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

YOUSEF F, SHAFIQUE F, *ALI Q, MALIK A

Institute of Molecular Biology and Biotechnology, The University of Lahore, Lahore, Pakistan

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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 7 days interval and data of different morphological traits was recorded each time. The treatments were included control, 0.25 Molar NaCl, 0.5 Molar 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±0.0211 cm and shoot length (11.139±0.0011 cm) while average fresh plant weight was recorded as 0.5811±0.0029 g 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 tolerance 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 hectares 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 coarse 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
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 availability 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 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       | 0.00036           | 0.00048         |
| 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      | 11.39        | 0.5811            | 0.2717          |
| Standard Error          |     | 0.0001      | 0.0211      | 0.0011       | 0.0002            | 0.0001          |

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Effects of salt stress on the overall performance of pea was better 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).

The average shoot length was recorded 11.139±0.0011 cm 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 (12.288 cm), 0.25Molar NaCl concentration (10.795 cm) and 0.5Molar NaCl concentrations (10.333 cm). The result from figure 2 indicated that highest shoot length in chickpea was under control (11 cm) while the lowest under 0.5Molar NaCl (8.56 cm) treatment. The highest length of shoot in pea was under control (12.23 cm) while lowest under 0.5Molar NaCl (8.56 cm) treatment. The result from figure 3 indicated that highest shoot length in chickpea was under control (11 cm) while the lowest under 0.5Molar NaCl (12.1 cm) 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).

| Plant species/salt treatments | Leaf length (cm) | Root length (cm) |
|-------------------------------|-----------------|-----------------|
| Chickpea 0.25Molar NaCl       | 1.19 ± 1.28     | 2.1 ± 1.45      |
| Chickpea 0.5Molar NaCl        | 1.19 ± 1.28     | 2.1 ± 1.45      |
| Pea 0.25Molar NaCl            | 1.19 ± 1.28     | 2.1 ± 1.45      |
| Pea 0.5Molar NaCl             | 1.19 ± 1.28     | 2.1 ± 1.45      |

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

**Figure 2** Root length of chickpea and pea under salt stress conditions

The average root length was recorded 5.7522±0.0211 cm 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 (6.3067 cm), 0.25Molar NaCl concentration (5.7567 cm) and 0.5Molar NaCl concentrations (5.1933 cm). The result from figure 2 indicated that highest root length in chickpea was under control (5.5 cm) while the lowest under 0.5Molar NaCl (5.12 cm) treatment. The highest length of root in pea was under control (7.1 cm) while lowest under 0.5Molar NaCl (2.4 cm) 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).
chickpea and pea present. 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 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

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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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