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Salinity and sodicity disturbs growth of medicinal crop Guar (*Cyanoposisa tetragonoloba*)

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Abstract

Salinity is one of the major and increasing problems in irrigated agriculture in Pakistan. Salinity stress negatively affects the growth and yield of plants guar (*Cyanoposisa tetragonoloba*). This experiment was conducted to evaluate the effects of (4 dSm^{-1}+ 13.5 (mmol $L^{-1})^{1/2}$, 5 dSm^{-1} + 25 (mmol $L^{-1})^{1/2}$, 5 dSm^{-1} + 30 (mmol $L^{-1})^{1/2}$, 10 dSm^{-1} + 25(mmol $L^{-1})^{1/2}$ and 10 dSm^{-1} + 30 (mmol $L^{-1})^{1/2}$) on biomass yield of guar against salinity tolerance . Maximum biomass yield (54.50 $gpot^{-1}$) was produced by 4 dSm^{-1}+ 13.5 (mmol $L^{-1})^{1/2}$ treatment. Biomass produce was reduced with the increase of the salts toxicity. Minimum biomass yield (30.17 $gpot^{-1}$) was attained under 10 dSm^{-1} + 30 (mmol $L^{-1})^{1/2}$. 5 dSm^{-1} + 25 (mmol $L^{-1})^{1/2}$ treatment exhibited improved outcome i.e. the least diminution % over control (18.66). Salinity cum sodicity showed staid effect on the growth reduction from 18.66% to 44.64%. This reduction fissure was impacted by the toxic effect of salinity and sodicity on Guar growth. Salinity- sodicity behaved toxic impact on the growth reduction from 18.66% to 44.64%. Based on the findings, guar (*Cyanoposisa tetragonoloba*) grows better at 4 dSm^{-1}+ 13.5 (mmol $L^{-1})^{1/2}$ treatment.

Keywords: Guar (*Cyanoposisa tetragonoloba*), Saline- sodic, Medicinal value and Biomass yield

1. Introduction

Salinity is one of the major and increasing problems in irrigated agriculture in Egypt. Salt effects on different morphological, physiological, and biochemical processes (Singh & Chatrath 2001). These include delays the seed germination as well as final germination percentage (Rahman et al., 2000; Hu & Schmidhalter, 2001), ion homeostasis (Zhu, 2001) and damaged photosynthetic components and decrease in photosynthetic activity(Wang & Nii, 2000). Presoaking seed treatments have been shown to enhance stand establishment in normal soils and have potential in saline areas as well (Ashraf & Ruaf, 2001; Basra et al., 2005).

Growing salt-tolerant under-explored crops utilizing saline ground water can provide for an economic use of abandoned semiarid lands. Field trials were conducted between 1999 and 2003 on a calcareous soil in a semiarid region of northwest India. Woody perennials were planted at the sill of furrows and irrigated with water of high salinity (EC 10–28 dSm^{-1}), low salinity (EC 5–9 dSm^{-1}) and alternately with these two waters. Woody species included *Azadirachta indica, Cordia rothii, Salvadora persica, Jatropha curcas, J. gossipifolia, Ricinus communis, Catharanthus roseus, Adhatoda vasica* and *Aloe barbadensis*.

Most of these could be grown successfully but *S. persica* a highly salt-tolerant halophyte though it produced huge biomass, could not yield mature fruit due to frost injury. The salinity build up in the soil was greater during low-rainfall years, but a good rainfall year, e.g. 714mm in 2001, helped to leach out the accumulated salts. The uptake of Na^+ in plants was greater when irrigated with water of high salinity, while K^+ accumulation was greater with water of low salinity. Na^+ accumulation was higher in roots as compared to other parts except in Jatropha and Salvadora, while K^+ accumulation was greater in leaves. There was a negative correlation between Na^+ and K^+ accumulation and a positive correlation between $Ca2^+$ and $Mg2^+$.
Some work on the effect of salinity on germination and growth of medicinal plants include *Linum usitatissimum*, *Trigonella foenum–graecum* (Ashraf et al., 2003; Mutlu & Bozcuk, 2007), *Glycine max* (Umezawa et al., 2000; Essa 2002), Brassica spp. (Farhandi & Sharif Zadah, 2006; Gul & Ahmad, 2007; Ulfat et al., 2007; Jenagand et al., 2008), *Ricinus* communis (Raghavaiah, 2002, 2006). It appears that little information is available regarding the effect of salinity on the growth and productivity of medicinal plants. *Lepidium sativum L., Linum usitatissimum L., Plantago ovata Forssk* and *Trigonella foenum-graecum* L. have been evaluated and proved to be moderately salt tolerant at germination and seedling growth stage (Muhammad & Hussain, 2009). The present study was focused to assess the tolerance of these medicinal plants towards salinity at their vegetative growth. The findings might help in utilizing saline habitats. The successful cultivation of medicinal plants will provide raw material to pharmaceutical companies and for local medicinal uses.
Guar or cluster bean (*Cyanopsisa tetragonoloba* L. Taub.) is an important summer leguminous crop of some Asian countries particularly inflicted with arid and semi-conditions. It is primarily cultivated in Asia, and its uses are of multifarious nature, e.g., it is used for human consumption and cattle forage as well as green manure (Rao & Shahid, 2011; Satyavathi et al., 2014 ; Choy et al., 2015). Its seed has 78–82% endosperm, which contains high levels of galactomannan gum, an increasingly important ingredient used in various products. Guar gum's richness and wide applicability for both food and non-food products has made it one of the most important industrial crops world-over (Pathak et al., 2010; Sultan et al., 2013). Thus, saline water (ECiw 12 dSm^{-1}) can successfully be used for growing several under-explored crops of high economic value.
Salinity is one of the rising problems causing tremendous yield losses in many regions of the world especially in arid and semi arid regions. To maximize crop productivity, these areas should be brought under utilization where there are options for removing salinity or using the salt-tolerant crops. Use of salt-tolerant crops does not remove the salt and hence halophytes that have capacity to accumulate and exclude the salt can be an effective way. Methods for salt removal include agronomic practices or phytoremediation.
The first is cost and labor-intensive and needs some developmental strategies for implication; on the contrary, the phytoremediation by halophyte is more suitable as it can be executed very easily without those problems. Several halophyte species including grasses, shrubs, and trees can remove the salt from different kinds of salt-affected problematic soils through salt excluding, excreting, or accumulating by their morphological, anatomical, physiological adaptation in their organelle level and cellular level. Exploiting halophytes for reducing salinity can be good sources for meeting the basic needs of people in salt-affected areas as well. This review focuses on the special adaptive features of halophytic plants under saline condition and the possible ways to utilize these plants to remediate salinity.
The average annual potential evaporation of the country is high, ranging from 700 to 4,000 mm. However, the sustainability of irrigated agriculture in Iran is threatened by the salinization of land and water resources, which is caused mainly by seepage from unlined canals, inadequate provision of surface and subsurface drainage, poor water management and inappropriate cultural practices, and use of saline water for irrigation (Qureshi *et al.* 2007). The renewable water resources in the country are estimated to be nearly 130 billionm3, annually. According to official predictions, the country will suffer severely from water scarcity problems in the near future (Ghamarnia *et al*. 2012b).
To mitigate the adverse impacts of such scarcity on the available water resources and to enhance food production to meet current and future growing demands, the use of nonconventional water resources including brackish water, saline water, treated sewerage, and reused water needs to be given a greater attention (Ghamarnia *et al*. 2012b). The saline and brackish water resources in Iran reach contribute between 10 and 11 billionm^3 to surface water resources and almost 1.7 billionm^3 to groundwater resources.
Salinity stress negatively affects the growth and yield of plants. Due to the increasing demand for products derived from medicinal plants and with regard to the growing problems caused by salinity of arable lands, the use of salt-tolerant species can be a strategic approach to cope with this problem. The aim of the present study was to evaluate the effect of salinity stress on the establishment of Guar plants under different salt stressed conditions.

2. Materials and methods

A pot study was conducted to evaluate the salt tolerance of Guar (*Cyanoposisa tetragonoloba*) as medicinal plant under different saline and sodic concentrations at green house of Land Resources Research Institute, National Agricultural Research Centre, Islamabad, Pakistan during, 2017. The soil used for the pot experiment was analysed and having 7.2 pH, 1.9 ECe (dSm^{-1}), 4.8 SAR ($(mmol\ L^{-1})^{1/2}$), 21.2 Saturation Percentage (%), 0.43 O.M. (%), 7.3 Available P (mg Kg^{-1}) and 97.1 Extractable K (mg Kg^{-1}). Considering the pre- sowing soil analysis the ECe (Electrical conductivity) and SAR (Sodium Absorption Ratio) was artificially developed with salts of NaCl, Na_2SO_4, $CaCl_2$ and $MgSO_4$ using Quadratic Equation.10 Kg soil was used to fill each pot. 10 seeds of Guar (*Cyanoposisa tetragonoloba*) as medicinal plant were sown in each pot. Fertilizer was applied @50-45-40 NPK Kg ha^{-1}. Treatments were (4 dSm^{-1}+ 13.5 $(mmol\ L^{-1})^{1/2}$, 5 dSm^{-1} + 25 $(mmol\ L^{-1})^{1/2,}$ 5 dSm^{-1} + 30 $(mmol\ L^{-1})^{1/2}$, 10dSm^{-1} + 25 $(mmol\ L^{-1})^{1/2,}$ 10dSm^{-1} + 25 $(mmol\ L^{-1})^{1/2}$ and 10 dSm^{-1} + 30 $(mmol\ L^{-1})^{1/2)}$. Completely randomized deign was applied with three repeats. Data on biomass yield were collected. Collected data were statistically analysed and means were compared by LSD at 5 % (Montgomery, 2001).

3. Results and discussions

Intense salinity decreases efficiency of many crops including most vegetables by causing various irregular morphological, physiological and biochemical alternations that basis late germination, high seedling transience, poor plant population, diminutive growth and lower yields. Biosaline agriculture (utilization of these salt- affected lands without disturbing present condition) is an economical way to reclaim the salt- affected soils and bring this area under cultivation. Keeping in view, a pot study was carried out to assess the salt tolerance of Guar (*Cyanoposisa tetragonoloba*) under different salt concentrations. Significant divergence was initiated with treatments on biomass yield (Table-1). Highest biomass yield (54.50 $gpot^{-1}$) was gained by 4 dSm^{-1}+ 13.5 $(mmol\ L^{-1})^{1/2}$ treatment. Biomass yield was decreased as well as the toxicity of salts was increased. Minimum biomass yield (30.17 $gpot^{-1}$) was produced at 10 dSm^{-1} + 30 $(mmol\ L^{-1})^{1/2}$**.** Salt effects on different morphological, physiological, and biochemical processes (Singh and Chatrath 2001).

Table 1: Effect of various salinity and sodicity levels on biomass yield of Guar (Cyanoposisa tetragonoloba) as medicinal crop

Treatments	**Biomass yield ($gpot^{-1}$)**	**% decrease over control**
ECe= 4 dSm^{-1}+ SAR=13.5 $(mmol\ L^{-1})^{1/2}$	54.50a	-------
ECe= 5 dSm^{-1} + SAR=25 $(mmol\ L^{-1})^{1/2}$	44.33ab	18.66
ECe= 5 dSm^{-1} + SAR= 30 $(mmol\ L^{-1})^{1/2}$	39.67b	27.21
ECe= 10dSm^{-1} + SAR=25 $(mmol\ L^{-1})^{1/2}$	34.17c	37.30
ECe= 10 dSm^{-1} + SAR= 30 $(mmol\ L^{-1})^{1/2}$	30.17d	44.64
LSD at 5%	6.72	

Table-1 also explained the % decrease in biomass yield over control. 5 dSm^{-1} + 25 $(mmol\ L^{-1})^{1/2}$ treatment performed better results i.e. the least reduction % over control (18.66). Salinity- sodicity showed serious effect on the growth reduction from 18.66 to 44.64%. This huge fissure was impacted by the negative effect of salinity cum sodicity on Guar (*Cyanoposisa tetragonoloba*) growth. Salinity- sodicity showed staid effect on the growth reduction from 18.66% to 44.64%. This reduction fissure was impacted by the harmful effect of salinity and sodicity on coriander growth. Salinity- sodicity behaved toxic impact on the growth reduction from 18.66 to 44.64%. Salinity and sodicity late the seed germination as well as final germination percentage (Rahman et al., 2000 and Hu & Schmidhalter, 2001), ion homeostasis (Zhu, 2001) and damaged photosynthetic components and decrease in photosynthetic activity (Wang and Nii, 2000).

4. Conclusion

Based on the findings, Guar (*Cyanoposisa tetragonoloba*) was able to how grow against more salt tolerance at 4 dSm^{-1}+ 13.5 $(mmol\ L^{-1})^{1/2}$ treatment. Therefore, Guar (*Cyanoposisa tetragonoloba*) is suggested to be cultivated in farmlands having salinity cum sodicity up to 4 dSm^{-1}+ 13.5 $(mmol\ L^{-1})^{1/2.}$

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