ISSN 0975-6299

Vol 2/Issue 2/Apr-Jun 2011

International Journal of Pharma and Bio Sciences

RESEARCH ARTICLE

BIO CHEMISTRY

VARIABILITY IN RESPONSE OF INDIAN FODDER LEGUME (*Medicago sativa*) TO SALT STRESS ON PHYSIOLOGICAL ATTRIBUTES

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ABSTRACT

Several biochemical processes of plants are affected adversely by soil salinity. In order to understand the mechanism of salt tolerance in *Medicago sativa L.* (Lucerne) an important fodder legume, present study was sought on enzyme activity at different levels of electrical conductivity of soil. Nitrate reductase activity and total nitrogen was inhibited by salinity. Where nitrite reductase and nitrogenase activity were observed increasement in their activity. The study with NaCl salinity was chosen as the North West belt of Uttar Pradesh (India) was found saline. It was done by chemical analysis of soil and plants collected from various sites of Rohilkhand division (Bareilly, UP).

KEY WORDS

Salinity, Enzyme activity, Alfa alfa Plant, soil quality.

INTRODUCTION

Soil structure is linked to hydraulic conductivity [1] ; interactions between structural and hydraulic characteristics are complex [2] established their links with salinity and sodicity [2]. However the magnitude of salt stress effects varies with the plant species, types and its levels [3]. Nutrition can significantly influence a plant's response to saline conditions [4]. The interaction between salinity is particularly complex and plant responses can vary according to which species or cultivar is being examined, the stage of plant growth as well as the level and form of NaCl and the specific conditions of the experiment [5]. Lucerne (*Medicago sativa* L.) is a species whose tolerance to NaCl alone has been well-studied [6] , however its performance under saline conditions. Excess salts in the soils adversely affect the crop growth and yield [7, 8, 9].

Both salinity and sodicity impose a significant limitation on productivity by adversely affecting the host plants, root nodules bacteria, symbiotic development and N_2 fixation capacity[10, 11]. High salt levels in effluent can have both direct and indirect effects on themetabolic and growth processes of the plants. Direct stresses include damage to the cytoplasm of plant cells, and ion toxicity and nutrient imbalances. Of the indirect effects, perhaps the biggest problem is with high soluble salt content in the soil that causes physiological drought. This is when salt levels in soil solution are high enough to cause a negative osmotic effect that limits the ability of the turfgrass to take up water.

The purpose of this study was to investigate the response of lucerne to the effects of NaCl to determine how these effects interact to influence salt tolerance. This information may be of importance when deciding fertilizer applications in saline areas or in areas where wastewaters (containing high salinity levels) are used for irrigation.

MATERIALS AND METHODS

Seeds of alfalfa (*Medicago sativa* L.) of two varieties Anand II and IGFRI-S-54 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.

Twelve soils samples were analyzed for electrical conductivity [12], sodium [12], potassium[13], calcium and magnesium [14] by using spectrophotometer, and chloride [15] by silver nitrate titration using an ion selective electrode.

The enzymes nitrate reductase activity [16], nitrite reductase activity, nitrogenase [17] and total nitrogen [18] in plant material was analyzed at three stages leafy stages, flowering stage and mature stage.

RESULTS AND DISCUSSION

The results from soil analysis indicated that pH of soil samples ranged from 4.0-5.8; the electrical conductivity of soil saturation extract was found to be about 4mScm^{-1} at 25 ^{0}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 60meq/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 measuring 13.5- 29.3 meq/l (Fig., 1).

Nitrate reductase activity (NRA)

Nitrate reductase enzyme activity inhibits due to NaCl salinity at all the three stages of growth studied. NRA was recorded maximum at leafy stage followed by flowering stage and minimum in mature plants. Salt tolerant Var. Anand II demonstrated NRA relatively higher than salt susceptible Var. IGFRI-S-54 in mature plants only. Under 4mScm^{-1} Ece treatment NRA decreased by 14% at leafy stage over control were recorded 25.2 % and 21.9% at both leafy stage and flowering stage, respectively. Similarly 8mScm^{-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 IGFRI-S-54 the NRA reduced by 23.7%, 16.2% and 6.27% under 4mScm^{-1} Ece; 28.8%, 41.0% and 31.2% under 6mScm^{-1} Ece and by 44.2%, 46.3% and 43.7% under 8mScm^{-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 [19] is often correlated with nitrogen status of plant [20].

Nitrite reductase activity (NiRA)

The activity of nitrite reductase (NiRA) was observed more in Var. Anand II than in Var. IGFRI-S-54. However the suppression took place more in later under 4mScm^{-1} the enzyme activity was reduced by 8.6%, 15.4% and 16.4% over control in plants of Var. Anand II at leafy, flowering and maturity stage. Under 6mScm^{-1} it is 20%, 19.7% and 26.5% over control; and under the influence of 8mScm^{-1} Ece the activity went down by 42%, 40.9% and 39.7 % over control at three stages studied(Fig., 3).

In Var. IGFRI-S-54 the activity of NiRA hampered by 6.2%, 13.0% and 9.06% over control under 4mScm^{-1} Ece at the selected stages. As regards the treatment of 6mScm^{-1} Ece, the activity of NiRA reduced by 20%, 31.1% and 28.4% and under 8mScm^{-1} Ece was recorded 41.6%, 49.3% and 46.1% over control at three growth stages respectively.

Nitrogenase activity

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

As regards the role of nitrogenase activity it enhanced the increasing soil salinity. Similar finding was made earlier [21, 22].

Total nitrogen

Alfalfa plant found good source of proteinaceous fooder 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 total nitrogen in both the varieties.

The adverse effect of salinity on total nitrogen was recorded more in susceptible Var. IGFRI-S-54 than in tolerant Var. Anand II. Except in mature plant matured by 8 mScm^{-1} Ece solution. The depleted percentage of total nitrogen in Var. Anand II was found 73.4%, 86.2% over in control in Var. IGFRI-S-54 under 8mScm^{-1} Ece at leafy stage; 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.

Salinity induced lowering 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 [23, 24]. Some of workers[25] 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. By some workers [26] have correlated reduced activity of nitrogenase reductase and NiRA with dissociation of FAD. According to the work [27] reduction in NAR and NiRA is due to reduced supply of substrate to active site of enzymes resulting from inhibition of nitrate uptake ie; depletion of endogenous nitrate pool.

Fig. 1

Different parameters soil effected soil of Uttar Pradesh. (Values are in soil saturation extract)

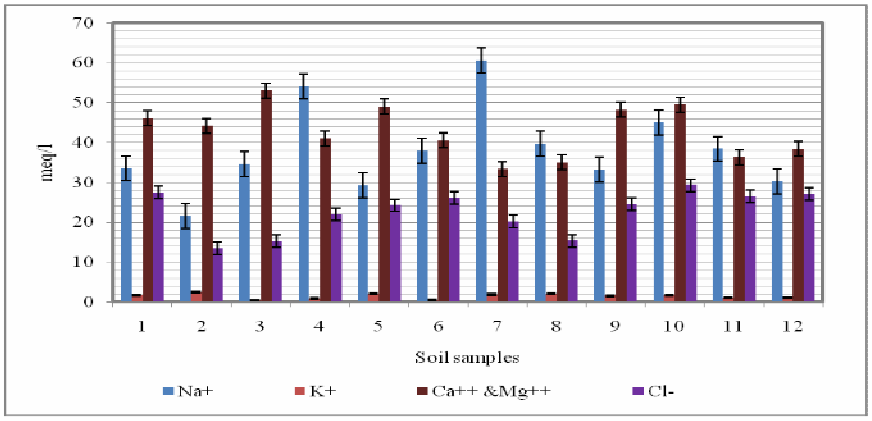
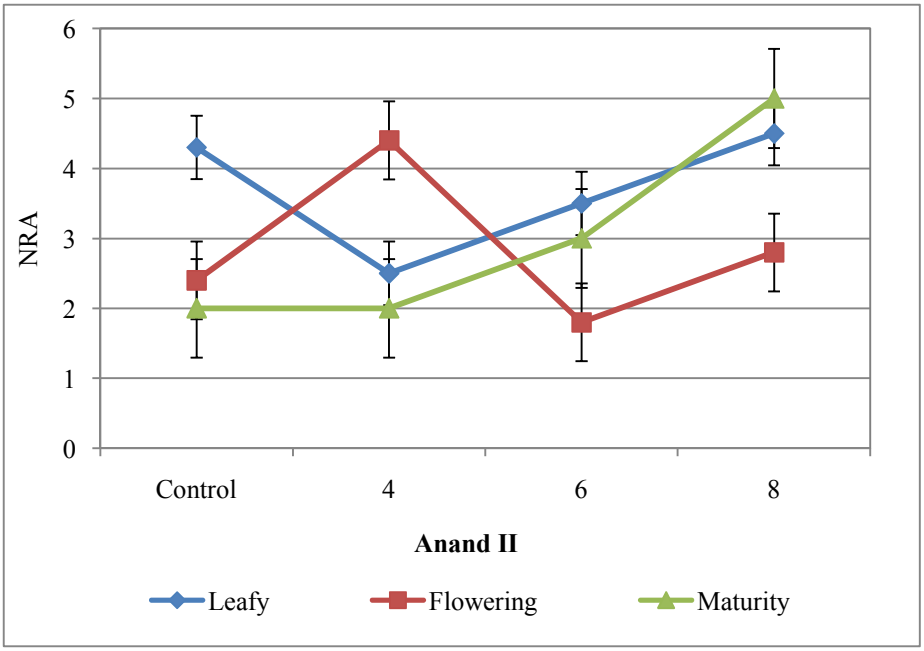


Fig. 2
Nitrate reductase activity



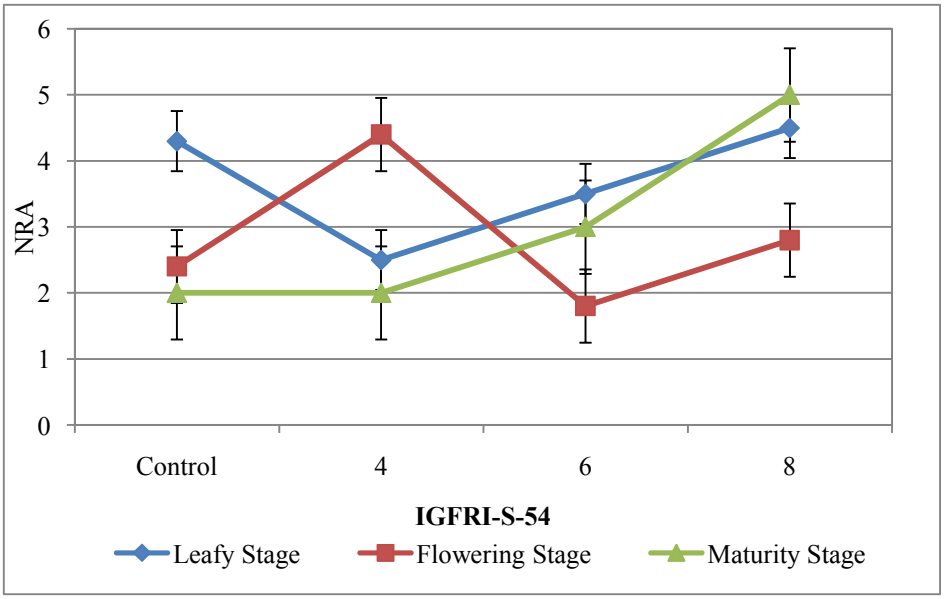
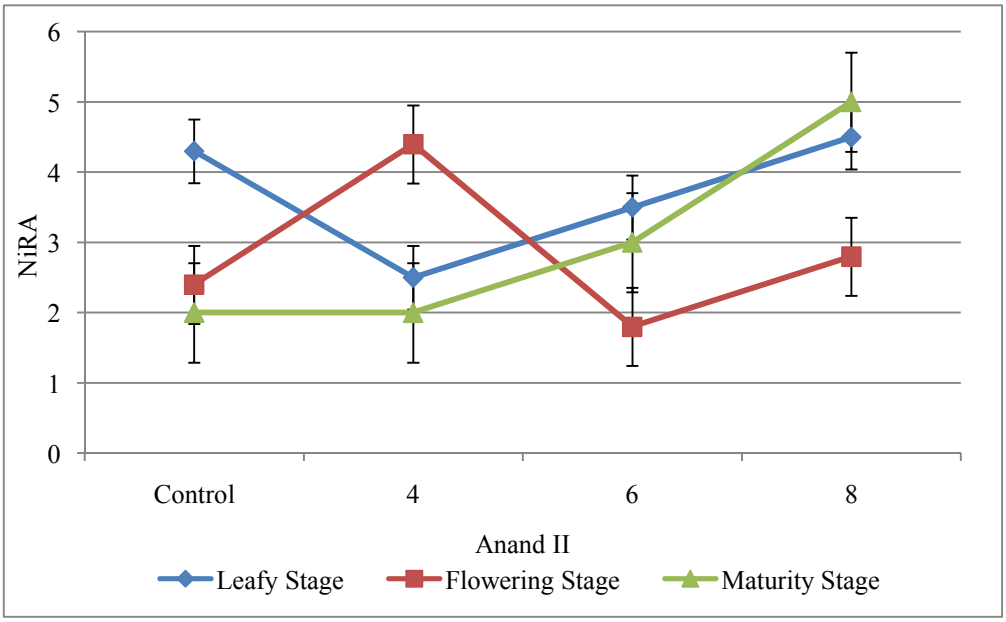


Fig. 3
Nitrite reductase activity



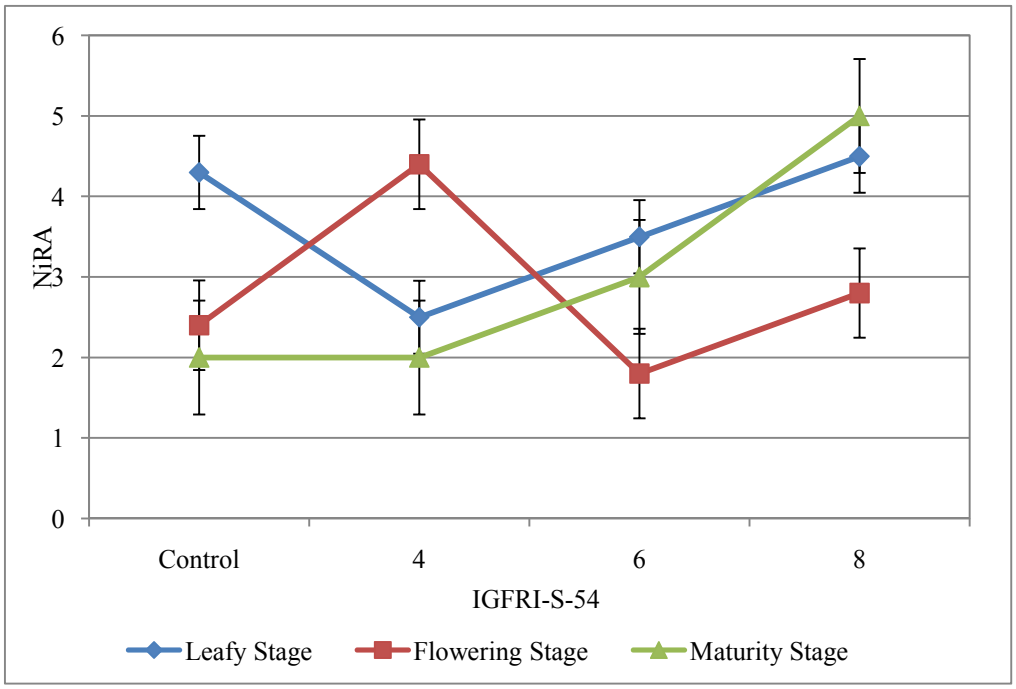
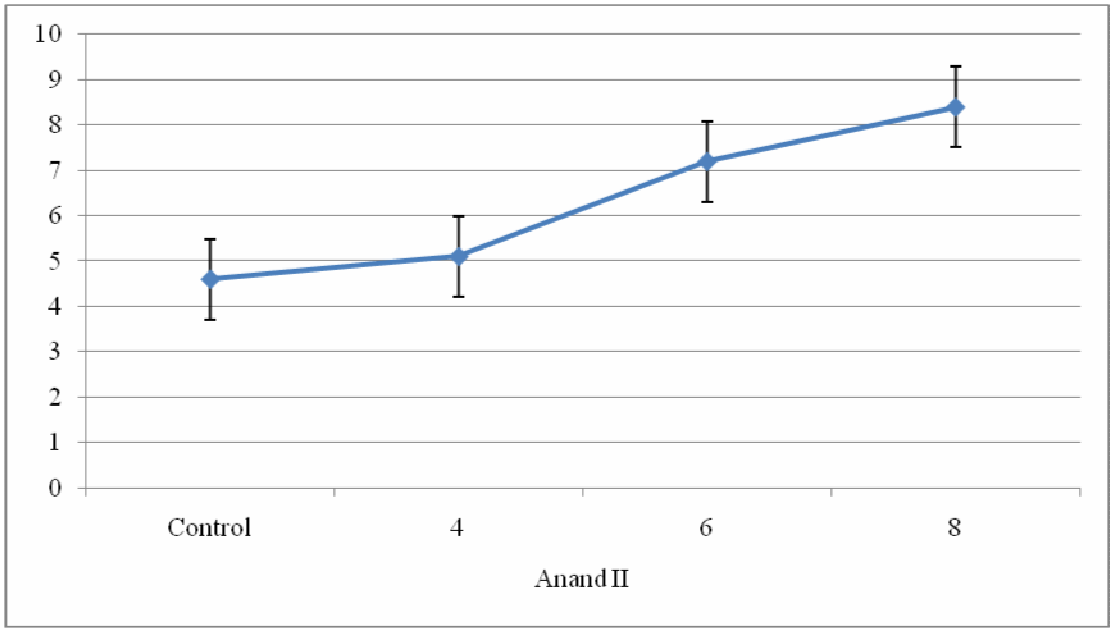


Fig. 4
Nitrogenase activity



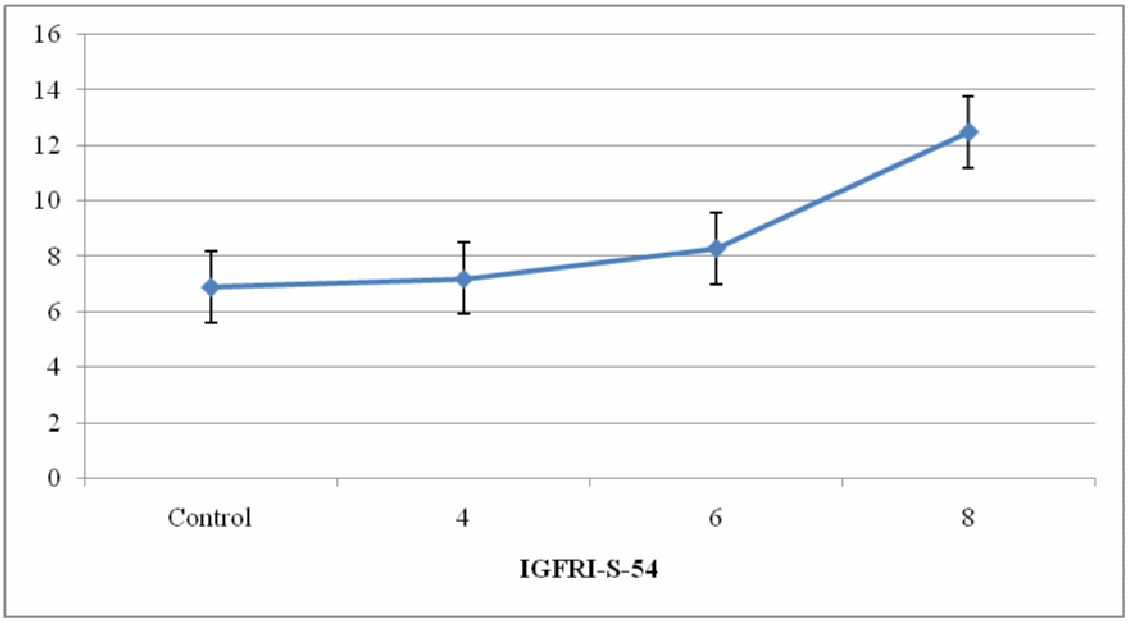
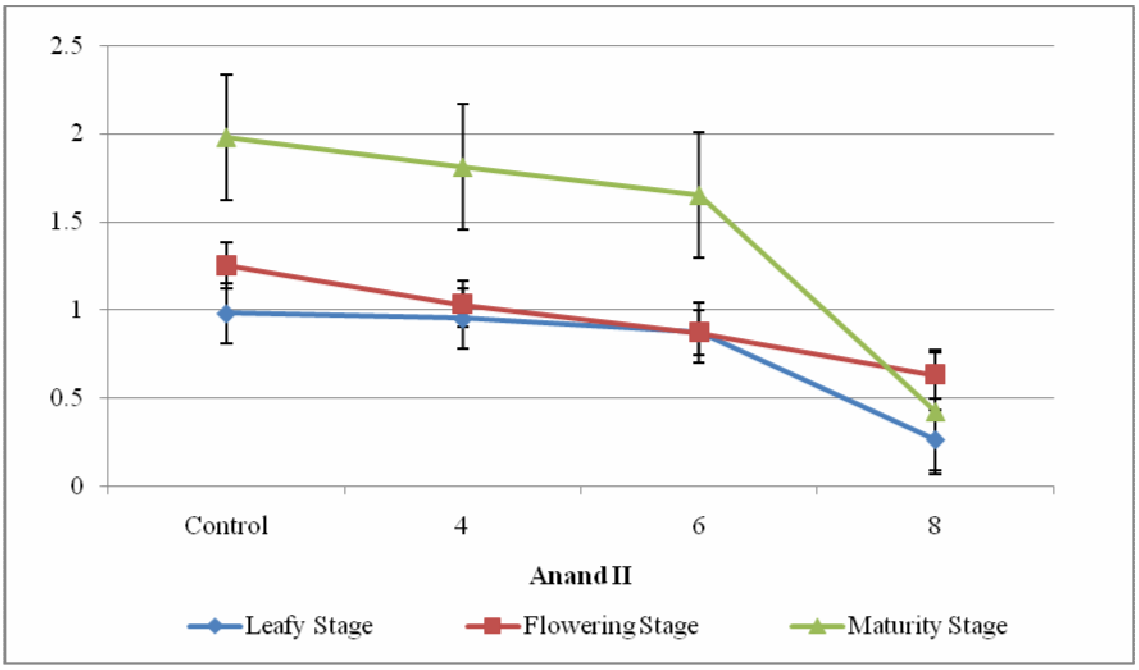
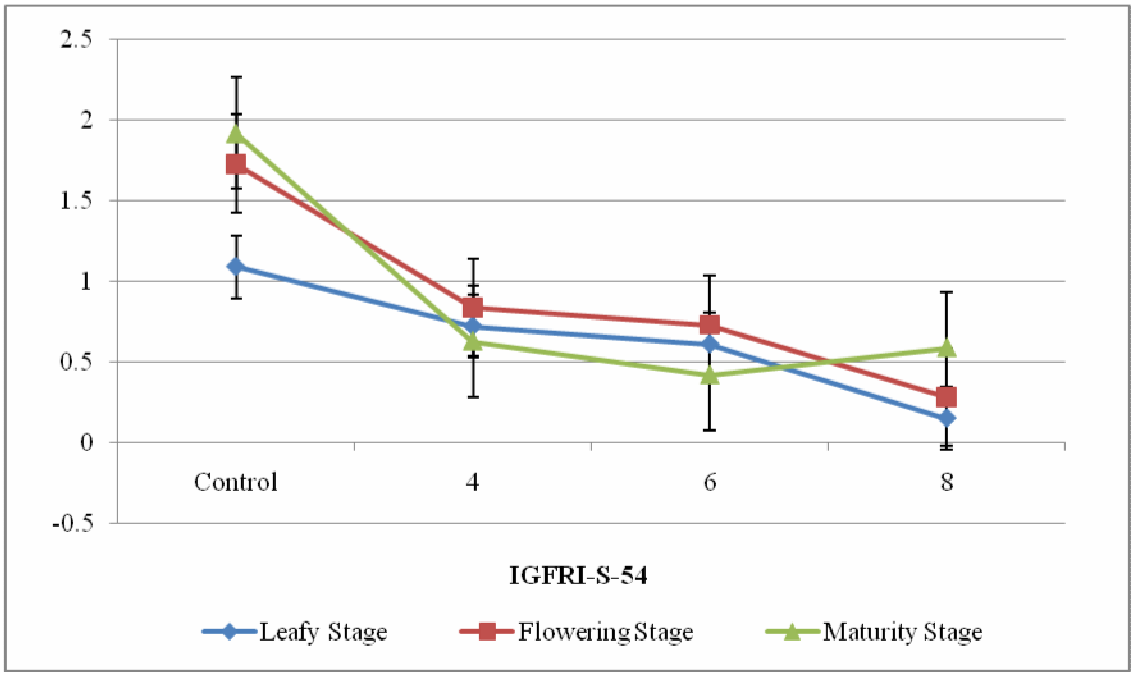


Fig. 5
Total nitrogen





REFERENCES

1. Abu-Sahrar, T. M., Bingam, F. T. and Rhoades, J. D., Reduction in hydraulic conductivity in relation to clay dispersion and disaggregation. Soil Sci, Soc. Am. J., 51: 342-346, (1987).
3. Fitzpatrick, R. W., Boucher, S.C., Naidu, R. and Fritsh, E, Environmental consequences of soil sodicity. Aust. J. Soil Res., 32 : 1069-1093, (1994).
3. Bishnoi, N. R. Siddiqui, S., and Kumar, S.,. Effect of salinity, salinization and desalinization on the various aspects of dry matter production at vegetative stage in pea and gram. Front. Bot., 1 : 1-11, (1987).
4. Grattan, S. R. and Grieve, C. M., Sci. Hort. 78, 127-157, (1999).
5. Champagnol, F., Phosphorus Agri. 76, 3-43, (1979).
6. Johnson, D.W., Smith, S. E. and Dobrenz, A. K., Theor. Appl. Gen. 83, 833-838 (1992).
7. Eaton, Toxicity and accumulation of chloride and sulphate salts in plants. J. Agri. Res., 64: 357-399, (1942).
8. Gauch, H. G and Wadleigh, C. H, The salt tolerance and chemical composition of Rhodes and Dallis grass grown in sand culture. Bot. Gazatte. 112 : 259-271, (1951).
9. Stronogov, B. P., Structure and function of plant cell in saline habitats. Willey Publication, London. 284, (1974).
10. Yousef, A. N. and Sprent, J. I.,. Effect of NaCl on growth nitrogen incorporation and chemical composition of inoculated and ammonium nitrate fertilized *Vicia faba* L. plants. J. Exp. Bot., 143: 941-950, (1982).
11. Zahran, H. H. and Sprent, J. I , Effect of sodium chloride and polyethylene glycol on root hair infection and

nodulation of *Vicia faba* L. plants. Planta., 167: 303-309, (1986).
12. Richards, L.A., Diagnosis and improvement of saline alkaline soils. Agricultural Handbook. USDA, Washington D.C., (1954).
13. Williams, W.O, Rapid determination of potassium with dipicrylamine. Amer. Soc. Hort. 28: 337-351, (1941).
14. Cheng, K.L and Brey, R. H., Determination of Ca and Mg in soil and plant material. Soil Sci. 72 : 449-458, (1951).
15. Reitemeier, R. F., Semi-micro analysis of saline solutions. Indus. Engin. Chem., Analytic Ed. 15; 393-402, (1943).
16. Wallace, W. and Pate, J. S., Nitrate reductase in field pea (*Pisum parvense* L.). Ann. Bot. 29: 655-671, (1965).
17. Hardy, R. W. F., Holston, R. D., Jackson., E. K. and Burns, R.C., The acytelene-ethylene assay for N_2 fixation, laboratory and field evaluation. Plant Physiol., 43 : 1185-1207, (1968).
18. Snell, F. D. and Snell, C. T., Colorimetric methods of analysis. Vol. III.A. 101, (1955).
19. Hewitt, E.J., Assimilatory nitrate-nitrite reduction. Ann. Rev. Plant. Physiol., 26 : 73-100, (1975).
20. Mishra, S.N. and Srivastav, H. S, Role of inorganic nitrogen in the synthesis and degradation of chlorophyll and cartenoids in maize leaves. Bio. Plant, 25: 21-27, (1983).
21. Rigaud J., 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, (1981).
22. Sawhney, V. Sheoran, I.S. and Singh, R.,. Effect of nitrate application on nitrogen fixation and nodule metabolism in *Cafarius ceyen*. Plant Physiol. Biochem., (Paris) 26: 753-760, (1998).
23. Singh, G. and Jain, S., Effect of some growth regulators on certain biochemical parameters during seed development in chickpea under salinity. Indian J. Plant Physiol. 25: 167-79, (1982).
24. Gill, K. S. and Dutt, S. K., Physiological aspects of salt tolerance. Effect of salinity on germination, grain yield, quality and chemical composition in barley. Sci. Cult., 48: 323-325, (1987).
25. Seeman, J. R. and Critchley. C., Effects of salt stress on the growth, ion content, stomatal behavior and photosynthetic capacity of salt sensitive species, *Phaseolus vulgaris.* L. Planta., 164: 151-162, (1985).
26. Safaraliev, P. N. L'ouv, N. P., Mandanar, A. A. and Kretorich, V. L., On the causes of decreased nitrate reductase activity in legumes under saline conditions. Fizol. Rast., 31 : 658-65, (1984). .
27. Trogish, G. D., Kocher, H and Ullerich, W.R.. Effect of glucosinate on anion uptake in Lemna gibba. *Naturo fresh.,* 44 : 33-38, (1989).