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Research Paper

Germination and seedling growth of *acacia senegal* (l.) Willd and *parkia biglobosa* (jacq.) As influenced by salinity in sokoto state nigeria

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Abstract: An investigation was carried out on the seed germination and seedling growth response of two indigenous savanna tree species *(Acacia senegal* and *Parkia biglobosa*) to salt (NaCl). Soil samples from two plots within Dabagi research farm of Usmanu Danfodiyo University Sokoto were used. These samples were taken from Dabagi Upland 2 (DUP_2) and Dabagi Lowland (DLL) at the depth of 0-30cm. The seeds were sown in the soil samples of $0.0dSm^{-1}$, $2.2dSm^{-1}$ and $2.8dSm^{-1}$ salt levels and observed until complete germination, and growth parameters (height and collar diameter) were measured fortnightly for 12 weeks. It was observed that salinity influenced the germination of seeds of the species with *A. senegal* (54%) showing a better germination at $2.2dSm^{-1}$ compared with *P. biglobosa* (44%). Secondly, the tree seedlings showed significant differences in their growth over the period of the study. It was observed that on the whole when compared, *P. biglobosa* showed a significant difference at ($P<0.05$) between $0.0dSm^{-1}$ and $2.8dSm^{-1}$. The result indicated that *P. biglobosa* though a savanna species, does not thrive well in high saline soils and should not be used in agro-forestry plot deep in the savanna where irrigation water may tend to increase soil salinity.

Keywords: Salinity, Savanna species, Growth, Dabagi farm and Electrical conductivity.

Introduction

Soil salinity has been defined as a soil condition characterized by a high concentration of soluble salts. Soils are classified as saline when the electrical conductivity of the saturated paste extract (EC) is 4dS/m or more, which is equivalent to approximately 40mM NaCl and generates an osmotic pressure of approximately 0.2MPa (USDA-ARS, 2008). Soil salinity has had an adverse effect since ancient civilization by limiting the available land for cultivation and to this day, it continues to affect agricultural productivity in many parts of the world.

According to FAO (2008), soil salinity is one of the major factors of soil degradation. More than 800 million hectares of land throughout the world are salt affected. This amount accounts for more than 6% of the world's total land area. Most of this salt-affected land has arisen from natural causes, from the accumulation of salts over long periods of time in arid and semiarid zones (Rengasamy, 2002). Tester and Davenport (2003) reported that high concentration of salts in soils account for large decrease in the yield of a wide range of crops all over the world.

Weathering of parent rocks release soluble salts of various types, mainly chlorides of sodium, calcium, and magnesium, and to a large extent, sulphates and carbonates (Szabolcs, 1989). Other causes of accumulation are the deposition of oceanic salts carried in wind and rain. Apart from natural salinity, a significant proportion of recently cultivated agricultural land has become saline owing to land clearing or irrigation, both of which cause water tables to rise and concentrate the salts in the root zone (Munns and Tester, 2008). Salinity effect is more conspicuous in the arid and semi-arid areas where 25% of the irrigated land is affected by salt (Munns and Tester, 2008).

Salt-tolerant plants (halophytes) have evolved to grow on these soils. Halophytes and less tolerant plants show a wide range of adaptations. Attempts to improve the salt tolerance of plants were met with very limited success due to the complexity of their trait both genetically and physiologically. The development of salt-tolerant plants is being pursued from many angles (Zhu, 2000). This has been tackled by either altering farming practices to prevent soil salinization occurring in the first place, or by implementing schemes to try to remediate salinized soils such as by planting perennials (trees) to lower water tables (Tester and Davenport, 2003).

The tree species selected for the study are *Acacia senegal* and *Parkia biglobosa. Acacia senegal* is grown in agro-forestry systems especially for gum, but plays a secondary role in agricultural systems, restoring soil fertility and providing fuel and fodder. *Parkia biglobosa* is generally used as food (Dawadawa and alcoholic beverage), fodder, fuel, timber and in medicine (as mouthwash) (Booth *et al*., 1988; Sabiiti *et al*., 1992). The danger to extinction faced by savanna tree species (Agboola, 1995) as a result of both biotic and abiotic factors necessitated the need to undertake the study. This study is aimed at investigating the germination and seedling growth of these indigenous semi-arid tree species under two salinity levels found within Sokoto, Nigeria, so as to encourage farmers to establish stands of the more tolerant species in the region.

Materials and Methods

Seed Collection and Processing

The pods of *Acacia senegal* and *Parkia biglobosa* were collected from trees growing under field conditions in semi arid region of Sokoto, Nigeria. The seeds were processed from pods. The seeds were pretreated to break dormancy. This involves soaking the *P.*

biglobosa seeds in hot water and *A. Senegal* seeds in cold water overnight. The seeds were used to test the salinity stress on germination and seedlings growth.

Fifty seeds from each of the two tree species were put on germination trays under the following conditions (A) the seeds were moistened regularly with distilled water free from salt (control). (B) the seeds were moistened with salt water at 2.2dS/m (DLL). (C) the seeds were moistened with salt water at 2.8dS/m (DUP_2). After two weeks when germinations were complete, germination percentages were calculated. To monitor the growth performance of the seedlings, five seedlings representing replicates were transplanted into pots and used for each treatment. The treatments were soil at 2.2dS/m (DLL), soil at 2.8dS/m (DUP_2) and control (washed sterile loamy soil). The height and collar diameter of the seedlings were recorded fortnightly for three months. Seedling heights were measured with a ruler (from the soil level to the apex). The collar diameter was measured using vernier caliper. The experiment was laid in a completely randomized design. Data collected were subjected to analysis of variance (ANOVA).

Results

Effects of Salinity on Germination and Seedling Growth of *A. senegal and P. biglobosa*

The result showed that control gave the highest germination percentages of 72% and 68% in *P. biglobosa* and *A. senegal* compared to other treatments. The germination percentages of 44% at $2.2dSm^{-1}$ and 36% at $2.8dSm^{-1}$ salinity levels could be taken as poor since these are less than 50%. The germination of *A. senegal* was also high at $0.0dSm^{-1}$ (68%) compared to 54% at $2.2dSm^{-1}$ and 42% at $2.8dSm^{-1}$ which could also be regarded as poor (Table 1). The height and collar diameter of *A. senegal* showed no significant difference at all the salt levels tested over the period of research. *P. biglobosa* also showed no significant difference at $0.00dSm^{-1}$ compared with $2.2dSm^{-1}$ and $2.2dSm^{-1}$ compared with $2.8dSm^{-1}$. However, height at 8-12WAP and Collar diameter at 6WAP in *P. biglobosa* showed significant difference ($P<0.05$) between salinity levels of $0.00dSm^{-1}$ and $2.8dSm^{-1}$. It was also clear that the collar diameter differed significantly ($P<0.05$) at 2WAP between the salt levels (Table 2).

Table 1: Effect of salinity on seed germination

Plant species	*A. senegal*			*P. biglobosa*		
	A	B	C	A	B	C
Total (out of 50)	34	27	21	36	22	18
Percentage (%)	68	54	42	72	44	36

Key:
A = $0.0dSm^{-1}$ (control)
B = $2.2dSm^{-1}$
C= $2.8dSm^{-1}$

Table 2: Effects of Salinity on Seedling Growth of *A. senegal and P. biglobosa*

Variables	*A. senegal*				*P. biglobosa*			
Height	0.0dS/m	2.2dS/m	2.8dS/m	Sig	0.0dS/m	2.2dS/m	2.8dS/m	Sig
2WAP	7.6	7.2	7.3	NS	10.3	8.6	7.7	NS
4WAP	8.8	8.3	8.5	NS	11.9	9.8	8.5	NS
6WAP	11.3	10.4	11.2	NS	14.8	11.2	9.3	NS
8WAP	14.4	14.1	14.9	NS	17.1^{a}	13.8^{ab}	10.3^{b}	S
10WAP	17.1	15.7	16.6	NS	20.2^{a}	16.1^{ab}	11.9^{b}	S
12WAP	20.1	18.3	19.8	NS	23.2^{a}	18.3^{ab}	13.4^{b}	S
Collar Diameter (mm)								
2WAP	0.6	0.5	0.5	NS	0.8^{a}	0.5^{c}	0.6^{b}	S
4WAP	0.6	0.5	0.5	NS	0.8^{a}	0.6^{b}	0.6^{b}	S
6WAP	0.6	0.6	0.6	NS	0.8^{a}	0.8^{a}	0.6^{b}	S
8WAP	0.8	0.6	0.7	NS	0.8	0.8	0.8	NS
10WAP	0.8	0.8	0.8	NS	0.8	0.9	0.8	NS
12WAP	0.9	0.8	0.8	NS	0.9	0.9	0.8	NS

Means with the same superscript in a column are not significantly different ($P>0.05$)
Key: WAP = Week after planting

Discussion

The salinity levels of the soil affected the germination of both *Acacia senegal* and *Parkia biglobosa*, however the extent of effect is more in *P. biglobosa*. This is expected since *P. biglobosa* thrives more along the lower fringes of the Sudan savanna in Nigeria while *.A senegal* is grown more in agro-forestry plots along the upper fringes. As reported by Tester and Davenport (2003) that, the concentration of salts in soils could account for the decrease in the germination of the tree species. *P. biglobosa* is affected more in terms of germination when subjected to salt condition compared to *A. Senegal*, as opposed to salt free condition in which *P. biglobosa* had greater germination potential. Even though there was no significant difference in height of *A. senegal* seedlings numerical values indicated that at 12 WAP, control gave the tallest seedlings compared to the other treatments. If the object of managing the tree species is to attain greater height then *A. senegal* can measure very well in salt affected soil. The height in *P. biglobosa* decrease with increasing concentration of salt, and this is evident that the species should not be used in any form of regeneration in salt affected areas.

Conclusion

The results from germination, height and collar diameter of these two species as shown above at two different salinity levels and control could be a positive indicator that salt (NaCl) is responsible for the differences in germination and growth of the indigenous trees.

Recommendations

Agricultural activities like irrigation, bush burning, and other poor soil management practices have made the available land saline and very unsuitable for improved agriculture, but *A. senegal* can be incorporated into all forms of cultivation to rehabilitate the saline condition on Savanna land. To promote the regeneration of important indigenous trees like P. biglobosa in the Sudan environment the soil has be reconditioned to eliminate or reduce the salinity level.

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