Bulletin of Environmental and Scientific Research
ISSN 2278-5205, Available online at http://www.besr.org.in
Vol. 4, Issue(1-2),pp.29-32
Received: 13 July 2014 / Accepted: 09 November 2014

Variability in response of Chickpea (*Cicer arietinum*) to salt stress on enzymatic activity

[1]Akanksha Bhardwaj, [1]K.A.Varshney and [2⋆]Nitin Kumar Sharma

[1]Bareilly College, Bareilly, Uttar Pradesh, India

[2]Savita Sankul, Near Iscon County,Boriavi Road Boriavi, Anand, Gujarat, India

⋆Email corresponding author: dr.nitinsharma1982 @gmail.com

Abstract

Soil salinity adversely affects majority of biochemical processes in plants. In the present study, the enzymatic activity at different levels of electrical conductivity in soil was studied in Chickpea (*Cicer arietinum*), in order to understand the mechanism of salt tolerance and evaluate the effects on the yield. Salinity was found to inhibit the activity of both Nitrate reductase as well as total nitrogen. Whereas nitrite reductase and nitrogenase were observed to be incensed in their activity. The study with sodium chloride salinity was chosen as the North belt of Uttar Pradesh (India) was found saline. Saline ground water and soils are dominated by either chloride or sulphate salts. The chemical analysis of soil and plant samples collected from a range of sites at Rohilkhand, India indicated that the enzyme activity in Chickpea was more sensitive to chloride-dominated saline water irrigation as compared with sulphate-dominated.

Keywords: *Salinity; Enzyme activity; Soil quality; Chickpea*

1 Introduction

Chickpea (*Cicer arietinum*) is the most important pulse crop of the arid and semi-arid areas. In India, it is cultivated during winter, depending on soil moisture stored from the preceding summer rain, which is often inadequate to ensure a satisfactory crop. Among agricultural practices, cultivation of crops is the most common and practiced worldwide. During their growth, crop plants are usually exposed to different environmental stresses which limit their growth and productivity. Among these, salinity and drought are the most sever once especially in arid and semi arid agro ecology (Moud and Maghsoudi, 2008). Several Researchers indicated that salinity is one of the major stresses, especially in arid and semi-arid regions, which severely limit crop production (Shannon, 1998; Greenway and Munns, 1980; Mano and Takeda, 1997; Shannon, 1985). Furthermore, salinity impairs seed germination, reduces nodule formation, retards plant development and reduces crop yield (Greenway and Munns, 1980). The effect of salinity on germination of seeds can be either by creating osmotic potential which prevent water uptake or by toxic effects of ion on embryo viability of the seeds (Houle et al., 2001). In addition to these, shoot growth is also reduced by salinity due to the inhibitory effect of salt on cell division and enlargement in the growing point (Kaymakanova, 2009). Since crop plants are affected by the concentration of salt in the soil or water, their productivity is also affected with severe reduction in the expected yield. Farmers all over the world face salinity problems. Worldwide, salinity affects 100 million hectares of arable lands and this area is expanding (Ghassemi et al.,1995). The investigation was based on the response of NaCl salinity on chickpea to determine interacts and influence salt tolerance. This information will be important when deciding fertilizer applications in saline areas or in areas where wastewater (containing high salinity levels) are used for irrigation.

2 Materials and methods

Seeds of chickpea of two varieties Pragati, DPC92-3 and Jyoti,BR17 were procured from Genetic Resource Unit, International Crop Research Institute for the Semi-Arid Tropics (ICRITSAT), Patancheru (AP) and G.B. Pant University of agriculture and technology, Pantnagar (UA) India. 16 soils samples were analyzed for following physical and chemical parameters viz., electrical conductivity, sodium (Richards 1954), potassium Williams (1941), calcium and magnesium Cheng and Brey (1951) by using spectrophotometer, and chloride Reitemeier (1943) by silver nitrate titration using an ion selective electrode. The enzymes nitrate reductase activity was determine by followed the method of Wallace and Pate (1965), nitrite reductase activity, nitrogenase Hardy et al., 1968 and total nitrogen Snell and Snell, 1955 of plant material was analyzed at three stages germinating, flowering and maturity.

3 Results and discussion

The analysis of soil analysis showed that pH of soil samples ranged from 4.0-5.8; the electrical conductivity of soil saturation extract was found to be about 4.1 mS cm^{-1} at 25 ° C. As is obvious from the results among different cations investigated the maximum was contributed by sodium ions i.e., some of the samples exceeded 60 meq/l, followed by calcium and magnesium displaying between 33.25 and 53.05 meq/l. However, potassium ions were recorded to be in least concentrations i.e. between 0.33 and 2.37 meq/l (Fig. 1). On the other hand, the maximum was contributed to the extensively accumulated soluble salts by chloride anions

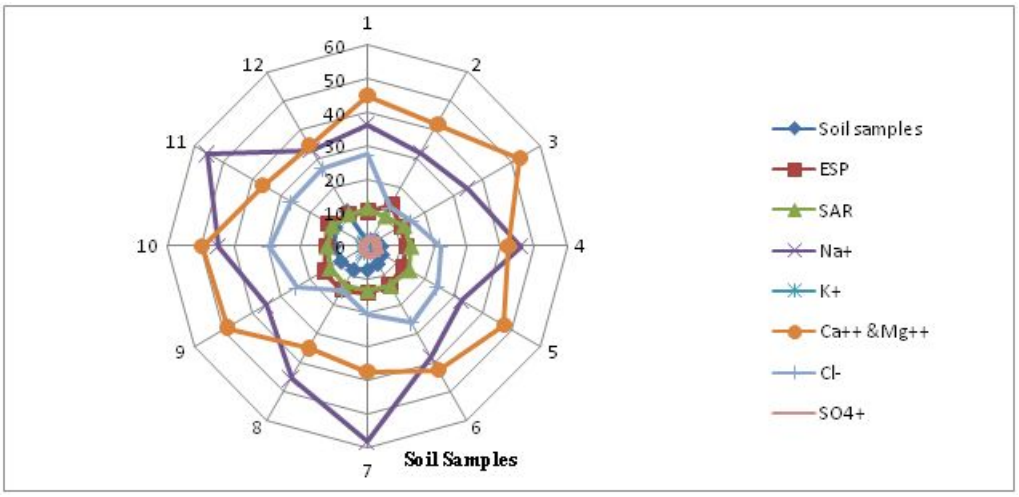

Figure 1: Parameters affecting soil of Uttar Pradesh. (Values are in soil saturation extract)

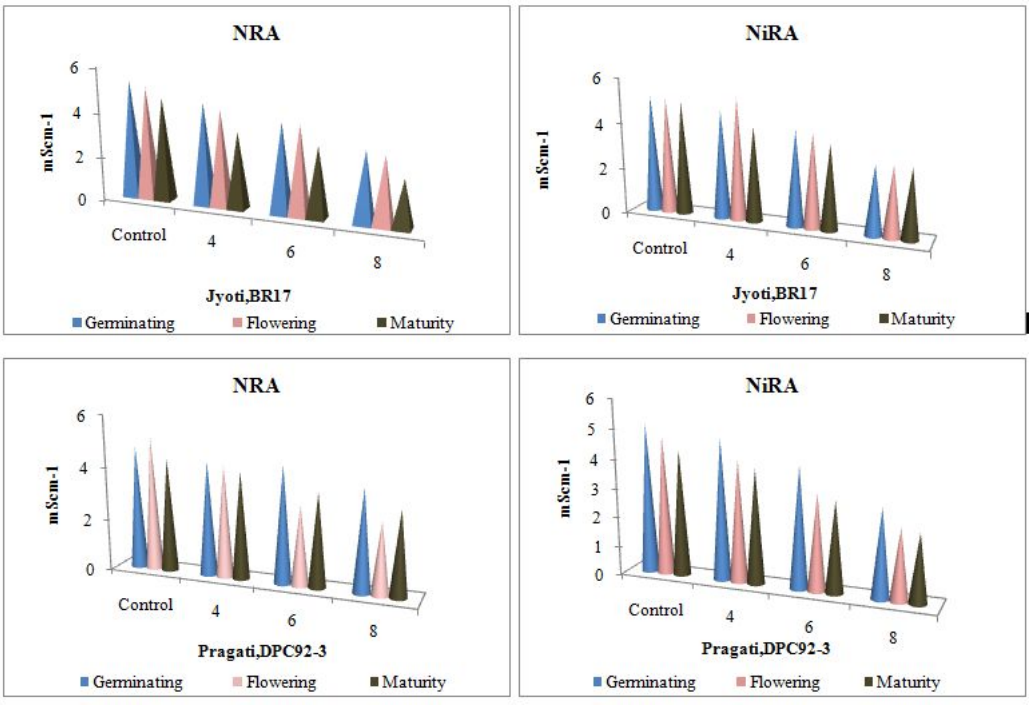

Figure 2: Nitrate and Nitrite Reductase Activity (Jyoti,BR17/ Pragati,Dpc92-3)

measuring 13.5- 29.3 meq/l (Fig.1).

3.1 Nitrate Reductase Activity (NRA)

NaCl salinity is introverted at the three stages of growth studied. NRA was recorded maximum at germinating stage followed by flowering and minimum in mature plants. Var. Jyoti,BR17 demonstrated NRA relatively higher than salt susceptible Var. PRAGATI,DPC92-3 in mature plants only. Under 4 mS cm^{-1} Ece treatment NRA decreased by 14% at germinating over control were recorded 25.2 % and 21.9% at both germinating and flowering, respectively. Similarly 8 mS cm^{-1} Ece the percentage reduction over control were recorded 40.9% and 40.7% at two growth stages respectively. On the other hand, in variety PRAGATI,DPC92-3 the NRA reduced by 23.7%, 16.2% and 6.27% under 4 mS cm^{-1} Ece; 28.8%, 41.0% and 31.2% under 6 mS cm^{-1} Ece and by 44.2%, 46.3% and 43.7% under 8 mS cm^{-1} Ece at their growth stage respectively (Fig.2). Nitrate Reductase is the key enzyme in the process of nitrate utilization, a significant step in plant growth, protein metabolism and yield is often correlated with nitrogen status of plant (Mishra and Srivastav, 1983).

3.2 Nitrite reductase activity (NiRA)

The activity of nitrite reductase (NiRA) was observed more in Var. Jyoti,BR17 than in Var. IGFRI-S-54. However, the suppression took place more in later under 4 mS cm^{-1} the enzyme activity was reduced by 8.6%, 15.4% and 16.4% over control in plants of Var. Jyoti,BR17 at leafy, flowering and maturity stage. Under 6 mS cm^{-1} it is 20%, 19.7% and 26.5% over control; and under the influence of 8 mS cm^{-1} Ece the activity went down by 42%, 40.9% and 39.7 % over control at three stages studied (Fig.2). In Var. PRAGATI,DPC92-3 the activity of NiRA hampered by 6.2%, 13.0% and 9.06% over control under 4 mS cm^{-1} Ece at the selected stages. As regards the treatment of 6 mS cm^{-1} Ece, the activity of NiRA reduced by 20%, 31.1% and 28.4% and under 8 mS cm^{-1} Ece was recorded 41.6%, 49.3% and 46.1% over control at three growth stages respectively.

3.3 Nitrogenase activity

The nitrogenase activity was observed in increasing under increasing Ece levels of NaCl salinity. It was recorded in more Var. Jyoti,BR17 than Var. IGFRI-S-54. It was exhumed from the results portrayed in Fig. 2. That nitrogenase activity enhanced by 10.8% under 4 Ece; 56.5% under 6 Ece and 82.6 over control under 8 mS cm^{-1} Ece in Var. Anand II. In case of salt susceptible Var. PRAGATI,DPC92-3 values were observed 4.3%, 20.2% and 81.1% over control (Fig.3).

As regards the role of nitrogenase activity it enhanced the increasing soil salinity. Similar finding was made earlier Rigaud (1981) and Sawhney et al.(1998).

3.4 Total nitrogen

Alfalfa plant found good source of proteinaceous fodder for milch cattle. Therefore, the effect of NaCl salinity was examined on total nitrogen contents. It was observed that salinity brought about a mark decreation in

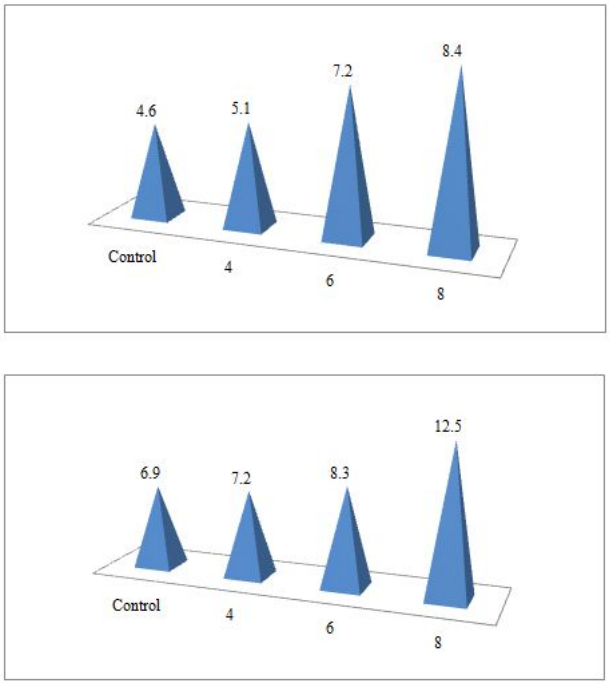

Figure 3: Nitrogenase activity (5 increase over control)

total nitrogen in both the varieties. The adverse effect of salinity on total nitrogen was recorded more in susceptible Var. PRAGATI,DPC92-3 than in tolerant Var. Anand II. Except in mature plant matured by 8 mS cm^{-1} Ece solution. The depleted percentage of total nitrogen in Var. Jyoti,BR17 was found 73.4%, 86.2% over in control in Var. PRAGATI,DPC92-3 under 8 mS cm^{-1} Ece at germinating; 49.6% against 83.8% over control at flowering stage; and 78.7% against 69.2% over control in mature plant under same level of salinity (Fig. 4).

Salinity induced flowering nitrogen contents might be due to hydrolysis of proteins into amino acids and locking up of nitrogen into some amino acids which act as osmolytes in the tissues. Our findings are in agreement with lots of workers Singh and Jain (1982) Gill and Dutt (1987). Seeman and Critchley (1985) have reported rapid stomatal closure leading into reduced rate of photosynthesis under saline conditions. Thus, it may be proposed that short supply of carbohydrates to root nodules enhance the rate of N_2 fixation by bacterioids via increased nitrogenase activity. Safaraliev,1984 hass correlated reduced activity of nitrogenase reductase and NiRA with dissociation of FAD. According to the work Trogish et al., 1989 reduction in NAR and NiRA is due to reduced supply of substrate to active site of enzymes resulting from inhibition of nitrate uptake i.e. depletion of endogenous nitrate pool.

4 Conclusion

From the results of this study, it can be concluded that for this particular condition, application of full water requirement of plants is economical. A perusal of results disinterred that both nitrate and nitrite reductase activity in green leaves declined in relation to NaCl salinity. The antagonistic effect of salinity was recorded more in

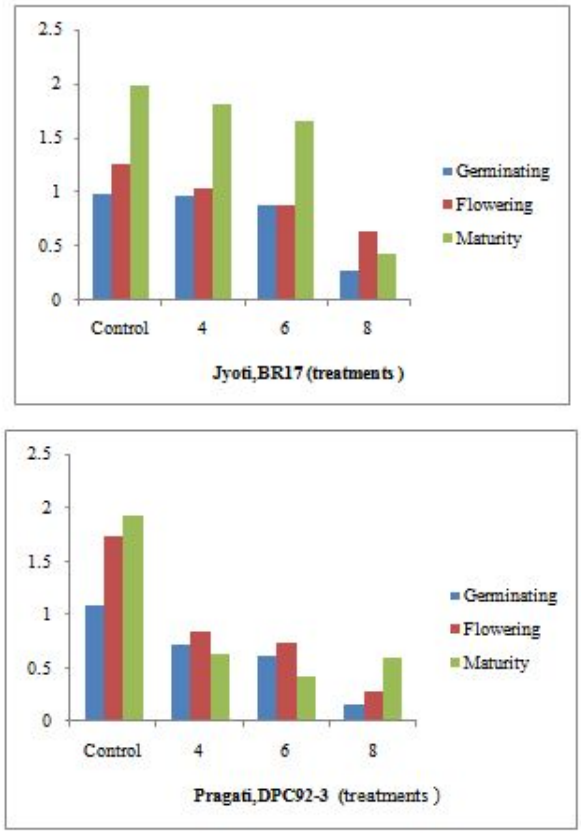

Figure 4: Total Nitrogen

case of NRA than NiRA. Activity of key enzyme nitrogenase of nitrate and nitrite reduction in the nodules of plants was found increasing due to salinity.

References

Cheng, K.L., Brey, R. H. 1951. Determination of Ca and Mg in soil and plant material. Soil Sci. 72 : 449-458.

Ghassemi F, Jakerman AJ, Nix HA. 1995. Salinization of land water resources. Wallingford: CAB International.

Gill, K. S., Dutt, S. K. 1987. Physiological aspects of salt tolerance. Effect of salinity on germination, grain yield, quality and chemical composition in barley. Sci. Cult., 48: 323-325.

Greenway H., Munns R. 1980. Mechanisms of salt tolerance in nonhalophytes. Annual Review of Plant Physiology 31, 149–190.

Hardy, R. W. F., Holston, R. D., Jackson., E. K. and Burns, R.C. 1968. The acytelene-ethylene assay for N2 fixation, laboratory and field evaluation. Annual. Review of Plant Physiology, 43 : 1185-1207.

Hewitt, E.J., 1975. Assimilatory nitrate-nitrite reduction. Annual. Review of Plant. Physiology., 26 : 73-100.

Houle GL, Morel L, Reynolds CE, Seigel J. 2001. The effect of salinity on different developmental stages of an endemic annual plant, Asterlaurenti anus. American Journal of Botany. 88:62-67.

Kaymakanova, M., 2009. Effect of salinity on germination and seed physiology in bean (Phaseolus vulgaris L.). Biotechnol. Biotechnol. Equipment, 23: 326-329

Y., Takeda. K.1997. Mapping quantitative trait loci for salt tolerance at germination and the seedling stage in barley (Hordeum vulgare L.). Euphytica, 94: 263-272.

Mishra, S.N., Srivastav, H. S, 1983. Role of inorganic nitrogen in the synthesis and degradation of chlorophyll and cartenoids in maize leaves. Biologia Plantarum, 25: 21-27.

Moud Aliakbar M., Maghsoudi Kobra , 2008. Application of Coleoptile Growth Response Method to Differentiate Osmoregulation Capability of Wheat (Triticum aestivum L.) Cultivars. Research Journal of Agronomy, 2: 36-43.

Reitemeier, R. F. 1943. Semi-micro analysis of saline solutions. Indus journal of Chemistry., Analytic Ed. 15; 393-402

Richards, L.A. 1954. Diagnosis and improvement of saline alkaline soils. Agricultural Handbook. USDA, Washington D.C.

Rigaud J. 1981. Comparison of the efficiency of nitrate and nitrogen fixation in cropyield. In nitrogen and carbon metabolism. J. B. Bewley. Ed. 17-48. Nihoff. The Hauge.

Safaraliev, P. N. L'ouv, N. P., Mandanar, A. A. and Kretorich, V. L., 1984. On the causes of decreased nitrate reductase activity in legumes under saline conditions. Fiziologiya Rastenii., 31 : 658-65.

Sawhney, V., Sheoran, I.S. Singh, R.,. 1998. Effect of nitrate application on nitrogen fixation and nodule metabolism in Cafarius ceyen. Plant Physiology., (Paris) 26: 753-760.

Seeman, J. R., Critchley. C., 1985. Effects of salt stress on the growth, ion content, stomatal behavior and photosynthetic capacity of salt sensitive species, Phaseolus vulgaris. L. Biologia Plantarum., 164: 151-162.

Shannon MC., 1985. Principles and strategies in breeding for higher salt tolerance Plant and Soil-89,227–241.

Singh, G. Jain, S., 1982. Effect of some growth regulators on certain biochemical parameters during seed development in chickpea under salinity. Indian J. Plant Physiol. 25: 167-79.

Snell, F. D. Snell, C. T. 1955. Colorimetric methods of analysis. Vol. III.A. 101.

Trogish, G. D., Kocher, H., Ullerich, W.R.. 1989. Effect of glucosinate on anion uptake in Lemna gibba. Naturo fresh., 44 : 33-38.

Wallace, W., Pate, J. S. 1965. Nitrate reductase in field pea (Pisum parvense L.). Annals of Botany. 29: 655-671.

Williams, W.O, 1941. Rapid determination of potassium with dipicrylamine. Amer. Soc. Hort. 28: 337-351.