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EFFECT OF DIFFERENT LEVELS OF SALT STRESS ON GROWTH AND YIELD OF WHEAT (*Triticum aestivum* L.) IN THE GARO HILLS OF MEGHALAYA

Mandaroi Langiar[1] and K. Dujeshwer[2]

ABSTRACT

A pot experiment was carried out to see the agronomic performance of wheat (*Triticum aestivum* L.) under different levels of salt stress, at the Instructional farm, Dept. of Rural Development and Agricultural Production, North-Eastern Hill University, Tura campus during *rabi* season of 2024. Wheat cultivar HD3369 was tested. Three levels of salt stress were induced by applying with irrigation water *viz.*, irrigation with 0.5%, 1.5% and 2.5% salt solution along with control. Results of the experiment reveals that growth attributes *i.e.* germination, plant height, tillers, dry weight and yield attributes *i.e.* spike length, number of grain spike^{-1} and test weight was significantly reduced by applying increased level of salt stress (1.5% and 2.5%). Grain yield reduction of 94.76% and 83.80% and straw yield reduction of 90.38% and 71.90% was observed under 1.5% and 2.5% levels of salt stress, respectively. Control and 0.5% level of salt stress performed superior in growth attributes, yield attributes and yield of wheat under Garo Hills condition of Meghalaya.

(Key words: Salinity, stress, wheat, growth, yield)

INTRODUCTION

Wheat (*Triticum aestivum* L.) is among most important and essential staple food-crop worldwide, particularly in India. Wheat is a crucial element of food security in India, it is a livelihood for millions of farmers and an important dietary requirement in almost every household (Ahmad *et al.*, 2023; Kaur *et al.*, 2023). Wheat accounting for 32.90 per cent with 117.95 MT production for the nation s total food grain production (2024-25). As of 2024-25, India ranks as the second-largest wheat producer accounting for roughly 14% of global output (Chaubey, 2025). In India, approximately 6.73 million hectares are affected by salt stress, representing nearly 75% of the saline and sodic soils found in the country. Estimates reported that current extent of salt-affected soils, which is 6.73 million hectares, may nearly triple to reach 20 million hectares by the year 2050 (Sharma *et al.*, 2014). Salinity problems in northeastern India are specific and mainly linked to natural and agricultural conditions. The region sees significant rainfall, which typically prevents widespread salinity issues (Choudhury *et al.*, 2016). However, in certain low-lying regions, waterlogging and inadequate drainage lead to the salt accumulation in the soil. This is particularly evident in river basins prone to flooding and in agricultural areas with poor irrigation practices (Dagar *et al.*, 2016). Soil salinity is a global concern. In India, salt stress poses a significant challenge to crop production. Elevated levels of salt adversely impact plant growth (Mer *et al.*, 2000). The increase in salinity decreased the tillers number and leaf area while raising the concentrations of sodium (Na^+) and chloride (Cl^-) in the leaves (Munns and Termaat, 1986). Ghane *et al.*, (2009) demonstrated that elevating the salinity of irrigation water from EC 4 to 12 dSm^{-1} led to the reduction in grain yield and overall productivity of wheat. Keeping in view to the above facts, the pot experiment was conducted to investigate the different concentrations of salt stress in wheat under a pot experiment with an objective to see the effect on agronomic parameter (growth and yield) under salt stress of wheat in the Garo Hills of Meghalaya.

MATERIALS AND METHODS

A pot experiment was carried out at the RDAP farm of the Instructional farm, Dept. of Rural Development and Agricultural Production, NEHU Tura campus during *rabi* season of 2024. The experiment was set up with Completely Randomized Design (CRD) replicated five times. The experiment utilized the wheat variety known as Pusa wheat, referred as HD3369 developed by the ICAR research station in Indore and known for its yield potential. The pots were filled with dried soil+ vermicompost at 1:1 ratio. Ten seeds of variety HD3369 were sown in each pot on November 5, 2024. About 5-7 cm of spacing between plant to plant was maintained. After sowing, all the pots were placed in open areas and exposed to sunlight. The salinity treatments were implemented right after the seeds were sown, followed by

1. P.G. Scholar, Dept. Rural Development and Agricultural Production, North-Eastern Hill University, Tura campus, Meghalaya, India- 794002
2. Asst. Professor, Dept. Rural Development and Agricultural Production, North-Eastern Hill University, Tura campus, Meghalaya, India- 794002 (Corresponding author)

additional applications every 15 days. Three distinct levels of salinity were tested, including a control group, achieved by incorporating specific quantities of commercial NaCl into the soil of each pot as a solution dissolved in water. The treatment level consisted of T_1 (Control), T_2 (Irrigation with 0.5 % salt solution), T_3 (Irrigation with 1.5 % salt solution), and T_4 (Irrigation with 2.5 % salt solution). To guarantee an even distribution, the salts were dissolved in a water solution before being added to the pots for accurate salinity application. The observation on germination was recorded at 7 days after sowing (DAS), plant height (cm) and number of tillers were recorded at maximum growth stage (at 90 DAS). Dry weight (g plant^{-1}), length of spike (cm), number of grains spike^{-1}, seed yield plant^{-1} (g), straw yield plant^{-1} (g) and test weight (g) were recorded at harvest stage. Harvest index (HI) serve as the indicator of proportion of economic yield (grain) from total biomass yield. HI (%) was calculated using following formula-

$$\text{Harvest index (\%)} = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

The data were statistically analyzed to compare the means 5% significance level using ANOVA of CRD experimental design suggested by Gomez and Gomez (1984). All the significant treatments were compared by critical difference (CD) values, and significant treatment differences were identified using Duncan s multiple range test (DMRT) (Duncan, 1955).

RESULTS AND DISCUSSION

Effect of salt stress on growth of wheat

The results showed that the salinity stress had a significantly influence on germination of wheat (Table 1). Increased salt concentration had adverse effect on germination. Treatment T_1 (control) recorded the maximum germination count and was statistically comparable to T_2 (Irrigation with 0.5 % salt solution) and T_3 (Irrigation with 1.5 % salt solution). The significantly lowest germination was recorded under treatment T_4 that was irrigation with 2.5% salt solution. The reduction in seed germination may be attributed to hormonal imbalances between abscisic acid (ABA) and gibberellic acid (GA) induced by elevated salinity levels. Increased ABA concentrations under saline conditions promote seed dormancy, leading to poor germination (Gholizadeh *et al.*, 2021). Additionally, salinity suppresses seed germination by imposing osmotic stress that restricts water uptake and by inducing ionic toxicity (El-Hendawy *et al.*, 2019). Plant height, tiller number plant^{-1}, and dry weight plant^{-1} were significantly reduced under higher salt stress, while the maximum plant height and dry weight were observed in T_2 (Irrigation with 0.5 % salt solution) followed by T_1 (control) and lowest was recorded under T_4 (Irrigation with 2.5 % salt solution). Significantly highest tillers plant^{-1} were found in T_1 followed by T_2. Higher level of salinity >1.5% salt solution applied in T_3 (Irrigation with 1.5 % salt solution) and T_4 (Irrigation with 2.5 % salt solution) failed to produce tillers. The adverse effects of salt stress on growth attributes are primarily due to disturbances in efficient nutrient and water absorption. Plant suffers from less nutrient and water caused restriction in cell division, such condition resulting in poor development of shoot length, tiller formation and biomass production (Mwando *et al.*, 2020).

Effect of salt stress on yield attributes of wheat

Salt stress has caused significant reduction in yield attributing parameters in wheat (Table 2). Results revealed that significantly lowest length of spike, number of grains spike^{-1} and test weight was recorded with 2.5% salt concentration (T_4), while all these parameters were found maximum with least salt stresses treatments T_1 (control) and T_2 (Irrigation with 0.5 % salt solution). Salinity can directly or indirectly suppress cell division and cell enlargement, leading to reduced shoot length, fewer leaves, lower dry matter accumulation, smaller leaf area, and impaired translocation of assimilates from source to sink, along with an increased rootshoot ratio. These effects ultimately influence plant growth and yield attributes through ionic toxicity and osmotic stress (Kumar *et al.*, 2012; El Sabagh *et al.*, 2021).

Effect of salt stress on yield attributes of wheat

Wheat yield under salt stress has caused significant reduction in seed and straw yield (Table 3). Treatment T_4 (Irrigation with 2.5% salt solution) recorded significant yield reduction in seed yield by 94.76% and straw yield by 90.38% over best performing treatment T_2 (Irrigation with 0.5% salt solution), while treatment T_3 (Irrigation with 1.5% salt solution) reported reduction in seed yield by 83.80% and straw yield by 71.90% over treatment T_2. Similarly, maximum harvest index was recorded and found comparable with treatment T_1 (control) and T_2 (Irrigation with 0.5 % salt solution) over T_3 (Irrigation with 1.5 % salt solution) and T_4 (Irrigation with 2.5 % salt solution). Salinity stress impairs photosynthetic efficiency, limits biomass production, and disrupts sourcesink relationships, thereby accelerating the senescence of reproductive organs and adversely affecting yield-determining factors (Khataar *et al.*, 2018). In wheat, salt stress hastens shoot apex development while reducing the formation of spikelet primordia, leading to an earlier onset of the terminal spikelet stage and anthesis. These changes result in fewer spikes and kernels per spike, ultimately diminishing the crop s yield potential (Maas and Grieve, 1990).

Salt stress has showed significantly adverse effect germination, growth attributes and yield attributes and yield of wheat under Garo hills condition of Meghalaya. Increased level of salt caused more detrimental effect in growth and yield, while a limited salt concentration (0.5%) favors the seed and straw yield over no salt application (control). Effect salinity stress was significant in all observations taken in the experiment.

Table 1. Effect of different concentrations of salt stress on growth attributes of wheat

Treatments	No. of germination at 7 DAS	Plant height (cm) at 90 DAS	No. of tillers plant^{-1} at 90 DAS	Dry wt. (g) plant^{-1} at harvest
T_1: Control	8.7a	62.9b	2.5a	3.04b
T_2: Irrigation with 0.5 % salt solution	7.3a	72.1a	1.1b	5.19a
T_3: Irrigation with 1.5 % salt solution	7.0a	54.7c	0.0c	1.24c
T_4: Irrigation with 2.5 % salt solution	2.6b	38.7d	0.0c	0.43d
SEm±	**0.81**	**2.14**	**0.11**	**0.28**
CD (0.05)	**2.43**	**6.42**	**0.33**	**0.84**

Means followed by same letter are not significantly different while different letters indicate significant differences (p< 0.05) under Duncan s multiple range test, NS= Not significant

Table 2. Effect of different concentrations of salt stress on yield attributes of wheat

Treatments	Length of spike (cm)	No. of grain spike^{-1}	Test weight (g)
T_1: Control	14.4a	34.1b	4.83a
T_2: Irrigation with 0.5 % salt solution	14.3a	55.9a	4.32a
T_3: Irrigation with 1.5 % salt solution	12.1b	20.7c	1.64b
T_4: Irrigation with 2.5 % salt solution	9.0c	9.7d	1.43b
SEm±	**0.44**	**4.31**	**0.35**
CD (0.05)	**1.32**	**12.93**	**1.05**

Means followed by same letter are not significantly different while different letters indicate significant differences (p< 0.05) under Duncan s multiple range test, NS= Not significant

Table 3 Effect of different concentrations of salt stress on yield of wheat

Treatments	Seed yield (g plant^{-1})	Straw yield (g plant^{-1})	Harvest index (%)
T_1: Control	1.63b	1.52b	51.8a
T_2: Irrigation with 0.5 % salt solution	2.10a	2.60a	44.9a
T_3: Irrigation with 1.5 % salt solution	0.34c	0.73c	31.0b
T_4: Irrigation with 2.5 % salt solution	0.11c	0.25c	32.0b
SEm±	**0.11**	**0.17**	**4.33**
CD (0.05)	**0.33**	**0.51**	**12.99**

Means followed by same letter are not significantly different while different letters indicate significant differences (p< 0.05) under Duncan s multiple range test, NS= Not significant

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