EFFECT OF SALINITY ON GROWTH AND YIELD OF SUMMER MUNGBEAN

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CERTIFICATE

This is to certify that the thesis entitled **'Effect of Salinity on growth and yield of Summer Mungbean'** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **Master of Science** in **Agronomy**, embodies the result of a piece of *bonafide* research work carried out by **Md. Arafat Hossain**, Registration number: **08-02930** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that any help or source of information, received during the course of this investigation has duly been acknowledged.

Dated:
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DEDICATED

TO

MY BELOVED PARENTS

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The Author

SALINITY BASED STUDY ON SUMMER MUNGBEAN ADAPTABLE TO SALINE AGRICULTURE IN BANGLADESH

ABSTRACT

The experiment effect of salinity on growth and yield of summer mungbean was conducted at the Agronomy Research Farm of Sher-e-Bangla Agricultural University (SAU), Dhaka during the period from August to November 2013. The experiment consisted of two factors: Factor A: mungbean crop 3 varieties like V_1: BARI Mung-6, V_2: BINA Mung-5, V_3: Local variety (Sonamung) and Factor B: salinity 5 levels eg. T_0: 0 dS m^{-1} (control), T_1: 2 dS m^{-1}, T_2: 4 dS m^{-1}, T_3: 6 dS m^{-1} and T_4: 8 dS m^{-1}. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. In case of variety, the tallest plant (45.33 cm), the highest number of pods $plant^{-1}$ (16.09), the highest number of seeds pod^{-1} (8.03) and the highest seed yield $plant^{-1}$ (6.65 g) was recorded from V_1, while those of the lowest (41.40 cm 14.18 cm, 6.69 and 4.34 g, respectively) were found from V_3. For levels of salinity, the tallest plant (47.45 cm), the highest number of pods $plant^{-1}$ (17.56), the highest number of seeds pod^{-1} (8.38) and the highest seed yield $plant^{-1}$ (7.56 g) were found from T_0, while the parameter4s were recorded as lowest values (36.72 cm, 10.78, 5.70 and 2.62 g, respectively) in T_4 treatment. Due to the interaction effect of mungbean varieties and levels of salinity, the tallest plant (51.38 cm), the highest number of pods $plant^{-1}$ (19.56), the highest number of seeds pod^{-1} (9.56) and the highest seed yield $plant^{-1}$ (9.76 g) were found from V_1T_0, while the parameter4s were recorded as lowest values (34.92 cm, 11.22, 5.43 and 2.62 g, respectively) in V_3T_4 treatment combination.

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CHAPTER I

INTRODUCTION

Mungbean (*Vigna radiata* L. Wilczek) belongs to the family Leguminosae and sub-family Papilionaceae is an important pulse crop of Bangladesh. It is composed of more than 150 species originating mainly from Africa and Asia where the Asian tropical regions have the greatest magnitude of genetic diversity (USDA-ARS GRIN, 2012). India is the largest producer of pulses which contributes 35.7% to the global pulse production (FAOSTAT, 2013). In Bangladesh, mungbean is cultivated in the area of 0.108 million hectares with production of 0.03 million tons (BBS, 2012). It is considered as a quality pulse in the country but production per unit area is very low (736 kg/ha) as compared to other countries of the world (BBS, 2012). Mungbean ranks the fifth position considering both acreage and production.

Mungbean is a cheap source of easily digestible dietary protein which complements the staple rice in the country. It's seed contains 24.7% protein, 0.6% fat, 0.9% fiber and 3.7% ash (Potter and Hotchkiss, 1997). Mungbean, being a leguminous crop, is capable of fixing atmospheric nitrogen through symbiotic relationship with soil bacteria and improve the soil fertility (Yadav *et al*., 1994). It plays an important role to supplement protein in the cereal-based low-protein diet of the people of Bangladesh, but the acreage production of mungbean is gradually declining (BBS, 2012). Mungbean is cultivated with minimum tillage, local varieties with no or minimum fertilizers, pesticides and very early or very late sowing, no practicing of irrigation and drainage facilities etc. with other different stress condition. All these factors are responsible for low yield of mungbean which is incomparable with the yields of developed countries of the world (FAO, 1999). The low yield of mungbean, besides other factors, may partially be due to lack of knowledge regards to production technology (Hussain *et al*., 2008). Modern variety with adoption in different stress condition is prerequisite for increasing the production of mungbean.

Salinity is a common abiotic stress factor seriously affecting crop production in different regions, particularly in arid and semi–arid regions. It is estimated that over 800 million hectare of land in the world are affected by both salinity and sodicity (Munns, 2005). The arable land is continuously transforming into saline (1-3% per year) either due to natural salinity or due to human interference which accounts nearly 20% of the irrigated agricultural land. Due to natural salinity and human interferences, the arable land is continuously transforming into saline that is expected to have overwhelming global effects, resulting in up to 50% land loss by 2050 (Saha *et al*., 2010; Hasanuzzaman *et al*., 2013). Salt stress imposes substantial adverse effects on the performance and physiology of the crop plants, which eventually leads to plant death as a consequence of growth arrest and metabolic damage (Hasanuzzaman *et al*., 2012).

There are various detrimental effects of salt stress in crop plants, which are responsible for severe decrease in the growth and yield of plants. Osmotic stress (drought problem), ion imbalance, particularly with Ca, K, and the direct toxic effects of ions on the metabolic process are the most important and widely studied physiological impairments caused by salt stress (Zhu, 2001; Munns *et al*., 2006 and Eker *et al*., 2006). High salt concentration in root affects the growth and yield of many important crops (Alam *et al*., 2004; Taffouo *et al*., 2004). The salinity may reduce the crop yield by upsetting water and nutritional balance of plant (Khan *et al*., 2007 and Taffouo, *et al*., 2009). It is recognized as major constraint in the production of this crop where 50 mM NaCl can cause yield losses ≥70% (Hasanuzzaman *et al*., 2013). However, the intensity of adverse and injurious, effects of salinity stress depends upon the nature of plant species, concentration and duration of salt stress, plant developmental stage, and mode of salt application to the crop. Salinity is a polygenic trait which adversely affected the biometric, morpho-physiological, biochemical and biophysical characters of mungbean (Mahajan and Tuteja, 2005). The increased salinity of agronomically important land is expected to have overwhelming global effects by the middle of the twenty-first century (Kandil, 2012; Karthikeyan *et al*., 2012).

Due to the complex nature of salinity stress and lack of appropriate techniques for introgression little progress has been made in developing salt tolerant mungbean varieties (Mahdavi and Sanavy, 2007). Worldwide, a total of 43,027 mungbean accessions are available at core collections or Gene Bank at different stations. To date, over 110 mungbean cultivars have been released by AVRDC in South and Southeast Asia and around the world. AVRDC has developed several mungbean with superior lines for production in the tropics and subtropics which are early and uniformly maturing (55-65 days), disease resistant, and high yielding. An improved variety is the first and foremost requirement for initiation and accelerated production program of any crop. Variety plays an important role in producing high yield of mungbean because different varieties differently for their genotypic characters. Recently, Sehrawat *et al*. (2013) reviewed that mungbean also encounters the cumulative adverse effects of other environmental factors as insects, pests, high temperature, pod-shattering along with salinity causing high yield loss. Due to the complex nature of salinity stress and lack of suitable techniques for introgression of desirable agronomic traits or resistant genes, little progress has been made in developing salt tolerant mungbean varieties (Singh and Singh, 2011).

Considering the above factors the present experiment was conducted to evaluate yield attributes and yield of mungbean varieties with the following objectives:

i. To investigate the morpho-physiology, yield contributing charcaters and yield response of diffent mungbean varieties to salt stress.

ii. To find out the interaction effect of different varieties and salt stress on growth and yield of mungbean.

CHAPTER II

REVIEW OF LITERATURE

Mungbean is an important pulse crop in Bangladesh and as well as many countries of the world although the crop has conventional less attention by the researchers on various aspects because normally it grows without or minimum care or management practices. Based on this a very few research work related to growth, yield and development of mungbean have been carried out in our country. However, researches are going on in home and abroad to maximize the yield of mungbean. Variety and salt stress play an important role in improving mungbean yield. But research works related to variety and salt stress as a management practices on mungbean are limited in Bangladesh context. However, some of the important and informative works and research findings related to the variety and salt stress so far been done at home and abroad have been reviewed in this chapter under the following headings:

2.1. Effects of varieties on plant characters of mungbean

Four mungbean accessions from the Asian Vegetable Research and Development Centre (AVRDC) were grown by Agugo *et al*. (2010). Results showed a significant difference in the yield of the varieties with VC 6372 (45-8-1) producing the highest seed yield of 0.53 t/ha. This was followed by NM 92, 0.48 t/ha; NM 94, 0.40 t/ha; and VC 1163 with 0.37 t/ha. The variety, VC 6372 (45-8-1), also formed good agronomic characters.

Field studies were conducted by Kumar *et al*. (2009) in Haryana, India to determine the growth behaviour of mungbean genotypes sown on different dates under irrigated conditions. The treatments consisted of 2 genotypes (SML 668 and MH 318) and 6 sowing dates starting from 1 March to 19 April, at of 10-day intervals. Results showed that SML 668 had higher plant height than MH 318 and the less height of both the genotypes during summer was due to low average temperature during the initial growth stage. SML 668 accumulated more dry matter than MH 318. The contribution of leaves and stem was more in SML 668, whereas the contribution of pods towards total aboveground biomass at harvest was higher in MH 318.

Quaderi *et al*. (2006) carried out an experiment in the Field Laboratory of the Department of Crop Botany, Bangladesh Agricultural University, Mymensingh to evaluate the influence of seed treatment with Indole Acetic Acid (IAA) at a concentration of 50 ppm, 100 ppm and 200 ppm on the growth, yield and yield contributing characters of two modern mungbean (*Vigna radiata* L.) varieties viz. BARI moog 4 and BARI moog 5. The two-factor experiment was laid out in Randomized Complete Block Design (RCBD) (factorial) with 3 replications. Among the mungbean varieties, BARI moog 5 performed better than that of BARI moog 4.

To study the nature of association between *Rhizobium phaseoli* and mungbean an experiment was conducted by Muhammad *et al*. (2006). Inocula of two Rhizobium strains, Tal-169 and Tal-420 were applied to four mungbean genotypes viz., NM-92, NMC-209, NM-98 and Chakwal Mung-97. A control treatment was also included for comparison. The experiment was carried out at the University of Arid Agriculture, Rawalpindi, Pakistan, during kharif. Both the strains in association with NM-92 had higher nodule dry weight, which was 13% greater than other strains × mungbean genotypes combinations. Strain Tal-169 was specifically more effective on genotype NCM-209 and NM-98 compared with NM-92 and Chakwal Mung-97. Strain Tal-420 increased branches plant^{-1} of all the genotypes. Strain Tal-169 in association with NCM-209 produced the highest yield of 670 kg ha^{-1} which was similar (590 kg ha^{-1}) in case of NCM-209 either inoculated with strain Tal-420 or uninoculated. Variety NM-92 produced the lowest grain yield (330 kg ha^{-1}) either inoculated with strain Tal-420 or uninoculated.

Islam *et al*. (2006) carried out an experiment at the field laboratory of the Department of Crop Botany, Bangladesh Agricultural University, Mymensingh to evaluate the effect of biofertilizer (*Bradyrhizobium*) and plant growth regulators (GA_3 and IAA) on growth of 3 cultivars of summer mungbean (*Vigna radiata* L.). Among the mungbean varieties, BINA moog 5 performed better than that of BINA moog 2 and BINA moog 4.

Mungbean cultivars Pusa 105 and Pusa Vishal were sown at 22.5 and 30 cm spacing and supplied with 36-46 and 58-46 kg NP/ha in a field experiment conducted in Delhi, India during the kharif season by Tickoo *et al*. (2006). Cultivar Pusa Vishal recorded higher biological and grain yield (3.66 and 1.63 t/ha, respectively) compared to cv. Pusa 105.

To evaluate the effects of crop densities (10, 13, 20 and 40 plants/m^2) on yield and yield components of two cultivars (Partow and Gohar) and a line of mungbean (VC-1973A), a field experiment was conducted by Aghaalikhani *et al*. (2006) at the Seed and Plant Improvement Institute of Karaj, Iran, in the summer of 1998. The results indicated that VC-1973A had the highest grain yield. This line was superior to the other cultivars due to its early and uniform seed maturity and easy mechanized harvest.

Rahman *et al*. (2005) carried out an experiment with mungbean in Jamalpur, Bangladesh, involving 2 planting methods, i.e. line sowing and broadcasting; 5 mungbean cultivars, namely Local, BARI moog 2, BARI moog 3, BINA moog 2 and BINA moog 5. Significantly the highest dry matter production ability was found in 4 modern mungbean cultivars, and dry matter partitioning was found highest in seeds of BINA moog 2 and lowest in Local. However, the local cultivar produced the highest portion of dry matter in leaf and stem.

Studies were conducted by Bhati *et al*. (2005) to evaluate the effects of cultivars and nutrient management strategies on the productivity of different kharif legumes (mungbean, mothbean and clusterbean) in the arid region of Rajasthan, India. The experiment with mungbean showed that K-851 gave better yield than Asha and the local cultivar. In another experiment, mungbean cv. PDM-54 showed 56.9%

higher grain yield and 13.7% higher fodder yield than the local cultivar. The experiment with mothbean showed that RMO-40 gave 34.8-35.2% higher grain yield and 30.2-33.4% higher fodder yield over the local cultivar as well as 11.8% higher grain yield and 9.2% higher fodder yield over RMO-257. The experiment with clusterbean showed that improved cultivars of RGC-936 gave 136.0 and 73.5% higher grain yield and 124.0 and 67.3% higher fodder yield over the local cultivar and Maru Guar, respectively.

A field experiment was conducted by Raj and Tripathi (2005) in Jodhpur, Rajasthan, India, during the kharif seasons, to evaluate the effects of cultivar (K-851 and RMG-62) as well as nitrogen and phosphorus on the productivity of mungbean. K-851 produced significantly higher values for seed and straw yields as well as yield attributes (plant height, pods plant^{-1}, seeds pod^{-1} and 1000-seed weight) compared with RMG-62. Higher net return and benefit:cost (B:C) ratio were also obtained with K-851 (Rs. 6544 ha^{-1} and 1.02, respectively) than RMG-62 (Rs. 4833 ha^{-1} and 0.76, respectively).

Chaisri *et al*. (2005) conducted a yield trial involving 6 recommended cultivars (KPS 1, KPS 2, CN 60, CN 36, CN 72 and PSU 1) and 5 elite lines (C, E, F, G, H) under Kasetsart mungbean breeding project in Lopburi Province, Thailand, during the dry (February-May 2002), early rainy (June-September 2002) and late rainy season (October 2002-January 2003). Line C, KPS 1, CN 60, CN 36 and CN 72 gave high yields in the early rainy season, while line H, line G, line E, KPS 1 and line C gave high yields in the late rainy session. Yield trial of the 6 recommended mungbean cultivars was also conducted in the farmer's field.

Two summer mungbean cultivars, i.e. BINA moog 2 and BINA moog 5, were grown during the kharif-1 season (February-May), in Mymensingh, Bangladesh, under no irrigation or with irrigation once at 30 days after sowing (DAS), twice at 30 and 50 DAS, and thrice at 20, 30 and 50 DAS by Shamsuzzaman *et al*. (2004). Data were recorded for days to first flowering, days to first leaf senescence, days to pod maturity, flower + pod abscission, root, stem+leaf, pod husk and seed dry matter content, pods $plant^{-1}$, seeds pod^{-1}, 100-seed weight, seed yield, biological yield and harvest index. The two cultivars tested were synchronous in flowering, pod maturity and leaf senescence, which were significantly delayed under different irrigated frequencies. BINA moog 2 performed slightly better than BINA moog 5 for most of the growth and yield parameters studied.

An experiment was conducted by Abid *et al*. (2004) in Peshawar, Pakistan to study the effect of sowing dates on the agronomic traits and yield of mungbean cultivars NM-92 and M-1. Data were recorded for days to emergence, emergence/m^2, days to 50% flowering, days to physiological maturity, plant height at maturity and grain yield. Sowing on 15 April took more number of days to emergence but showed maximum plant height. The highest emergence/m^2 and higher mean grain yield was recorded in NM-92 than M-1.

A field experiment was conducted by Apurv and Tewari (2004) during kharif season in Uttaranchal, India, to investigate the effect of *Rhizobium* inoculation and fertilizer on the yield and yield components of three mungbean cultivars (Pusa 105, Pusa 9531 and Pant mung 2). Pusa 9531 showed higher yield components and grain yield than Pusa 105 and Pant mung 2.

To find out the effects of *Rhizobium* inoculation on the nodulation, plant growth, yield attributes, seed and stover yields, and seed protein content of six mung bean (*Vigna radiata*) cultivars were investigated by Hossain and Solaiman (2004). The mungbean cultivars were BARI mung-2, BARI mung-3, BARI mung-4, BARI mung-5, BINA mung-2 and BU mung-1. Among the cultivars, BARI mung-4 performed the best in all aspects showing the highest seed yield of 1135 kg/ha. *Rhizobium* strain TAL169 did better than TAL441 in most of the studied parameters. It was concluded that BARI mung 4 in combination with TAL169 performed the best in terms of nodulation, plant growth, seed and stover yields, and seed protein content.

The performance of 20 mungbean cultivars were evaluated by Madriz-Isturiz and Luciani-Marcano (2004) in a field experiment conducted in Venezuela. Data on plant height, clusters per plant, pods per plant, pod length, seeds per pod, grain yield by plant and yield/ha were recorded. Significant differences in the values of the parameters measured due to cultivar were recorded. The average yield was 1342.58 kg/ha. VC 1973C, Creole VC 1973A, VC 2768A, VC 1178B and Mililiter 267 were the most promising cultivars for cultivation in the area.

Effect of sowing rates on the growth and yield of mungbean cultivars NM-92, NARC mung-1 and NM-98 was evaluated by Riaz *et al*. (2004) in Faisalabad, Pakistan. NM-98 produced the maximum pod number of 77.30, grain yield of 983.75 kg/ha and harvest index value of 24.91%. NM-92 also produced the highest seed protein content of 24.64%.

Brar *et al*. (2004) introduced SML 668 high yielding variety of summer mungbean selection from AVRDC line NM 94, is a cultivar recommended for general cultivation in irrigated areas of Punjab, India. This early maturing cultivar flowers in 34 days and matures in 60 days. It has an average plant height of 44.6 cm and bears an average of 16 pods per plant and 10.4 seeds per pod. Seeds are bold with 100-seed weight of 5.7 g and devoid of hard seeds. Protein content is 22.7% and water absorption capacity is high (91%).

Seed treatment with biofertilizers in controlling foot and root rot of mungbean cultivars BINA moog-3 and BINA moog-4 was investigated by Mohammad and Hossain (2003) under field conditions in Pakistan. Treatment of seeds of BINA moog-3 with biofertilizer showed a 5.67% increase in germination over the control, but in case of BINA moog-4 10.81% increase in germination over the control was achieved by treating seeds with biofertilizer. The biofertilizers caused 77.79% reduction of foot and root rot disease incidence over the control along with BINA moog-3 and 76.78% reduction of foot and rot disease in BINA moog-4. Seed treatment with biofertilizer also produced up to 20.83% higher seed yield in BINA moog-3 and 12.79% higher seed yield BINA moog-4 over the control.

Three mungbean cultivars (LGG 407, LGG 450 and LGG 460) and two urd bean [black gram] cultivars (LBG 20 and LBG 623) were sown in Lam, Guntur, Andhra Pradesh, India, by Durga *et al*. (2003) and subjected to severe moisture stress during the first 38 days after sowing (DAS) and only a rainfall of 21.4 mm was received during this period. Mungbean registered higher root length (11.83%), root volume (37.50), root weight (31.43%), lateral roots (81.71%), shoot length (13.04%), shoot weight (84.62%), leaf number (25.75%), leaf weight (122.86%) and leaf area (108.60%) than the urd bean. Mungbean recorded better leaf characters than urd bean, but root and shoot characters were better in the latter. Among the mungbean cultivars, LGG 407 recorded the highest yield. Between the urd bean cultivars, LBG 20 had a higher yield than LBG 623. Among the mung bean cultivars, LGG 407 was the most tolerant, while in urd bean, LBG 20 was more efficient in avoiding early drought stress than LBG 623.

Taj *et al*. (2003) carried out an experiment to find out the effects of sowing rates (10, 20, 30 and 40 kg seed/ha) on the performance of 5 mungbean cultivars (NM-92, NM 19-19, NM 121-125, N/41 and a local cultivar) were studied in Ahmadwala, Pakistan, during the summer season. Among the cultivars, NM 121-125 recorded the highest average pods per plant (18.18), grains per pod (9.79), 1000-grain weight (28.09 g) and grain yield (1446.07 kg ha^{-1}).

Satish *et al*. (2003) conducted an experiment in Haryana, India to investigate the response of mung bean cultivars Asha, MH 97-2, MH 85-111 and K 851 to different P levels. Results revealed that the highest dry matter content in the leaves, stems and pods was obtained in Asha and MH 97-2. The total above-ground dry matter as well as the dry matter accumulation in leaves, stems and pods increased with increasing P level up to 60 kg P ha^{-1}. MH 97-2 and Asha produced significantly more number of pods and branches/plant compared to MH 85-111 and K 851.

The development phases and seed yield were evaluated by Infante *et al*. (2003) in mungbean cultivars ML 267, Acriollado and VC 1973C under the agroecological conditions of Maracay, Venezuela. The differentiation of the development phases and stages, and the morphological changes of plants were studied. The variable totals of pod clusters, pods per plant, seeds per pods and pod length were also studied. The earliest cultivar was ML 267 with 34.87 days to flowering and 61.83 to maturity. There were significant differences for total pod clusters per plant and pods per plant, where ML 267 and Acriollado had the highest values. The total seeds per pod of VC 1973C and Acriollado were significantly greater than ML 267. Acriollado showed the highest yield with 1438.33 kg/ha.

Seeds of mungbean cultivars BM-4, S-8 and BM-86 were inoculated with *Rhizobium* strains M-11-85, M-6-84, GR-4 and M-6-65 before sowing in a field experiment conducted by Navgire *et al*. (2001) in Maharashtra, India during the kharif season. S-8, BM-4 and BM-86 recorded the highest mean nodulation (16.66), plant biomass (8.29 q/ha) and grain yield (4.79 q/ha) during the experimental years. S-8, BM-4 and BM-86 recorded the highest nodulation, plant biomass and grain yield.

Hamed (1998) carried out two field experiments in Shalakan, Egypt, to evaluate mung bean cultivars Giza 1 and Kawny 1 under 3 irrigation intervals after flowering (15, 22 and 30 days) and 4 fertilizer treatments: inoculation with *Rhizobium* (R) + Azotobacter (A) + 5 (N_1) or 10 kg N/feddan (N_2), and inoculation with R only +5 (N_3) or 10 kg N/feddan (N_4). Kawny 1 surpassed Giza 1 in pod number per plant (24.3) and seed yield (0.970 t/feddan), while Giza 1 was superior in 100-seed weight (7.02 g), biological and straw yields (5.53 and 4.61 t/feddan, respectively). While Kawny 1 surpassed Giza 1 in oil yield (35.78 kg/feddan), the latter cultivar recorded higher values of protein percentage and yield (28.22% and 264.6 kg/feddan). The seed yield of both cultivars was positively and highly significantly correlated with all involved characters, except for 100-seed weight of Giza 1 and branch number per plant of Kawny 1.

2.2. Effects of salinity on mungbean

The effect of salt stress on two popular mungbean varieties (Pusa vishal and Pusa ratna) has been compared by Sehrawat *et al*. (2015) during summer and spring seasons. The experiment was carried out at two salinity stress levels (50 mM and 75 mM NaCl). Significant variations and adaptability among stressed and non-stressed plants were observed in both varieties. The plants in early vegetative stage were found more resistant to salinity as compared to plants in late vegetative and reproductive stage. Salt stress, high temperature and salinity induced osmotic stress severely limited the plant growth, morphology, physiology and yield characteristics during summer. Measured parameters were less affected during spring season. The tolerant variety 'Pusa vishal' exhibited less reduction in plant height, total chlorophyll and carotenoid contents, plant length, leaf area, rate of photosynthesis, number of pods per plant and grain yield at high salinity level. However, the susceptible variety 'Pusa ratna' showed higher reduction for the measured parameters under salinity stress. A delay in pod ripening during spring season resulted in less pod-shattering. The present study may help to execute further research on screening of large mungbean germplasm for salt tolerance during spring season. The germplasm screening may help to identify resistant genotypes for genetic improvement of mungbean for growing in saline soil.

Ghosh *et al.* (2014) evaluated the physiological and biochemical responses to increasing NaCl concentrations, along with low concentrations of gibberellic acid or spermine, either alone or in their combination, were studied in mungbean seedlings. Similarly, oxidative stress markers such as proline, malondialdehyde (MDA), and hydrogen peroxide (H_2O_2) contents also increased as a result of progressive increase in salt stress. Combined application of NaCl along with low concentrations of either gibberellic acid (5 μM) or spermine (50 μM) in the test seedlings showed significant alterations, that is, drastic increase in seedling elongation, increased biomass production, increased chlorophyll content, and significant lowering in all the antioxidant enzyme activities as well as oxidative stress marker contents in comparison to salt treated test seedlings, leading to better growth and metabolism. The study shows that low concentrations of either gibberellic acid or spermine will be able to overcome the toxic effects of NaCl stress in mungbean seedlings.

Kandil *et al*. (2012) conducted an a laboratory experiment to study the performance of mungbean to salinity stress with salinity tolerance of two mungbean varieties (Kawmy-1 and IV 2010) to eight salinity levels i.e. 0, 2, 4, 6, 8, 10, 12 and 14 dS/m of NaCl concen-trations. Mungbean (*Vigna radiata* (L.) Wilczek) varieties were compared for germination efficiency and seedling characters. The obtained results suggested that the two varieties registered a decrease in the percentage of germination and seedlings growth at higher NaCl concentrations. Results clearly indicated that mungbean Kawme-1 variety appeared to be more tolerant to salt stress than IV 2010 variety recording higher germination parameters and seedling characters. Increasing salinity concentrations significantly reduced germination percentage, seedling vigor index, coefficient of velocity, mean germination time, shoot and root length, shoot and root fresh and dry weight. It could be concluded that germination efficiency i.e. final germination percentage, germination index, energy of germination, mean germination time, abnormal seed percentage, root and shoot length, seedling total fresh and dry weight, dry weight reduction and shoot length reduction were gradually decreased significantly when salinity increased.

The salinity sensitivity of mungbean was studied by Amira and Abdul (2010) to determine the effect of salinity on vegetative growth (plant dry weight and plant height), yield components (plant height, pods number, pods weight, seeds number/pod, seeds weight/plant and biological yield/plant), nutritional value of produced seeds (N, P, K, Ca, Mg, Na, Cl, soluble carbohydrate, polysaccharides, total carbohydrate, proline, total amino acids and protein contents) and mineral contents in green shoot at harvest (N, P, K, and Na). Also, the role of arginine in alleviating the effect of salinity stress was studied. Munbean seeds were planted in soils of different salinity levels. The concentration of the irrigation water used in this experiment were (0, 15000, 3000, 4500 and 6000 ppm). All growth parameters were significantly reduced with high salinity levels (4500 and 6000 ppm) while 1500 and 3000 ppm induced slight increase. Salinity stress also, induced significant increases in Na, Cl, Ca and Mg and decreased significantly N, P, and K contents. Salinity stress reduced most yield components and nutritional value of produced seeds. However, spraying plants with arginine could alleviate the harmful effect of salinity at all studied parameters.

A pot experiment was conducted by Hossain *et al*. (2008) at the Bangladesh Institute of Nuclear Agriculture (BINA) experimental farm, Mymensingh, to observe the response of three mungbean genotypes (Binamoog-4 and two-advanced line BMX 92007-3 and BMX 94010-11) under different salt stress (control, 3.89 deci-Siemen per metre (ds m^{-1}) and 7.82 ds m^{-1}). All morpho-physiological characters such as plant height, number of leaf, leaf area, yield contributing characters such as number of pods $plant^{-1}$, number of seeds pod^{-1}, 1000 seed weight, harvest index were reduced with the increase of salinity levels as compared to control. Plant height and yield attributes like number of pods $plant^{-1}$, number of seeds pod^{-1}, 1000 seed weight, harvest index were the highest in advanced line BMX 94010-11 compared to those in Binamoog-4 and advanced line BMX 92007-3.

Going through the above reviews, it is concluded that the variety and salt stress is an important factor in consideration of growth and yield of mungbean. The literature reveals that the effects of variety and salinity effect have not been studied well for the production of mungbean under Bangladesh condition.

CHAPTER III

MATERIALS AND METHODS

The materials and methods that were used for conducting the experiment have been presented in this chapter. It includes a short description of the location of experimental site, soil and climate condition of the experimental area, materials used for the experiment, design of the experiment, data collection and data analysis procedure.

3.1. Experimental site

The experiment was conducted at the Agronomy Research Farm of Sher-e-Bangla Agricultural University (SAU), Dhaka. It was located in 24.09^0N latitude and 90.26^0E longitudes. The altitude of the location was 8 m from the sea level as per the Bangladesh Metrological Department, Agargaon, Dhaka-1207 (Anon., 1989).

3.2. Characteristics of soil that used in pot

The soil of the experiment belongs to the Modhupur Tract (UNDP, 1988) under AEZ No. 28 and it was medium high in nature with adequate irrigation facilities and remained fallow during the previous season. The soil texture was sandy loam. The nutrient status of the farm soil under the experimental pot were collected and analyzed in the Soil Research and Development Institute Dhaka, and result has been presented in Appendix I.

3.3. Climatic condition of the experimental site

Experimental area is situated in the sub-tropical climate zone, which is characterized by heavy rainfall during the months of April to September and scanty rainfall during the rest period of the year. Details of the meteorological data during the period of the experiment was collected from the Bangladesh Meteorological Department, Agargoan, Dhaka and presented in Appendix II.

3.4. Planting material

The varieties of mungbean like BARI Mung-6, BINA Mung-5 and local variety (Sonamung) were used as the test crop. The seeds of BARI Mung-6 were collected from the Pulse Seed Division of Bangladesh Agricultural Research Institute, Joydevpur, Gazipur, seeds of BINA Mung-5 were collected from Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh and local variety was collected from Siddique bazar, Dhaka.

3.5. Treatment of the experiment

The experiment consisted of two factors:

Factor A: Mungbean variety (3 varieties)

i. V_1: BARI Mung-6
ii. V_2: BINA Mung-5
iii. V_3: Local variety (Sonamung)

Factor B: Soil salinity (5 levels)

i T_0: 0 dS m^{-1} (control)
ii. T_1: 2 dS m^{-1}
ii. T_2: 4 dS m^{-1}
iii. T_3: 6 dS m^{-1}
v. T_4: 8 dS m^{-1}

There were 15 (3 × 5) treatments combination such as V_1T_0, V_1T_1, V_1T_2, V_1T_3, V_1T_4, V_2T_0, V_2T_1, V_2T_2, V_2T_3, V_2T_4, V_3T_0, V_3T_1, V_3T_2, V_3T_3 and V_3T_4.

3.6. Design and layout of the experiment

The two factors experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The experimental units were divided into three equal blocks. Each block contained 15 pots where 15 treatments combination were allotted at random. Three plants were kept under each treatment combination. There were 45 unit pot altogether in the experiment.

3.7. Preparation of the pot

The experimental pots were first filled on 20 August, 2013. Potted soil was brought into desirable fine tilth by hand mixing. The stubble and weeds were removed from the soil. The final pot preparation was done on 25 August, 2013. The soil was treated with insecticides (cinocarb 3G @ 4 kg/ha) at the time of final pot preparation to protect young plants from the attack of soil inhibiting insects such as cutworm and mole cricket.

3.8. Fertilizer application

Urea, Triple super phosphate (TSP), Muriate of potash (MoP) and gypsum were used as a source of nitrogen, phosphorous, potassium and sulphur, respectively. Urea, TSP, MP and gypsum were applied @ 50, 35, 85 and 10 kg ha^{-1} respectively following Bangladesh Agricultural Research Institute (BARI) recommendation. All of the fertilizers were applied during final pot soil preparation.

3.9. Sowing of seeds in the pot

The seeds of mungbean were sown on August 25, 2013 in having a depth of 2-3 cm and 5 seeds were sown in each pot. Before sowing seeds were treated with Bavistin to control the seed borne disease.

3.10. Application of NaCl

As per the treatment the required amount of NaCl was applied in the pot during application of water. The tray was used in the bottom of each pot to collect the water and different nutrient. NaCl solution and Ca^{2+} were applied in the pot soil for maintaining available soil moisture for the plant.

3.11. Intercultural operations

3.11.1. Thinning

Seeds started germination from four days after sowing (DAS). Thinning was done in each pot by keeping 3 healthy seedlings as to maintain optimum plant population in each pot.

3.11.2. Irrigation and weeding

Irrigation was done as per requirements with saline water based on treatment. The hand weeding was done as when necessary to keep the pots free from weeds.

3.11.3. Protection against insect and pest

At early stage of growth few worms (*Agrotis ipsilon*) and virus vectors (jassid) infested the young plants and at later stages of growth pod borer (*Maruca testulalis*) attacked the plant. Dimacron 50EC was sprayed @ 1 litre/ha to control the insects.

3.12. Harvest and post harvest operations

Harvesting was done when 90% of the pods became brown to black in color**.** The matured pods were collected by hand picking from each pot.

3.13. Data collection

The following data were recorded

i. Plant height at 20, 30, 40, 50 DAS (days after sowing) and harvest
ii. Number of leaves per plant at 20, 30, 40, 50 DAS and harvest
iii. Dry matter content at 20, 30, 40, 50 DAS and harvest
iv. Days to 1st flowering
v. Days to harvest
vi. Number of pods plant^{-1}
vii. Number of seeds pod^{-1}
viii. Pod length
ix. Weight of 1000 seeds
x. Seed yield hectare^{-1}
xi. Stover yield hectare^{-1}
xii. Biological yield hectare^{-1}
xiii. Harvest index

3.14. Procedure of data collection

3.14.1. Crop growth characters

Plant height (cm)

The height of plant was recorded in centimeter (cm) at 20, 30, 40, 50 DAS and at harvest. After thinning there were three plants in each pot. Data were recorded from 3 plants from each pot and average plant height plant^{-1} was recorded as per treatment. The height was measured from the ground level to the tip of the plant by a meter scale.

Number of leaves plant^{-1}

The number of leaves plant^{-1} was counted at 20, 30, 40, 50 DAS and at harvest. Data were recorded from 3 plants from each pot and average number of leaves plant^{-1} was recorded as per treatment.

Dry matter of plant

Fresh weight of a plant samples were put into envelops and placed in an oven maintained at 70^{0}C for 72 hours. The sample was then transferred into desiccators and allowed to cool down at room temperature. The final weight of the sample was taken and recorded in gram.

Estimated growth parameter

Using the data on dry matter, the following growth parameters were derived (Hunt, 1978):

Crop Growth Rate (CGR)

Crop growth rate was calculated using the following formula:

$$CGR = \frac{1}{GA} \times \frac{W_2 - W_1}{T_2 - T_1} \ \text{g m}^{-2}\text{day}^{-1}$$

Where,

GA = Ground area (m^2)

W_1 = Total dry weight at previous sampling date (T_1)

W_2 = Total dry weight at current sampling date (T_2)

T_1 = Date of previous sampling

T_2 = Date of current sampling

Relative Growth Rate (RGR)

Relative growth rate was calculated using the following formula:

$$RGR = \frac{LnW_2 - LnW_1}{T_2 - T_1} \quad (g\ g^{-1} day^{-1})$$

Where,

W_1 = Total dry weight at previous sampling date (time T_1)

W_2 = Total dry weight at current sampling date (time T_2)

T_1 = Date of previous sampling

T_2 = Date of current sampling

Ln = Natural logarithm

3.14.2. Yield contributing characters

Days to 1st flowering

Days to 1st flowering were recorded by counting the number of days required to start flower initiation of mungbean plant in each pot.

Days to harvest

Days to harvest were recorded by counting the number of days required to harvest of mungbean plant in each pot.

Number of pods plant^{-1}

Numbers of total pods of 3 plants from each pot were counted and the mean numbers were expressed as plant^{-1} basis.

Number of seeds pod^{-1}

The number of seeds pods^{-1} was recorded from randomly selected pods at the time of harvest. Data were recorded as the average of 10 pods selected at random from each pot.

Pod length

Pod length was taken from randomly selected 10 pods and the mean length was expressed as per pod basis.

Weight of 1000 seeds

One 100 cleaned, dried seeds were counted randomly from each harvest sample and weighed by using a digital electric balance and weight was expressed in gram by multiplying 10.

3.14.3. Yield

Seed yield

The seeds collected from plant of each pot were sun dried properly. The weight of seeds was taken and converted the seed yield in g plant^{-1}.

Stover yield

The stover collected from plant of each pot was sun dried properly. The weight of stover was taken and converted the stover yield in g plant^{-1}.

Biological yield

Grain yield and stover yield together were regarded as biological yield of mungbean. The biological yield was calculated with the following formula:

$$\text{Biological yield (g plant}^{-1}\text{)} = \text{Seed yield} + \text{Stover yield}$$

Harvest index (%)

Harvest index was calculated from the seed and stover yield of mungbean for each plant and expressed in percentage.

$$HI = \frac{\text{Economic yield (seed weight)}}{\text{Biological yield (Total dry weight)}} \times 100$$

3.15. Statistical analysis

The data obtained for different parameters were statistically analyzed to find out the significant differences on yield and yield contributing characters of mungbean under the treatments designed. The mean values of all the characters were calculated and the analysis of variance (ANOVA) was performed by the 'F' (variance ratio) test. The significance of the difference among the treatment means was estimated by the Least Significant Difference (LSD) at 5% level of probability (Gomez and Gomez, 1984).

CHAPTER IV

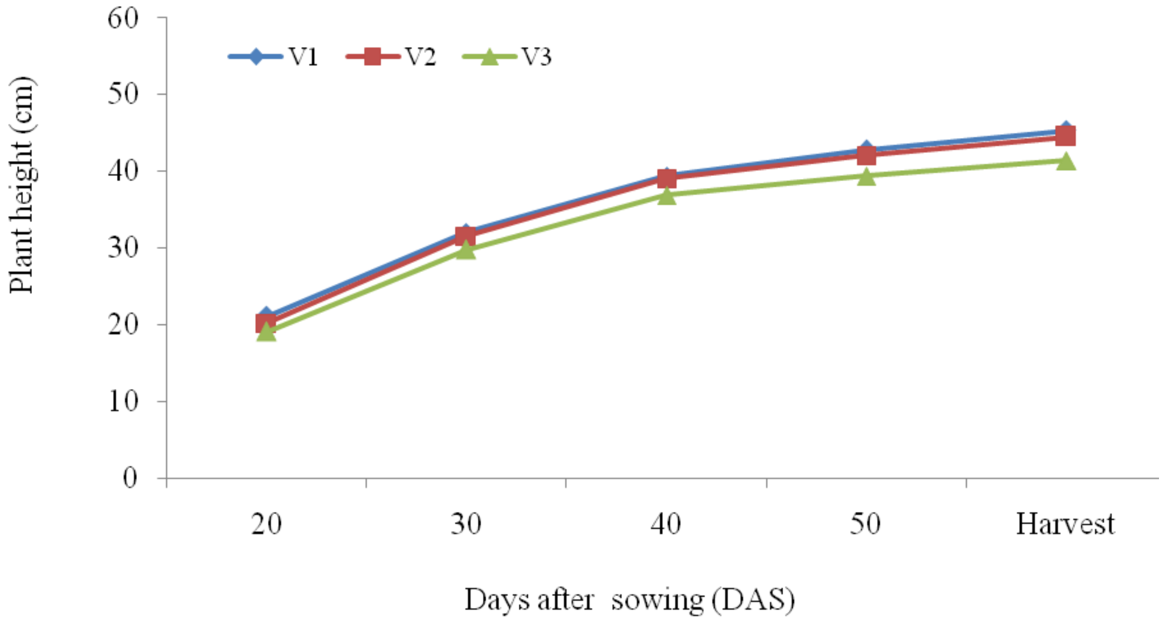
RESULTS AND DISCUSSION

The analyses of variance (ANOVA) of the data on different growth, yield parameters and yield are presented in Appendix III-IX. The results have been presented and discussed in the different tables and graphs and possible interpretations given under the following headings:

4.1. Crop Growth Characters

4.1.1. Plant Height

Plant height of mungbean at 20, 30, 40, 50 DAS and at harvest showed statistically significant variation due to different varieties (Appendix III). At 20, 30, 40, 50 DAS and at harvest, the tallest plant (21.11, 32.00, 39.34, 42.77 and 45.33 cm, respectively) was recorded from V_1 (BARI Mung-6) which was statistically similar (20.20, 31.52, 39.02, 42.05 and 44.48 cm, respectively) to V_2 (BINA Mung-5). Whereas, the shortest plant (19.11, 29.80, 36.88, 39.36 and 41.40 cm, respectively) was recorded from V_3 (Local variety-Sonamug) at 20, 30, 40, 50 DAS and at harvest (Figure 1). Variety plays an important role in producing high yield of mungbean because varieties differ as of their genotypic characters. Different varieties showed different plant height due to their varietal characters and an improved variety is the first and foremost requirement for initiation and accelerated production program of any crop. As of complex nature of salinity stress and lack of appropriate techniques for introgression little progress has been made in developing salt tolerant mungbean varieties (Mahdavi and Sanavy, 2007). Brar *et al.* (2004) reported that SML 668 has an average plant height of 44.6 as an early maturing cultivar.



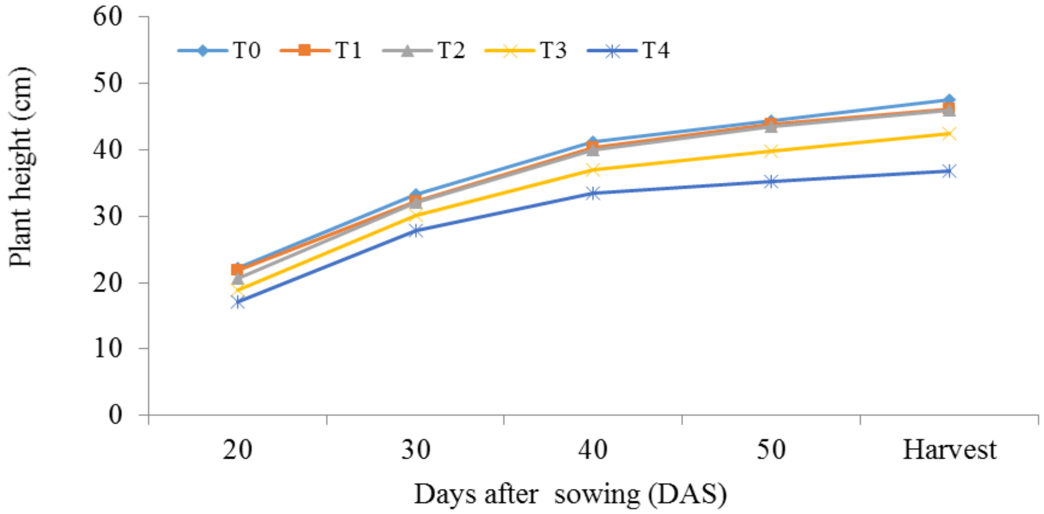
V_1: BARI Mung-6 V_2: BINA Mung-5

V_3: Local variety (Sonamung)

$LSD_{(0.05)}$: 0.91, 0.88, 1.32, 1.22, 1.27 at 20, 30, 40, 50 DAS and at Harvest respectively

Figure 1. Effect of different varieties on plant height of mungbean.

Different levels of salinity showed significant variation in terms of plant height of mungbean at 20, 30, 40, 50 DAS and at harvest (Appendix III). At 20, 30, 40, 50 DAS and at harvest, the tallest plant (22.19, 33.32, 41.19, 44.42 and 47.45 cm, respectively) was found from T_0 (0 dS m^{-1} i.e. control), which was statistically similar (21.79, 32.23, 40.35, 43.83 and 46.15 cm, respectively) to T_1 (2 dS m^{-1}) and closely followed (20.68, 32.01, 39.98, 43.56 and 45.87 cm, respectively) by T_2 (4 dS m^{-1}). On the other hand, the shortest plant (17.09, 27.78, 33.52, 35.30 and 36.72 cm, respectively) was observed from T_4 (8 dS m^{-1}) which was followed (18.94, 30.19, 37.03, 39.86 and 42.50 cm, respectively) by T_3 (6 dS m^{-1}) at 20, 30, 40, 50 DAS and at harvest, respectively (Figure 2). Data revealed that the salt stress reduced the plant height of mungbean. Salt tolerance to plant is generally thought of the inherent ability of the plant to withstand the effects of high salt concentration in the rhizosphere. Mungbean is one of the world's most important and widespread crops with adverse effects of salinity (Sehrawat *et al*., 2015).



T_0: 0 dS m^{-1} (control) T_1: 2 dS m^{-1} T_2: 4 dS m^{-1}

T_3: 6 dS m^{-1} T_4: 8 dS m^{-1}

$LSD_{(0.05)}$: 1.18, 1.14, 1.71, 1.58, 1.64 at 20, 30, 40, 50 DAS and at Harvest respectively

Figure 2. Effect of different levels of salinity on plant height of mungbean.

Interaction effect of mungbean varieties and levels of salinity showed significant differences on plant height at 20, 30, 40, 50 DAS and at harvest (Appendix III). The tallest plant (25.03, 35.30, 44.73, 46.90 and 51.38 cm, respectively) was recorded from V_1T_0 (BARI Mung-6 +0 dS m^{-1} i.e. control), while the shortest plant (16.72, 27.40, 32.30, 33.93 and 34.92 cm, respectively) was recorded from V_3T_4 (Local variety + 8 dS m^{-1}) treatment combination (Table 1).

4.1.2. Number of Leaves plant^{-1}

Varieties of mungbean varied significantly on number of leaves plant^{-1} at 20, 30, 40, 50 DAS and at harvest (Appendix IV). At 20, 30, 40, 50 DAS and at harvest, the maximum number of leaves plant^{-1} (13.53, 23.67, 30.20, 33.20 and 34.60, respectively) was recorded from V_1 which was statistically similar (12.67, 22.93, 30.07, 32.00 and 33.20, respectively) to V_2, while the minimum number (11.80, 18.67, 24.07, 27.40 and 28.33, respectively) was recorded from V_3 at 20, 30, 40, 50 DAS and at harvest (Figure 3). Management practices influence the number of leaves per plant but varieties itself also manipulated it.

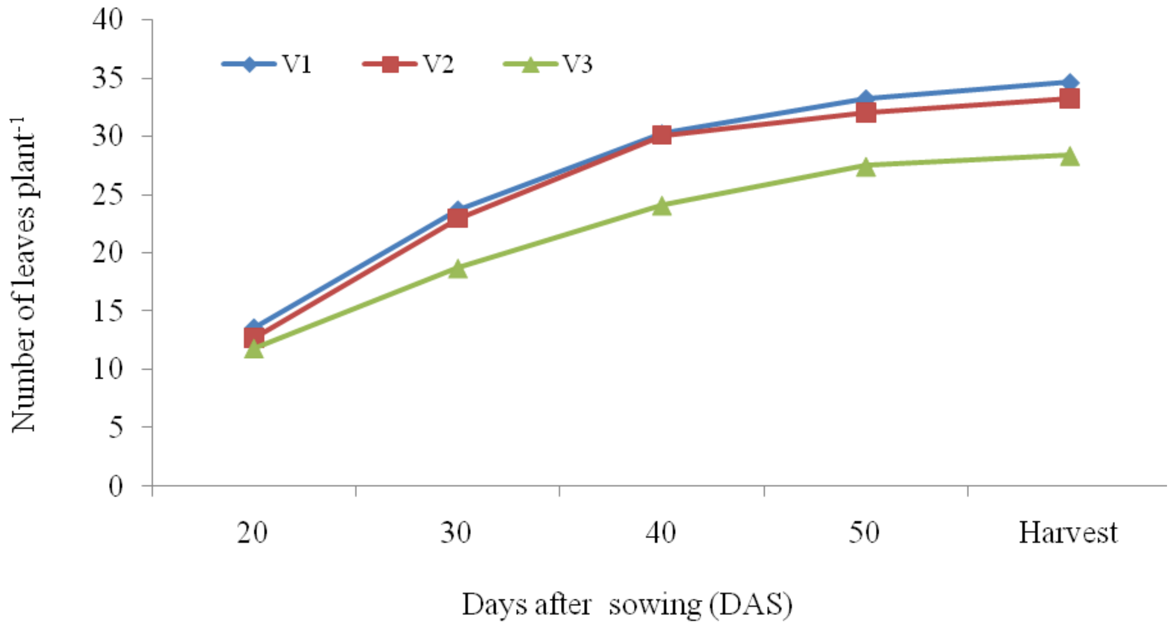
Table 1. Effect of different varieties and salinity levels on plant height of mungbean at different days after sowing (DAS)

Treatments	Plant height (cm)at				
	20 DAS	30 DAS	40 DAS	50 DAS	Harvest
V_1T_0	25.03 a	35.30 a	44.73 a	46.90 a	51.38 a
V_1T_1	22.70 b	33.95 ab	41.92 ab	46.64 a	48.67 ab
V_1T_2	20.78 bcd	32.84 b	40.04 bcd	44.49 a	46.30 bcd
V_1T_3	19.43 def	30.20 cd	36.62 ef	39.73 c	42.78 e
V_1T_4	17.62 fg	27.68 e	33.38 g	36.10 d	37.54 f
V_2T_0	22.26 bc	33.94 ab	41.28 b	45.15 a	47.92 b
V_2T_1	21.56 bcd	31.98 bc	40.39 bc	43.96 ab	46.46 bc
V_2T_2	20.95 bcd	33.00 b	41.08 b	44.94 a	47.02 bc
V_2T_3	19.30 def	30.42 cd	37.46 cdef	40.32 c	43.33 de
V_2T_4	16.94 g	28.26 de	34.89 fg	35.86 d	37.69 f
V_3T_0	19.29 def	30.71 c	37.55 cdef	41.20 bc	43.05 e
V_3T_1	21.12 bcd	30.76 c	38.73 bcde	40.89 c	43.33 de
V_3T_2	20.32 cde	30.18 cd	38.84 bcde	41.25 bc	44.28 cde
V_3T_3	18.10 efg	29.94 cd	37.00 def	39.54 c	41.40 e
V_3T_4	16.72 g	27.40 e	32.30 g	33.93 d	34.92 f
$LSD_{(0.05)}$	2.042	1.973	2.955	2.738	2.844
CV(%)	6.06	5.79	4.60	5.96	4.89

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

V_1: BARI Mung-6
V_2: BARI Mung-5
V_3: Local variety (Sonamung)

T_0: 0 dS m^{-1} (control)
T_1: 2 dS m^{-1}
T_2: 4 dS m^{-1}
T_3: 6 dS m^{-1}
T_4: 8 dS m^{-1}



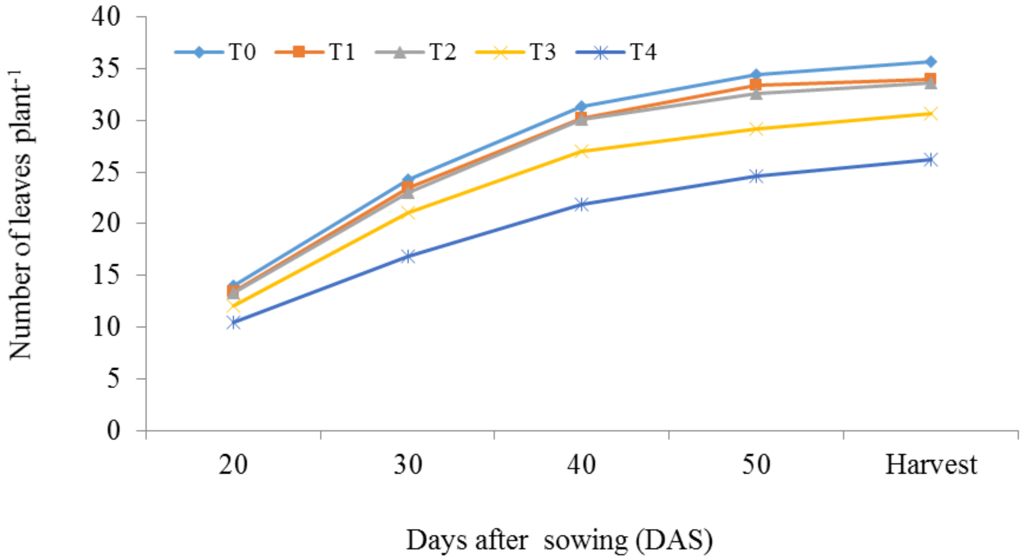
V_1: BARI Mung-6 V_2: BINA Mung-5

V_3: Local variety (Sonamung)

LSD(0.05) : 0.56, 1.25, 1.70, 1.46, 1.41 at 20, 30, 40, 50 DAS and at Harvest respectively

Figure 3. Effect of different varieties on number of leaves plant^{-1} of mungbean.

Number of leaves plant^{-1} of mungbean at 20, 30, 40, 50 DAS and at harvest showed significant variation for different levels of salinity (Appendix IV). At 20, 30, 40, 50 DAS and at harvest, the maximum number of leaves plant^{-1} (14.00, 24.33, 31.33, 34.44 and 35.67, respectively) was found from T_0, which was statistically similar (13.44, 23.44, 30.22, 33.44 and 34.00, respectively) to T_1 and was closely followed (13.33, 23.00, 30.11, 32.56 and 33.67, respectively) by T_2. On the other hand, the minimum number (10.44, 16.89, 21.89, 24.67 and 26.22, respectively) was observed from T_4 which was followed (12.11, 21.11, 27.00, 29.22 and 30.67, respectively) by T_3 at 20, 30, 40, 50 DAS and at harvest, respectively (Figure 4). Amira and Abdul (2010) reported that growth parameters were significantly reduced with high salinity levels.



T_0: 0 dS m^{-1} (control) T_1: 2 dS m^{-1} T_2: 4 dS m^{-1}

T_3: 6 dS m^{-1} T_4: 8 dS m^{-1}

$LSD_{(0.05)}$: 0.73, 1.61, 2.19, 1.88, 1.82 at 20, 30, 40, 50 DAS and at Harvest respectively

Figure 4. Effect of different levels of salinity on number of leaves plant^{-1} of mungbean.

Statistically significant variation was recorded in terms of number of leaves plant^{-1} at 20, 30, 40, 50 DAS and at harvest due to the interaction effect of mungbean varieties and levels of salinity (Appendix IV). The maximum number of leaves plant^{-1} (15.67, 27.67, 36.00, 39.33 and 40.33, respectively) was recorded from V_1T_0, while the minimum number (10.00, 13.67, 20.33, 22.33 and 24.00, respectively) was recorded from V_3T_4 treatment combination (Table 2).

4.1.3. Dry Matter Content Plant^{-1}

Different varieties of mungbean varied significantly in terms of dry matter content plant^{-1} at 20, 30, 40, 50 DAS and at harvest (Appendix V). Those times, the highest dry matter content plant^{-1} (1.59, 6.87, 13.47, 15.92 and 17.68 g, respectively) was recorded from V_1 which was statistically similar (1.48, 6.61, 12.85, 15.70 and 17.32 g, respectively) to V_2, while the lowest (1.35, 5.89, 11.59, 14.68 and 15.79 g, respectively) was recorded from V_3 at 20, 30, 40, 50 DAS and at harvest (Figure 5). Variety plays an important role on yield potentiality of their genotypic makeup to accumulate dry matter content (Singh and Singh, 2011).

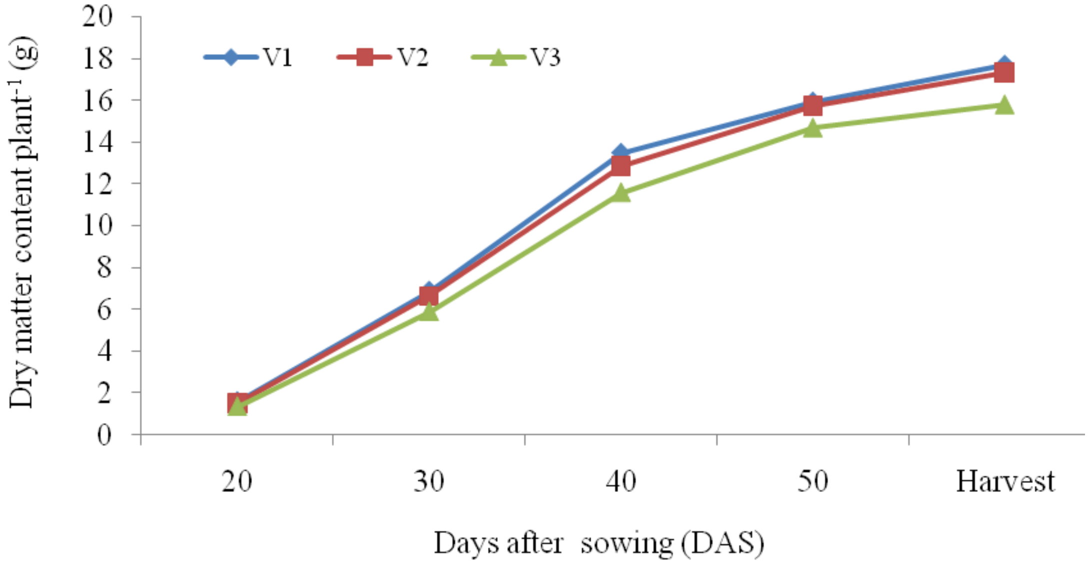
Table 2. Effect of different varieties and salinity levels on number of leaves plant^{-1} of mungbean at different days after sowing (DAS)

Treatments	Number of leaves plant^{-1} at				
	20 DAS	30 DAS	40 DAS	50 DAS	Harvest
V_1T_0	15.67 a	27.67 a	36.00 a	39.33 a	40.33 a
V_1T_1	14.67 ab	26.67 ab	35.00 ab	36.67 ab	38.33 a
V_1T_2	14.00 bc	22.33 cd	30.67 c	33.67 bc	35.00 bc
V_1T_3	12.33 de	23.67 bc	27.67 cdef	30.67 cde	32.00 cde
V_1T_4	11.00 ef	18.00 f	21.67 gh	25.67 f	27.33 f
V_2T_0	14.33 b	26.33 ab	35.33 a	36.67 ab	38.00 ab
V_2T_1	13.33 bcd	24.00 bc	31.33 bc	34.00 bc	35.00 bc
V_2T_2	13.33 bcd	24.00 bc	31.33 bc	33.33 bcd	34.33 cd
V_2T_3	12.00 de	21.33 cde	28.67 cd	30.00 de	31.33 de
V_2T_4	10.33 f	19.00 ef	23.67 fgh	26.00 f	27.33 f
V_3T_0	12.00 de	19.00 ef	22.67 gh	27.33 ef	28.67 ef
V_3T_1	12.33 de	19.67 def	24.33 efgh	29.67 e	28.67 ef
V_3T_2	12.67 cd	22.67 cd	28.33 cde	30.67 cde	31.67 cde
V_3T_3	12.00 de	18.33 ef	24.67 defg	27.00 ef	28.67 ef
V_3T_4	10.00 f	13.67 g	20.33 h	22.33 g	24.00 g
$LSD_{(0.05)}$	1.259	2.791	3.806	3.260	3.152
CV(%)	5.94	7.67	8.10	6.32	5.88

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

V_1: BARI Mung-6
V_2: BARI Mung-5
V_3: Local variety (Sonamung)

T_0: 0 dS m^{-1} (control)
T_1: 2 dS m^{-1}
T_2: 4 dS m^{-1}
T_3: 6 dS m^{-1}
T_4: 8 dS m^{-1}



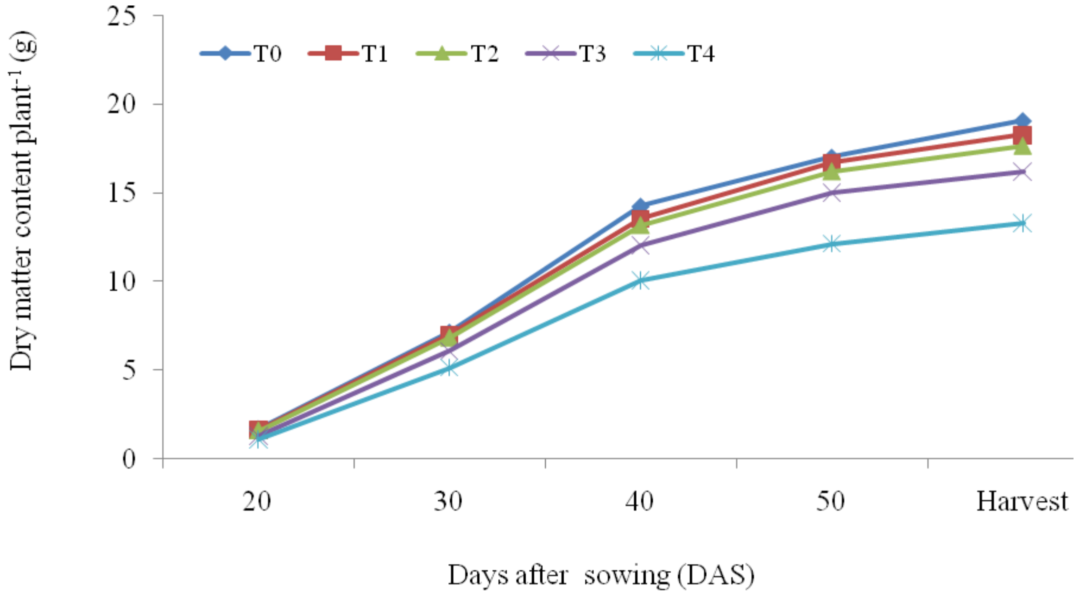
V_1: BARI Mung-6 V_2: BINA Mung-5

V_3: Local variety (Sonamung)

$LSD_{(0.05)}$: 0.05, 0.27, 0.45, 0.49, 0.52 at 20, 30, 40, 50 DAS and at Harvest respectively

Figure 5. Effect of different varieties on dry matter contents plant^{-1} of mungbean.

Dry matter content plant^{-1} (g) of mungbean at 20, 30, 40, 50 DAS and at harvest showed significant variation due to different levels of salinity (Appendix V). At 20, 30, 40, 50 DAS and at harvest, the highest dry matter content plant^{-1} (1.71, 7.15, 14.26, 17.02 and 19.08 g, respectively) was found from T_0, which was statistically similar (1.64, 7.01, 13.57, 16.69 and 18.29 g, respectively) to T_1 and closely followed (1.60, 6.85, 13.20, 16.24 and 17.69 g, respectively) by T_2. On the other hand, the lowest dry matter content plant^{-1} (1.09, 5.16, 10.09, 12.18 and 13.34 g, respectively) was observed from T_4 which was followed (1.32, 6.11, 12.06, 15.03 and 16.23 g, respectively) by T_3 at 20, 30, 40, 50 DAS and at harvest, respectively (Figure 6).



T_0: 0 dS m^{-1} (control) T_1: 2 dS m^{-1} T_2: 4 dS m^{-1}

T_3: 6 dS m^{-1} T_4: 8 dS m^{-1}

LSD(0.05) : 0.06, 0.35, 0.57, 0.63, 0.67 at 20, 30, 40, 50 DAS and at Harvest respectively

Figure 6. Effect of different levels of salinity on dry matter content plant^{-1} of mungbean.

Statistically significant variation was observed in terms of dry matter content plant^{-1} at 20, 30, 40, 50 DAS and at harvest due to the interaction effect of mungbean varieties and levels of salinity (Appendix V). The highest dry matter content plant^{-1} (2.01, 7.93, 15.09, 17.95 and 20.34 g, respectively) was recorded from V_1T_0, while the lowest dry matter content plant^{-1} (1.02, 5.02, 10.05, 11.97 and 13.07, respectively) was recorded from V_3T_4 treatment combination (Table 3).

Table 3. Effect of different varieties and salinity levels on dry matter content plant^{-1} (g) of mungbean at different days after sowing (DAS)

Treatments	Dry matter contents plant^{-1} (g) at				
	20 DAS	30 DAS	40 DAS	50 DAS	Harvest
V_1T_0	2.01 a	7.93 a	15.90 a	17.95 a	20.34 a
V_1T_1	1.83 b	7.86 a	15.44 a	17.73 abc	19.35 abc
V_1T_2	1.56 cd	6.95 b	13.32 bc	16.62 bcde	18.50 c
V_1T_3	1.41 ef	6.27 cde	12.58 bcd	15.09 f	16.43 ef
V_1T_4	1.13 h	5.33 fg	10.14 f	12.21 g	13.77 g
V_2T_0	1.77 b	7.77 a	15.18 a	17.78 ab	19.80 ab
V_2T_1	1.61 c	6.97 b	13.44 b	16.58 cde	18.59 bc
V_2T_2	1.61 c	6.90 bc	13.31 bc	16.66 bcd	18.22 cd
V_2T_3	1.27 g	6.27 cde	12.24 cde	15.14 f	16.77 e
V_2T_4	1.13 h	5.13 fg	10.08 f	12.36 g	13.19 g
V_3T_0	1.34 fg	5.75 ef	11.72 de	15.32 f	17.09 de
V_3T_1	1.49 de	6.19 de	11.83 de	15.78 def	16.94 e
V_3T_2	1.62 c	6.70 bcd	12.97 bc	15.45 ef	16.34 ef
V_3T_3	1.27 g	5.79 ef	11.37 e	14.86 f	15.49 f
V_3T_4	1.02 i	5.02 g	10.05 f	11.97 g	13.07 g
$LSD_{(0.05)}$	0.106	0.612	0.997	1.086	1.168
CV(%)	4.19	5.67	4.71	6.21	4.13

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

V_1: BARI Mung-6
V_2: BARI Mung-5
V_3: Local variety (Sonamung)

T_0: 0 dS m^{-1} (control)
T_1: 2 dS m^{-1}
T_2: 4 dS m^{-1}
T_3: 6 dS m^{-1}
T_4: 8 dS m^{-1}

4.1.4. Crop Growth Rate (CGR)

Data revealed that crop growth rate (CGR) varied significantly due to different mungbean varieties at 20-30, 30-40, 40-50 DAS and 50 DAS-harvest (Appendix VI). At 20-30 DAS, the highest CGR (7.58 g $m^{-2}day^{-1}$) was found from V_1, which was statistically similar (7.32 g $m^{-2}day^{-1}$) to V_2, while the lowest CGR (6.49 g $m^{-2}day^{-1}$) from V_3 (Table 4). At 30-40 DAS, the highest CGR (9.44 g $m^{-2}day^{-1}$) was found from V_1, which was followed (8.92 g $m^{-2}day^{-1}$) by V_2, while the lowest CGR (8.14 g $m^{-2}day^{-1}$) from V_3. At 40-50 DAS, the highest CGR (4.41 g $m^{-2}day^{-1}$) was found from V_3, which statistically similar (4.08 g $m^{-2}day^{-1}$) to V_2, while the lowest CGR (3.49 g $m^{-2}day^{-1}$) from V_1. At 50 DAS-harvest, the highest CGR (2.90 g $m^{-2}day^{-1}$) was found from V_1, which was followed (2.13 g $m^{-2}day^{-1}$) by V_2, while the lowest CGR (0.99 g $m^{-2}day^{-1}$) from V_3.

Crop growth rate (CGR) varied significantly due to different levels of salinity at 20-30, 30-40, 40-50 DAS and 50 DAS-harvest (Appendix VI). At 20-30 DAS, the highest CGR (7.84 g $m^{-2}day^{-1}$) was found from T_0, which was statistically similar (7.66 g $m^{-2}day^{-1}$ and 7.50 g $m^{-2}day^{-1}$) to T_1 and T_2, while the lowest CGR (5.81 g $m^{-2}day^{-1}$) from T_4 (Table 4). At 30-40 DAS, the highest CGR (10.17 g $m^{-2}day^{-1}$) was found from T_0, which was followed (9.37 g $m^{-2}day^{-1}$ and 9.07 g $m^{-2}day^{-1}$) by T_1 and T_2, while the lowest CGR (7.04 g $m^{-2}day^{-1}$) from T_4. At 40-50 DAS, the highest CGR (4.47 g $m^{-2}day^{-1}$) was found from T_1, which was followed (4.35 g $m^{-2}day^{-1}$ and 4.24 g $m^{-2}day^{-1}$) by T_2 and T_3, while the lowest CGR (2.98 g $m^{-2}day^{-1}$) from T_4. At 50 DAS-harvest, the highest CGR (3.38 g $m^{-2}day^{-1}$) was found from T_1, which was followed (2.12 g $m^{-2}day^{-1}$ and 1.84 g $m^{-2}day^{-1}$) by T_2 and T_3, while the lowest CGR (1.25 g $m^{-2}day^{-1}$) from T_4.

Interaction effect of different varieties and levels of salinity varied CGR values at 20-30, 30-40, 40-50 DAS and 50 DAS-harvest (Appendix VI). At 20-30 DAS, the highest CGR (8.66 g $m^{-2}day^{-1}$) was found from V_1T_0, while the lowest CGR (5.71 g $m^{-2}day^{-1}$) from V_3T_4 (Table 5). At 30-40 DAS, the highest CGR (11.38 g $m^{-2}day^{-1}$) was found from V_1T_0, while the lowest (6.87 g $m^{-2}day^{-1}$) from V_1T_4. At 40-50 DAS, the highest CGR (5.64 g $m^{-2}day^{-1}$) was found from V_3T_1, while the lowest (2.74 g $m^{-2}day^{-1}$) from V_3T_4. At 50 DAS-harvest, the highest CGR (5.41 g $m^{-2}day^{-1}$) was found from V_1T_0, while the lowest (0.54 g $m^{-2}day^{-1}$) from V_3T_3.

Table 4. Effect of different varieties and salinity level on Crop Growth Rate (CGR) of mungbean

Treatments	CGR: Crop Growth Rate (g $m^{-2}day^{-1}$) at			
	20-30 DAS	30-40 DAS	40-50 DAS	50 DAS-Harvest
Variety				
V_1	7.58 a	9.44 a	3.49 b	2.90 a
V_2	7.32 a	8.92 b	4.08 ab	2.13 b
V_3	6.49 b	8.14 c	4.41 a	0.99 c
$LSD_{(0.05)}$	0.364	0.430	0.735	0.634
Level of salinity				
T_0	7.84 a	10.17 a	3.93 ab	3.38 a
T_1	7.66 a	9.37 b	4.47 a	2.12 b
T_2	7.50 a	9.07 b	4.35 a	1.84 b
T_3	6.85 b	8.50 c	4.24 a	1.45 b
T_4	5.81 c	7.04 d	2.98 b	1.25 b
$LSD_{(0.05)}$	0.470	0.556	0.949	0.819
CV(%)	6.83	6.51	14.60	12.22

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

V_1: BARI Mung-6
V_2: BARI Mung-5
V_3: Local variety (Sonamung)

T_0: 0 dS m^{-1} (control)
T_1: 2 dS m^{-1}
T_2: 4 dS m^{-1}
T_3: 6 dS m^{-1}
T_4: 8 dS m^{-1}

Table 5. Interaction effect of different varieties and salinity levels on Crop Growth Rate (CGR) of mungbean

Treatments	CGR: Crop Growth Rate (g $m^{-2}day^{-1}$) at			
	20-30 DAS	30-40 DAS	40-50 DAS	50 DAS-Harvest
V_1T_0	8.66 a	11.38 a	2.92 cd	5.41 a
V_1T_1	8.62 a	10.82 a	3.27 bcd	2.50 bcd
V_1T_2	7.69 b	9.10 bc	4.71 abc	2.78 bc
V_1T_3	6.94 bcde	9.01 bcd	3.59 bcd	1.93 bcde
V_1T_4	6.00 fg	6.87 f	2.95 cd	1.90 bcde
V_2T_0	8.56 a	10.58 a	3.73 bcd	3.24 b
V_2T_1	7.65 b	9.24 b	4.49 abcd	2.63 bc
V_2T_2	7.56 bc	9.16 b	4.78 abc	1.96 bcde
V_2T_3	7.13 bcde	8.53 bcd	4.15 abcd	1.89 bcde
V_2T_4	5.72 g	7.07 ef	3.25 bcd	0.94 de
V_3T_0	6.30 efg	8.53 bcd	5.14 ab	1.50 cde
V_3T_1	6.71 cdef	8.06 cde	5.64 a	1.22 cde
V_3T_2	7.26 bcd	8.96 bcd	3.54 bcd	0.78 e
V_3T_3	6.47 defg	7.97 de	4.99 ab	0.54 e
V_3T_4	5.71 g	7.19 ef	2.74 d	0.92 de
$LSD_{(0.05)}$	0.814	0.962	1.643	1.418
CV(%)	6.83	6.51	14.60	12.22

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

V_1: BARI Mung-6
V_2: BARI Mung-5
V_3: Local variety (Sonamung)

T_0: 0 dS m^{-1} (control)
T_1: 2 dS m^{-1}
T_2: 4 dS m^{-1}
T_3: 6 dS m^{-1}
T_4: 8 dS m^{-1}

4.1.5. Relative Growth Rate (RGR)

Statistically non significant variation was recorded for relative growth rate (RGR) due to different varieties of mungbean at 20-30 and 30-40 but significant for 40-50 DAS and 50 DAS-harvest (Appendix VII). However, at 40-50 DAS, the highest RGR (0.023 g g^{-1} day^{-1}) was recorded from V_3 and the lowest RGR (0.017 g g^{-1} day^{-1}) from V_1. At 50 DAS-harvest, the highest RGR (0.012 g g^{-1} day^{-1}) was recorded from V_1 and the lowest RGR (0.005 g g^{-1} day^{-1}) from V_3 (Table 6)

Relative growth rate (RGR) of mungbean showed statistically significant variation due to different levels of salinity at 20-30 and 50-harvest but non significant for 30-40 DAS and 40-50 DAS (Appendix VII). At 20-30 DAS, the highest RGR (0.155 g g^{-1} day^{-1}) was recorded from T_4 and the lowest RGR (0.144 g g^{-1} day^{-1}) from T_0 (Table 6). At 30-40 DAS, the highest RGR (0.069 g g^{-1} day^{-1}) was recorded from T_0 and the lowest RGR (0.066 g g^{-1} day^{-1}) from T_1 and T_2. At 40-50 DAS, the highest RGR (0.022 g g^{-1} day^{-1}) was recorded from T_3 and the lowest RGR (0.018 g g^{-1} day^{-1}) from T_1. At 50 DAS-harvest, the highest RGR (0.013 g g^{-1} day^{-1}) was recorded from T_0 and the lowest RGR (0.006 g g^{-1} day^{-1}) from T_4.

Interaction effect of variety and levels of salinity varied RGR significantly at 20-30, 40-50 DAS and 50 DAS-harvest but non significant for 30-40 DAS (Appendix VII). At 20-30 DAS, the highest RGR (0.160 g g^{-1} day^{-1}) was recorded from V_3T_4 and the lowest RGR (0.137 g g^{-1} day^{-1}) from V_1T_0 (Table 7). At 40-50 DAS, the highest RGR (0.029 g g^{-1} day^{-1}) was recorded from V_3T_1 and the lowest RGR (0.012 g g^{-1} day^{-1}) from V_1T_0. At 50 DAS-harvest, the highest RGR (0.020 g g^{-1} day^{-1}) was recorded from V_1T_0 and the lowest RGR (0.002 g g^{-1} day^{-1}) from V_3T_3.

Table 6. Effect of different varieties and salinity level on Relative Growth Rate (RGR) of mungbean

Treatments	RGR: Relative growth rate (g g^{-1} day^{-1}) at			
	20-30 DAS	30-40 DAS	40-50 DAS	50 DAS-Harvest
Variety				
V_1	0.147	0.067	0.017 c	0.012 a
V_2	0.150	0.067	0.020 b	0.009 b
V_3	0.148	0.068	0.023 a	0.005 c
$LSD_{(0.05)}$	0.007	0.007	0.002	0.002
Level of salinity				
T_0	0.144 b	0.069	0.018	0.013 a
T_1	0.145 ab	0.066	0.021	0.008 b
T_2	0.146 ab	0.066	0.021	0.007 b
T_3	0.153 ab	0.068	0.022	0.007 b
T_4	0.155 a	0.067	0.019	0.006 b
$LSD_{(0.05)}$	0.009	0.009	0.009	0.003
CV(%)	5.43	6.22	0.01	0.01

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

V_1: BARI Mung-6
V_2: BARI Mung-5
V_3: Local variety (Sonamung)

T_0: 0 dS m^{-1} (control)
T_1: 2 dS m^{-1}
T_2: 4 dS m^{-1}
T_3: 6 dS m^{-1}
T_4: 8 dS m^{-1}

Table 7. Interaction effect of different varieties and salinity levels on Relative Growth Rate (RGR) of mungbean

Treatments	RGR: Relative growth rate (g g^{-1} day^{-1}) at			
	20-30 DAS	30-40 DAS	40-50 DAS	50 DAS-Harvest
V_1T_0	0.137 b	0.070	0.012 f	0.020 a
V_1T_1	0.146 ab	0.067	0.014 ef	0.009 bcd
V_1T_2	0.149 ab	0.065	0.022 bc	0.011 bc
V_1T_3	0.148 ab	0.070	0.018 cdef	0.009 bcd
V_1T_4	0.155 ab	0.064	0.019 cde	0.010 bc
V_2T_0	0.148 ab	0.067	0.016 def	0.012 b
V_2T_1	0.146 ab	0.066	0.021 bcd	0.010 bc
V_2T_2	0.145 ab	0.066	0.023 bc	0.008 bcde
V_2T_3	0.159 a	0.067	0.021 bcd	0.008 bcde
V_2T_4	0.151 ab	0.068	0.020 cd	0.005 cde
V_3T_0	0.146 ab	0.071	0.027 ab	0.006 bcde
V_3T_1	0.142 ab	0.065	0.029 a	0.005 cde
V_3T_2	0.142 ab	0.066	0.018 cdef	0.003 de
V_3T_3	0.152 ab	0.067	0.027 ab	0.002 e
V_3T_4	0.160 a	0.069	0.017 cdef	0.005 cde
$LSD_{(0.05)}$	0.017	0.017	0.005	0.005
CV(%)	5.43	6.22	0.01	0.01

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

V_1: BARI Mung-6
V_2: BARI Mung-5
V_3: Local variety (Sonamung)

T_0: 0 dS m^{-1} (control)
T_1: 2 dS m^{-1}
T_2: 4 dS m^{-1}
T_3: 6 dS m^{-1}
T_4: 8 dS m^{-1}

4.2 Yield contributing characters

4.2.1. Days to 1st Flowering

Different varieties played significantly on days to flowering (Appendix VIII). The highest days to flowering (36.13) was recorded from V_3 which was closely followed (34.93) by V_2, while the lowest days to flowering (34.00) was recorded from V_1 (Table 8). Days to 1st flowering varied for different varieties might be due to genetical and environmental influences as well as management practices.

Days to flowering of mungbean showed significant variation for different levels of salinity (Appendix VIII). The highest days to flowering (36.89) was found from T_4, which was statistically similar (35.89) to T_3 and closely followed (34.56) by T_2, while the lowest days to flowering (33.44) was observed from T_0 which was followed (34.33) by T_1 (Table 8). Amira and Abdul (2010) reported that growth parameters were significantly reduced with high salinity levels.

Statistically significant variation was recorded in terms of days to flowering due to the interaction effect of mungbean varieties and levels of salinity (Appendix VIII). The highest days to flowering (37.67) was recorded from V_3T_4, while the lowest days to flowering (31.67) was recorded from V_1T_0 treatment combination (Table 9).

4.2.2. Days to Harvest

Different varieties of mungbean varied significantly in terms of days to harvest (Appendix VIII). The highest days to harvest (66.07) was recorded from V_3 which was followed (61.27) by V_2, while the lowest days to harvest (59.40) was recorded from V_3 (Table 8).

Days to harvest of mungbean showed significant variation for different levels of salinity (Appendix VIII). The highest days to harvest (63.89) was found from T_4, which was statistically similar (62.89 and 62.44) to T_1 and T_2, while the lowest days to harvest (60.33) was observed from T_0 which was followed (61.67) by T_1 (Table 8).

Table 8. Effect of different varieties and salinity levels on days to flowering and maturity, number of seeds pod^{-1} and pod length of mungbean

Treatments	Days to 1st flowering	Days to harvest	Number of seeds pod^{-1}	Pod length (cm)
Variety				
V_1	34.00 c	59.40 c	8.03 a	8.02 a
V_2	34.93 b	61.27 b	7.56 b	7.47 b
V_3	36.13 a	66.07 a	6.69 c	6.52 c
$LSD_{(0.05)}$	0.798	1.120	0.261	0.296
Level of salinity				
T_0	33.44 c	60.33 c	8.38 a	8.26 a
T_1	34.33 bc	61.67 bc	8.18 ab	8.01 ab
T_2	34.56 b	62.44 ab	7.84 b	7.67 b
T_3	35.89 a	62.89 ab	7.04 c	7.01 c
T_4	36.89 a	63.89 a	5.70 d	5.75 d
$LSD_{(0.05)}$	1.030	1.446	0.337	0.378
CV(%)	5.04	4.41	4.71	5.35

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

V_1: BARI Mung-6
V_2: BARI Mung-5
V_3: Local variety (Sonamung)

T_0: 0 dS m^{-1} (control)
T_1: 2 dS m^{-1}
T_2: 4 dS m^{-1}
T_3: 6 dS m^{-1}
T_4: 8 dS m^{-1}

Table 9. Interaction effect of different varieties and salinity levels on days to flowering and maturity, number of seeds pod^{-1} and pod length of mungbean

Treatments	Days to 1st flowering	Days to harvest	Number of seeds pod^{-1}	Pod length (cm)
V_1T_0	31.67 f	56.33 f	9.56 a	9.26 a
V_1T_1	33.67 de	59.33 e	8.90 b	8.86 ab
V_1T_2	33.67 de	59.67 de	8.27 c	8.25 b
V_1T_3	35.00 bcde	60.00 de	7.53 de	6.89 cde
V_1T_4	36.00 abc	61.67 cde	5.90 h	6.85 cde
V_2T_0	33.00 ef	59.00 e	9.00 ab	9.13 a
V_2T_1	34.33 cde	61.00 cde	8.43 bc	8.27 b
V_2T_2	34.33 cde	61.00 cde	8.00 cd	7.22 cd
V_2T_3	36.00 abc	62.33 bcd	6.60 fg	7.42 cd
V_2T_4	37.00 ab	63.00 bc	5.77 h	5.29 f
V_3T_0	35.67 abcd	65.67 a	6.57 g	6.39 e
V_3T_1	35.00 bcde	64.67 ab	7.20 ef	6.89 cde
V_3T_2	35.67 abcd	66.67 a	7.27 e	7.53 c
V_3T_3	36.67 ab	66.33 a	7.00 efg	6.71 de
V_3T_4	37.67 a	67.00 a	5.43 h	5.10 f
$LSD_{(0.05)}$	1.783	2.504	0.584	0.656
CV(%)	5.04	4.41	4.71	5.35

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

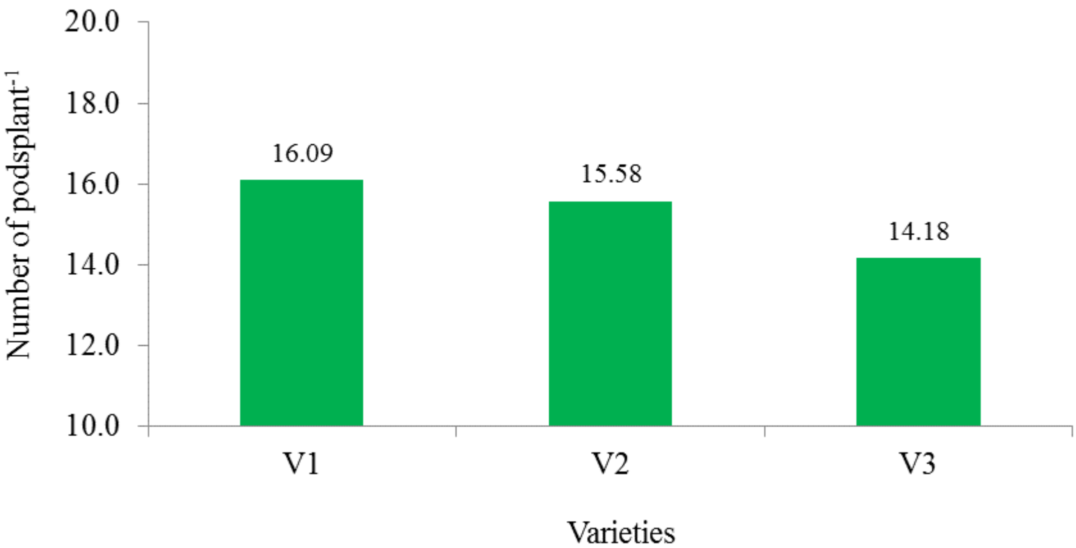
V_1: BARI Mung-6
V_2: BARI Mung-5
V_3: Local variety (Sonamung)

T_0: 0 dS m^{-1} (control)
T_1: 2 dS m^{-1}
T_2: 4 dS m^{-1}
T_3: 6 dS m^{-1}
T_4: 8 dS m^{-1}

Statistically significant variation was recorded in terms of days to harvest due to the interaction effect of mungbean varieties and levels of salinity (Appendix VIII). The highest days to harvest (67) was recorded from V_3T_4, while the lowest days to harvest (56.33) was recorded from V_1T_0 treatment combination (Table 9).

4.2.3. Number of Pods plant^{-1}

Different varieties of mungbean varied significantly in terms of number of pods plant^{-1} (Appendix VIII). The highest number of pods plant^{-1} (16.09) was recorded from V_1 which was statistically similar (15.58) to V_2, while the lowest number (14.18) was recorded from V_3 (Figure 7). Different varieties responded differently for pods per plant to input supply, method of cultivation and the prevailing environment during the growing season. Riaz *et al*. (2004) reported that NM-98 produced the maximum pod number of 77.30.

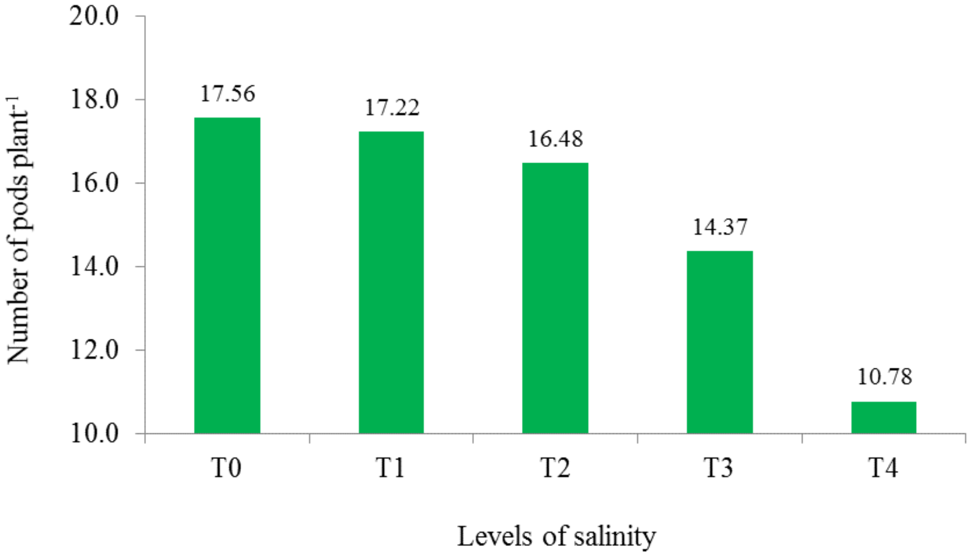


V_1: BARI Mung-6 (Sonamung) V_2: BINA Mung-5 V_3: Local variety

LSD(0.05) : 0.74

Figure 7. Effect of different varieties on number of pods plant^{-1} of mungbean.

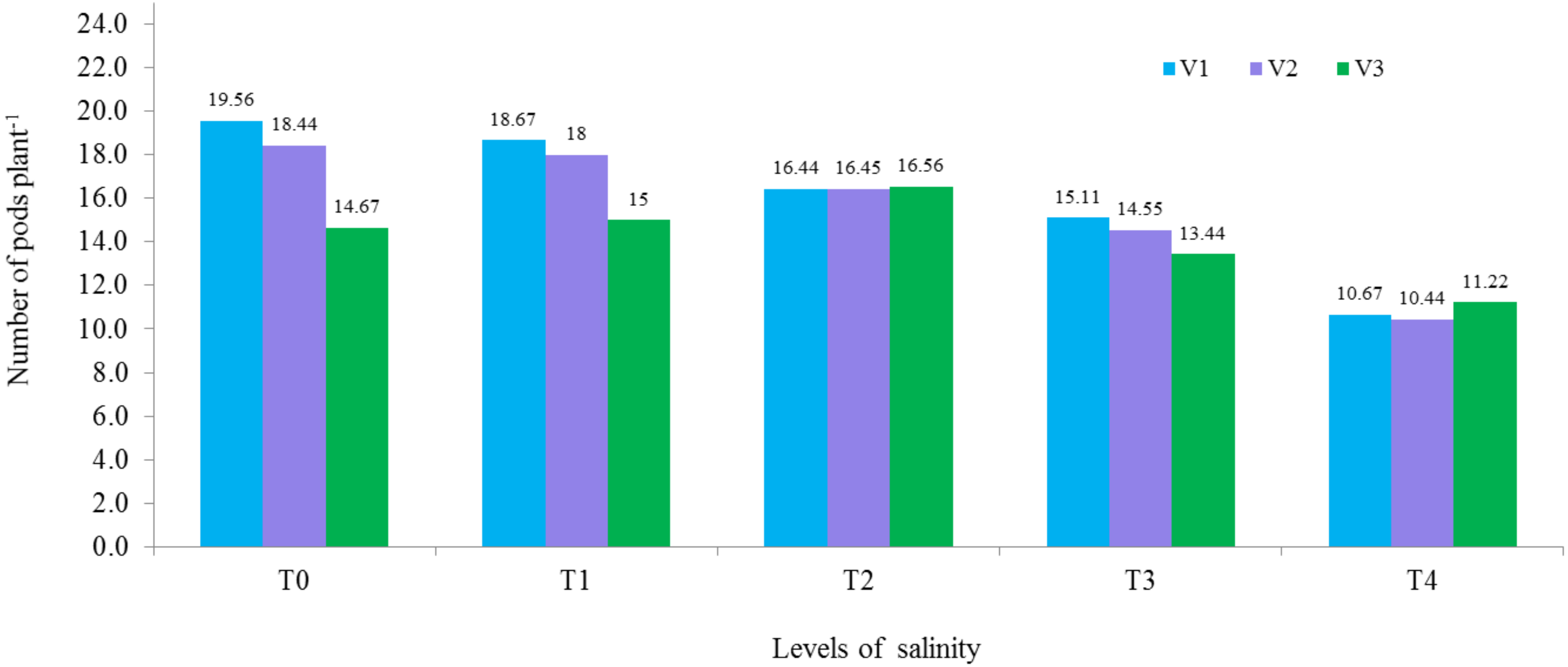
Number of pods plant^{-1} of mungbean showed significant variation for different levels of salinity (Appendix VIII). The highest number of pods plant^{-1} (17.56) was found from T_0, which was statistically similar (17.22) to T_1 and closely followed (16.48) by T_2, while the lowest number (10.78) was observed from T_4 which was followed (14.37) by T_3 (Figure 8). Amira and Abdul (2010) reported that growth parameters were significantly reduced with high salinity levels.



T_0: 0 dS m^{-1} (control) T_1: 2 dS m^{-1} T_2: 4 dS m^{-1}
T_3: 6 dS m^{-1} T_4: 8 dS m^{-1}
$LSD_{(0.05)}$: 0.95

Figure 8. Effect of different levels of salinity on number of pods plant^{-1} of mungbean.

Statistically significant variation was recorded in terms of number of pods plant^{-1} due to the interaction effect of mungbean varieties and levels of salinity (Appendix VIII). The highest number of pods plant^{-1} (19.56) was recorded from V_1T_0, while the lowest number (11.22) was recorded from V_3T_4 treatment combination (Figure 9).



V_1: BARI Mung-6 V_2: BINA Mung-5 T_0: 0 dS m^{-1} (control) T_1: 2 dS m^{-1} T_2: 4 dS m^{-1}

V_3: Local variety (Sonamung) T_3: 6 dS m^{-1} T_4: 8 dS m^{-1}

Figure 9. Combined effect of different varieties and levels of salinity on Number of pods plant^{-1} of mungbean. $LSD_{(0.05)}$: 1.65

4.2.4. Number of Seeds pod^{-1}

Different varieties of mungbean varied significantly in terms of number of seeds pod^{-1} (Appendix VIII). The highest number of seeds pod^{-1} (8.03) was recorded from V_1 which was followed (7.56) by V_2 while the lowest number (6.69) was recorded from V_3 (Table 8).

Number of seeds pod^{-1} of mungbean showed significant variation for different levels of salinity (Appendix VIII). The highest number of seeds pod^{-1} (8.38) was found from T_0 which was statistically similar (8.18) to T_1 and closely followed (7.84) by T_2 while the lowest number (5.70) was observed from T_4 which was followed (7.04) by T_3 (Table 8).

Statistically significant variation was recorded in terms of number of seeds pod^{-1} due to the interaction effect of mungbean varieties and levels of salinity (Appendix VIII). The highest number of seeds pod^{-1} (9.56) was recorded from V_1T_0 while the lowest number (5.43) was recorded from V_3T_4 treatment combination (Table 9).

4.2.5. Pod length

Varieties of mungbean varied significantly in terms of pod length (Appendix VIII). The highest pod length (8.02 cm) was recorded from V_1 which was followed (7.47 cm) to V_2, while the lowest pod length (6.52 cm) was recorded from V_3 (Table 8).

Pod length also showed significant variation exposed to levels of salinity (Appendix VIII). The highest pod length (8.26 cm) was found from T_0 which was statistically similar (8.01 cm) to T_1 and closely followed (7.67 cm) by T_2, while the lowest pod length (5.75 cm) was observed from T_4 which was followed (7.01 cm) by T_3 (Table 8). Amira and Abdul (2010) reported that growth parameters were significantly reduced with high salinity levels.

Statistically significant variation was recorded on pod length due to the interaction effect of mungbean varieties and levels of salinity (Appendix VIII). The highest pod length (9.26 cm) was recorded from V_1T_0 while the lowest pod length (5.10 cm) was recorded from V_3T_4 treatment combination (Table 9).

4.2.6. Weight of 1000 Seeds

Different varieties of mungbean varied significantly in terms of weight of 1000 seeds (Appendix VIII). The highest weight of 1000 seeds (49.07 g) was recorded from V_1 which was similar (48.03 g) to V_2 while the lowest weight of 1000 seeds (44.83 g) was recorded from V_3 (Table 10). Taj *et al*. (2003) recorded that highest average 1000-seeds weight 28.09 g from cultivars, NM 121-125.

Weight of 1000 seeds of mungbean showed significant variation for different levels of salinity (Appendix VIII). The highest weight of 1000 seeds (49.64 g) was found from T_0 which was statistically similar (49.17 g and 48.84 g) to T_1 and T_2 while the lowest weight of 1000 seeds (42.76 g) was observed from T_4 which was followed (46.15 g) by T_3 (Table 10).

Statistically significant variation was recorded in terms of weight of 1000 seeds due to the interaction effect of mungbean varieties and levels of salinity (Appendix VIII). The highest weight of 1000 seeds (52.17 g) was recorded from V_1T_0 while the lowest weight of 1000 seeds (41.67 g) was recorded from V_3T_4 treatment combination (Table 11).

Table 10. Effect of different varieties and salinity levels on weight of 1000 seeds, seed yield, stover yield and harvest index of mungbean

Treatments	Weight of 1000-seeds (g)	Seed yield (g plant^{-1})	Stover yield (g plant^{-1})	Harvest Index (%)
Variety				
V_1	49.07 a	6.65 a	11.14 a	36.02 a
V_2	48.03 a	5.95 b	10.56 b	34.77 a
V_3	44.83 b	4.34 c	9.57 c	30.72 b
$LSD_{(0.05)}$	1.296	0.373	0.539	1.719
Level of significance	0.01	0.01	0.01	0.01
Level of salinity				
T_0	49.64 a	7.56 a	11.96 a	37.68 a
T_1	49.17 a	7.06 b	11.56 a	37.38 a
T_2	48.84 a	6.31 c	11.35 a	35.81 a
T_3	46.15 b	4.69 d	9.51 b	32.85 b
T_4	42.76 c	2.62 e	7.74 c	25.46 c
$LSD_{(0.05)}$	1.673	0.481	0.697	2.219
CV(%)	5.66	8.82	6.92	6.79

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

V_1: BARI Mung-6
V_2: BARI Mung-5
V_3: Local variety (Sonamung)

T_0: 0 dS m^{-1} (control)
T_1: 2 dS m^{-1}
T_2: 4 dS m^{-1}
T_3: 6 dS m^{-1}
T_4: 8 dS m^{-1}

Table 11. Interaction effect of different varieties and salinity levels on weight of 1000 seeds, seed yield, stover yield and harvest index of mungbean

Treatments	Weight of 1000-seeds (g)	Seed yield (g plant^{-1})	Stover yield (g plant^{-1})	Harvest Index (%)
V_1T_0	52.17 a	9.76 a	12.82 a	43.22 a
V_1T_1	51.27 ab	8.53 b	12.77 a	40.03 ab
V_1T_2	49.03 abc	6.67 c	12.28 a	35.20 cd
V_1T_3	48.97 abc	5.56 de	9.73 c	36.33 bc
V_1T_4	43.92 def	2.76 g	8.11 de	25.32 g
V_2T_0	51.28 ab	8.51 b	12.67 a	40.20 ab
V_2T_1	51.21 ab	7.78 b	11.68 a	39.97 ab
V_2T_2	48.76 bc	6.42 cd	11.61 ab	35.59 cd
V_2T_3	46.24 cd	4.44 f	9.54 c	31.77 de
V_2T_4	42.68 ef	2.57 g	7.30 e	26.30 fg
V_3T_0	45.47 de	4.40 f	10.40 bc	29.61 ef
V_3T_1	45.04 de	4.86 ef	10.23 c	32.13 de
V_3T_2	48.73 bc	5.86 cd	10.17 c	36.63 bc
V_3T_3	43.23 def	4.07 f	9.27 cd	30.45 e
V_3T_4	41.67 f	2.54 g	7.80 e	24.75 g
$LSD_{(0.05)}$	2.898	0.833	1.207	3.843
CV(%)	5.66	8.82	6.92	6.79

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

V_1: BARI Mung-6
V_2: BARI Mung-5
V_3: Local variety (Sonamung)

T_0: 0 dS m^{-1} (control)
T_1: 2 dS m^{-1}
T_2: 4 dS m^{-1}
T_3: 6 dS m^{-1}
T_4: 8 dS m^{-1}

4.3 Yield

4.3.1. Seed Yield

Different varieties of mungbean varied significantly in terms of seed yield plant^{-1} (Appendix IX). The highest seed yield plant^{-1} (6.65 g) was recorded from V_1 which was closely followed (5.95 g) by V_2, while the lowest seed yield plant^{-1} (4.34 g) from V_3 (Table 10). Varieties plays an important role in producing high yield of mungbean and yield varied for different varieties might be due to genetical and environmental influences as well as management practices. Tickoo *et al*. (2006) recorded highest seed yield (1.63 t/ha) from cultivar Pusa Vishal.

Seed yield plant^{-1} of mungbean showed significant variation for different levels of salinity (Appendix IX). The highest seed yield plant^{-1} (7.56 g) was found from T_0, which was statistically similar (7.06 g) to T_1 and closely followed (6.31 g) by T_2, while the lowest seed yield plant^{-1} (2.62 g) was observed from T_4 which was followed (4.69 g) by T_3 (Table 10).

Statistically significant variation was recorded in terms of seed yield plant^{-1} due to the interaction effect of mungbean varieties and levels of salinity (Appendix IX). The highest seed yield plant^{-1} (9.76 g) was recorded from V_1T_0, while the lowest seed yield plant^{-1} (2.54 g) from V_3T_4 treatment combination (Table 11).

4.3.2. Stover Yield

Different varieties of mungbean varied significantly in terms of stover yield plant^{-1} (Appendix IX). The highest stover yield plant^{-1} (11.14 g) was recorded from V_1 which was closely followed (10.56 g) by V_2, while the lowest stover yield plant^{-1} (9.57 g) was recorded from V_3 (Table 10).

Stover yield plant^{-1} of mungbean showed significant variation for different levels of salinity (Appendix IX). The highest stover yield plant^{-1} (11.96 g) was found from T_0, which was statistically similar (11.56 g and 11.35 g) to T_1 and T_2, while the lowest stover yield plant^{-1} (7.74 g) was observed from T_4 which was followed (9.51 g) by T_3 (Table 10).

Statistically significant variation was recorded in terms of stover yield plant^{-1} due to the interaction effect of mungbean varieties and levels of salinity (Appendix IX). The highest stover yield plant^{-1} (12.82 g) was recorded from V_1T_0, while the lowest stover yield plant^{-1} (7.30) from V_2T_4 treatment combination (Table 11).

4.3.3. Biological Yield

Different varieties of mungbean varied significantly in terms of biological yield plant^{-1} (Appendix IX). The highest biological yield plant^{-1} (17.80 g) was recorded from V_1 which was followed (16.50 g) by V_2, while the lowest biological yield plant^{-1} (13.92 g) was recorded from V_3 (Figure 10).

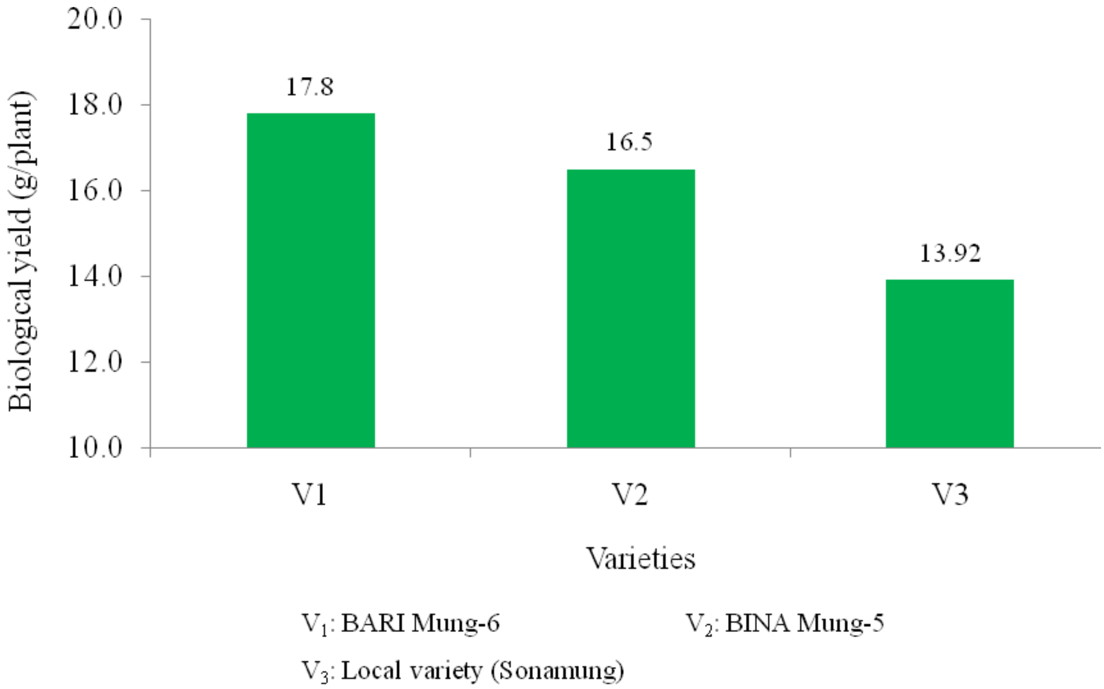
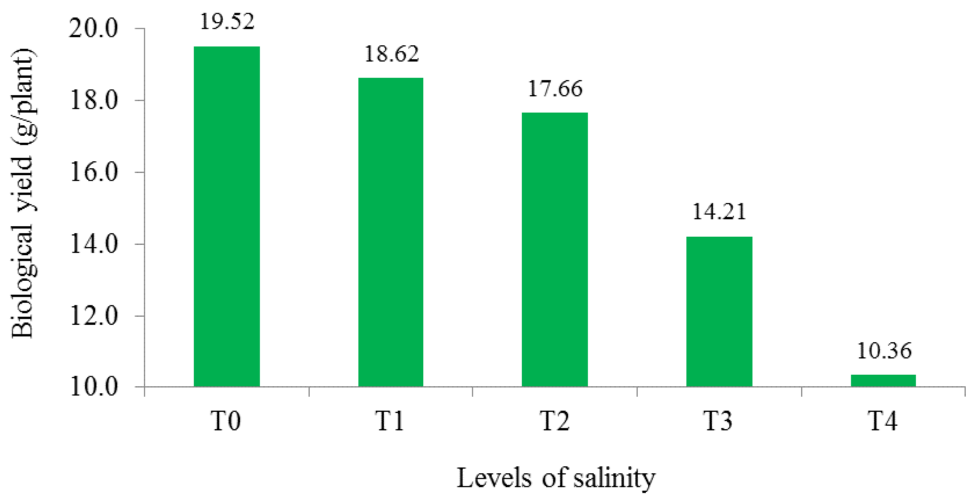


Figure 10. Effect of different varieties on biological yield of mungbean. $LSD_{(0.05)}$: 0.76

Biological yield plant^{-1} of mungbean showed significant variation for different levels of salinity (Appendix IX). The highest biological yield plant^{-1} (19.52 g) was found from T_0, which was statistically similar (18.62 g) to T_1 and closely followed (17.66 g) by T_2, while the lowest biological yield plant^{-1} (10.36 g) was observed from T_4 which was followed (14.21 g) by T_3 (Figure 11).

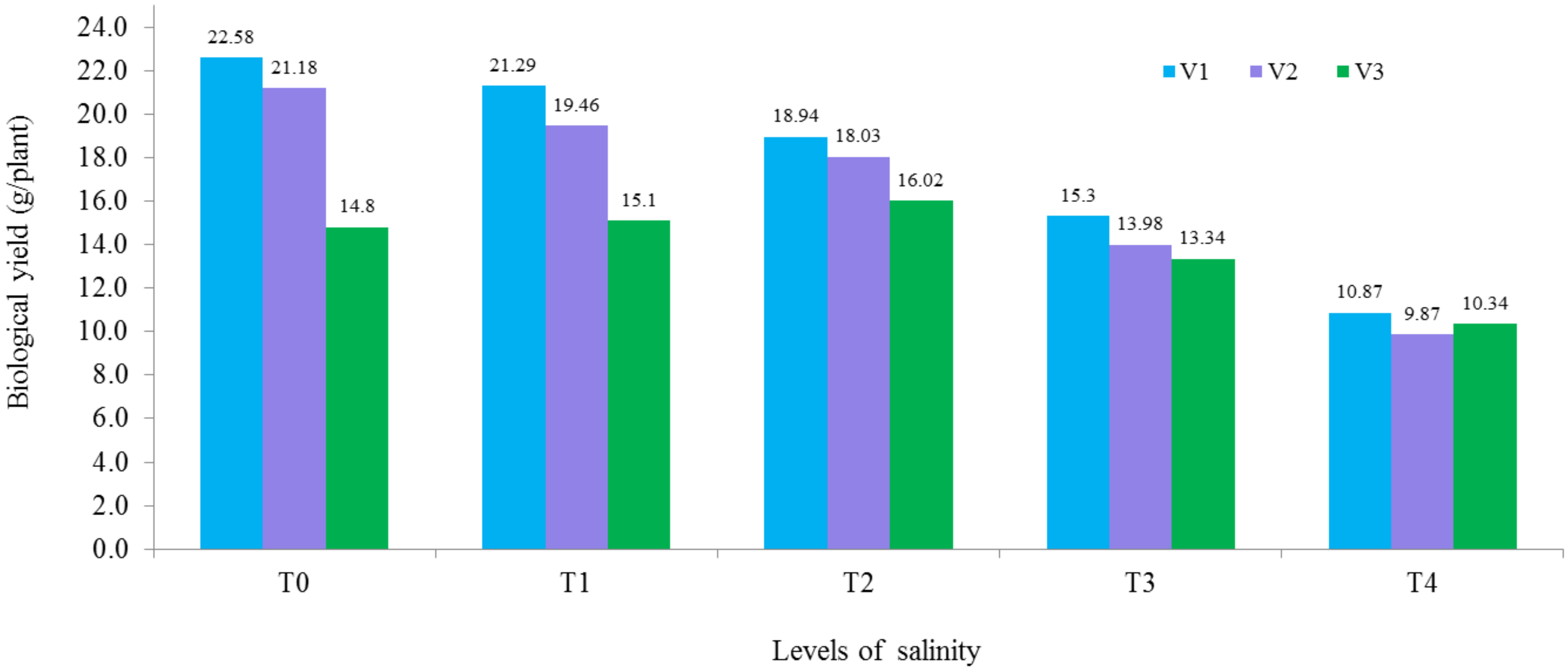


T_0: 0 dS m^{-1} (control) T_1: 2 dS m^{-1} T_2: 4 dS m^{-1}

T_3: 6 dS m^{-1} T_4: 8 dS m^{-1}

Figure 11. Effect of different levels of salinity on biological yield of mungbean. LSD$_{(0.05)}$: 0.97

Statistically significant variation was recorded in terms of biological yield plant^{-1} due to the interaction effect of mungbean varieties and levels of salinity (Appendix IX). The highest biological yield plant^{-1} (22.58 g) was recorded from V_1T_0, while the lowest biological yield plant^{-1} (9.87 g) was recorded from V_2T_4 treatment combination (Figure 12).



V_1: BARI Mung-6 V_2: BINA Mung-5 V_3: Local variety (Sonamung)

T_0: 0 dS m^{-1} (control) T_1: 2 dS m^{-1} T_2: 4 dS m^{-1} T_3: 6 dS m^{-1} T_4: 8 dS m^{-1}

Figure 12. Combined effect of different varieties and levels of salinity on biological yield of mungbean. $LSD_{(0.05)}$: 1.69

4.3.4. Harvest index

Different varieties of mungbean varied significantly in terms of harvest index (Appendix IX). The highest harvest index (36.02%) was recorded from V_1 which was statistically similar (34.77%) to V_2, while the lowest harvest index (30.72%) was recorded from V_3 (Table 10).

harvest index of mungbean showed significant variation for different levels of salinity (Appendix IX). The highest harvest index (37.68%) was found from T_0, which was statistically similar (37.38%) to T_1 and closely followed (35.81%) by T_2, while the lowest harvest index (25.46%) was observed from T_4 which was followed (32.85%) by T_3 (Table 10).

Statistically significant variation was recorded in terms of harvest index due to the interaction effect of mungbean varieties and levels of salinity (Appendix IX). The highest harvest index (43.22%) was recorded from V_1T_0, while the lowest harvest index (24.75%) was recorded from V_3T_4 treatment combination (Table 11).

CHAPTER V

SUMMARY AND CONCLUSION

The experiment salinity based study on summer mungbean adaptable to saline agriculture in Bangladesh was conducted at the Agronomy Research Farm of Sher-e-Bangla Agricultural University (SAU), Dhaka during the period from August to November 2013. The experiment consisted of two factors: Factor A: Different mungbean variety (3 varieties)- V_1: BARI Mung-6, V_2: BINA Mung-5, V_3: Local variety (Sonamung) and Factor B: Different levels of salinity (5 levels)-T_0: 0 dS m^{-1} (control), T_1: 2 dS m^{-1}, T_2: 4 dS m^{-1}, T_3: 6 dS m^{-1} and T_4: 8 dS m^{-1}. The two factors experiment was laid out in Randomized Complete Block Design (RCBD) with three replications.

In case of variety, 20, 30, 40, 50 DAS and at harvest, the tallest plant (21.11, 32.00, 39.34, 42.77 and 45.33 cm, respectively) was recorded from V_1, whereas the shortest plant (19.11, 29.80, 36.88, 39.36 and 41.40 cm, respectively) was recorded from V_3. At 20, 30, 40, 50 DAS and at harvest, the maximum number of leaves plant^{-1} (13.53, 23.67, 30.20, 33.20 and 34.60, respectively) was recorded from V_1, while the minimum number (11.80, 18.67, 24.07, 27.40 and 28.33, respectively) was recorded from V_3. At 20, 30, 40, 50 DAS and at harvest, the highest dry matter content plant^{-1} (1.59, 6.87, 13.47, 15.92 and 17.68 g, respectively) was recorded from V_1, while the lowest (1.35, 5.89, 11.59, 14.68 and 15.79 g, respectively) was recorded from V_3 at 20, 30, 40, 50 DAS and at harvest. At 20-30 DAS, the highest CGR (7.58 g $m^{-2}day^{-1}$) was found from V_1, while the lowest CGR (6.49 g $m^{-2}day^{-1}$) from V_3. At 30-40 DAS, the highest CGR (9.44 g $m^{-2}day^{-1}$) was found from V_1, while the lowest CGR (8.14 g $m^{-2}day^{-1}$) from V_3. At 40-50 DAS, the highest CGR (4.41 g $m^{-2}day^{-1}$) was found from V_3, while the lowest CGR (3.49 g $m^{-2}day^{-1}$) from V_1. At 50 DAS-harvest, the highest CGR (2.90 g $m^{-2}day^{-1}$) was found from V_1, while the lowest CGR (0.99 g $m^{-2}day^{-1}$) was recorded from V_3. At 20-30 DAS, the highest RGR (0.150 g g^{-1} day^{-1}) was recorded from V_3 and the lowest RGR (0.150 g g^{-1} day^{-1}) from V_2. At 30-40 DAS, the highest RGR (0.068 g g^{-1} day^{-1}) was recorded from V_3 and the lowest RGR (0.067 g g^{-1} day^{-1}) from V_2 and V_1. At 40-50 DAS, the highest RGR (0.023 g g^{-1} day^{-1}) was recorded from V_3 and the lowest RGR (0.017 g g^{-1} day^{-1}) from V_1. At 50 DAS-harvest, the highest RGR (0.012 g g^{-1} day^{-1}) was recorded from V_1 and the lowest RGR (0.005 g g^{-1} day^{-1}) from V_3.

The highest days to flowering (36.13) was recorded from V_3, while the lowest days to flowering (34.00) was recorded from V_1. The highest days to harvest (66.07) was recorded from V_3 while the lowest days to harvest (59.40) was recorded from V_3. The highest number of pods $plant^{-1}$ (16.09) was recorded from V_1, while the lowest number (14.18) was recorded from V_3. The highest number of seeds pod^{-1} (8.03) was recorded from V_1, while the lowest number (6.69) was recorded from V_3. The highest pod length (8.02 cm) was recorded from V_1, while the lowest pod length (6.52 cm) was recorded from V_3. The highest weight of 1000 seeds (49.07 g) was recorded from V_1, while the lowest weight of 1000 seeds (44.83 g) was recorded from V_3. The highest biological yield $plant^{-1}$ (17.80 g) was recorded from V_1, while the lowest biological yield $plant^{-1}$ (13.92 g) was recorded from V_3. The highest harvest index (36.02%) was recorded from V_1 while the lowest harvest index (30.72%) was recorded from V_3.

For levels of salinity, at 20, 30, 40, 50 DAS and at harvest, the tallest plant (22.19, 33.32, 41.19, 44.42 and 47.45 cm, respectively) was found from T_0 and the shortest plant (17.09, 27.78, 33.52, 35.30 and 36.72 cm, respectively) was observed from T_4. At 20, 30, 40, 50 DAS and at harvest, the maximum number of leaves $plant^{-1}$ (14.00, 24.33, 31.33, 34.44 and 35.67, respectively) was found from T_0, and the minimum number (10.44, 16.89, 21.89, 24.67 and 26.22, respectively) was observed from T_4. At 20, 30, 40, 50 DAS and at harvest, the highest dry matter content $plant^{-1}$ (1.71, 7.15, 14.26, 17.02 and 19.08 g, respectively) was found from T_0, and, the lowest dry matter content $plant^{-1}$ (1.09, 5.16, 10.09, 12.18 and 13.34 g, respectively) was observed from T_4. At 20-30 DAS, the highest CGR (7.84 g $m^{-2}day^{-1}$) was found from T_0, while the lowest CGR (5.81 g $m^{-2}day^{-1}$) from T_4 (Table 4). At 30-40 DAS, the highest CGR (10.17 g $m^{-2}day^{-1}$) was found from T_0, while the lowest CGR (7.04 g $m^{-2}day^{-1}$) from $T_{4.}$ At 40-50 DAS, the highest CGR (4.47 g

$m^{-2}day^{-1}$) was found from T_1, while the lowest CGR (2.98 g $m^{-2}day^{-1}$) from T_4. At 50 DAS-harvest, the highest CGR (3.38 g $m^{-2}day^{-1}$) was found from T_1, while the lowest CGR (1.25 g $m^{-2}day^{-1}$) from T_4. At 20-30 DAS, the highest RGR (0.155 g g^{-1} day^{-1}) was recorded from T_4 and the lowest RGR (0.144 g g^{-1} day^{-1}) from T_0 . At 30-40 DAS, the highest RGR (0.069 g g^{-1} day^{-1}) was recorded from T_0 and the lowest RGR (0.066 g g^{-1} day^{-1}) from T_1 and T_2. At 40-50 DAS, the highest RGR (0.022 g g^{-1} day^{-1}) was recorded from T_3 and the lowest RGR (0.018 g g^{-1} day^{-1}) from T_1. At 50 DAS-harvest, the highest RGR (0.013 g g^{-1} day^{-1}) was recorded from T_0 and the lowest RGR (0.006 g g^{-1} day^{-1}) from T_4.

The highest days to flowering (36.89) was found from T_4, while the lowest days to flowering (33.44) was observed from T_0. The highest days to harvest (63.89) was found from T_4, while the lowest days to harvest (60.33) was observed from T_0. The highest number of pods $plant^{-1}$ (17.56) was found from T_0, while the lowest number (10.78) was observed from T_4. The highest number of seeds pod^{-1} (8.38) was found from T_0, while the lowest number (5.70) was observed from T_4. The highest pod length (8.26 cm) was found from T_0, while the lowest pod length (5.75 cm) was observed from T_4. The highest weight of 1000 seeds (49.64 g) was found from T_0, while the lowest weight of 1000 seeds (42.76 g) was observed from T_4. The highest seed yield $plant^{-1}$ (6.65 g) was recorded from V_1, while the lowest seed yield $plant^{-1}$ (4.34 g) from V_3. The highest stover yield $plant^{-1}$ (11.14 g) was recorded from V_1, while the lowest stover yield $plant^{-1}$ (9.57 g) was recorded from V_3. The highest biological yield $plant^{-1}$ (19.52 g) was found from T_0, while the lowest biological yield $plant^{-1}$ (10.36 g) was observed from T_4. The highest harvest index (37.68%) was found from T_0, while the lowest harvest index (25.46%) was observed from T_4 which was followed (32.85%) by T_3.

Due to the interaction effect of mungbean varieties and levels of salinity, At 20, 30, 40, 50 DAS and harvest the tallest plant (25.03, 35.30, 44.73, 46.90 and 51.38 cm, respectively) was recorded from V_1T_0, while the shortest plant (16.72, 27.40, 32.30, 33.93 and 34.92 cm, respectively) was recorded from V_3T_4. The maximum number of leaves $plant^{-1}$ (15.67, 27.67, 36.00, 39.33 and 40.33, respectively) was recorded from V_1T_0, while the minimum number (10.00, 13.67, 20.33, 22.33 and 24.00, respectively) was recorded from V_3T_4 treatment combination. The highest dry matter content plant^{-1} (2.01, 7.93, 15.09, 17.95 and 20.34 g, respectively) was recorded from V_1T_0, while the lowest dry matter content plant^{-1} (1.02, 5.02, 10.05, 11.97 and 13.07, respectively) was recorded from V_3T_4 treatment combination. At 20-30 DAS, the highest CGR (8.66 g m^{-2}day^{-1}) was found from V_1T_0, while the lowest CGR (5.71 g m^{-2}day^{-1}) from V_3T_4. At 30-40 DAS, the highest CGR (11.38 g m^{-2}day^{-1}) was found from V_1T_0, while the lowest CGR (6.87 g m^{-2}day^{-1}) from V_1T_4. At 40-50 DAS, the highest CGR (5.64 g m^{-2}day^{-1}) was found from V_3T_1, while the lowest CGR (2.74 g m^{-2}day^{-1}) from V_3T_4. At 50 DAS-harvest, the highest CGR (5.41 g m^{-2}day^{-1}) was found from V_1T_0, while the lowest CGR (0.54 g m^{-2}day^{-1}) from V_3T_3. At 20-30 DAS, the highest RGR (0.160 g g^{-1} day^{-1}) was recorded from V_3T_4 and the lowest RGR (0.137 g g^{-1} day^{-1}) from V_1T_0 (Table 7). At 30-40 DAS, the highest RGR (0.071 g g^{-1} day^{-1}) was recorded from V_3T_0 and the lowest RGR (0.064 g g^{-1} day^{-1}) from V_1T_4. At 40-50 DAS, the highest RGR (0.029 g g^{-1} day^{-1}) was recorded from V_3T_1 and the lowest RGR (0.012 g g^{-1} day^{-1}) from V_1T_0. At 50 DAS-harvest, the highest RGR (0.020 g g^{-1} day^{-1}) was recorded from V_1T_0 and the lowest RGR (0.002 g g^{-1} day^{-1}) from V_3T_3.

The highest days to flowering (37.67) was recorded from V_3T_4, while the lowest days to flowering (31.67) was recorded from V_1T_0 treatment combination. The highest days to harvest (67) was recorded from V_3T_4, while the lowest days to harvest (56.33) was recorded from V_1T_0 treatment combination. The highest number of pods plant^{-1} (19.56) was recorded from V_1T_0, while the lowest number (11.22) was recorded from V_3T_4 treatment combination. The highest number of seeds pod^{-1} (9.56) was recorded from V_1T_0, while the lowest number (5.43) was recorded from V_3T_4 treatment combination. The highest pod length (9.26 cm) was recorded from V_1T_0, while the lowest pod length (5.10 cm) was recorded from V_3T_4 treatment combination. The highest weight of 1000 seeds (52.17 g) was recorded from V_1T_0, while the lowest weight of 1000 seeds (41.67 g) was recorded from V_3T_4 treatment combination. The highest seed yield plant^{-1} (9.76 g) was recorded from V_1T_0, while the lowest seed yield plant^{-1} (2.54 g) from V_3T_4 treatment combination. The highest seed yield plant^{-1} (7.56 g) was found from T_0, while the lowest seed yield plant^{-1} (2.62 g) was observed from T_4. The highest stover yield plant^{-1} (12.82 g) was recorded from V_1T_0, while the lowest stover yield plant^{-1} (7.30) from V_2T_4 treatment combination. The highest stover yield plant^{-1} (11.96 g) was found from T_0, while the lowest stover yield plant^{-1} (7.74 g) was observed from T_4. The highest biological yield plant^{-1} (22.58 g) was recorded from V_1T_0, while the lowest biological yield plant^{-1} (9.87 g) was recorded from V_2T_4 treatment combination. The highest harvest index (43.22%) was recorded from V_1T_0, while the lowest harvest index (24.75%) was recorded from V_3T_4 treatment combination.

Considering the situation of the present experiment, further studies in the following areas may be suggested:

1. Others mungbean varieties may be used for further study.
2. Another experiment may be carried out with more range of salt stress.
3. Such study is needed in different agro-ecological zones (AEZ) of Bangladesh for regional compliance and other performance.

REFERENCES

Abid, H., Khalil, S. K., Sartaj, K. and Haroon, K. (2004). Effect of sowing time and variety on grain yield of mungbean. *Sarhad J. Agric*., **20**(4): 481-484.

Aghaalikhani, M., Ghalavand, A. and Ala, A. (2006). Effect of plant density on yield and yield components of two cultivars and a line of mungbean [*Vigna radiata* (L.) Wilczek] in Karaj Region. *J. Sci, Tech. Agric. Natural Res*., **9**(4): 111-121.

Agugo B. A. C., Oguike, P. C. and Kanu, B. O. (2010). A preliminary field assessment of mungbean (*Vigna radiata* L. Wilczek) yield in the rain forest zone of southeastern Nigeria. *American Eurasian J. Agril. Env. Sci*., **8**(6): 752-757.

Alam, M., Stuchbury, Z. T., Naylor, R.E.L. and Rashid, M. A. R. (2004). Effect of salinity on growth of some modern rice cultivar. *J. Agron*., **3**: 1-10.

Amira, M. S. and Abdul, Q. (2010). Effect of arginine on growth, nutrient composition, yield and nutritional value of mungbean plants grown under salinity stress. *Nature & Sci*., **8**(7): 30-42.

Anonymous. (1989). Annual Report 1987-88. Bangladesh Agricultural Research Institute. Joydebpur, Gazipur. p. 133.

Apurv, P. and Tewari, S. K. (2004). Yield dynamics of mungbean (*Vigna radiata* L. Wilczek) varieties in poplar based agroforestry system. *Indian J. Agroforest*. **6**(2): 89-91.

BBS. (2012). Statistical Yearbook of Bangladesh. Bangladesh Bureau of Statistics. Statistics Division, Ministry of Planning, Govt. of Peoples Republic of Bangladesh. Dhaka. Bangladesh. p. 79.

Bhati, T. K., Rathore, S. S. and Gaur, N. K. (2005). Effect of improved varieties and nutrient management in kharif legumes under arid ecosystem in Institution Village Linkage Programme. *J. Arid Leg.*, **2**(2): 227-229.

Brar, J. S., Inderjit, S., Sarvjeet, S. and Bains, T. S. (2004). SML 668: a new early maturing and high yielding variety of summer mungbean. *J. Res. Punjab Agril. Univ*., **41**(1): 174-181.

Chaisri, P., Kaveeta, L., Chaisri, S. and Kaveeta, R. (2005). Mungbean yield trial for cropping system in Lopburi area. *Proceedings of 43rd Kasetsart University Annual Conference*, Thailand, 1-4 February, 2005: 214-222.

Durga, K. K., Rao, M. M., Reddy, M. V. and Rao, Y. K. (2003). Effect of early drought stress on morpho-physiological characters and yield of mungbean and urdbean cultivars. *Indian J. Pulses Res.*, **16**(2): 133-135.

Eker, S., Comertpay, G., Konuskan, O., Ulger, A. C., Ozturk, L. and Cakmak, I. (2006). Effect of salinity stress on dry matter production and ion accumulation in hybrid maize varieties. *Turk J. Agric. For*., **30**: 365-373.

FAO (Food and Agriculture Organization). (1999). FAO Production Yearbook. Basic Data Unit. Statistic Division, FAO. Rome, Italy.

FAOSTAT (2013): http://faostat.fao.org.

Ghosh, S., Mitra, S. and Paul, A. ().Physiochemical Studies of Sodium Chloride on Mungbean (*Vigna radiata* L. Wilczek) and Its Possible Recovery with Spermine and Gibberellic Acid. *The Scientific World J.*, **2015**: 1-8.

Gomez, K. A. and Gomez, A. A. (1984). Statistical Procedure for Agricultural Research (2nd edn.). *Intl. Rice Res. Inst., A Willey Int. Sci*., pp. 28-192.

Hamed, M. F. (1998). Response of two mungbean varieties under irrigation intervals and certain fertilization treatments. *Ann. Agril. Sci*., **36**(1): 31-42.

Hasanuzzaman, M., Hossain, M. A., Silva, J. A. T. and Fujita, M. (2012). Plant responses and tolerance to abiotic oxidative stress: antioxidant defenses is a key factors. In: Bandi, V., Shanker, A. K., Shanker, C., Mandapaka, M. (Eds.), Crop stress and its management: perspectives and strategies. Springer, Berlin, pp. 261-316.

Hasanuzzaman, M., Nathan, K. and Fujita, M. (2013). Plant response to salt stress and role of exogenous protectants to mitigate salt-induced damages. In: Ahmad, P., Azooz, M. M., Prasad, M. N. V. (Eds.), Ecophysiology and responses of plants under salt stress. Springer, New York, pp. 25-87.

Hossain, D. and Solaiman, A. R. M. (2004). Performances of mungbean varieties as affected by Rhizobium inoculants. *Bulletin of the Inst. Tropic. Agric.*, **27**: 35-43.

Hossain, M. M., Miah, M. N. A., Rahman, M. A., Islam, M. A. and Islam, M. T. (2008). Effect of salt stress on growth and yield attributes of Mungbean. *Bangladesh Res. Pub. J*., **1**(4): 324-336.

Hunt, R. (1978). Plant growth analysis. The institute of Biology's studies in Biology No. 96. Edward Arnold (Publishers) Limited, London, UK.

Hussain, N., Khan, M.B. and Ahmad, R. (2008). Improving mungbean productivity in calcareous soils through band replacement of farmyard manure with phosphorus. *Internl. J. Agri Biol*., **10**: 709-714.

Infante, N., Madriz, P. and Gonzalez, T. (2003). Phases of development and yield components of three mungbean cultivars (*Vigna radiata* (L) Wilczek) in Maracay, Aragua state, Venezuela. *Revista Faculty of Agron*., **20**(4): 417-429.

Islam, M. K., Islam, S. M. A., Harun-or-Rashid, M., Hossain, A. F. M. G. F. and Alom, M. M. (2006). Effect of biofertilizer and plant growth regulators on growth of summer mungbean. *Intl. J. Bot.*, **2**(1): 36-41.

Kandil, A. A., Arafa, A.A., Sharief, A.E. and Ramadan, A.N. (2010). Genetic transformation of Vigna species: Current status and future prospect. (2012). Genotypic Differences between Two Mungbean Varieties in Response to Salt Stress at Seedling Stage. *Intl. J. Agric. Sci*., **4**(7): 278-283.

Karthikeyan, A., Valarmathi, R., Nandini, S., Nandhakumar, M. R. (2012). Genetically Modified Crops: Insect Resistance. *Biotech*., **11**: 119-126.

Khan, M. A., Qayym, A. and Noor, E. (2007): Assessment of wheat genotypes for salinity tolerance proceedings of 8th. *African Crop Sci. Conf.* October 27-31., El Minia, Egypt, p. 75-78.

Kumar, M., Lathwal, O. P. and Kumar, S. (2009). Growth behaviour of mungbean genotypes under varying sowing time during summer season. *Haryana J. Agron*., **25**(1/2): 79-81.

Madriz-Isturiz, P. M. and Luciani-Marcano, J. F. (2004). Agronomic characterization of 20 cultivars of mungbean, *Vigna radiata* (L.) Wilczek during three seasons, in Maracay, Aragua state, Venezuela. *Revista Fac. Agron*. **21**(1): 19-35.

Mahajan, S. and Tuteja, N. (2005). Cold, salinity and drought stresses: An overview. *Arch. Biochem. Biophys*. **444**: 139–158.

Mahdavi, B. and Sanavy, S. A. (2007). Techniques for introgression in developing salt tolerant mungbean varieties. *Pakistan J. Biol. Sci*., **10**(2): 273-279.

Mohammad, D. and Hossain, I. (2003). Seed treatment with biofertilizer in controlling foot and root rot of mungbean. *Pakistan J. Plant Patho*., **2**(2): 91-96.

Muhammad, A., Abdul, R., Muhammad, A. and Zafar, M. I. (2006). Association among Rhizobium phaseoli strains and mungbean genotypes under rainfed conditions. *Sarhad J. Agric*., **22**(3): 453-457.

Munns, R. (2005). Genes and salt tplerance bringing them together. *New Phytol*., **167**: 645-663.

Munns, R., James, R. A. and Lauchli, A. (2006). Approaches to increasing the salt tolerance of wheat and other cereals. *J. Exp. Bot*., **57**: 1025-1043.

Navgire, K. D., Datar, V. V., Asewar, B. V. and Dahiwal, A. L. (2001). Response of mungbean cultivars to different Rhizobium strains under rainfed conditions. *Ann. Plant Physio*., **15**(2): 134-137.

Potter, Y. K. and Hotchkiss, M. P. (1997). Nutrient content in mungbean. *Ann. Agril. Sci*., **35**(2): 23-28.

Quaderi, R. S., Islam, S. M. A., Hossain, A. F. M. G. F., Hoque, M. M. and Haque, M. S. (2006). Influence of seed treatment with indole acetic acid on mungbean cultivation. *Intl. J. Bot*., **2**(1): 42-47.

Rahman, M. S., Eunus, M. and Awal, M. A. (2005). Dry matter production and partitioning of mungbean (*Vigna radiata* I.) varieties as influenced by sowing date and planting method in summer. *Bangladesh J. Training and Dev*., **15**(1/2): 193-199.

Raj, S. and Tripathi, K. P. (2005). Productivity and economics of mungbean (*Vigna radiata* L.) as influenced by varieties and nutrient management. *J. Arid Leg*., **2**(2): 223-226.

Riaz, A., Imran, M., Javed, K. and Bukhari, S. A. H. (2004). Growth and yield response of three mungbean (*Vigna radiata* L.) cultivars to varying seeding rates. *Internl. J. Agric. Bio*., **6**(3): 538-540.

Saha, P., Chatterjee, P. and Biswas, A. K. (2010): NaCl pretreatment alleviates salt stress by enhancement of antioxidant defense and osmolyte accumulation in mungbean (*Vigna radiata* L. Wilczek). *Indian J. Exp. Biol*., **48**: 593-600.

Satish, K., Singh, R. C. and Kadian, V. S. (2003). Response of mungbean genotypes to phosphorus application. *Indian J. Pulses Res*., **16**(1): 65-66.

Sehrawat, N., Jaiwal, P. K., Yadav, M., Bhat, K. V., Sairam, R. K. (2013). Salinity stress restraining mungbean (*Vigna radiata* L. Wilczek) production: gateway for genetic improvement. *Int. J. Agri. Crop Sci*., **6**: 505-509.

Sehrawat, N., Yadav, M., Bhat, K. V., Sairam, R. K., and Jaiwal, P. K. (2015). Effect of Salinity Stress on Mungbean [*Vigna radiata* (L.) wilczek] during consecutive summer and spring seasons. *J. Agric. Sci*., **60**(1): 23-32.

Shamsuzzaman, A.M.M., Alam, M.S., Mondal, G. and Ahamed, K.U. (2004). Growth and yield response of summer mungbean to irrigation frequency. *J. Agric. Rural Dev.*, **2**(1): 95-100.

Singh, D. P. and Singh, B. B. (2011). Breeding for tolerance to abiotic stresses in mungbean. *J. Food Legumes*, **24**: 83-90.

Taffouo V. D., Kouamou J. K., Ngalangue L.M.T., Ndjeudji B.A.N. and Akoa A. (2009). Effects of salinity stress on growth, Ion partitioning and yield of some cowpea (*Vigna unguiculata* L. Walp.) cultivars. *Inter. J. Bot.*, **5**(2): 135-143.

Taffouo, V. D., Kenne, M., Fokam Tasse, R., Fotsoe, W. O., Fonkou, T., Vondo, Z. and Amougou, A. (2004). Salt stress variation response in five leguminous plants. *Agron. Africa*, **16**: 33-44.

Taj, F. H., Muhammad, A. and Kakar, K. M. (2003). Effect of seed rates on mungbean varieties under dryland conditions. *Interl. J. Agric. Biol.*, **5**(2): 160-161.

Tickoo, J. L., Naresh, C., Gangaiah, B. and Dikshit, H. K. (2006). Performance of mungbean (*Vigna radiata*) varieties at different row spacings and nitrogen-phosphorus fertilizer levels. *Indian J. Agric. Sci.*, **76**(9): 564-565.

UNDP. (1988). Land resources appraisal of Bangladesh for agricultural development report 2: Agro-ecological Regions of Bangladesh, FAO, Rome. p. 212.

USDA-ARS, Germplasm resources information network (GRIN). (2012). http://www.ars-grin.gov/cgi bin/npgs/html/tax_search.

Yadav, D. S., Panwar, K. S. and Singh, V. K. (1994). Management of pulse crops in sequential cropping. 27p. *In* Abstract. *Proc. Intecropping Symp. on Pulses Rws*. 2-6 April, 1994, New Delhi, India.

Zhu, J. K. (2001). Plant salt tolerance. *Trends Plant Sci*., **6**: 66-71.

APPENDICES

Appendix I. Soil characteristics of experimental pot

A. Morphological characteristics of the experimental field

Morphological features	Characteristics
Location	Agronomy farm field , SAU, Dhaka
AEZ	Madhupur Tract (28)
General Soil Type	Shallow red brown terrace soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled

B. Physical and chemical properties of the initial soil

Characteristics	Value
% Sand	27
% Silt	43
% clay	30
Textural class	silty-clay
pH	5.6
Organic matter (%)	0.78
Total N (%)	0.03
Available P (ppm)	20.00
Exchangeable K (me/100 g soil)	0.10
Available S (ppm)	45

Source: Soil Resources Development Institute (SRDI), Khamarbari, Farmgate, Dhaka

Appendix II. Monthly record of air temperature, relative humidity, rainfall and sunshine hour of the experimental site during the period from August November 2013

Month (2013)	*Air temperature (°c)		*Relative humidity (%)	Total Rainfall (mm)	*Sunshine (hr)
	Maximum	Minimum			
August	36.0	23.6	81	319	7.2
September	34.8	24.4	81	279	7.1
October	26.5	19.4	81	22	6.9
November	25.8	16.0	78	00	6.8

* Monthly average,

* Source: Bangladesh Meteorological Department (Climate & weather division) Agargoan, Dhaka – 1212

Appendix III. Analysis of variance of the data on plant height of mungbean as influenced by different variety and levels of salinity

Source of variation	Degrees of freedom	Mean square				
		Plant height (cm) at				
		20 DAS	30 DAS	40 DAS	50 DAS	Harvest
Replication	2	0.166	0.758	0.390	0.323	0.115
Variety (A)	2	15.079**	20.024**	26.696**	48.438**	64.288**
Levels of salinity (B)	4	40.407**	42.456**	89.390**	133.343**	168.665**
Interaction (A×B)	8	3.554*	3.181*	7.254*	14.235*	6.516*
Error	28	1.490	1.391	3.122	2.680	2.892

** Significant at 0.01 level of probability; * Significant at 0.05 level of probability

Appendix IV. Analysis of variance of the data on number of leaves plant^{-1} of mungbean as influenced by different variety and levels of salinity

Source of variation	Degrees of freedom	Mean square				
		Number of leaves plant^{-1} at				
		20 DAS	30 DAS	40 DAS	50 DAS	Harvest
Replication	2	0.067	0.356	0.822	0.467	0.622
Variety (A)	2	11.267**	109.356**	184.089**	140.600**	162.289**
Levels of salinity (B)	4	18.167**	79.078**	132.278**	142.744**	124.589**
Interaction (A×B)	8	1.350*	10.328**	25.561**	11.961**	13.539**
Error	28	0.567	2.784	5.179	3.800	3.551

** Significant at 0.01 level of probability; * Significant at 0.05 level of probability

Appendix V. Analysis of variance of the data on dry matter content plant^{-1} (g)of mungbean as influenced by different variety and levels of salinity

Source of variation	Degrees of freedom	Mean square				
		Dry matter contents plant^{-1} (g) at				
		20 DAS	30 DAS	40 DAS	50 DAS	Harvest
Replication	2	0.001	0.117	0.080	0.133	0.121
Variety (A)	2	0.222**	3.860**	13.858**	6.607**	15.125**
Levels of salinity (B)	4	0.600**	6.147**	23.963**	34.896**	45.892**
Interaction (A×B)	8	0.063**	0.759**	3.056**	1.093*	1.104*
Error	28	0.004	0.134	0.355	0.422	0.488

** Significant at 0.01 level of probability; * Significant at 0.05 level of probability

Appendix VI. Analysis of variance of the data on Crop Growth Rate (CGR) of mungbean as influenced by different variety and levels of salinity

Source of variation	Degrees of freedom	Mean square			
		CGR: Crop Growth Rate (g m^{-2}day^{-1}) at			
		20-30 DAS	30-40 DAS	40-50 DAS	50 DAS-Harvest
Replication	2	0.130	0.008	0.740	0.692
Variety (A)	2	4.897**	6.379**	3.279*	13.867**
Levels of salinity (B)	4	6.181**	12.254**	3.231*	6.314**
Interaction (A×B)	8	0.940**	1.707**	1.968*	1.328*
Error	28	0.237	0.331	0.965	0.719

** Significant at 0.01 level of probability; * Significant at 0.05 level of probability

Appendix VII. Analysis of variance of the data on Relative Growth Rate (RGR) of mungbean as influenced by different variety and levels of salinity

Source of variation	Degrees of freedom	Mean square			
		RGR: Relative growth rate (g g^{-1} day^{-1}) at			
		20-30 DAS	30-40 DAS	40-50 DAS	50 DAS-Harvest
Replication	2	0.0001	0.0001	0.0001	0.0001
Variety (A)	2	0.0001	0.0001	0.0001**	0.0001**
Levels of salinity (B)	4	0.0001**	0.0001	0.0001	0.0001**
Interaction (A×B)	8	0.0001*	0.0001	0.0001*	0.0001*
Error	28	0.00001	0.00001	0.00001	0.00001

** Significant at 0.01 level of probability; * Significant at 0.05 level of probability

Appendix VIII. Analysis of variance of the data on days to flowering and harvest, number of pods $plant^{-1}$, number of seeds pod^{-1} and pod length of mungbean as influenced by different variety and levels of salinity

Source of variation	Degrees of freedom	Mean square				
		Days to 1st flowering	Days to harvest	Number of pods $plant^{-1}$	Number of seeds pod^{-1}	Pod length (cm)
Replication	2	0.089	1.622	0.122	0.044	0.043
Variety (A)	2	17.156**	177.422**	14.679**	6.926**	8.593**
Levels of salinity (B)	4	16.689**	16.078**	70.875**	10.731**	9.099**
Interaction (A×B)	8	10.989**	9.895*	4.784**	1.161**	1.583**
Error	28	1.137	2.241	0.978	0.122	0.154

** Significant at 0.01 level of probability; * Significant at 0.05 level of probability

Appendix IX. Analysis of variance of the data on weight of 1000 seeds, seed, stover, biological yield and harvest index of mungbean as influenced by different variety and levels of salinity

Source of variation	Degrees of freedom	Mean square				
		Weight of 1000-seeds (g)	Seed yield (g plnat^{-1})	Stover yield (g plant^{-1})	Biological yield (g plant^{-1})	Harvest Index (%)
Replication	2	0.022	0.002	0.300	0.282	0.762
Variety (A)	2	73.475**	21.008**	9.435**	58.523**	115.317**
Levels of salinity (B)	4	75.011**	36.307**	28.287**	128.301**	230.321**
Interaction (A×B)	8	8.360*	4.067**	1.271*	8.503**	32.963**
Error	28	3.002	0.248	0.521	1.029	5.280

** Significant at 0.01 level of probability; * Significant at 0.05 level of probability