND WATER QUANTITY ON SEEDLING GROWTH AND SURVIVAL OF *Rothmannia hispida (K. Schum)*

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## *ABSTRACT*

***The study investigated the effects of growth medium and water quantity on seedling growth of Rothmannia hispida with a view of promoting its conservation. The study was conducted at the Nursery of the Faculty of Agriculture, Department of Forestry and Wildlife Management unit, University of Port Harcourt. Seeds were collected from Forestry Research Institute of Nigeria, Edo State. Three hundred and sixty seeds were selected and sown into three growth media which were replicated three times before laying the experiment in a Completely Randomized Design. Fifteen healthy seedlings were selected and replicated three times. A total of one hundred and thirty five seedlings were used for the experiment. Three watering applications at (0.5 litres, 0.75 litres and 1.5 litres) were used. This was allowed to seep into the polypot at five drops per minute; the experiment was arranged in a 3x3 factorial design. Growth parameters were assessed to estimate the optimum water requirement at the nursery. Destructive sampling was carried out on all the seedlings for root length assessment. The results on the effects of growth media and water quantity were significant ($\alpha_{0.05}$) on height, number of leaves and root length, the highest mean value for watering volume was recorded as 0.75 litres (10.22±2.570) followed by 0.75 litre (3.267 ±1.52) and 1.5 litres had (7.431±2.313) respectively while the highest mean value for growth medium on plant height, number of leaves and root length was recorded as mixture (10.15±2.342), mixture (3.275±1.156) and sawdust (7.938±2.112) respectively. The assessment on collar diameter showed no significant difference ($\alpha_{0.05}$). The study shows that better growth parameters could be achieved using watering volume of 0.75 litres and mixtures of growth media.***

**Keywords:** Growth media, water quantity, seedlings, poly pot, *Rothmannia hispida*

## INTRODUCTION

The variations in environmental and weather conditions necessitated by the global climatic change in recent times have created diverse reactions from plants, animals and among other microorganism. This situation have greatly influence the rainfall pattern with its attendant unpredictable flooding and drought conditions around the globe that have create a new approach to doing research on regeneration of useful forest species (Gbadamosi, 2014). Water sourced naturally or artificially is an important component for plants growth, survival and productivity. Adequate quantity of water is critical to the successful growth of any forest seedlings in the nursery (Simon *et al;* 2011; Gbadamosi, 2014). Seedlings' water requirements are dependent on the growth parameters of specific forest seedlings, its stage of growth and the prevailing atmospheric conditions (Farah, 1996). According to Awodol and Nwoboshi (1993), water is a considerable factor in forest land ecosystems both in arid, semi-arid and rainforest ecosystem and it is important for tree growth and development. The required volume of water for tree growth and development is dependent on tree species, growth stage and time of the year.

Plants required water for the manufacture of carbohydrates and as a means for transportation of foods and mineral elements, however depletion in food and water reserves cause seedlings to depend on photosynthesis for their steady survival and

growth (Bargali and Tewari, 2004). Available and sufficient water in plants aids vital processes such as cell division, cell elongation, stem enlargement, leaf enlargement and chlorophyll formation (Price *et al.,* 1986). Levy and Krikum, (1983) reported that a change in all structures leading to the death of the plants is due to insufficient water in the plants below critical level. In dry climates, for a successful vegetative growth, hundreds of tons of water are consumed by the particular growing plant. Awodola (1984) observed that a reduction in the contents of relative water affects plant growth and its physiological processes. Similarly, water present above its required volume in plants may cause retardation in their physiological processes. It was stated that soil water balance influences the stomata and the xylem pressure (Komer *et al*., 1999). There has been a rising conflict regarding the type of growth medium most suitable for the growth and development of most forest seedlings *as* it played a positive and negative role on the growth and development of seedlings. An important natural resource that supports life and growth of plants is water, however, in recent times there has been an alarm as regards water availability (Goyne and McIntyre, 2003).

The availability of permanent water supply has been one of the major challenges in forest nursery establishment and management especially in the drier regions of the tropics and sub-tropics and determination of the exact volume of water required for the survival and development of nursery seedlings (Morrison *et al.,* 2009). Hence the research investigates the effects of growth medium and water quantity on the seedling growth and survival of *Rothmannia hispida* with a view to enhancing and promoting its conservation.

## MATERIALS AND METHODS

### Experimental site

This study was conducted at the Nursery of the Department of Forestry and Wildlife Management Faculty of Agriculture, University of Port Harcourt. Geographically, the experimental site is lies between latitude 4o53' 14"N through 4o54' 42"N and longitude 6º 54' 00"E through 6º 55' 50"E (Chima *et al.*, 2015).

### Collection and preparation of seeds

The seeds of *Rothmannia hispida* used for the experiment were collected from Sapoba Forest Reserve in Esan West local Government Area of Edo State. The collected seeds were carefully preserved and transported to the experimental site. Viability test was carried out by soaking the seeds in water for 45 minutes in order to separate the healthy viable seeds from the premature ones after which the healthy ones were selected for sowing.

### Experimental Design and Procedure

### Seed Germination

Three hundred and sixty (360) viable seeds of *Rothmannia hispida* were selected and used for the germination experiment. The seeds were sown into three growth media (decomposed sawdust, topsoil and mixture of top soil and decomposed sawdust) which were replicated three times before laying the experiment in a Completely Randomized Design (CRD.

Fifteen fairly healthy seedlings of equal height were selected from already germinated seedlings and use for growth experiment. This was replicated three times. A total of one hundred and thirty five seedlings of *R. hispida* were used for the experiment and transplanted into different growth media such as (decomposed sawdust, topsoil and mixture) having a total of forty five seedlings each per growth media. After transplanting, all the polypots were watered at field capacity during acclimatization and then subjected to three different watering applications (0.5 litres, 0.75 litres and 1.5 litres). litres of water were hanged over each polypot with one seedling and allowed to drip into the each polypot. These drip sets were replaced to ascertain the actual liter of water used per seedlings during the experimental period. The experiment was replicated three times and arranged in a 3x3 factorial design in a Completely Randomized Design (CRD). Different growth parameters were collected and evaluated to estimate the optimum water requirement and quantity of water required at the nursery. Growth parameters: height, collar diameter, leaf count, root depth and survival rate were assessed using meter rule, venier caliper and ocular measurement.

**Figure 1: Different litres of water on seedlings**

**Data Analysis**

At the end of the experiment, the polythene was removed and data were collected on root of seedlings. A meter rule was used to measure the length of root per seedling. Data were analyzed using SPSS 16.0 software. A two-way ANOVA test was conducted at 5% level of significance and the Duncan Multiple Range Test (DMRT) was used to separate significant means.

**RESULTS**

**Effects of growth media and water quantity on seedling height assessment of *Rothmannia hispida***

There were significant differences in the effects of watering quantity and growth medium on the height of *Rothmannia hispida* (Table1).The highest mean height was recorded in seedlings sown in sawdust under watering volume of 0.75 litres which had with a mean of (11.12) this was closely followed by the seedlings sown in mixture (topsoil and sawdust) subjected to a watering volume of 1.5 litres which had mean of (10.76). The least was recorded in seedlings sown with sawdust under 0.5 litres watering volume which had mean value of (0.51) (table 1).

**Effects of Growth Medium and Water Quantity on Seedling Collar Diameter Assessment**

There were no significant differences in the effects of growth medium and watering quantity on the collar diameter of *Rothmannia hispida* (Table 2).However the highest collar diameter which had mean value of (0.5434) was recorded in seedlings sown with top soil and watering quantity of 0.75 litres, this followed by seedlings sown with sawdust under a watering regime of 0.5 litres which had (0.5162); the least was observed in seedlings sown with topsoil with a mean of (0.3915) under 1.5 litres watering.

**Table 1: Effects of growth media and water quantity on seedlings height of *Rothmannia hispida***

| Variables | 0.5 litres | 0.75 litres | 1.5 litres | Mean |
|---|---|---|---|---|
| Sawdust | 0.53±0.17 | 11.12±2.55 | 10.090±2.14 | 7.24±5.15 |
| Mixture (T&S) | 10.39±2.19 | 9.29±2.90 | 10.76±1.45 | 10.15±2.34 |
| Topsoil | 8.93±1.72 | 10.27±1.81 | 9.33±2.13 | 9.51±1.97 |
| Mean | 6.61±4.64 | 10.22±2.57 | 10.07±2.02 | 8.97±3.68 |
| Pvalue | 0.000 | 0.000 | 0.000 | |

**Table 2. Effects of growth media and water quantity on seedlings collar diameter**

| Variables | 0.5 litres | 0.75 litres | 1.5 litres | Mean |
|---|---|---|---|---|
| Sawdust | 0.52±0.17 | 0.48±0.15 | 0.50±0.19 | 0.49±0.17 |
| Mixture (T&S) | 0.45±0.18 | 0.45±0.16 | 0.49±0.15 | 0.46±0.17 |
| Topsoil | 0.39±0.08 | 0.54±0.19 | 0.39±0.10 | 0.44±0.16 |
| Mean | 0.45±0.16 | 0.49±0.17 | 0.46±0.16 | |
| P value | 0.000 | 0.390 | 0.00 | |

**Effects of Growth Medium and Water Quantity on Seedling Leave Production**

There were no significant difference on the effects of watering volume and growth medium on leave production of *Rothmannia hispida*, (Table 3) the result shows that highest leave production was observed in seedlings sown in topsoil under a watering regime of 0.75 litres which had (3.717±1.251) this was followed by seedlings sown in sawdust under a watering volume of 0.5 litres which had(3.300±1.026) while the least was recorded in seedlings sown in topsoil medium under a watering volume of 0.5 litres with mean value of (2.991±1.04918).

**Table 3. The effects of water quantity and growth medium on leave production of *Rothmannia hispida***

| Variables | 0.5 litres | 0.75 litres | 1.5 litres | Mean |
|---|---|---|---|---|
| Sawdust | 3.30±1.026 | 3.10±1.05 | 3.22±0.98 | 3.21±1.02 |
| Mixture (T&S) | 3.21±1.315 | 2.98±1.00 | 3.05±1. 07 | 3.08±1.14 |
| Topsoil | 2.99±1.04918 | 3.71±1.25 | 3.12±1.03 | 3.28±1.16 |
| Mean | 3.17±1.142 | 3.27±1.15 | 3.13±1.03 | 3.19±1.11 |
| Pvalue | 0.000 | 0.000 | 0.364 | |

**Effects of Sowing Medium and Water Volume on Root Length of *Rothmannia hispida.***

The effects of growth media and watering volume on the root length as shown in (Table 4) shows that the longest root length was observed in seedlings sown with sawdust under a watering regime of 1.5 litres which had (9.000±0.465) this was followed by seedling sown in sawdust under a watering volume of 0.5 litres which had (7.700±0.465); while the least was recorded in seedlings sown with topsoil which had (5.960±0.465) under a watering volume of 1.5 litres.

**Table 4. Effects of growth media and watering volume on the root length of *Rothmannia hispida***

| | 0.5 litres | 0.75 litres | 1.5 litres | MEAN |
|---|---|---|---|---|
| Sawdust | 7.70±0.47 | 7.11±0.47 | 9.00±0.47 | 7.94±2.11 |
| Mixture (T&S) | 6.52±0.47 | 7.27±0.47 | 7.33±0.47 | 7.04±1.99 |
| Topsoil | 6.03±0.47 | 6.45±0.47 | 5.96±0.47 | 6.15±1.29 |
| Mean | 6.75±1.82 | 6.94±1.68 | 7.43±2.31 | |

## DISCUSSION

**Effects of the Growth Media on *Rothmannia hispida* Seedlings**

The experiment reveals a great deal that the use of growth media were suitable, and support the growth and production of healthy seedlings of *Rothmannia hispida*; this was evident in the germination experiment and agrees with the work of Agbo and Omaliko (2006) who reported that growth media influence the quality of seedlings produced. The regular watering allows nutrient to dissolve and transport to appropriate area for leaf expansion and

photosynthesis. Regular watering enhanced the nutrient uptake of phosphorus in plant seedling. This corroborated with the documentation of Olubode *et al.* (2018).

**Effects of water volume on seedling growth of *Rothmannia hispida***

The effects of water quantity on *Rothmannia hispida* seedlings showed significant difference on seedlings height; this finding agrees with report of Taiz *et al., al.,* (1998) who stated that plants require water, soil nutrients, carbon dioxide, oxygen and solar radiation for growth. This observation also supports the finding of Rodriguez-Iturbe and Porporato, (2004) who clearly stated that the survival of seedlings is dependent on the water content of the soil and its growing environment. The lowest height mean was recorded under the watering volume of 0.5 litres (0.61±4.643) which was significantly different from the other watering volume. This finding corroborate with the reports of TNAU (2016) who discovered that when seedlings lack the required condition to keep the nutrient uptake, stress build thus the certainty of their survival is not guaranteed. It was recorded that watering volume on heights of *Rothmannia hispida* seedlings were significant difference. However, there was no significant difference on the effects of collar diameter on the seedlings. This observation disagrees with the findings of Tolulope and Joshua (2018) on height parameters of *Dioscoreophyllum cumminsii* and collar diameter as they stated that increasing volume of watering frequency yielded a significant increase in the stem, height and collar growths of nursery seedlings. The highest number of leaves production of *Rothmannia hispida* was recorded in seedlings subjected to the watering volume of 1.5 litres . Similar observation was made in the report of Dauda *et al;* (2009) who stated that the rate of increase in leaf number of vegetables can be directly proportional to the frequency of watering regime. Other reports findings from various researchers (Akinyele 2007, Oboho and Igharo 2017, Ogidan *etal*. 2018 and Gbadamosi 2014) also state that the highest growth parameters occur in seedlings exposed to regular watering. However, this disagrees with the findings of Gush and Moodley (2007) who stated that little quantity of water is needed for the overall healthy growth performance of forest seedlings otherwise frequent application of water will reduce seedling vigor significantly and eventually resulting in death of the plant and water logging of the growing site

**Effects of sowing media and water volume on root length of *Rothmannia hispida***

Water plays a major role in root length increment. The experiment shows that maximum root length was recorded under the watering volume of 1.5 litres this finding corroborate with the work of Seyed *et al.* (2014) who stated that plants experience water stress when the supply of water in plant roots is limited or when the transpiration rate is very high. The experiment also agrees with the work of TNAU (2016) who reported that water plays an essential roles in growth and development of plants ranging from the formation of the constituent of protoplasm, acting as a solvent for nutrients absorption, sources of transpiration and carrier of nutrients (roots) from the soil to green plant tissues. Sowing media and watering volume played a major role in root length evident in the result shows the highest total root length in sawdust, this finding agrees with Bhardwaj, (2014) who stated that suitable growth media is essential for the production of quality plant seedlings for afforestation and reforestation program and that growth medium directly affects the root performance and the overall performance of plant seedlings.

**CONCLUSION**

The result of the experiment shows that water is the most important amongst all other factors that influence growth parameters, uptake of nutrients in plants, their biochemical and physiological development. The result on the effects of growth medium and watering quantity revealed that the best growth medium for *Rothmannia hispida* seedlings is the combination of sawdust and top soil and the most suitable watering regime for raising quality *Rothmannia hispida* seedlings was 0.75 litres. Large scale production of seedlings for afforestation and refforstation program can best be obtained from the best growth parameters, seedlings of *Rothmannia*

*hispida* should be sown in the mixture medium under a watering regime of 0.75 litres.

**Recommendation**

Further research on growth parameters is however needed on the effects of growth medium and water quantity on the growth and survival forest seedlings.

**Acknowledgements**

The authors gratefully acknowledge the contributions of the staffs of the Forestry and Wildlife Management Nursery University of Port Harcourt, Nigeria.

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