Research Article

Response of Different Concentration of Salt Stress on the Morphological Traits of Maize (*Zea mays*)

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Abstract | The global threat posed by rising soil salinity to agricultural production is serious. The Harmonized World Soil Database is the only database that currently offers data on worldwide soil salinity; however, it has a number of limitations regarding the way soil salinity is measured. A new assessment is therefore required. The present research work was conducted at Botanical Garden, Department of Botany, University of Malakand, Khyber Pakhtunkhwa Pakistan. Different mays verities at morphological level were treated with different salt stress as compared to control environment. After germination, four maize genotypes were evaluated for morphological study. Different concentration (0, 50, 100 and 200) mM NaCl were applied at appropriate stages. Salt stress shows reduction in growth of all mays varieties. Plant height in case of control and treated, the mean value was 31.27, standard error 1.16, coefficient of variance was 26.94, range from Minimum 25 cm and maximum 32 cm, leaf length in control and treated, the mean value was 21.50, standard error 1.74, coefficient of variance was 33.45, range from Minimum8.00cm and maximum 32 cm, leaf width incase control and with salt treated mean value was 0.37, with standard error 0.02, coefficient of variance was 0.00, range from minimum 0.30cm and maximum 0.50, respectively. All varieties were compared under different salt stresses to control condition.

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Keywords | Basmati rice, Planting methods, Yield attributes, Grain yield, Economic analysis

Introduction

The maize (*Zea mays* L.) is one of the most important third cereal crops that are used as a food resource for the people (Rehman *et al*., 2021) and is widely cultivated crop in Pakistan. Mays provides many essential mineral, multiple vitamins B, and is a good fibers source but is lacking in vitamin C, vitamin B12, calcium and iron etc. The occurrence of salinity in unwanted amount in soil which changes plants normal growth and change normal physiological functions. Salinity is one of the most serious abiotic stress factors that decrease crop production. Salinity affects plants. Several techniques have been proposed for improvement of plant performance in saline environments (Munns, 2002). During salinity stress photosynthesis is one of the most effected processes (Safdar *et al*., 2019), in which causes decrease level of chlorophyll and inhibitions that the key photosynthetic enzymes, Rubisco (Yue *et al*., 2019). This process affects plant growth and production. The saline water inhabits development in two aspects. The root's ability to retain water which interrupted by high salt concentration in soil water (Hailu and Mehari, 2021). Plant response to salinity is reflected in morphological, physiological and some other changes. Salinity stresses that result in osmotic stress, ion toxicity, and nutritional imbalances that reduce growth and alter the levels of cell metabolites. Salinity is a major abiotic stress that inhibits plant growth and reduces crop yield. Worldwide the major problems of irrigation are salinity. It is one of the biotic stresses that causes a huge decline in growth and productivity. Worldwide 602 to 832 hectares' area is affected by salinity. Globally about 10% of land area in each year is damaged by salinity (Hassani *et al*., 2020). Pakistan is an agricultural country, which improvements and developments are depending upon agricultural sector. Agriculture of Pakistan is in risk by number of reasons like change in climate, low and high-water stress, and soil salinity. Comparison is according to economic survey (2016-17, 2017-18) of Pakistan; crop production was decreasing around 4.4 percent in a year. The aim of the present study is to investigate different mays genotypes for salt stress as compared to control check, to find out the morphological variation of different traits under salt stress condition, and to figure out salt resistant and susceptible line for future improvement.

Materials and Methods

This study was conducted in Glasshouse, University of Malakand Botanical Garden Herbarium. Improved genotype of mays was collected from the Plant Genetic Resources Institute (PGRI) Islamabad. It was cultivated to apply salt stress to evaluate resistant and susceptible varieties was reported. Four genotype ((LP) Lower polo, (DLW) dir lower white, (DLH) dir upper white and YC Yellow Color) were collected and were sown in the pot in equal proportion of sand. After fifteen days of germination two uniform plants were selected from each pot for further research. Irrigation was given both replications of control and treated plants. The salt stress treatment was given alternatively for 28 days (about 4 weeks). During maturity stage different morphological and physiological traits were studied. Salt tolerance capacity was tested on four-week-old seedlings cultivated in the glasshouse. All pots with tested lines treated for 28 days with 200mM NaCl. Control pots were irrigated with the same amount of water. Survival rates were examined after the treatment and images will be captured to reveal visible phenotypes. Under the control environment, various morphological characteristics of the selected varieties were recorded. For example, Fresh and Dry Weight, Plant Length and Fresh weights of roots and shoots were determined. Plant length is measured by metric scale in centimeters. The shoot and root length will be measured in centimeters at the time of experiment termination by using scales. Roots and shoots separate from each other and weigh them in grams (g) with a digital balance. Then Roots and shoots were dried in oven at 80°C for 72 hours and measure dry weight by digital balance. At each pot, the plant height was measured from the base up to upper tips through meter. The data were analyzed through excel sheet in form replicate and SPSS and Statistica 8.1 software.

Result and Discussion

The present experiment was conducted at Botanical Garden University of Malakand to perform the response of selected genotype under stress of different concentrations of salts. Four different varieties were collected from various locations of Dir lower. The seeds were grown in pots. Four seeds sown in each pot. After that, two plants were selected for further research to investigate the effects salt (NaCl) on morphological characters of mays under the salt stress. At each stage of germination shoot and root length, total plant length was measured and counted. Descriptive statistics for different morphological traits are given the Table 1.

Table 1: *Descriptive statistic for morphological traits.*

Traits	Mean	Standard error	Variance	Minimum	Maximum	CV%
PH	31.27	1.16	14.82	25.00	37.00	26.94
LL	21.50	1.74	33.45	8.00	32.00	12.33
LW	0.37	0.02	0.05	0.30	0.50	19.12
NO.L	3.73	0.24	0.62	2.00	5.00	15.72
RL	5.15	0.47	2.39	3.40	9.00	11.03
NO.R	4.82	0.23	0.56	4.00	6.00	21.29

Plant height

Salinity cause decrease in plant height of all genotypes except LP which show positive response towards salt stress as we increase concentration (0, 50mM, 100mM and 200mM) show little resistance incase LP (32 cm, 26cm, 23 cm), and DLW in case of control (31cm) treatment one (32cm), treatment two 26cm and treatment three 25cm. DLH the control 33cm, treatment one 24, treatment 27 and treatment three 32cm, while in Malakand genotype control 35cm, treatment one 35cm, treatment two 24cm , treatment three 27cm which shown in the table (3.2). Descriptive statistic for plant height incase control and with salt treated mean value was 31.27, with standard error 1.16, coefficient of variance was 26.94, range from Minimum 25cm and maximum 32cm shown in Figure 1, Table 1.

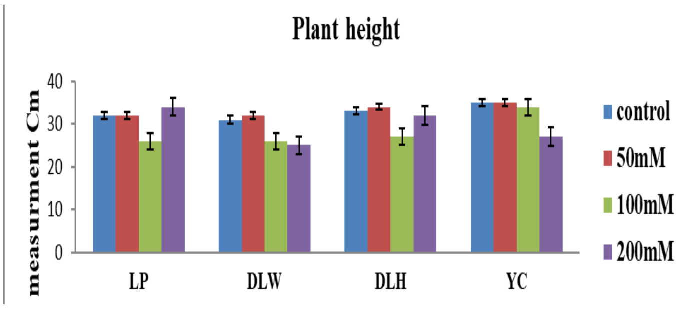

Figure 1: *Graphical representation of plant height of four different regions under control and salt stress.*
LP, Lower polo; DLW, dir lower white; DLH, dir upper white and YC Yellow Color.

Leaf length

Leaf length decrease of all genotypes except LP which show positive response towards salts stress as we increase stress the leaf length shows little resistance incase LP (25.2 cm, 19 cm, 21.9 cm, 19.1cm), and DLW in case of control (31cm) treatment one (30cm), treatment two 32cm and treatment three 27.1cm. DLH the control 25.2cm, treatment one 23cm, treatment two 21cm and treatment three 21cm, while in Malakand genotype control 32cm, treatment one 25cm, treatment two 20cm, treatment three 22cm which shown in the Table 1. Descriptive statistica for leaf length in case control and with salt treated mean value was 21.50, with standard error 1.74, coefficient of variance was 33.45, range from Minimum 8.00cm and maximum 32.00cm shown in Figure 2, Table 1.

Leaf width

Leaf width decrease of all genotypes except LP which show positive response towards salts we increase stress (0, 50mM, 100mM and 200mM) show little resistance incase LP (o.4cm, 0.3cm, 0.4cm, 0.4cm), and DLWin case of control (0.4cm) treatment one (0.4cm), treatment two 0.3cm and treatment three 0.4cm. DLH the control 0.4cm, treatment one 0.4cm, treatment two 0.3cm and treatment three 0.3cm, while in Malakand genotype control 0.5cm, treatment one 0.4cm, treatment two 0.3cm , treatment three 0.4cm which shown in the table (3.4). Descriptive Statistica for leaf width incase control and with salt treated mean value was 0.37, with standard error 0.02, coefficient of variance was 0.00, range from Manimum0.30cm and maximum 0.50 shown in Figure 3, Table 1.

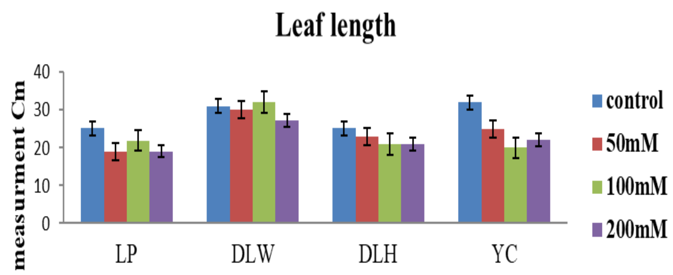

Figure 2: *Graphical representation of leaf length of four different regions under control and salt stress.*

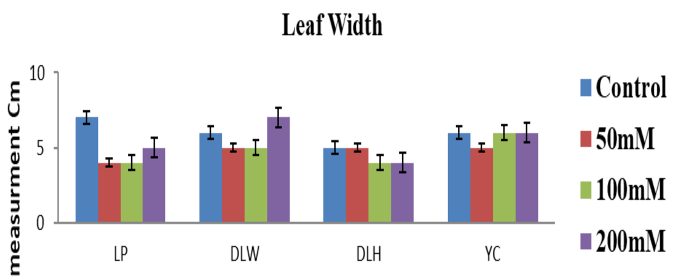

Figure 3: *Graphical representation of Leaf width of four different regions under control and salt stress.*

No of leaves

No of leaves decrease of all genotypes except LP which show positive response towards salts stress we increase stress (0, 50mM, 100mM and 200mM) show little resistance incase LP (3, 2, 4, 3), and DLW in case of control (3) treatment one (4), treatment two 4 and treatment three 3. DLH the control 4, treatment one 4, treatment two 3 and treatment three 5, while in Malakand genotype control 4, treatment one 4, treatment two 4, treatment three 4 which is shown in the Table 1. Descriptive statistica for no of leaves in case control and with salt treated mean value was 3.73, with standard error 0.24, coefficient of variance was 0.62, range from Minimum 2.00cm and maximum 5.00 shown in Figure 4, Table 1.

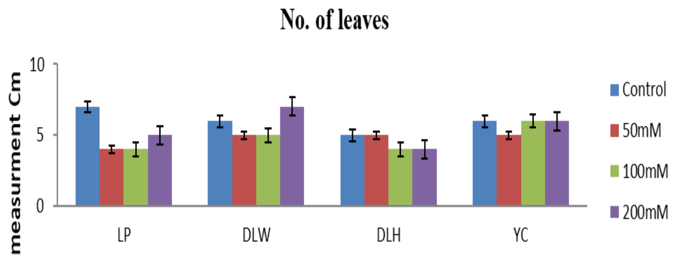

Figure 4: *Graphical representation of number of leaves of four different regions under control and salt stress.*

Root length

In case of root length stress cause decrease of all genotypes except LP which show positive response towards salts stress we increase stress (0, 50mM, 100mM and 200mM) show little resistance incase LP (5.1cm, 3.4cm, 6cm, 5cm) and DLW in case of control (5cm) treatment one (4cm), treatment two 5cm, and treatment three 6cm. DLH the control 4cm, treatment one 9cm, treatment two 4.8cm and treatment three 3.4cm, while in Malakand genotype control 6cm, treatment one 5cm, treatment two 5cm, treatment three 5cm which shown in the Table 1. Descriptive statistica for root length in case control and with salt treated mean value was 5.15, with standard error 0.47, coefficient of variance was 2.39, range from Minimum 3.40cm and maximum 9.00 shown in Figure 5, Table 1.

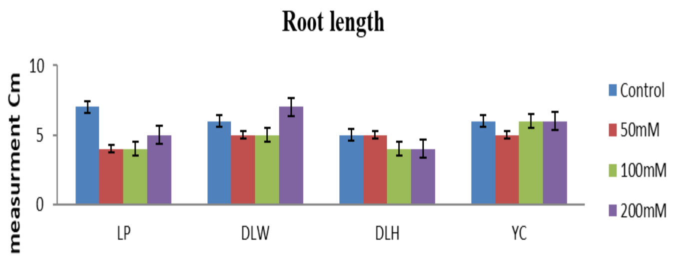

Figure 5: Graphical representation of root length of four different regions under control and salt stress

No of roots

Genotype except LP which show positive response towards salts stress we increase stress (0, 50mM, 100mM and 200mM) show little resistance in case LP (7, 4, 4, 5) and DLW in case of control (6) treatment one (5), treatment two 5, and treatment three 7. DLH the control 5, treatment one 5, treatment two 4, and treatment three 4, while in Malakand genotype control 6, treatment one 5, treatment two 6, treatment three 6, which shown in the Table 1. Descriptive statistica for no of roots in case control and with salt treated mean value was 4.82, with slandered error 0.23, coefficient of variance was 0.56, range from minimum 4.00cm and maximum 6.00 shown in Figure 6, Table 1.

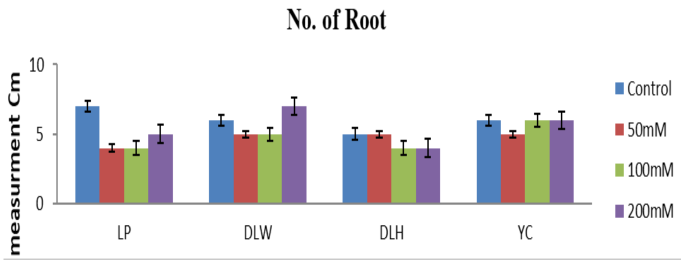

Figure 6: *Graphical representation of number of roots of four different regions under control and salt stress.*

Correlation analysis

Correlation analysis was computed for different morphological traits, leaf length was positive correlate with plant height (0.387), leaf width also strongly positive correlate with plant height (0.676**), no of leaves also strongly positive correlate with plant height (0.490**), root length was positive correlate with plant height (0.278), no of root also positive correlate with plant height (0.226), leaf length was positive correlate with plant height, leaf width also strongly positive correlate with plant height (0.441*), no of leaves also strongly positive correlate with plant height (0.429**), root length was positive correlate with plant height (0.205), no of roots was positive correlate with plant height (0.304), leaf width also positive correlate with plant height (1.000), no of leaves was positive correlate with plant height (0.232). Root length also positive correlate with plant height (0.483), no of root also strongly correlate with plant height (0.506*), no of leaves was positive correlate with plant height, root length also positive correlate with plant height (0.184), no of root also positive correlate with plant height (0.416), root length was positive correlate with plant height, no of root also positive correlate with plant height (-0.164), no of root was positive correlate with plant height (Table 2).

Table 2: *Correlation for morphological traits of mays genotype.*

Traits	PH	LL	LW	NO.L	RL	NO.R
PH	1.000					
LL	0.387	1.000				
LW	0.676**	0.441*	1.000			
NO.L	0.490**	0.429**	0.232	1.000		
RL	0.278	0.205	0.483	0.184	1.000	
NO.R	0.226	0.304	0.506*	0.416	-0.164	1.000

The current experiments were done to determine the effects of salt stress on mays varieties. Because *Zea mays* is a major grain legume crop, which is third in importance after soybeans and peanuts (Sofi, 2018). The mays grain contains a high amount of protein, so it was grown and eaten as food legume. Different strategies of crop rotation have been used to adopt the salt stress and failure the expected economic loss of important crops (Oerke *et al*., 2012). In the present study the effect of salinity was tested in mays genotype. For this purpose, four verities of mays were collected from Malakand Division named (DLH, DLW, YC and LP). Seed was sown in plastic pots and different salt stresses were applied on seedling of mays. The different morphological parameters of the selected varieties were documented, i.e., dry weight, leaves width, root length, leaves length and plant height, affected by salinity. Similarly, salt stresses effects developmental process such as seed germination, growth, flowering and fruit (Abdel-Farid *et al*., 2021).The ability of plants growth is directly proportional to the moisture the of soil (Biglouei *et al*., 2010; Kataria and Verma, 2018). Salt stress cause a clear decrease of all genotypes except LP which show clear positive response toward salinity as we increase stress (0, 50mM, 100mM and 200mM) the LP height show little resistanceincase LP (32cm, 32cm, 30.1cm, 30), and DLr in case of control (31cm) treatment one (32cm), treatment two 26cm and treatment three 25cm. DLH the control 33cm, treatment one 30, treatment 27 and treatment three 32cm, while in Malakand genotype control 35cm, treatment one 35cm, treatment two 30cm, treatment three 27cm same result was investigate reported plant height values 92.6 to 101.3 cm, correspondingly, in their study. Descriptive statistica for leaf length incase control and with salt treated mean value was 21.50, with standard error 1.74, coefficient of variance was 33.45, range from minimum 8.00cm and maximum 32.00cm, no of roots incase control and with salt treated mean value was 4.82, with slandered error 0.23, coefficient of variance was 0.56, range from minimum 4.00cm and maximum 6.00, Salt stress cause a clear decrease of all verities except LP which show clear positive response toward salinity as we increase stress the leaf lengthshow little resistance incase LP (25.2cm, 19cm, 21.9cm, 19.1cm), and DL in case of control (31cm) treatment one (30cm), treatment two 32cm and treatment three 27.1cm. DLH control 25.2cm, treatment one 23cm, treatment two 21cm and treatment three 21cm, while in Malakand genotype control 32cm, treatment one 25cm, treatment two 20cm, treatment three 22cm. Correlation was done for morphological traits leaf length was positive correlate with plant height (0.387), leaf width also strongly positive correlate with plant height (0.676**), no of leaves also strongly positive correlate with plant height (0.490**),root length was positive correlate with plant height (0.278), no of root also positive correlate with plant height (0.226), leaf length was positive correlate with plant height (1.000), leaf width also strongly positive correlate with plant height (0.441*), no of leaves also strongly positive correlate with plant height (0.429**), Abiotic stress tolerance has been observed by cultivars capacity to sustained chlorophyll contents in leaves (Kiani *et al*., 2014).

Conclusions and Recommendations

The results of this study showed that there was a considerable difference between the high-yielding genotype DLH and the low-yielding genotype YC in their response to salinity, being the most differential factor that might be due to some phenolic compounds that have shown antioxidant response through preventing the oxidative damage as the high-yielding genotype DLH shows better protection with an increased chlorophyll, proline, protein, and hydrogen peroxide under salinity.

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Novelty Statement

Novelty of this research is to identify salt resistant genotype in maize genotype. This kind of research was not carried out before in the study area.

Author's Contribution

Arshad Khan: Result collection and field work, objective and title configuration.
Mohammad Ihsan: Result calibration with software's.
Ali Hazrat: Discussion calibration with result.
Gul Rahim: Helped in collection of data from the field.
Maryam Bibi: References designing according to the journal standard.
Fazl Ullah: Review of literature.

Komail Khan: Overall compilation of the paper

Conflict of interest

The authors have declared no conflict of interest.

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