INTERNATIONAL JOURNAL OF PLANT, ANIMAL AND ENVIRONMENTAL SCIENCES

IJPAES

Volume-3, Issue-2, April-June-2013

ISSN 2231-4490

Coden : IJPAES www.ijpaes.com

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*Received: 08th Dec-2012* *Revised: 18th Dec-2012* *Accepted: 18th Dec -2012*

*Research article*

# EFFECT OF WATERING REGIME ON THE EARLY GROWTH OF *Acacia Senegal* (LINN) WILLD. PROVENANCES

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**ABSTRACT:** Water is the physical basis of life in the living organism. Water is required by plants for the manufacture of carbohydrates and as a means for transportation of foods and mineral elements. The present study was undertaken to examine the effect of watering regime on early growth of *Acacia senegal* (LINN) Willd provenances at Usmanu Danfodiyo University (UDU), Sokoto. Seeds from four provenances (Yobe, Borno, Kano and Jigawa) were sown in a randomized complete block design with 4 replicates each. Seedlings were monitored under 4 different watering regimes (once daily, twice daily, once in 2 days and once in 3 days) and growth parameters were measured forthnightly for 12 weeks. The result indicated that, Yobe and Borno provenance performed better when watered once in three days. Jigawa and Kano Provenance also showed good growth performance when watered once in two days, and this reflects the capability of these species in coping with the drought stress. The Study therefore recommends that watering of *A.senegal* seedlings once between two to three days should be adopted in the semi-arid zone, since it ensures proper growth performance of this species.

**Key words:** Watering Regime, Early Growth, Provenances, Seedlings and *A.senegal*

## INTRODUCTION

*Acacia senegal* is a drought tolerant plant characterized with features that has potentials for ecosystem stabilization and anti desertification in the semi-arid area [8]. The tree is also highly valued for gum arabic which is used in foods, pharmaceuticals, textiles, cosmetics and other industrial application. Gum is a substance that is taken from two sub-Saharan species of Acacia tree; *Acacia senegal* and *Acacia* seyal [19, 2, 18]. It is called Gum Arabic because the first traders on the gum exudates were the Arabs [27, 13, 3], and it has been in trade since the most remote records of historical antiquity [11, 15, 19, 9]. Gum Arabic provides a valuable source of income for many poor smallholders or itinerant labourers, either in very poor countries or in the poorest regions of rather more developed countries. Poor yield of the species in the semi arid region of Nigeria may be attributed to inadequate physiological and silvicultural information regarding the species. Hence to adequately integrate *A. senegal* with the other semiarid trees for the control of desertification and for the production of its very valuable and high-quality gum- Arabic, there is urgent need to delineate its required physiological and silvicultural characteristics. Water is a significant factor in dryland forestry and it is critical to tree growth and development in the tropics [7]. 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 enlargement and chlorophyll formation depends on plant water availability [23]. As noted by [16], insufficient water in plants below a critical level is usually demonstrated by changes in all structures leading to the death of the plants. According to Miller, for each ton of vegetative growth, hundreds of tons of water may be consumed by the growing plant particularly in dry climates. As observed by [6], the 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. In particular, 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 [14]. [12] reported that root to shoot ratio to be 3.5 times higher in water stressed plants.

The objective of this study is to examine the effect of watering regime on early growth of four (4) different provenances of *Acacia senegal* (LINN) Willd, a condition that could improve the yield and productivity of the plants.

## MATERIALS AND METHOD

### Samples Collection

Four (4) sources of *A. senegal* seeds were selected purposively based on distribution by hectares of Gum arabic plantations in the producing states of Nigeria. The seeds were collected from prominent centers in Borno state (FRIN N-E Reaserch Station, Damasak, Maiduguri), Yobe State (Barema farm, Damaturu), Jigawa State Ministry of Environment and Kano State Ministry of Environment. These provenances have different rainfall, co-ordinates and relief (Table 1).

**Table 1: Seed sources of *Acacia senegal* used in the study**

| Provenances | Rainfall (mm) | Latitude | Longitude | Altitude (m) |
|---|---|---|---|---|
| Yobe | 600 | $11^0$44' N | $11^0$57' E | 456 |
| Borno | 800 | $13^0$1' N | $12^0$5' E | 284 |
| Jigawa | 600 | $12^0$15' N | $9^0$54'E | 373 |
| Kano | 950 | $12^0$3' N | $8^0$32'E | 476 |

Source: Anon, (2011)

### Research Procedures

*Acacia senegal* seeds from different sources were soaked in freshly boiled water for 10 minutes before sowing as recommended by [24] in order to break seeds dormancy and to hasten germination and/or to obtain a more even germination. The treated seeds were sown in polythene pots (with diameter of 12cm and a depth of 26.5cm) using appropriate potting mixture of top soil rich in organic matter and farm yard manure in 2:1 ratio. The experiment was laid out in Randomized Complete Block Design (RCBD) with four replications per treatment. Prior to the sowing operation, the sowing media were fully watered to maintain the moisture content of the soil. Seedlings from each seed source were watered once in a day, twice in a day, once in 2 days and once in 3 days to determine the most appropriate watering regime on the early growth of *A.senegal* provenances. Weeding was done manually at one week interval throughout the period of the experiment so that the seedlings could be free from weeds, as weeds compete with plants for air, light, nutrient, space and water. Growth parameters (number of leaves, number of primary branches, stem length at first branching, collar diameter and plant height) were measured forthnightly for 12 weeks starting from one month after sowing (when germination was complete). Number of primary branches was determined through physical count. Collar diameter was determined using veneer caliper and plant height was measured using meter rule, the measurement was taken from the surface of the potting mixture to the terminal bud of the plants. At 16 weeks of age, four plants were sampled from each Provenance and under four different watering regimes and oven dried at 65$^o$C to a constant weight to obtain the total dry matter yield per-treatment. The plants were weighed using electronic weighing balance. Data collected from the nursery were subjected to Analysis of Variance (ANOVA) using Statistical Package of Social Sciences (SPSS) version 17. Where significance difference existed among the means, Duncan Multiple Range Test (DMRT) was used to separate the mean values.

## RESULTS AND DISCUSSION

### Effect of Watering Regime on Early Growth of *Acacia senegal* (LINN) Willd. Provenances

Table 2 indicated that number of leaves was higher ($p<0.05$) in K $W_3$ (334.88), K $W_4$ (304.31), K $W_1$ (296.50), J $W_3$ (217.94) Y $W_4$ (244.12) and Y $W_2$ (245) compared to Y $W_1$ (102.75), Y $W_3$ (139), B $W_1$ (157.44), B $W_3$ (147.31), J $W_2$ (129.88) and K $W_2$ (116), while J $W_4$ (100.31) had the lowest. B $W_1$, B $W_4$, B $W_2$, B $W_3$, J $W_2$, K $W_1$, K $W_4$, B $W_3$, J $W_1$, J $W_3$ and K $W_3$ had higher ($p<0.05$) number of primary branches than others. Their mean values ranged from 17.13 for B $W_1$ to 10.81 for J $W_3$ and K $W_3$ each, while Y $W_1$ (3.19) had the least.

Stem length at first branching was similar (p>o.05) in B $W_4$, B $W_3$, B $W_2$, B $W_1$, J $W_3$ and J $W_2$, but higher (p<0.05) than Y $W_1$ (0.15cm) and Y $W_2$ (0.73cm). Collar diameter were similar (p>0.05) in J $W_3$, B $W_4$, B $W_1$, K $W_4$, B $W_2$, J $W_2$, B $W_3$, Y $W_4$, J $W_1$ and K $W_1$. Their mean values ranged between 0.3cm for J $W_3$ and 0.19cm for Y $W_4$ and K $W_1$ each, but higher (p<0.05) compared to Y $W_1$ (0.8cm) and 0.11cm each for Y $W_3$ and K $W_2$ (Table 2). Plant height was higher (p<0.05) in B $W_4$ (33.9cm), B $W_2$ (28.25cm), J $W_2$ (26.96cm), B $W_3$ (26.79cm), B $W_1$ (26cm) and J $W_3$ (25.54cm) compared to Y $W_1$ (7.19cm), K $W_2$ (9.78cm) and Y $W_3$ (11.56cm). Significant differences were observed on seedlings early growth of *A.senegal* provenances under different watering regimes. The results indicated that, seedlings of Yobe and Borno sources performed better when watered once in three days ($W_4$). However, seedlings from Jigawa and Kano provenances also showed better growth performance when watered once in two days ($W_3$). The findings have been supported by [21], who found that, twice weekly watering is most suitable for tending the seedlings of *A.senegal* in the nursery. This is evident because daily watering produced fragile seedlings that may not be able to withstand the harsh drought condition in the field. This is also in conformity with the observation made by [6, 12]. Similarly, [17] reported that, mango seedlings under mild water deficit (watering once or twice in a week) promote growth rate as compared to well watered seedling (watering once or twice daily). The results also support the findings of Abdelbasit *et al*. (2012), who reported that water stress causes significant variation on seedlings relative growth rate (stem length, leaf, root and total plant biomass) in tree provenances (Elgetiana, Halfa Elgadida and Shandi) of Sudan. [10] also reported significant variation in both morphological and physiological adaptation to water stress in tree species provenances. The variation might also be from genetic differentiation, resulting from minor environmental differences among the habitats occupied by these species. The variation in this study was significant, although indicating similarity between the population diverse environmental conditions, such as seasonal changes in water availability which may result in large inter-specific variation in both morphological and physiological traits [26].

**Table 2: Effect of Watering Regime on Early Growth of *Acacia senegal* (LINN) Willd.Provenances**

| PR/WR | Number of Leaves | Number of primary branches | Stem length at first branching | Collar Diameter (cm) | Plant height (cm) |
|---|---|---|---|---|---|
| Y /$W_1$ | $102.75^{cd}$ | $3.19^{e}$ | $0.15^{f}$ | $0.08^{d}$ | $7.19^{e}$ |
| Y /$W_2$ | $224.5^{abc}$ | $6.75^{cde}$ | $0.73^{ef}$ | $0.15^{bcd}$ | $15.50^{cde}$ |
| Y /$W_3$ | $139.00^{cd}$ | $4.86^{de}$ | $0.70^{ef}$ | $0.11^{cd}$ | $11.56^{de}$ |
| Y /$W_4$ | $244.12^{abc}$ | $7.63^{bcde}$ | $1.48^{cde}$ | $0.19^{abcd}$ | $18.49^{bcde}$ |
| B /$W_1$ | $157.44^{cd}$ | $17.13^{a}$ | $1.98^{abcd}$ | $0.28^{ab}$ | $26.00^{abc}$ |
| B /$W_2$ | $190.31^{bcd}$ | $12.56^{abc}$ | $2.16^{abc}$ | $0.25^{ab}$ | $28.25^{ab}$ |
| B /$W_3$ | $147.31^{cd}$ | $10.94^{abcd}$ | $2.55^{ab}$ | $0.23^{abc}$ | $26.79^{abc}$ |
| B /$W_4$ | $184.88^{bcd}$ | $13.31^{ab}$ | $2.73^{a}$ | $0.29^{a}$ | 33.91a |
| J /$W_1$ | $179.81^{bcd}$ | $10.94^{abcd}$ | $1.17^{cde}$ | $0.21^{abcd}$ | $19.51^{bcd}$ |
| J /$W_2$ | $129.88^{cd}$ | $12.19^{abc}$ | $2.15^{abc}$ | $0.23^{abc}$ | $26.96^{abc}$ |
| J /$W_3$ | $217.94^{abcd}$ | $10.81^{abcd}$ | $2.16^{abc}$ | $0.30^{a}$ | $25.54^{abc}$ |
| J /$W_4$ | $100.31^{d}$ | $7.31^{bcde}$ | $1.01^{def}$ | $0.16^{bcd}$ | $16.58^{bcde}$ |
| K /$W_1$ | $296.50^{ab}$ | $11.44^{abc}$ | $1.19^{cde}$ | $0.19^{abcd}$ | $19.97^{bcde}$ |
| K /$W_2$ | $116.00^{cd}$ | $6.13^{cde}$ | $0.97^{ef}$ | $0.11^{cd}$ | $9.78^{de}$ |
| K /$W_3$ | $334.88^{a}$ | $10.81^{abcd}$ | $1.60^{bcde}$ | $0.21^{abcd}$ | $19.66^{bcd}$ |
| K /$W_4$ | $304.31^{ab}$ | $11.00^{abcd}$ | $0.72^{ef}$ | $0.28^{ab}$ | $17.86^{bcde}$ |
| SE ± | 11.316 | 0.519 | 0.088 | 0.011 | 0.998 |

Means followed by the same letter(s) within a column are not significantly different (P<0.05)
PR- Provenance WR- Watering regime $W_1$ – watering twice daily $W_2$ – watering once daily $W_3$ – watering once in 2 days $W_4$ – watering once in 3days Y-Yobe B-Borno J-Jigawa K – Kano

**Effect of Watering Regimes and Provenance on Dry Matter Accumulation at 16 weeks**

Table 3 indicated that, $W_1$ Y and $W_1$ B were statistically similar with values of 2.9g and 2.8g, but significantly higher ($p< 0.05$) than 2.1g each for $W_2$ Y and $W_2$ J and 2.3g in $W_3$ K. It was also observed that $W_1$ J (1.5g), $W_3$ J (1.5g), $W_3$ B (1.2g) and $W_4$ K (1.2g) gave statistically the same dry matter contents. 0.9g was the least dry matter obtained from $W_3$ Y. The result from this study showed significant effect of watering regime and provenance on dry matter accumulation. The findings have been supported by the concept of [20] who reported large differences in dry matter accumulation as a result of water stress on seedlings of *Acacia tortilis* from different habitats in Kenya. [1] also conducted a provenance trial in Sudan on *A. tortolis* from different sources and found changes in dry matter as influenced by water stress. Similarly, [22], reported differences in relative growth rate (RGR) among plant species, which could be related to water stress, environmental conditions and inherent characteristics. [5], (1998) also reported huge differences in RGR due to water stress from contrasting habitats.

**Table 3: Effect of Watering Regimes and Provenance on Dry mater Accumulation at 16 weeks**

| Treatment | Dry matter accumulation (g) |
|---|---|
| $W_1$ Y | $2.9^{a}$ |
| $W_1$ B | $2.8^{a}$ |
| $W_1$ J | $1.5^{c}$ |
| $W_1$ K | $1.0^{d}$ |
| $W_2$ Y | $2.1^{b}$ |
| $W_2$ B | $1.0^{d}$ |
| $W_2$ J | $2.1^{b}$ |
| $W_2$ K | $2.2^{b}$ |
| $W_3$ Y | $0.9^{d}$ |
| $W_3$ B | $1.2^{cd}$ |
| $W_3$ J | $1.5^{c}$ |
| $W_3$ K | $2.3^{b}$ |
| $W_4$ Y | $1.0^{d}$ |
| $W_4$ B | $1.0^{d}$ |
| $W_4$ J | $1.3^{c}$ |
| $W_4$ K | $1.2^{cd}$ |
| SE | 0.062 |

Means followed by the same letter(s) within a column are not significantly different ($p<0.05$)

## CONCLUSION

The results from this study indicated that, Yobe and Borno provenances performed better when watered once in three days. Conversely, Jigawa and Kano provenances had higher growth performance when watered once in two days, and this reflects the capability of this species to cope with drought stress. Watering of *A.senegal* seedlings once in two days or once in three days should be adopted in the semi-arid zone, since it ensures proper growth performance of this species.

## REFERENCES

[1] Abdelbasit, H.E; Sadya, M. and Ahamed E. 2012. Variation in Drought Tolerance and Survival among Three Provenances of Acacia tortilis Subspecies Raddiana and Subspecies Spirocarpa Seedlings. Asian Journal of Agricultural Sciences 4(2): 134-139pp.

[2] Anderson, D.M.W. 1991. Recent changes in toxicological status of permitted food emulsifiers, stabilizers and thickener. South Africa Journal of food science and nutrition 3(2): 25pp.

[3] Anderson, D.M.W; Bridgeman, M.M.E; Farquhar J.G.K and Mcnab C.G.A. 1993. The chemical characterization of test article used in toxicological studies of gum Arabic (Acacia Senegal (L.) (Willd).The International Tree Crops Journal. (2):245-254pp.

[4] Annonymous, 2011. http://itouchmap.com/latlong.html
[5] Atkin, O.K; Schortemeyer, M; McFarlancen and Evans, J.R. 1998. Variation in the components of relative growth rate in ten Acacia species from Contrasting environments. Plants Cell Environment 21: 1007-1017.p
[6] Awodola, A. M. 1984. Growth response of some tree seedlings to drought conditions. Msc. Thesis (unpublished), University.
[7] Awodola, A.M and L.C. Nwoboshi 1993. Effect of source of Potassium and frequency of moisture application on growth and macronutrient distribution in seedlings of Parkia biglobosa. Nigerian Journal of Forestry 23 (2).
[8] Awodola, A.M and S.P.A Okoro 1986. Early growth of Sudan Savanna species of varying media and moisture regimes. Proceedings of 16th Annual Conference of Forestry Association of Nigeria. 422-423pp.
[9] Awouda, H.M. 1990. Outlook for gum Arabic production and supply. Gum and Stabilizers for the Food Industry, (4). Proceedings of 4th International Conference, Wrexham July, 1987. 425-434pp.
[10] Cregg, B.M. 1993. Carbon allocation, gas exchange and nidle morphology of Pinus ponddirosa genotype, known to differ in growth and survival under imposed drought. Tree physiology (14): 883-898pp
[11] Gerstanzang, J. and Sanders, E. 2007. Impacts of Bush s Sudan sanction doubted. Los Angeles Times Magazine. May 30th, 2007.
[12] Huang, R.S; Smith, W.K. and Yost, R.S. 1985. Influence of vesicula rarbiscular mycorrhiza on growth, water relations and lead orientation in Leucaena leucocephala (Lan) wit. New Phytol., 99: 229-243pp.
[13] Jurasek, P; Kosik, M. and Philips, G.O. 1993a. The classification of natural gums. 11. Acacia senegal and related species (gum Arabic). Food hydrocolloids. 7(3): 255-280pp.
[14] Komer C, Scheel JA, Bauer H 1979. Maximum leaf diffusive condudtance in vascular plants. Photosynthetica. 13: 45-82pp.
[15] Lawal, A.M. 1998. Export Marketing of Gum Arabic. The Nigerian Experience. Invited paper. Tech. Workshop on Gum Arabic. FDA Abuja, July 2002.
[16] Levy Y, Krikum J 1983. Effects of irrigation, water and salinity and root-stock on the vertical distribution of vesicular arbuscular mycorrhiza on citrus roots. New Phytology. 15: 397-403pp.
[17] Luvaha, E; Netondo, G.W. and Ouma, G. 2012. Effect of Water Deficit On the Growth Of Mango (Mangifera indica) Rootstock Seedlings. Department of Botany and Horticulture Kisumu, Maseno University, Kenya.pp 2-4pp.
[18] Maydell, H.V. 1990. Trees and Shrubs of the Sahel: their characteristics and uses. Typo-druk pub. Gmb. Germany. 41:343pp.
[19] Omar, A. and Wasila, E. 1993. Gum Arabic- An essential non-wood beased product in Sudan. Regional expert consultation on Non-wood Forest Products (NWFP) for English-speaking African countries. Arusha, Tanzania.
[20] Otieno, D.O; Kinyamario, J.I. and Omenda, T.O. 2001. Growth features of Acacia tortilis and Acacia xanthophoea seedling and their response to cyclic soil drought stress. African Journal of Ecology. 39(21): 126-132.
[21] Oyun, M.B; Adeduntan, S. A. and Suberu, S. A. 2010. Influence of watering regime and mycorrhizae inoculations on the physiology and early growth of Acacia senegal (L.) Wild. African Journal of Plant Science Vol. 4(7): 210-216pp.
[22] Poorter, H. and Remkes, C. 1996. Leaf area ratio and assimilation rate of 24 wild species differing in relative growth rate. Oecologia, 83: 553-559.
[23] Price DT, Black TA, Kelliher FM 1986. Effects of sala understorey Removal on photosynthesis rate and stomata conductance of young Douglas-fir Trees. Canadian Journal of Forest Resource. 16: 90-97pp.
[24] Raw Materials Research and Development Council 2004. Reports on survey of Agro Raw Materials in Nigeria, Gum Arabic (Maiden Edition). Federal Ministry of Science and Technology, Abuja, pp. 9-11.
[25] Shivanna, H; Nayak, B; Patel, J.S. and Sanjeer, O.K. 2002. Provenance variation for seed quality and seed germination in Acacia nilotica. Karnataka Journal of Agricultural Sciences 15(1): 88-93.
[26] Tuomela, K. 1997. Physiological and morphological response of Eucalyptus microthica provenances to water aviability in tropical dry lands. Ph.D. Thesis, Tropical Forestry reports (13). Universityof Helsinki, Department of Forest Ecology.
[27] Wyk, V. and Erick, B. 2005. Food Plants of the World. Portland, Oregon. Timber Press Inc.78pp.