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Effect of Salinity on Growth and Yield of Desi and Kabuli Chickpea Cultivars

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Abstract: To evaluate the effects of different level of Na salinity (0, 3, 6 and 9 dS m^{-1}) on growth, yield and yield component of Kabuli (Hashem and Jam) and Desi (Kaka and Pirooz) chickpea cultivars a factorial experiment based on randomized complete block design with four replications was carried out in Research Greenhouse of Mokrian Agricultural Extension Center near Mahabad, Iran at 2006. Seeds of four chickpea cultivars were grown under 0, 3, 6 and 9 dS m^{-1} levels of salinity until maturity. Salinity reduced the plant growth, flower, pod and seed number and seed weight. As increase in salinity, the undesirable effect of Na^+ was more pronounced and reached the highest value at 9 dS m^{-1} in all cultivars. Four chickpea cultivar have different responses to salinity and the Kabuli cultivars seemed to have a greater capacity for salt tolerance compared to Desi cultivars. Hahshem cultivar has the highest salinity tolerance among all cultivars.

Key words: Chickpea, cultivar, growth, salinity, yield parameters

INTRODUCTION

Worldwide, about one-third of irrigated arable is already affected and that level is still rising (Lazof and Bernstein, 1997). Salinity occurs through natural or human-induced activities that result in the accumulation of soluble salt in soil and the problem of soil salinity is expected to boost in future with the progress of decertification process and greenhouse effect (Tejera *et al*., 2006).

Chickpea is one of the most important grain legumes which traditionally cultivated in marginal areas and saline soils (Rao *et al*., 2002). The agronomical importance of chickpea is based on its high protein content (25.3-28.9%) in human and animal diet (Hulse, 1991). Chickpea cultivars which are grown in Iran include native (Desi) or Mediterranean (Kabuli) types (Koocheki and Avel, 2004). Chickpea is highly sensitive to salinity, similar to many other leguminous crops (Ashraf and Waheed, 1993).

Salinity adversely affects plant growth and development (Lazof and Bernstein, 1997). Salinity drastically affects photosynthesis (Seeman and Sharkey, 1986; Soussi *et al*., 1998), nitrogen (Cordovilla *et al*., 1995; Mansour, 2000) and carbon metabolism (Delgado *et al*., 1994; Soussi *et al*., 1999; Balibrea *et al*., 2000). Salinity causes nutritional disorders in plants which may lead to deficiencies of several nutrients and drastically increasing in Na^+ levels (Cordovilla *et al*., 1995; Grattan and Grieve, 1999; Mengel and Kirkby, 2001). Such physiological changes will result in a decrease in plant growth (Mensah *et al*., 2006) and consequently in crop yield.

The ability of plants for tolerance and thrive in saline soil condition has a great importance in agriculture, which indicates the salinity tolerances capacity of plant as a desirable trait (Francois and Mass, 1994; Mahmood *et al*., 2000). Hence selection and breeding of cultivars that can grow and provide economical yield under saline conditions may be an efficient tool in resolving the salinity problems (Ashraf and McNeilly, 2004). The aim of this research was comparing the growth and yield responses of Kabuli and Desi chickpea cultivars to salinity.

MATERIALS AND METHODS

In order to comparing the responses of Desi and Kabuli chickpea cultivars to Na^+ salinity a factorial experiment based on randomized complete block design with four replications was carried out in Research Greenhouse of Mokrian Agricultural Extension Center near Mahabad, Iran at 2006. The experimental factors were chickpea cultivars Hashem and Jam (Kabuli) and Kaka and Pirooz (Desi) and different level of Na^+ salinity solution with electrical conductivity levels 0, 3, 6 and 9 dS m^{-1}. Seed of Desi type were obtained from Iran Agricultural research Organization. At first seeds were sterilized in 5% sodium hypo chlorite solution for 8 min (Ashraf and Waheed, 1993). In this study, 40 seed from each cultivar were sown in pots. Each pot was filled with mixture of soil, sand and farmyard manure in proportion of 2:2:1 by

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volume. Primarily before sowing of seeds in order to obtain the desirable salinity level the pots were irrigated with different salinity solutions in 3 consecutive days. The pots were irrigated with desired salinity levels throughout the growing period of crop at regular weekly intervals. The electrical conductivities of different salinity levels were adjusted on direct conductivity meter readings. The control pots were irrigated with normal water. Three plants with similar growth rate were maintained in each pot. With the onset of flowering 12 uniform plants from each treatment were marked for recording the number of flowers produced on 3 days interval. The number of flowers, pods and seed per plant and were recorded. At harvest, the same plants were used and the number of pods and seeds per plant, seed weight per plant were recorded. Yield was obtained from multiply seed number per plant and plant number per m^2 and the changing in hectare. Total dry weight of plants were taken at 105 days after sowing by drying the samples in an electric oven for 72 h at 70°C.

Data obtained from this experiment were subjected to analyses of variance using SAS and SPSS statistical soft wares. The graphs were drawn using EXCEL software.

RESULTS AND DISCUSSION

Salinity reduced plant growth in all cultivars (Fig. 1). Munns (2003) stated that suppression of plant growth under saline conditions may either be due to decreasing the availability to water or increasing in sodium chloride toxicity associated with increasing salinity. Also Salinity adversely affects plant growth and development (Lazof and Bernstein, 1997). In plants, salinity drastically affects photosynthesis (Seeman and Sharkey, 1986; Soussi *et al.*, 1998), nitrogen metabolism (Cordovilla *et al.*, 1995; Mansour, 2000) carbon metabolism (Delgado *et al.*, 1994; Soussi *et al.*, 1999; Balibrea *et al.*, 2000) and provokes disorders in plant nutrition which may lead to deficiencies of several nutrients and high levels of Na^+ (Cordovilla *et al.*, 1995; Grattan and Grieve, 1999; Mengel and Kirkby, 2001). Such physiological changes will result in a decrease in plant growth (Mensah *et al.*, 2006) and consequently in crop yield. The reduction in growth was visible at saline level of 3 dS m^{-1}, but became more pronounced at 9 dS m^{-1} salinity level. Under control condition and different saline levels Hashem, Jam, Kaka and Pirooz had highest total dry weight, respectively. In other words, the Kabuli types produced more total dry weight compared to Desi types.

Negative effects of salinity on plant growth had a direct effect on ultimate plant productivity (total plant dry mass accumulation, grain yield etc.) (Fig. 2a, b, 3a, b and 4). Salinity reduced the number of flowers and pods

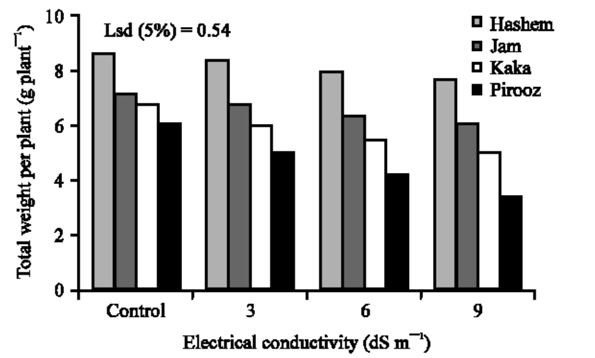

Fig. 1: Effect of different salinity levels (0, 3, 6 and 9 dS m^{-1}) on total dry weight (g $plant^{-1}$) in four chickpea cultivars (Hashem, Jam, Kaka and Pirooz)

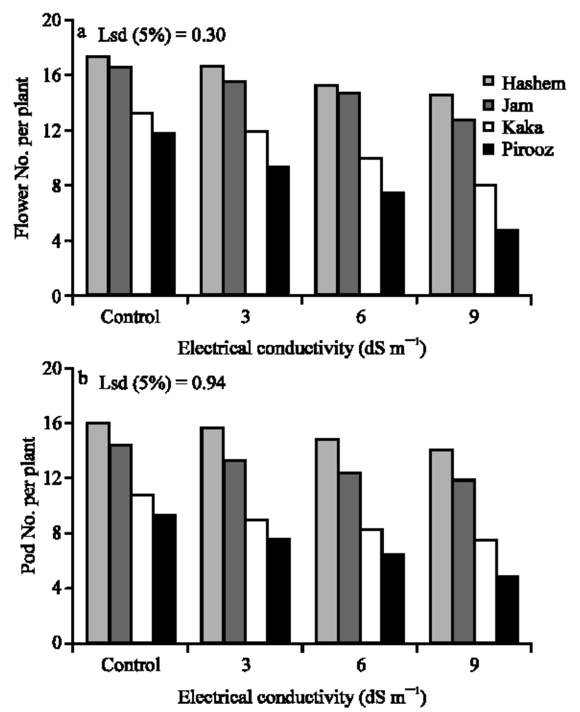

Fig. 2: Effect of different salinity levels (0, 3, 6 and 9 dS m^{-1}) on flower number (a) and pod number (b) per plant, in four chickpea cultivars (Hashem, Jam, Kaka and Pirooz)

per plants in all cultivars. As increase in salinity until 9 dS m^{-1} this reduction became more pronounced in all cultivars. Hashem and Pirooz cultivars have the greatest and lowest flower and pod production compared to the other cultivars under control and saline conditions, respectively (Fig. 2a, b). Hayat *et al.* (2001) were reported that salinity reduced the number of flowers and pods in six chickpea genotypes.

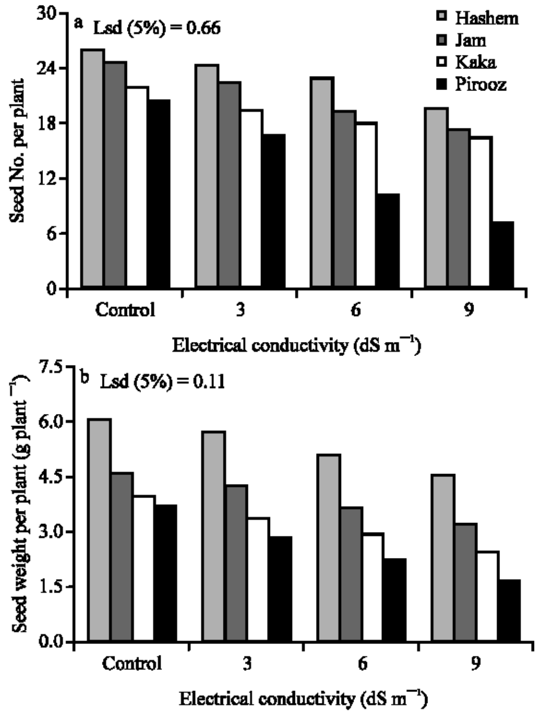

Fig. 3: Effect of different salinity levels (0, 3, 6 and 9 dS m^{-1}) on seed number (a) and seed weight (g $plant^{-1}$) (b) in four chickpea cultivars (Hashem, Jam, Kaka and Pirooz)

Figure 3a and b show that seed number and seed weight more severely affected by salinity in all chickpea cultivars. With increase in salt concentration from 3 to 9 dS m^{-1}, there was a sharp decrease in seed number and seed weight. This reduction in Kabuli cultivars (Kaka and Pirooz) was more pronounced in comparison to Desi cultivars (Hashem and Jam). The main reason for this reduction is mostly attributed to decrease in photosynthesis, nitrogen metabolism and carbon metabolism under saline conditions (Tejera *et al*., 2006). The highest seed number and seed weight have belonged to Hashem and Jam cultivars, under control and saline conditions.

Yields were affected by salinity in all chickpea cultivars, so that increasing salt concentration, decreased yield of all the cultivars (Fig. 4). Sadiki and Rabih (2001) stated that the salt reduced yield by 26 to 38% according to genotypes. Salinity drastically affects photosynthesis (Seeman and Sharkey, 1986; Soussi *et al*., 1998), nitrogen metabolism (Cordovilla *et al*., 1995; Mansour, 2000) carbon metabolism (Delgado *et al*., 1994; Soussi *et al*., 1999; Balibrea *et al*., 2000) and provokes disorders in plant nutrition which may lead to deficiencies of several nutrients and high levels of Na^+ (Cordovilla *et al*., 1995;

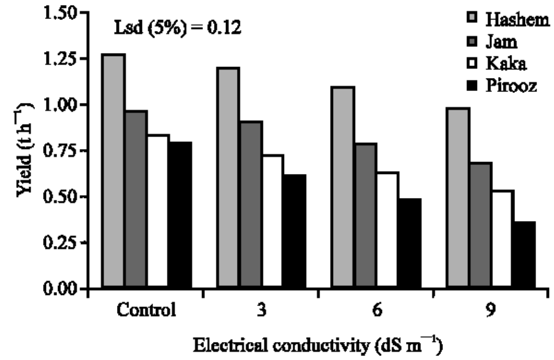

Fig. 4: Effect of different salinity levels (0, 3, 6 and 9 dS m^{-1}) on yield (t h^{-1}) in four chickpea cultivars (Hashem, Jam, Kaka and Pirooz)

Grattan and Grieve, 1999; Mengel and Kirkby, 2001), that in our research were resulted to create a cumulative effect of various factors like decline in number of flowers, pod setting, the number of ovules fertilized and nurtured into healthy seed and thus the number of seeds per pod and seed weight that induced decreasing crop yield, ultimately. These results about crop yield reduction under salinity are consistent with previous findings (Bishnoi *et al*., 1990; Sharma *et al*., 1993). Hashem and Jam cultivars (Kabuli types) have higher yield in comparison to Kaka and Pirooz cultivars (Desi types) in the saline and non-saline condition.

These results showed that decrease in various yield parameters was more sever in Desi cultivars in comparison to Kabuli types, under control and saline conditions, which may be related to lower total plant dry mass accumulation in Desi cultivars. Dua and Sharma (1995) also stated that the Kabuli types have been found to be more tolerant of salinity than the Desi types.

CONCLUSION

The results suggest that different salinity levels, decline the growth and yields of different chickpea cultivars. This reduction is different in various cultivars, but with increasing salinity, become more sever in all cultivars. In general, both Kabuli cultivars seemed to have a greater capacity for salt tolerance compared to the Desi cultivars. Hashem cultivar was the best amongst all cultivars that could be more noticed by experts of plant breeding. Determination and identifying the tolerant chickpea cultivars to salinity that give minimum depression in yield when grown in saline soils may be an efficient tool in resolving the salinity problem to some extent.

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