INTERNATIONAL JOURNAL OF AGRICULTURE & BIOLOGY
1560–8530/2003/05–2–191–193
http://www.ijab.org

Alleviation of Salinity Stress Using Bio–Power (Bio–fertilizer) in Mungbean (*Vigna radiata* L. Wilczek)

SAADIA CHUGHTAI, M. MUZAMMIL SALEEM, MUMTAZ HUSSAIN AND IRFAN AFZAL†
Departments of Botany and †Crop Physiology, University of Agriculture, Faisalabad–38040, Pakistan

ABSTRACT

A pot experiment was conducted to study the accumulation of Na^+, Cl^-, K^+ and Ca^{2+} ions by two mungbean varieties viz., NM-51 and NM-92 when subjected to three salinity levels i.e., 2.5, 3.5 and 4.5 dS m^{-1} with Bio–Power inoculation. Salinity increased Na^+, Cl^- contents including K^+ and Ca^{2+}. However, Bio–Power inoculation also increased them to some extent. Thus, Bio–Power has exerted a positive influence by increasing the accumulation of K^+ and Ca^{2+} ions for minimizing the deteriorating effect of NaCl salinity. Mungbean variety NM-92 performed better than NM-51 under saline conditions.

Key Words: Bio–Power; Salinity; Mungbean

INTRODUCTION

Salinity whether natural or induced by human is a wide spread environmental stress that can limit growth and development of salt sensitive plants (Greenway & Munns, 1980; McWilliam, 1986). Increasing salinity from human disturbance and climate change is a critical problem worldwide because it has dramatic effects on plant physiology and performance. In Pakistan, salt affected lands are estimated to be about 6.67 mha (Qureshi & Barrett-Lennard, 1998) and is mostly caused by the presence of NaCl (Mushtaq & Rafique, 1977).

In general, growth reduction due to salinity is attributed to ion toxicity, nutrient imbalance and osmotic effect. High concentration of NaCl may influence uptake and translocation of nutrients and increases the concentration of certain ions like Na^+ and Cl^- in plants (Evangelous & McDonald, 1999) resulting in the accumulation of Na^+ and Cl^- to toxic levels in wheat (Naseem *et al*., 2000) while K^+ and Ca^{2+} uptake varied depending upon the type of cultivars (Jafri & Ahmed, 1994). It is observed that concentration of Na^+ and Cl^- is higher in the tops compared to roots of cotton crop. Large quantities of salts are accumulated in leaf blades (Bhatti & Wieneke, 1984), and increased concentration of chloride caused a continuous decline in growth rate (Sangwan *et al*., 1996). In this regard, fertilizer management could be practiced to alleviate the effect of salinity on agricultural crops (Mass & Hoffman, 1977). "Bio–Power" a biofertilizer product of National Institute for Biotechnology and Genetic Engineering (NIBGE), has been helpful in minimizing the deleterious effects of salinity on nutrient balance in mungbean (Chughtai *et al.*, 2001).

Among legumes, mungbean (*Vigna radiata* L. Wilczek) is extensively grown in Pakistan due to its rapid growth and early maturity. It is very important from nutritional point; whereas, its seeds contain 347 kcal/100 g of food energy including proteins, carbohydrates, lipids, crude fiber, ash and water (John, 1991). But a number of environmental and ecological factors including soil salinity are decreasing its productivity.

Keeping in view the above facts, present work was conducted to assess the extent of ion accumulation in mungbean in response to salinity and to see the benefits of adding Bio–Power.

MATERIALS AND METHODS

The combined effect of salinity and Bio–Power inoculation to study the ion accumulation in mungbean was evaluated at University of Agriculture, Faisalabad during 2000-2001. Polyethylene lined earthen pots measuring 30 cm in diameter were filled with 10 kg oven-dried soil, having an EC level of 1.5 dS m^{-1}, pH 8.2 and saturation percentage 34% (USDA Salinity Lab. Staff, 1954).

Seeds of both varieties were divided into two lots, one of which was inoculated with Bio–Power (1/2kg). Bio–Power is a trade name of a fertilizer prepared by NIBGE, Faisalabad, chemical composition is not known. Seeds of both control and inoculated lots were sown in pots and after germination, thinning was carried out to maintain three plants in each pot.

EC levels of 2.5 (S_2), 3.5 (S_3) and 4.5 (S_4) dS m^{-1} were used to induce salinity to the 25 days old plants in three installation while field soil (EC 1.5 dS m^{-1}) acted as control. The experiment comprised of eight treatments, each replicated six times, arranged in Completely Randomized Design (CRD) with three factor factorial arrangement. Concentration of different cations in shoots i.e. Na^+, K^+ and Ca^{2+} was determined with a flame photometer and Cl^- with a chloride meter. These were subjected to statistical analysis and Duncan's Multiple Range Tests (DMRT) was applied to compare the means (Steel & Torrie, 1980).

RESULTS AND DISCUSSION

The data regarding concentrations of different cations in shoots presented in Table I indicating that sodium, potassium and chloride contents increased due to salinity, while there was not a significant change in calcium contents. However maximum value of Na^+ (2.19 mg/g) was found in highest salinity level under inoculation while un-inoculated plants at highest salinity level showed 60.50% increase over control. These results tally with Alyemeni (1997) who applied fertilizer and salinity to *Vigna ambacensis* L. and observed a considerable increase in sodium concentration. The Cl^- accumulation revealed maximum value (1.95 mg/g) in inoculated plants at highest salinity level while minimum (0.27 mg/g) was depicted under inoculated non-saline plants.

Significant increase in K^+ concentration (6.64 mg/g) was observed at highest salinity level (4.5 dS m^{-1}) under inoculation compared to control (3.76 mg/g). Un-inoculated plants showed 29.1, 15.28 and 26.2% increase at levels of 2.5, 3.5 and 4.5 dS m^{-1}, respectively as compared to control, while among inoculated ones 25.2, 46.52 and 64.96% increase was recorded with increasing salinity levels over control, indicating that Bio–Power has increased the potassium concentration in plants.

Increased Ca^{2+} concentration was found in inoculated plants as compared to un-inoculated ones. Inoculated plants at 2.5, 3.5 and 4.5 dS m^{-1} accumulated 20.40, 44.90 and 55.10% more Ca^{2+}, respectively over control while in un-inoculated ones; the increase was 70, 67.5 and 70%, respectively over control. These results are in accordance with findings of Arun *et al.* (1997) who reported a significant increase in Ca^{2+} and K^+ uptake under salinity and fertilizer inoculation.

Comparison between varieties for ion accumulation (Table II) reflects that NM-51 showed greater accumulation under NaCl stress compared to NM- 92. All the treatments exhibited significant differences (except Cl^-) indicating a decline with decrease in salinity in both varieties.

Salinity increases the amount of sodium accumulation in shoots and the maximum amount (2.03 mg/g) was observed at 4.5 dS m^{-1}. Increase of 25.3, 22.38 and 52% was given off over control in NM-51. Same trend was recorded in NM-92 but with lower extent. Salinity increased the amount of K^+ in shoots significantly. NM-92 showed maximum accumulation of potassium ion with a 96% increase over control, while NM-92 depicted 12% increase only. Sharma (1995) observed a considerable increased influx of sodium and potassium ion in case of *Vicia faba* L.

Treatment means indicated that amount of Cl^- accumulation in shoots of NM-51 showed an 11% increase over NM-92 at highest salinity level (4.5 dS m^{-1}). Though the accumulation of calcium content showed a significant increase indicating 41, 76 and 98% over control at levels of 2.5, 3.5 and 4.5dS m^{-1}, respectively in NM-51 while NM-92 depicted with 24.4, 34.6 and 28.5%, respectively to salinity stress. Cordovilla *et al.* (1995) also recorded a significant increase in the calcium uptake under saline conditions in *Vicia faba*.

So, from all results it is may be concluded that Bio–

Table I. Interactive effect of salinity and BioPower on ion accumulation in the shoot of mungbean

	Salinity level	Na^+ (mg/g)	Cl^- (mg/g)	K^+ (mg/g)	Ca^{2+}(mg/g)
Without BioPower	1.5dS m^{-1}	1.14	0.30	3.76e	0.40d
	2.5dS m^{-1}	1.48 (30.29%)	0.65 (111.65%)	4.86cd (29.1%)	0.68b (67.40%)
	3.5 dS m^{-1}	1.60 (40.36%)	1.24 (361.94%)	4.33de (50.28%)	0.67b (64.70%)
	4.5 dSm^{-1}	1.83 (60.50%)	1.69 (447.89%)	4.75cd (26.2%)	0.68b (67.40%)
With BioPower	1.5dS m^{-1}	1.39	0.27	4.03e	0.49c
	2.5dS m^{-1}	1.70 (22.04%)	0.84 (211.39%)	5.04c (25.2%)	0.50c (2.0%)
	3.5 dS m^{-1}	1.80 (29.3%)	1.05 (286.76%)	5.90b (46.5%)	0.71ab (42.97%)
	4.5 dSm^{-1}	2.19 (56.76%)	1.95 (618.01%)	6.64a (64.96%)	0.76a (53.61%)

Table II. Interactive effect of variety x salinity on ion accumulation in the shoot of mungbean

Varieties	Salinity level	Na^+ (mg/g)	Cl^- (mg/g)	K^+ (mg/g)	Ca^{2+} (mg/g)
NM- 92	1.5dS m^{-1}	1.19f	0.27	4.30c	0.49e
	2.5dS m^{-1}	1.50d (26.05%)	0.51 (88.82%)	5.21b (21.16%)	0.61cd (24.49%)
	3.5 dS m^{-1}	1.76b (47.90%)	0.97 (0259.26%)	5.21b (21.16%)	0.66bc (34.69%)
	4.5 dSm^{-1}	1.99a (73.95%)	1.72 (537.04%)	4.81bc (11.87%)	0.63cd (28.57%)
NM-51	1.5dS m^{-1}	1.34e	0.30	3.49d	0.41f
	2.5dS m^{-1}	1.68bc (25.37%)	0.98 (251.85%)	4.69bc (34.38%)	0.58d (41.46%)
	3.5 dS m^{-1}	1.64c (22.39%)	1.32 (340%)	5.03b (44.13%)	0.72b (75.61%)
	4.5 dSm^{-1}	2.03a (51.49%)	1.91 (536.66%)	6.85a (96.28%)	0.81a (97.56%)

Means having same letters are statistically non-significant; % = an increase over respective control

Power has exerted a positive influence to some extent with increasing concentrations of K^+ and Ca^2 for minimizing the deteriorating effect of NaCl salinity and maximal resistance was recorded in NM-92

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(Received 26 February 2003; Accepted 21 March 2003)