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NaCl salinity - induced changes on the Germination and Growth of *Vigna unguiculata* (L.) Walp

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ABSTRACT: The effect of NaCl stress on *Vigna unguiculata* (L.) was conducted at germination and early seedling stages. The seeds of the test crop were germinated in clean oven dried Petri-dishes which had been lined with filter paper in distilled water (control) or NaCl solution (0.5%, 1%, 2% and 4%) for 7 days. Emergence of one millimeter of the radicle was used as the criterion for germination. Measurements of the radicle length and plumule length were made and the seedlings were separated into radicle and plumule for fresh and dry matter determinations. The germination, plumule and radicle lengths, plumule and radicle fresh weights, plumule and radicle dry weights of NaCl treated seedlings were significantly inhibited at $P < 0.05$. The inhibition of the germination and seedling growth of the test crop by the saline solution was dose dependent.

KEYWORDS: Seedling growth, *Vigna unguiculata,* NaCl stress, inhibition, germination

I. INTRODUCTION

Cowpea (*Vigna unguiculata* (L.) Walpers) which belongs to the family **Fabaceae is an** economically significant legume in the tropics. Its grains are consumed by man as cheap plant protein (IITA, 1984) since fish, meat, milk and egg proteins are fast disappearing (Alabi *et al*., 2003). It is also used as cover crop in farms that have erosion problem (Okigbo, 1978). Its young green succulent pods are eaten as vegetable in some African communities (Bittenbender *et al.*, 1984).

Stalinization of soils or waters is one of the world's most serious environmental problems in agriculture. Although more frequent in arid lands, salt-affected soils are also present in areas where salinity is caused by poor quality of irrigation water and excessive fertilizer application. Saline soil induces physiological and metabolic disturbances in plants, affecting development, growth, yield, and quality of plants (Zeinolabedin, 2012). Soil salinity in agriculture soils refers to the presence of high concentration of soluble salts in the soil moisture of the root zone. These concentrations of soluble salts through their high osmotic pressures affect plant growth by restricting the uptake of water by the roots. Salinity can also affect plant growth because the high concentration of salts in the soil solution interferes with balanced absorption of essential nutritional ions by plants-(Tester and Devenport, 2003). During stress conditions plants need to maintain internal water potential below that of soil and maintain turgor and water uptake for growth. The deleterious effects of salinity on plant growth are associated with: (1) low osmotic potential of soil solution (water stress), (2) nutritional imbalance, (3) specific ion effect (salt stress) or (4) a combination of these factors (Ashraf 1994).

Proline, which occurs widely in higher plants and accumulates in larger amounts than other amino acids (Abraham *et al.* 2003), regulates the accumulation of useable Nitrogen. Proline accumulation normally occurs in the cytosol where it contributes substantially to the cytoplasmic osmotic adjustment (Ketchum *et al*. 1991). Salt stress can elicit a change from C3 to the CAM (crassulacean acid metabolism) mode of photosynthesis in plant *Mesembryanthemum crystallinum*). Some of the enzymatic machinery for CAM metabolism, e.g. phosphoenolpyruvate (PEP) carboxylase, is induced by a few hours of salt stress. The main advantage of the CAM metabolism is an increased water use efficiency because the stomata only open at night when evaporative water loss is at a minimum. Nutrient disturbances under salinity reduce plant growth by affecting the availability, transport, and partitioning of nutrients. Excessive sodium ions at the root surface disrupt plant potassium nutrition.

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Seed germination, seedling emergence, and their survival are particularly sensitive to substrate salinity (Baldwin *et al.*, 1996). High levels of soil salinity can significantly inhibit seed germination and seedling growth, due to the combined effects of high osmotic potential and specific ion toxicity (Grieve and Suarez, 1997). Almansouri *et al.* (2001) reported that soil salinity affects plants at seedling stage much higher than other plant growth stage because seed germination usually occurs in the uppermost soil layers which accumulate soluble salts as a result of evaporation and capillary rise of water.

Salinity reduced growth in radish (*Raphanus sativus* L.) at high salinity level and this reduction could be attributed to a reduction in leaf area expansion and hence to a lower light interception (Marcelis and Hooijdonk, 1999). Jeannette *et al*. (2002) reported that total fresh weight of root and shoot of cultivated accessions of cowpea was reduced with increased salt stress .Demir and Arif (2003) observed that the root growth was more adversely affected as compared to shoot growth by salinity. Decrease in shoot biomass indicates an inverse relationship between salinity and biomass production (Gururaja Rao *et al*., 2005). Its effects on plant water relations, nutritional imbalance and ion toxicity are responsible for the inhibition of growth and as a consequence decrease in plant yield (McKensie and Leshen, 1994).

Germination and early seedling growth of *V. unguiculata* L. have been regarded as critical phases, which are greatly influenced by stressful conditions (Shah and Dubey, 1995). Therefore, the objective of this study was to investigate the effect of salinity on the germination and early seedling growth of *V. unguiculata* L.

II.MATERIALS AND METHODS

The seeds of *V. unguiculata* were collected from IITA (International Institute of Tropical Agriculture) Ibadan. Petri-dishes were thoroughly washed and oven dried. The seeds of the different test plant were selected randomly on the basis of uniformity of size and the seed were then soaked for five minutes separately in 5% sodium hypochlorite to prevent fungal infection. Thereafter, they were rinsed for about five minutes in running water. Ten of these seeds were placed in each of the clean oven dried Petri-dish which had been lined with a Whatman No 1 filter paper. The filter paper in each of the Petri-dishes allocated to the control was moistened with 10 mL of distilled water while that of the Petri-dishes allocated to the other treatments were moistened with 10 mL of the different concentrations of the salt solutions (0.5%, 1%, 2%, 4% w/v). The Petri-dishes were incubated at room temperature for 7 days. Emergence of one millimetre of the radicle was used as the criterion for germination. Daily measurements of the plumule and radicle lengths were taken using a metre ruler. Five seedlings were randomly harvested in each regime and each seedling was separated into plumule and radicle. The fresh weight of the different plants parts of each seedling was obtained using a Mettler Toledo (PB153) chemical balance. The fresh plants parts used for the fresh weight analysis were packaged separately in envelopes and dried to constant weight at 80^{o}C in a GallenKamp (Model IH-150) incubator. The dried plant parts were weighed on a chemical balance (Mettler Toledo balance) to obtain the dry weights of the plant parts. Statistical analysis was performed using a one way ANOVA ($P< 0.05$).

III. RESULTS AND DISCUSSION

The germination of *V. unguiculata* treated with the different salt solutions was found to be lower than that of the seeds in the control and the reduction of the germination percentage of the test crop was in the order of 4% > 2% > 1% > 0.5% (w/v) salt solution. This was consistent with the finding of Prakash *et al.* (2010) who reported that the germination percentage of seeds of *V. unguiculata* was highly reduced by salinity. The reduction of seed germination could be as a result of the decrease of the water movement into the seeds during imbibitions. According to Ashraf, *et al.* (2004) plants take up high amounts of Na^+ while uptake of K^+ and Ca^{2+} are significantly reduced under excessive saline conditions. These could lead to nutritional imbalance and ion toxicity which could be responsible for the reduction in the growth of the test crop by the application of the salt solutions. Turan *et al*. (2007) stated that salinity reduced growth and yield of non halophytes plants by decreasing the availability of water to the roots as a result of the osmotic effect of external salts and by toxic effect of excessive salt accumulation in the plant. The plumule and radicle lengths of the seedlings in the salt solution regimes are shown in figs 2 and 3. The results showed that the different salt solutions significantly reduced the plumule and radicle lengths of the test crop at $P< 0.05$. The salt solutionsof higher concentrations was more inhibitory on these growth parameters than the lower concentrations. The plumule growth of the test crop was less affected by the salt stress compared with the root growth. At salt concentration of 2% w/v the plumule length was equivalent to that of the control. This agreed with the work of Demir and Arif (2003) who observed that the root

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International Journal of Advanced Research in Science, Engineering and Technology
Vol. 4, Issue 8 , August 2017

growth was more adversely affected as compared to shoot growth by salinity. The effects of the different salt solutions on the yield parameters of the test crop are shown in figs 3 – 7. These yield parameters were inhibited by the salt solutions except the plumule fresh weight where the 0.5% NaCl solution did not affect this parameter. The inhibitory effect of the salt solutions on the yield parameters was concentration dependent since inhibition of these parameters increased as the concentration of the salt solutions increased. This was consistent with the work of Ali *et al.* (2015) who reported that the germination, length of root and shoot and fresh weight of root and shoot of *Lens culinaris* L. decreased with increase in the concentration of salt.

IV. CONCLUSION

This study demonstrated that germination and seedling growth of NaCl treated *V. unguiculata* varied according to the change in NaCl level. Therefore NaCl has direct harmful effects on the test crop. Considering the inhibitory effects of NaCl on the germination and seedling growth of *V. unguiculata* important features like increased germination capacity and proline accumulation have to be explored in programs to select and/or develop tolerant cultivars, to make possible the utilization of waste saline water as well as the cultivation of vast areas of the tropical world.

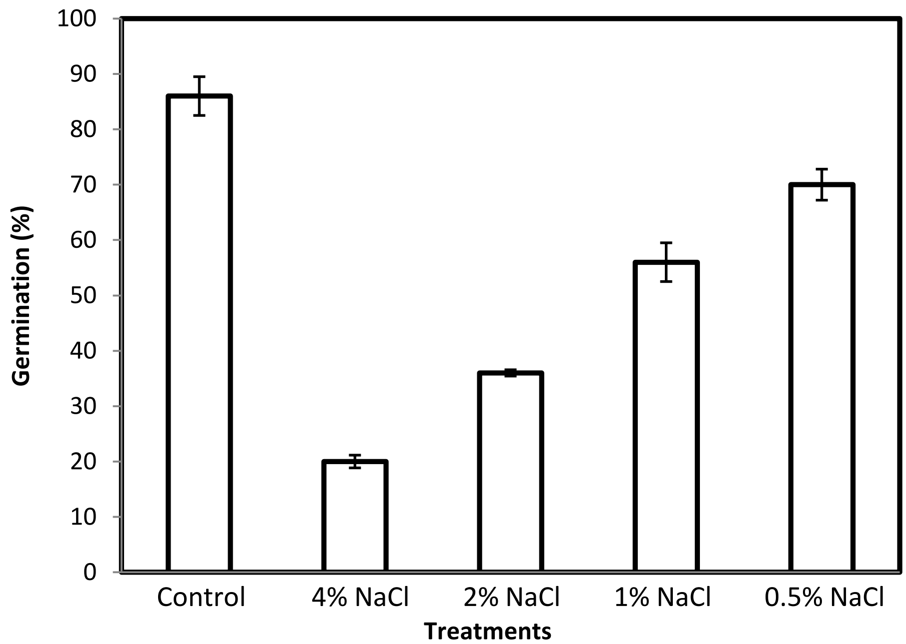

Fig. 1 Effects of the different salt solutions on the germination of *V. unguiculata*

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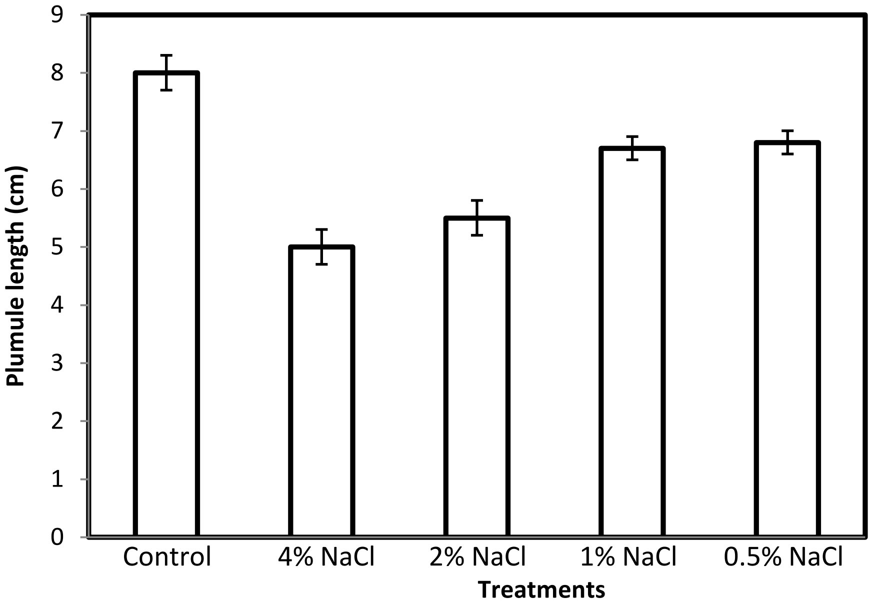

Fig. 2 Variation in the plumule length of *V. unguiculata* treated with the different levels of NaCl solution

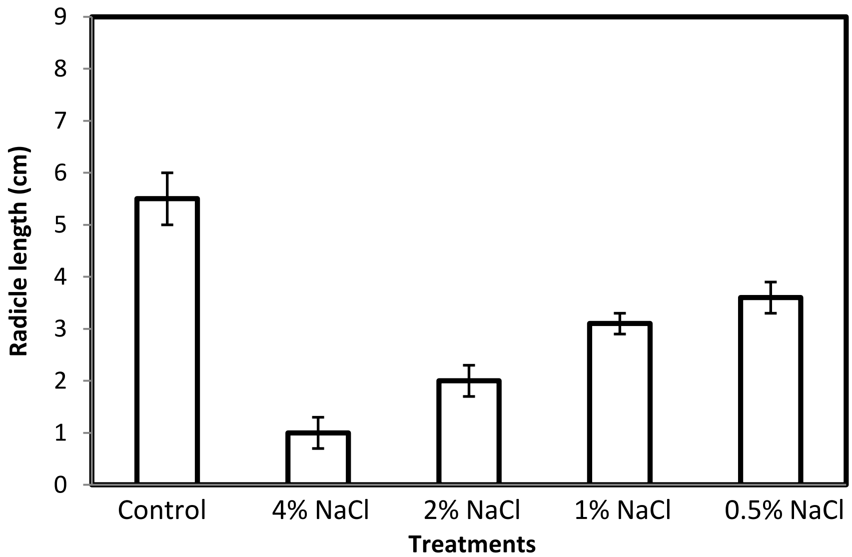

Fig. 3. Variation in the radicle length of *V. unguiculata* treated with the different levels of NaCl solution

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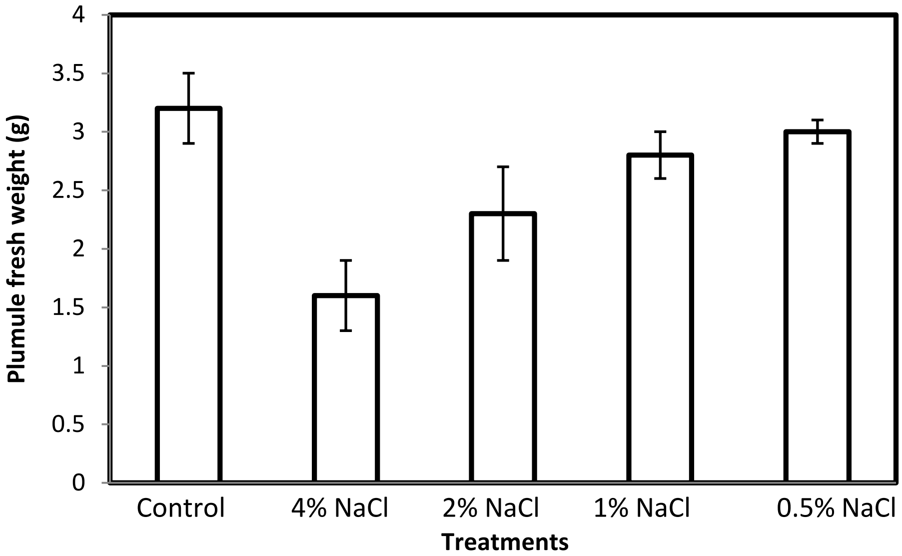

Fig. 4 Effects of the different salt solutions on the plumule fresh weight of *V. unguiculata*

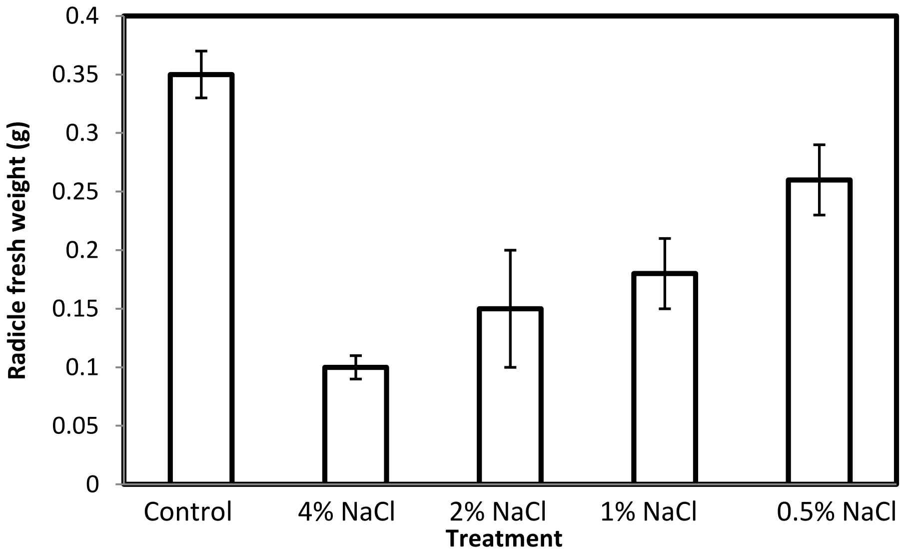

Fig.5 Effect of the different salt solutions on the plumule fresh weight of *V. unguiculata*

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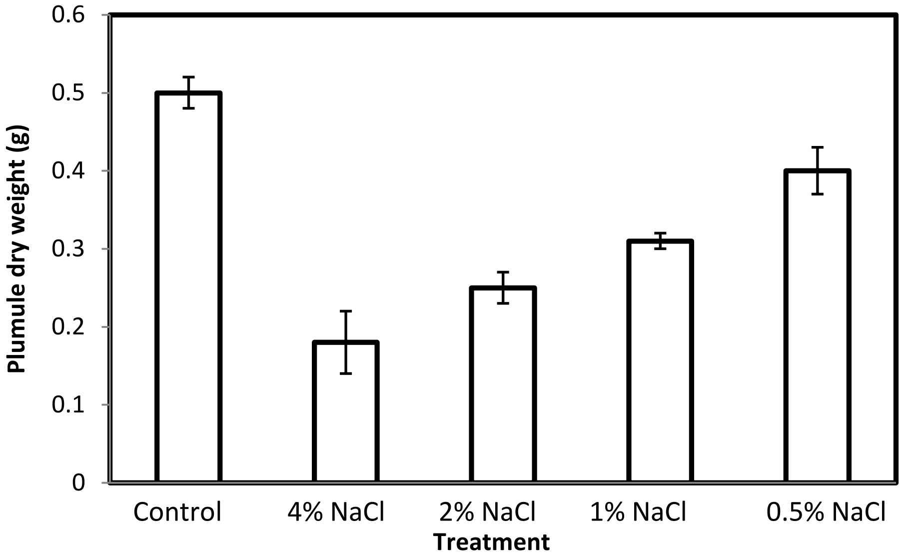

Fig. 6 plumule dry weight of *V. unguiculata as* affected by the different salt solutions

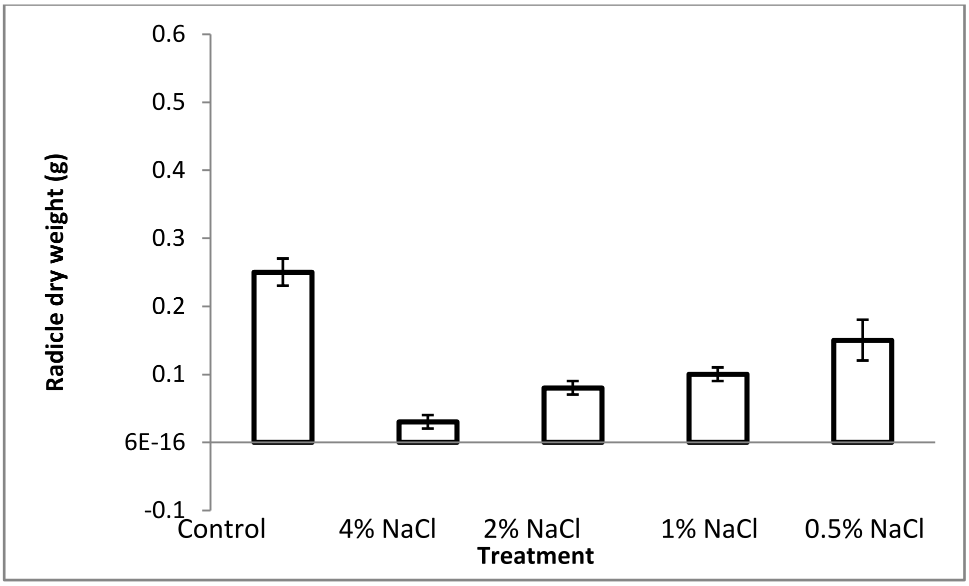

Fig. 7 Radicle dry weight of *V. unguiculata* as affected by different salt solutions

ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 4, Issue 8 , August 2017

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