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Effects of Watering Regimes on Germination and Early Seedling Growth of *Tetrapleura tetraptera* (Schum and Thonn) Taub

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Original Research Article

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Abstract: This study examined the watering regime that will enhance best germination and early seedling growth of *Tetrapleura tetraptera.* Seeds and seedlings of the plant were subjected to five different watering regimes viz: watering once weekly with 50ml, watering twice weekly with 50ml, watering once weekly with 100ml, watering twice weekly with 100ml and watering with 100ml only on the day of planting (as control for the seeds experiment), no watering (as control for the seedling experiments). The results of the experiment showed that watering once weekly with 100ml was the most effective watering regime for enhancing seed germination. This resulted in 85% germination, followed by the seeds watered twice weekly with 50ml (65%) and watering twice weekly with 100ml (50%). Other watering regimes were less or not effective. While watering twice weekly with 100ml was the most effective watering regime for enhancing seedling growth in this plant. This resulted in significantly highest plant height, number of leaves and broadest leaf area (22.00 cm, 15.00 and 27.51cm^2 respectively) at the third month of planting. It also resulted in highest seedling stem girth (3.50 cm) though this was not significantly different from seedling treated with other watering regimes except for seedling treated with no watering which gave 0.20 cm. The results of these studies demonstrated that water supply may be a limitation for raising *Tetrapleura tetraptera* in the nursery as the soil moisture influenced germinability and early growth of this plant.

Keywords: Watering regimes, germination, medicinal plant, seedling growth, *Tetrapleura tetraptera*.

INTRODUCTION

The important of water to plants cannot be over emphasized. Water requirements of plants are dependent on the botanical characters of the plant, its stage of growth and the prevailing weather conditions [1]. Water is an important factor in the growth, development and productivity of plants [2]. It is a determinant for seed germination and can affect both the percent germination and germination rate. Also it is essential for enzyme activation, breakdown, translocation and use of reserve storage material [3]. Water is required by plants for the manufacture of carbohydrates and as a means for transportation of foods and mineral elements. Various vital processes in plants such as cell division, cell elongation, stem as well as leaf enlargements and chlorophyll formation depends on plant water availability [4].

Levy & Krikum [5] opined that insufficient water in plants below a critical level is usually demonstrated by changes in all structures leading to the death of the plants. Also Awodola [6] asserted that reduction in relative water contents affects physiological processes and hence plant growth. Similarly, too much water in excess of plant need may retard physiological processes in plants [7]. Stomata conductance, which is a numerical measure of the maximum rate of passage of either water vapour or carbon dioxide through the stomata, and the xylem pressure potential, which is the component of water potential due to hydrostatic pressure that is exerted on water in a cell, are influenced by the soil-water balance [8]. Huang *et. al.* [9] reported that the root to shoot ratio was 3.5 times higher in water stressed plants.

Plant species respond differently to water availability. Also, different plant parts adapt differently to varying water stress conditions. Seeds of many plant species are sensitive to flooding stress during germination [10-12]. While prolonged flooding eliminates some species and favour others [13]. Seabloom *et. al.* [14] opined that the depth of flooding can also have significant effect on species composition and biomass of established plants. Roots play a vital role in plant survival during periods of drought [15]. Hsiao & Xu [16] reported that growth is readily inhibited under water deficiency and growth of roots is favoured over that of leaves. Often, leaves of plant growing in water stressed environment are small both in number and size.

Tetrapleura tetraptera is a tropical deciduous forest tree of 15-25m tall with characteristic distinctive four-winged fruits consisting of woody shell, and fleshy pulp. It is generally found in the lowland forest of tropical Africa. The fruits contain small, hard, brownish-black, flat and oval 10-15 seeds of about 8 mm long [17]. The plants belong to fabaceae family. Its fruits have various applications in Nigerian folk medicine and are used extensively for the management of an array of human ailments including hypertension, arthritis, diabetes mellitus, epilepsy, convulsion, leprosy, inflammation and rheumatoid pains [18, 17].

Medicinal plant is defined as those plants that are commonly used in treating and preventing specific ailments and diseases that are generally considered harmful [19]. WHO [20] defines medicinal plants as a basis for herbal products which may be produced for immediate consumption by subjecting plant materials to extraction, fractionation, purification, concentration or other physical or biological processes. Medicinal plants contribute significantly to rural livelihood of the people and social equilibrium in Africa [21].

Poor performance of some medicinal plant species may be attributed to inadequate physiological and silvicultural information regarding the species. Hence to adequately cultivate *Tetrapleura tetraptera* for its medicinal value, there is a need to delineate its required physiological and silvicultural characteristics. This constitutes the aim of this study being reported here.

MATERIALS AND METHODS

Seed Source

Fresh fruits of *Tetrapleura tetraptera* were obtained from Oba's market, Ado-Ekiti, Ekiti State, Nigeria and were taken to the herbarium of the Department of Plant Science and Biotechnology, Ado-Ekiti, Nigeria for authentication.

Viability Test

Seeds were subjected to viability test by using Tetrasolium chloride according to Kruse *et al.*, [22]. The seeds were cut and placed directly into the Tetrasolium solution and the viable seeds were stained red.

Stage 1: Seed Germination

One hundred viable seeds of *Tetrapleura tetraptera* were divided into five groups and sown separately in weathered heterogeneous sawdust filled into plastic germination pots. These were subjected to five watering regimes, viz: watering once weekly with 50ml (T_1); watering twice weekly with 50ml (T_2); watering once weekly with 100ml (T_3); watering twice weekly with 100ml (T_4) and watering only on the day of planting with 100ml (control) (T_5). Germination was observed and recorded weekly for two months. The data obtained were expressed in percentages.

Stage 2: Early Seedling Development

Seedlings of *Tetrapleura tetraptera* at two – leaf stage were pricked into polythene bags filled with top soil. A total of twenty (20) seedlings were selected and arranged in completely randomized design (CRD). Five watering regimes and frequencies were used namely; watering once weekly with 50ml (T_1); watering twice weekly with 50ml (T_2); watering once weekly with 100ml (T_3); watering twice weekly with 100ml (T_4) and no watering (control) (T_5). The experiment was replicated three times. Seedlings were allowed to stabilize for two weeks after which growth assessment commenced and were carried out for three months. Parameters assessed were plant height, leaf production per seedling, stem girth and leaf area. Data collected were subjected to analysis of variance (ANOVA) and Duncan Multiple Range Test (DMRT) at $P \leq 0.05$ was used to separate the means.

Statistical Analysis

The data collected were subjected to one-way analysis of variance (ANOVA) and the means were separated at $P \leq 0.05$ using Duncan's Multiple Range Test (DMRT). All statistical analyses were done using SAS software, 1999 version.

RESULTS

Effect of watering Regime on Percentage Germination

Table-1 shows the effect of varying watering regimes on percentage germination of seed of *Tetrapleura tetraptera.* The results revealed that the highest mean percentage germination (85%) was obtained from the seeds treated with 100mls of water once in a week, this was followed by those that received 50mls of water twice in a week and 100mls twice per week (65% and 50% respectively). Seeds treated with 50mls once in a week gave 25%. While the control, that is, seedlings treated with 100mls of water only on the day of planting had the least value of 15%.

Table-1: Effect of varying watering regimes on percentage germination of seeds of *Tetrapleura tetraptera*

Watering regimes	Germination (%)
T_1 (50mls once/week)	25
T_2 (50mls twice/week)	65
T_3 (100mls once/week)	85
T_4 (100mls twice/week)	50

T_5 (100mls only on the day of planting)	15

Effect of watering Regime on Seedlings Height

The effect of varying watering regimes on seedling height of *T. tetraptera* at the end of third month is shown in Table-2. The highest plant height was observed in seedlings subjected to watering twice per week with 100mls i.e. T_4 (22.00cm). This was followed by those that received 100mls of water once in a week and those that received 50mls of water twice in a week (20.00cm and 18.62cm respectively). Seedlings that received no water, that is, the control kept decreasing in height each month. Statistical analysis revealed that means with different alphabet in each column shows significant differences ($P \leq 0.05$) in the seedlings height due to differences in the watering regimes.

Table 2: Effect of varying watering regimes on seedling height of *Tetrapleura tetraptera*

Treatments	Seedling Height (cm) / Month		
	One	Two	Three
T_1 (50mls once/week)	12.50^{bc}	14.50^{b}	17.50^{b}
T_2 (50mls twice/week)	14.00^{ab}	16.00^{b}	18.62^{ab}
T_3 (100mls once/week)	14.50^{ab}	18.40^{a}	20.00^{ab}
T_4 (100mls twice/week)	16.00^{a}	20.00^{a}	22.00^{a}
T_5 (No watering)	10.00^{c}	8.00^{c}	5.00^{c}

Values with the same letter(s) within the column are not significantly different at $P \leq 0.05$

Effect of watering Regime on Numbers of Leaf

Table-3 shows the effect of varying watering regimes on leaf production in *T. tetraptera*. Results obtained revealed that the highest means leaf production of 15.00 was recorded in T_4 which is made up of seedlings watered with 100mls twice per week for three months. T_2 and T_3 that is seedling treated with 50mls twice per week and 100mls once per week has the same mean value of 14.00 followed by T_1, that is, seedling watered with 50mls once in a week recorded 13.00. While the least was observed in the control, that is, seedlings that received no water (4.00).

Table-3: Effect of varying watering regimes on numbers of leaf in*Tetrapleura tetraptera*

Treatments	Numbers of Leaf / Month		
	One	Two	Three
T_1 (50mls once/week)	10.00^{a}	12.00^{a}	13.00^{b}
T_2 (50mls twice/week)	11.00^{a}	13.00^{a}	14.00^{ab}
T_3 (100mls once/week)	11.00^{a}	13.00^{a}	14.00^{ab}
T_4 (100mls twice/week)	11.00^{a}	13.00^{a}	15.00^{a}
T_5 (No watering)	7.00^{b}	6.00^{b}	4.00^{c}

Values with the same letter(s) within the column are not significantly different at $P \leq 0.05$

Effect of watering Regime on Stem Girth

The results obtained from Table-4 revealed that the highest mean stem girth of 3.50cm was recorded in T_4, that is, seedlings treated with 100mls twice in a week, though, the value has no significant difference from T_3, T_2 and T_1 which gave 3.20cm, 3.15cm and 3.00cm respectively. The least was recorded in the control, that is, seedlings that received no water with the value of 0.20cm.

Effect of watering Regime on Leaf Area

Table-5 shows the effect of varying watering regimes on leaf area of *Tetrapleura tetraptera*. The largest mean leaf area of 27.51cm^2 was recorded in T_4, that is, seedlings treated with 100mls of water twice in a week. This was followed by T_3, that is, the seedlings watered with 100mls once per week (24.67cm^2) and the least value (3.50cm^2) was recorded in T_5, that is, seedlings that were treated with no water for three months. Statistical analysis ($P \leq 0.05$) showed that the values obtained were significantly different in the varying treatments.

Table-4: Effect of varying watering regimes on stem girth of *Tetrapleura tetraptera*

Treatments	Stem Girth (cm) / Month		
	One	Two	Three
T_1 (50mls once/week)	2.00^{a}	2.30^{a}	3.00^{a}
T_2 (50mls twice/week)	2.05^{a}	2.40^{a}	3.15^{a}
T_3 (100mls once/week)	2.10^{a}	2.43^{a}	3.20^{a}
T_4 (100mls twice/week)	2.20^{a}	2.50^{a}	3.50^{a}
T_5 (No watering)	0.71^{b}	0.60^{b}	0.20^{b}

Values with the same letter(s) within the column are not significantly different at $P \leq 0.05$

Table-5: Effect of varying watering regimes leaf area of *Tetrapleura tetraptera*

Treatments	Leaf Area (cm^2) / Month		
	One	Two	Three
T_1 (50mls once/week)	14.52^d	16.50^d	19.00^d
T_2 (50mls twice/week)	16.74^c	19.20^c	21.50^c
T_3 (100mls once/week)	18.24^b	22.95^b	24.67^b
T_4 (100mls twice/week)	19.51^a	23.71^a	27.51^a
T_5 (No watering)	8.80^e	7.10^e	3.50^e

Values with the same letter(s) within the column are not significantly different at $P \leq 0.05$

DISCUSSION

Water is required by plants for the manufacture of carbohydrates and as a means for transporting foods and mineral elements. Various vital processes in plants such as cell division, cell elongation, stem as well as leaf enlargement and chlorophyll formation depends on plant water availability [4]. The results of different treatments in this study revealed that the highest percentage germination value was observed in watering once in a week with 100mls. However, the germination percentage obtained in seedling watered once only on the day of planting was found to be very low, this indicates that the water availability is below what is necessary for germination of *Tetrapleura tetraptera*. Thus little moisture supply may not enhance the germination of this species. This corroborates the report of Mantovani & Iglesias [23] that germination percentage, growth rate and synchronicity varied with increasingly negative water potentials.

The highest plant height was observed in seedlings watered twice in a week with 100mls, this may be attributed to the fact that the species is a tropical deciduous forest plant that germinate well with availability of regular moisture of the soil. Previous study by Awodola [6] asserted that water is a significant factor in dry land forestry and it is critical to tree growth and development in the tropics. Whereas the seedlings treated with no water kept decreasing physiologically. This may be attributed to lack of soil moisture. This agreed with the report of Levy & Krikum [5] that insufficient water in plants below a critical level is usually demonstrated by changes in all structures leading to the death of the plant. Seiler & Cazella [24] also reported that extreme soil drying ultimately reduces root growth.

Seedlings treated with 100mls of water twice in a week also brought about significant increase in leaf production when compared to those with other treatments. In particular, those that were not watered, their leaves kept reducing in number each month due to unavailability of water. Thus, supporting the assertion of Hartmann & Kester [25] that water limits the plant growth in virtually all environments. Gbadamosi [2] also reported that ordinarily, plants as part of their survival strategy to reduce water loss during period of severe water stress, may reduce leaf area or formation of new leaves.

Results of this study revealed that the largest stem girth was recorded in seedlings watered twice in a week with 100mls but this was not statistically different from other treatments except for the seedlings that were not watered where the lowest stem girth mean value was recorded. The unimproved stem girth may be due to the presence of water stress. This agreed with the opinion of Abdelbasit *et al.*, [26] who reported that water stress causes significant variation on seedlings relative growth rate (stem length, leaf, root and total plant biomass).

The largest leaf area was recorded in seedlings watered twice in a week with 100mls. Statistical analysis ($P \leq 0.05$) showed that the values obtained were significantly different in the varying treatments and the least mean leaf area value was recorded in the seedlings treated with no water for three months. This could be as a result of lack of sufficient water for the proper growth of this species. Mcmaster & Smike [27] and Abo El-Kheir [28] have earlier reported that during vegetative growth, phyllochron decreases under water stress and leaves become smaller, which results in low leaf area index. Lawlor & Leach [29] also reported that decrease in leaf area is a common effect of drought.

CONCLUSION

The results of these studies demonstrated that water supply may be a limitation for raising *Tetrapleura tetraptera* in the nursery. Also, soil moisture had influence on the germinability and early growth of *Tetrapleura tetraptera*. The species does better with sufficient water supply. Insufficient water supply hindered the rapid development of *Tetrapleura tetraptera* seedling height, stem girth, number of leaves and leaf area while seedlings on dry soil are liable to death as observed in these studies. It is therefore recommended that effective domestication of this species in the nursery where water is scarce should be supported with minimum but regular supply of water.

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