

IMPACT OF BORON AND NITROGEN UNDER DIFFERENT SALINITY LEVELS ON THE POTENTIAL OF COTTON VARIETIES

Muhammad Sarosh Nazar

University of Agriculture, Faisalabad

Email: soilscientist03@gmail.com

Muhammad Abubakar siddiq

Scientific officer (lab), Soil and water testing Laboratory, Sargodha

Email: abubakarsaggu104@gmail.com

Syed Ashgar Hussain Shah

Principal Scientist, Soil and Water Testing Laboratory for Research, Sargodha

Email: asghar2626@gmail.com

Ahmad Raza

Senior Scientist, Soil and Water Testing Laboratory for Research, Sargodha

Email: raza_a340@hotmail.com

Zara Jabeen

Assistant professor, Riphah International University, Faisalabad Campus

Email: zarajabeen.2011@gmail.com

Muhammad Ibrar Ahmad (Corresponding Author)

Scientific officer, Fodder Research Institute, Sargodha

Email: ibraragrarian1982@gmail.com

Hafiz Muhammad Anwar ul Haq

Professor, Institute of soil and environmental sciences, university of agriculture Faisalabad

Email: mailto:haq.gondal@uaf.edu.pk

ABSTRACT

Abstract: Cotton is one of the most important fibrous crops and its productions is decreasing day by day due to salinity stress. Soil salinity may limit the crop yield adversely influencing the leaf water potential and some other physiological responses in arid and semi-arid zone. An experimental study was conducted to evaluate the impact of Boron (B) and Nitrogen (N) under salinity on the

potential of two cotton varieties (*Gossypium hirsutum* L.). The experiment was laid out following CRD 2 –factorial using seven treatments (Control, EC @ 10 d Sm⁻¹, B @ 6mM0, B@6 mM + EC @ 10d Sm⁻¹, N @50 ppm, N @ 50 ppm + EC @ 10d Sm⁻¹, B @6 m + N @50 ppm + EC @ 10 dSm⁻¹) each with three replications. Two varieties of cotton (FH-Lalazar and FH-114) were sown. Obtained data of all parameters was statistically analyzed by using statistix 8.1. Significant treatment means were separated by least significant difference (LSD) test. The results showed that B fertilization @ 6mM and N @ 50ppm improved significantly shoot fresh weight, chlorophyll content, plant height and relative water contents with and without salinity, while significant decrease in K⁺ was observed where NaCl salt was applied. The B application helped in increasing K⁺ concentration in shoot where B was applied @ 6Mm

Keywords: Cotton (*Gossypium Hirsutum* l.), Boron, Nitrogen, Salinity Stress, Growth and Physiology, Chlorophyll Content, Relative Water Content

Introduction

Soil salinity is one of the foremost abiotic stresses to agriculture all over the world. It has been estimated that more than 800 m.ha of land around the globe is facing higher salt build up. Forty five m.ha out of total irrigated land is salt affected which is about 20% of the total (FAO, 2008). Yield reduction due to salinity is one the major problems in Pakistan.(Ashraf et al., 2008). Higher accumulation of salts in root zone restricts plant growth by limiting the uptake of different essential elements such as K⁺ and water (Abbas et al., 2013).

Cotton is the most important crop of Pakistan and is largely exported by the country (Ahmad et al., 2009). Cotton is a major crop of Pakistan after wheat and it occupies the largest area in Pakistan compared to other crops. Cotton crop earns the country largest export revenues and in addition to the lint, the seed of cotton for oil and meal accounts for 80 percent of the national production of oilseed. Cotton and cotton related products contribute 10 percent to gross domestic product (GDP) and 55 percent to the foreign exchange earnings of the country. The area under the cultivation of cotton crop increased significantly in the last 30 years, around 7.86 million acres in 2015–2016 (Economic Survey of Pakistan, 2015-16).

Being the structural part of many bio-molecules N is required through all growth stages of plant development. Deficiency of N results in stunting, chlorosis, fewer and smaller balls and canopy development in cotton is strongly controlled by N uptake (Reiter et al., 2013). During the vegetative growth period, rapid growth of the leaves demands higher N contents. Fruit production and retention are also dependent on the N levels in plant. (Oosterhuis et al., 1983).

Boron application, generally positively influence the cotton growth, however it has very narrow range between satisfactory and toxicity. Foliar application of B did not show the consistent results (Oliveira et al., 2006). Generally cotton (*Gossypium hirsutum* .L)-growing areas of the world are

deficient in B (Rosolem and Bogiani, 2011). Boron is an essential nutrient for plant growth and its deficiency in soil and irrigation water adversely effect the crop growth (Tanaka and Fujiwara, 2008). Boron is the most vital micronutrient for cotton crop and is required by plant at flowering, pollination, and boll development stages (Gormus, 2005; Reiter et al., 2013). Primarily it is utilized in cell wall structure, in several metabolic pathways and membrane processes (Brown et al., 2002; Lauchli, 2002) and its deficiencies negatively affect water and nutrient transportation to new cells, flower production, and fruit development (Havlin et al., 2005).

It has been found that presence of B in different concentrations saline areas, the crops will show more tolerance against salinity (Ferguson et al., 2002; Mehmood et al., 2009) but it has also been shown that under salinity stress there is also minimum tolerance to B (Alpasalan and Gunes, 2001; Wimmer et al., 2003). Boron occurs in soil as a leachable form named as boric acid, but is retained by organic matter (OM) and made plant available upon OM decomposition. (Crozier et al., 2013). It has been reported that interactive effect of B toxicity and salt stress result less deleterious effects on plant growth than which would be expected if effects of the separate factors were additive, suggesting low uptake of B in the presence of Cl^- and low uptake of Cl^- in the presence of B (Yermiyahu et al., 2008).

Cotton shows positive response in interaction between B and N . The application of N synthesize high level of N in leaf and better response was obtained when B applied with low rates of N but yield analysis indicated that B was not sufficient for cotton in such soil type (Gormus., 2004)

An interaction of salinity and B in arid-semi arid regions has been found when there is application of irrigation water because this water contains maximum concentration of B (Ben-Gal and Shani 2002). This interaction leads to reduce growth as well as yield of crop plant (Grieve and Poss 2000). Various reports showed that there is no chemical effect of both B and salinity on the dry weight of shoot of certain plant species telling that the interaction is independent (Edelstein et al. 2005). Keeping in view the above scenario an experimental study was conducted to evaluate the effect of B and N under saline conditions on soil the present study was conducted to study salinity-B interaction in cotton (*Gossypium hirsutum* L.) the role of N and B to decline salinity stress and improve cotton yield.

Material and Methods

A pot experiment was conducted in wire house of Saline Agricultural Research Center, Institute of Soil and Environmental Sciences University of Agriculture Faisalabad to monitor the impact of salinity, B and N on growth and ionic composition to evaluate the tolerance of different genotypes of cotton (*Gossypium hirsutum* L.) under different salinity levels. Soil samples of study area were collected and analyzed for soil pH_s , soil EC, saturation percentage, soluble Ca^{2+} , Mg^{2+} (Richards, 1954), Na^+ and K^+ (U.S. Salinity Lab. Staff, 1954), Soluble Cl^- (U.S. Salinity Lab. Staff, 1954), sodium adsorption ratio (SAR) (U.S. Salinity Lab. Staff, 1954), soil B (Rashid,

1997; Bingham, 1982) and total N (Jackson, 1962). The seeds of two cotton genotypes (FH-114) and (FH-Lalazar) were collected from Ayub Agricultural Research Institute Faisalabad and were grown. Experiment was designed according to Completely Randomized Design (CRD) in factorial arrangement with three repeats and seven treatments. Recommended dose of NPK was applied (90-45-45 kg ha⁻¹) for cotton in each pot. The experiment was consisted of seven treatments that were used (T1: Control, T2: EC @ 10dsm⁻¹, T3: Boron @6mm, T4: Boron@6mM + EC @ 10dsm⁻¹, T5: Nitrogen @50ppm, T6: Nitrogen @ 50ppm + EC @ 10dsm⁻¹, T7: Boron @6mm + Nitrogen @50ppm + EC @ 10dsm⁻¹) with three replications. Different plant parameters were studied such as shoot length, Shoot fresh weight, Chlorophyll content (SPAD value), Leaf relative water content (Weatherley, 1950) and membranes stability index (Sairum, 1994) plant samples were analyzed for Leaf sap extraction (Gorham et al., 1984), Determination of Na⁺ and K, Cl⁻ (U.S. Salinity Lab. Staff, 1954) and plant B (Mills and Jones 1996). All obtained data was analyzed by statistical technique (Steelet al., 1997). Treatments and varieties were compared following LSD Test.

Results and Discussion

Table 1: Basic soil analysis of study area

Soil property	Unit	Value
Textural class	-	Loam
Sand	%	40
Silt	%	32
Clay	%	28
PHs	-	7.28
ECe	dS m ⁻¹	0.78
TSS	me L ⁻¹	7.8
Ca ⁺² + Mg ⁺²	mmol _c L ⁻¹	7.65
Na ⁺	mmol _c L ⁻¹	2.11
SAR	(mmol _c L ⁻¹) ^{1/2}	4.47
6Total N	%	0.025
B	Ppm	0.62

Root Length (cm plant⁻¹)

The treatments and genotypic interactions significantly affect the root length (Table 2). Application

of B @ 6mM and N increased shoot length 11.68% to 16.36% and 7.25% to 13.71% respectively.. Treatment T₄ (B + EC) and T₆ (N + EC) showed an increase of (22.17% and 13.71%) in root length. The interactive effect of N and B with EC showed that an increase of (25.40 % and 34.95%) in root length. As N and B had significant effect by decreasing the deleterious effects of salinity. If we make the comparison between two varieties maximum root length was attained by FH-114 while minimum was found in FH-Lalazar. It was observed that FH-114 performed best in all treatments. Lauchli and Epstein (1990) also found that salinity caused reduction in root growth. Similar results were obtained by Yang and Lu (2005) on maize crops. The application of supplemental Ca⁺² alleviates the negative effects of salinity (Cramer, 2002).

Table No 2: Effect of N and B on root length ((cm plant⁻¹) of cotton during salinity stress.

	Treatments	FH-114	FH-Lalazar
1	Control	82.66 ± 0.88	75.33 ± 0.88
2	EC 10 dSm ⁻¹	65.66 ± 1.76 (d)(20.56)	55.33 ± 1.45 (f)(26.54)
3	B	73 ± 1.15 (c)(11.68)	63 ± 1.15 (de)(16.36)
4	B+EC	64.33 ± 0.88 (de)(22.17)	54.33 ± 0.88 (f)(27.87)
5	N	76.66 ± 1.45 (b)(7.25)	65 ± 1.15 (de)(13.71)
6	N+EC	65.33 ± 1.20 (d)(20.96)	46 ± 1.73 (g)(38.93)
7	N+B+EC	61.66 ± 1.20 (e)(25.40)	49 ± 1.15 (g)(34.95)

Shoot Length (cm plant⁻¹)

The treatments and genotypic interactions significantly affect the shoot lengths (Table 3). Application of B @ 6mM and N increased shoot length 11.68% to 16.36% and 7.25% to 13.71% respectively.. Treatment T₄ (B + EC) and T₆ (N + EC) showed an increase of (22.17% and 13.71%) in shoot length. The interactive effect of N and B with EC showed that an increase of (25.40 % and 34.95%) in shoot length. As N and B had significant effect by decreasing the deleterious effects of salinity. If we make the comparison between two varieties maximum shoot length was attained by FH-114 while minimum was found in FH-Lalazar. It was observed that FH-114 performed best in all treatments. Lauchli and Epstein (1990) also found that salinity caused reduction in shoot growth.

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Table No 3: Effect of N and B on shoot length ((cm plant⁻¹) of cotton during salinity stress.

	Treatments	FH-114	FH-Lalazar
1	Control	82.66 ± 0.88	75.33 ± 0.88
2	EC 10 dSm ⁻¹	65.66 ± 1.76 (d)(20.56)	55.33 ± 1.45 (f)(26.54)
3	B	73 ± 1.15 (c)(11.68)	63 ± 1.15 (de)(16.36)
4	B+EC	64.33 ± 0.88 (de)(22.17)	54.33 ± 0.88 (f)(27.87)
5	N	76.66 ± 1.45 (b)(7.25)	65 ± 1.15 (de)(13.71)
6	N+EC	65.33 ± 1.20 (d)(20.96)	46 ± 1.73 (g)(38.93)
7	N+B+EC	61.66 ± 1.20 (e)(25.40)	49 ± 1.15 (g)(34.95)

Shoot fresh weight (g plant⁻¹)

Statistical significant data of shoot fresh weight was observed due to treatment and interactive affect of varieties (table 4). Nitrogen and B application improved plant growth, when N was applied @ 50ppm about 17.98% increase in shoot fresh weight was observed as compared to control for FH-114 but a reduction of about 22.09% in shoot fresh weight for variety FH-Lalazar. The maximum shoot fresh weight (60.95% and 66.97%) was observed at treatment in which N was applied along with which EC @ 10dSm⁻¹ was maintained. The comparison of genotypes indicated that FH-114 produced highest shoot fresh weight in all salinity treatments along with N and B application. The absorption of excess salts occurs under high salinity level which finally effects the plant growth indirectly by reducing the amount of photosynthesis and growth factors. According to Fercha (2011) in wheat, salinity (150 mM NaCl) drastically decreased 33% leaf area and 32% leaf fresh weight. Similarly Irshad et al. (2002) reported that soil salinity reduced plant height, shoot and root dry yield of maize. These results are also in agreement with the finding of Abid et al. (2001).

Table No 4: Effect of N and B on shoot fresh weight (g plant⁻¹) of cotton during salinity stress.

	Treatments	FH-114	FH-Lalazar
1	Control	57.75 ± 0.76	65.68 ± 1.09
2	EC 10 dSm ⁻¹	46.94 ± 1.78 (d)(18.71)	33.51 ± 0.98 (ef)(48.97)
3	B	55.69 ± 1.16 (c)(3.56)	65.76 ± 2.00 (b)(0.12)
4	B+EC	36.29 ± 1.70 (e)(37.16)	31.58 ± 2.95 (f)(51.91)
5	N	70.51 ± 1.50 (a)(22.09)	53.87 ± 1.54 (c)(17.98)
6	N+EC	22.55 ± 1.91 (g)(60.95)	21.69 ± 1.28 (g)(66.97)
7	N+B+EC	33.31 ± 1.04 (ef)(42.32)	30.53 ± 1.35 (f)(53.51)

Chlorophyll content (SPAD value)

Chlorophyll content were significantly affected by treatments and varieties (Figure 1). The maximum chlorophyll content (7.65% and 1.68 %) was found when B and N was applied along with which EC @ 10dSm⁻¹ was maintained. On overall basis the chlorophyll content of both cotton genotype FH-Lalazar and FH-114 were better in all treatments. Comparison of genotypes showed that FH-Lalazar produced more chlorophyll content. The chlorophyll content reduction due to many reasons, one of

them is deterioration of membrane (Ashraf and Bhatti. 2000). High amount of salt which accumulate in cell wall reduce cell wall elasticity, metabolic pathway is reduced and ultimately results in limited relative chlorophyll content. Chookhampaeng (2011) reported that all physiological parameters chlorophyll contents were significantly decreased by increasing the level of salinity. Zahoor et al. (2011) reported that salinity decreased the chlorophyll contents in maize.

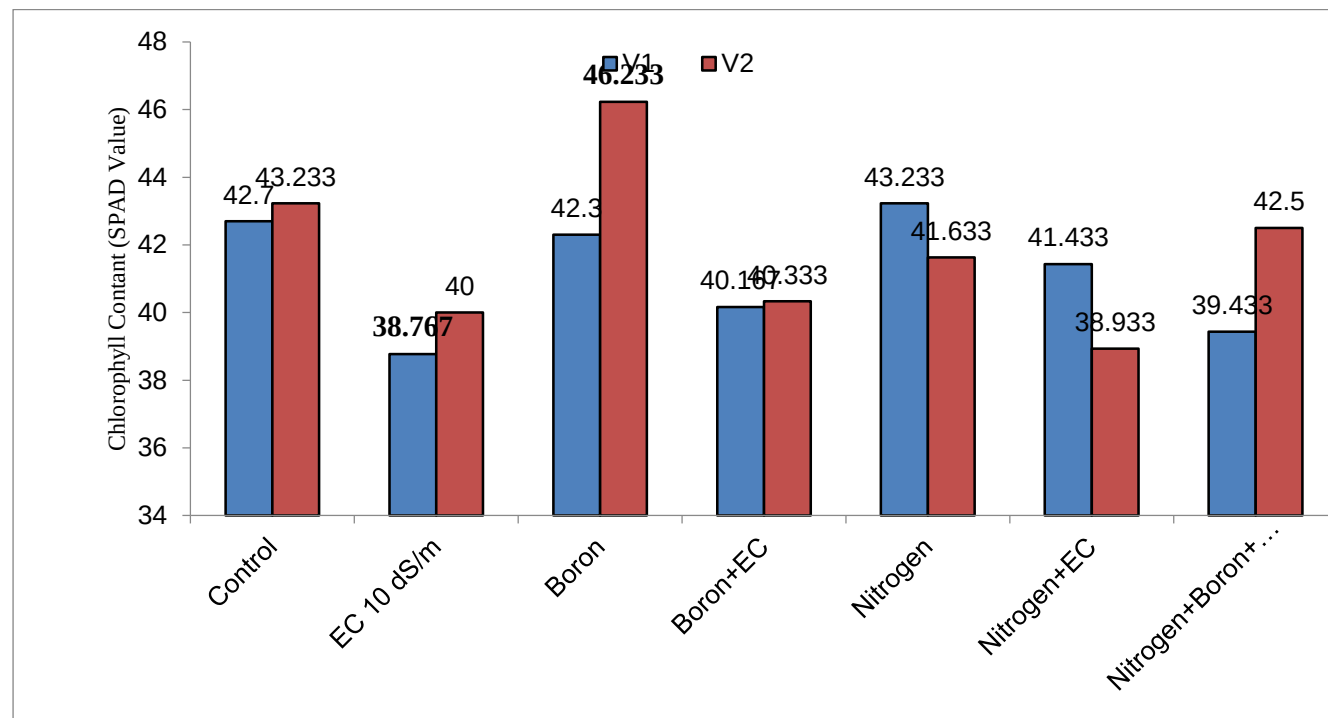


Fig. 4.3 Leaf chlorophyll content (SPAD value) of cotton genotypes grown under saline conditions with application of B and N

Relative Water Content

The treatments effect on relative water content was found significant at ($p < 0.05$), while similar was found with treatment genotypic interaction (table 5). Addition of N and B in saline conditions improved relative water contents more effectively at T_4 (B + EC) and T_6 (N + EC) and both varieties FH-114 and FH-Lalazar performed better in salt stress conditions. While the genotypic comparison between two varieties showed that FH-114 showed better performance in maximum treatments. Shaheen and Shahbaz (2012) performed to assess salt induced adverse effects on cotton (*Gossypium hirsutum* L.) and finding was significantly reduced relative water contents. Subbarao et al. (2000) reported the reduction of RWC in red beat. Similar Fercha (2011) reported that effect of salinity on wheat decreased the relative water content.

Table No 5: Effect of N and B on relative water content (%) of cotton during salinity stress.

Treatments	FH-114	FH-Lalazar
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1	Control	72.51 ± 1.32	66.97 ± 0.70
2	EC 10 dSm ⁻¹	55 ± 1.19 (gh)(24.14)	53.11 ± 0.87 (gh)(20.69)
3	B	63.26 ± 1.13 (d)(12.75)	52.93 ± 0.87 (h)(20.96)
4	B+EC	61.44 ± 1.32 (de)(15.26)	59.27 ± 1.32 (ef)(11.49)
5	N	74.99 ± 0.96 (a)(3.42)	63.36 ± 1.17 (d)(5.39)
6	N+EC	64.42 ± 0.53 (cd)(11.15)	61.05 ± 1.33 (de)(8.83)
7	N+B+EC	61.22 ± 1.28 (de)(15.57)	57.16 ± 0.67 (ef)(14.64)

Membrane Stability Index (MSI %)

The treatments and genotypic effect on membrane stability index was found significant (table 6). Reduction in MSI was observed at all salinity level along with B and N application however, the interaction between N, B and EC showed that decrease of MSI about (14.21% and 65.34%) was observed. It was found that FH-114 has more membrane stability index and FH-Lalazar has the lowest membrane stability index. Accumulation and uptake of Ca⁺⁺ is reduced under saline condition that results in reduction of membrane stability (Arshad et al., 2012). Membrane stability index reduction in high salinity may depend on genetics of the variety. MSI of Glycophytes like wheat is less affected if genotype is genetically able to resist the toxic level of NaCl reach to leaves or through osmotic adjustments by accumulating the solutes such as proline (Hasegawa et al., 2000).

Number of Leaves

Significant effect on number of leaves has been found in all treatments and genotypes (table 7). The interaction of N, B and EC showed that with the application of N and B an increase of about 2.47% for FH-114 but reduction of about 2.91% for FH-Lalazar. On an overall average basis maximum number of leaves was attained by FH-114 while minimum was found in FH-Lalazar. It was found that genotype FH-114 performed best in maximum treatments. Accumulation and uptake of NaCl that results in reduction of no of leaves and significant reduction in growth was observed by the soil salinity level. The results showed that a significant reduction in no of leaves when N comes in contact with salinity however maximum no of leaves were produced by the application of N alone (Chen et al., 2010).

Table No 6: Effect of N and B on Membrane Stability Index (%) of cotton during salinity stress

Treatments	FH-114	FH-Lalazar
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1	Control	66.26 ± 0.83	49.43 ± 1.32
2	EC 10 dS/m	53.64 ± 1.29 (g)(19.04)	51.15 ± 0.60 (gh)(3.47)
3	B	61.95 ± 0.90 (f)(6.50)	49.09 ± 0.77 (h)(0.68)
4	B+EC	75.16 ± 1.12 (d)(13.43)	83.37 ± 1.11 (c)(68.66)
5	N	87.5 ± 0.30 (b)(32.05)	68.37 ± 0.92 (f)(38.31)
6	N+EC	91.85 ± 0.84 (a)(38.62)	89.32 ± 0.65 (ab)(80.7)
7	N+B+EC	75.68 ± 0.98 (d)(14.21)	81.73 ± 1.04 (c)(65.34)

Table No 7: Effect of N and B on number of leaves of cotton during salinity stress.

	Treatments	FH-114	FH-Lalazar
1	Control	13.33 ± 0.66	11.66 ± 0.33
2	EC 10 dSm ⁻¹	8.33 ± 0.33 (e)(37.50)	12 ± 0.57 (cd)(2.91)
3	B	12.66 ± 0.88 (c)(5.02)	11.66 ± 0.88 (cd)(0)
4	B+EC	16.33 ± 0.88 (b)(22.50)	10.33 ± 0.66 (de)(11.40)
5	N	22.33 ± 0.88 (a)(67.51)	16.33 ± 0.88 (b)(40.05)
6	N+EC	12 ± 0.57 (cd)(9.97)	10.33 ± 0.88 (de)(11.40)
7	N+B+EC	13.66 ± 0.33 (c)(2.47)	12 ± 0.57 (cd)(2.91)

Sodium (Na⁺) Concentration (%) in shoot

Shoot sodium concentration was significantly affected by treatments and different genotypes (table 8). The treatment in which B was applied a significant reduction of about (52.77% and 37.03%) was observed, while the treatment in which N was applied @ 50ppm a significant reduction of about (63.88% and 33.33%) was observed, The interaction between N, B and EC in last treatment showed that an increase of about (66.66% and 114.81%) was observed as in this treatment EC was developed. Among the genotypes FH-114 performed better in treatments having salinity. Increased concentration of sodium under saline environment suppressed the leaf gas exchange and photochemical activity and hampered the growth and development of plants (Dionisiosese and Tobita, 2000). Our results confirmed the

finding of Cicek and Cakirlar (2002) that Na^+ concentration increased in shoot of cotton plant. Increase in Na^+ concentration become toxic and adversely affect plant growth (Hasegawa et al., 2000).

Potassium (K^+) Concentration (%) in shoot

The treatments along with genotypes significantly effects on shoot potassium concentration (table 8). Salinity reduced K^+ concentration of cotton genotypes. When B was applied @ 10dSm^{-1} it was observed that an increase (9.17% and 7.84%) uptake of K^+ was found. However the interaction between B, N and EC shows that due to presence of NaCl the K^+ concentration was reduced (15.13% and 15.19%), hence it was concluded from the above discussion that the presence of NaCl reduces the availability of K^+ . The comparison between genotypes showed that FH-114 accumulated the highest concentration of K^+ . Pervaiz et al. (2002) reported a decrease in K^+ contents whereas Na^+ concentration was increased, while variation between cotton genotypes was also observed. It was concluded that K^+ had beneficial impact on cotton grown under saline conditions (Maqsood et al. (2008).

Table No 8: Effect of N and B on sodium concentration (%) of cotton during salinity stress.

	Treatments	FH-114	FH-Lalazar
1	Control	0.36 ± 0.017	0.27 ± 0.0115
2	EC 10 dSm^{-1}	0.58 ± 0.014 (abc)(61.11)	0.54 ± 0.026 (c)(100)
3	B	0.17 ± 0.02 (f)(52.77)	0.17 ± 0.020 (f)(37.03)
4	B+EC	0.61 ± 0.011 (a)(69.44)	0.54 ± 0.017 (bc)(100)
5	N	0.13 ± 0.008 (f)(63.88)	0.18 ± 0.015 (f)(33.33)
6	N+EC	0.54 ± 0.020 (bc)(50)	0.59 ± 0.023 (ab)(118.51)
7	N+B+EC	0.6 ± 0.020 (a)(66.66)	0.58 ± 0.020 (abc)(114.81)

Potassium (K^+) Concentration (%) in shoot

The treatments along with genotypes significantly effects on shoot potassium concentration (table 9). Salinity reduced K^+ concentration of cotton genotypes. When B was applied @ 10dSm^{-1} it was observed that an increase (9.17% and 7.84%) uptake of K^+ was found. However the interaction between B, N and EC shows that due to presence of NaCl the K^+ concentration was reduced (15.13% and 15.19%), hence it was concluded from the above discussion that the presence of NaCl reduces the availability of K^+ . The comparison between genotypes showed that FH-114 accumulated the highest concentration of K^+ . Pervaiz et al. (2002) reported a decrease

in K^+ contents whereas Na^+ concentration was increased, while variation between cotton genotypes was also observed. It was concluded that K^+ had beneficial impact on cotton grown under saline conditions (Maqsood et al. (2008).

Table No 9: Effect of N and B on potassium concentration (%) of cotton during salinity stress

	Treatments	FH-114	FH-Lalazar
1	Control	2.18 ± 0.014	2.04 ± 0.017
2	EC 10 dSm ⁻¹	1.74 ± 0.017 (d)(20.18)	1.65 ± 0.023 (e)(19.11)
3	B	1.98 ± 0.014 (b)(9.17)	1.88 ± 0.017 (c)(7.84)
4	B+EC	1.85 ± 0.02 (c)(15.13)	1.89 ± 0.11 (c)(7.35)
5	N	1.34 ± 0.017 (h)(38.53)	1.45 ± 0.017 (g)(28.92)
6	N+EC	1.71 ± 0.017 (d)(21.55)	1.57 ± 0.011 (f)(23.03)
7	N+B+EC	1.85 ± 0.023 (c)(15.13)	1.73 ± 0.018 (d)(15.19)

Potassium sodium ratio ($K^+ : Na^+$):

The treatments effect on potassium sodium ratio in shoot ($K^+ : Na^+$) was found significant at ($p < 0.05$) and similar trend was observed in genotypic $\times$ treatment interaction (Table 10). Results revealed that significant variation among the genotypes in different treatments. On an average basis, the maximum ratio was observed by FH-114 and minimum was observed in FH-Lalazar. Among the treatments, when B was applied @ 6mM there was increase in $K^+ : Na^+$ concentration (132.28% and 43.69, similarly when N was applied @ 50ppm an increase of (83.85% and 9.80%) was seen in $K^+ : Na^+$ concentration. However the interaction between B, N along with which EC was also maintained it was observed that due to presence of NaCl, reduction in $K^+ : Na^+$ concentration (44.38% and 58.12%) was found. The ability of plant cells to retain K^+ is vital for salt tolerance, rather than their capability to restrict Na^+ from uptake. As a result of a better ability to retain K^+ , salt-tolerant varieties were able to maintain higher K^+/Na^+ in the root, enabling better performance in saline conditions. This is consistent with literature reports (Zhu et al., 1998; Nublat et al., 2001; Tester and Davenport, 2003). There is an antagonistic relationship between sodium and potassium uptake (Epstein, 1966). The literature (Al-Khatib et al., 1993; Maiti et al., 1996; Salam et al., 1999) supports the results that there is a positive correlation between seedling performance and adult plant performance.

Table No 10: Effect of N and B on $K^+ : Na^+$ (%) concentration of cotton during salinity stress.

	Treatments	FH-114	FH-Lalazar
1	Control	5.7 ± 0.07	7.14 ± 0.06
2	EC 10 dSm ⁻¹	2.96 ± 0.06 (e)(48.07)	3.16 ± 0.06 (e)(55.74)
3	B	13.24 ± 0.59 (a)(132.28)	10.26 ± 0.62 (b)(43.69)
4	B+EC	3.02 ± 0.04 (e)(47.017)	3.46 ± 0.08 (e)(51.54)
5	N	10.48 ± 0.49 (b)(83.85)	7.84 ± 0.31 (c)(9.80)
6	N+EC	3.08 ± 0.09 (e)(45.96)	2.64 ± 0.31 (e)(63.02)
7	N+B+EC	3.17 ± 0.09 (e)(44.38)	2.99 ± 0.10 (e)(58.12)

Chloride (Cl⁻) Concentration (%) in shoot

The treatments and both genotypes significantly effect on chloride concentration in shoot (table 11). Chloride concentration also increased with salinity and it followed increasing trend of Na⁺ concentration. The treatments T₂, T₄, T₆, T₇ having salinity (EC 10 dS m⁻¹, B + EC, N + EC, B + N + EC) significantly increased Cl⁻ concentration with respect to control. It was found that the treatment in which only B was applied about (6.25% and 3.24%) increase in in Cl⁻ concentration. Similarly when sole N was applied it was found that a significant increase in in Cl⁻ concentration (8.59% and 5.84%). The treatment in which EC was maintained @ 10 dSm⁻¹ it was observed that an increase of (114.06% and 83.76%) in chloride concentration. The interaction between N, B along with which EC was also maintained showed that maximum accumulation in Cl⁻ concentration was found (139.06% and 97.40. FH-114 accumulated highest concentration of Cl⁻ in saline conditions . It was observed by Ahmad et al. (2009) that increased in sodium & chloride and decreased in potassium level in leaf sap with increase substrate salinity. Plant growth reduced due to the interaction between Na⁺ and Cl⁻ in saline medium (Rozeff, 1995). Similarly, Khan et al. (2003) observed that salinity stress on maize that decreased sugar contents and fresh weight of stalks.

Table No 11: Effect of N and B on Cl⁻ concentration (%) of cotton during salinity stress.

	Treatments	FH-114	FH-Lalazar
1	Control	1.28 ± 0.038	1.54 ± 0.110

2	EC 10 dSm ⁻¹	2.74 ± 0.081 (abc)(114.06)	2.83 ± 0.205 (ab)(83.76)
3	B	1.36 ± 0.092 (e)(6.25)	1.49 ± 0.115 (e)(3.24)
4	B+EC	2.55 ± 0.147 (bcd)(99.21)	2.45 ± 0.137 (cd)(59.09)
5	N	1.39 ± 0.177 (e)(8.59)	1.45 ± 0.07 (e)(5.84)
6	N+EC	2.55 ± 0.092 (bcd)(99.21)	2.36 ± 0.160 (d)(53.24)
7	N+B+EC	3.06 ± 0.062 (a)(139.06)	3.04 ± 0.05 (a)(97.40)

B Concentration in Leaf (ppm):

The treatments effect on B concentration in shoot was found significant at ($p < 0.05$) but insignificant was observed in genotypic $\times$ treatment interaction (Table 12). B concentration decreases in salinity level. The treatments having salinity significantly decreased B concentration with respect to control. The treatment in which EC was maintained @ 10dSm⁻¹ it was found that a significant reduction in B concentration (20.94% and 19.43%). The treatment in which only B was applied @ 6mM an increase of about (16.35% and 20.07%) in B concentration was observed. The interaction between N, B along with which EC also maintained showed that B concentration tend to increase (16.01% and 17.18%) However, the different genotypes varied significantly B contents. Among the genotypes, FH-114 accumulated highest concentration of B in saline conditions. When salinity was combined with B and N mean B concentration was significantly increased in T₇. Earlier researchers have reported increased uptake of B, Na⁺ and Cl⁻ under salinity $\times$ B treatment as compared to separate treatments of salinity and B for cucumber (Alpaslan and Gunes, 2001) where as decreased for maize (Martinez-Ballesta et al. 2008). Boron is present primarily in the cell wall thus affect the pectin fraction that is important and has great effect on membrane stability as it link with cell polymers (Donghualiu et al., 2000). Saqib et al. (2009) observed that salinity increases the B toxicity symptoms on cotton plants and increases the B soluble concentration in leaves.

Table No 12: Effect of N and B on B concentration (ppm) of cotton during salinity stress.

	Treatments	FH-114	FH-Lalazar
1	Control	42.2 ± 0.50	40.5 ± 1.06
2	EC 10 dSm ⁻¹	33.36 ± 0.92 (d)(20.94)	32.63 ± 1.89 (d)(19.43)

3	B	49.1 ± 1.09 (a)(16.35)	48.63 ± 0.38 (a)(20.07)
4	B+EC	39.4 ± 1.19 (c)(6.63)	42.03 ± 1.04 (bc)(3.77)
5	N	42.1 ± 0.52 (bc)(0.23)	41.36 ± 0.67 (bc)(2.12)
6	N+EC	39.66 ± 0.28 (bc)(6.01)	40.16 ± 0.78 (bc)(0.83)
7	N+B+EC	48.96 ± 0.59 (a)(16.01)	47.46 ± 1.30 (a)(17.18)

Nitrogen Concentration in Shoot (%):

Nitrogen concentration was found insignificant at ($p < 0.05$), while similar was found with treatment genotypic interaction (Table 13). Cotton genotypes (FH-114, FH-Lalazar) showed different response in term of N concentration under saline and non-saline conditions. The treatment T_2 in which EC @ 10 dSm^{-1} was maintained a significant reduction (24.05% and 32.19%) was observed in N concentration as salinity suppresses the uptake of N. In the treatment T_3 in which B was applied @ 6mM it was found that the N concentration increased (1.60% and 3.68%). However in T_5 when N was applied @ 50ppm a significant increase in N concentration was observed (37.44% and 42.33%) but when N was applied @ 50 ppm along with which EC @ 10 dSm^{-1} was also maintained, the N concentration tend to decrease (9.29% and 5.20%) due to presence of salinity. If we make the comparison between two varieties of cotton, on an overall average basis maximum N accumulation was found by FH-Lalazar. Irshad et al., 2016 observed that N uptake was not consistent and decreasing considerably with salinity. The decrease uptake could have been due to nutritional imbalance under salinity stress

Table No 13: Effect of N and B on N concentration(%) of cotton during salinity stress.

	Treatments	FH-114	FH-Lalazar
1	Control	3.496 ± 0.20	3.497 ± 0.20
2	EC 10 dS/m	2.655 ± 0.16 (d)(24.05)	2.371 ± 0.13 (d)(32.19)
3	B	3.552 ± 0.16 (bc)(1.60)	3.626 ± 0.05 (b)(3.68)
4	B+EC	2.572 ± 0.07 (d)(26.43)	2.351 ± 0.050 (d)(32.77)
5	N	4.805 ± 0.09 (a)(37.44)	4.974 ± 0.05 (a)(42.23)

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6	N+EC	3.171 ± 0.08 (c)(9.29)	3.315 ± 0.11 (bc)(5.20)
7	N+B+EC	3.197 ± 0.06 (c)(8.55)	3.38 ± 0.13 (bc)(3.34)

Conclusions

Study concluded that: The growth parameters, chlorophyll contents and RWC cotton genotypes were decreased under saline conditions as compared to control. And applications of N and B along salinity improved growth parameters of cotton genotypes. At salinity level the maximum growth parameters were observed in FH-114. The maximum chlorophyll contents and RWC were observed in FH-Lalazar. The Na^+ concentration of cotton genotypes was increased with increase in salinity as compared to control. At salinity levels the maximum Na^+ concentration was produced in FH-114. While the application of B and N significantly reduced the Na^+ concentration. The K^+ concentration of all cotton genotypes was with increase in salinity as compared to control. Under saline conditions. Addition of B and N against salinity improved K concentration. The Cl^- concentration of cotton genotypes was increased in salinity level and the maximum Cl^- concentration was produced in FH-Lalazar. Application of both N and B decreased Cl^- concentration. The B concentration of cotton genotypes was increased with its application as compared to control. Under saline conditions the maximum B concentration was produced in FH-Lalazar. The minimum B concentration was recorded in FH-114 in salinity level. But interaction of both N and B increase its concentration. The $\text{K}^+ : \text{Na}^+$ ratio of cotton genotypes were decreased in salinity treatment as compared to control. At salinity level the maximum $\text{K}^+ : \text{Na}^+$ ratio was produced in FH-114. The minimum $\text{K}^+ : \text{Na}^+$ ratio was recorded in FH-Lalazar in shoot. Application of B and N against salt stress improved $\text{K}^+ : \text{Na}^+$. So it was concluded that salinity adversely reduced the plant growth while the application of B and N reduced the adverse effect by increasing the K^+ concentration and reducing the Na^+ concentration. Among the two genotypes (FH-114 and FH FH-114) performed better on the basis of more dry matter production and more K^+ and less concentration of Na^+ .

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