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Effect of salinity on germination and seedling growth of five wheat cultivars in hydroponic technique

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Abstract:

A petri dish and a hydroponic experiment were conducted at Plant Physiology Laboratory, Department of Crop Botany, Bangladesh Agricultural University, Mymensingh, during the period from December, 2014 to January, 2015, to investigate the effect of NaCl on germination, morphological characters and growth of wheat seedlings. The experiment comprised of two levels of NaCl concentration viz., 0(control) and 8ds/m and five varieties viz.;Kanchan , BARI Gom-24, BARI Gom-26, BARI Gom-27, BARI Gom-28. The Experiment is laid out in two treatments completely randomized design with three replications. Application of 8ds/m NaCl had a profound influence on hypocotyls and epicotyls length, germination percentage, and root, shoot length and fresh and dry mass production in wheat seedlings. Results indicated that germination percentage, hypocotyls and epicotyls length, root and shoot length, leaf length, plant height, fresh

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and dry mass were influenced by NaCl stress which indicating that some cultivars of wheat seedlings are highly susceptible to concentrated NaCl. However, among tested varieties, BARI Gom-26 showed the best performance considering the seedlings growth, germination percentage. Kanchan and BARI Gom-24 showed the highest sensitivity to NaCl stress in this experiment based on the above parameters studied.

Key words: Hydroponic, Salinity, NaCl Concentration, Germination, Seedling Growth

INTRODUCTION

Wheat *(Triticum aestivum L.)* belongs to the family Gramineae and it is the second largest cereal crop next to rice in Bangladesh. During the year 2013-2014, 1.30 million metric tons of wheat was produced from 0.43million hectares of land with an average yield of 3.033 mt/ha in the country (BBS,2014).

Wheat is also a major staple food crop for more than one-third of the world population and is the main staple food in Asia. It is originated in South Western Asia and has been a major agricultural commodity since prehistoric times. According to the USDA report, in 2014-15 world production of wheat was 726 million tons, making it the second most-produced cereal after corn (996 million tons) and production of rice is 476 million tons. It has more salt tolerance ability than rice. Globally, wheat is the leading source of vegetable protein in human food, having higher protein content than either maize (corn) or rice, the other major cereals. Wheat is grown both as spring and winter crop.

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.

Thepresent population of Bangladesh will progressively increase to 223 million by 2030, requiring 48.0 million tons of food grains (Karim *et al.,* 1990*).* Owing to population pressure, the cultivable area is decreasing day by day, and this problem will gradually but soon be acute.

The wheat research centre of Bangladesh Agricultural Research Institute has released a good number of varieties, which covers the major area of crops. Plant productivity is severely threatened by enhanced salinity. Actually 800 million hectares of land throughout the world are salt-affected, either by salinity (397 million ha) or the associated conditions of sodicity (434 million ha) (FAO, 2005). Therefore, saline soils are those with EC more than $4dSm^{-1}$ equivalent to 40mMNaCI, ESP less than 15% and p^H below 8.5 (Waisel, 1972; Abrol, 1986; Szabolcs, 1994).More than one million hectares of land of Bangladesh is affected by salinity that reduces crop yield (Zeba*et al.* 2005)

Cropping intensity in saline area of Bangladesh is relatively low, ranging from 62 percent in Chittagong coastal region to 114 percent in Patuakhali coastal region compared to 191%, the national average(BBS,2011In wide range of salinity up to $16dSm^{-1}$ wheat could be grown (Karim *et al.,*1990). In Bangladesh as the salinity ranges from $2dSm^{-1}$to $16dSm^{-1}$ wide area can be brought under wheat cultivation during winter 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. The screening of salt tolerant lines/ cultivar has been attempted by many researchers on various species at seedling growth stage. The relation of various seedling growth parameters of seed yield and yield component under conditions are important for the development of salt tolerant cultivar for production under saline condition. With this view in mind the present experiment was conducted to find out the effects of salt stress on the germination, seedling growth and development, and variability in five wheat cultivars of Bangladesh in hydroponic culture.

Considering these facts 5 high yielding wheat varieties such as Kanchan, BARI Gom 24(Prodip), BARI Gom 26(Hashi), BARI Gom27(Francolin) and BARI Gom28 were grown in hydroponic culture under salinity stress to investigate their growth characteristics. The study was carried out to find out the effect of salinity on growth and development of wheat seedlings in hydroponic culture.

MATERIALS AND METHODS

Experimental Laboratory

The Experiment was conducted at the Growth Chamber for Hydroponic Culture, Crop Physiology Laboratory, Department of Crop Botany, Bangladesh Agricultural University, Mymensingh,during the period from December, 2014 to January, 2015.

Planting material

The test crop under investigation was five varieties of wheat cultivated in Bangladesh. The seeds were collected from the Bangladesh Agricultural Research Institute (BARI),Joydevpur, Gazipur, Bangladesh.

Five varieties of wheat are as follows:

1. Kanchan
2. BARI Gom24(Prodip)
3. BARI Gom26(Hashi)
4. BARI Gom27(Francolin)
5. BARI Gom28

Experimental Design

The factorial experiment was laid out in Completely Randomized Design (CRD) with three replications having 2 treatments. Factor A: two levels of salinity viz., 0 dsm^{-1} and 8 dsm^{-1}; Factor B: Varity (5).Thus, the total number of Petri dishes and water tank used in this study were 30(5×2×3). The individual pot size was 8L. The treatments were randomly distributed to the tank. All the experiments were conducted in a growth room at 25°C under a 12h light and 12h dark regime, 70% relativehumidity and p^H 6.5.

Treatments of the Experiment

The experiment was consisted of two treatments comprising NaCI application and control. Each treatment was received equal amount of macro and micro nutrients. NaCI treated water tank were supplied with a concentration of 8 dS/m NaCl.

Application of NaCl and Nutrients

NaCI solution of $8dSm^{-1}$ concentration was sprayed to the seeds on Petri dishes. All other nutrients except NaCl were incorporated to the tank at recommended dose. NaCl solutions of $8dSm^{-1}$ were added to the water into the tank at a 5 days interval.

Sowing of Seeds

Seeds were sown on 29th December, 2014. The seeds were washed and soaked with distilled water and kept in refrigerator for 24 hrs. Fifteen imbibed seeds were placed for germination on filter papers in each Petri dishes containing 100µM $CaCI_2$. Simultaneously 25 germinated seeds were placed in net with water for hydroponic experimental set up containing 100µM $CaC1_2$.

Germination of Seeds

Germination of seeds started from the 2nd days after sowing.

Hydroponic Experimental Set Up

One-week-old seedlings were transferred to continuously aerated nutrient solution in8-L plastic tank on Styrofoam blocks with 4 holes and three plants per hole, supported with sponge. The composition of the nutrient solution was presented below:

Table 1.Nutrient sources and the recommended dose used for the experiment

Sources	Doses
NH_4NO_3	500 µM
$Ca(NO_3)_2$	500µM
$MgSO_4$	200µM
KH_2P0_4	100µM
$FeCl_3$	2µM
H_2B0_3	11 µM
$MnCl_2$	2µM
$ZnCl_2$	0.35µM
$CuCl_2$	0.2µM
$(NH_4)_6Mo_70_4$	0.1 µM

Data Collection

Data on the following characteristics at selected stages (4, 6 and 8 days after sowing) of germinated seeds were collected.

a) Plumule length
b) Radical length
c) Germination percentage

Data on the following physical characteristics at selected stages (10 and 15 days after sowing) of seedlings were collected.

a) Root length
b) Shoot length
c) Leaf length
d) Plant height
e) Fresh weight

f) Dry weight

After collection of data on different growth stages of wheat seedlings, 15 days aged wheat seedling's root and shoot were collected and dried the root and shoot of all selected varieties.
The seedlings were collected and prepared to study the fresh and dry weight.

The weights of 8 fresh seedlings were recorded and the seedlings were placed in an ovenfor 24 hrs at 80±2°C. Then the dry weights were measured using an electrical balance.

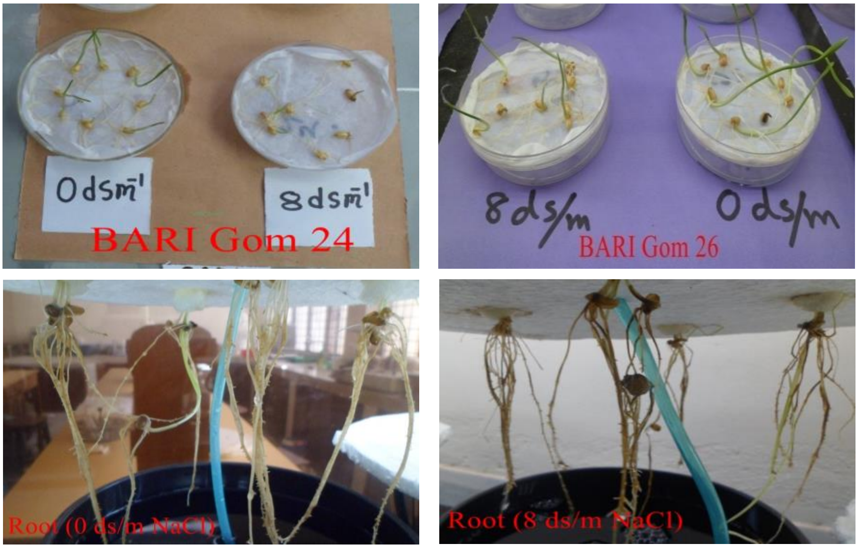

Fig.1: Different Salt Effects on Wheat Seedlings

Statistical Analysis

Data were statistically analyzed for analyses of variance (ANOVA) using the M-STAT Statistical Computer Package Programmer in accordance with the principles ofCompletely Randomized Design. Duncan's Multiple Range Test (DMRT) was used to compare variations among the treatments.

RESULT AND DISCUSSION

Effect of NaCl Levels on Crop Characters of Wheat Grown in Petri Dish

Length of Radical

The effect of NaCl levels and variety on radicle length at 4, 6 and 8 days after sowing was significant (Table 2).That radicle length was greater in control plant than in NaCl treated plants at all growth stages.This result is consistent with Azmi andAlam (1990) who reported that wheat root length decreased under NaC1 stress than control.

The highest radicle length was observed in BARI Gom26 (3.815, 4.92and 5.68cm for 4, 6 and 8 DAS).In contrast, the shortest radicle length was observed in Kanchan .(Table 2).

The interaction effect of variety and NaCl level on radicle length at 4, 6 and 8 DAS was significant (Table 2). The longest radicle length was recorded in the treatment combination of BARI Gom26 at all growth stages (3.93,5.38 and 6.47 cm for 4, 6 and 8 DAS, respectively) followed by BARI Gom27 (3.89, 4.84 and 6.00 cm for 4, 6 and 8 DAS, respectively). On the other hand, the shortest radicle was observed in Kanchan at all growth stages (2.30, 2.73 and 2.92 cm for 4, 6 and 8 DAS, respectively at 8dsm^{-1})

Table 2. Effect of NaCl and varieties on radicle lengths in wheat grow in petridish

NaCl concentration	Variety	Radicle length (cm)		
		4 DAS	6 DAS	8 DAS
0 dsm^{-1}	Kanchan	3.14de	4.13d	4.94de
	BARIGom 24	3.41cd	4.30cd	5.00d
	BARIGom 26	3.93a	5.38a	6.47a
	BARIGom 27	3.89a	4.84b	6.00b
	BARIGom 28	3.60bc	4.47c	5.33c
8 dsm^{-1}	Kanchan	2.30f	2.73h	2.92g
	BARIGom 24	2.97e	3.14g	3.20g
	BARIGom 26	3.70ab	4.46c	4.89de
	BARIGom 27	3.22de	3.92e	4.66e
	BARIGom 28	2.97e	3.60f	3.98f
$LSD_{0.05}$		0.263	0.178	0.299
Level of significance		*	**	*
CV (%)		4.69	2.54	3.73

Means bearing similar letter within a column did not differ significantly and dissimilar letter differed significantly at ≤0.05

Length of Plumule

NaCl had a significant influence on plumule length at 4, 6 and 8DAS in wheat (Table 3.) and Plumule length also varied significantly due to variety at 4, 6 and 8 DAS (Table 3).Results showed that plumules length was higher in control plant than NaCl treated plants at all growth stages. This result is consistent with Azmi and Alam (1990) who reported that wheat shoot length decreased grown in NaCl concentrated solution than control.

The variety BARI Gom26 showed longest plumule followed by BARI Gom 27 at 4, 6 and 8 DAS. However, at 8 DAS, the highest plumule was recorded in BARI Gom 26 (7.385 cm) followed by BARI Gom27 (6.165 cm). The shortest plumule were recorded in Kanchan at most of the growth stages (2.32, 2.74and 4.77cm at 4,6,8DAS respectively).

The interaction effect of variety and NaCl level on plumule length at 4, 6 and 8 DAS was significant (Table 3.). At 8 DAS, the longest plumules were recorded in the treatment combination of BARI Gom26 with Odsm^{-1} (8.00 cm) and the shortest was recorded in Kanchan with 8dsm^{-1}NaCl (4.00 cm).

Table 3. Effect of variety and NaCl concentration on plumule length of wheat grown in petri dish.

NaCl concentration	Variety	Plumule length (cm)		
		4 DAS	6 DAS	8 DAS
0dsm^{-1}	Kanchan	2.91bcd	3.55bc	5.53e
	BARIGom 24	3.03b	3.91ab	6.23cd
	BARIGom 26	3.50a	4.18a	8.00a
	BARIGom 27	3.39a	4.16a	6.33c
	BARIGom 28	3.12b	3.91ab	6.33c
8dsm^{-1}	Kanchan	1.72f	1.94d	4.00h
	BARIGom 24	2.56e	3.13c	4.43g
	BARIGom 26	2.99bc	3.58bc	6.77b
	BARIGom 27	2.81cd	3.38bc	6.00d
	BARIGom 28	2.70de	3.19c	5.00f
$LSD_{0.05}$		0.208	0.496	0.29
Level of significance		**	*	**
CV (%)		4.26	8.36	2.89

Means bearing similar letter within a column did not differ significantly and dissimilar letter differed significantly at ≤0.05

Germination Percentage

The effect of NaCland variety on germination percentage at 2, 4 and 6 days after sowing was significant. Results showed that germination percentage was greater in control plant than in NaCl treated plants at all growth stages. This result is consistent with Haqqani*et al.* (1984) who reported that wheat germination percentage decreased when grown in NaCl concentrated solution than control. This result is also supported by Azmi and Alam.(1990) in wheat.

The highest germination percentage was recorded in the variety BARI Gom26 (93.75%) followed by BARI Gom 27 (87.50%). The lowest germination was recorded in Kanchan (75.00%). Genotypic variations in germination percentage under NaCl stress were also observed by Parasher and V.arma (1992) in wheat.

The interaction effect of variety and NaCl level on germination percentage at 2, 4 and 6 DAS was significant (Fig.2). The highest germination percentage was recorded in the treatment combination of BARI Gom26 with 0dsm^{-1} NaCl at all growth stages (95.83%). The lowest germination percentage was observed in Kanchan and BARI Gom24 with 8dsm-1. BARI Gom 28 showed same result at all growth stage with 8 dsm^{-1}

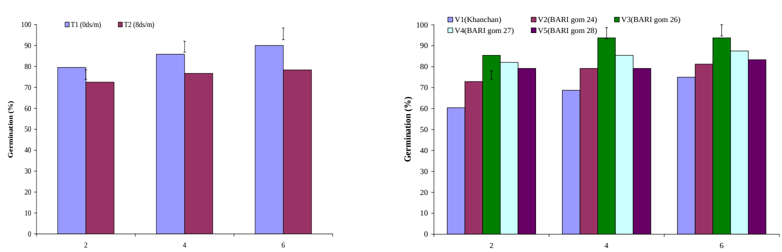

Fig.2. Effect of treatment (A) and varieties (B) on germination percent in wheat grown in petridish. Bar represents at LSD 0.05.

Effect of NaCl Levels on Crop Characters of Wheat Grown in Hydroponic Culture

Root Length

Root length varied significantly due toNaClconcentration and variety at 10 and 15 DAS (Table 4.).Results showed that root length was higher in control plant than NaCl treated plants at both the growth stages. This result is consistent with Ehsan*et al.* (1986) who reported that wheat root length decreased grown in NaCl concentrated solution than control.

Root length varied significantly due to variety at 10 and 15 DAS (Table 4.). The genotype BARI Gom26 showed highest root length both at 10 and 15 DAS (9.83and 11.33cm). The lowest root length was recorded in BARI Gom24 both at 10 and 15 DAS (7.00 and 8.16 cm). Genotypic variation in root length was also observed by Ehsan *et al.* (1986) in wheat that supported the present experimental result.

The interaction effect of variety and NaCl on root length was significant (Table 4.). The highest root length was observed in the treatment combination of BARI Gom26 with Odsm^{-1}NaCl (12.33 cm) and the lowest was recorded in the treatment combination of BARI Gom24 with 8dsm^{-1} NaCl (7.67 cm).

Shoot Length

NaCl and variety had a significant influence on shoot length at 10 and 15 DAS in wheat (Table 4.). Results showed that shoot length was higher in control plant than in NaCl treated plants at 10 and 15 DAS. This result is consistent with Zahid*et al.* (1986) who reported that wheat shoot length decreased grown in NaCl concentrated solution than control.

The variety BARI Gom26 showed the highest shoot length at 10 and 15 DAS (4.17 and 6.00 cm). The lowest shoot length was recorded in BARI Gom24 at 15 DAS (4.67 cm) followed by Kanchan (5.00 cm). Genotypic variations in shoot length were also observed by Ashrafuzzaman*et al.* (2002) in mungbean which supported the present experimental result.

Table4. Combined effect of variety and NaCl concentration on root length and shoot length of wheat grown on hydroponic culture

NaCl concentration	Variety	Root length (cm)		Shoot length (cm)	
		10 DAS	15 DAS	10 DAS	15 DAS
0 dsm^{-1}	Kanchan	8.00d	9.00c	3.83c	5.67c
	BARIGom 24	7.33f	8.66c	3.67d	5.33d
	BARIGom 26	10.00a	12.33a	4.67a	6.67a
	BARIGom 27	9.67b	10.33b	4.00b	6.33b
	BARIGom 28	8.00d	9.33c	4.00b	5.67c
8 dsm^{-1}	Kanchan	7.67e	8.67c	3.00g	4.33g
	BARIGom 24	6.67g	7.67d	2.67h	4.00h
	BARIGom 26	9.67b	10.33b	3.67d	5.33d
	BARIGom 27	9.00c	10.33b	3.33e	4.83e
	BARIGom 28	7.67e	8.67c	3.17f	4.67f
$LSD_{0.05}$		0.22	0.88	0.08	0.15
Level of significance		*	*	**	**
CV (%)		1.54	5.42	1.30	1.70

Means bearing similar letter within a column did not differ significantly and dissimilar letter differed significantly at ≤ 0.05.

The interaction effect of variety and NaCl level on shoot length at 10 and 15 DAS was significant (Table 3.). At 15 DAS, the highest shoot length was recorded in the treatment combination of BARI Gom26 with Odsm^{-1}NaCl (4.00 cm). The lowest shoot length was recorded in BARI Gom24 with 8dsm^{-1} (6 cm).

Leaf Length

The effect of NaCl levels and variety on leaf length at 10 and 15 DAS was significant. Results showed that leaf length was higher in control plant than in NaCl treated plants at 10 and 15 DAS. This result is consistent with Boursier*et al.* (1987) who reported that leaf length decreased grown in NaCl concentrated solution than control.

The leaf length increased with age. The highest leaf length at 10 and 15 DAS was observed in BARI Gom26 (12.17 and 12.66cm for 10 and 15 DAS, respectively). In contrast, the lowest leaf length at 10 and 15 DAS was observed in Kanchan (9.165 cm and 9.835 cm). Genotypic variations in leaf length were also observed by Gupta *et al.* (1989) in wheat that supported the present experimental result.

The interaction effect of variety and NaCl level on leaf length at 15 DAS was significant (Table 5.) 10 DAS was non significant. The longest leaf length was recorded in the treatment combination of BARI Gom26 with 0dsm^{-1} NaCl at 15 DAS (13.33 cm). On the other hand, the shortest leaf length was observed in Kanchan with 8dsm^{-1}NaCl (9.00 cm at 15 DAS)

Table 5. Combined effect of variety and treatment on leaf length on hydroponic culture.

NaCl Concentration	Variety	Leaf length (cm)	
		10 DAS	15 DAS
0dsm^{-1}	Kanchan	10.00	10.67e
	BARIGom 24	11.00	11.67d
	BARIGom 26	12.67	13.33a
	BARIGom 27	12.33	13.00b
	BARIGom 28	11.33	12.00c
8dsm^{-1}	Kanchan	8.330	9.00f
	BARIGom 24	10.00	10.67e
	BARIGom 26	11.67	12.00c
	BARIGom 27	11.00	11.67d
	BARIGom 28	10.33	11.67d
$LSD_{0.05}$		0.62	0.26
Level of significance		NS	**
CV (%)		3.36	1.32

Means bearing similar letter within a column did not differ significantly and dissimilar letter differed significantly at ≤ 0.05

Plant Height

The effect of NaCl levels on plant height at 10 and 15 DAS was significant (Fig.3.). Results showed that plant height was higher in control plant than in NaCl treated plants at 10 and 15 DAS. Gradually decrease in plant height might be due to the decreased nutrients availability caused by increased salinity due to the inhibition of cell division or cell enlargement. Ehsan*et al.* (1986) reported that increasing salinity reduced plant height. Similar results also found by Saod and Ashour (1974) and Chhipa and Lal (1985).

The effect of variety on plant height at 10 and 15 DAS was significant (Fig. 3.). Results showed that plant height increased with age. The highest plant height at 10 and 15 DAS was observed in BARI Gom26 (16.67 and 18.0 cm for 10 and 15 DAS, respectively). In contrast, the lowest plant height 15 DAS was observed in Kanchan (14 cm). These differences were found significant among cultivars, which indicated that the tolerance to salinity varies with cultivars.

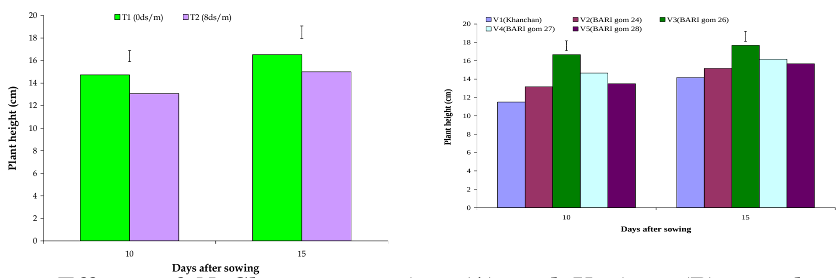

Fig.3. Effects of NaCl concentration (A) and Variety (B) on plant height on hydroponic culture. Bar represents at LSD 0.05.

Fresh Root And Shoot Weight

The effect of NaCl on fresh root and shoot weight per 8 plant was significant. Results showed that fresh weight per 8 plant was greater in control plant than NaCl treated.

The fresh root and shoot weight per 8 plant varied significantly due to variety (Table 6.). The highest fresh root weight was observed in BARI Gom26 (0.57gwtper 8 plants) and highest fresh shoot weight was observed also in BARI Gom26(1.653gwt per 8 plants).In contrast, the lowest fresh weight was observed in Kanchan (0.21gwtper 8 plants and 0.92gwtper 8 plants root and shoot respectively)

The interaction effect of variety and NaCl level on shoot weight per 8 plants was significant (Table 6.). But fresh root per 8 plants was not significant. The highest fresh root and shoot weight per 8 plants was recorded in the treatment combination of BARI Gom26 with 0dsm^{-1}NaCl (0.57gwtper 8 plants and 1.653g wt per 8 plants). On the other hand, the lowest fresh root and shoot weight was observed in Kanchan with 8dsm^{-1}NaCl (0.21g wt per 8 plants and 0.92gwtper 8 plants).

Dry Root and Shoot Weight

There was significant difference between with and without NaCl on dry weight plan^{-8}. (Table 6.).Results showed that dry weight pert 8 plants was greater in control plants than in NaCl treated plants due to increased root and shoot length in 0 dsm^{-1}NaCl than 8 dsm^{-1}NaCl. This result was supported by Ha1im *et al.* (1988) in wheat. Chhipa B P and Lal P (1985) reported the mechanism of NaCl tolerance on the basis of mineral uptake and utilization. They opined that the tolerant cultivars efficiently took up and utilized Ca and P in the presence of a NaCl with less NaCl uptake which stimulated root growth and resulting increased plant growth and development. On the other hand, a susceptible NaCl cultivars exhibited less Ca and P uptake with higher NaCl uptake at higher concentration of NaCl, root growth was strongly inhibited with cellular damage in peripheral root cell resulting less amount of nutrient uptake and exhibited lower growth and development of NaCl susceptible plant and produced lesser amount of dry mass. In the present experiment, the NaCl susceptible variety produced lesser amount of dry mass under higher concentration of NaCl than NaCl tolerant ones.

The effect of variety on dry weight per 8 plants was also significant (Table 6.). The highest dry root was observed in BARI Gom26 (0.049g wt per 8 plants) and highest dry shoot weight was also obserbed in BARI Gom26(0.1767gwtper 8 Plants). In contrast, the lowest dry weight was observed in Kanchan (.022 gwtper 8 plants and .11gwtper 8 plants at dry root and dry shoot respectively) .Genotypic variation in dry weight was also observed by Halim *et al.* (1988) in wheat that supported the present experimental result.

The interaction effect of variety and NaCl level on dry root per 8 plants was significant (Table 6.). And dry shoot weight per 8 plants was not significant. The highest dry weight plant$_{-8}$ was recorded in the treatment combination of BARI Gom26 with 0 dsm^{-1} NaCl (0.049 and 0.1767g wt per 8 plants dry root and dry shoot respectively). On the other hand, the lowest dry weight was observed in Kanchan with 8dsm^{-1}NaCl (.022 g wt per 8 plants and .11g wtplant^{-8}at dry root and dry shoot respectively).

Table 6.: Combined effect of variety and treatment on fresh root weight, fresh shoot weight, dry root weight and dry shoot weight of wheat grown on hydroponic culture

NaCl Con.	Variety	Fresh root weight (g)	Fresh shoot weight (g)	Dry weight of root (g)	Dry weight of Shoot (g)
0dsm^{-1}	Kanchan	0.247	1.10f	0.026f	0.120
	BARIGom 24	0.307	1.30d	0.031de	0.130
	BARIGom 26	0.570	1.65a	0.049a	0.176
	BARIGom 27	0.433	1.55b	0.044b	0.170
	BARIGom 28	0.353	1.39c	0.033cd	0.143
8 dsm^{-1}	Kanchan	0.210	0.92g	0.022g	0.110
	BARIGom 24	0.283	1.22e	0.029e	0.130
	BARIGom 26	0.553	1.60ab	0.042b	0.170
	BARIGom 27	0.416	1.33d	0.035c	0.150
	BARIGom 28	0.330	1.32d	0.032d	0.133
$LSD_{0.05}$		0.016	0.053	0.002	0.016
Level of significance		NS	**	**	NS
CV (%)		2.57	1.37	3.99	6.62

Means bearing similar letter within a column did not differ significantly and dissimilar letter differed significantly at ≤ 0.05

Considering the decrement of dry mass production under NaCl results showed that the decrement of dry mass dueto NaCl toxicity was minimum in BARI Gom26. On the other hand, the maximum decrement in dry massproduction was observed in Kanchan and BARI Gom24 indicating these two genotypes was more susceptible to NaCl toxicity than the other genotypes in wheat.

CONCLUSION

Application of 8dSm^{-1} NaCl had a profound influence on radical and plumule length, germination percentages in wheat. Radical and plumule length and germination percentage decreased under 8 dSm^{-1}NaCl compared to control at 4, 6 and 8 days after sowing indicating 8 dSm^{-1} concentration is toxic to wheat seedlings growth and development.

The effect of variety on radical and plumules length and germination percentage was significant. The highest radical length was observed in BARI Gom 26 (5.68 cm) while the highest plumules length was recorded in BARI Gom 26 (7.385cm). In contrast, the lowest plumule length was observed in Kanchan (4.76 cm) and the lowest radical length was observed in Kanchan.

The interaction effect of radical and plumules length and germination percentage was significant. The highest radical length was observed in the treatment combination of BARI Gom 26 with control at all growth stages while the highest plumules length was observed in the treatment combination of BARI Gom 26 with control. However the lowest radical length was observed in the treatment combination of Kanchan with 8 dSm^{-1}NaCl while the lowest plumules length was observed also in Kanchan with 8 dSm^{-1}NaCl. Again the highest germination percentage was recorded in the treatment combination of BARI Gom 26 with control.

The effect of concentrated NaCl on root and shoot length, root number, leaf length, plant height, fresh and dry weight at 10, 15 DAS was significant but leaf length at 10 DAS and fresh root weight and dry shoot weight was non-significant. The root and shoot length, leaf length, plant height, fresh and dry weight of varieties were greater in control compared to 8 dSm^{-1}NaCl. In genotypes, the highest shoot length was observed in BARI Gom 26 which resulted the highest dry mass plant^{-8} at 10 and15 DAS. In contrast, the lowest fresh and dry weight wasobserved in Kanchan. The interaction effect of variety and NaCl on root and shoot length, root number was significant.

For dry mass reduction due to concentrated NaCl stress, the result showed that the lowest dry mass reduction under NaCl stress in compare to control was observed in BARI Gom-26 indicating the variety is more tolerant to NaCl than others. In contrast, the higher dry mass reduction was observed in BARI Gom 26.

Based on the experimental results, it may be concluded that The NaCl concentration of 8dsm^{-1} had tremendous negative effect on germination percentage, growth and development of wheat seedlings; and Among the varieties, BARI Gom 26 had the highest tolerance to NaCl. toxicity in respect of growth and development.

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