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Exogenous application of potassium improves the drought tolerance in chickpea

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A B S T R A C T

Drought is one of the major agricultural problems which cause losses to crop productivity. It is a worldwide problem and prevails in many parts of the world as a major threat to agriculture. Potassium (K) is considered to be an essential nutrient that plays an important role in growth, development and defense response in the plant under stressful conditions. This work investigated the effects of K in drought tolerance of chickpea seedlings by examining growth, photosynthetic performance, total osmo-regulation substance contents and antioxidative enzymes subjected to drought stress. The drought stress impaired the growth (root and shoot dry weight, root: shoot ratio, seedlings biomass), water relations, photosynthetic attributes, transpiration rate and chlorophyll contents and anti-oxidants activity of chickpea seedlings. Nonetheless, the foliar application K improved the growth, water relations, photosynthetic attributes, transpiration rate, chlorophyll contents and anti-oxidative activity of chickpea under drought conditions. Moreover, an increase in antioxidant enzyme activity and accumulation of osmoprotectants (proline, soluble protein and soluble sugar) was noted under stressed conditions, which was more pronounced in chickpea which experienced of K application. To conclude that, foliar application of K mitigated the adverse effect of drought, K was proved to be even more effective in alleviating the adverse effect of drought stress on chickpea.

INTRODUCTION

Water stress is one of the major limitations to agricultural productivity worldwide. Chickpea (*Cicer arietinum.*) is one of the oldest grain legumes and is grown in a wide geographical range with varied agroclimatic conditions (Esfahani *et al.,* 2010; Rahman *et al.,* 2008). It is a cool season annual crop which grows well in limited rainfall areas of the world. It is cultivated on a large scale under rainfed conditions, where water stress is considered a major limiting abiotic factor which reduces the growth and development (Hussain *et al.,* 2004). It is leading grain legume in Pakistan being cultivated on 1104 thousand hectares with an annual production of 1234 thousand tons (GOP, 2016-17), with a major contribution from Punjab province. In Punjab, it is predominately cultivated rainfed crop in Thal region (Khushab, Mianwali, Bhakkar, Layyah and Jhang districts) on sandy soils with residual soil moisture conserved during monsoon season. In another study, it was reported that that drought stress alone is the reason for 50% reduction in chickpea yield (Hosseinzadeh *et al.,* 2016). The rapid growth stage of this plant coincides with the time in which the level of moisture in the soil decreases significantly (Rahbarian *et al.,* 2011). Late season drought stress during flowering, pod formation and grain filling stages, is major abiotic stress which reduces chickpea yield capacity (Molina *et al.,* 2008; Sabaghpour *et* *al.,* 2006). Therefore, studies are needed to increase the effective use of the water available. It is important to elucidate the drought tolerance mechanism of these species in order to improve its agronomic performances (Subbarao *et al.,* 1995). Status of mineral nutrients in plants plays a critical role in increasing plant resistance to drought stress (Marschner 1995).

The management of plant nutrients is very useful to develop plant tolerance to drought. Better plant nutrition can effectively alleviate the adverse effects of drought by a number of mechanisms (Farooq *et al.,* 2009; Waraich *et al.,* 2011). Potassium (K) is reported to improve plant's resistance against drought stress (Marschner 1995) and can alleviate water shortages in many legume crops (Kurdali *et al.,* 2002, Kurdali and Al-Shammaa, 2010). This is attributed to its role in cell turgor control and metabolic activity (Beringer *et al.,* 1983). Foliar application of K is known to improve the drought tolerance of cereals and led to improved growth and yield components (Aown *et al.,* 2012). Similarly, foliar application of potassium nitrate at vegetative growth stages had also augmented growth parameters, yields and yield components of pulses under drought conditions (Thalooth *et al.,* 2006). Therefore, the present study was planned to evaluate the potential of K to ameliorate the adverse effect of drought stress on chickpea.

MATERIALS AND METHODS

Growth conditions and treatments: A pot experiment was carried out to assess the effect of foliage applied K in improving the drought tolerance in chickpea at greenhouse College of Agriculture, BZU, Bahadur Campus Layyah Pakistan. Chickpea variety Noor-2009 was used as an experimental material that was obtained from Arid Zone Research Institute Bhakkar Pakistan. The 10 seeds were sown in each pot (15.5 cm in diameter, 60 cm in height) having 12 kg of the well ground and fine sandy soil. The 5 plants per pot were maintained.

The effects were evaluated in terms of two factors; the first factor was different levels of drought stress *viz* 100%, 50% and 25% field capacity and the second factor was potassium application *viz* 0, 100 mM, 150 mM. Foliar application of K was done in the evening between 6 and 9 p.m and 10 mL volume was consumed for each pot in each time. The pots were arranged in a completely randomized design (CRD) in a factorial arrangement with four replications.

Growth characteristics: Fifteen days old seedling of chickpea was cut from the soil surface and the roots were washed to make them free from the soil. Root and shoot lengths and fresh weights were measured. The samples were then oven-dried at 75ºC till a constant weight for dry weights of root and shoot. The root-shoot ratio was calculated on a dry weight basis. Root and shoot dry weights were pooled and total dry biomass weight was also calculated.

Statistical analysis: Data collected on all parameters were analyzed statistically by using Fisher's Analysis of Variance technique. Least Significant Difference (LSD) test at 5% probability level was applied to compare the treatments' means (Steel *et al.,* 1997).

RESULTS AND DISCUSSION

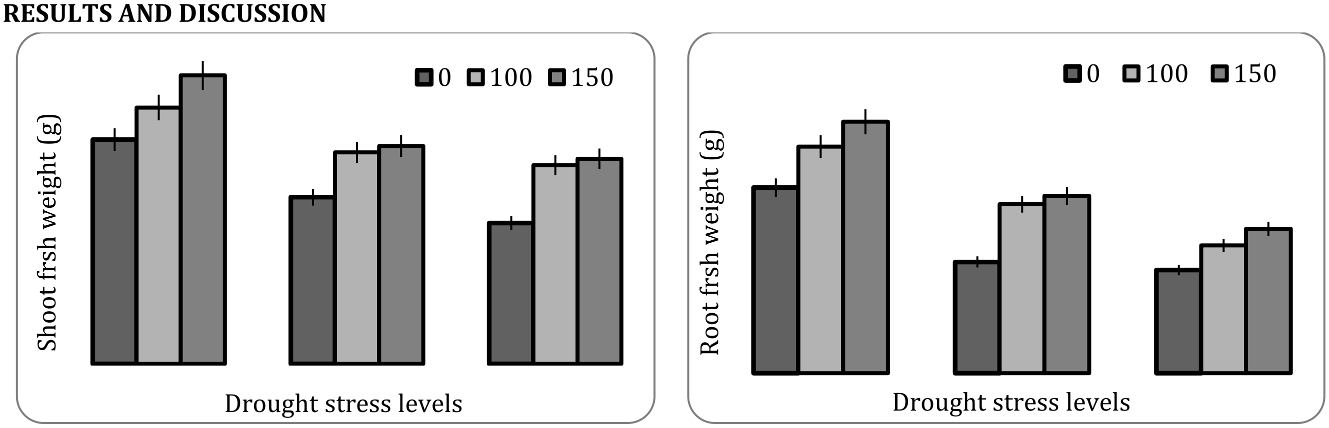

Figure1. Influence of foliage applied potassium on shoot fresh weight and root fresh weight of chickpea under drought stress.

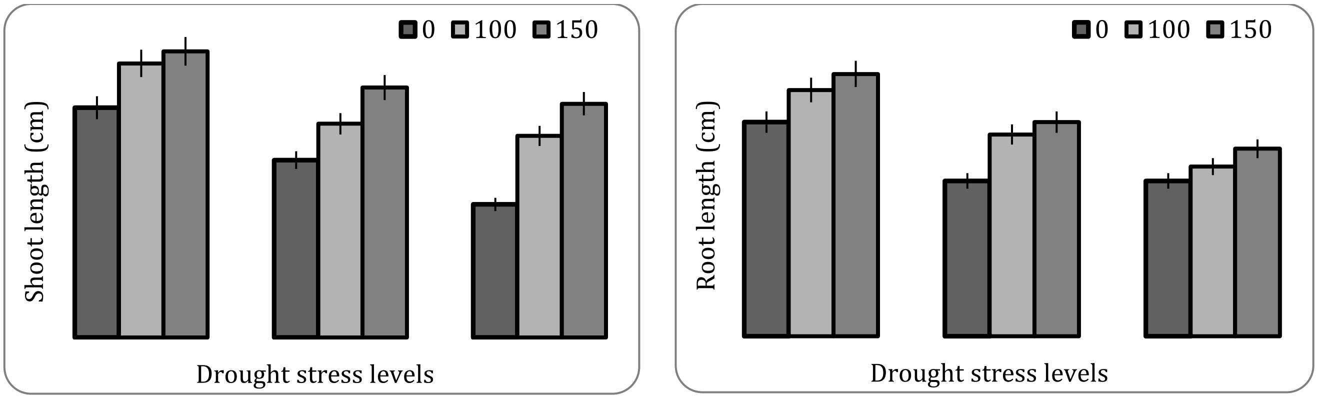

Figure2. Influence of foliage applied potassium on shoot length and root length of chickpea under drought stress.

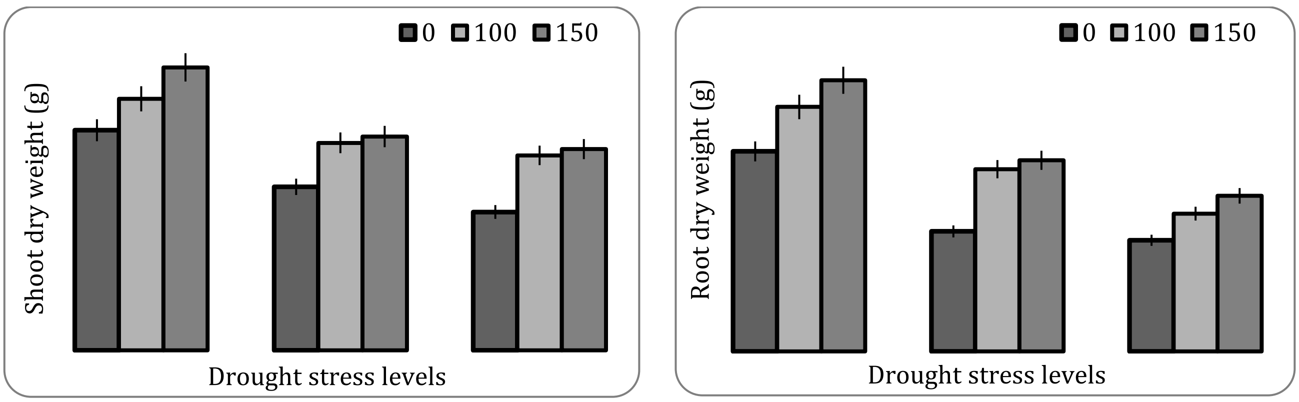

Figure3. Influence of foliage applied potassium on shoot dry weight and root dry weight of chickpea under drought stress.

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