Journal of Biotechnology and Crop Science
1(1): 47-53, 2012

Physiological performance of mungbean *(Vigna radiata* L.) under salinity conditions

Pragati Baghel, A Hemantranjan, Rajesh Singh

Received: 07 April 2012 Revised Accepted: 22 May 2012

ABSTRACT

Mungbean is an important traditional legume crop of India. Salinity is serious problem for agriculture. The seeds germination was decreased linearly depending on salinity levels have recorded similar responses in different genotypes of mungbean. This corroborates further with the observation in Phaseolus also. The germination reduction could be due to imbalance in osmotic or ionic concentration rendering ionic toxicity, which varies from plant species to species. Germin ability indicates the establishment of seedling and crops production. The environmental condition is much important in the influctuation of gene during growth and development condition. The purpose of present investigation is to describe our work with regard to the dilution of the negative effect of salt stress on mungbean crops by use of growth regulator kinetin. The investigation was carried out by inducing salinity in pot culture with four controls and four under salinity NaCl@1000mM. Next eight pots are treated with two different concentration of kinetin under induced salinity.

Key Words: *Chlorophyll content, Mungbean, Nitrate reductase activity, Germination, Root length, Salinity*

INTRODUCTION

Mungbean (*Vigna radiata* L.) Wilczek) is an important food grain legume crop grown all over the world. Mungbean is commonly known as golden gram in India. It has tremendous value in agriculture as a good source of plant protein for its high digestibility, good flavor, and high protein content and free from flatulent effects which are common to pulses (Ahmed *et al* 1978). The whole seed of crop contains 51% carbohydrate, 26% protein, 3% minerals, 3% vitamins and 10% moisture (Kaul 1982).The mungbean crop enrich atmospheric nitrogen in soil by nitrogen fixation through root nodules. Mungbean is mostly taken during the summer and *Kharif* season about 40^0C in north India. Salinity is serious problem for agriculture (FAO 2008). The variety Pusa Vishal is preferred for its short growth duration, tolerance, bold seed size, shiny green colour and its ability to fit in various cropping systems (Chandra and Tickoo 2004). However, the soil salinity is a major limitation to legume production (Abd-Alla M H *et al* 2005). Salt stress causes decline in seed germination, shoot-root lengths, fresh mass and seedling vigor in mungbean. It is demonstrated that increasing levels of salinity or osmotic stress remarkably decreased seed germination, seedling vigor and hydrolytic enzymes influencing growth in other legumes also demonstrated salinity caused decrease in mungbean and other plant growth could be mitigated by bioinoculants or hormones.

Salt stress is implicated in ionic stress (Alpaslan *et al* 2005) must be culminating into micronutrient imbalances consequently limiting the growth and establishment of plants. Kinetin is one of the cytokinins known to significantly improve the growth of crop plants grown under salinity (Salama

Pragati Baghel (✉)
NABARD, Raipur, Chhattisgarh
Email:pbaghel88@gmail.com

A Hemantranjan
Plant Physiology, Institute of Agricultural Sciences BHU Varanasi

Rajesh Singh
Genetics and Plant Breeding, IAS, BHU, Varanasi-221005

and Awadalla 1987), soil water logging (Gadallah 1995a) and soil acidity (Gadallah 1994). Kinetin is a cytokinin that stimulates plants to grow under different environmental condition. Kinetin is improving stress resistance in native crop plants. Reports mentioned above deal with the effects of kinetin on plants at a young stage (Ribaut and Pilet 1994).

MATERIALS AND METHODS

Collection and Analysis of Soils: Collected experimental soils from the research farm, Institute of Agricultural Sciences (IAS), Banaras Hindu University (BHU) Varanasi. The experiment was carried out in the Department of Plant Physiology. IAS, BHU, Varanasi. It was cleared by removing weeds, stones etc. and the soils samples were air dried and sieved (< 2 mm stainless steel mesh) before determination of chemical properties. The soil sample were used in the pots, dried and mixed completely. Each plastic pots (10x10) were filled up with 3.5 kg dried soils.

Table 1 Showing physical proportion of the soil.

Physical properties	**Values**
Black density (mgm-3)	1.32
Particle density(mgm-3)	2.54
Water holding capacity	44.45
Sand(%)	47.00
Day(5)	22,00
Texture	Sandy loam
Chemical properties	**Uses**
Organic carbon (g/kg)	3.4
Organic matter(g/kg)	4.88
Available nitrate(kg/ha)	225.50
Available Zink (mg/ha)	0.75
Electrical properties	**Uses**
pH	7.4
EC (dsm-1)	0.26

Selection of seeds: Disease free healthy seeds of mungbean cultivar HUM-12 having 96-98% viability were used for sowing. These seeds were sterilized by 0.1% mercuric chloride solution. Sterilized seeds were transferred into petridishes having moist filter paper. Among the major pulses mungbean is one of the most popular amongst the Indian people. The seed of mungbean contains 25% protein, mungbean occupies third position in India.

Germination Study: Germination study under saline condition. Germination percentage was calculated by the following formula,

$$\text{Germination (\%)} = \frac{\text{Number of Germination Seeds}}{\text{Total Number of Seeds in pots}}$$

Morpho-physiological parameters: The height of plants, length of root number of root, number of leaves, total leaves, fresh weight contents and dry weight contents per plants were measured in cm with the help of tap scale at distance lying between the portion of the shoot just touching the soil and tip of the plants.

Biochemical parameters

(A) Chlorophyll Contents: One plant per replicate was used for chlorophyll and proline determination. A leaf sample was taken from the youngest fully expanded leaf. Chlorophyll concentrations were calculated using the equation proposed by Strain and Svec (1966). Proline was determined according to the method described by Bates *et al* (1973).

(B)Nitrate Reductase (NR) Activity: For the estimation of nitrate reductase activity, leaves from uniformly grown seedling in a homogenous population were selected for enzyme induction. The enzyme activity was assayed in vitro by the method of Srivastava (1975) in the first fully expanded leaf.

(C) Proline Contents: Proline, one of the important amino acids, is known to occur widely in higher plants and normally accumulates in large quantities in response to environmental stress (Kavi Kishore *et al* 2005). Most plant species exhibit a remarkable increase in their proline content under salt stress (Delauney and Verma 1993). In the present

experiment, a similar increase in the leaves of Mungbean seedlings with respect to proline content was found, where salt stress resulted in a substantial proline accumulation.

RESULTS AND DISCUSSION

Growth Parameters: In the adverse environment study of Mungbean were treated with Kinetin. A number of observations were recorded at various growth stages of crops. Generally the growth parameters were affected in plants grown under induced salinity i.e, NaCl@ 100mM. The result obtained especially on the establishment of seedling stages are described below:

Length of Root and Height of Shoot: Length of root and height of shoot differed with growth stages. Length of root was greatly enhanced by the treatment of kinetin. However, the length of root was less affected by the treatment of kinetin as compared to shoot treated with kinetin.

Table 2 Influence of kinetin on germination of mungbean in petriplates.

Kinetin @ 25 micromolar	Kinetin @ 5 micromolar	Controls
R1=14	R1=11	R1=15
R2=15	R2=12	R2=13
R3=17	R3=20	R3=10
R4=10	R4=12	R4=06

Average germination percentage with kinetin @ 2.5 micrometer X1=70%
Average germination percentage with kinetin @ 5 micrometer X2=68%
Average germination percentage of control replication X3=55%

Table 3 Observation of Kinetins after 3hrs.

Kinetin 2.5 micrometers	Kinetins micrometers	Controls
R1=20	R1=20	R1=20
R2=20	R2=20	R2=18
R3=18	R3=20	R3=15
R4=20	R4=20	R4=13
R1=20	R1=20	R1=20
R2=20	R2=20	R2=20
R3=20	R3=20	R3=20
R4=20	R4=20	R4=20

Average germination percentage of Mungbean with kinetin@ 2.5 micrometer is X1=97.5%
Average germination percentage of Mungbean with icontrol X2=100%
Average germination percentage of Mungbean with kinetin @ 2.5 micrometer is X3=82.5%
Average germination percentage of Mungbean with control @ 5 micrometer is X1=100%

Table 4 Influence of Kinetin on length of root and height of shoot per plants of Mungbean under induced salt stress in pot culture.

Number of Replication	4
Number of plants	80
2.5 micro molar kinetin	0.93cm
5 micro molar of kinetin	1cm
Control	0.85cm

Number of Leaves per plant: After 15 days of sowing the number of leaves per plant in control was 6, but in case of plant treated with Nacl@100mM number of leaves were 2. In this way NaCl reduced the number of leaves per plants according to its concentration. The number of leaves in case of combination of 100mM NaCl+2.5 micro molar kinetin is 5 which was 5.6 at same growth stages in case of 100mM NaCl+5 micro molar kinetin. The number of leaves was increased to a maximum of 5.8 and 6 in the plants treated with 2.5 and 5 micro molar kinetin, respectively.

Total Leaf Area per Plant: NaCl has negative effects, where as the kinetin has the positive effect on total leaf area per plants treated with 100mM NaCl. When kinetin was applied under salinity stress; the leaf area per plants increased significantly. Maximum leaf area was obtained in plants treated with kinetin.

Total Fresh Weight per Plant: Total fresh weight per plant was greatly affected by NaCl treatment and considerably enhanced by kinetin treatment which was significant. In control replication total fresh weight was increased as compare to induced salinity. The maximum total fresh weight was obtained with in plants treated kinetin concentration only.

Table 5 Influence of Kinetin on number of leaves per plants of Mungbean under induced salt stress in pot culture.

Control X0	6
100mM NaCl X1	2
100mM NaCl X1+2.5micromolar kinetinX2	5
100mM NaCl X1+5micromolar kinetinX3	5.6
2.5micromolar kinetinX4	5.8
5micromolar kinetinX5	6

Table 6 Influence of kinetin on total leaf area (square cm) of mungbean under induced salt stress in pot culture.

Control X0	26
100mM NaCl X1	20
100mM NaCl+2.5micromolar kinetinX2	25
100mM NaCl X1+5micromolar kinetinX3	22
2.5micromolar kinetinX4	28
5micromolar kinetinX5	30

Table 7 Influence of kinetin on fresh weight per plants (g) of Mungbean under induced salt salinity stress in pot culture.

Control X0	0.402
100mM NaCl X1	0.336
100mM NaCl+2.5micromolar kinetinX2	0.325
100mM NaCl X1+5micromolar kinetinX3	0.398
2.5micromolar kinetinX4	0.425
5micro molar kinetinX5	0.430

Total Dry Weight per Plants: Total dry weight per plant was greatly affected/ reduced by NaCl treatment and considerably enhanced by kinetin treatment which was also significant. In control replication total dry weight increasing as compare to enhanced salinity. The maximum total dry weight was obtained in plants treated with kinetin concentration.

Chlorophyll Content: Total chlorophyll content plants in Mungbean were greatly affected by NaCl and kinetin treatment. The chlorophyll content of control was the 20.5 and the chlorophyll content was reduced to 17 on treating with 100mM NaCl. But the chlorophyll content was increased to 18 and 19 on adding kinetin to above NaCl treatment. The chlorophyll content was maximum 25 and 28 at concentrations of 2.5 and 5 micro molar kinetin respectively. In this way kinetin has a favorable effect on chlorophyll development under stress.

Proline Content: The behavior of proline accumulated under salt stress was quit opposite to the NR activity, nitrogen and chlorophyll content. The accumulation of proline was fond to be increased in the concentration of salt in the growing medium. The maximum accumulation was reported in the seedling stressed with 100 mM Nacl. However, application of NaCl and kinetin caused a decline in the level of proline.

Nitrate reductase activity: The maximum (Nitrate Reductase Activity) NRA was observed at highest induced salinity at 100 mM NaCl; the maximum NRA was observed in plants when treated with kinetin. It showed significantly reduced NRA in salt treated plants. In this way kinetin showed complete recovery of adverse effect of NaCl thoughout the plants growth.

Table 8 Influence of kinetin on dry weight per plants (g) of mungbean under salinity stress in pot culture.

Control X0	0.201
100mM NaCl X1	0.156
100mM NaCl+2.5micromolar kinetinX2	0.145
100mM NaCl+5micromolar kinetinX3	0.195
2.5micromolar kinetinX4	0.220
5micro molar kinetinX5	0.225

Table 9 Influence of kinetin on chlorophyll content plant of mungbean under induced salt stress in pot culture.

Control X0	20.5
100mM NaCl X1	17.0
100mM NaCl+2.5micromolar kinetinX2	18.0
100mM NaCl+5micromolar kinetinX3	19
2.5micromolar kinetinX4	25
5micro molar kinetinX5	28

Table 10 Influence of kinetin on proline content of mungbean under induced salt stress condition in pot culture.

Control X0	30.5
100mM NaCl X1	40.0
100mM NaCl+2.5micromolar kinetinX2	35.0
100mM NaCl+5micromolar kinetinX3	36.0
2.5micromolar kinetinX4	36.5
5micro molar kinetinX5	38.0

Table 10 Influence of kinetin on NRA nM of nitrate in mungbean fresh leaves under induced salt stress in pot culture.

Control X0	350
100mM NaCl X1	325
100mM NaCl+2.5micromolar kinetinX2	330
100mM NaCl+5micromolar kinetinX3	310
2.5micromolar kinetinX4	390
5micro molar kinetinX5	400

Although kinetin is not naturally occurring P.G. K and its does not occur as a base in a DNA of any species it is a byproduct of heat induced degradiation of DNA. The decrease of nuclic acid (DNA/RNA) of Mungbean shoots occur with increase in RNase activity which can be attributed to the increase in salinity level which might be involved in inhibiting nuclic acid biosynthesis and stimulate their degradiation. Salinity effects are more immigrated land is affected by salts.

REFERENCES

Abd-Alla MH, Vuang TD, Harper JE (1998) Genotypic differences in dinitrogen fixation response to NaCl stress in intact and grafted soybean. Crop Sci 38: 72-77.

Ahmad W, Niaz A, Kanwal S, Rahmatullah Khalid Rasheed M (2009) Role of Boron in plant growth: A review. J Agric Res 47: 329-338.

Alpaslan M, Gunes A (2001) Interactive effect of Boron and salinity stress on the growth, membrane permeability and mineral composition of tomato and cucumber plants. Plant and Soil 236: 123-128.

Benlloch-Gonzalez M, Fournier JM, Ramos J, Benlloch M (2005) Strategies underlying salt tolerance in halophytes are present in Cynara cardunculus. Plant Sci 168: 653-659.

Cakmak I, Torun B, Erenoglu B, Kalayci M, Yilmaz A, Ekiz H, Brun HJ (1996) Zinc deficiency in soils and plants in Turkey and plant mechanism involved in Zinc deficiency, Turk. J Agric Special issue 13-23.

Camacho-Cristobal JJ, Rexach J, Gonzaleg-Fontes A (2008) Boron in plants: Deficiency and toxicity. Integrative Plant Biology 50: 1247-1255.

Chandra N, Tickoo JL (2004) Seed production, distribution and extension of Pusa Vishal in different states of India. Proceedings of the final workshop and planning meeting, Punjab Agricultural University, Punjab, 27-31. International Journal of Plant, Animal and Environmental Sciences Page: 136 Available online at www.ijpaes.com Anita et al Copyrights@2012 IJPAES ISSN 2231-4490

Coleman JE (1991) Zinc proteins: Enzymes, storage proteins, transcription factors and Replication Proteins. Ann Rev Biochem 61: 897-946.

Dell B, Huang L (1997) Physiological response of plants to low boron. Plant Soil. 193, 103-120. Duffy, B. 2007, Zinc and plant disease, In. Mineral nutrition and plant disease. L.E. Datnoff, W.H. Elmer, D.M. Huber Eds., 155-175.

Eraslan F, Inal A, Pilbeam DJ, Gunes A (2008) Interactive effects of salicylic acid and silicon on oxidative damage and antioxidant activity in spinach grown under Boron toxicity and salinity. Plant Growth Regul 55: 207-219.

Fageria NK, Baligar VC (2005) ciency of upland rice genotypes. Pesq. Agropec. Bras. 40, 1211-1215. [13] Fageria, NK 2009. The use of nutrients in crop plants Boca Raton FL CRC Press.

FAO (2008) FAO land and plant nutrition management science, http://www.fao.org/ag/agl/agll/spush.

Goldbach HE, Wimmer MA (2007) Boron in plants and animals: Is there a role beyond cell-wall structure? J Plant Nutr Soil Sci 170: 39-48.

Gupta PK, Sharma NN, Acharya HK, Gupta SK, Mali C, Henry A, Kumar D, Singh NB (2003) Response of mungbean to zinc and

iron on vertisols in south-eastern plain of Rajasthan. Adv Arid Legume Res 259-262.

Herrera-Rodriguez MB, González-Fontes A, Rexach J, Camacho-Cristobal JJ, Maldonado JM, Navarro-Gochicoa MT (2010) Role of boron in vascular plants and response mechanism to Boron stresses. Plant Stress 4: 115-122

Jeanette S, Bayuelo-Jimenze Richard C, Jonathan PL (2002) Seed physiology, production and technology: salinity tolerance of Phaseolus species during germination and early seedling growth. Crop Sci 42: 1584-1594

Kassab OM (2005) Soil moisture stress and micronutrients foliar application effects on growth and yield of mungbean plants. J Agric Sci 30: 247-256

Krishna S (1995) Effect of sulphur and zinc application on yield, sand Zn uptake and protein content of mung (green gram). Legume Res 18: 89-92.

Marschner H (1995) Mineral nutrition of higher plants. Academic press, San Diego, USA, 379-396.

Mayer AM, Polyakoff-Mayber A (1982) The germination of seeds. Pergamm Press Oxford.

Mensah JK, Ihenyen J (2009) Effects of salinity on germination, seedling establishment and yield of three genotypes of mungbean in Edo State, Nigeria. Nigerian Ann. of Natural Sciences. 8, 17-24.

Mensah JK, Olukoya R Tope (2007) Performance of mung beans (Vigna Mungo L. Hepper) grown in mid-west Nigeria. American-Eurasian J Agric Environ Sci 2: 696-701.

Mishra N, Dwivedi UN (2004) Genotypic difference in salinity tolerance of green gram cultivars. Plant Sci 166: 1135-1142

Munns R (2002) Comparative physiology of salt and water stress. Plant Cell Environ. 25, 239-250.

Nable RO, Banuelos GS, Paull JG (1997) Boron toxicity. Plant and Soil 193: 181-198.

O'Neill MA, Ishii T, Albershim P, Darvill AG (2004) Rhamnogalacturonan II: Structure and function of a borate cross-linked cell wall pectic polysaccharite. Ann Rep Plant Biol 55: 109-139.

Obata H, Kawamura S, Senoo K, Tanaka A (1999) Changes in the level of protein and activity of Cu/Zn Superoxide dismutase in Zinc deficient rice plants *Oryza savita* L. Soil Sci Plant Nutr 45: 891-896.

Pandey S, Bahuguna RN, Pal M, Trivedi AK, Hemantaranjan A, Srivastava JP (2010) Effect of Pretreatment and foliar application of Zn on growth and yield components of mungbean under induced salinity. Indian J Plant Physiol 15: 164-167.

Promila K, Kumar S (2000) Vigna radiata seed germination under salinity. Biol. Plant. 43, 423-426.

Rabie GH (2005) Influence of arbuscular mycorrhizal fungi and kinetin on the response mungbean plants to irrigation with sea water. Mycorrhiza. 15, 225-230.