EFFECT OF SALINITY ON GROWTH, YIELD AND NUTRIENT CONTENTS IN DIFFERENT WHEAT (*Triticum aestivum* L.) CULTIVARS

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CERTIFICATE

This is to certify that the thesis entitled "**EFFECT OF SALINITY ON GROWTH, YIELD AND NUTRIENT CONTENTS IN DIFFERENT WHEAT (*Tritium aestivum* L.) CULTIVARS**" 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 Agricultural Chemistry**, embodies the result of a piece of bona fide research work carried out by **Md. Motiur Rahman Sourav**, Registration number: **11-04499** 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: June, 2017
Dhaka, Bangladesh

Prof. Dr. Md. Abdur Razzaque
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"A single tear caused by the remberance of ALLAH brings a comfort to the heart that nothing in the dunya can match"

DEDICATED TO

My Beloved Father & Mother

The person who taught me that

"Always Trust Your Struggle"

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SAU, Dhaka

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ABSTRACT

A pot experiment was held in the net house of the Department of Agricultural Chemistry, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207, during November 2016 to March 2017, to study the effect of salinity on growth, yield and nutrient contents in different wheat (*Triticum aestivum* L.) cultivars. Three cultivar viz., BARI gom-24, BARI gom-25 and BARI gom-26 and five salinity treatments viz., S_0 (control), S_1 (3 dSm^{-1}), S_2 (6 dSm^{-1}), S_3 (9 dSm^{-1}) and S_4 (12 dSm^{-1}) were associated in this experiment. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Significant variation was recorded among three cultivars on growth, yield and nutrient contents. Germination percentage, plant heights, tiller number, effective tiller, spike length, total grain, 1000 grain weight, grain yield per pot, straw weight, root weight and chemical compositions (Nitrogen, Phosphorus, and Potassium) were found to be decreased gradually with increasing salinity level, and also significant variations were observed among cultivars. Number of ineffective tiller, unfilled grain and chemical compositions (Sodium and Calcium) were noticed to be increased gradually with the gradual increase in salinity levels as compared to the control. All the three cultivars could be survived and produced grain yield up to S_2 (6 dSm^{-1}) treatment. But in S_3 (9 dSm^{-1}) treatment, BARI gom-24 and BARI gom-26 produced significantly less grain compared to BARI gom-25. At S_4 (12 dSm^{-1}) treatment, all the three cultivars, were produced less grain yield and were not suitable for cost-effective production in Bangladesh aspects. From this execution, it can be stated that BARI gom-25 showed the best performance and more tolerant in respect of all parameters than those of BARI gom-24 and BARI gom-26.

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Acronyms

Abbreviation	**Full word**
%	Percent
@	A the rate of
ºC	Degree Celsius
AEZ	Agro Ecological Zone
BBS	Bangladesh Bureau of Statistics
BARI	Bangladesh Agricultural Research Institute
cm	Centimeter
$CuSO_4.5H_2O$	Green vitriol
CV%	Percentage of Coefficient of Variance
Cv	Cultivar(s)
DAS	Days after sowing
DMRT	Duncan’s Multiple Range Test
dS/m	Deci Semens per Meter
EC	Electrical conductivity
e.g	As for example
et al	And others
G	Gram
i.e	That is
K	Potassium
Kg	Kilogram
Kg/ha	Kilogram per hectare
KCl	Potassium chloride
LSD	Least significance difference
m	Meter
MoP	Murate of potash
N	Nitrogen
Na	Sodium
NaOH	Sodium hydroxide
NS	Not significance
OM	Organic matter
P	Phosphorus
pH	Hydrogen ion concentration
S	Sulphur
SAU	Sher-e-Bangla Agricultural University
TSP	Triple super phosphate
Zn	Zinc

CHAPTER I
INTRODUCTION

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INTRODUCTION

Wheat is the cereal plant of the genus *Triticum*, especially, *T. aestivum*, of the family Graminae. The grain constitutes a major food item and an important commodity on the world grain market. It is one of the first of the grains domesticated by human in the world. It is the second largest grain cereal crop next to rice in Bangladesh. During the year 2013-2014, 1302998 tons of wheat were produced from 429607 hectares of land with an average yield of 3.03 t/ha in the country (BBS, 2014). In Bangladesh wheat is gaining popularity day by day. The wheat Research centre of Bangladesh Agricultural Research Institute has released a good number of varieties, which covered the major area of the crops. Bangladesh is a populous country but its land is limited. Food production is less than the requirement. So, the country is suffering from food shortage. Government of Bangladesh imported wheat at a cost of Tk. 27770 million during the year 2012-2013 (BBS, 2014). Increasing food production through the cultivation of high yielding wheat varieties is, therefore, a necessity to meet food shortage.

From an agricultural point of view, salinity is the accumulation of dissolved salts in the soil water to an extent that inhibits plant growth (Gorham, 1992). There are mainly two forms of soil salinity: primary and secondary salinity. Primary salinity results from the accumulation of salts in the soil or groundwater through natural processes over long period of time. Two natural processes caused primary salinity. The first is the weathering of parent materials containing soluble salts. The second is the deposition of oceanic salt carried through wind and rain. Secondary salinization results from human activities that change the hydrologic balance of the soil between water applied (irrigation or rainfall) and water used by crops and transpiration. The most common causes of secondary salinization are (i) land clearing and the replacement of perennial vegetation with annual crops and (ii) irrigation schemes using salt rich irrigation water or having insufficient drainage water.

Salinity is a major constraint to food production because it limits crop yield and restricts use of land previously uncultivated. Estimates vary, but approximately 7% of the world's total land area is affected by salinity (Flowers *et al*., 1997). Most importantly, the percentage of cultivated land affected by salt is even greater. Furthermore, there is also a dangerous trend of a 10 % per year increase in the saline area throughout the world (Pannamieruma, 1984). In addition, salinity is a problem for agriculture because also only few crop species and genotypes are adapted to saline conditions. Although irrigation covers only about 15% of the cultivated land of the world, irrigated land has at least twice the productivity of rain-fed land, and may therefore produce one-third of the world's food. The reduced productivity of irrigated lands due to salinity is, therefore, a serious issue. Productivity will need to increase by 20% in the developed countries and by 60% in the developing countries. In the light of these demographic, agricultural and ecological issues, the threat and effects of salinity become even more alarming. Reducing the spread of salinization and increasing the salt tolerance of crops and improving species or genotypes to salt tolerance, particularly the high yielding ones are, therefore, issues of global importance.

Presence of excess soluble salt in soil is one of the major factors that reduces the growth and development of cultivated crop plant in coastal areas of Bangladesh. Salts primarily have two types of effects on the growing plants, specific effect due to rising of osmotic pressure of the soil solution in and around the root regime of the crop. In the long run prolonged transpiration brings old leaves that causes its senescence. This process eventually limits the supply of assimilates to growing parts and limits yields of the crop. It has been reported that there are some plant that have their capability of developing adaptive mechanism to salinity (Flower *et al*., 1977; Greenway and Munns, 1980) which in turn induces the plant to have better growth and yield under saline conditions.

The present population of Bangladesh will progressively increase to 223 million by 2030, requiring 48.0 million tons of food grains (Karim *et al.*,1990). The cultivable area is decreasing day by day, and this problem will gradually but soon be acute due to pressure of population. About 0.833 million hectares of arable land of Bangladesh which constitutes 52.8 percent of the net cultivable area in 64 thanas of 13 coastal districts are affected by varying degrees of soil salinity (Karim *et al*., 1990). Coastal saline soils are mostly mono cropped with local T. Aman rice, giving poor yield. Cultivation of winter crops are very limited due to accumulation of salts in the surface soil and lack of quality irrigation water during dry seasons. Crops vary in their relative tolerance to soil salinity. Selection of crops for their tolerance is thus an important aspect for the management of saline soils (Gupta and Gupta, 1987). Research findings indicate that the soil salinity of coastal area is generally varied from EC 2 dSm^{-1} to 18 dSm^{-1} during dry season. Yield of wheat in saline areas also decreases with increasing salinity level. Salt tolerant wheat crop may be an alternative for increasing production in these problem soils.

Considering the above facts, the present study was undertaken with the following objectives:-

i. To observe the effect of different salinity levels on growth, yield and yield contributing characters in wheat genotypes; and
ii. To identify level of salt tolerance in the genotypes under study.
iii. To determine different nutrient contents under saline condition.

CHAPTER II

REVIEW OF LITERATURE

CHAPTER II

REVIEW OF LITERATURE

Salinity is one of the major abiotic stresses, which adversely effects crop growth and yield and nutrient contents. Cultivated wheat under saline condition faces at least two types of stress i.e. ion toxicity and the other arises from low water availability. The effects of salinity on crop growth have been carried out by a large number of scientists at home and in abroad. But the physiological aspects of growth, yield and nutrient contents with growth analysis on various crops to identify the reason of yield reduction due to increasing salinity of soils has not yet been done at appropriate level. In this chapter attempt has been made review some of the available information on the soil salinity and its effects on growth, yield, nutrient contents and yield components of wheat.

2.1 Impact of salinity in agriculture

Agriculture plays an important role in the entire life of a given economy. It is a key economic driver and also a key to a healthy biosphere (Mulvany, 2003). However, agricultural productivity is affected by salinity. Flowers (2006) observed that "Salinity has been a threat to agriculture in some parts of the world for over 3000 years; in recent times, the threat has grown". Salinity is a problem in many irrigated, arid and semiarid regions, where precipitation is insufficient to leach salts from the root zone (Francois and Maas 1994). Salinization of agricultural lands has serious consequences because much of the land must ultimately be withdrawn from production (Hopkins and Huner 2004), hence a huge impact in agriculture. As a result of an increase in population, there is competition for fresh water among the municipal, industrial and agricultural sectors in many regions. According to Tilman *et al.* (2012), this has resulted to a decreased allocation of fresh water to agriculture. This problem is expected to continue and to intensify in arid and semiarid regions, as well as less developed countries that already have high population growth rates. For this reason, growers have been pressurized to irrigate with water of certain salt content, such as drainage water, treated sewage water and ground water. Plants are divided into halophytes and non-halophytes (glycophytes) depending on their response to salinity. Halophytes grow in high salt soils, for example marsh grass (the most tolerant one will continue to grow at concentrations of NaCl in the 200 to 500 mM range), while glycophytes such as beans, rice and maize can tolerate very little salt and may suffer irreparable damage at concentration of NaCl less than 50 mM (Hopkins and Huner 2004). Plants are affected by salinity in different ways such as osmotic effect, toxic effect and ionic imbalance (Lauchli and Epstein 1990, Munns, 2005; and Podmore, 2009). Osmotic stress is due to the presence of ions mainly Na^+ and Cl^- in the soil which limits the availability of water to the plant. On the other hand, excess accumulation of these ions in leaves leads to ion toxicity.

Podmore (2009) stated that “an excess of some salts can cause an imbalance in the ideal ratio of salts in solution and reduce the ability of plants to take up nutrients. For example, relatively high levels of calcium can inhibit the uptake of iron (‘lime induced chlorosis’), and high sodium can exclude potassium”. The result of these effects leads to plant death due to severe growth retardation and molecular damage.

2.2 Effects of salinity on seed germination

Acquaah (2002) defined seed as, ‘the propagational unit of flowering species and the economic part of grain crops’. Seed is one of the most important inputs in crop production. Seed germination is one of the most critical stages in plant life and the most vulnerable to environmental stresses (Catalan *et al*., 2009 and Saritha *et al*., 2012). Salinity is one of the most important abiotic environmental stresses affecting seed germination. It affects germination in two ways; there may be enough salt in the medium to decrease the osmotic potential to such a point which retard or prevent the uptake of water necessary for mobilization of nutrients required for germination and the salt constituents or ions may be toxic to the embryo (Rahman *et al*., 2008).

Investigations showed that the increase in salinity not only decrease the germination but also delayed the germination initiation (Rahman *et al*., 2008 and Hussain *et al*., 2013). This complements Akbarimoghaddam *et al*. (2011) who found that by increasing NaCl concentration, germination is delayed and decreased germination in bread wheat cultivars. Findings by Sholi (2012) also indicated that, an increase of salt concentrations delayed seed germination of tomato cultivars especially at the highest concentration (150 mM).

2.3 Effects of salinity on plant growth and development

Growth is an irreversible increase in size or volume, while development is defined as changes during the life history of an organism, for example tissues form a specific pattern. Development is controlled by mechanisms such as genes, hormones, environment and cellular changes. Growth stages include embryogenesis, vegetative and reproductive development. Salinity affects both vegetative and reproductive development (Lauchli and Grattan 2007) and often reduces shoot growth, particularly leaf area, more than root growth (Lauchli and Epstein 1990). Most investigations indicate that with increased concentration of NaCl, both root and shoot lengths decreases. This was found in barley (Naseer *et al*., 2001 and

Yousofinia *et al*., 2012) and wheat (Rahman *et al.* 2008, Akbarimoghaddam *et al*., 2011).

Azini and Alam (1990) made an experiment and found the seedling growth of 9 varieties of wheat under various concentration of salinity (1: 1 of NaCl and Na_2SO_4 by weight). Leaf anatomy and growth habit were also studied under the same salinity regimes. There was a maximum reduction in seedling growth in LU 265 and the minimum in Sonalika.

2.3.1 Effect of salinity on plant height

Bhatti *et al.* (2009) carried out an experiment with 50 salt tolerant wheat lines using tissue culture technique in a greenhouse having salinity levels of EC 1.5 (control) 6 and 9 dSm^{-1}. They found that increasing salinity levels drastically affected the seedling growth.

An experiment showed that the effect of different concentration of salinity (NaCl up to 250 mM) on the plant height, dry matter suction and same relevant metabolic parameters of two lines (Sukha 69 and Sakha164, and one cultivar (Stork) of wheat *(Triticum aestivum)* conducted by Ismail (2013). He observed that during germination and seedling stages, the lines could be tolerated in lower and moderate doses of salinity, while the growth was significantly detained at the lower and moderate levels and completely inhibited at higher levels of salinity and plant height was decreased with the increased of salinity.

Rajpar and Sial (2002) conducted a pot experiment with eight varieties of wheat such Kharchia-65, Anmol, NIAB-20 PAI-8l,TW-161, Bakhtwar, KTDH- 19 and SARC-1, They observed that plant height, shoot dry weight and root length were decreased salinity up to EC 12 dsm^{-1}.

2.3.2 Effect of salinity on number of tiller per seedling

Cheong *et al.* (1995) investigated salt tolerance of 5 wheat cultivars in seedlings at tillering and at spike formation in 0.5%, 0.6% and 0.9% saline water respectively. They reported that mean plant height reduction and tiller reduction by salinity at the tillering stage were 22.6%, 30.5% and 45.9% and 11.2%, 36.2% and 36.0% in early medium and medium late maturing cultivars respectively.

Chhipa and Lal (1985) was conducted a pot experiment with five varieties of wheat such as Kharchia 65, HD 2009, Kalayan sona, Raj 114 and Raj 911. They observed that under saline conditions ranging from EC 4.2-18.1 mmhos cm^{-1}, plant height, number of effective tillers, grain and straw yield were reduced with increasing salinity above EC 8.1 mmhos cm^{-1}.

2.3.3 Effect of salinity on root growth

Gawish *et al.* (2008) studied the responses of status and translocation of Na, Cl, N and production for both shoots and roots of two wheat varieties differing in salt tolerance, Giza-164 a relatively salt tolerant and Sakha-69 a relatively salt sensitive variety. The plants were treated with NaCl, $CaCl_2$ or their mixture at a level of 50, 750, 1500 or 3000 ppm, after the first leaf had emerged. The status of Na and CI positively responded in shoots. The rate of translocation for the different ions was higher under salinity conditions, particularly in relatively salt tolerant plants presumably due to osmotic adjustment and to reduce the adverse effect on root growth.

A pot experiment was conducted by Halim *et al.* (1988) with Maxipak wheat grown in saline soil salanized by the addition of $MgSO_4$: NaCI: $CaCl_2$ (5: 2: 3 respectively). The salinity level of EC 1.7, 4.2, 5.8, 9.4 and

11.0 dSm^{-1} were used at 25, 50 and 75 percent levels of depletion of available soil moisture. They observed that as soil organic matter decreased the soil salinity increased, the dry matter per plant, plant height, tiller spike number per plant were decreased at all the growth stages. Grain yield, grain number and root dry matter decreased. Root growth showed the greatest sensitivity to soil salinity.

Khajanchi *et al*. (2010) conducted a hydroponic experiment, effects of 0, 40, 80 and 160 mM NaCl applied for 4 and 7 days were studied on root morphology of 19 days old wheat (*Triticum aestivum* L.) and barley (*Hordeum vulgare* L.). The 80 mM NaCl treatment significantly reduced the fresh yield, relative plant growth rate, root length and root surface area of wheat by 42, 62, 45 and 51%, respectively measured 4 days after salt application. The deleterious effects of salinity on wheat were recorded even at of 40 mM NaCl concentration when applied for longer duration of 7 days. In general barley could tolerate 80 mM of NaCl without any adverse effect on the parameters studied except the plant biomass obtained 7 days after salt application. The adverse effects were prominent at 160 mM NaCl both in wheat and barley and more so when applied for longer duration. Under similar levels, NaCl stress was found to be more harmful to wheat than barley. A negative plant growth rate was recorded in wheat 7 days after application of 160 mm NaCl. Majority of the roots of wheat and barley were found in the 0.0 to 0.5 mm diameter category.

2.4 Effect of salinity on dry matter content

In an experiment with four wheat cultivars, Sholi (2012) reported that growth parameters (such as fresh and dry weights) were reduced by the saline conditions. As the salt concentration was increased, plant growth was reduced. Naseer *et al*. (2001) also reported that under salt stress fresh and dry weights (root and shoot) of barley cultivars decreased significantly. This was also recorded in wheat (Akbarimoghaddam *et al*. 2011). Salinity does not only affect vegetative development but also reproductive development.

Shazia *et al*. (2001) examined the effect of foliar application of indole Acetic Acid on growth and yield of two lines of spring wheat, Kohistan-97, and Parwaz-94 under different levels (8.12 and 16 dSm^{-1}) of NaCl salinity. The results revealed that all the growth and yield parameters such as plant height, root length, number of leaves per number of fertile tillers, spike length, number of spikelets/spike, number grain/spike, 1000 grain weight and grain yield/plant were decreased progressively with increasing salinity.

Ashraf *et al.* (2002) conducted an experiment on the effect of salt stress on the growth, ion accumulation and photosynthetic capacity of two spring wheat cultivars, & Barani-83 (Salt Sensitive) and SARC-1 (Salt tolerant). Three week old plants of both cultivars were exposed to 0, 100 and 200 mol m^{-3} NaCl in (Hogland nutrient) solution. They observed that fresh weights of shoots and roots, plant height and leaf areas were decreased with increasing levels of salinity.

Keles and Oncel (2004) conducted an experiment on the soluble metabolites in several cultivars of *Triticum aestivum* and *T. durum* with exposed to water logging, drought and salinity (0.7% NaCl, w/w) stresses for six days. They found that root and shoot fresh weights, significantly decreased under water logging, drought and salt stress and proline content significantly increased in case of salt stress.

Power and Metha (1997) conducted a greenhouse experiment, with 6 rice cultivars grown at salinity levels of 1.5, 3.0, 6.0 or 9.0 dSm^{-1}. They reported that grain yield decreased with increasing salinity levels.

2.5 Effect of salinity on mineral contents

Goudarzi and Pakniyat (2010) conducted an experiment with Fifteen (15) Iranian wheat cultivars (*Triticum aestivum* L.) were compared for salt tolerance using three treatments: 1.26 (control), 6.8 and 13.8 dS/m in a greenhouse. During vegetative growth, shoot Na^+, K^+, K^+:Na^+ ratio and agronomic traits were measured. In general, tolerant cultivars (Kavir, Niknejad, Chamran and Falat) with better agronomic performance, contained low Na^+ and higher K^+ and K^+:Na^+ ratio compared to non-tolerant ones (Ghods, Bayat, Cross Adl and Zarin). Shoot Na^+ content was negatively correlated with grain yield.

Dravid and Goswami (1986) conducted a pot experiment with 4 wheat and 4 maize cultivars using N, P, K and Fe or CI with two moisture regimes and saline soils. They noted that increasing salinity from 0.05 to 14.9 mhos cm^{-1} significantly decreased the yields and uptake of P, K, Ca, Mg and S in both crops. They also noted that wheat cv. Kalayansona and maize hybrid Ganga-5 had greater tolerance to salinity than that in other cultivars.

A study was carried out by Bouaouina *et al.* (2000) with the salt tolerance durum wheat *(Triticum turgidum).* They observed decreased growth of whole plants, delayed emergence of new leaves and limited K^+ and Ca^{2+} accumulation in these organs under NaCl treated soil salinity. Moreover, Na^+ accumulation decreased from older to younger leaves. Cellular dry matter production was not much affected in spite of a drop in cellular water content. Depressive effects of K^+ and Ca^{2+} accumulation were evident while Na^+ cellular accumulation increased with NaCI concentration. These results suggest that wheat has mechanisms to restrict Na^+ transport and accumulation in younger leaves.

From the above review of literatures, it is evident that different levels of salinity significantly affected the growth, yield and nutrient contents of wheat. The yield and yield contributing characters decreased with the increasing level of salinity. Some nutrients were increased and some were decreased with the increasing level of salinity. Most of the authors showed that increasing level of salinity decreased yield and yield contributing characters especially number of spikelet per spike, number of effective tillers per hill, number of total grain per spike, 1000 grain weight etc. As a result total yield significantly decreased.

CHAPTER III
MATERIALS AND METHODS

CHAPTER III

MATERIALS AND METHODS

The present chapter deals with the materials used and methodology followed in conducting the experiment, the location of experiment, experimental materials, methodology, design of experiment, data collection, chemical analysis procedure and statistical analysis of collected data. The experiment was conducted at Net House of the Agro-environmental Chemistry Laboratory of the Department of Agricultural Chemistry, Sher-e-Bangla Agricultural University (SAU), Dhaka. Effect of different concentrations of NaCl on seed germination and subsequent seedling growth and development, Yield and Nutrient contents of three varieties of wheat were investigated. Details of different materials and methodologies followed in conducting the experiment are presented below.

3.1 Materials

3.1.1 Plant Materials

Three Wheat cultivars *viz*. BARI gom-24 (Prodip), BARI gom-25 (Tista) and BARI gom-26 (Hashi) were used in the experiment.

3.1.2 Experiment Pots

Empty 45 pots were used in the experiment. The pots were 30 cm depth and 12 cm diameter in measure. Every pot contained 8.5 kilograms sun dried fine textured soil.

3.1.3 Salinity Treatments

The salinity treatments were applied at the time of pot preparation. There were Five (5) salinity levels including control where development of salinity by adding respected amount of commercial NaCl salt to the soil/pot as water dissolved solution. The salinity levels were S_0 (control, i.e. no salt added), S_1 (3dSm^{-1}), S_2 (6dSm^{-1}), S_3 (9dSm^{-1}) and S_4 (12dSm^{-1}). 640 mg of NaCl salt dissolved in one (1) liter distilled water indicates 1 dSm^{-1} solution. The salts were dissolved in a liter distilled water solution and mixed well with soil at the time of pot preparation so that the salinity level was homogenous in each pot. Average soil salinity was found 0 dSm^{-1}, 3 dSm^{-1}, 6 dSm^{-1}, 9 dSm^{-1} and 12 dSm^{-1} as denoted by S_0, S_1, S_2, S_3 and S_4 respectively.

3.2 Experimental site

3.2.1 Location

The experimental area of net house was situated at 23º77´ North latitude and 90º33´East longitude at an altitude of 8.6 meter above the sea level.

3.2.2 Soil

The soil used in pots was collected from the experimental field of Sher-e-Bangla Agricultural University (SAU), Dhaka. The topography of the land was medium high and the soil was collected from 0-15 cm depth. After collecting the soil, it was sun dried and ground well. Then the soil debris was removed by sieving and the soil was put into earthen pot after mixing with fertilizer. The soil of this experiment was sandy loam in texture.

3.2.3 Climate

The experimental site falls under the sub-tropical climate, which is characterized, by high temperature, high humidity and heavy rainfall with occasional gusty winds in the Kharif season (April-September) and less rainfall associated with moderately low temperature during the Rabi season (October-March) (Biswas, 1987). Weather information regarding daily maximum and minimum temperature, relative humidity, rainfall and sunshine hours prevailed at the experimental site during the experiment are presented in the Appendix I.

3.3 Treatment

There were 15 treatments under 2 factors.

Factor-A:- (genotype 3)

1. BARI gom-24 (Prodip)
2. BARI gom-25 (Tista)
3. BARI gom-26 (Hashi)

Factor-B:- (salinity level 5)

1. S_0- control (No salt added)
2. S_1- 3 dSm^{-1}
3. S_2- 6 dSm^{-1}
4. S_3- 9 dSm^{-1}
5. S_4- 12 dSm^{-1}

3.4 Design and layout of the experiment

The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications (appendix IV). There were 45 pots all together replication with the given factors.

3.5 Conduction of the experiment

3.5.1 Seed collection

All the three wheat genotypes were collected from Plant Breeding Division, Bangladesh Agricultural Research Institute (BARI), Gazipur.

3.5.2 Preparation of pot

The collected soil was sun dried, crushed and sieved properly. The soil and fertilizers were mixed well before placing the soils into the pots. Then the salinity treatments were done in a such manner that all the soil of same salinity level were mixed together and applied salt solution and mixed well. This solution was also used to maintain the perfect level of moisture for wheat seed germination. Then each pot was filled up with 8.5 kg soil. Pots were placed at the southern part of the net house. Then the pots were labeled with tag for each treatment and variety.

3.5.3 Fertilizer application

The nitrogenous, phosphatic, sulphur and potassic fertilizer were applied in the experimental pots @ 220 kg/ha, 180 kg/ha, 120 kg/ha and 50 kg/ha in the form of urea, triple super phosphate, muriate of potash and gypsum, respectively. Each pot contained 4.6g Urea, 4.1g TSP, 2.7g MOP and 1.2g Gypsum (source: BARI, Fertilizer recommendation guide) One-third of urea and the whole amount of other fertilizers were applied in the soil at final pot preparation before seed sowing. Rest of the Urea fertilizers were applied in two equal splits one at crown root initiation stage and the rest at panicle initiation stage when panicle primordia was about 1-2 mm.

3.5.4 Seed sterilization

Seeds were surface sterilized with 1% sodium hypochloride solution prior to germination test. Distilled water containing glass vials for rinsing seed was sterilized for 20 minutes in an autoclave at 121±1ºC and at 15 bar air pressure.

3.5.5 Seed sowing technique

Before placing the seeds into pots, germination test were done. Fifteen healthy seeds were placed into each pot. After germination five plants were allowed to grow in each pot.

3.5.6 Intercultural operation

3.5.6.1 Gap filling and thinning

Continuous observation was done after seed sowing. It was observed that some seeds germinated early and some were later. Keen observation was made for thinning to maintain five seedlings. Thinning was done to maintain spacing of the plants.

3.5.6.2 Weeding and Irrigation

Sometimes there were some weeds observed in pots which were uprooted manually. Irrigation was done one day after one day to maintain moisture level with a hand sprayer in a certain amount so that salinity levels were not changed.

3.5.6.3 Plant protection measure

As the pots were in net house, Birds did not harm. There was not seen any other insect pests except rat. For this reason, rodenticides were used to control rat.

3.5.6.4 General observation of the experimental pots

Observations were made regularly and the plants looked normal green. No lodging was observed at any stage. The maximum tillering, panicle initiation, and flowering stages were not uniform.

3.5.6.5 Observation maximum tillering and panicle initiation stages

Maximum tillering and panicle initiation stages were observed through field observations. When the number of tiller hill^{-1} attained the highest number and there after decreasing in trend, was identified as maximum tillering stage. When a small growth at the top of upper most node of main stem was seen like a dome indicated the beginning of panicle initiation stage. These stages were not uniform. These were changed with varieties as well as salt treatments.

3.6 Data collection at different growth stages

3.6.1 Germination percentages

For each treatment two pots were selected randomly for observation of seedling emerging after two days from sowing date. Keen observation was followed for the germination percentages.

3.6.2 Plant sampling

For each treatment three (3) plants from each pot were selected randomly for data collection at 30 DAS, 60 DAS and maturity (100±5 DAS). Then the selected pots were taken into keen observation for different data and these were taken to the available water source. After harvesting, the wheat plant from the soil block carefully, the roots were collected and washed with force flash tap water to remove soil and then the roots were washed with distilled water. Root-shoot zone was cut by a sickle. Then the separation of leaf blades was done by using scissors.

3.6.2 Measurement of plant height

Measurement of plant height was done at 30 DAS, 60 DAS and at maturity (100±5 DAS). Measurement was taken from tip of the longest leaf to base of the plant at vegetative stage and up to the tip of the longest spike at maturity stage.

3.6.3 Counting tiller number

The tiller which had at least one visible leaf was counted at 30 DAS, 60 DAS and a harvest (100±5 DAS) from the selected plants of each pot.

3.6.4 Number of effective and ineffective tillers

Number of effective and ineffective tillers pot^{-1} was counted from the selected plants of the pots after harvesting and finally averaged.

3.6.5 Spike lengths

The spike length (cm) was measured with a meter scale from the selected plants of each pot and the average value was recorded as per plant.

3.6.6 Number of filled grains and unfilled grains

From the five spikes of selected plants of the each pot, number of filled grain and unfilled grain were counted and recorded. The grains which were lack of food materials were identified as unfilled grain.

3.6.7 Weight of 1000-grain

100 grains from each pot were randomly selected and weighted by an electric balance after sun dried and then the weight was multiplied with 10.

3.6.8 Grain yield

Grain harvested from each pot was sun dried and weighed carefully. The dry weight of the grain of the respective pot yield was recorded carefully.

3.6.9 Straw yield

Straw obtained from each pot were sun-dried and weighed carefully. The dry weight of straw of the respective pot yield was recorded carefully.

3.7 Analysis of different chemical constituents in plant samples

Wheat plants after harvesting, were separated into roots and shoots, and rinsed repeatedly with tap water and finally with distilled water and then dried in an oven at 70 ºC to obtain content weight.

3.7.1 Grinding

The samples after oven dried were ground in a Wiley Hammer Mill, passed through 40 mesh screens, mixed well and stored in plastic vials.

3.7.2 Digestion

Exactly 1g oven-dried samples of wheat plant were taken in digestion tube. About 10 mL of Di-acid mixture (conc. HNO_3 and 60% $HClO_4$) in a digestion tube and left to stand for 20 minutes and then transferred to a digestion block and continued heating at 100 ^{0}C. The temperature was increased to 365 ^{0}C gradually to prevent frothing (50 ^{0}C steps) and left to digest until yellowish color of the solution turned to whitish color. Then the digestion tubes were removed from the heating source and allowed to cool to room temperature. About 40 mL of distilled water was carefully added to the digestion tubes and the contents filtered through Whatman no. 40 filter paper into a 100 mL volumetric flask and the volume was made up to the mark with distilled water. The samples were stored at room temperature in clearly marked containers.

3.7.3. Determination of Phosphorus

The amount of phosphorus was determined by ascorbic acid blue color method with the help of spectrophotometer.

Reagents required

A. Mixed reagent: 12.0 g ammonium molybdate $(NH_4)_6Mo_7O_{24}.4H_20$ was dissolved in 250 mL distilled water. About 0.2908 g antimony potassium tartarate $K_2Sb_2(C_4H_2O_6)_2.3H_2O$ was dissolved in 1000 mL $H_2SO_{4.}$ Two solutions were mixed together and volume was made up to 2000 mL with distilled water and stored in a pyrex bottle in a dark cool place.
B. Color developing reagent: 0.53 g ascorbic acid was added to 100 mL of the mixed reagent.
C. Standard Phosphorus solution (100 ppm): 0.439 g potassium dihydrogen phosphate (KH_2PO_4) was weighed into a 1L volumetric flask. About 500 mL distilled water was added and shaked the contents until the salt dissolved. Then the volume was made up to 1L with distilled water.

Procedure

A. Color development: About 20 mL of the extract was pipetted out in a 100 mL volumetric flask. About 20 mL color developing reagent was added slowly and carefully to prevent the loss of sample due to excessive foaming. After the evolution of CO_2 had ceased, the flask was shaked gently to mixed the contents. The volume was made up to the mark by adding distilled water.

B. Preparation of working standard P solution: About 20 mL of the standard P solutions (100 ppm) was pipetted to a 1L volumetric flask and volume was made up to the mark by distilled water. This solution contained 2 ppm P. About 0, 5, 10, 15, 20 and 25 mL aliquot were pipetted out from 2 ppm solution in 100 mL volumetric flask respectively. About 20 mL color developing reagent was added to each flask, mixed and volume was made with distilled water. These solutions gave 0, 0.1, 0.2, 0.3, 0.4 and 0.5 ppm of P solution respectively. The solution was allowed to stand for 15 minutes and then color intensity (% absorbance) was measured at 660 nm. A standard curve was prepared from the spectrophotometer reading and concentrations of plant samples were calculated from the curve.

3.7.4 Determination of Potassium

The amount of potassium was determined from the plant extract with the help of a flame photometer.

Preparation of primary potassium standard solution (1000 ppm): 1.918 g potassium chloride was taken in a 1L volumetric flask. About 200-300 mL distilled water was added and the flask was shaked thoroughly until a clear solution was obtained. The volume was made up to the mark with distilled water. Thus, 1000 ppm K solution was prepared.

Preparation of secondary potassium solution (100 ppm and 10 ppm): About 10 mL of the 1000 ppm K solution was taken in a 100 mL volumetric flask. The volume was made up to mark with distilled water and shaked thoroughly. Thus, 100 ppm K solution was prepared. From 100 ppm solution, 10 mL was taken in a 100 mL volumetric flask. The volume was made up to the mark with distilled water and shaked thoroughly. Thus, 10 ppm solution was obtained.

Preparation of potassium standard series solution: A series of standard solution containing 1 ppm, 2 ppm, 3 ppm, 4 ppm, 5 ppm and 6 ppm were prepared by pipetting 10 mL, 20 mL, 30 mL, 40 mL, 50 mL and 60 mL of 10 ppm K solution in six different 100 mL volumetric flask respectively. The volume was made up to the mark by distilled water and shaked thoroughly. Then, the reading (% emission) were taken from flame emission spectrophotometer and a standard curve was prepared from the reading taken. Plant samples were taken in volumetric flask and volume was made up to the mark by distilled water. Then the samples reading were taken and concentrations were calculated from the standard curve.

3.7.5 Determination of Sodium

The amount of Sodium was determined from the plant extract with the help of a flame photometer.

Preparation of primary sodium standard solution (1000 ppm): 2.542 g sodium hydroxide was taken in a 1L volumetric flask. About 200-300 mL distilled water was added and the flask was shacked thoroughly until a clear solution was obtained. The volume was made up to the mark with distilled water. Thus, 1000 ppm Na solution was prepared.

Preparation of secondary sodium solution (100 ppm and 10 ppm): About 10 mL of the 1000 ppm Na solution was taken in a 100 mL volumetric flask. The volume was made up to mark with distilled water and shaked thoroughly. Thus, 100 ppm Na solution was prepared. From 100 ppm solution, 10 mL was taken in a 100 mL volumetric flask. The volume was made up to the mark with distilled water and shaked thoroughly. Thus, 10 ppm solution was obtained.

Preparation of sodium standard series solution: A series of standard solution containing 1 ppm, 2 ppm, 3 ppm, 4 ppm, 5 ppm and 6 ppm were prepared by pipetting 10 mL, 20 mL, 30 mL, 40 mL, 50 mL and 60 mL of 10 ppm Na solution in six different 100 mL volumetric flask respectively. The volume was made up to the mark by distilled water and shaked thoroughly. Then, the reading (% emission) were taken from flame emission spectrophotometer and a standard curve was prepared from the reading taken. Plant samples were taken in volumetric flask and volume was made up to the mark by distilled water. Then the samples reading were taken and concentrations were calculated from the standard curve.

3.7.6 Determination of Nitrogen

The Macro Kjeldahl method was used to determine the total Nitrogen in root, shoot and grain of plant samples. Three steps were followed in this method. Here is given below:-

A. Digestion: In this step the organic nitrogen was converted to ammonium sulphate by sulphuric acid and digestion accelerators (Catalyst Mixture) at a temperature of 360-440º C.

$$N + H_2SO_4 = (NH_4)_2SO_4$$

B. Distillation: In this step, the solution was made alkaline from the distillation of ammonia. The distilled ammonia was received in boric acid solution.

$$(NH_4)_2SO_4 + NaOH = Na_2SO_4 + NH_3 + H_2O$$

$$NH_3 + H_3BO_3 = (NH_4)_2BO_3 + H_2O$$

C. Titration: To determine the amount of NH_3, ammonium borate was titrated with standard sulfuric acid.

$$(NH_4)_2BO_3 + H_2SO_4 = (NH_4)_2SO_4 + H_2O$$

Reagents: 4% Boric Acid solution, Mixed indicator (Bromocresol green and Methyl red), 4% Sodium Hydroxide solution, Standard Sulphuric Acid solution and 0.05 N Na_2CO_3 solution.

Procedure: About 0.25 g of oven dried grain sample was weighed and then taken into a 250 ml Kjeldahl flask. Then 5 g catalysts mixer (K_2SO_4:$CuSO_4.5H_2O$: Ratio=100:1) was added in to flask. Then about 25 ml concentrated H_2SO_4 was also added o the flask. The flask was heated until the solution become clear and then allowed to cool. After digestion, 40% NaOH was added o the conical flask and attached quickly to the distillation set. Then the flask was heated continuously. In the meantime, 25 ml of 4% boric acid solution and 2-4 drops of mixed indicator was added into the receiver conical flask. After distillation, the distillate was collected into receiver conical flask. The distillate was then titrated with standard H_2SO_4 taken from a burette until the green color completely turns to pink. The same procedure was followed for a blank sample. The result was calculated using the following formula-

$$\%N=(T-B)\times N\times 1.4/S$$

Where, T= Titration value for sample (ml), B= Titration value for blank (ml), N= Normality of H_2SO_4, S= Weight of the sample, 1.4= Factor

3.7.7 Determination of Calcium

The amount of calcium was determined from the plant extract with the help of a flame photometer.

Preparation of primary calcium standard solution (1000 ppm): 2.4973 g calcium carbonate was taken in a 1L volumetric flask with 25 mL of 1M hydrochloric acid. About 200-300 mL distilled water was added and the flask was shaked thoroughly until a clear solution was obtained. The volume was made up to the mark with distilled water. Thus, 1000 ppm Ca solution was prepared.

Preparation of secondary calcium solution (100 ppm and 10 ppm): About 10 mL of the 1000 ppm Ca solution was taken in a 100 mL volumetric flask. The volume was made up to mark with distilled water and shaked thoroughly. Thus, 100 ppm Ca solution was prepared. From 100 ppm solution, 10 mL was taken in a 100 mL volumetric flask. The volume was made up to the mark with distilled water and shaked thoroughly. Thus, 10 ppm solution was obtained.

Preparation of calcium standard series solution: A series of standard solution containing 10 ppm, 20 ppm, 30 ppm, 40 ppm, 50 ppm and 60 ppm were prepared in six different 100 mL volumetric flask respectively. The volume was made up to the mark by distilled water and shaked thoroughly. Then, the reading (% emission) were taken from flame emission spectrophotometer and a standard curve was prepared from the reading taken. Plant extracts were taken in volumetric flask and volume was made up to the mark by distilled water. Then the extracts reading were taken and concentrations were calculated from the standard curve.

3.8 Statistical Analysis

The data from wheat samples were compiled and tabulated in proper form and were subjected to statistical analysis. The computer package MSTAT-C program developed by Russel (1986) was used to analysis of variance. The mean differences among the treatments were adjusted by least significant difference (LSD) test at 5% level of significance (Gomez and Gomez, 1984).

CHAPTER IV
RESULTS AND DISCUSSION

CHAPTER IV

RESULTS AND DISCUSSION

The present chapter deals with the result of the experiment as influenced by the effect of three wheat cultivars under different salinity stress condition and their interaction on morphological characters, yield contributing characters and nutrient contents are presented in table 1-28. The analysis of variance and other necessary information have been presented in Appendices I to XVIII. Results and discussion of the experiment are given below.

4.1 Effect of salinity on the morphological and yield contributing characters

4.1.1 Germination

It was found that germination percentage was significantly varied with varieties. Figure 1 shows that BARI gom-25 was recorded maximum germination percentage (73.88%) and minimum germination percentage was found in BARI gom-24 (62.72%).

Germination percentage was significantly varied with different levels of salinity. Figure 2 shows that salinity treatment S_0 recorded the highest germination percentage (100%) and the lowest germination percentage was found in S_4 (23.73%). Similar results were found in wheat germination under different salinity levels by Rahman *et al*. (2008), and Hussain *et al*. (2013).

The interaction effect between salinity treatment and cultivars were greatly influenced. Maximum germination percentage (100%) was found in BARI gom-24, BARI gom-25 and BARI gom-26 at S_0 (control) whereas the lower germination percentage (15.15%) were found in BARI gom-24 at S_4 (12 dSm^{-1}) salinity treatment (Figure 3).

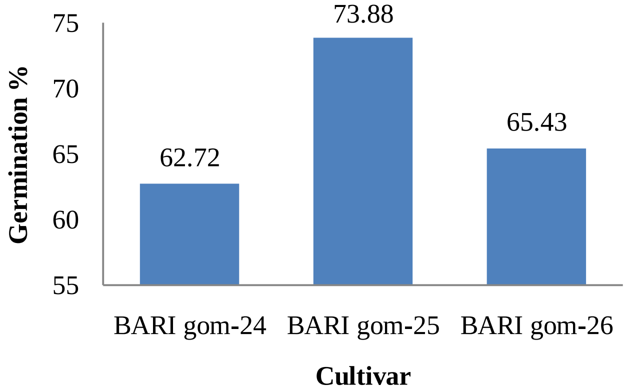

Figure 1: Effect of cultivar on germination

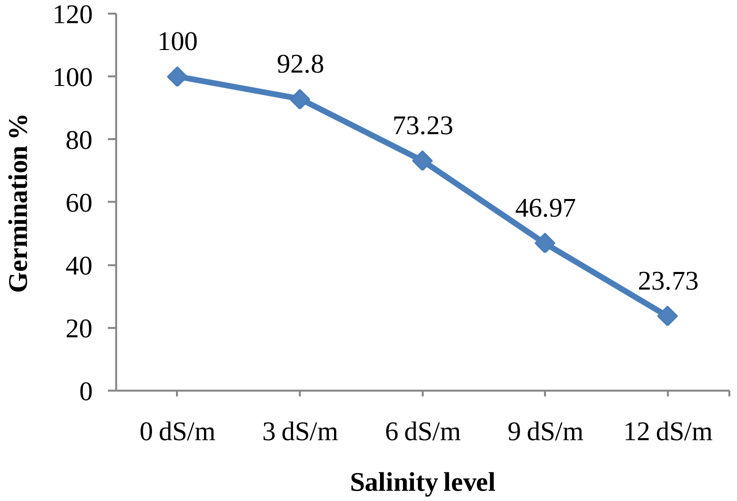

Figure 2: Effect of salinity level on germination

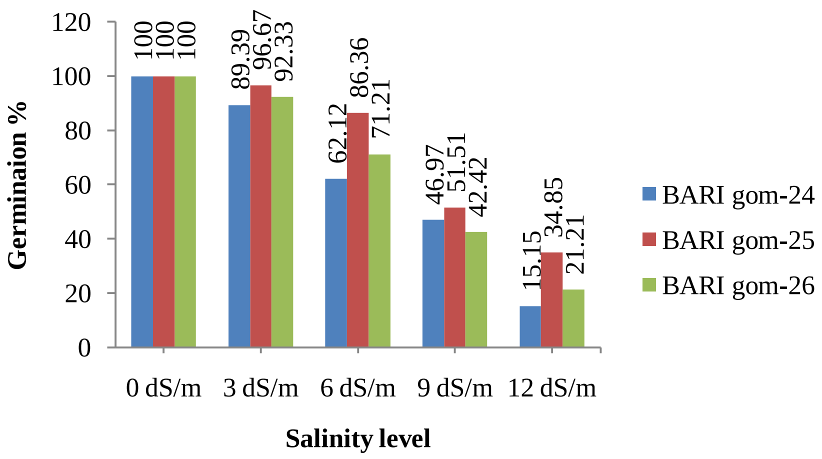

Figure 3: Interaction effect between salinity and cultivar on germination

4.1.2 Plant height

The plant height of three cultivars was significantly varied at 30, 60 and 95 DAS (Appendix XI). The longest plant height was recorded 19.61 cm, 52.54 cm and 67.67 cm in BARI gom-25 at 30, 60 and 95 DAS respectively. But at 60 DAS BARI gom-25 and BARI gom-26 were shown statistically similar height. This significant variation might be associated mainly with the genetic makeup of the cultivars (Figure 4).

Due to the effect of salinity stresses, the plant height was varied significantly at 30, 60 and 95 DAS (Appendix XIII). Plant height was decreased with increased salinity level. The highest plant height 21.16 cm, 56.89 cm and 72.26 cm were recorded at 30, 60 and 95 DAS respectively in S_0 (control) treatment. But at 60 DAS S_0 (control) and S_1 (3 dSm^{-1}) treatment were found statistically similar height. The lowest plant height 12.88 cm, 43.52 cm and 53.63 cm were found at 30, 60 and 95 DAS respectively in S_4 (12 dSm^{-1}) treatment. Due to decreased nutrient availability caused by increased salinity levels, it might be the main reason of decreased plant height. Bhatti *et al*. (2004) reported that increased salinity levels drastically affected plant height, similar results were found by Ismail (2003), Rajpar and Sial (2002) who reported thar plant height was decreased in the stress treatments which might be due to the fact that cell division or cell enlargement was inhibited due to salinity stress (Figure 5).

Table 1 shows that the interaction effect between salinity level and cultivars on plant height was significantly varied (p≤ 0.05) at 30, 60 and 95 DAS.

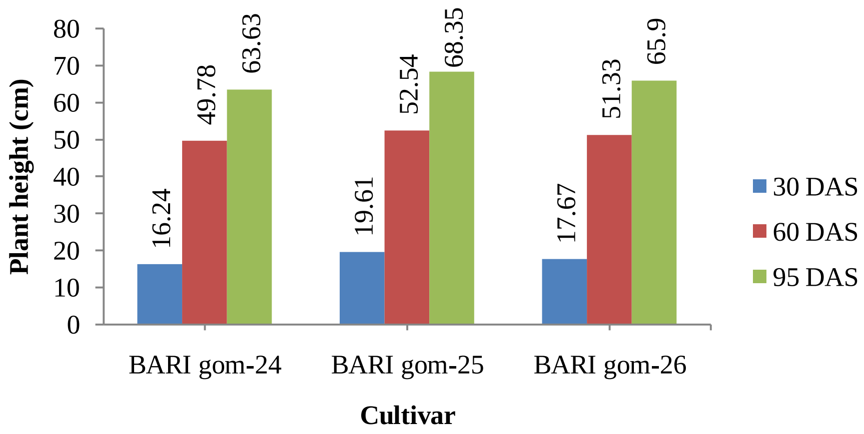

Figure 4: Effect of cultivar on plant height at 30 DAS, 60 DAS and 95 DAS

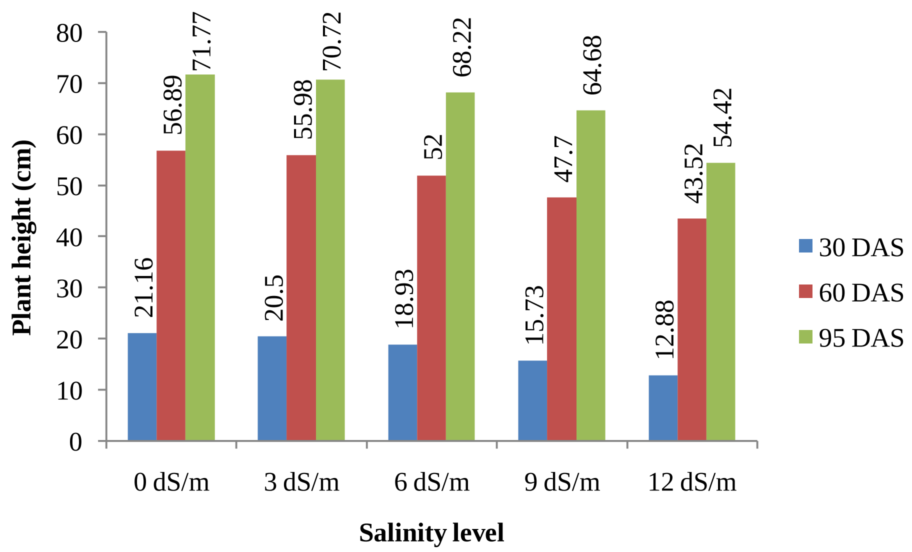

Figure 5: Effect of salinity on plant height at 30, 60 and 95 DAS

4.1.3 Number of total tiller per pot

Due to salinity stress, number of total tiller per pot among three cultivars was significantly varied (Appendix XI). Maximum number of total tiller per pot (15.6) was found at BARI gom-25 and minimum number of total tiller per pot (13.77) was found at BARI gom-24 (Figure 6).

Table 1: Interaction effect between salinity level and cultivar on plant height at different days

Cultivar	Salinity level (dSm^{-1})	Plant height (cm)		
		30 DAS	60 DAS	95 DAS
BARI gom-24	0	20.50 bc	55.40 bcd	71.27 bc
	3	19.33 d	54.27 cd	68.50 de
	6	17.23 e	51.33 e	65.97 f
	9	13.93 f	46.77 f	61.57 g
	12	10.20 h	41.13 h	49.63 j
BARI gom-25	0	20.97 bc	56.87 abc	71.77 ab
	3	21.17 ab	55.57 bcd	70.10 bcde
	6	20.23 c	53.37 de	69.50 cde
	9	19.10 d	51.00 e	68.53 de
	12	16.57 e	45.90 fg	58.43 h
BARI gom-26	0	22.00 a	58.40 a	73.73 a
	3	21.00 bc	58.10 ab	70.53 bcd
	6	19.33 d	51.30 e	68.03 ef
	9	14.17 f	45.33 fg	62.50 g
	12	11.87 g	43.53 gh	52.83 i
$LSD_{0.05}$		0.8379	2.800	2.216
Level of significance		*	*	*
CV %		2.81	3.27	4.02

LSD = Least Significant Difference, CV = Coefficient of variation, * = Significant at 5% level

The number of total tiller per pot significantly varied with the salinity stress (Appendix XIII). The highest number of total tiller per pot (17.89) was found in S_0 (control) treatment and lowest number was found in S_4

(12 dSm^{-1}) treatment (Figure 7). These results agree with Iqbal (2003) who observed reduced number of total tiller at higher level of salinity. Similar results were shown in Shazia *et al*. (2001), Singh *et al*. (2000), Cheong *et al*. (1995) and Dravid and Goswami (1986).

The interaction effect between cultivars and salinity levels on total tiller per pot was significantly varied. Table 2 shows that BARI gom-26 was recorded maximum total tiller number per pot (18.67) at S_0 salinity level and BARI gom-25 have shown statistically similar result at same treatment. The lowest number of total tiller per pot (7.66) was recorded in BARI gom-26 at S_4 (12 dSm^{-1}) treatment. It is clear from the data that number of total tiller per pot decreased with the increased salinity levels.

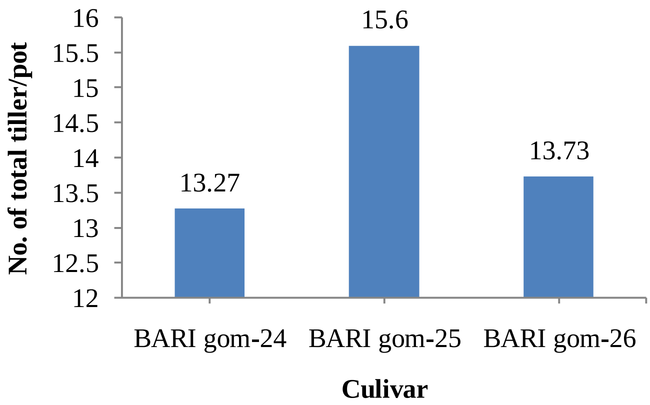

Figure 6: Effect of cultivar on number of total tiller/pot

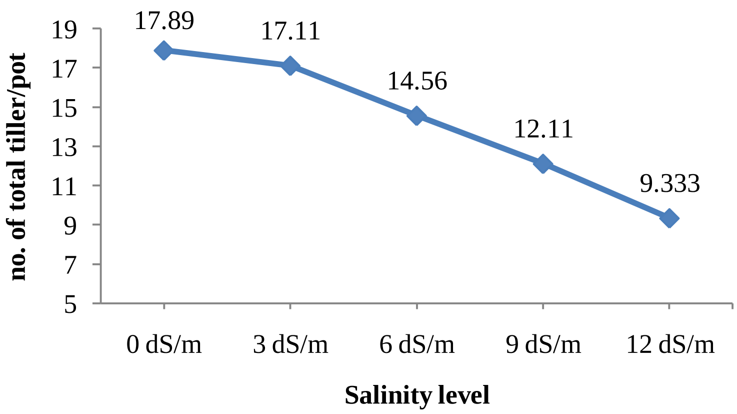

Figure 7: Effect of salinity on number of total tiller/pot

Table 2: Interaction effect between salinity level and cultivar on number of total tiller per pot

Cultivar	Salinity level (dSm^{-1})	No. of total tiller/pot
BARI gom-24	0	16.67 de
	3	16.33 e
	6	13.33 f
	9	11.33 g
	12	8.667 h
BARI gom-25	0	18.33 ab
	3	17.67 bc
	6	16.67 de
	9	13.67 f
	12	11.67 g
BARI gom-26	0	18.67 a
	3	17.33 cd
	6	13.67 f
	9	11.33 g
	12	7.667 i
$LSD_{0.05}$		0.9520
Level of significance		*
CV %		4.01

LSD = Least Significant Difference, CV = Coefficient of variation,

* = Significant at 5% level

4.1.4 Number of effective tiller per pot

Cultivars had a significant influence on the number of effective tiller per pot (Appendix XI). The Maximum number of effective tiller per pot (12.87) was found in BARI gom-25. The minimum number of effective tiller per pot was recorded from BARI gom-24, and it was statistically similar to the BARI gom-26 (Figure 8).

The number of effective tiller per pot was greatly influenced by the salinity levels (Appendix XIII). The highest number of effective tiller per pot (17.89) was recorded from S_0 (control) treatment. The lowest number of effective tiller per pot (3.56) was recorded from S_4 (12 dSm^{-1}) treatment (Figure 9). The results show that as the salinity stress increased, the number of effective tiller per pot was decreased. This indicated that salinity stress had direct effect on number of effective tiller per pot. The findings of Shazia *et al.* (2001) and Chhipa and Lal (1985) were similar to the present study that the number of fertile tillers in wheat was significantly reduced with increasing salinity level.

The interaction effect between cultivars and salinity stress was also significant (Table 3). The highest number of effective tiller per pot (18.67) was found in BARI gom-26 at S_0 (control) treatment, and BARI gom-25 producing 18.33 effective tiller per pot, had shown statistically similar result at S_0 (control) treatment.

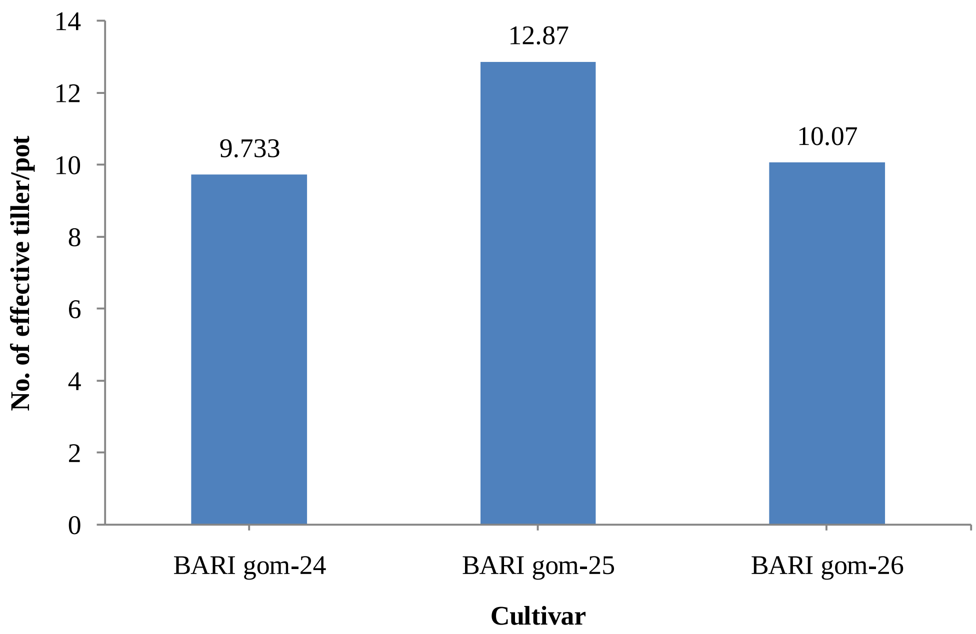

Figure 8: Effect of cultivar on number of effective tiller/pot

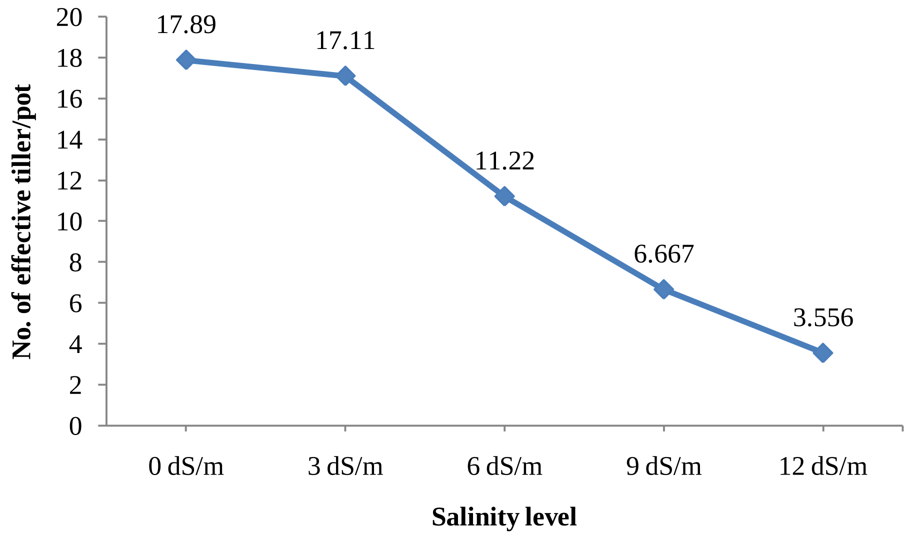

Figure 9: Effect of salinity on number of effective tiller/pot

Table 3: Interaction effect of salinity level and cultivar on effective tiller per pot

Cultivar	Salinity level (dSm^{-1})	No. of effective tiller/pot
BARI gom-24	0	16.67 b
	3	15.00 c
	6	9.667 e
	9	5.000 g
	12	2.333 h
BARI gom-25	0	18.33 a
	3	16.67 b
	6	14.67 cd
	9	8.667 e
	12	6.000 fg
BARI gom-26	0	18.67 a
	3	13.67 d
	6	9.333 d
	9	6.333 e
	12	2.333 f
$LSD_{0.05}$		1.017
Level of significance		*
CV %		5.59

LSD = Least Significant Difference, CV = Coefficient of variation, * = Significant at 5% level

4.1.5 Number of ineffective tiller per pot

Cultivars had a significant influence on the number of ineffective tiller per pot (Appendix XI). The maximum number of ineffective tiller per pot (3.67) was recorded from BARI gom-26, and it was also found that BARI gom-24 was statistically similar to the number of ineffective tiller per pot (3.53). The lowest number of ineffective tiller per pot (2.73) was recorded from BARI gom-25 (Figure 10).

The effect of different levels of salinity treatment on number of ineffective tiller per pot was significant (Appendix XIII). The highest number of ineffective tiller per pot (5.77) was recorded from salinity level S_4 (12 dSm^{-1}), and from the salinity level S_3 (9 dSm^{-1}), number of ineffective tiller per pot (5.44) had shown statistically similar result to the salinity level S_4 (12 dSm^{-1}). The lowest number of ineffective tiller per pot (0) was recorded from the salinity level S_0 (control). It was found that number of ineffective tiller per pot was increased with the increasing level of salinity (Figure 11).

The interaction effect between cultivars and salinity levels was also significant (table 4). The highest number of ineffective tiller per pot (6.33) was recorded from BARI gom-24 at the both salinity level of S_3 (9 dSm^{-1}) and S_4 (12 dSm^{-1}). Number of ineffective tiller per pot (5.67) was recorded from BARI gom-25 at S_4 (12 dSm^{-1}) salinity level, that was statistically similar to the S_3 and S_4 salinity treatment of BARI gom-24. The lowest number of ineffective tiller per pot (0) was recorded from the three cultivars (BARI gom-24, BARI gom-25 and BARI gom-26) at S_0 (control) salinity level. From this result, it was clear that increasing salinity stress had directly impact on production of ineffective tiller. Increasing salinity level increases ineffective tiller production.

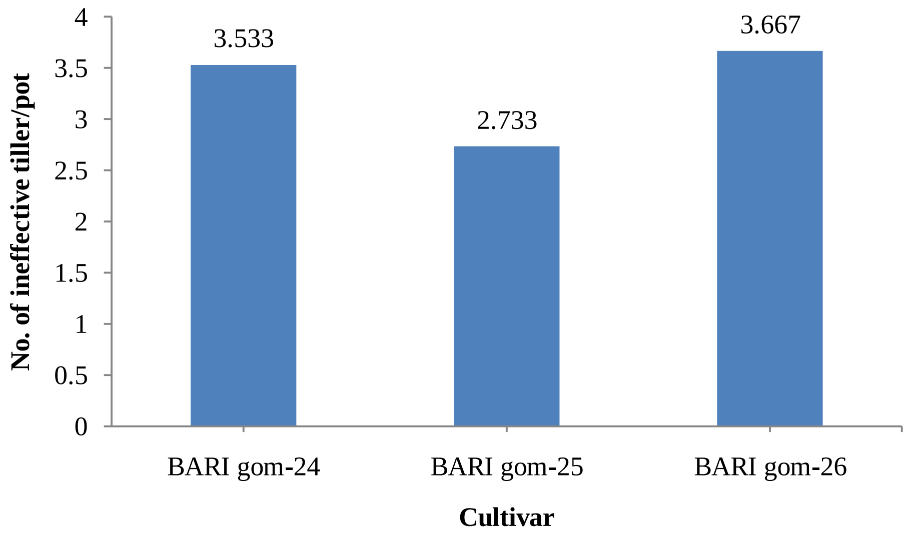

Figure 10: Effect of cultivar on number of ineffective tiller/pot

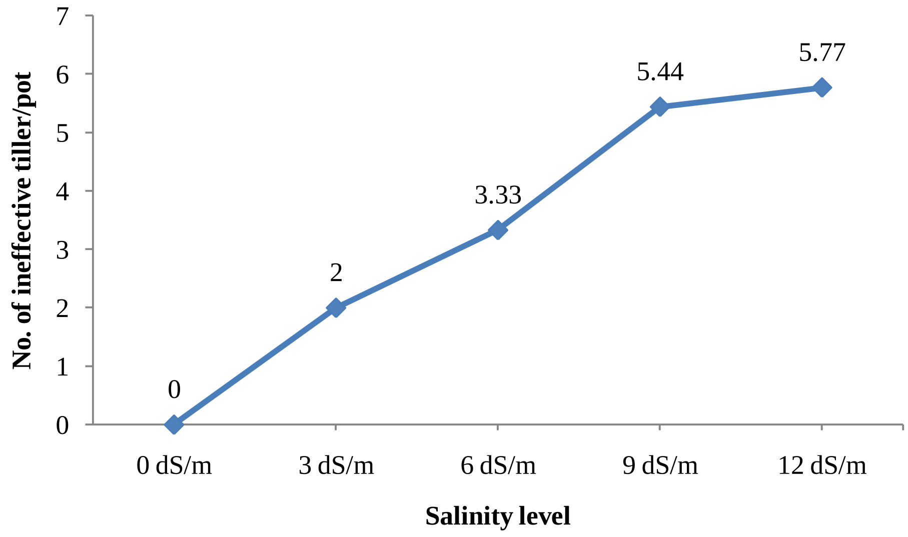

Figure 11: Effect of salinity level on number of ineffective tiller/pot

4.1.6 Spike length

Length of spike among three cultivars was significant (Appendix XI). The maximum length of spike (12.88 cm) was recorded from BARI gom-25. The minimum length of spike (9.693 cm) was recorded from BARI gom-26. It was evident from the results that the three cultivars had different degrees of salinity tolerance on the length of spike (Figure 12).

Table 4: Interaction effect between salinity level and cultivar on number of ineffective tiller per pot

Cultivar	Salinity level (dSm^{-1})	No. of ineffective tiller/pot
BARI gom-24	0	0.000 g
	3	1.333 ef
	6	3.667 d
	9	6.333 a
	12	6.333 a
BARI gom-25	0	0.000 g
	3	1.000 f
	6	2.000 e
	9	5.000 bc
	12	5.667 ab
BARI gom-26	0	0.000 g
	3	3.667 d
	6	4.333 cd
	9	5.000 bc
	12	5.333 b
$LSD_{0.05}$		0.7076
Level of significance		*
CV %		12.79

LSD = Least Significant Difference, CV = Coefficient of variation,
* = Significant at 5% level

The effect of salinity levels on spike length was significant (Appendix XIII). The highest length of spike (14.99 cm) was obtained from S_0 (control) treatment. The lowest length of spike (5.367 cm) was recorded from S_4 (12 dSm^{-1}) treatment. From the results, as the salinity level increased, length of spike was decreased (Figure 3). Similar result was found by Akram *et al.* (2002) who reported that spike length was significantly affected by increasing irrigation with saline water (Figure 13).

The interaction effect of salinity level and cultivars on length of spike was also significant (Table 5). The maximum length of spike (15.60 cm) was recorded from BARI gom-26 at S_0 (control) salinity level. BARI gom-25 had shown statistically similar result at S_0 (control) salinity level with a spike length (15.07 cm) that of BARI gom-26 at same level of salinity treatment. The minimum length of spike (3.467 cm) was recorded from BARI gom-26 at S_4 ($12dSm^{-1}$) treatment. BARI gom-24 had shown statistically similar result at S_4 ($12\ dSm^{-1}$) treatment with BARI gom-26 at same level of salinity treatment.

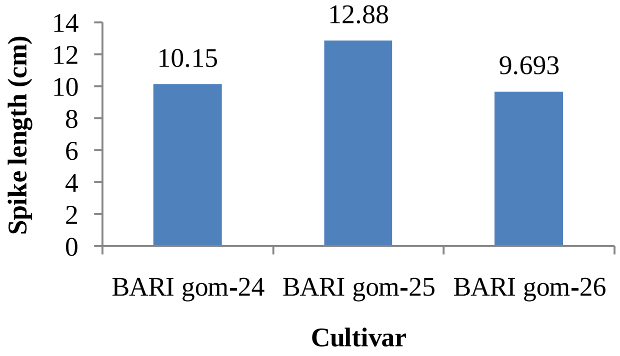

Figure 12: Effect of cultivar on spike length

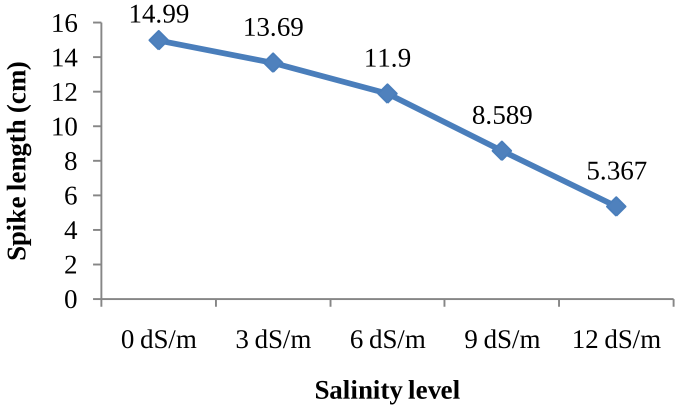

Figure 13: Effect of salinity level on spike length

Table 5: Interaction effect between salinity level and cultivar on spike length (cm)

Cultivar	Salinity level (dSm^{-1})	Spike length (cm)
BARI gom-24	0	14.30 bc
	3	13.50 de
	6	11.50 f
	9	7.300 i
	12	4.133 k
BARI gom-25	0	15.07 ab
	3	14.50 bc
	6	14.10 cd
	9	12.23 f
	12	8.500 h
BARI gom-26	0	15.60 a
	3	13.07 e
	6	10.10 g
	9	6.233 j
	12	3.467 k
$LSD_{0.05}$		0.7809
Level of significance		*
CV %		4.28

LSD = Least Significant Difference, CV = Coefficient of variation,
* = Significant at 5% level

4.1.7 Number of total grain per spike

Number of total grain per spike was statistically significant in respect of cultivars (Appendix IV). The number of total grain per spike was highest in BARI gom-25 (34.60) and lowest in BARI gom-24 (30.20). From the results it was clear that the different cultivars had different degrees of salinity tolerance for the number of grain per spike (Figure 14).

The number of total grain per spike was significant in respect of different levels of salinity treatment (Appendix VI). The highest number of total grain per spike (43.78) was recorded from S_0 (control) salinity treatment. The lowest number of total grain per spike (12.89) was obtained from S_4 (12 dSm^{-1}) salinity treatment. Increasing level of salinity decreased the number of total grain per spike (Figure 15). Salinity stress hinders the photosynthetic efficiency as well as assimilates translocation ability of plant from vegetative organ to reproductive organ. For these reason, less number of grains were developed in spike. Similar result was observed by Shazia *et al*. (2001) who reported that number of total grain per spike was decreased progressively with the increasing salinity level.

Between cultivars and salinity level, the interaction effect on number of total grain per spike was also significant (Table 6). The highest number of total grain per spike (46.67) was recorded from BARI gom-26 at S_0 (control) salinity treatment. The lowest number of total grain per spike (11.33) was recorded from BARI gom-26 at S_4 (12 dSm^{-1}) salinity treatment.

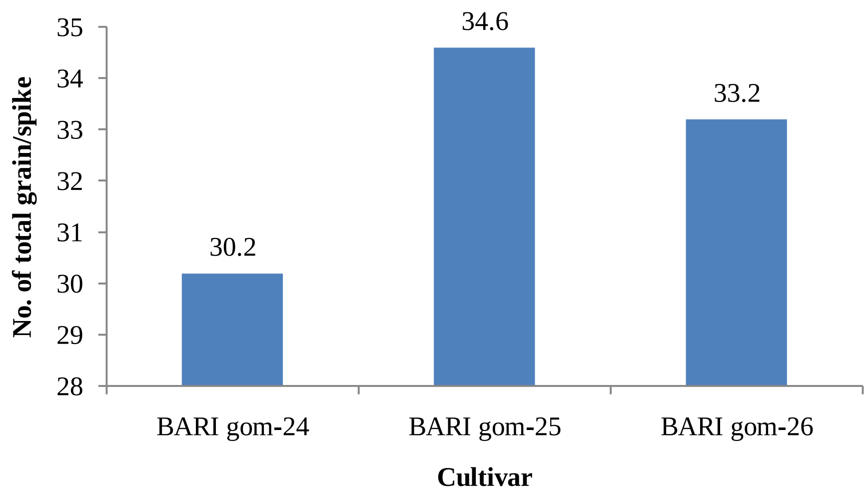

Figure 14: Effect of cultivar on number of total grain/spike

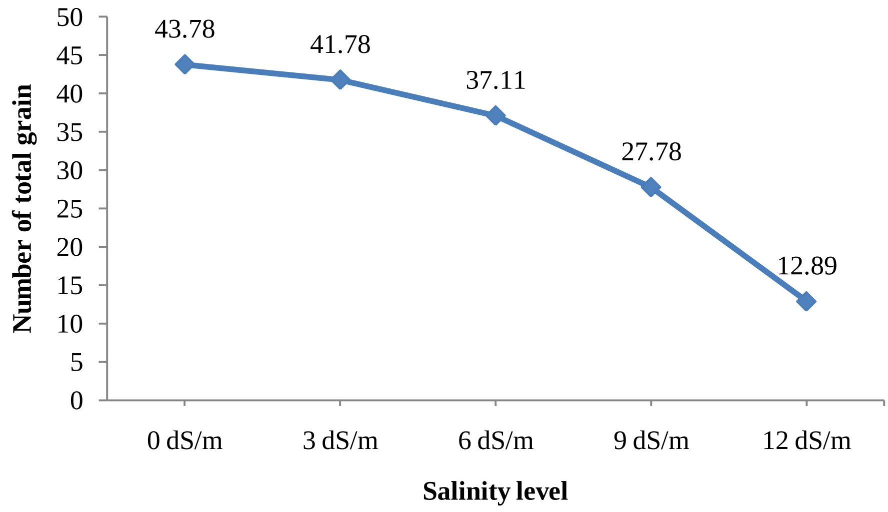

Figure 15: Effect of salinity level on number of total grain/spike

Table 6: Interaction effect between salinity level and cultivar on number of total grain per spike

Cultivars	Salinity level (dSm^{-1})	Number of total grain/spike
BARI gom-24	0	41.67 bc
	3	40.00 d
	6	33.00 f
	9	24.00 i
	12	12.33 k
BARI gom-25	0	43.00 b
	3	43.20 b
	6	40.67 cd
	9	31.33 g
	12	15.00 j
BARI gom-26	0	46.67 a
	3	42.33 b
	6	37.67 e
	9	28.00 h
	12	11.33 l
$LSD_{0.05}$		1.361
Level of significance		*
CV %		2.49

LSD = Least Significant Difference, CV = Coefficient of variation,
* = Significant at 5% level

4.1.8 Number of filled grain per spike

The effect of cultivars on number of filled grain per spike under salinity treatment was significant (Appendix XII). The maximum filled grain per spike (23.07) was recorded from BARI gom-25. The minimum number of filled grain per spike (16.20) was obtained from BARI gom-24. From the results, it was observed that different cultivars had different degrees of salinity tolerance on the number of filled grain per spike (Figure 16).

Due to salinity treatment the number of filled grain per spike was significant (Appendix XIV). The highest number of filled grain per spike (42.22) was recorded from S_0 (control) treatment. The lowest number of filled grain per spike (0) was recorded from S_4 (12 dSm^{-1}) treatment. Similar result was observed by Ashraf and Paveen (2002) who reported that increase in NaCl concentration, decreased the number of filled grain per spike (Figure 17).

The interaction effect between salinity level and cultivars on number of filled grain per spike was also significant (Table 7). The highest number of filled grain per spike (43.33) was recorded from BARI gom-26 at S_0 (control) treatment. Statistically similar result was found in BARI gom-25 at same salinity treatment. The lowest number of filled grain per spike (0) was recorded from all the three cultivars- BARI-gom24, BARI gom-25 and BARI gom-26 at S_4 (12 dSm^{-1}) treatment.

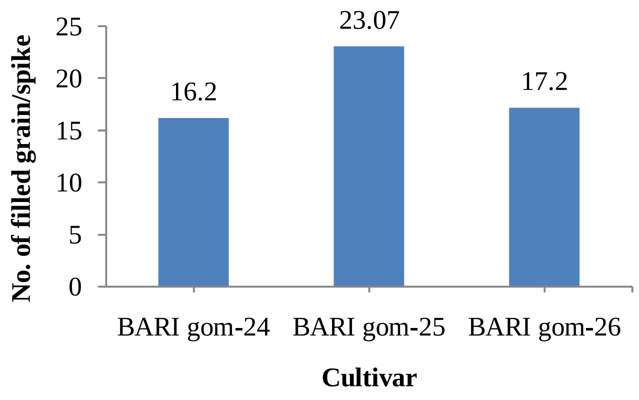

Figure 16: Effect of cultivar on number of filled grain/spike

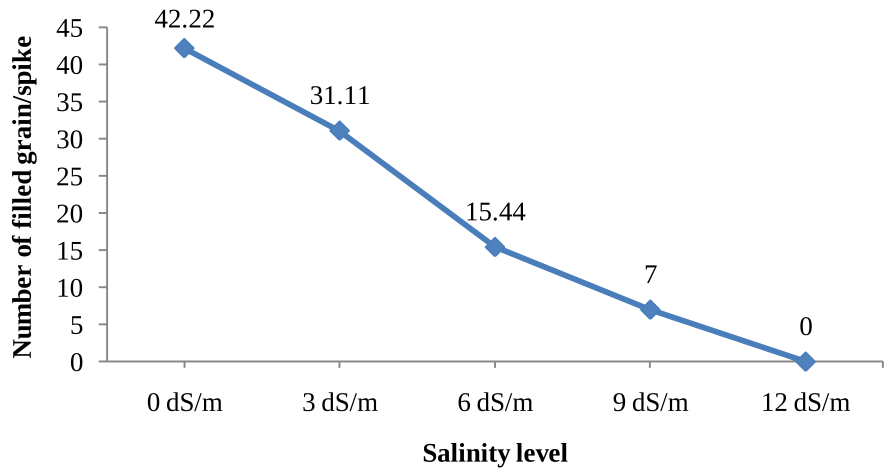

Figure 17: Effect of salinity level on number of filled grain/spike

4.1.9 Number of unfilled grain per spike

The effect of cultivars on number of unfilled grain per spike was significant (Appendix XII). The highest number of unfilled grain per spike (9.2) was recorded from BARI gom-24, and statistically similar unfilled grain number (8.867) was recorded from BARI gom-26. The lowest number of unfilled grain per spike (7.067) was recorded from BARI gom-25. From the results, it was evident that different cultivars had different degrees of salinity tolerance on unfilled grain production (Figure 18).

Table 7: Interaction effect between salinity level and cultivar on number of filled grain per spike

Cultivars	Salinity level (dSm^{-1})	Number of filled grain/spike
BARI gom-24	0	40.67 b
	3	28.00 d
	6	11.67 fg
	9	5.667 h
	12	0.000 j
BARI gom-25	0	42.67 a
	3	36.67 c
	6	23.33 e
	9	12.67 f
	12	0.000 j
BARI gom-26	0	43.33 a
	3	28.67 d
	6	11.33 g
	9	2.667 i
	12	0.000 j
$LSD_{0.05}$		1.062
Level of significance		*
CV %		3.31

LSD = Least Significant Difference, CV = Coefficient of variation,
* = Significant at 5% level

Number of unfilled grain per spike was significant due to salinity treatment (Appendix XIV). The highest number of unfilled grain per spike (11.22) was obtained from the S_4 (12 dSm^{-1}) salinity level, treatment S_3 (9 dSm^{-1}) and S_2 (6 dSm^{-1}) were shown statistically similar result to the number of unfilled grain production per spike. The lowest number of unfilled grain per spike (1.67) was recorded from S_0 (control) treatment. Salinity stress had directly effect on unfilled grain production. Increasing salinity level increased unfilled grain production (Figure 19).

The interaction effect between salinity level and cultivar on number of unfilled grain per spike was significant (Table 8). The highest number of unfilled grain per spike (14.33) was recorded from BARI gom-24 at S_4 (12 dSm^{-1}) salinity level. The lowest number of unfilled grain per spike (2.0) was recorded from BARI gom-26 at S_0 (control) treatment. Increasing salinity level increased unfilled grain production in different rate at different cultivar.

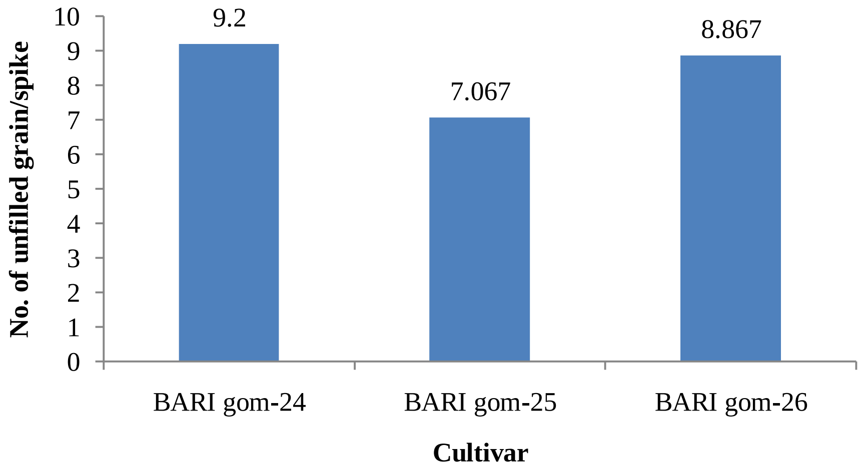

Figure 18: Effect of cultivar on number of unfilled grain/spike

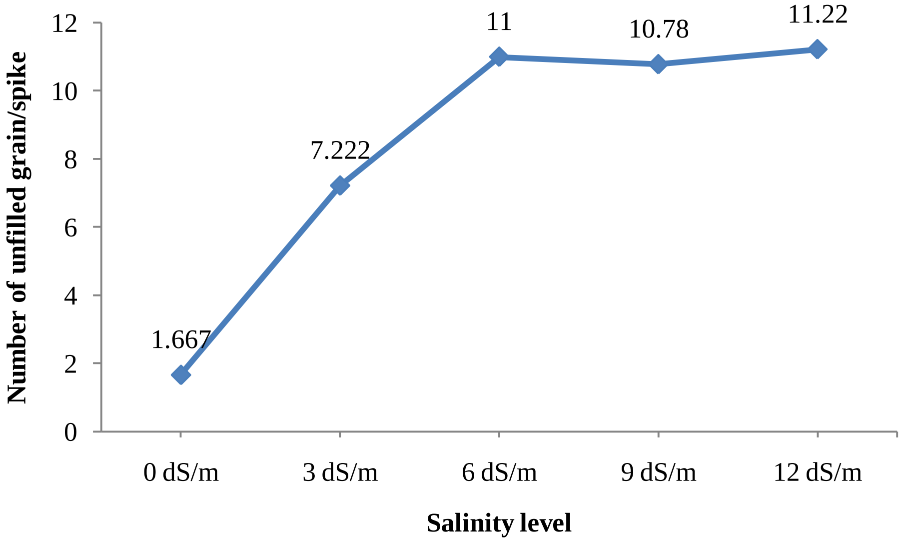

Figure 19: Effect of salinity level on number of unfilled grain/spike

Table 8: Interaction effect between salinity level and cultivar on number of unfilled grain per spike

Cultivars	Salinity level (dSm^{-1})	Number of unfilled grain/spike
BARI gom-24	0	1.667 h
	3	8.333 e
	6	10.33 cd
	9	11.33 bc
	12	14.33 a
BARI gom-25	0	1.333 h
	3	3.667 g
	6	6.667 f
	9	11.33 bc
	12	12.33 b
BARI gom-26	0	2.000 h
	3	9.667 d
	6	10.00 d
	9	10.67 cd
	12	12.00 b
$LSD_{0.05}$		1.236
Level of significance		*
CV %		8.82

LSD = Least Significant Difference, CV = Coefficient of variation,

* = Significant at 5% level

4.1.10 1000-grain weight

Individual grain weigh of a wheat cultivar indicates its grain size. 1000 grain weight among three wheat cultivars was significant (Appendix XII). The maximum 1000 grain weight (47.24 g) was obtained from BARI gom-25. The minimum 1000 grain weight (41.29 g) was obtained from BARI gom-24, and BARI gom-26 produced 42.25 g 1000 grain weight that was statistically similar to the BARI gom-24. From this result, it might be concluded that there was cultivars difference in size of the seed (Figure 20).

The effect of salinity level on 1000 grain weight was significant (Appendix XIV). The highest 1000 grain weight (51.18 g) was recorded from S_0 (control) treatment. Salinity level S_1 (3 dSm^{-1}) produced 50.76 g 1000 grain weight that was statistically similar to the S_0 (control) treatment. The lowest 1000 grain weight (27.89 g) was recorded from S_4 (12 dSm^{-1}) salinity treatment (Figure 21). From these findings, it was evident that increasing salinity level decreased 1000 grain weight; it might be the result of decreased seed size for increasing salinity level.

The interaction effect between salinity level and cultivar was also significant (Table 9). The highest 1000 grain weight (51.77 g) and (51.43 g) were recorded from BARI gom-26 and BARI gom-25 respectively at S_0 (control) treatment. BARI gom-24 at S_0 (control) and S_1 (3 dSm^{-1}) salinity treatment, BARI gom-25 at S_1 (3 dSm^{-1}) salinity treatment and BARI gom-26 at S_1 (3 dSm^{-1}) salinity treatment had shown statistically similar 1000 grain weight with BARI gom-26 and BARI gom-25 at S_0 (control) treatment. The lowest 1000 grain weight (21.47 g) was recorded from BARI gom-24 a S_4 (12 dSm^{-1}) salinity treatment. From the result BARI gom-25 was more tolerant than other cultivars.

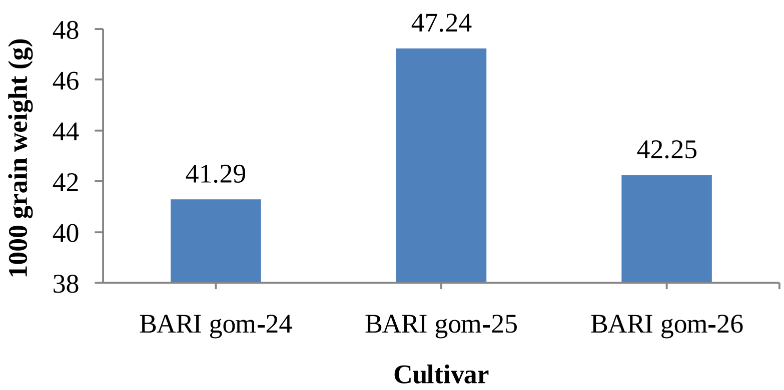

Figure 20: Effect of cultivar on 1000-grain weight

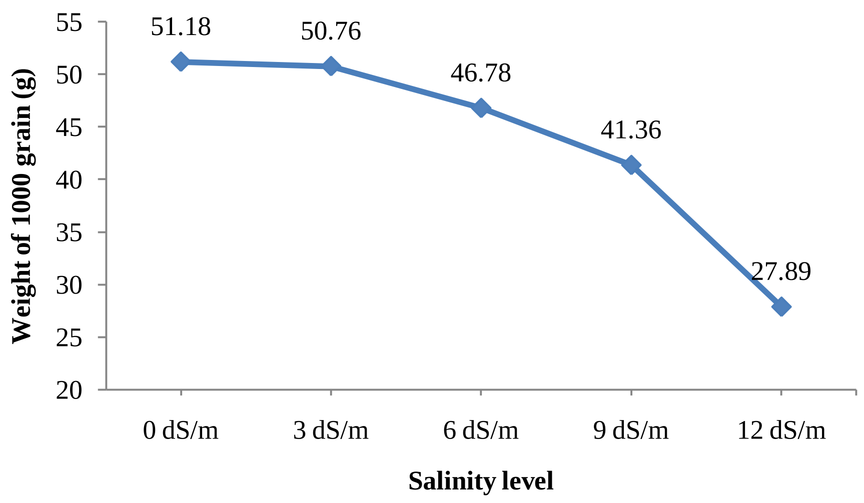

Figure 21: Effect of salinity on 1000-grain weight

Table 9: Interaction effect between salinity level and cultivar on 1000-grain weight

Cultivars	Salinity level (dSm^{-1})	1000 grain weight (g)
BARI gom-24	0	50.53 ab
	3	49.73 ab
	6	45.40 c
	9	39.30 d
	12	21.47 f
BARI gom-25	0	51.43 a
	3	51.23 ab
	6	49.20 b
	9	46.23 c
	12	38.10 d
BARI gom-26	0	51.77 a
	3	51.10 ab
	6	45.73 c
	9	38.53 d
	12	24.10 e
$LSD_{0.05}$		2.156
Level of significance		*
CV %		3.96

LSD = Least Significant Difference, CV = Coefficient of variation,

* = Significant at 5% level

4.1.11 Grain yield per pot

Production of wheat grain from each pot indicates grain yield per pot. Grain yield among three cultivars was significant (Appendix XII). The maximum grain yield (19.78 g) was obtained from BARI gom-25. The minimum grain yield was (13.35 g) obtained from BARI gom-24 (Figure 22).

The effect of salinity level on grain yield per pot was significant (Appendix XIV). The highest grain yield per pot (34.51 g) was recorded from S_0 (control) treatment. The lowest grain yield per pot (0.67 g) was recorded from S_4 (12 dSm^{-1}) treatment. It was clearly noticed that increasing salinity level decreased grain yield (Figure 23). Due to salinity stress plant produced less number of tillers, less number of spikes and less assimilate through photosynthesis. As a result plants bearded less number of spikes which contributed fewer yields per plant. Padole *et al.*, (1995) stated from a study that the yield of wheat was decreased in highly saline soil. The present result was fully consistent with this finding.

The interaction effect of salinity level and cultivar on grain yield per pot was also significant (Table 10). The maximum grain yield per pot (40.68 g) was recorded from BARI gom-26 at S_0 (control) treatment. The minimum grain yield per pot (0.305 g) was recorded from BARI gom-26 at S_4 (12 dSm^{-1}) treatment followed by grain yield per pot (0.353 g), BARI gom-24 at S_4 (12 dSm^{-1}) treatment.

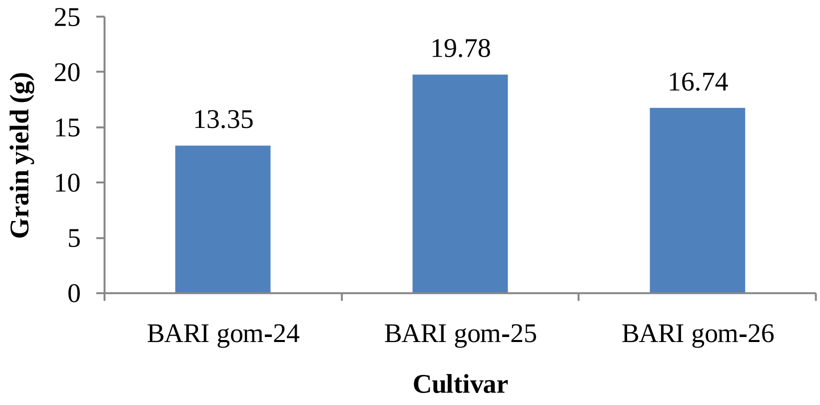

Figure 22: Effect of cultivar on grain yield per pot (g)

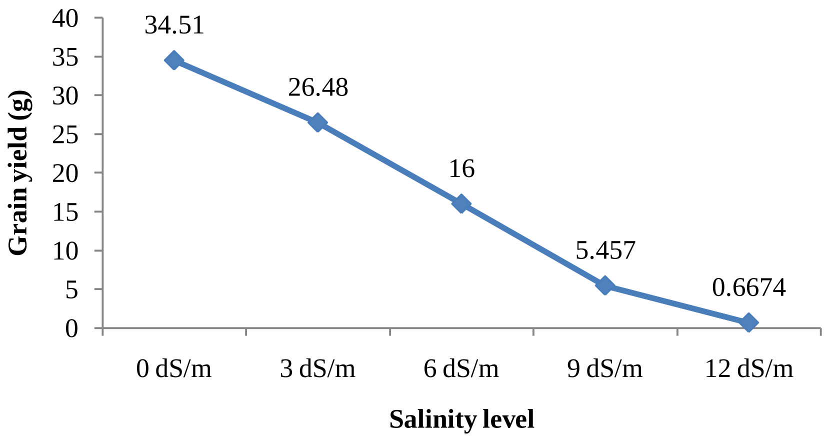

Figure 23: Effect of cultivar on grain yield per pot (g)

4.1.12 Straw yield per pot

Straw yield per pot among cultivars was significant (Appendix XII). The highest straw weight per pot (80.26 g) was recorded from BARI gom-25. The lowest straw weight per pot (77.85 g) was recorded from BARI gom-26, and it was statistically similar to the straw weight per pot (77.55 g) from BARI gom-24. Different cultivar produced different amount of straw for salinity treatment (Figure 24).

Table 10: Interaction effect between salinity level and cultivar on grain yield per pot (g)

Cultivars	Salinity level (dSm^{-1})	Straw weight/pot (g)
BARI gom-24	0	28.96 c
	3	24.06 d
	6	10.51 f
	9	2.883 hg
	12	0.353 i
BARI gom-25	0	33.91 b
	3	30.86 c
	6	24.25 d
	9	8.52 f
	12	1.34 hi
BARI gom-26	0	40.68 a
	3	24.52 d
	6	13.23 e
	9	4.97 g
	12	0.313i
$LSD_{0.05}$		2.35
Level of significance		*
CV %		8.47

LSD = Least Significant Difference, CV = Coefficient of variation,

* = Significant at 5% level

The effect of salinity level on straw weight per pot was significant (Appendix XIV). The maximum straw weight per pot (87.14 g) was recorded from S_0 (control) treatment. The lowest straw weight per pot (64.84 g) was recorded from S_4 (12 dSm^{-1}) salinity treatment. From the result, it is clear that increasing salinity level decreased straw weight (Figure 25). This result agrees with the findings of Chhipa and Lal (1985) who have conducted a pot experiment and observed that salinity stress affected straw yield of wheat. Similar results were reported by Haqqani *et al*., (1984), Khandelwal and Lal (1991).

The interaction effect between salinity level and cultivar was also significant (Table 11). The maximum straw weight per pot (88.87 g) was obtained from BARI gom-26 at S_0 (control) treatment. BARI gom-24 produced (85.73 g) straw and BARI gom-25 produced (86.83 g) straw at S_0 (control) treatment were statistically similar with the BARI gom-26 at S_0 (control) treatment. Increasing level of salinity decreased straw weight in every cultivar.

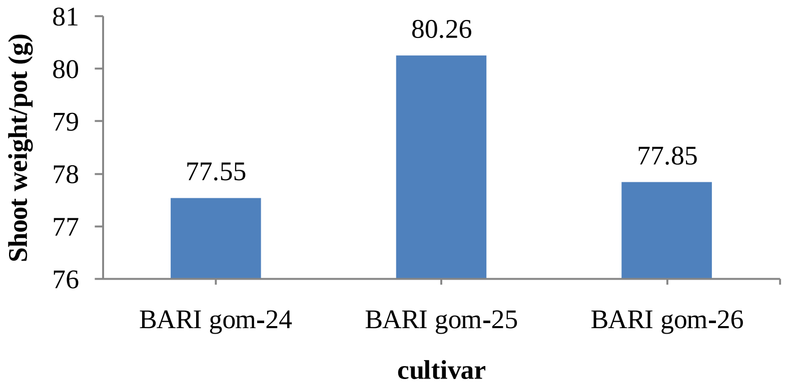

Figure 24: Effect of cultivar on straw weight/pot

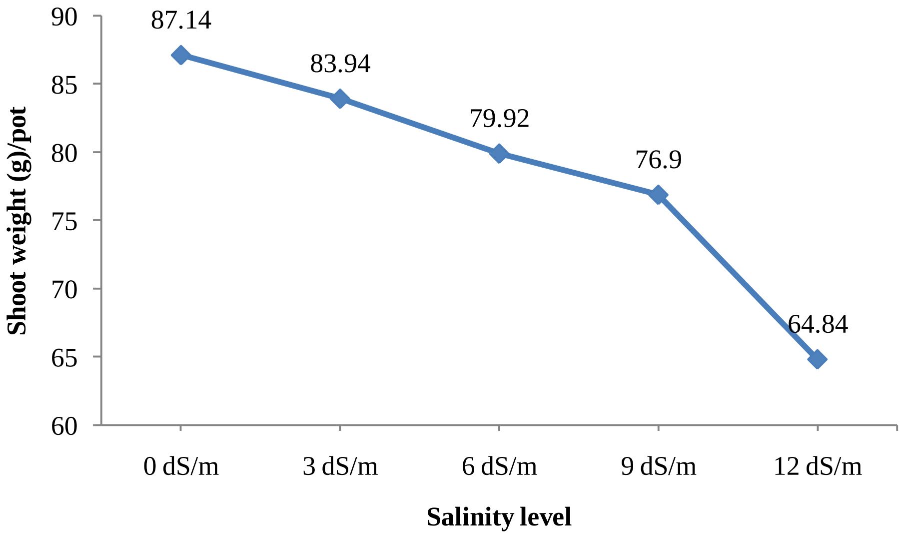

Figure 25: Effect of salinity on straw weight/pot

Table 11: Interaction effect between salinity level and cultivar on straw weight per pot

Cultivars	Salinity level (dSm^{-1})	Straw weight/pot (g)
BARI gom-24	0	85.73 abc
	3	84.67 bc
	6	78.47 e
	9	76.20 ef
	12	62.67 h
BARI gom-25	0	86.83 ab
	3	84.03 bc
	6	82.50 cd
	9	79.43 de
	12	68.50 g
BARI gom-26	0	88.87 a
	3	83.13 c
	6	78.80 e
	9	75.07 f
	12	63.37 h
$LSD_{0.05}$		3.286
Level of significance		*
CV %		4.50

LSD = Least Significant Difference, CV = Coefficient of variation,

* = Significant at 5% level

4.1.12 Root length per plant

Effect of different wheat cultivars on root length per plant was insignificant (Appendix IV).

The effect of salinity on root length of wheat cultivar was significant (Appendix VI). The longest root length per plant (24.86 cm) was obtained from S_0 (control) treatment. Salinity treatment S_1 (3 dSm^{-1}) showing 24.60 cm root length, was statistically similar with the S_0 (control) treatment. The smallest root length per plant (18.37 cm) was obtained from S_4 (12 dSm^{-1}) treatment which was statistically similar to the S_3 (9 dSm^{-1}) treatment with bearing 19.96 cm root length. Increasing salinity level decreased root length (Figure 26).

The interaction effect between salinity level and cultivar on root length was also significant (Table 12). The longest root length per plant (25.80 cm) was recorded from BARI gom-26 at S_0 (control) treatment. BARI gom-24 at S_0 (control) and S_1 (3 dSm^{-1}); BARI gom-25 at S_0 (control) and S_1 (3 dSm^{-1}) and BARI gom-26 at S_1 (3 dSm^{-1}) were statistically similar on root length per plant with BARI gom-26 at S_0 (control) treatment. The smallest length of root per plant (18.03 cm) was recorded from BARI gom-26 at S_4 (12 dSm^{-1}) treatment. BARI gom-24 at S_3 (9 dSm^{-1}) and S_4 (12 dSm^{-1}); BARI gom-25 at S_4 (12 dSm^{-1}) and BARI gom-26 at S_3 (9 dSm^{-1}) were statistically similar on root length per plant with BARI gom-26 at S_4 (12 dSm^{-1}) treatment.

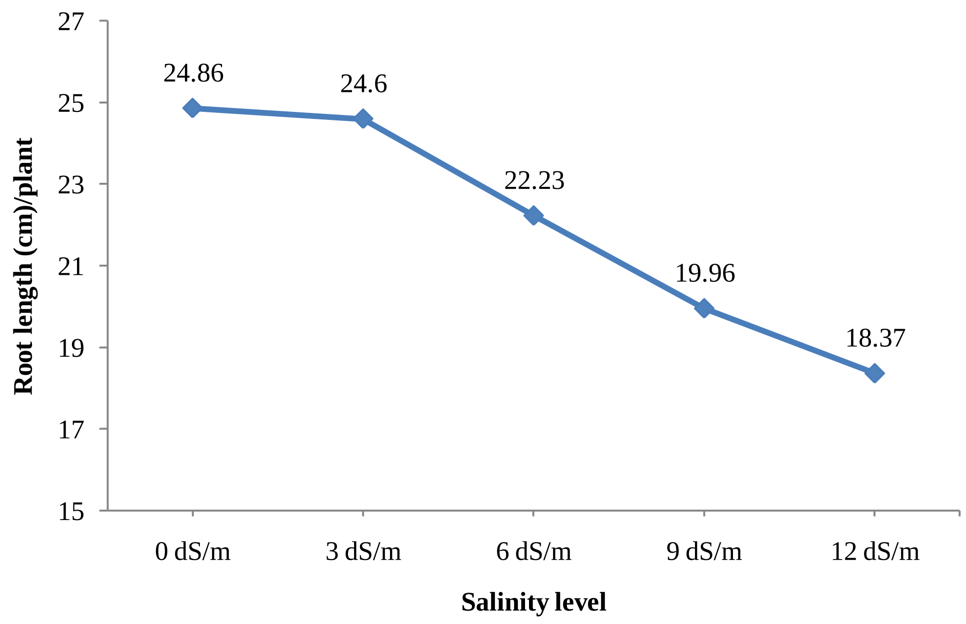

Figure 26: Effect of salinity level on root length (cm)/plant

Table 12: Interaction between salinity level and cultivar on root length per plant

Cultivars	Salinity level (dSm^{-1})	Root length (cm)
BARI gom-24	0	23.53 abc
	3	24.00 abc
	6	21.27 cd
	9	19.20 de
	12	18.53 de
BARI gom-25	0	25.23 ab
	3	24.87 ab
	6	22.70 bc
	9	21.17 cd
	12	18.53 de
BARI gom-26	0	25.80 a
	3	24.93 ab
	6	22.73 bc
	9	19.50 de
	12	18.03 e
$LSD_{0.05}$		2.971
Level of significance		*
CV %		8.07

LSD = Least Significant Difference, CV = Coefficient of variation,

* = Significant at 5% level

4.1.13 Root dry weight per pot

Dry weight of root indicates the amount of root produced by a plant. The higher the root activity, higher the nutrient uptake from soil and it helps to grow plant healthy and increase production. The effect of cultivar on root dry weight was significant (Appendix XII). The highest root dry weight per pot (5.627 g) was recorded from BARI gom-25. BARI gom-26 was statistically similar in root dry weight (5.52 g) with BARI gom-25. The lowest root dry weight per pot (5.307 g) was recorded from

BARI gom-24 (Figure 27). Similar results were also reported by Halim *et al*. (1988).

The effect of salinity level on root weight per pot was significant (Appendix XIV). The highest root dry weight per pot (6.6 g) was counted from S_0 (control) treatment. The lowest root weight per pot (4.267 g) was counted from S_4 (12 dSm^{-1}) treatment. From the findings, it is clear that increasing salinity level decreased root weight (Figure 28).

The interaction effect between salinity level and cultivar on root dry weight was also significant (Table 13). The highest root dry weight (6.933 g) was recorded from BARI gom-26 at S_0 (control) treatment. The lowest root dry weight (4.0 g) was recorded from BARI gom-26 at S_4 (12 dSm^{-1}) treatment. BARI gom-24 had shown statistically similar result at S_4 (12 dSm^{-1}) treatment with the BARI gom-26 at S_4 (12 dSm^{-1}) treatment. Increasing salinity level decreased root dry weight at each cultivar (Figure 26).

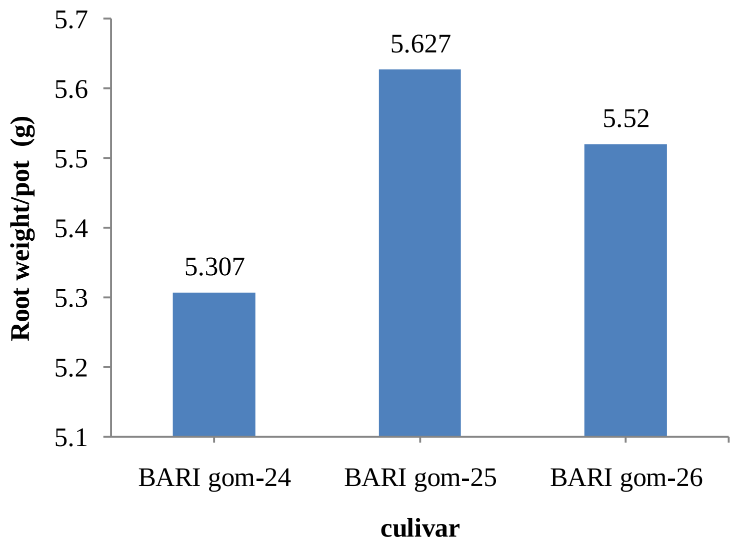

Figure 27: Effect of cultivar on root weight/pot

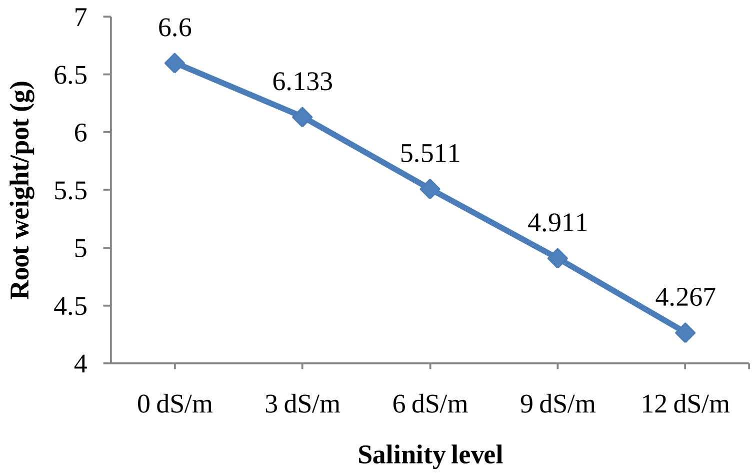

Figure 28: Effect of salinity level on root weight/pot

Table 13: Interaction effect between salinity level and cultivar on root weight per pot

Cultivars	Salinity level (dSm^{-1})	Root dry weight (g)
BARI gom-24	0	6.533 b
	3	5.900 c
	6	5.300 de
	9	4.700 f
	12	4.100 g
BARI gom-25	0	6.333 b
	3	6.233 b
	6	5.633 c
	9	5.233 e
	12	4.700 f
BARI gom-26	0	6.933 a
	3	6.267 b
	6	5.600 cd
	9	4.800 f
	12	4.000 g
$LSD_{0.05}$		0.308
Level of significance		*
CV %		3.37

LSD = Least Significant Difference, CV = Coefficient of variation,
* = Significant at 5% level

4.2 Chemical Composition

4.2.1 Nitrogen content in Root

Effect of cultivar on nitrogen (N) content in root was significant (Appendix XV). The highest content of Nitrogen in root (0.6727%) was recorded from BARI gom-25 and followed by (0.6467%) in BARI gom-24. The lowest content of Nitrogen in root (0.5847%) was recorded from BARI gom-26 (Figure 29).

Effect of salinity treatment on Nitrogen content in root was significant (Appendix XVI). The highest nitrogen content (0.9078%) was obtained from S_0 (control) treatment. The lowest nitrogen content in root (0.2378%) was obtained from S_4 (12 dSm^{-1}) treatment. From the result it was clear that the increasing salinity level significantly decreased Nitrogen content in wheat root (Figure 30).

The interaction effect of salinity and cultivar on nitrogen content in wheat root was also significant (Table 14). The highest nitrogen content in root (0.95%) was recorded from BARI gom-25 at S_0 (control) treatment. BARI gom-24 at S_0 (control) and S_1 (3 dSm^{-1}) treatment were showed statistically similar results with the BARI gom-25 at S_0 (control) treatment. The lowest nitrogen content in root (0.186%) was recorded from BARI gom-26 at S_4 (12 dSm^{-1}) treatment, and followed by BARI gom-24 at S_4 (12 dSm^{-1}) with nitrogen content (0.213%).

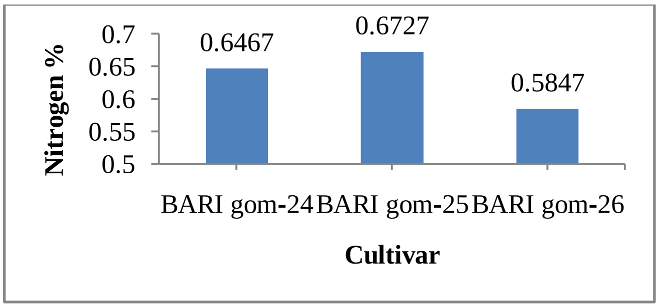

Figure 29: Effect of cultivar on Nitrogen (%) in root

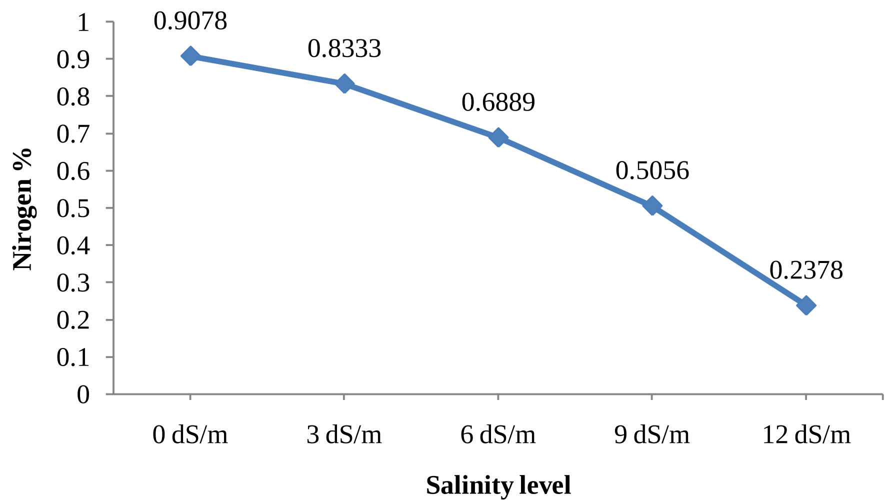

Figure 30: Effect of salinity on Nitrogen (%) in root

Table 14: Interaction effect between salinity level and cultivar on Nitrogen content (%) in root

Cultivar	Salinity (dSm^{-1})	Nitrogen (%) in Root
BARI gom-24	0	0.920 ab
	3	0.906 ab
	6	0.670 e
	9	0.523 f
	12	0.213 i
BARI gom-25	0	0.950 a
	3	0.806 c
	6	0.730 de
	9	0.563 f
	12	0.313 h
BARI gom-26	0	0.853 bc
	3	0.786 cd
	6	0.666 e
	9	0.430 g
	12	0.186 i
$LSD_{0.05}$		0.0748
Level of significance		*
CV %		6.85

LSD = Least Significant Difference, CV = Coefficient of variation,

* = Significant at 5% level

4.2.2 Nitrogen content in straw

The effect of cultivar on Nitrogen content in wheat straw was significant (Appendix XV). The highest nitrogen content in straw (1.702%) was recorded from BARI gom-25. The lowest nitrogen content in straw (1.398%) was recorded from BARI gom-26 (Figure 31).

The effect of salinity treatment on Nitrogen in wheat straw was significant (Appendix XVI). The highest Nitrogen content in straw (2.533%) was obtained from S_0 (control) treatment. The lowest Nitrogen content in straw (0.56%) was obtained from S_4 (12 dSm^{-1}) treatment. It was evident that increasing salinity level significantly decreased Nitrogen content in wheat straw (Figure 32).

The combined effect of salinity and cultivar was also significant on Nitrogen content on wheat straw (Table 15). The highest Nitrogen content in straw (2.633%) was recorded from BARI gom-25 at S_0 (control) treatment. The lowest Nitrogen content in straw (0.5167%) was recorded from BARI gom-26 at S_4 (12 dSm^{-1}) and followed by (0.533%) and (0.633%) from BARI gom-24 and BARI gom-26 respectively at same salinity level.

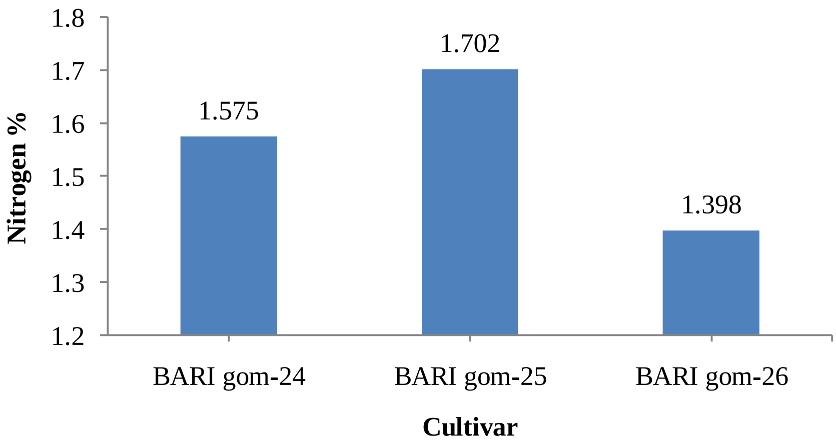

Figure 31: Effect of cultivar on Nitrogen (%) in straw

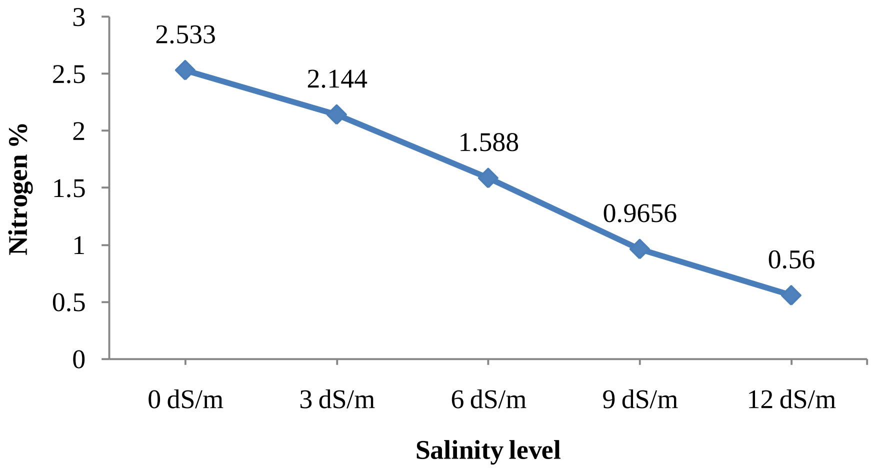

Figure 32: Effect of salinity level on Nitrogen (%) in straw

Table 15: Interaction effect between salinity level and cultivar on nitrogen content in straw

Cultivar	Salinity (dSm^{-1})	Nitrogen (%) in straw
BARI gom-24	0	2.54 ab
	3	2.097 d
	6	1.78 e
	9	0.923 g
	12	0.533 h
BARI gom-25	0	2.633 a
	3	2.277 c
	6	1.877 e
	9	1.093 f
	12	0.63 h
BARI gom-26	0	2.427 b
	3	2.06 d
	6	1.107 f
	9	0.880 g
	12	0.5167 h
$LSD_{0.05}$		0.1183
Level of significance		*
CV %		4.74

LSD = Least Significant Difference, CV = Coefficient of variation,
* = Significant at 5% level

4.2.3 Nitrogen content in Grain

The effect of cultivar on Nitrogen content in wheat grain was significant (Appendix XV). The highest Nitrogen content in grain (1.898%) was obtained from BARI gom-25 and followed by BARI gom-24 with Nitrogen content (1.839%). The lowest nitrogen content in grain (1.722%) was obtained from BARI gom-26 (Figure 33).

The effect of salinity treatment on Nitrogen content in grain was significant (Appendix XVI). The highest Nitrogen content in grain (2.696%) was recorded from S_0 (control) treatment. The lowest Nitrogen content in grain (0.605%) was recorded from S_4 (12 dSm^{-1}) treatment. From the results, it was clear that the increasing salinity level decreased Nitrogen content in grain (Figure 34).

The interaction effect of salinity level and cultivar on nitrogen content in grain was also significant (Table 16). The highest Nitrogen content in grain (2.723%) was recorded from BARI gom-26 at S_0 (control) treatment and followed by Nitrogen content (2.703% and 2.66%) at same salinity level from BARI gom-25 and BARI gom-24 respectively. The lowest Nitrogen content in grain (0.456%) was recorded from BARI gom-24 at S_4 (12 dSm^{-1}) treatment.

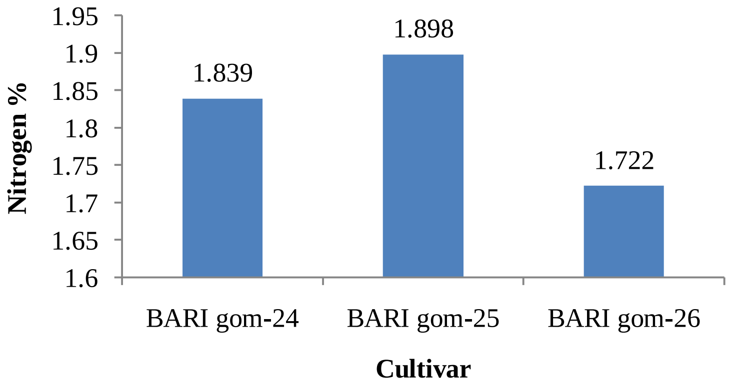

Figure 33: Effect of cultivar on nitrogen (%) in grain

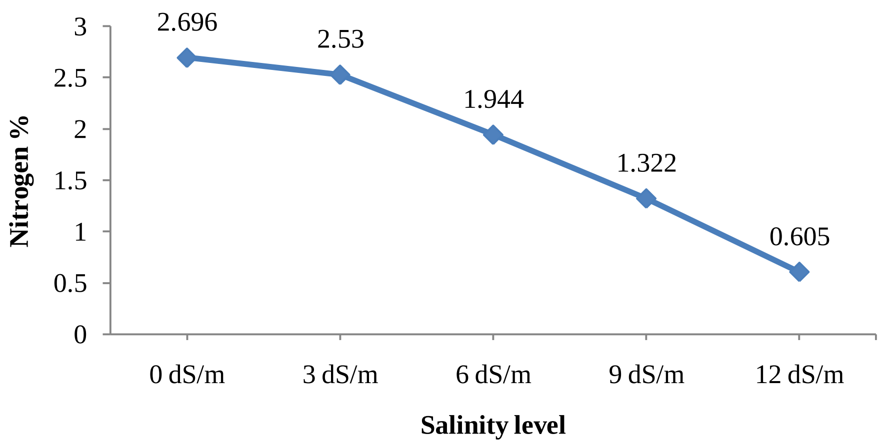

Figure 34: Effect of salinity on Nitrogen (%) in grain

Table 16: Interaction effect between salinity level and cultivar on nitrogen content in grain

Cultivar	Salinity (dSm^{-1})	Nitrogen (%) in grain
BARI gom-24	0	2.660 a
	3	2.577 ab
	6	2.083 c
	9	1.417 e
	12	0.456 h
BARI gom-25	0	2.703 a
	3	2.583 ab
	6	2.113 c
	9	1.347 ef
	12	0.743 g
BARI gom-26	0	2.723 a
	3	2.430 b
	6	1.637 d
	9	1.203 f
	12	0.616 gh
$LSD_{0.05}$		0.175
Level of significance		*
CV %		5.63

LSD = Least Significant Difference, CV = Coefficient of variation,
* = Significant at 5% level

4.2.4 Phosphorus content in Root

The effect of cultivar on Phosphorus content in root was insignificant (Appendix XV).

The effect of salinity on Phosphorus content in root was significant (Appendix XVI). The highest Phosphorus content in root (0.6624%) was obtained from S4 (12 dSm^{-1}) treatment. The lowest Phosphorus content in root (0.1701%) was obtained from S_0 (control) treatment. From the results, it was clear that the increasing salinity level increased Phosphorus content in wheat root (Figure 35).

The interaction effect of salinity and cultivar was also significant (Table 17). The highest Phosphorus content in root (0.672%) was recorded from BARI gom-25 at S_4 (12 dSm^{-1}) treatment and followed by Phosphorus content (0.663% and 0.652%) in BARI gom-26 and BARI gom-24 respectively at same level of salinity treatment. The lowest level of Phosphorus content in root (0.165%) was recorded from BARI gom-25 and followed by Phosphorus content (0.1703% and 0.1750%) in BARI gom-26 and BARI gom-24 respectively at same level of salinity treatment.

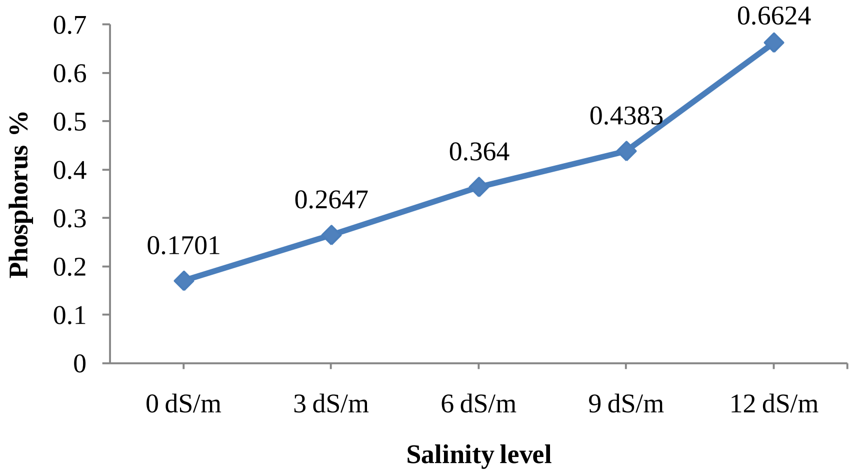

Figure 35: Effect of salinity level on Phosphorus (%) in root

Table 17: Interaction effect between salinity level and cultivar on phosphorus content in root

Cultivar	Salinity (dSm^{-1})	Phosphorus (%) in root
BARI gom-24	0	0.175 f
	3	0.261 e
	6	0.3523 d
	9	0.422 bc
	12	0.652 a
BARI gom-25	0	0.165 f
	3	0.2763 e
	6	0.3817cd
	9	0.4553 b
	12	0.672 a
BARI gom-26	0	0.1703 f
	3	0.2567 e
	6	0.358 d
	9	0.4377 b
	12	0.6633 a
$LSD_{0.05}$		0.053
Level of significance		*
CV %		2.29

LSD = Least Significant Difference, CV = Coefficient of variation,
* = Significant at 5% level

4.2.5 Phosphorus content in Straw

The effect of cultivar on Phosphorus content in wheat straw was insignificant (Appendix XV).

The effect of salinity on phosphorus content in straw was significant (Appendix XVI). The highest Phosphorus content in straw (0.202%) was recorded from S_4 (12 dSm^{-1}) and followed by Phosphorus content (0.189%) from S_3 (9 dSm^{-1}) treatment. The lowest Phosphorus content (0.089%) was recorded from S_0 (control) treatment, and followed by Phosphorus content (0.099%) in S_1 (3 dSm^{-1}) treatment (Figure 36).

The interaction effect of salinity and cultivar was significant on Phosphorus content in wheat straw (Table 18). The highest Phosphorus content in straw (0.21%) was found from BARI gom-24 at S_4 (12 dSm^{-1}) treatment. The lowest phosphorus content in straw (0.081%) was found from BARI gom-24 at S_1 (3 dSm^{-1}) treatment followed by 0.085% and 0.089% from BARI gom-25 and BARI gom-26 respectively at S_0 (control) treatment.

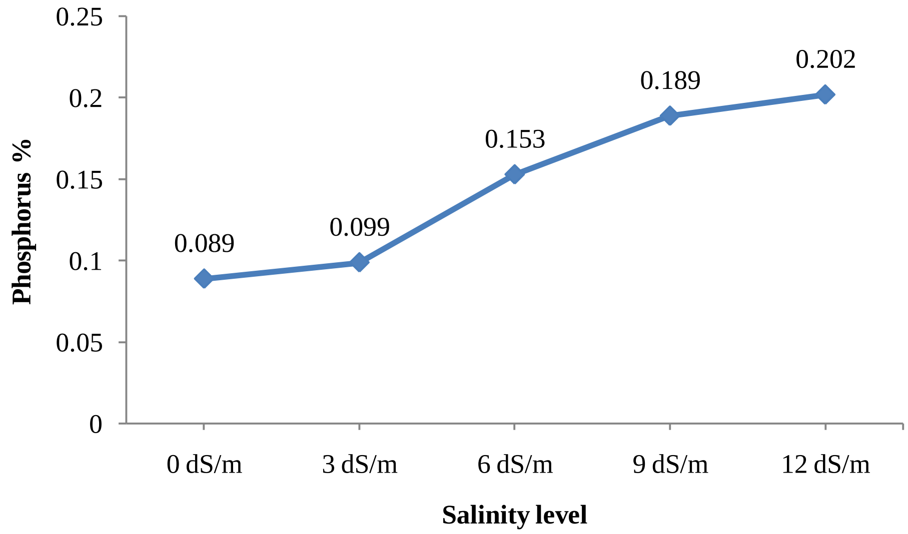

Figure 36: Effect of salinity level on Phosphorus (%) in straw

4.2.6 Phosphorus content in grain

The effect of cultivar on Phosphorus content in grain was insignificant (Appendix XV).

The effect of salinity on Phosphorus content in grain was significant (Appendix XVI). The highest Phosphorus content in grain (0.189%) was found from S_0 (control) treatment. Statistically similar result was found in S_1 (3 dSm^{-1}) treatment with Phosphorus content (0.1687%). The lowest Phosphorus content in grain (0.0452%) was found from S_4 (12 dSm^{-1})

treatment. From the result, it was clear that increasing salinity level significantly decreased Phosphorus content in grain (Figure 37).

Table 18: Interaction effect between salinity level and cultivar on phosphorus content in straw

Cultivar	Salinity (dSm^{-1})	Phosphorus (%) in straw
BARI gom-24	0	0.093 fg
	3	0.081 g
	6	0.164 abcd
	9	0.195 abc
	12	0.21 a
BARI gom-25	0	0.085 g
	3	0.104 efg
	6	0.144 cdef
	9	0.184 abc
	12	0.196 abc
BARI gom-26	0	0.089 g
	3	0.113 defg
	6	0.152 bcde
	9	0.188 abc
	12	0.201 ab
$LSD_{0.05}$		0.052
Level of significance		*
CV %		11.58

LSD = Least Significant Difference, CV = Coefficient of variation,
* = Significant at 5% level

The interaction effect of salinity treatment and cultivar was also significant (Table 19). The highest Phosphorus content in grain (0.1953%) was found from BARI gom-26 at S_0 (control) treatment. BARI gom-24 at S_0 (control), S_1 (3 dSm^{-1}) and S_2 (6 dSm^{-1}); BARI gom-25 at S_2 (6 dSm^{-1}) and BARI gom-26 at S_1 (3 dSm^{-1}) and S_2 (6 dSm^{-1}) had shown statistically similar results with the BARI gom-26 at S_0 (control) treatment. The lowest Phosphorus content in grain (0.00209%) was found from BARI gom-24 at S_4 (12 dSm^{-1}) treatment.

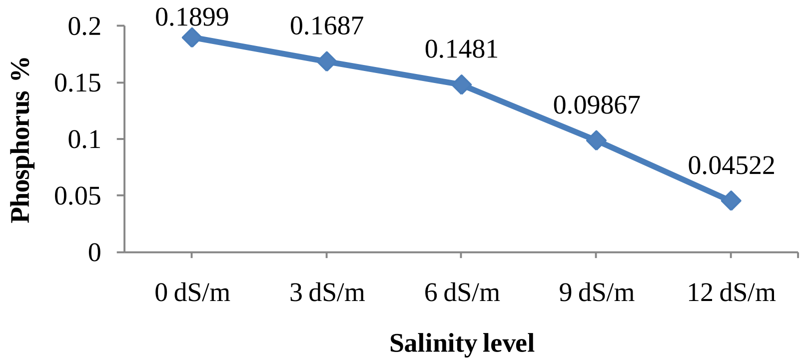

Figure 37: Effect of salinity level on phosphorus (%) in grain

Table 19: Interaction effect between salinity level and cultivar on phosphorus content in grain

Cultivar	Salinity (dSm^{-1})	Phosphorus (%) in grain
BARI gom-24	0	0.1899 ab
	3	0.1687 ab
	6	0.1481 abcd
	9	0.09867 def
	12	0.00209 i
BARI gom-25	0	0.04522 ghi
	3	0.1637 ab
	6	0.1420 bcde
	9	0.09333 efg
	12	0.03367 hi
BARI gom-26	0	0.1953 a
	3	0.1730 ab
	6	0.1543 abc
	9	0.1043 cdef
	12	0.05533 fgh
$LSD_{0.05}$		0.052
Level of significance		*
CV %		4.82

LSD = Least Significant Difference, CV = Coefficient of variation,
* = Significant at 5% level

4.2.7 Potassium content in Root

The effect of cultivar on Potassium content in root was insignificant (Appendix XV).

The effect of salinity level on Potassium content in root was significant (Appendix XVI). The highest Potassium content in root (0.3827%) was recorded from S_4 (12 dSm^{-1}) treatment. The lowest Potassium content in root (0.1182%) was recorded from S_2 (6 dSm^{-1}) treatment followed by S_1 (3 dSm^{-1}) treatment with Potassium content 0.1373% (Figure 38).

The interaction effect between salinity level and cultivar was also significant (Table 20). The highest Potassium content in root (0.388%) was recorded from BARI gom-26 at S_4 (12 dSm^{-1}) treatment followed by S_4 (12 dSm^{-1}) treatment of BARI gom-24 and BARI gom-25. The lowest Potassium content in root (0.112%) was recorded from BARI gom-25 at S_2 (6 dSm^{-1}) followed by BARI gom-24 at S_2 (6 dSm^{-1}) treatment.

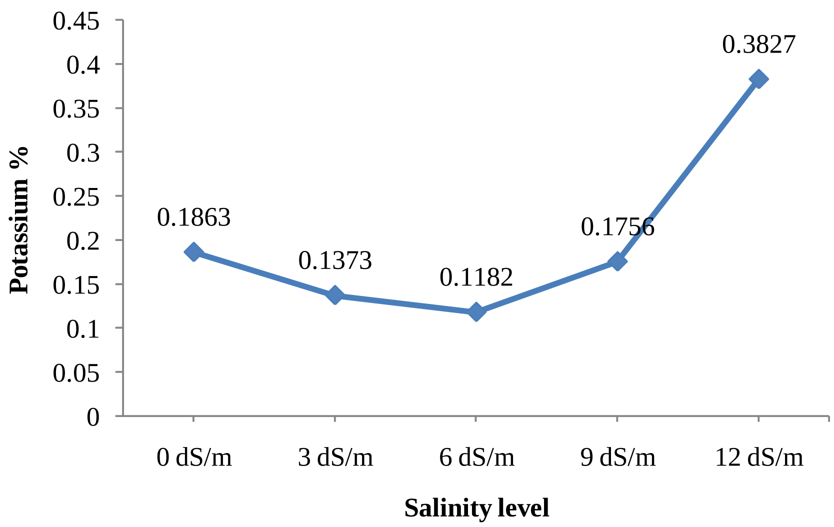

Figure 38: Effect of salinity level on Potassium Content in root

Table 20: Interaction effect between salinity level and cultivar on potassium content in root

Cultivar	Salinity (dSm^{-1})	Potassium (%) in root
BARI gom-24	0	0.1903 b
	3	0.1383 bcde
	6	0.1193 e
	9	0.1747 bcd
	12	0.3857 a
BARI gom-25	0	0.1840 bc
	3	0.1397 bcde
	6	0.1120 e
	9	0.1887 b
	12	0.3743 a
BARI gom-26	0	0.1847 bc
	3	0.1340 cde
	6	0.1233 de
	9	0.1633 bcde
	12	0.3880 a
$LSD_{0.05}$		0.054
Level of significance		*
CV %		3.27

LSD = Least Significant Difference, CV = Coefficient of variation,
* = Significant at 5% level

4.2.8 Potassium content in Straw

The effect of cultivar on Potassium content in straw was insignificant (Appendix XV).

The effect of salinity level on Potassium content in straw was highly significant (Appendix XVI). The highest potassium content in straw (1.842%) was recorded from S_0 (control) treatment. The lowest Potassium content in straw (0.4756%) was recorded from S_4 (12 dSm^{-1}) treatment. From the result, it was evident that increasing salinity level decreased Potassium content in straw (Figure 39).

The interaction effect between salinity and cultivar was also significant (Table 21). The highest Potassium content in straw (1.937%) was recorded from BARI gom-25 at S_0 (control) treatment followed by BARI gom-24 at same level of salinity treatment. The lowest Potassium content in straw (0.423%) was recorded from BARI gom-26 at S_4 (12 dSm^{-1}) treatment and followed by BARI gom-24 at same level of salinity level.

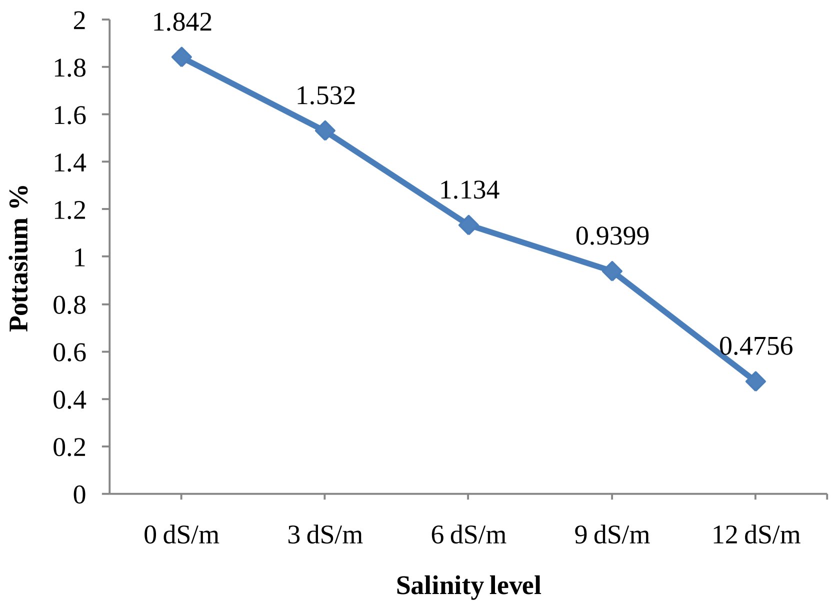

Figure 39: Effect of salinity level on Potassium content in straw

4.2.9 Potassium content in Grain

The effect of cultivar on Potassium content in grain was significant (Appendix XV). The highest Potassium content in grain (0.543%) was found from BARI gom-25. The lowest Potassium content in grain (0.4319%) was found in BARI gom-26 and followed by BARI gom-24 (Figure 40).

Table 21: Interaction effect between salinity level and cultivar on potassium content in straw

Cultivar	Salinity (dSm^{-1})	Potassium (%) in straw
BARI gom-24	0	1.863 a
	3	1.562 c
	6	1.099 e
	9	0.947 f
	12	0.443 h
BARI gom-25	0	1.937 a
	3	1.399 d
	6	1.152 e
	9	0.919 f
	12	0.559 g
BARI gom-26	0	1.727 b
	3	1.635 c
	6	1.151 e
	9	0.952 f
	12	0.423 h
$LSD_{0.05}$		0.0916
Level of significance		*
CV %		4.89

LSD = Least Significant Difference, CV = Coefficient of variation,
* = Significant at 5% level

The effect of salinity level on Potassium content in grain was significant (Appendix XVI). The highest amount of Potassium content in grain (0.6867%) was found in S_0 (control) treatment. The lowest amount of Potassium content in grain (0.1936%) was found in S_4 (12 dSm^{-1}) treatment. Due o salinity effect Potassium content in grain was affected. From the result, it was found that increasing salinity level decreased Potassium content in grain (Figure 41).

The interaction effect between salinity level and cultivar on Potassium content in grain was also significant (Table 22). The highest Potassium content in grain (0.757%) was recorded from BARI gom-25 at S_0 (control) treatment. The lowest Potassium content in grain (0.165%) was recorded from BARI gom-24 at S_4 (12 dSm^{-1}) treatment followed by BARI gom-26 with 0.1747% Potassium content at same level of salinity treatment.

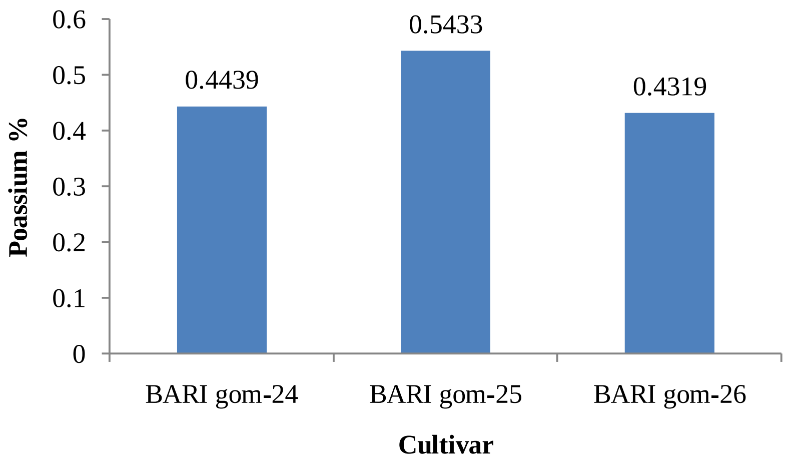

Figure 40: Effect of Cultivar on Potassium (%) in grain

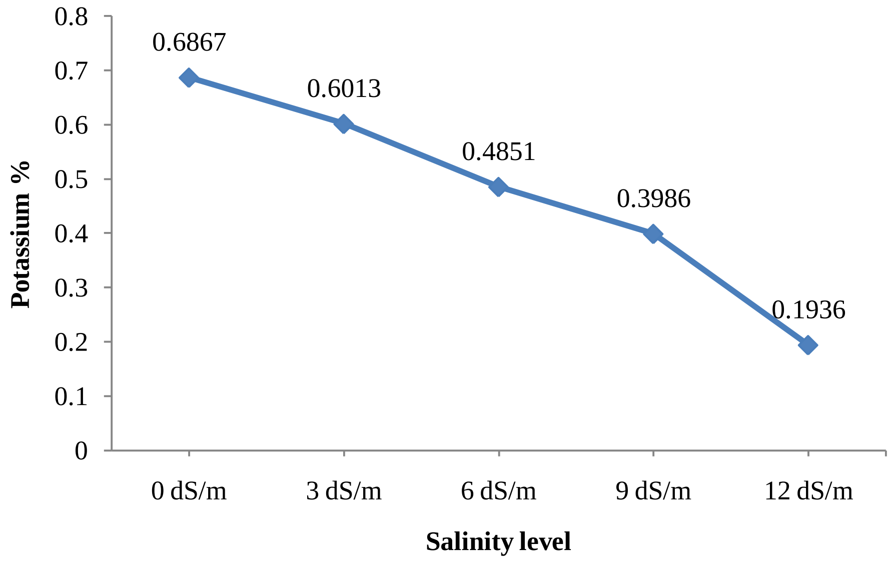

Figure 41: Effect of salinity level on Potassium (%) content in grain

Table 22: Interaction effect between salinity level and cultivar on potassium content in grain

Cultivar	Salinity (dSm^{-1})	Potassium (%) in grain
BARI gom-24	0	0.6710 b
	3	0.5847 cd
	6	0.4450 e
	9	0.3540 f
	12	0.1650 h
BARI gom-25	0	0.7570 a
	3	0.6813 b
	6	0.5693 d
	9	0.4677 e
	12	0.2410 g
BARI gom-26	0	0.6320 bc
	3	0.5380 d
	6	0.4410 e
	9	0.3740 f
	12	0.1747 h
$LSD_{0.05}$		0.051
Level of significance		*
CV %		5.43

LSD = Least Significant Difference, CV = Coefficient of variation,
* = Significant at 5% level

4.2.10 Sodium content in Root

The effect of cultivar on Sodium content in root was significant (Appendix XVII). The highest Sodium content in root (0.6145%) was recorded from BARI gom-26. The lowest Sodium content in root (0.5346%) was recorded from BARI gom-25 (Figure 42). From the result, it was evident that different cultivar had different degrees of sodium uptake.

The effect of salinity level on Sodium content in root was significant (Appendix XVIII). The highest Sodium content in root (1.323%) was recorded from S_4 (12 dSm^{-1}) treatment. The lowest Sodium content root (0.2251%) was recorded from S_0 (control) treatment. From the findings, it was clear that increasing level of salinity increased Sodium content in root (Figure 43).

The interaction effect between salinity level and cultivar on Sodium content in root was also significant (Table 23). The highest Sodium content in root (1.425%) was recorded from BARI gom-26 at S_4 (12 dSm^{-1}) treatment. The lowest Sodium content in root (0.213%) was recorded from BARI gom-25 at S_0 (control) followed by BARI gom-26 (0.23%) and BARI gom-24 (0.232%) at same level of salinity treatment.

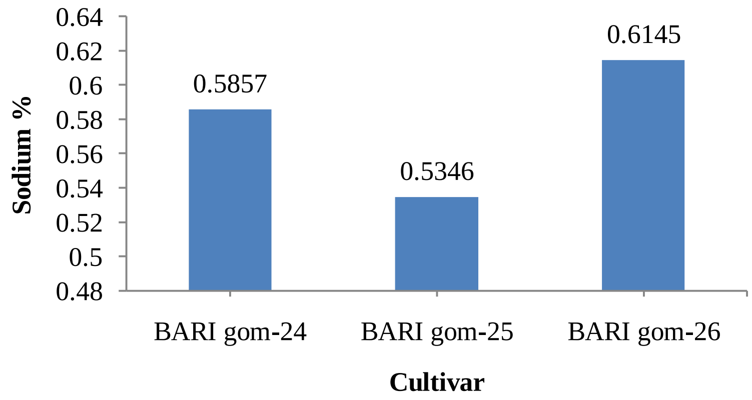

Figure 42: Effect of cultivar on Sodium Content (%) in root

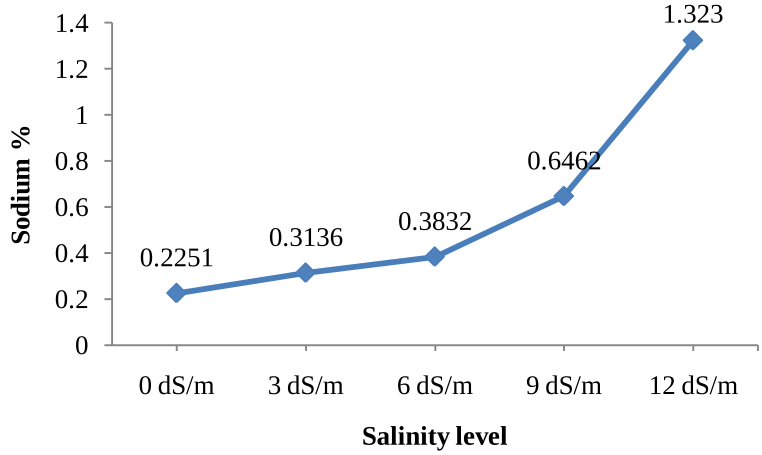

Figure 43: Effect of Salinity level on Sodium content (%) in root

Table 23: Interaction effect between salinity level and cultivar on sodium content in root

Cultivar	Salinity (dSm^{-1})	Sodium (%) in root
BARI gom-24	0	0.2320 h
	3	0.3173 g
	6	0.3967 f
	9	0.6523 de
	12	1.330 b
BARI gom-25	0	0.2133 h
	3	0.2950 g
	6	0.3420 g
	9	0.6080 e
	12	1.215 c
BARI gom-26	0	0.2300 h
	3	0.3283 g
	6	0.4110 f
	9	0.6783 d
	12	1.425 a
$LSD_{0.05}$		0.053
Level of significance		*
CV %		6.65

LSD = Least Significant Difference, CV = Coefficient of variation,
* = Significant at 5% level

4.2.11 Sodium content in Straw

The effect of cultivar on Sodium content in straw was significant (Appendix XVII). The highest Sodium content straw (1.741%) was recorded from BARI gom-26. The lowest Sodium content in straw (1.47%) was recorded from BARI gom-25 (Figure 44).

The effect of salinity level on Sodium content in straw was significant (Appendix XVIII). The highest Sodium content in straw (4.59%) was recorded from S_4 (12 dSm^{-1}) treatment. The lowest Sodium content in straw (0.2711%) was recorded from S_0 (control) treatment. Increasing salinity level had directly affected on Sodium content in straw. Sodium content in straw was increased due to increasing salinity level (Figure 45).

The interaction effect between salinity level and cultivar on Sodium content in straw was also significant (Table 24). The highest Sodium content in straw (4.959%) was recorded from BARI gom-26 at S_4 (12 dSm^{-1}) treatment. The lowest Sodium content in straw (0.2587%) from BARI gom-25 at S_0 (control) treatment followed by BARI gom-24 (0.2743%) and BARI gom-26 (0.2803%) at same level of salinity treatment.

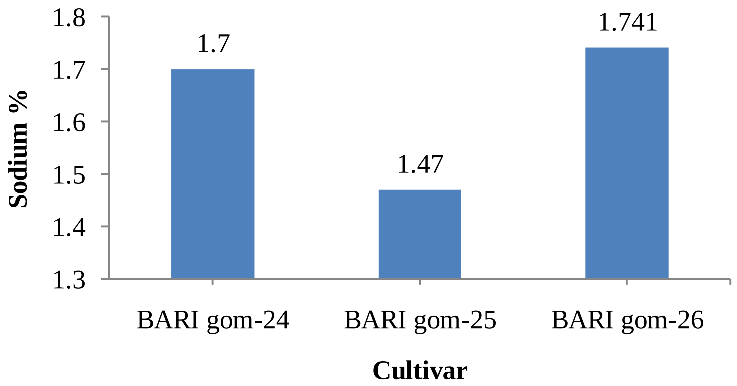

Figure 44: Effect of cultivar on Sodium content (%) in straw

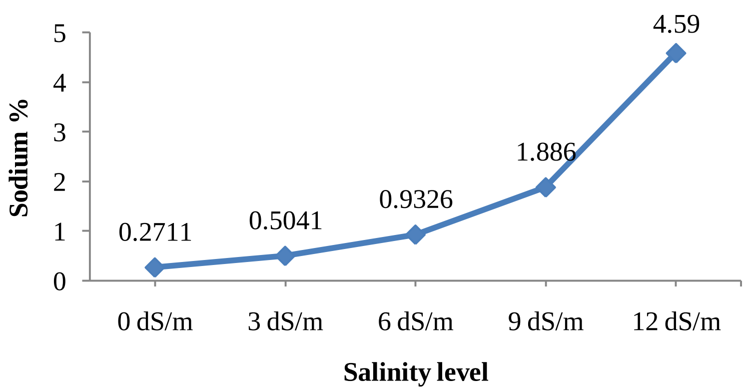

Figure 45: Effect of salinity on sodium content (%) in straw

Table 24: Interaction effect between salinity level and cultivar on sodium content in straw

Cultivar	Salinity (dSm^{-1})	Sodium (%) in straw
BARI gom-24	0	0.2743 j
	3	0.5353 h
	6	0.9740 f
	9	1.958 d
	12	4.757 b
BARI gom-25	0	0.2587 j
	3	0.4357 i
	6	0.8510 g
	9	1.748 e
	12	4.054 c
BARI gom-26	0	0.2803 j
	3	0.5413 h
	6	0.9727 f
	9	1.952 d
	12	4.959 a
$LSD_{0.05}$		0.075
Level of significance		*
CV %		3.92

LSD = Least Significant Difference, CV = Coefficient of variation,
* = Significant at 5% level

4.2.12 Sodium content in Grain

The effect of cultivar on Sodium content in grain was significant (Appendix XVI). The highest Sodium content in grain (0.0935%) was recorded from BARI gom-26. The lowest Sodium content in grain 0.0734% was recorded from BARI gom-25 followed by BARI gom-24 0.0838% (Figure 46).

The effect of salinity level on Sodium content in grain was significant (Appendix XVII). The maximum Sodium content in grain (0.135%) was recorded from S_4 (12 dSm^{-1}) treatment followed by S_3 (9 dSm^{-1}) treatment

(0.1081%). The minimum Sodium content in grain (0.02567%) was recorded from S_0 (control) treatment. Increasing level of salinity increased Sodium content in grain (Figure 47).

The interaction effect between salinity level and cultivar was also significant (Table 25). The maximum Sodium content in grain (0.154%) was recorded from BARI gom-26 at S_4 (12 dSm^{-1}) treatment. BARI gom-24 at S_3 (9 dSm^{-1}) and S_4 (12 dSm^{-1}) treatment; BARI gom-25 at S_3 (9 dSm^{-1}) and S_4 (12 dSm^{-1}) treatment had shown statistically similar result. The minimum Sodium content in grain (0.021%) was recorded from BARI gom-24 at S_0 (control) treatment followed by BARI gom-25 at same level of salinity treatment.

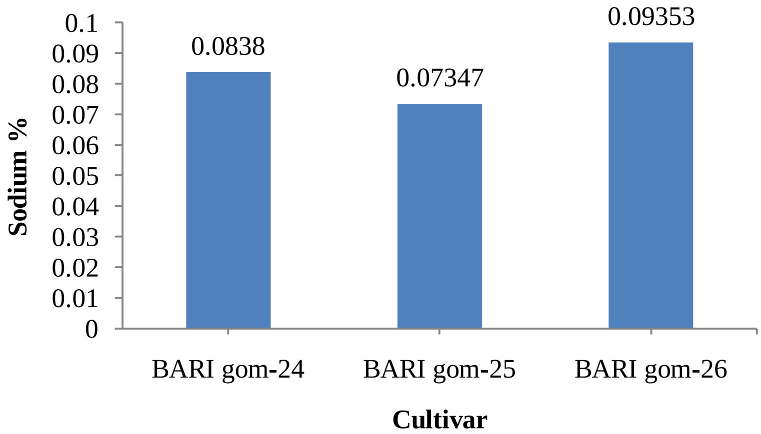

Figure 46: Effect of cultivar on Sodium content (%) in grain

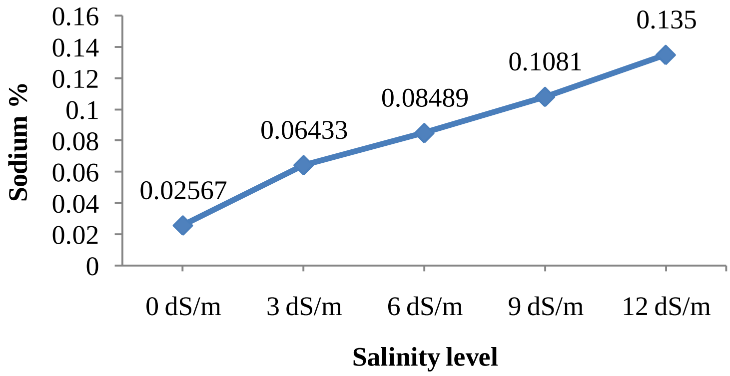

Figure 47: Effect of Salinity level on Sodium content (%) in grain

Table 25: Interaction effect between salinity level and cultivar on sodium content in grain

Cultivar	Salinity (dSm^{-1})	Sodium (%) in grain
BARI gom-24	0	0.02100 f
	3	0.06233 def
	6	0.08267 cde
	9	0.1100 abcd
	12	0.1430 ab
BARI gom-25	0	0.02133 f
	3	0.06000 def
	6	0.07967 cde
	9	0.09833 bcd
	12	0.1080 abcd
BARI gom-26	0	0.03467 ef
	3	0.07067 cdef
	6	0.09233 bcd
	9	0.1160 abc
	12	0.1540 a
$LSD_{0.05}$		0.0527
Level of significance		*
CV %		8.13

LSD = Least Significant Difference, CV = Coefficient of variation,
* = Significant at 5% level

4.2.13 Calcium content in Root

The effect of cultivar on Calcium content in root was insignificant (Appendix XVII).

The effect of salinity level on Calcium content in root was significant (Appendix XVIII). The maximum Calcium content in root (0.5596%) was recorded from S_4 (12 dSm^{-1}) treatment. The minimum Calcium content in root (0.2329%) was recorded from S_2 (6 dSm^{-1}) treatment (Figure 48).

The interaction effect between salinity level and cultivar on Calcium content in root was also significant (Table 26). The highest Calcium content in root (0.582%) from BARI gom-25 and followed by BARI gom-26 (0.5527%) at S_4 (12 dSm^{-1}) treatment. The lowest Calcium content in root (0.2283%) was recorded from BARI gom-26 at S_2 (6 dSm^{-1}) treatment.

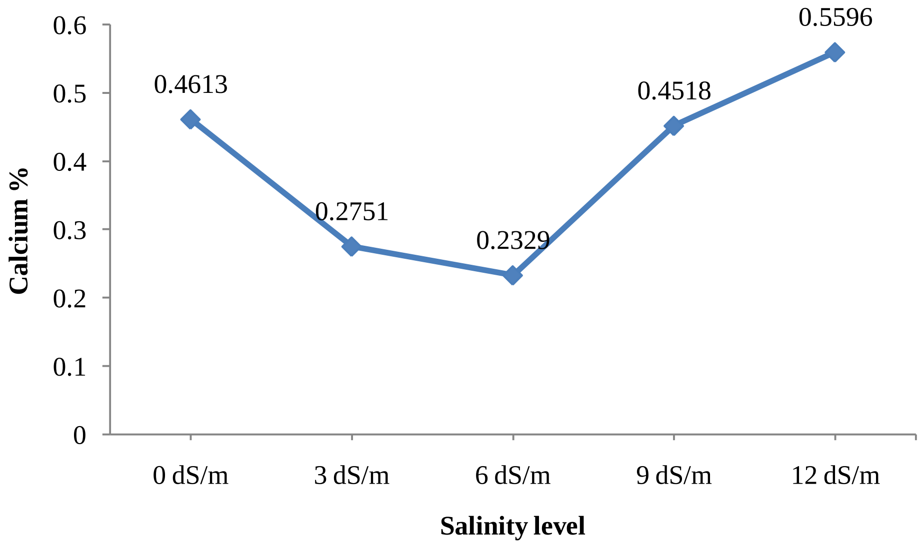

Figure 48: Effect of salinity level on Calcium content (%) in root

4.2.14 Calcium content in Straw

The effect of cultivar on Calcium content present in straw was insignificant (Appendix XVII).

The effect of salinity level on Calcium content in straw was significant (Appendix XVIII). The highest Calcium content in straw (0.3703%) was recorded from S_4 (12 dSm^{-1}) treatment. The lowest Calcium content in straw (0.1179%) was recorded from S_0 (control) treatment and followed by S_1 (3 dSm^{-1}) treatment. From the findings, it was clear that increasing salinity level increased Calcium content in root (Figure 49).

Table 26: Interaction effect between salinity level and cultivar on calcium content in root

Cultivar	Salinity (dSm^{-1})	Calcium (%) in root
BARI gom-24	0	0.4617 c
	3	0.2853 d
	6	0.2313 d
	9	0.4373 c
	12	0.5440 ab
BARI gom-25	0	0.4653 c
	3	0.2610 d
	6	0.2390 d
	9	0.4750 bc
	12	0.5820 a
BARI gom-26	0	0.4570 c
	3	0.2790 d
	6	0.2283 d
	9	0.4430 c
	12	0.5527 a
$LSD_{0.05}$		0.0748
Level of significance		*
CV %		3.09

LSD = Least Significant Difference, CV = Coefficient of variation, * = Significant at 5% level

The interaction effect between salinity level and cultivar on Calcium content in straw was significant (table 27). The highest Calcium content in straw (0.385%) was recorded from BARI gom-25 at S_4 (12 dSm^{-1}) treatment and followed by BARI gom-26 (0.3813%) and BARI gom-24 (0.3447%) at same level of salinity treatment. The lowest Calcium content in straw (0.113%) was recorded from BARI gom-24 at S_0 (control) treatment and followed by BARI gom-25 (0.122%) and BARI gom-26 (0.123%) at same level of salinity treatment.

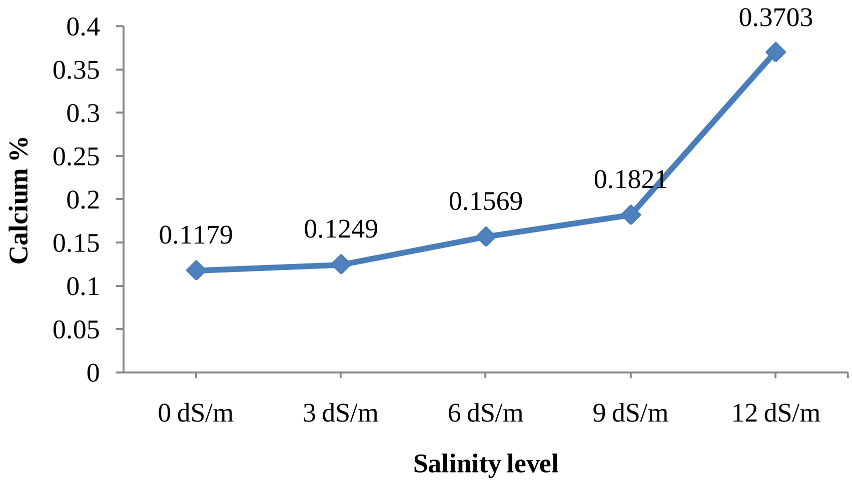

Figure 49: Effect of salinity level on Calcium content (%) in straw

Table 27: Interaction effect between salinity level and cultivar on calcium content in straw

Cultivar	Salinity (dSm^{-1})	Calcium (%) in straw
BARI gom-24	0	0.1130 d
	3	0.1260 cd
	6	0.1623 bcd
	9	0.1770 bc
	12	0.3447 a
BARI gom-25	0	0.1220 d
	3	0.1253 cd
	6	0.1590 bcd
	9	0.1877 b
	12	0.3850 a
BARI gom-26	0	0.1187 d
	3	0.1233 d
	6	0.1493 bcd
	9	0.1817 b
	12	0.3813 a
$LSD_{0.05}$		0.052
Level of significance		*
CV %		5.77

LSD = Least Significant Difference, CV = Coefficient of variation, * = Significant at 5% level

4.2.15 Calcium content in Grain

The effect of cultivar on Calcium content in grain was insignificant (Appendix XVII).

The effect of salinity level on Calcium content in grain was significant (Appendix XVIII). The highest Calcium content in grain (0.0748%) was recorded from S_0 (control) treatment. S_1 (3 dSm^{-1}) treatment had shown statistically similar result with the S_0 (control) treatment. The lowest Calcium content in grain (0.0152%) was recorded from S_4 (12 dSm^{-1}) treatment. S_2 (6 dSm^{-1}) and S_3 (9 dSm^{-1}) had shown statistically similar result with S_4 treatment. From the findings, it was evident that increasing salinity level decreased Calcium content in grain (Figure 50).

The interaction effect between salinity level and cultivar on Calcium content in grain was also significant (table 12). The highest Calcium content in grain (0.08467%) was recorded from BARI gom-24 at S_0 (control) treatment. The lowest Calcium content in grain (0.0133%) was recorded from BARI gom-25 at S_4 (12 dSm^{-1}) treatment, and followed by 0.016%, 0.0163% and 0.02267% Calcium content from BARI gom-26, BARI gom-24 and BARI gom-26 at S_4 (12 dSm^{-1}) and S_3 (9 dSm^{-1}) treatment respectively.

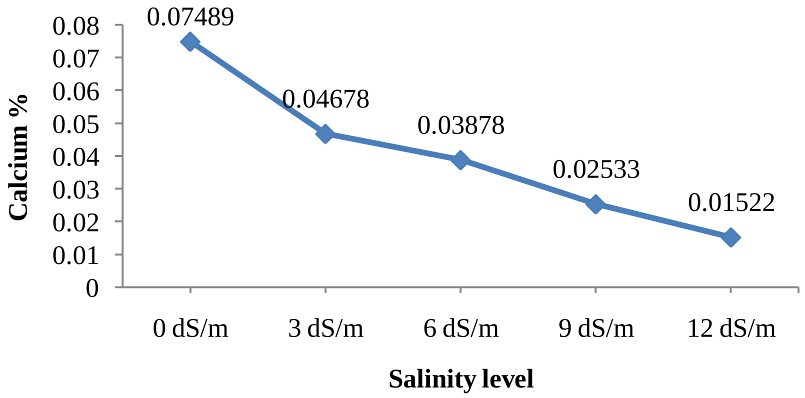

Figure 50: Effect of salinity level on Calcium content (%) in grain

Table 28: Interaction effect between salinity level and cultivar on calcium content in grain

Cultivar	Salinity (dSm^{-1})	Calcium (%) in grain
BARI gom-24	0	0.08467 a
	3	0.04967 abc
	6	0.04300 abc
	9	0.02700 bc
	12	0.01633 c
BARI gom-25	0	0.07700 ab
	3	0.04633 abc
	6	0.03867 abc
	9	0.02633 bc
	12	0.01333 c
BARI gom-26	0	0.06300 abc
	3	0.04433 abc
	6	0.03467 abc
	9	0.02267 c
	12	0.01600 c
$LSD_{0.05}$		0.053
Level of significance		*
CV %		14.02

LSD = Least Significant Difference, CV = Coefficient of variation, * = Significant at 5% level

CHAPTER V

SUMMARY AND CONCLUSION

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SUMMARY AND CONCLUSION

A pot experiment was carried out at the net house of the Agro-environmental Chemistry Laboratory of the Department of Agricultural Chemistry, Sher-e-Bangla Agricultural University, Dhaka-1207 during the period from November 2016 to March 2017 to study the Effect of Salinity on Growth, Yield and nutrient contents in different Wheat (*Triticum aestivum* L) cultivars. The experiment comprised three wheat cultivarss viz.;V_1 (BARI gom-24), V_2 (BARI gom-25) and V_3 (BARI gom-26) and five salinity level viz.; S_0 (control), S_1 (3 dSm^{-1}), S_2 (6 dSm^{-1}), S_3 (9 dSm^{-1}) and S_4 (12 dSm^{-1}). The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications.

The data on germination, plant height at different days, number of total tiller per pot, number of effective tiller per pot, number of ineffective tiller per pot, spike length, number of total grain per spike, number of filled grain per spike, number of unfilled grain per pot, 1000 grain weight, grain yield per pot, straw weight per pot, root length per plant, root weight per pot and chemical composition (Nitrogen, Phosphorus, Potassium, Sodium and Calcium on Root, Straw and Grain) were recorded.

Growth, development and yield contributing parameters of different cultivars were shown significantly variations. The highest germination percentage (73.88%) was recorded from BARI gom-25 whereas the lowest percentage (62.72%) was recorded from BARI gom-24. At 30, 60 and 95 DAS respectively, the tallest plant (19.61, 52.54 and 67.67 cm) was recorded from BARI gom-25 and the smallest plant (16.24, 49.78 and 63.39 cm) was recorded from BARI gom-24. The highest number of total grain per pot (15.6), highest number of effective tiller per pot (12.87) and highest spike length (12.88 cm) were recorded from BARI gom-25, whereas the lowest number of total grain per pot (13.27), minimum number of effective tiller per pot (9.73) and lowest spike length (9.69 cm) were recorded from BARI gom-24. The highest number of ineffective tiller per pot (3.67) was recorded from BARI gom-26 and lowest number of ineffective tiller per pot (2.73) was recorded from BARI gom-25. The highest number of total grain per spike (34.6), highest number of filled grain per spike (23.07), highest 1000 grain weight (47.24 g), maximum grain yield per pot (19.78 g), highest straw weight per pot (80.26 g) and maximum root weight per pot (5.627 g) were recorded from BARI gom-25, whereas the lowest number of total grain per spike (30.2), lowest number of filled grain per spike (16.2), minimum weight of 1000 grain (41.29 g), minimum grain yield per pot (13.35 g), minimum straw weight (77.55 g) and minimum root weight (5.307 g) were recorded from BARI gom-24. But root length of cultivars was insignificant. The highest number of unfilled grain per spike (9.2) was recorded from BARI gom-24 and lowest number of unfilled grain (7.067) was recorded from BARI gom-25.

Chemical composition was also shown significant variations among different cultivars. The highest Sodium content in root (0.6145%), straw (1.741%) and grain (0.0935%) were found from BARI gom-26, whereas the lowest amount of Sodium in root (0.5346%), straw (1.741%) and grain (0.07347%) were found from BARI gom-25. The highest amount of Nitrogen in root (0.6727%), straw (1.702%) and grain (1.898%) were recorded from BARI gom-25, whereas BARI gom-26 had shown lowest Sodium content in root (0.5847%), straw (1.398%) and grain (1.72%). Highest potassium content in grain (0.543%) was recorded from BARI gom-25 and lowest potassium content (0.4319%) was recorded from BARI gom-26. Phosphorus content in root, straw and grain; Potassium content in root and straw and Calcium content in root, straw and grain were insignificant in different cultivars.

Growth, yield and nutrient contents were significantly influence due to salinity treatment. The highest germination percentage (100%) was recorded from S_0 (control) treatment, whereas the lowest germination percentage (23.73%) was recorded from S_4 (12 dSm^{-1}) treatment. At 30, 60 and 95 DAS, the tallest plants (21.16, 56.89 and 72.26 cm) were recorded from S_0 (control) treatment, whereas the smallest plants (12.88, 43.52 and 53.63 cm) were recorded from S_4 (12 dSm^{-1}) treatment. The highest number of total tiller per pot (17.89), highest number of effective tiller per pot (17.89), maximum length of spike (14.99 cm), highest number of total grain per spike (43.78), highest number of filled grain per spike (42.22), highest weight of 1000 grain (51.18 g), maximum grain yield per pot (34.51 g), highest straw weight (87.14 g), maximum root length per pot (24.86 cm) and highest root weight per pot (6.6 g) were recorded from S_0 (control) treatment. The lowest number of total tiller per pot (9.33), lowest number of effective tiller per pot (3.56), smallest spike length (5.367 cm), lowest number of grain per spike (12.89), lowest number of filled grain per spike (0), lowest weight of 1000 grain (27.89

g), minimum grain weight per pot (0.67 g), minimum straw weight (64.84 g), minimum root length per plant (18.37 cm) and lowest root weight per pot (4.267 g) were recorded from S_4 (12 dSm^{-1}) treatment. Highest number of ineffective tiller per pot (5.77) and highest number of unfilled grain per spike (11.22) were recorded from S_4 (12 dSm^{-1}) treatment, whereas the minimum number of ineffective tiller per pot (0) and minimum number of unfilled grain per spike (1.667) were recorded from S_0 (control) treatment. The highest Nitrogen percentage in root (0.9078%), straw (2.53%) and grain (2.696%) were found from S_0 (control) treatment, whereas the lowest amount of Nitrogen in root (0.2378%), straw (0.56%) and grain (0.605%) were found from S_4 (12 dSm^{-1}) treatment. Highest Phosphorus content in root (0.6624%) and straw (0.202%) were recorded from S_4 (12 dSm^{-1}) treatment, whereas the lowest Phosphorus content in root (0.1701%) and straw (0.089%) were recorded from S_0 (control) treatment. The highest Phosphorus content in grain (0.6867%) was found from S_0 (control) treatment, and lowest (0.1936%) from S_4 (12 dSm^{-1}) treatment. The highest amount of Sodium in root (1.323%), straw (4.59%) and grain (0.135%) were recorded and the lowest amount of Sodium content was found in root (0.2251%), straw (0.2711%) and grain (0.0256%) from S_0 (control) treatment. The highest Calcium content in root (0.5596%) and root (0.3703%) were recorded from S_4 (12 dSm^{-1}) treatment, whereas the lowest Calcium content was found in root (0.2329%) at S_2 (6 dSm^{-1}) treatment and in straw (0.1179%) at S_0 (control) treatment.

The interaction effect between salinity treatment and cultivars was significant on growth, yield and nutrient contents. All the three cultivars were shown maximum germination percentage (100%) from S_0 (control) treatment. BARI gom-26 had shown maximum plant height (22, 58.40 and 73.73 cm at 30, 60 and 95 DAS respectively) at S_0 (control) treatment, whereas BARI gom-24 had shown minimum plant height (10.20, 41.13 and 49.63 cm at 30, 60 and 95 DAS respectively) at S_4 (12 dSm^{-1}) treatment. The highest number of total tiller per pot (18.67), highest number of effective tiller per pot (18.67) and maximum spike length (15.60 cm) were recorded from BARI gom-26 at S_0 (control) treatment. The lowest number of total grain per spike (8.667) and minimum number of effective tiller per pot (2.33) were recorded from BARI gom-24 at S_4 (12 dSm^{-1}) treatment. The highest weight of 1000 grain (51.43 g) was recorded from BARI gom-25 at S_0 (control) treatment, whereas the lowest weight of 1000 grain (24.10 g) was recorded from BARI gom-26 at S_4 (12 dSm^{-1}) treatment. The maximum grain yield per pot (40.68 g) was recorded from BARI gom-26 at S_0 (control) treatment and lowest grain yield per pot (0.305 g) was recorded from BARI gom-26 at S_4 (12 dSm^{-1}) treatment. The highest Nitrogen content in root (0.95%), straw (2.63%) and grain (2.703%) were recorded from BARI gom-25 at S_0 (control) treatment, whereas the lowest Nitrogen content in root (0.186%) and straw (0.5167%) were recorded from BARI gom-26 at S_4 (12 dSm^{-1}) treatment. The highest Phosphorus content in grain (0.1953%) was found BARI gom-26. The highest Sodium content in root (1.425%), straw (4.959%) and grain (0.154%) were obtained from BARI gom-26 at S_4 (12 dSm^{-1}) treatment, whereas the lowest Sodium content in root (0.232%), straw (0.2743%) and grain (0.021%) were obtained from BARI gom-24 at S_0 (control) treatment. The highest Calcium content in root (0.582%) and straw (0.385%) were recorded from BARI gom-25 at S_4 (12 dSm^{-1}) treatment. The lowest Calcium content in grain (0.016%) was recorded from BARI gom-26 at S_4 (12 dSm^{-1}) treatment.

It may be concluded within the scope and limitation of the present study that the performances of the wheat cultivarss were best in control treatment. As salinity level increased the wheat cultivarss showed their more susceptibility to salt in respect of growth, yield and nutrient contents. Considering the performance of the three cultivarss (BARI gom-24, BARI gom-25 and BARI gom-26) BARI gom-25 performed best. However, further studies are necessary to arrive at a definite conclusion.

CHAPTER VI

REFERECES

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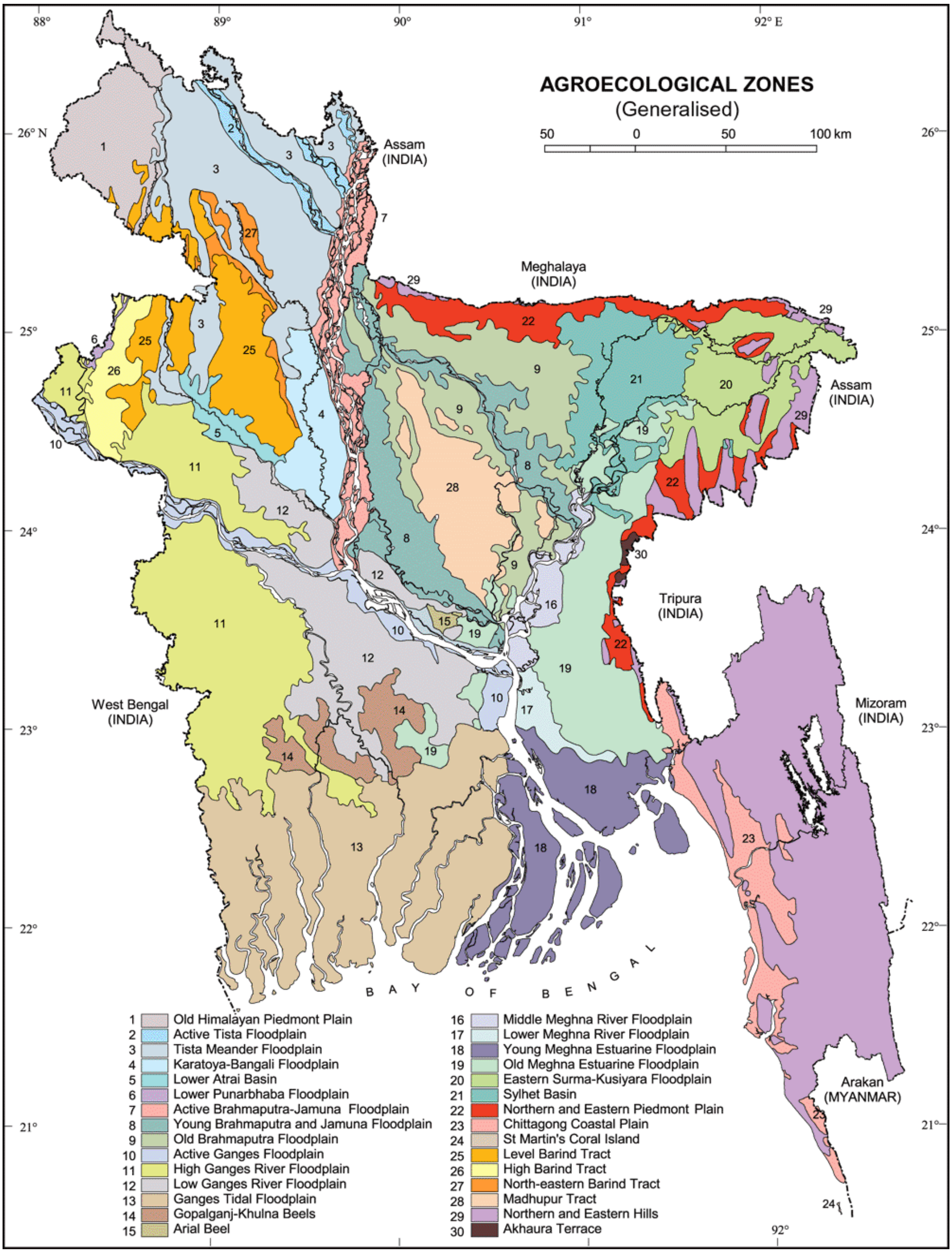
APPENDICES

Appendix I: Experimental location on the map of Agro Ecological Zones of Bangladesh



Appendix II: Morphological characteristics of the experimental field

Morphology	Characteristics
Location	SAU Farm, Dhaka.
Agro-ecological zone	Madhupur Tract (AEZ- 28)
General Soil Type	Deep Red Brown Terrace Soil
Parent material	Madhupur Terrace.
Topography	Fairly level
Drainage	Well drained
Flood level	Above flood level

(SAU Farm, Dhaka)

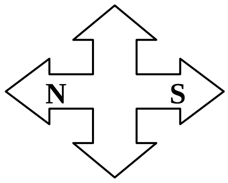
Appendix III: Initial physical and chemical characteristics of the soil

Characteristics	Value
Mechanical fractions: % Sand (2.0-0.02 mm) % Silt (0.02-0.002 mm) % Clay (<0.002 mm)	 22.26 56.72 20.75
Textural class	Silt Loam
pH (1: 2.5 soil- water)	5.9
Organic Matter (%)	1.09
Total N (%)	0.028
Available K (ppm)	15.625
Available P (ppm)	7.988
Available S (ppm)	2.066

(SAU Farm, Dhaka)

Appendix IV: Layout of the experimental Plot

V_2S_3	**V_1S_4**	**V_3S_4**
V_3S_1	**V_3S_3**	**V_1S_0**
V_1S_2	**V_2S_2**	**V_2S_1**
V_1S_4	**V_2S_3**	**V_3S_2**
V_3S_3	**V3S1**	**V2S4**
V_2S_2	**V_1S_2**	**V_1S_1**
V_3S_4	**V_3S_0**	**V_2S_3**
V_1S_0	**V_1S_3**	**V_3S_1**
V_2S_1	**V_2S_0**	**V_1S_2**
V_3S_0	**V_3S_2**	**V_1S_4**
V_1S_3	**V_2S_4**	**V_3S_3**
V_2S_0	**V_1S_1**	**V_2S_2**
V_3S_2	**V_3S_4**	**V_3S_0**
V_2S_4	**V_1S_0**	**V_1S_3**
V_1S_1	**V_2S_1**	**V_2S_0**



Row to row distance = 60 cm
Pot to pot distance,
in each row = 20 cm
Pot diameter,
Upper part = 20 cm
Lower part = 15 cm
Height of pot = 25 cm

V_1 = BARI gom-24

V_2 = BARI gom-25

V_3 = BARI gom-26

S_0 = Control (No salt)

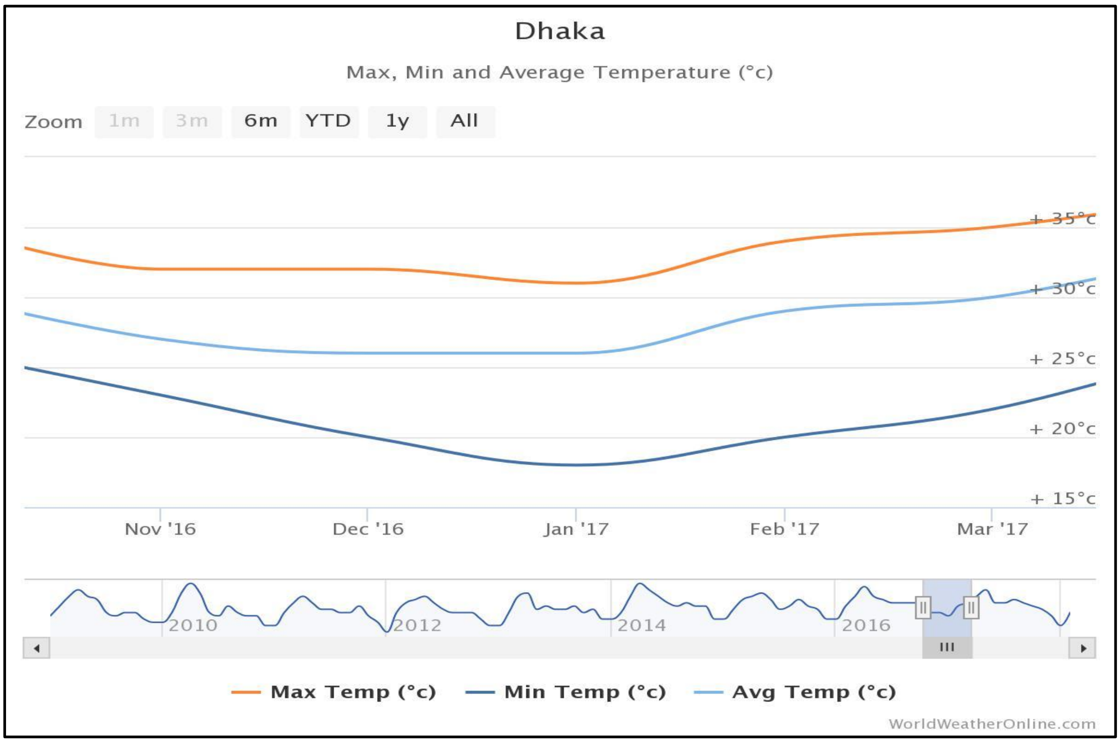
S_1 = 3 dSm^{-1}

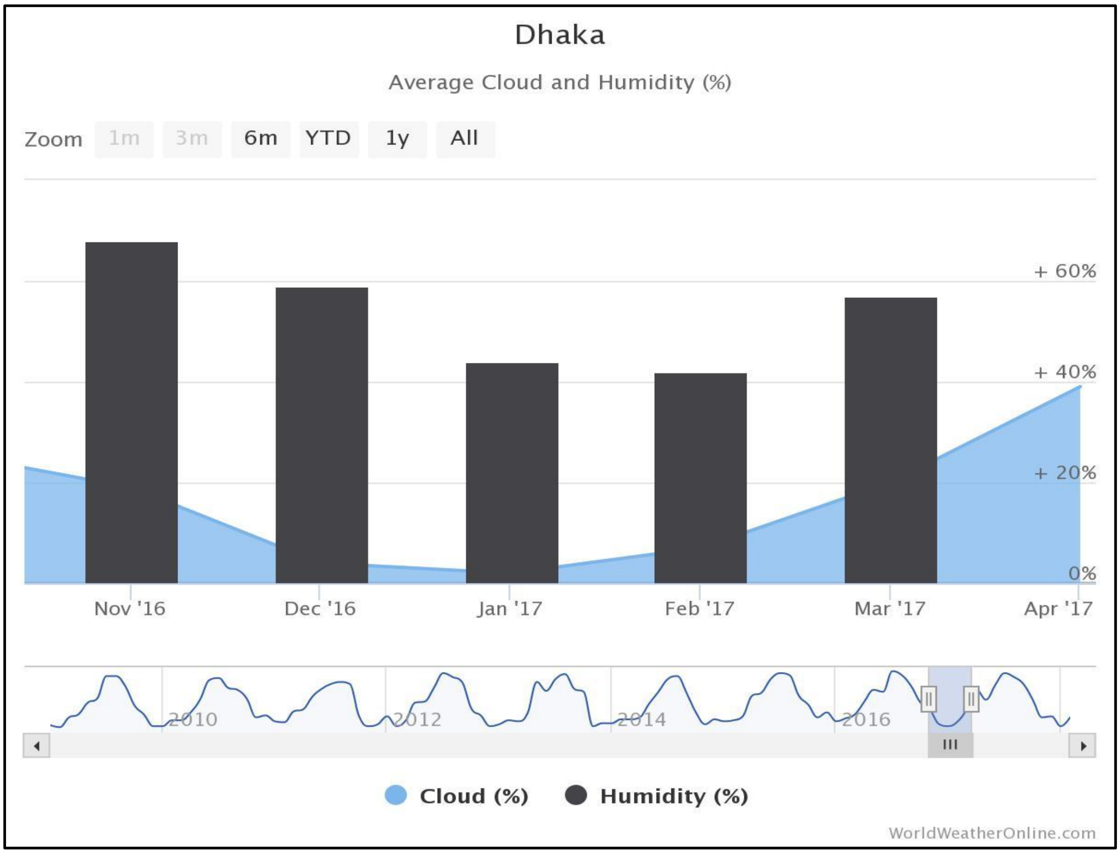
S_2 = 6 dSm^{-1}

S_3 = 9 dSm^{-1}

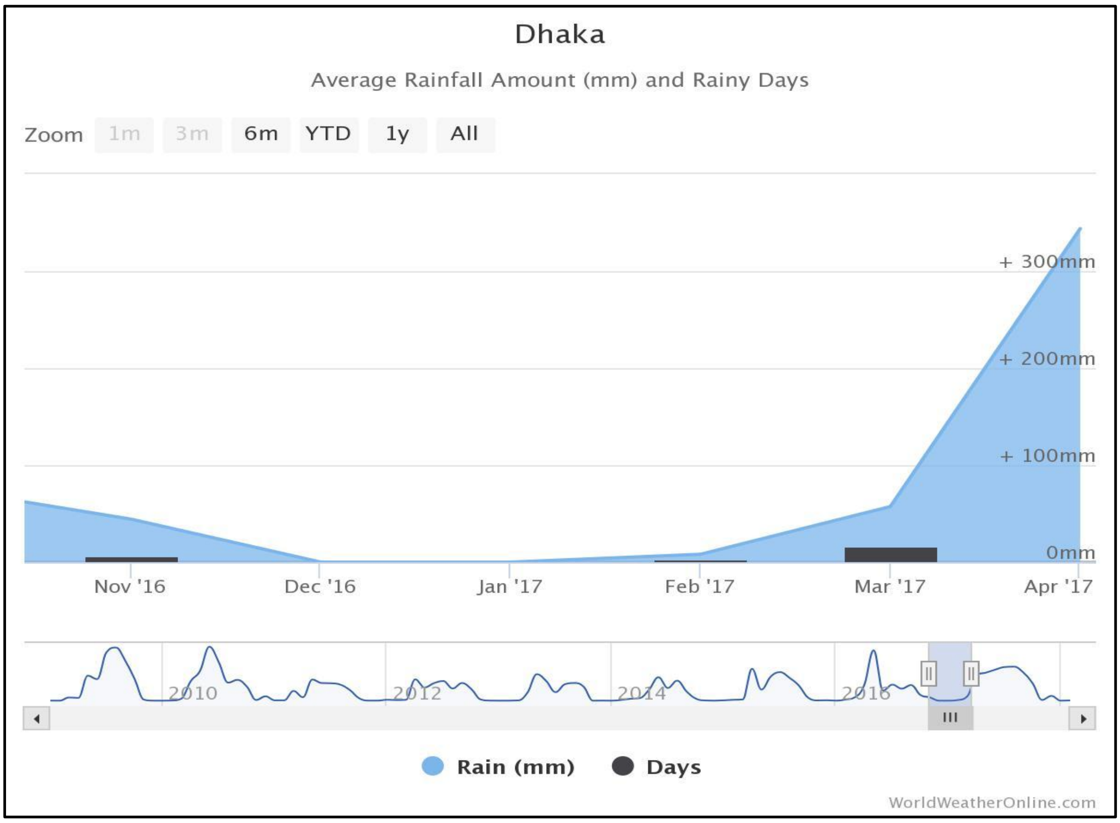
S_4 = 12 dSm^{-1}

Appendix V: Monthly weather data of Dhaka during experiment (from Nov'2016 to Mar'2017)





(Source- www.worldweatheronline.com)



(Source- www.worldweatheronline.com)

Appendix VI: Analysis of variance of the data on germination, plant height at 30 DAS and tiller number

Source of variation	Degrees of freedom	Mean square		
		Germination	Plant height at 30 DAS	Tiller number
Replication	2	42.64**	0.083	0.467
Cultivar (A)	2	507.56**	42.817**	22.867**
Salinity (B)	4	9148.23**	108.73**	113.07**
Interaction (A×B)	8	87.48**	6.85**	2.644**
Error	28	9.735	0.251	0.324

Appendix VII: Analysis of variance of the data on total grain, spike length and 1000 grain weight

Source of variation	Degrees of freedom	Mean square		
		Total Grain	Spike length	1000 grain weight
Replication	2	2.4	0.845	1.478
Cultivar (A)	2	75.8**	44.275**	153.24**
Salinity (B)	4	1442.89**	138.275**	833.85**
Interaction (A×B)	8	11.94**	5.961**	39.35**
Error	28	0.662	0.218	1.662

Appendix VIII: Analysis of variance of the data on N, P, K, Na and Ca contents in straw.

Source of variation	Degrees of freedom	Mean square				
		N	P	K	Na	Ca
Replication	2	0.51	0.32	0.003	0.001	0
Cultivar (A)	2	0.35*	0.001*	0.001^{NS}	0.321**	0.001**
Salinity (B)	4	5.947*	0.024^{NS}	2.517^{NS}	27.96*	0.097*
Interaction (A×B)	8	0.075^{NS}	0.001*	0.024*	0.106*	0^{NS}
Error	28	0.005	0.001	0.003	0.002	0.001

NS = Non-significant, * = Significant at 5% level, ** = Significant at 1% level

Appendix IX: Analysis of variance of the data on N, P, K, Na and Ca contents in root

Source of variation	Degrees of freedom	Mean square				
		N	P	K	Na	Ca
Replication	2	0.001	0.054	0	0.005	0
Cultivar (A)	2	0.031^{NS}	0.001*	0.002^{NS}	0.025*	0.001**
Salinity (B)	4	0.665**	0.317*	0.403**	1.783*	0.17^{NS}
Interaction (A×B)	8	0.005**	0^{NS}	0.002	0.004**	0.001**
Error	28	0.002	0.001	0.001	0.001	0.001

Appendix X: Analysis of variance of the data on N, P, K, Na and Ca Contents in grain

Source of variation	Degrees of freedom	Mean square				
		N	P	K	Na	Ca
Replication	2	0.003	0	0	0	0.001
Cultivar (A)	2	0.12**	0.001^{NS}	0.056**	0.002**	0.062**
Salinity (B)	4	6.77	0.031^{NS}	0.328**	0.016	0.005**
Interaction (A×B)	8	0.054**	0^{NS}	0.001*	0^{NS}	0.017*
Error	28	0.011	0.001	0.001	0.001	0.003

NS = Non-significant, * = Significant at 5% level, ** = Significant at 1% level

Appendix XI: Effect of different cultivar on growth and development parameters

Cultivars	Germination (%)	Plant height (cm)			No. of total tiller/pot	No. of effective tiller/pot	No. of ineffective tiller/pot	Spike length (cm)
		30 DAS	60 DAS	95 DAS				
BARI gom-24	62.72 c	16.24 c	49.78 b	63.39 c	13.27 c	9.733 b	3.533 a	10.15 b
BARI gom-25	73.88 a	19.61 a	52.54 a	67.67 a	15.60 a	12.87 a	2.733 b	12.88 a
BARI gom-26	65.43 b	17.67 b	51.33 a	65.53 b	13.73 b	10.07 b	3.667 a	9.693 c
LSD $_{0.05}$	2.334	0.3747	1.252	0.9912	0.4258	0.4550	0.3165	0.3492
Level of significance	*	*	*	*	*	*	*	*
CV %	4.63	2.81	3.27	4.02	4.01	5.59	12.79	4.28

Appendix XII: Effect of different cultivar on yield contributing parameters

Cultivars	Number of total grain/spike	Number of filled grain/spike	Number of unfilled grain/spike	1000 grain weight (g)	Grain yield per pot (g)	Straw weight (g)	Root length (cm)	Root weight (g)
BARI gom-24	30.20 c	16.20 c	9.200 a	41.29 b	13.35 c	77.55 b	21.31 a	5.307 b
BARI gom-25	34.60 a	23.07 a	7.067 b	47.24 a	19.78 a	80.26 a	22.50 a	5.627 a
BARI gom-26	33.20 b	17.20 b	8.867 a	42.25 b	16.74 b	77.85 b	22.20 a	5.520 a
LSD $_{0.05}$	0.6086	0.4748	0.5527	0.9643	1.053	1.470	1.329	0.1379
Level of significance	*	*	*	*	*	*	NS	*
CV %	2.49	3.31	8.82	3.96	8.47	4.50	8.07	3.37

LSD = Least Significant Difference, CV = Coefficient of variation, * = Significant at 5% level, NS= Non-Significant

Appendix XIII: Effect of different salinity level on growth and development parameters

Salinity level (dSm^{-1})	Germination (%)	Plant height (cm)			No. of total tiller/pot	No. of effective tiller/pot	No. of ineffective tiller/pot	Spike length (cm)
		30 DAS	60 DAS	95 DAS				
0	100.0 a	21.16 a	56.89 a	72.26 a	17.89 a	17.89 a	0.00 d	14.99 a
3	92.80 b	20.50 b	55.98 a	69.71 b	17.11b	17.11 b	2.00 c	13.69 b
6	73.23 c	18.93 c	52.00 b	67.83 c	14.56 c	11.22 c	3.33 b	11.90 c
9	46.97 d	15.73 d	47.70 c	64.20 d	12.11 d	6.667 d	5.44 a	8.589 d
12	23.73 e	12.88 e	43.52 d	53.63 e	9.333 e	3.556 e	5.77 a	5.367 e
$LSD_{0.05}$	3.013	0.4838	1.616	1.280	0.5496	0.5874	0.4085	0.4509
Level of significance	*	*	*	*	*	*	*	*
CV %	4.63	2.81	3.27	4.02	4.01	5.59	12.79	4.28

Appendix XIV: Effect of different salinity level on Yield contributing parameters

Salinity level (dSm^{-1})	Number of total grain/spike	Number of filled grain/spike	Number of unfilled grain/spike	1000 grain weight (g)	Grain yield per pot (g)	Straw weight (g)	Root length (cm)	Root weight (g)
0	43.78 a	42.22 a	1.667 c	51.18 a	34.51 a	87.14 a	24.86 a	6.600 a
3	41.78 b	31.11 b	7.222 b	50.76 a	26.48 b	83.94 b	24.60 a	6.133 b
6	37.11 c	15.44 c	11.00 a	46.78 b	16.0 c	79.92 c	22.23 b	5.511 c
9	27.78 d	7.000 d	10.78 a	41.36 c	5.45 d	76.90 d	19.96 c	4.911 d
12	12.89 e	0.000 e	11.22 a	27.89 d	0.67 e	64.84 e	18.37 c	4.267 e
$LSD_{0.05}$	0.7857	0.6130	0.7135	1.245	1.360	1.897	1.715	0.1781
Level of significance	*	*	*	*	*	*	*	*
CV %	2.49	3.31	8.82	3.96	8.47	4.50	8.07	3.37

LSD = Least Significant Difference, CV = Coefficient of variation, * = Significant at 5% level

Appendix XV: Effect of different cultivar on Chemical composition (Nitrogen, Phosphorus and Potassium)

Cultivar	Nitrogen %			Phosphorus %			Potassium %		
	Root	Straw	Grain	Root	Straw	Grain	Root	Straw	Grain
BARI gom-24	0.6467 a	1.575 b	1.839 a	0.3725	0.1489	0.1231	0.2017	1.183	0.4439 b
BARI gom-25	0.6727 a	1.702 a	1.898 a	0.3901	0.1429	0.1365	0.1997	1.193	0.5433 a
BARI gom-26	0.5847 b	1.398 c	1.722 b	0.3772	0.1491	0.1307	0.1987	1.178	0.4319 b
$LSD_{0.05}$	0.0334	0.053	0.0784	0.0236	0.0241	0.033	0.023	0.0409	0.0215
Level of significance	*	*	*	NS	NS	NS	NS	NS	*
CV %	6.85	4.74	5.63	2.29	11.58	4.82	3.27	4.89	5.43

Appendix XVI: Effect of different salinity level on Chemical composition (Nitrogen, Phosphorus and Potassium)

Salinity (dSm^{-1})	Nitrogen %			Phosphorus %			Potassium %		
	Root	Straw	Grain	Root	Straw	Grain	Root	Straw	Grain
0	0.9078 a	2.533 a	2.696 a	0.1701 e	0.089 c	0.1899 a	0.1863 b	1.842 a	0.6867 a
3	0.8333 b	2.144 b	2.530 b	0.2647 d	0.099 c	0.1687 ab	0.1373 c	1.532 b	0.6013 b
6	0.6889 c	1.588 c	1.944 c	0.3640 c	0.153 b	0.1481 b	0.1182 c	1.134 c	0.4851 c
9	0.5056 d	0.965 d	1.322 d	0.4383 b	0.189 a	0.09867 c	0.1756 b	0.9399 d	0.3986 d
12	0.2378 e	0.560 e	0.605 e	0.6624 a	0.202 a	0.04522 d	0.3827 a	0.4756 e	0.1936 e
$LSD_{0.05}$	0.043	0.068	0.1013	0.0305	0.0305	0.0305	0.029	0.053	0.031
Level of significance	*	*	*	*	*	*	*	*	*
CV %	6.85	4.74	5.63	2.29	11.58	4.82	3.27	4.89	5.43

LSD = Least Significant Difference, CV = Coefficient of variation, * = Significant at 5% level

Appendix XVII: Effect of different cultivar on Chemical composition (Sodium and Calcium)

Cultivar	Sodium %			Calcium %		
	Root	Straw	Grain	Root	Straw	Grain
BARI gom-24	0.5857 b	1.700 b	0.08380 b	0.3919	0.1846	0.04413
BARI gom-25	0.5346 c	1.470 c	0.07347 b	0.4045	0.1958	0.04033
BARI gom-26	0.6145 a	1.741 a	0.09353 a	0.3920	0.1909	0.03613
$LSD_{0.05}$	0.023	0.033	0.0107	0.024	0.025	0.0237
Level of significance	*	*	*	NS	NS	NS
CV %	6.65	3.92	8.13	3.09	5.77	11.02

Appendix XVIII: Effect of different salinity level on Chemical composition (Sodium and Calcium)

Salinity (dSm^{-1})	Sodium %			Calcium %		
	Root	Straw	Grain	Root	Straw	Grain
0	0.2251 e	0.2711 e	0.02567 d	0.4613 b	0.1179 c	0.07489 a
3	0.3136 d	0.5041 d	0.06433 c	0.2751 c	0.1249 c	0.04678 ab
6	0.3832 c	0.9326 c	0.08489 bc	0.2329 d	0.1569 b	0.03878 bc
9	0.6462 b	1.886 b	0.1081 ab	0.4518 b	0.1821 b	0.02533 bc
12	1.323 a	4.590 a	0.1350 a	0.5596 a	0.3703 a	0.01522 c
$LSD_{0.05}$	0.0299	0.0431	0.0298	0.03	0.032	0.031
Level of significance	*	*	*	*	*	*
CV %	6.65	3.92	8.13	3.09	5.77	11.02

LSD = Least Significant Difference, CV = Coefficient of variation, * = Significant at 5% level

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