Original Research Article

EFFECTS OF SALINITY STRESS ON GROWTH PARAMETERS OF SOYBEANS (*Glycine max*) CULTIVATED IN OBUBRA LOCAL GOVERNMENT AREA, OF CROSS RIVER STATE NIGERIA.

ABSTRACT

Soybean (*Glycine max*) is a strategic crop plant grown to obtain edible oil and forage. High sensitivity is one of the biggest problems with soybean crop. A pot experiment was conducted in the screen house at the Cross River University of Technology, Obubra Campus to investigate the effects of different salt concentrations on the growth parameters of three different varieties of soybeans *(Glycine max).* The experiment was laid in complete randomized design (CRD) with twenty replicates for each variety. Growth parameters which include germination percentage, plant height, number of leaves and number of branches per plant were measured, and data collected was subjected to statistical analysis using Analysis of variance (ANOVA) and means were compared using Duncan's New Multiple Range Test (DNMRT). The results showed that salinity stress led to a significant reduction in percentage of germination, plant height, number of leaves, and number of branches per plant over control. At 30mM Nacl which was the highest level of saline water TGX 1987-10F had a better germination percentage as compared to other varieties, which might be because of some salt tolerant genes. Plant height reduced significantly under salinity stress as compared with the control, but TGX 1835-10F at 30mM which was the highest saline treatment showed a better salt tolerance level as compared with other varieties. Number of leaves per plant, as the salinity levels increases it affected the number of leaves. There was a drastic reduction in the number of leaves with increasing salinity levels as compared with the control. TGX 1987-10F had the highest number of leaves and it was closely followed by TGX 1835-10E while 1448-2E was the least and there were significantly different from the ones at different salinity levels. The result revealed highly significant differences (p=0.05) in the varieties, with TGX 1987-10F as the best variety appropriate for saline regions. It is therefore recommended that, TGX 1987-10F should be cultivated in saline regions since it showed a better tolerance level as compared to other varieties.

INTRODUCTION

The beginning of 21st century is marked by global scarcity of water resources, environmental pollution and increased salinization of soil and water (Ghulam *et al*, 2019). Increasing human population and reduction in land available for cultivation are two threats for agricultural sustainability (Pooja & Rajeh, 2015). Various environmental stresses viz. high winds, extreme temperatures, soil salinity, drought and flood have affected the production and cultivation of agricultural crops, among these, soil salinity is one of the most devastating environmental stresses, which causes major reductions in cultivated land area, crop productivity and quality (Pooja & Rajeh, 2015; Kekelesto*et al*., 2021; Rui &Ricardo, 2017). A saline soil is generally defined as one in which the electrical conductivity (EC) of the saturation extract (ECe) in the root zone exceeds 4 dSm_1 (approximately 40 mM NaCl) at 25 _C and has an exchangeable sodium of 15%. The yield of most crop plants is reduced at this ECe, though many crops exhibit yield reduction at lower ECes (Kumari *et al*., 2018, Singh *et al*., 2019; Ahmad *et al*., 2018; Muhammad *et al.*, 2020). It has been estimated that worldwide 20% of total cultivated and 33% of irrigated agricultural lands are afflicted by high salinity. Furthermore, the salinized areas are increasing at a rate of 10% annually for various reasons, including low precipitation, high surface evaporation, weathering of native rocks, irrigation with saline water, and poor cultural practices. It has been estimated that more than 50% of the arable land would be salinized by the year 2050 (Dennis, 2020).

Water and soil management practices have facilitated agricultural production on soil marginalized by salinity but an additional gain from these approaches seems problematic (Pooja and Rajesh, 2015). Impacted soils are a major limiting production factor worldwide for every major crop (Bashir *et al*, 2021; Chartes& Noble, 2015).

Soybean (*Glycine max* L.) is a strategic crop plant grown to obtain edible oil and forage (Ieyla*et al*., 2018). High sensitivity to soil and water salinity is one of the biggest problems with soybean crop. Results have indicated that salinity affects growth and development of plants through osmotic and ionic stresses. Because of accumulated salts in soil under salt stress condition plant wilts apparently while soil salts such as Na^+ and Cl^- disrupt normal growth and development of plant (Vaishnav *et al*. 2016; Zewdu *et al*., 2017). The agronomic traits of soybean could be severely affected by high salinity, including reduction in height, leaf size, biomass, number of internodes, number of branches, number of pods, weight per plant, and weight of 100 seeds (Otie *et al*., 2021, Farooq *et al.*,2015).

MATERIALS AND METHODS

A pot experiment was conducted in the screen house at the Cross River University of Technology, Obubra Campus to evaluate the effects of different salt concentrations on some growth parameters of three varieties of soybeans. Obubra is in central Senatorial area of Cross River State, it lies within latitude 6.0767200^0 and longitude 8.3324100^0. It has an annual rainfall of about 2000- 2500mm with maximum temperature of about 21^0-30^0C (NIMET, 1996). The soil samples were collected from different experimental units at a depth of 0-30cm, they were bulked, air dried, sieved with 2mm mesh sieve and used for laboratory analysis for the pot experiment.

The soils were analysed for particle size distribution using the hydrometer method (Saketu&Gezahagn, 2020). Soil PH was determined in 1:2:5 soil to water ration on a direct reading PH meter using the glass electrode with saturated potassium chloride calomel reference electrode. Organic carbon was determined by the wet oxidation method as described by (Berger *et al*., 2016). The value of organic matter was obtained by multiplying the values for organic carbon by 1.724. Exchangeable basic cations were extracted with K and Na leachate determined using EFL flame photometer and Ca and Mg by EDTA titration method, Exchangeable acidity was by Mclean method (1965). Effective cation exchange capacity (ECEC) was done by summation method. Available P was done by Bray P-2 method (Bray and Kurtz ,1945).

The pot experiment was laid out in a Randomized Complete Design (CRD) with twenty replications. The treatments comprised of four levels of salt (0, 10, 20 and 30mM Nacl).

The seeds of the *Glycine max* varieties TGX1835-10E, TGX1987-10F and TGX 1448-2E were obtained from International Institute of Tropical Agriculture (IITA), Ibadan Nigeria. 240 plastics pots of equal sizes were filled with 12kg of soil, four seeds of each variety were sown at the depth of 2cm and were later thinned down to two seedlings per pot at two weeks after planting (WAP). After planting, tap water (0.043mM) was applied to control pots and 2 dS/m NaCl-salinity irrigation water was added to the rest of the pots. When the first new leaf appeared, i.e., ten days after emergence (DAE), irrigation water with selected NaCl salinity (0, 10, 20 and 30mM) was applied, except for the control pots. Plants in the control groups were irrigated with tap water. The salt solution was applied daily until harvesting.

Data collection: The following parameters were measured.

Germination percentage = total number of plants germinated

total number of seeds sown

Plant height: The heights of the tagged plants was measured with measuring tape from the base to the top of the main axis and the mean values were recorded.

Number of leaves: The number of leaves of the tagged plants was determined by counting the numbers of fully expanded leaves and the mean values were recorded.

Number of branches: The number of branches of the tagged plants was determined by counting the branches and the mean values were recorded.

Data analysis: The data were analysed with SPSS version 20 software and all data collected were subjected to Analysis of Variance (ANOVA) according to Gomez and Gomez (1984) and treatments were compared using Duncan Multiple Test Range (DMRT) 1995.

Table 1: Effects of different levels of salinity on growth parameters of three varieties of soybeans

Varieties	Treatments	Germination percentage (%)	Plant height (cm)	Number of leaves	Number of branches
TGX 1835	Control (0)	85c	30.5c	11.1b	7.1b
-10E	10mM (Nacl)	70e	25.3d	8.0e	4.0d
	20mM (Nacl)	60g	15.1g	5.1h	2.1f
	30mM (Nacl)	50i	10.0h	2.0j	1.0g
TGX 1987	Control (0)	90b	34.3b	12.2a	8.4a
-10F	10mM (Nacl)	80d	20.3e	9.0d	5.1c
	20mM (Nacl)	65f	13.1g	6.4g	3.1e
	30mM (Nacl)	55h	7.3i	3.2i	1.5g
TGX 1448	Control (0)	92a	38.1a	4.8g	9.5a
-2E	10mM (Nacl)	80d	24.1d	10.3c	6.2c
	20mM (Nacl)	70e	16.2f	7.0f	4.1d
	30mM (Nacl)	50i	5.3j	3.3i	2.0f

mM=Milliltres, Nacl= Sodium chloride. Means with the same superscript letter (s) in the same column are not significantly different ($p \leq 0.05$) following separation by Duncan Multiple Range Test.

RESULTS AND DISCUSSION

Table 1 showed a decrease in percentages of germination at different salinity levels as compared with the control. TGX 1448-2E had the highest germination percentage followed by TGX1987-10F and the least was from TGX 1835-10E in the control plots. At 30mM which was the highest level of treatment TGX 1987-10F showed better tolerance level than other varieties. It showed that TGX 1987-10F had a better tolerance level than other varieties. This agrees with the findings of (Mshelmbula*et al*., 2015; Kumar, 2017) who reported that increasing salinity levels reduces the rate of seed germination.

Number of leaves, as the salinity levels increases it affected the number of leaves. There was a drastic reduction in the number of leaves with increasing salinity levels as compared with the control. TGX 1987-10F had the highest number of leaves and it was closely followed by TGX 1835-10E while 1448-2E was the least and there were significantly different from the ones at different salinity levels. This might be that salinity caused deficiency of potassium,which led to reduction in the number of leaves in soybeans plants. This finding corroborates with that of (Smrutishree*et al*.,2018; Amirhossein *et al*., 2021) who reported that salinity induced reduction in the number of leavesin plants.

The result for plant height, revealed a reduction in plant height at every level of salinity as compared with the control. TGX 1448-2E had the highest plant height, followed by TGX 1987-10F while the least was TGX 1835-10E in the control plots. But at 30mM which was the highest level of saline water TGX 1835-10F had the highest plant height and it was closely followed by TGX 1987-10F, this showed that there is presence of salt tolerance genes in the varieties. This result agrees with (Davood *et al*., 2019)who reported a reduction of plant growth under saline conditions which may either be due to osmotic reduction in water availability which resulted in increasing stomatal resistance or to excessive ions, Na and CI accumulation in the plant tissues (Machado and Serralheiro, 2017). It has been reported that salinity stress significantly reduced net photosynthetic rates, increased energy losses for salt exclusion mechanism, largely decreased nutrient uptake and finally reduced plant growth (Machado and Ricardo, 2017)). Salinity inhibits the growth of the plants by affecting both water absorption and biochemical processes, such as nitrogen and carbon dioxide assimilation and protein biosynthesis (Mohammad *et al*., 2017). Under saline conditions, plants fail to maintain the required balance of organic and inorganic constituents leading to suppress growth and yield (Maximillian *et al*., 2019). Mshelmbula*et al.* (2015) also reported a reduction of plant height in Cowpea with an increasing level of salinity.

Salinity stress led to a significant reduction in number of branches per plant over control and TGX 1448-2E had the highest number of branches per plant and it was closely followed by TGX 1987-10F while TGX 1835-10E had the least. At 10mM, 20mM and 30mM TGX 1448-2E showed a better level of salt tolerance than both TGX 1835-10E and TGX 1987-10F. Similar result was reported by Azene*et al.* (2014), who reported decrement in number of branches of lentil under different salinity levels.Salinity inhibits the formation of new branch and facilitate the aging of old branch at various degrees.

CONCLUSION

Growth parameters of soybeans irrespective of variety were influenced by different levels of salinity. As soil salinity increased all the traits exhibited decreasing trends. The findings of this showed that salinity stress significantly affected all the studied parameters as compared to the control. It can be summarized that TGX 1987-10F showed relatively salt tolerant ability as compared with other varieties, therefore it is recommended for cultivation in saline prone area of Cross River State, Nigeria.

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