Original Research Article

Evaluation of the Effects of Salinity Stress on Yield Parameters of Soybeans Cultivated in Obubra, Cross River State Nigeria

ABSTRACT

A pot experiment was conducted in the screen house at the Cross River University of Technology, Obubra Campus to evaluate the effect of different salt concentrations on the yield of three different varieties of soybeans *(Gycine max).* The experiment was laid in complete randomized design (CRD) with twenty replicates for each variety. Yield parameters which include number of pods per plant, 100 seed weight (g) and seed yield 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 number of pods per plant over control. At 30mM which was the highest level of saline water TGX 1987-10F had a better salt tolerance level as compared to other varieties, which might be as a result of some salt tolerance genes. 100 seed weight (g) reduced significantly under salinity stress as compared with the control, but TGX 1987-10F showed better salt tolerance level as compared with other varieties. Seed yield per plant decreased significantly with increasing salinity levels and a greater reduction was observed in TGX 1448-2E and TGX 1835-10E. It was concluded that Soybean is a sensitive plant to salinity stress, but the extent of this sensitivity varies among varieties. TGX 1987-10F showed a better tolerance level as compared with other varieties. Therefore, it is recommended that TGX 1987-10F should be cultivated in saline areas.

INTRODUCTION

Agricultural productivity in arid and semiarid regions of the world is very low due to accumulation of salts in soils (Munns, 2002). Plants tend to be exposed to many stress factors, such as drought, high salinity, or pathogens, which reduce the yield of the cultivated plants or affect the quality of the harvested products (Arafa *et al.*, 2009). Salt stress can directly or indirectly affect the physiological status of plants by disturbing their metabolism, growth, development, and productivity (Zhu, 2001). Salinity causes several changes in plant metabolism, through ion toxicity and osmotic stress (Mittler, 2002).

Soybean (*Glycine max* L.) is a strategic crop plant grown to obtain edible oil and forage. 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 (KhajehHosseini *et al.,* 2003; Farhoudi *et al.,* 2007). 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 (Chang *et al*., 1994). In general, salt stress reduces the protein contents in soybean seeds (Chang *et al*, 1994; Wan *et al*., 2002). However, the effect of salt on yield of soybean seeds is still inconclusive since experimental results varied in different field sites using different cultivars treated with different salinity levels (Chang *et al*, 1994; Wan *et al*., 2002). However, soybean growth is severely suppressed, and yield decreases dramatically under salt stress (Katerji *et al*., 2003). Soybean production may be limited by environmental stresses such as soil salinity (Ghassemi-Golezani *et al*., 2009). As more and more agricultural lands are affected by soil salinity, soybean production is being threatened. Thus, it is very important to breed salt tolerant soybean cultivars (Lee *et a*l., 2009).

Therefore, the present study is to compare the salinity stress adaptations in three different soybean varieties to identify the soybean varieties with a better performance even under saline conditions, for enhancing soybean production in Obubra Local Government Area of State Cross River State, Nigeria.

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 the yield 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. 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 (Juo, 1979). 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 JUO (1979). 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, 10mM, 20mM and 30mM).

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 2mM 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 (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.

Plant Sampling Measurement and Data Analysis

At seed maturity, the twenty plants per replication were harvested to determine number of pods per plant, number of filled pods,100 seed weight per plant and seed yield per plant. 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 yield parameters of three varieties of soybeans

Varieties	Treatment	No of pods per plant	100 seed weight (g)	Seed yield per Plant (g)
TGX 1835-10E	Control (0)	26.7b	14.3b	16.3a
	10mM (Nacl)	17.3c	9.2d	7.5c
	20mM (Nacl)	13.5d	7.1e	7.5c
	30mM (Nacl)	8.1de	4.3g	3.4f
TGX 1987-10F	Control (0)	30.3a	17.3a	15.8a
	10mM (Nacl)	23.0c	12.5c	8.2b
	20mM (Nacl)	18.0c	10.4d	6.3d
	30mM (Nacl)	10.1d	5.3f	4.0e
TGX 1448-2E	Control (0)	31.2a	17.5a	15.9a
	10mM (Nacl)	26.0b	13.7b	8.9b
	20mM (Nacl)	16.4c	9.0d	4.8e
	30mM (Nacl)	7.3e	2.8h	2.0f

RESULTS AND DISCUSSION

Data in (Table 1) indicated that salinity stress led to a significant reduction in number of pods per plant over control. TGX 1448-2E produced the highest number of pods per plant in the control plots though it was not significantly different from TGX 1835-10E but significantly different from TGX 1987-10F. At 30mM which was the highest level of saline water TGX 1987-10F showed a better level of salt tolerance as compared to other varieties, it means that there might be presence of salt tolerant genes. Salinity stress significantly reduced the number of pods per plant in soybean. These results agree with Ayman *et al.* (2015) who reported that,

the agronomic traits of soybean could severely be affected under salinity, including reduction in number of pods. Moreover, Taffouo *et al.* (2009) reported that, the significant decrease of yield components under salt stress in cowpea would be partly related to a significant reduction of foliar chlorophyll contents in saline medium. Mensah *et al*. (2006) also reported a significant decrease in number of pods in groundnut in saline soils.

100 seed weight reduced significantly under salinity stress as compared with the control. But TGX 1987-10F showed better salt tolerance as compared with other varieties. The stress at pod filling stage can cause a significant decrease in the photosynthate mobilization to grains and thereby decreasing grain weight. Ayman *et al.* (2015) also reported significant decrease under salinity stress. The result agrees with that of Mensah *et al*. (2006) who reported a total decrease in seed weight of groundnut in saline medium.

Seed yield plant per decreased significantly with increasing salinity levels and a greater reduction was observed in TGX 1448-2E and TGX 1835-10E. The result agrees with that of Ayman *et al.* (2015) who reported a significant decrease in seed yield of some varieties of soybean with increasing salinity. Sohrabiet *et al.* (2008) also reported a drastic reduction of grain yield in chickpea because of salt stress**.** Mostafizur *et al*. (2018) also reported a significant decrease in net yield in tomatoes as compared to control plants.

CONCLUSION

Salinity stress can considerably reduce productivity in soybeans in different varieties. Number of pods, 100 seed weight (g) and seed yield per plant were drastically reduced as compared with the control plants. TGX 1987-10F showed a better performance under salt stress, therefore it is more suitable for cultivation under saline conditions.

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