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Original Research

EFFECTS OF SALT STRESS ON THE GROWTH TRAITS OF CHICKPEA (*CICER ARIETINUM* L.) AND PEA (*PISUM SATIVUM* L.) SEEDLINGS

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Abstract: *Chickpea (Cicer arietinum L.) and pea (Pisum sativum L.) both are important legume crops grown throughout the world for protein and they also contain essential vitamins and fibers. Chick pea and pea are very sensitive to abiotic stress that includes heat, drought, cold and salt stress conditions. To access the effects of salt stress on the chick pea and pea an experiment was performed in the Green House of Institute of Molecular Biology and Biotechnology, The University of Lahore, Lahore. The seeds of both genotypes were grown in 18 pots with 2 kg pure sand and applied different concentrations of NaCl stress after 7 days of germination. The application of salt treatments was repeated 4 times each after 7days interval and data of different morphological traits was recorded each time. The treatments were included control, 0.25Molar NaCl, 0.5Molar NaCl concentrations. The data was recorded and pooled analysis of variance was carried out for significance of results. The average root length was recorded as 5.7522±0.0211cm and shoot length (11.139±0.0011cm) while average fresh plant weight was recorded as 0.5811±0.0002g under different salt stress conditions. The finding of our result proved that both varieties chickpea and pea showed variable behavior under salt stress conditions while the pea genotype showed more tolerant against different salt treatments which indicated pea genotypes may be used for future breeding to improve yield and growth of pea crop. The results showed that there was significant and positive correlation among root length, shoot length and leaf length of chickpea and pea seedlings which concluded that root length and shoot length may be used as selection criteria to induced stress tolerance in crop plants.*

Keywords: *Cicer arietinum*, *Pisum sativum*, salt stress, root length, correlation

Introduction

Chickpea (*Cicer arietinum* L.) is one of the ancient and immensely cultivated legumes in South Asia and third largest cultivated crop worldwide. Chickpea is cultivated in more than 50 countries (89.7% in Asia 4.3% in Africa 2.6 in Oceania 2.9% in America and 0.4% in Europe) (Gaur *et al*., 2010). The major cultivators of Chickpea are India, Pakistan and Turkey constitutes 65%, 9.5% and 6.7% of the global production (Millan *et al.*, 2005). Chickpea is the most vital and cultivated Rabi legume crop of Pakistan and grown on an area of 1050 thousand hectors with yearly production of 571 thousand tons per hectares (Ali *et al*., 2011b). Chickpea has two types Desi type and Kabuli type. The Desi type contains brown, yellow, green or black hues with course seed coat while the Desi type contains whitish or beige appearance. The Desi type constitutes up to 80–85% of chickpea production (Gaur *et al*., 2010). Chickpea is also a rich source of unsaturated fatty acids including linoleic acid and stigma sterol is abundantly present in chickpea. Chickpea also provides us with vitamins like riboflavin, niacin, thymine and folate as well (Gaur *et al*., 2012; Jukanti *et al*., 2012; Varshney *et al*., 2013). Chickpea serves as cheap and readily available source of proteins for millions of the people in the world who cannot afford protein via animals or are vegetarians (Parihar *et al*., 2014; Rodríguez-Serrano *et al*., 2006). Chickpea is a legume crop of cold season but serves as winter crop in tropical areas and summer crop in temperate periphery. Temperature, day length and moisture level dictates the yield and quality of crop. Chickpea is a temperature sensitive legume crop it can tolerate temperature as high as >37˚C or as low as < than 15˚C. Increase in temperature in both cases causes drastic effects (Gaur *et al*., 2010). Chickpea is also sensitive to salinity. When cultivated in saline environment the level of Cl^- ions is elevated because it is also secreted by leaves via glandular hairs and stems is higher in shoots rather than Na^+ and it also reduces the capacity of water intake ability of crop from the soil and result in poor quality yield (Flowers *et al*., 2010; Parihar *et al*., 2014). Pea (*Pisum sativum* L.) is an annual legume inherit to cold season with high economic status and is grown in Tukey and other countries of Mediterranean region as a cost

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effective source of protein for animals and plants as well (Okçu *et al*., 2005; Parihar *et al*., 2014). The variant "Dry pea" contains a marketed name called dry coated or dry shelled variety and is utilized in Human and Livestock region. The major cultivators of this crop are Russia, China, United States, Europe, Australia and Canada. In 2002 there were approximately 300, 000 acres of pea's crop cultivated in US (Dahl *et al*., 2012; Gaur *et al*., 2012). If harvested on commercial scale it is used for canning purpose and rationally it is cultivated as a dry grain or fruit (Kluth *et al*., 2005; Okçu *et al*., 2005). Pea is sensitive to drought, salinity and oxidative stress. Presence of excess salt is the main reason for soil infertility and crops like pea are not resistant to this environment so there is a decline in productivity moreover salt inhibit plant growth and availably of photosynthates an influence nodule formation and cause infection. The research was conducted keeping few research objectives in mind to evaluate the effects of NaCl stress on chickpea and pea seedling growth and to find out the stress resistant variety from selected varieties for research work.

MATERIALS AND METHODS

The present research experiment was conducted in the greenhouse of the Institute of Molecular Biology and Biotechnology, to evaluate the impact of salt stress on the growth of pea and chickpea seedlings. The seeds were sown to grow in pots. The pots were filled with the layers of sand. In each pot 8 to 10 seeds were sown. One group was treated as control second was treated with 0.25Molar NaCl and third was treated with 0.5M NaCl. The roots and stems were removed to evaluate, root and leaf length, leaf weight and Dry shoot and root weight. The roots and stems were weighed using measuring balance. After that the stems were allowed to dry and were weighed again**.** Plants were harvested a week after the treatment**.** Measure the root, shoot, leaf and stem weight and length as well. Now compare the dry and fresh weight of plants roots shoot, stem and leaves. The data was recorded 4 times each after a week the plants grown from each pot were cultivated carefully and various parameters like (shoot length, root length, leave length and weights) were measured. Before measurements make sure to remove sand. Plants were washed and packed in clean bags and brought to Lab for further measurements. The recorded data was subjected to analysis of variance through using SPSS 23.1 version.

Results and discussions

The results from our finding though statistical analysis of chickpea and pea revealed that there were significant differences between the treatments of salt stress for all studied traits. The result indicated that the coefficient of variance was recorded lower which showed our findings were significant. The result is very helpful to increase the plant growth and it indicated that the leaf length, root length, shoot length, fresh plant weight and dry plant weight was good against different treatment of NaCl concentrations. The average leaf length is recorded 1.4461±0.0001cm under different concentrations. The results indicated that the length of leaf increased which suggested that both genotypes showed tolerance (Table 1). The pairwise comparison results showed that the rate of growth was higher for leaves in both genotypes chick pea and pea under control (1.7050cm) was higher leaf length as compared with 0.25Molar NaCl concentration (1.3967cm) and 0.5Molar NaCl concentrations (1.2367cm) (Table 2). The finding of our results showed that the different NaCl stress concentrations disturb the growth of leaves in plant. The results in figure 1 indicate that highest length of leaf was found for chickpea under control (1.5cm) while the lowest was under 0.5Molar NaCl (1.28cm). The highest length of leaf in pea was present under control (2.1cm) while lowest under 0.5Molar NaCl (1.21cm) (Table 3). The results for pea indicated that higher leaf length was found for pea as compared to chickpea (Figure 1). The genotype which showed higher leaf length under stress conditions indicated that it may be used for the improvement of grain yield under stressful environmental conditions (Gaur, 2012).

Table 1: Pooled analysis of variance for different traits of chickpea and pea genotypes

Source	DF	Leaf length	Root length	Shoot length	Fresh plant weight	dry plant weight
Replication	2	0.01242	0.01841	0.6806	0.00016	0.00084
Treatment	5	0.35561*	2.8800	16.5121	0.00802	0.00103
Genotypes	2	0.34001*	1.85936	6.2652	0.00591	0.00386
Treatment × Genotypes	10	0.25437*	0.8582	3.046	0.00391	0.00899
Error	34	0.00852	0.0075	0.2731	0.00014	0.00047
Grand mean	53	1.4461	5.7522	11.139	0.5811	0.2717
Standard Error		0.0001	0.0211	0.0011	0.0002	0.0001

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Coefficient of variation	6.38	1.51	4.69	2.05	7.98

* = Significant at 5% probability level

Table 2: Tukey HSD for all-pairwise comparisons test for different stress treatments

Treatments	Leaf length	Shoot length	Root length	Fresh plant weight	Dry plant weight
Control	1.7050A	12.288A	6.3067A	0.6017A	0.2983A
0.25 Molar NaCl	1.3267B	10.795B	5.7567B	0.5967B	0.2688AB
0.5Molar NaCl	1.2367C	10.333C	5.1933C	0.5450C	0.2478B

Table 3: Tukey HSD all-pairwise comparisons test of different traits for genotypes

DF	Leaf length	Shoot length	Root length	Fresh plant weight	Dry plant weight
Pea	1.5867A	12.097A	6.1522A	0.6022A	0.2792A
Chickpea	1.3056B	10.181B	5.3522B	0.5600B	0.2641B

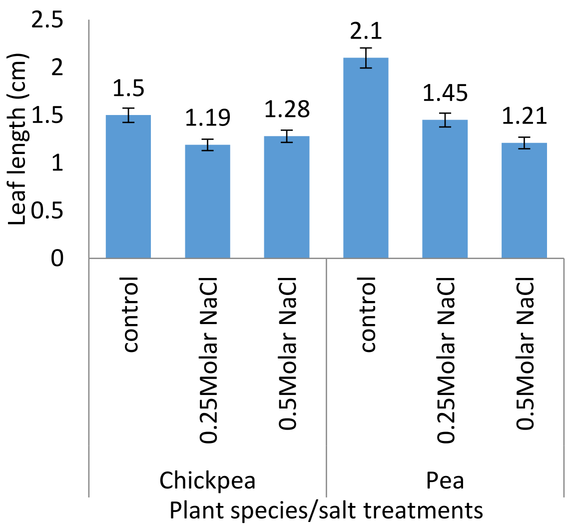

Figure 1 Leaf length of chickpea and pea under salt stress conditions

The average root length was recorded 5.7522±0.0211cm under different concentrations. The pairwise comparison (Table 2) result indicated that the rate growth was higher for roots in both varieties of chickpea and pea present under control (6.3067cm), 0.25Molar NaCl concentration (5.7567cm) and 0.5Molar NaCl concentrations (5.1933cm). The result from figure 2 indicated that highest root length in chickpea was under control (5.5cm) while the lowest under 0.5Molar NaCl (5.12cm) treatment. The highest length of root in pea was under control (7.1cm) while lowest under 0.5Molar NaCl (2.4cm) treatment. The pea variety shows that they have high growth of roots (Table 3) as compared with chickpea. The overall performance of pea was better when concentration of stress is normal rather than when the concentration is high and it showed more tolerance than chickpea (Ahmad *et al*., 2016; Ali *et al*., 2011a; Ali *et al*., 2010; Ali *et al*., 2011b; Okçu *et al*., 2005).

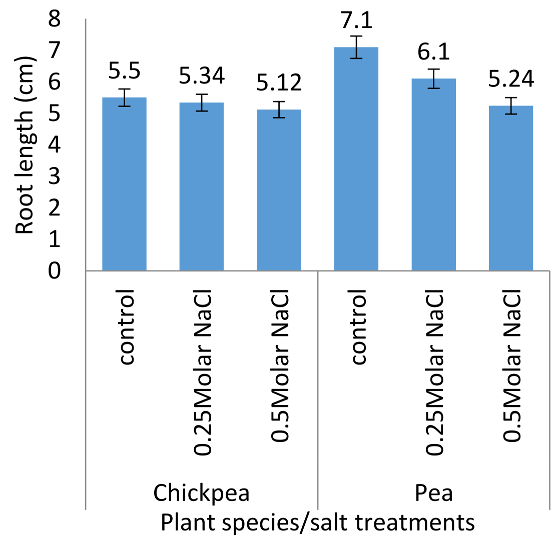

Figure 2 Root length of chickpea and pa under salt stress conditions

The average shoot length was recorded 11.139±0.0011cm under different concentrations. The pairwise comparison (Table 2) result indicated that the rate growth was higher for shoot in both varieties of chickpea and pea present under control (12.288cm), 0.25Molar NaCl concentration (10.795cm) and 0.5Molar NaCl concentrations (10.333cm). The result from figure 3 indicated that highest shoot length in chickpea was under control (11cm) while the lowest under 0.5Molar NaCl (8.56cm) treatment. The highest length of shoot in pea was under control (12.23cm) while lowest under 0.5Molar NaCl (12.1cm) treatment. The pea variety shows that they have high growth of shoot (Table 3) as compared with chickpea. The overall performance of pea was better when concentration of stress is normal rather than when the concentration is high and it showed more tolerance than chickpea (Ali and Ahsan, 2011; Ali *et al*., 2014; Babbar *et al*., 2012; Okçu *et al*., 2005).

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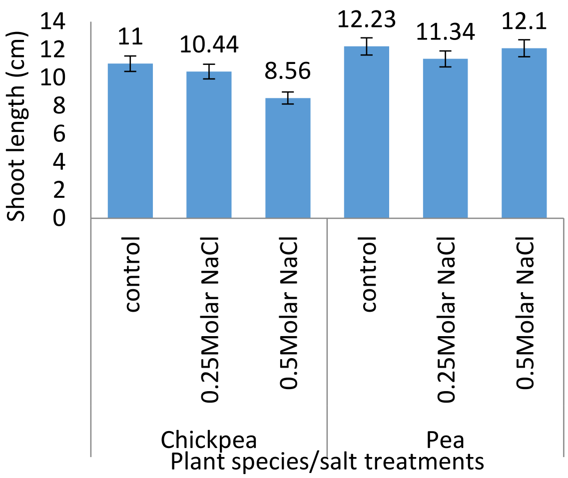

Figure 3.Shoot length of chickpea and pea under salt stress conditions

The average fresh plant weight was recorded 0.581±0.0002g under different concentrations. The pairwise comparison (Table 2) result indicated that the rate growth was higher for fresh plant weight in both varieties of chickpea and pea present under control (0.6017g), 0.25Molar NaCl concentration (0.5967g) and 0.5Molar NaCl concentrations (0.5450g). The result from figure 4 indicated that highest fresh plant weight in chickpea was under control (1.7g) while the lowest under 0.5Molar NaCl (1.19g) treatment. The highest fresh plant weight in pea was under control (3.76g) while lowest under 0.5Molar NaCl (1.19g) treatment. The pea variety shows that they have high growth of roots, leaves and shoot (Table 3) as compared with chickpea which caused increased fresh plant weight of pea. The overall performance of pea was better when concentration of stress is normal rather than when the concentration is high and it showed more tolerance than chickpea (Agrawal, 2017; Agrawal *et al*., 2018; Ahsan and Ali, 2014; Waseem *et al*., 2014).

The average dry plant weight was recorded 0.2717±0.0001g under different concentrations. The pairwise comparison (Table 2) result indicated that the rate growth was higher for dry plant weight in both varieties of chickpea and pea present under control (0.2983g), 0.25Molar NaCl concentration (0.2688g) and 0.5Molar NaCl concentrations (0.2478g). The result from figure 5 indicated that highest dry plant weight in chickpea was under control (1.253g) while the lowest under 0.5Molar NaCl (0.996g) treatment. The highest dry plant weight in pea was under control (1.433g) while lowest under 0.5Molar NaCl (0.953g) treatment. The pea variety showed that they have high growth of roots, leaves and shoot (Table 3) as compared with chickpea which caused increased dry plant weight of pea. The overall performance of pea was better when concentration of stress is normal rather than when the concentration is high and it showed more tolerance than chickpea (Mustafa *et al*., 2013; Tahir *et al*., 2020; Zubair *et al*., 2016)**.**

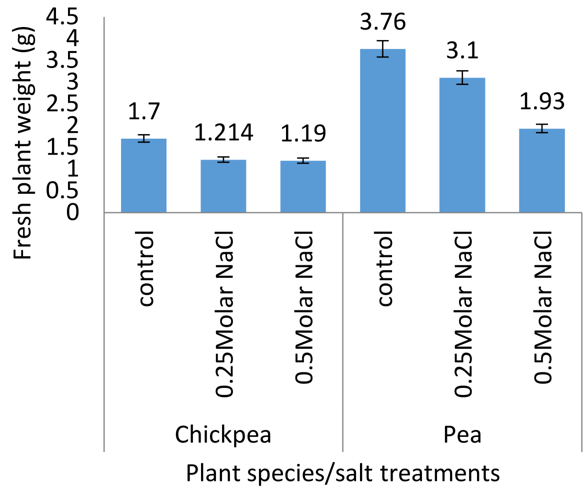

Figure 4 Fresh plant weight of chickpea and pea under salt stress condition

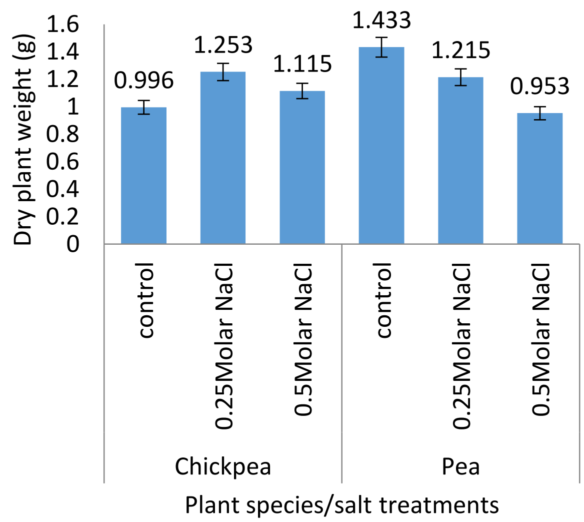

Figure 5 Dry plant weight of chickpea and pea under salt stress conditions

The results from table 4 indicated that there was significant correlation between leaf length root length, shoot length fresh plant weight and dry plant weight. The correlation between root length and shoot length was also found as positive and significant. The positive and significant correlation among studied traits indicated that the selection of chickpea and pea genotypes for salt stress tolerance may be helpful to improve yield under salt stress environmental conditions (Ali *et al*., 2013; Ali *et al*., 2016; Flowers *et al*., 2010; Khalil *et al*., 2020; Mazhar *et al*., 2020).

Table 4 Pooled correlation analysis among different traits of chickpea and pea under salt stress

Traits	Leaf length	Root length	Shoot length	Fresh plant weight
Root length	0.3482*			
Shoot length	0.4021*	0.7643*		
Fresh plant weight	0.5623*	0.3721*	0.2341	
Dry plant weight	0.3012*	0.2921	0.2902	0.1029

Conflict of interest

The authors have declared absence of any type of conflict of interest.

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