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Research Article

Growth, Yield and Nutrient Performance of Salinity Tolerant Sunflower (cv. BARI Surjomukhi 2) Cultivar on Soils with Different Salinity Levels

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Abstract

Salinity indeed is a great barrier for crop production. An experiment was carried growth, yield and nutrient performance of a salinity tolerant sunflower cultivar on soils with different salinity levels**.** Salinity's impact on seed germination and vigour exponent were studied. Pot experiment was done with sunflower on different salinity levels (0.55; 2.80; 3.55; 5.05; 6.95; 8.35; and 11.25 dSm^{-1}) were created by using NaCl following CRD with 3 replications. Diverse agronomic parameters and chemical parameters were analyzed. The highest plant height (146.0±3.2 cm) was observed at 0.55 dSm^{-1} and the lowest (80.3±4.8 cm) was observed in 11.25 dSm^{-1}. The greatest amount of seeds pot^{-1}(300.0 ±4.619) was observed in 3.55 dSm^{-1} and least number of seeds pot^{-1} (170.0 ±2.887) was recorded in 11.25 dSm^{-1}. The most seed yield (19.80 ±0.1299 t ha^{-1}) was recorded in 3.55 dSm^{-1} and the least (6.3 ±0.1299 t ha^{-1}) in 11.25 dSm^{-1} soil salinity level. The superior K content in shoot (2.540 ±0.02309%) was observed in 0.55 dSm^{-1} and the inferior K contents (1.190±0.005774%) was recorded in 11.25 dSm^{-1}. The maximum Na contents (2.960 ±0.03464 %) was observed in 11.25 dSm^{-1} and the minimum Na contents (0.5800 ±0.01155%) was observed in 0.55 dSm^{-1} soil salinity level. The effects of salinity on all agronomic parameters were significant. All the chemical parameters show statistically significant on different salinity levels. The seed yield of sunflower growing on different salinity levels can be produced considerable seed yield up to 8.35 dSm^{-1}.

Keywords

Salinity, CRD, Growth, Yield and Nutrient

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1. Introduction

In Bangladesh, sunflower is a relatively latterly exhibited crop for oil seed [1]. Because it's substantial amount of polyunsaturated fatty acids and 0 cholesterol. Sunflowers are grown all throughout the world and are particularly popular in regions with salty soils such as India and China. Sodium chloride salinity has harmed a huge percentage of Bangladesh's coastal area and southern areas [2]. During the Rabi season, when cropland is left fallow, this spot could be seeded with the salinity tolerant species. That would be useful for both our nation and our farmers if any sunflower cultivars were released as salinity resistant is vital to enhance manufacturing oil seeds in our nation to be able to alleviate the oil seed issue shortages.

The rapid growth of the people on the planet and large proportion of agricultural grains are grown on low-quality soils that are sometimes salinized [3] The salinity of soil is rising problem around the globe, and it drastically decreases agricultural productivity, in particular in areas where irrigating is necessary [4]. In dry and arid parts of globe, salt stress presents a severe risk to agricultural productivity due to scarcity of rain and inadequate water and soil control approaches. [5]. Global agriculture output is severely affected by high soil and irrigation water salinity (sodium chloride) [6, 7]. Just 10% of Bangladesh is lower than one meter beneath average sea level, and marine departures affect one-third of the country [1, 2].

Photosynthesis is the main driver that determines growth of plants and output. It is evident that stomata and non-stomata duties are restricted in salt stress, leading to decreased transpiration, net CO_2 absorption, and water consumption performance [8]. The beginning of germination is signaled by elements encircling the embryo by the radicle appearing. The primary elements for salt stress are branch and root width since roots are situated directly contact the earth and draw moisture from it, while shoots distribute it to the remaining plant parts. Thus, the reaction of a plant to salt stress can be inferred a great deal from the length of its roots and shoots [9]. High salt levels can prevent root and shoot expansion because it reduces the plant's capacity for utilizing water [10]. Abnormal saplings can arise from metabolic and molecular issues caused by salt hatred, which can hinder or postpone germination. The consequences of salinity on plants include osmotic impacts, specific-ion toxicities, and dietary dysfunctions. [11, 12]. It not only affects the morphology of plants but also alters their metabolisms by inhibiting their growth.

2. Resources and Techniques

2.1. Trial Location and Material

The trial was carried out at the Postgraduate laboratories and the net home of the Department of Agricultural Chemistry at BAU, during the period July 2023 to June 2024. The test crop under investigation was used for assessing the salinity-tolerance of a sunflower cultivar. The Sunflower (cv. BARI Surjamukhi 2) seeds were collected from (BARI), Gazipur

2.2. Investigational and Pilot Approaches Techniques

The following nine salinity levels were established by adding different dosages of sodium chloride to soils to evaluate the growth performance of salt-tolerant and moderately plants that can withstand salt on soils with diverse salinity equality. For each treatment, three replications were employed. The study was conducted with a completely random design (CRD). There are 7 treatment with expected salinity levels (dSm^{-1}) such as; T_0 =0 (control), T_2 = 2 (dSm^{-1}), T_2 = 2 (dSm^{-1}), T_4 = 4 (dSm^{-1}), T_6 =6 (dSm^{-1}), T_8 = 8 (dSm^{-1}), T_{10} = 10 (dSm^{-1}), T_{12} = 12 (dSm^{-1}).

2.3. Collection of Data

Data collection was recorded germination percentage, vigor index, plant height (cm), root length (cm), shoot length (cm), fresh weight (g), dry weight (g), stem diameter (cm), diameter of pod (cm), number of seeds pod^{-1} and 1000 seeds weight (g) were measured [26]. To calculate the dry mass (g) produced, the final weights of the root and stem were recorded. With the use of the proper screens and a flame release spectrophotometer (Jenway PEP-7), the amounts of sodium and potassium in each specimen were separated. Calcium and magnesium content was determined by the complicated metric titration technique with completing agent Na2-EDTA [13]. Finally, the concentration of sulphur for an unknown test solution was calculated from the standard curve [14].

2.4. Analytical Statistics

Statistics were used to analyze the data. The three replicates' means ± standard error of the mean (SEM) were used to convey the findings. To ascertain the degree of significance, a t-test was employed, and using MSTAT-C computer package program in various characters was used to fit the graph.

3. Results and Discussions

3.1. Effect of Salinity on Seed Germination of Sunflower

The result shows the increment of seed germination percentage of sunflower with the days after seed sowing nonetheless, there was little variation in the germination % of sunflower at varying salt levels (Figures 1, 2). Moreover, the highest germination percentage (90%) was observed at lowest salinity treatment 0 dSm^{-1} and the lowest germination percentage (63.33%) was observed at the utmost salinity treatment 20 dSm^{-1}. However, a reduction in sunflower seed germination was observed at 16 dSm^{-1} and 20 dSm^{-1} salinity level [12] also found that Hysun-33 attained maximum germination at a salinity index of 1.15 dSm-1 for the whole of the period of testing, with the exception of the 30th day of germination, or from the 10th day (100%) to the 25th day (97%) of germination.

Figure 1. *Seed germination of sunflower (cv. BARI Surjomukhi 2) at 9 days after seed sowing on diverse salinity equality 0, 4, 8, 12, 16 and 20 dSm^{-1}.*

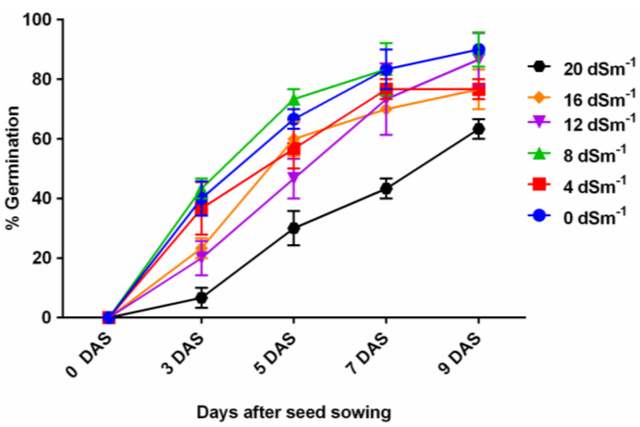


Figure 2. *Seed germination of sunflower at different days after seed sowing on diverse salinity equality 0, 4, 8, 12, 16 and 20 dSm^{-1}.*

3.2. Impact of Salinity on Seedlings Vigor Exponent of Sunflower

The indicator of seedling vigor statistically significant variation was observed. In major findings from a Tukey's one-way ANOVA multiple comparisons test decline of seedlings vigour index in elevated soil salinity equality in comparison with control treatment. (Figure 3). Comparing treatment groups (12 dSm^{-1}, 16 dSm^{-1} and 20 $dSm^{-1}$to control groups (0 dSm^{-1}), 4 dSm^{-1} and 8 dSm^{-1} The length of the sunflower's roots and shoots was significantly decreased, especially at 14.1 dSm^{-1} NaCl. At all salt levels, the expansion of sunflower shoots were more impacted than growth of roots. At every salinity treatment, the weight of the fresh shoots and roots was likewise significantly impacted. Similar results were also observed by [9].

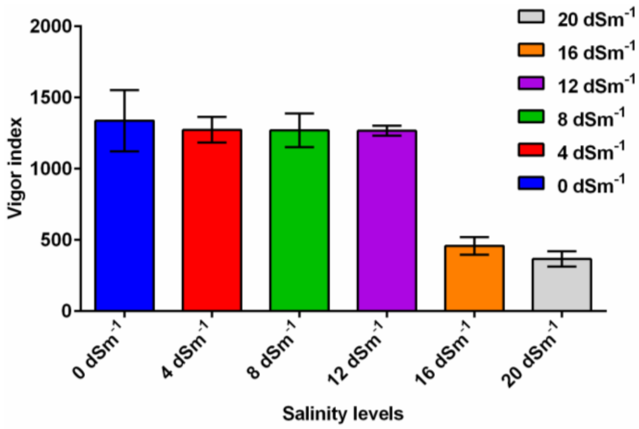


Figure 3. *Impacts of salinity on seed vigor index of sunflower at diverse level of salinity.*

3.3. Impacts of Salinity on Plant Height of Sunflower

The plant heights of sunflower growing on soils with different salinity levels were recorded at 7, 14, 21, 28, 35, 42, 49, 60, 70 and 105 days after seed sowing (DAS) and 28 DAS showed significant decline of plant height due to increased soil salinity levels from 2.80 dSm^{1} towards. (Figures 4, 5, 6) At 105 DAS, the highest plant height of sunflower (146.0±3.2 cm) was recorded at 0.55 dSm^{-1} soil salinity level and the lowest plant height (80.3±4.8 cm) was observed at 11.25 dSm^{-1} soil salinity level. This result is evaluated the impression of salt stress on the number of leaves, diameter of stem, height, and concentrations of inorganic and organic the substance; also, it dramatically decreased the cultivar's susceptibility to salt stress [15, 16].

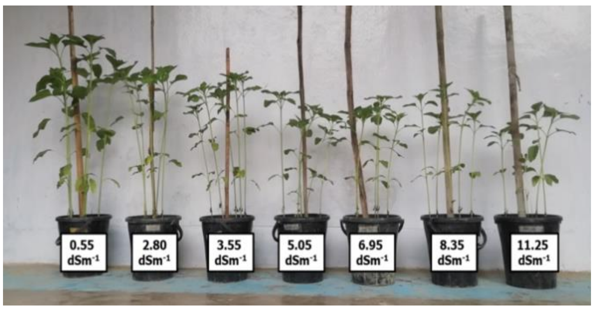


Figure 4. *Sunflower (cv. BARI Surjomukhi 2) growing on soils with different salinity equality (0.55 dSm^{-1}; 2.80 dSm^{-1}; 3.55 dSm^{-1}; 5.05 dSm^{-1}; 6.95 dSm^{-1}; 8.35 dSm^{-1}; and 11.25 dSm^{-1}) at 28 DAS.*

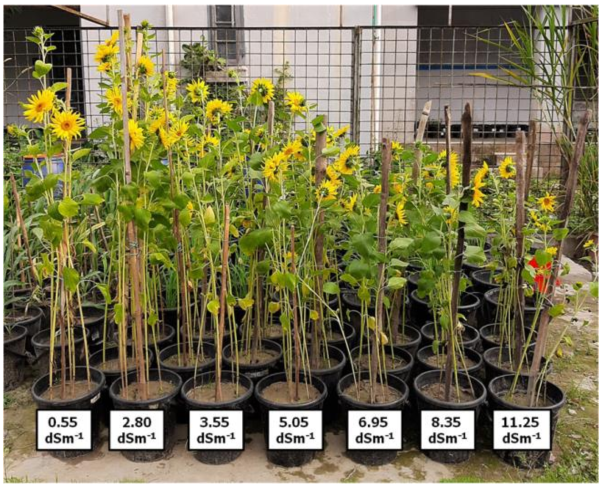


Figure 5. *Sunflower (cv. BARI Surjomukhi 2) growing on soils with different salinity equality (0.55 dSm*$^{-1}$*; 2.80 dSm*$^{-1}$*; 3.55 dSm*$^{-1}$*; 5.05 dSm*$^{-1}$*; 6.95 dSm*$^{-1}$*; 8.35 dSm*$^{-1}$*; and 11.25 dSm*$^{-1}$*) at 70 DAS.*

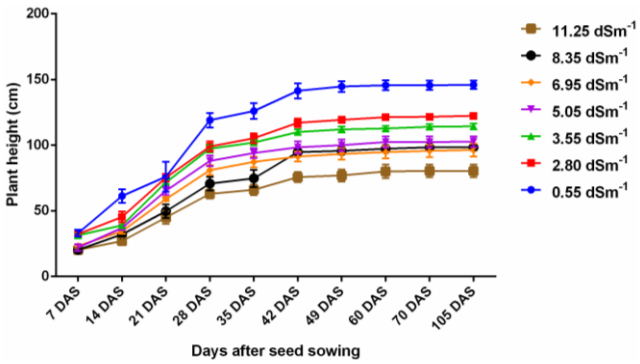


Figure 6. *Plant height of sunflower growing on soils with diverse salinity equality (0.55 dSm*$^{-1}$*; 2.80 dSm*$^{-1}$*; 3.55 dSm*$^{-1}$*; 5.05 dSm*$^{-1}$*; 6.95 dSm*$^{-1}$*; 8.35 dSm*$^{-1}$*; and 11.25 dSm*$^{-1}$*) at different DAS.*

3.4. Impacts of Salt on Sunflower Length of the Roots and Shoots

The maximum shoot and length of root sunflower (117.7±5.457 cm) was noticed at 0.55 dSm^{-1} soil salinity equality and the minimum shoot length (70.47±2.64 cm) was noticed at 11.25 dSm^{-1} soil salinity level. Conversely, the longest root length of sunflower (15.80±2.163 cm) was recorded at 2.80 dSm^{-1} soil salinity level and the lowest root length (9.017±0.8448 cm) was noticed at 11.25 dSm^{-1} soil salinity equality. (Figure 4) This result is in conformity with [17] who observed that different hybrid responded differentially and significant reduction in plant length was executed with increasing the level of salinity found several genotypes of sunflowers experienced a decrease in shoot and root length due to salt stress. (Figure 7)

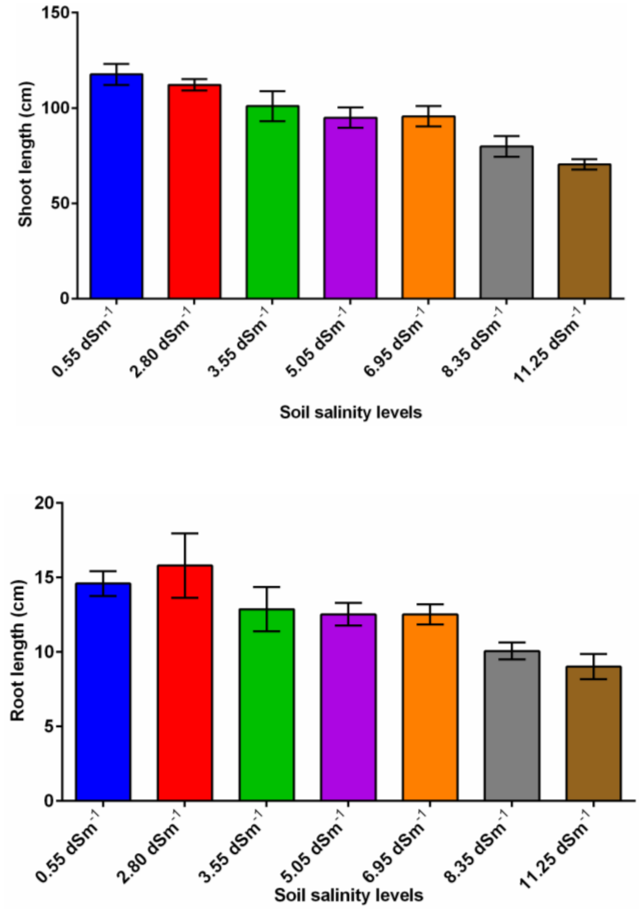


Figure 7. *Impact of diverse salinity level on shoot and root length of sunflower.*

3.5. Impact of Salinity on Shoot and Head Diameter of Sunflower

In respect shoot and head diameter of sunflower statistically significant variation was observed the treatment. (Figure 5). The maximum shoot diameter of sunflower (5.760±0.4545 mm) was noticed at 0.55 dSm^{-1} soil salinity equality and the minimum shoot diameter (3.403±0.1120 mm) was recorded at 11.25 dSm^{-1} soil salinity equality On the other hand in respect head diameter of sunflower statistically significant variation was noticed the treatment. The maximum head diameter of sunflower (6.533±0.8511 cm) was observed at 0.55 dSm^{-1} soil salinity equality and the minimum head diameter (3.027±0.6670 cm) was observed at 11.25 dSm^{-1} soil salinity equality [12, 27] Similar results have been found in this research where like other parameters diameter of stem decrease with the increase of soil salinity and Hysun 33 showed best performance among the 6 varieties in all salinity equality. (Figure 8)

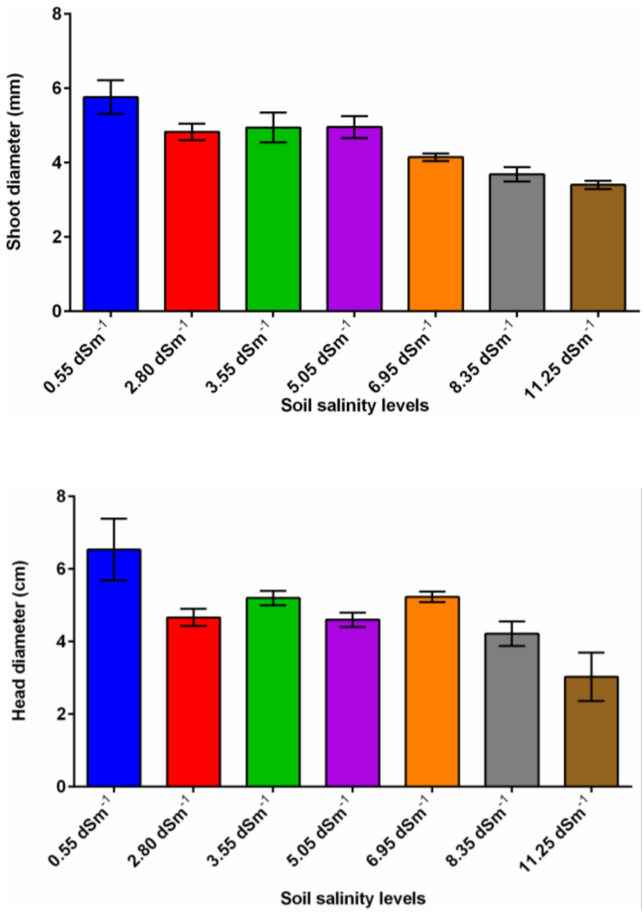


Figure 8. Impact of different salinity level on shoot and head diameter of sunflower.

3.6. Salinity's Impact on Sunflower Seed Pot-1 Quantity

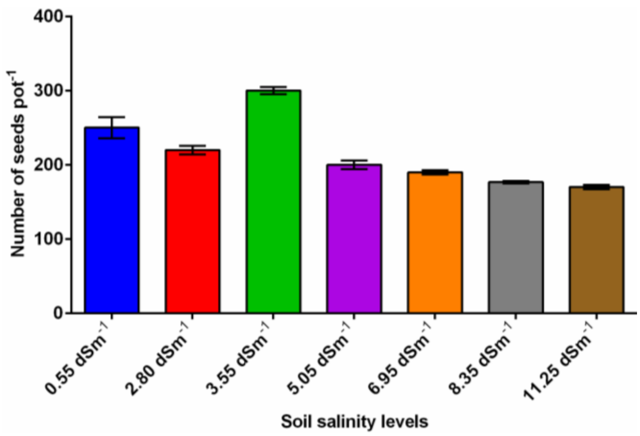


Figure 9. Impact of different salinity levels on amount of seeds pot^{-1} of sunflower.

The quantity of sunflower seeds (pot-1) growing on soils with different salinity levels (0.55 dSm^{-1}; 2.80 dSm^{-1}; 3.55 dSm^{-1}; 5.05 dSm^{-1}; 6.95 dSm^{-1}; 8.35 dSm^{-1}; and 11.25 dSm^{-1}) were recorded after harvesting showed significant decline of number of seeds pot^{-1} due to increased soil salinity levels from 3.55 dSm^{-1} onwards. The maximum number of seeds pot^{-1} of sunflower (300.0±4.619) was noticed at 3.55 dSm^{-1} soil salinity level and the minimum number of seeds pot^{-1} (170.0±2.887) was observed at 11.25 dSm^{-1} soil salinity level. (Figure 9)

3.7. Impact of Salt on the Weight (g) of Sunflower Seeds in a Pot

The maximum seed weight (g) pot^{-1} of sunflower (cv. BARI Surjomukhi 2) (88.00±0.5774g) was noticed at 3.55 dSm^{-1} soil salinity level and the minimum seed weight (g) pot^{-1} (28.00±0.5774g) was recorded at 11.25 dSm^{-1} soil salinity level [18, 26] examined the effects of salty water irrigation on sunflower development and yield.

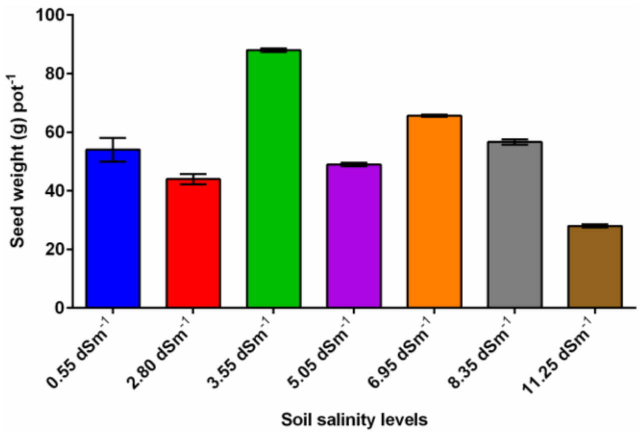


Figure 10. Impact of diverde salinity levels on seed weight pot^{-1} of sunflower.

3.8. Salinity's Impact on the Weight of a Thousand Sunflower Seeds

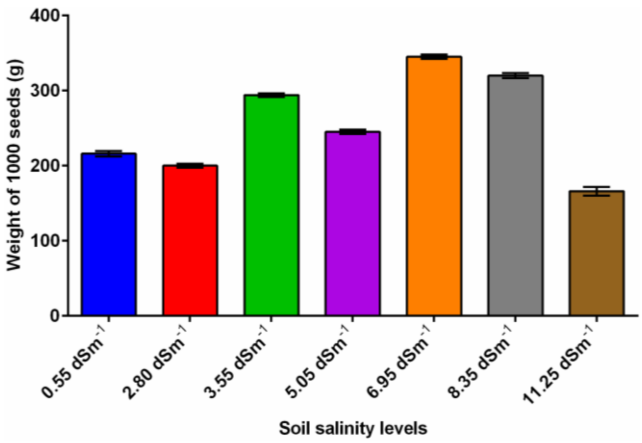


Figure 11. Impact of different salinity levels on weight of one thousand sunflower seeds.

The maximum weight of one thousand sunflower seeds (345.0±2.887g) was noticed at 6.95 dSm^{-1} soil salinity level and the minimum weight of 1000 seeds (166.0±5.774) was observed at 11.25 dSm^{-1} soil salinity level. This result was similar to [19]. Hysun-33 fared well in saline soils but poorly in non-saline soils when it came to seed yield head^{-1}. KUSL-1 achieved the optimum yield of seeds head^{-1} in non-saline soil (Figure 11).

3.9. Impact of Salinity on Sunflower Seed Yield

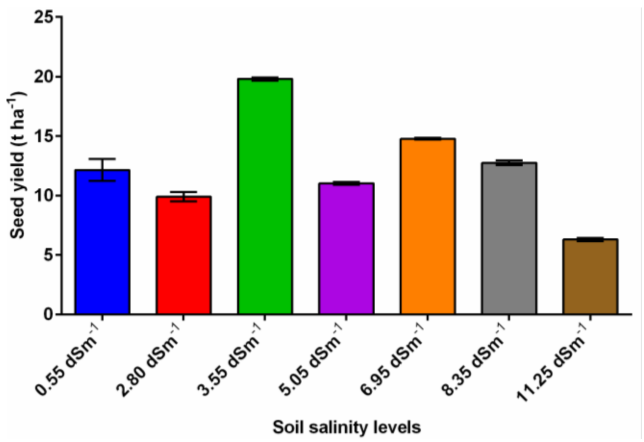


Figure 12. *Impact of diverse salinity levels on seed weight pot^{-1} of sunflower.*

The seed yield (t ha^{-1}) of sunflower (growing on soils with different salinity levels (0.55 dSm^{-1}; 2.80 dSm^{-1}; 3.55 dSm^{-1}; 5.05 dSm^{-1}; 6.95 dSm^{-1}; 8.35 dSm^{-1}; and 11.25 dSm^{-1}) were recorded after harvesting showed significant decline of seed weight (g) pot^{-1} due to increased soil salinity levels from 3.55 dSm^{-1} onwards (Figure 12). The maximum seed yield of sunflower (19.80±0.1299 t ha^{-1}) was noticed at 3.55 dSm^{-1} soil salinity level and the minimum seed yield (6.3±0.1299 t ha^{-1}) was observed at 11.25 dSm^{-1} soil salinity level. As salt levels increased, plant seed output fell off dramatically [20]. Salinity and reactions with nutrients decreased agricultural output by 20% on average dependent on the salinity and salt content [15].

3.10. Salinity's Impact on the Amount of Phosphorus (P) in Sunflower Roots and Shoots

The amount of P in a sunflower shoot were recorded after harvesting showed significant increase of P contents occurs due to increased soil salinity levels from 3.55 dSm^{-1} upto 8.35 dSm^{-1} and then declined (Figure 13). The maximum P contents in shoot of sunflower (0.0690±0.0005773%) was noticed at 3.55 dSm^{-1} soil salinity level and the minimum P content (0.0200±0.001155%) was observed at 11.25 dSm^{-1} soil salinity level. The maximum phosphorus contents in shoot of sunflower (0.0870±0.0005773 %) was noticed at 3.55 dSm^{-1} soil salinity level. The minimum P content (0.0180±0.001732 %) was observed at 2.80 dSm^{-1} soil salinity level. This result was confirmed by [21] to Phosphate applied exogenously can mitigate the negative impacts of salt stress on sunflower.

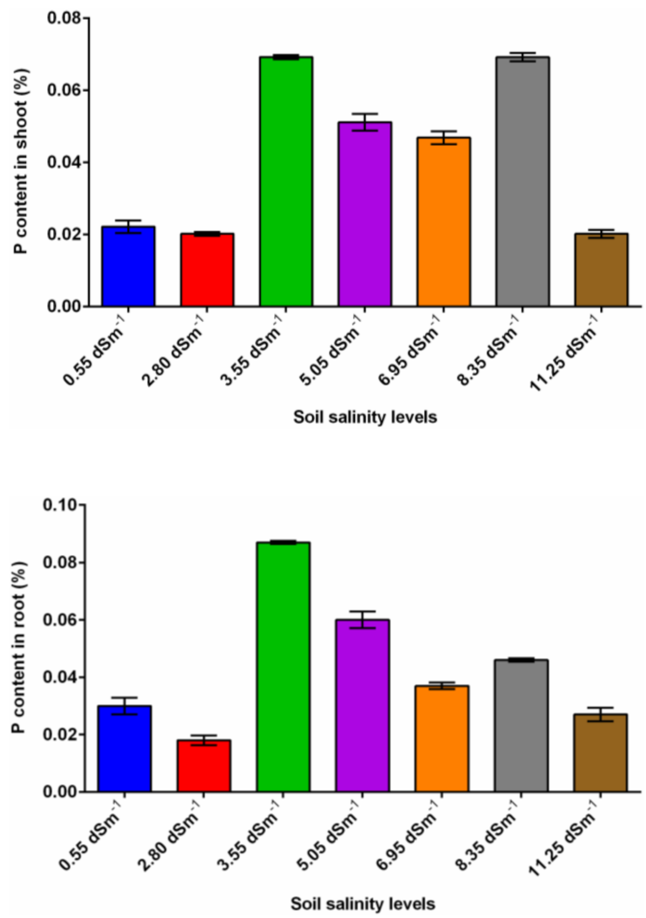


Figure 13. *Impact of diverse salinity levels on phosphorus uptake in shoot and root of sunflower.*

3.11. Impact of Salinity on the Potassium (K) Concentrations in Sunflower Roots and Shoots

The K value of a sunflower shoot after harvesting showed significant decline of K contents occurs due to increased soil salinity levels (Figure 14). The maximum K content in shoot of sunflower (2.540±0.02309%) was noticed at 0.55 dSm^{-1} soil salinity level and the minimum potassium contents (1.190±0.005774%) was recorded at 11.25 dSm^{-1} soil salinity level. On the other hand the utmost potassium contents in root of sunflower (0.9700±0.01155%) was noticed at 0.55 dSm^{-1} soil salinity level and the least potassium contents (0.2000±0.01155%) was noticed at 8.35 dSm^{-1} soil salinity level. Increased Na^+ buildup in the plant tissues inhibits the uptake of K^+, a necessary plant macronutrient.

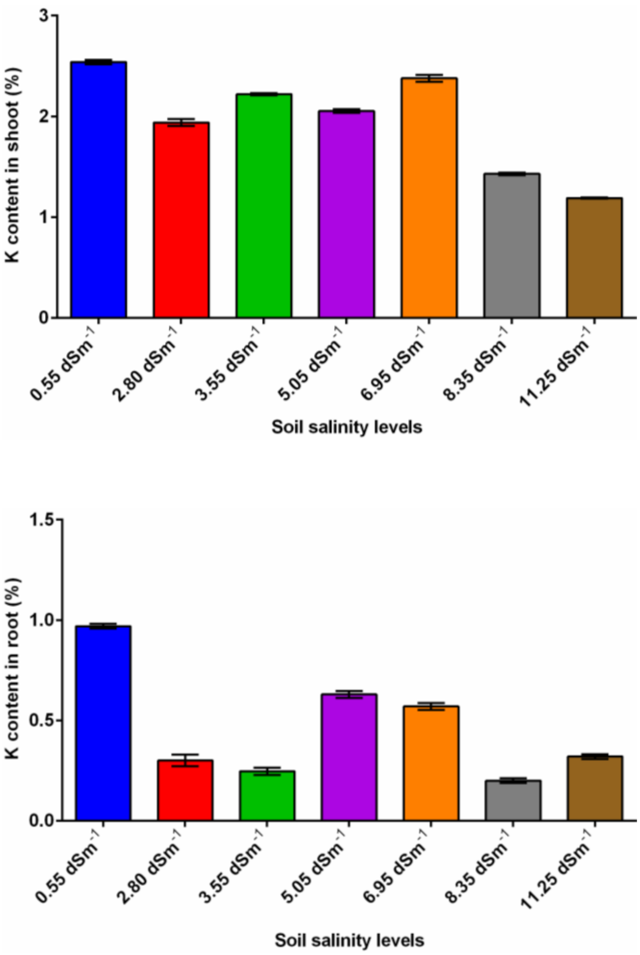
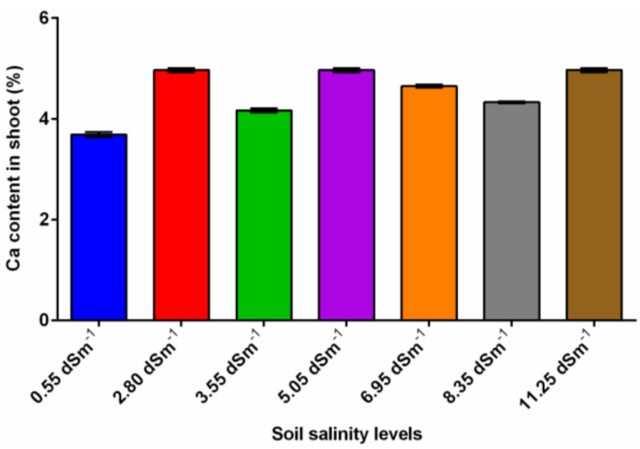


Figure 14. *Impact of varying saline levels on potassium concentrations in sunflower roots and shoots.*

3.12. Salinity's Impact on the Amount of Calcium (Ca) in Sunflower Roots and Shoots



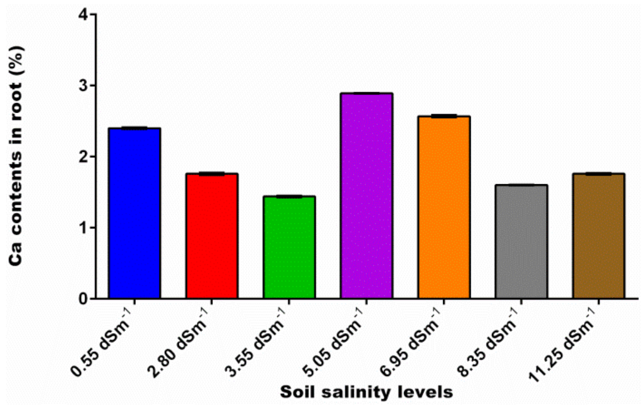
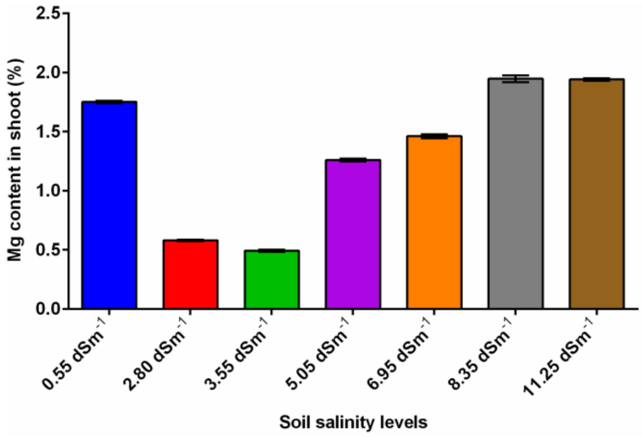


Figure 15. *Impact of diverse salinity levels on calcium contents in shoot and root by sunflower.*

The amount of calcium in a sunflower shoot growing on soils with different salinity levels were recorded after harvesting showed significant increasing of Ca contents occurs due to increased soil salinity levels from 0.55 dSm^{-1} onward. (Figure 15). The maximum Ca contents in shoot of sunflower (4.970±0.01155%) was noticed at 11.25 dSm^{-1} soil salinity level and the minimum Ca contents (3.690±0.01732%) was recorded at 0.55 dSm^{-1} soil salinity level. On the other hand the maximum Ca contents in root of sunflower (2.890±0.005773 %) was observed at 5.05 dSm^{-1} soil salinity level and the minimum Ca contents (1.600 ±0.005773 %) was noticed at 8.35 dSm^{-1} soil salinity level. Comparable outcomes were observed in [22] on a line of sunflower that was salt-sensitive and salt-tolerant to different levels of calcium in saline sand culture.

3.13. Effect of Salinity on Magnesium (Mg) Substances Found in a Sunflower's Root and Shoot



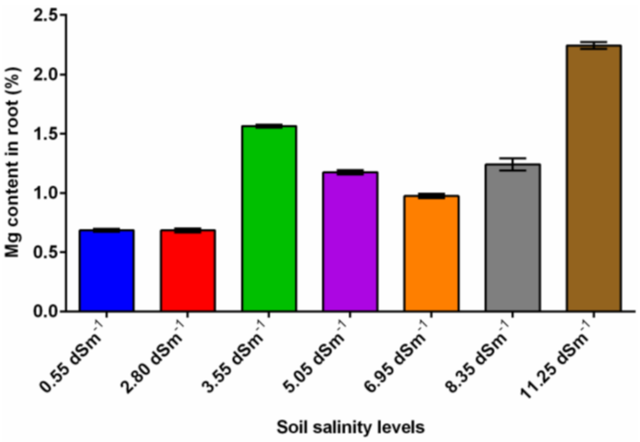
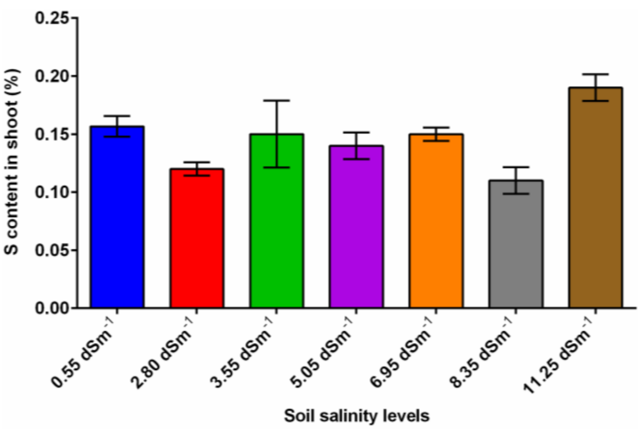


Figure 16. *Impact of diverse salinity levels on magnesium contents in shoot and root of sunflower.*

The Mg object in shoot and root of sunflower growing on soils with different salinity levels were recorded after harvesting showed significant increasing of Mg contents occurs due to increased soil salinity levels from 0.55 dSm^{-1} onwards (Figure 16). The maximum Mg contents in shoot of sunflower (1.947±0.02906%) was noticed at 8.35 dSm^{-1} soil salinity level and the minimum Mg contents (0.4933±0.008819%) was recorded at 3.55 dSm^{-1} soil salinity level. Conversely, though the superior Mg contents in shoot of sunflower (2.240±0.02887%) was noticed at 11.25dSm^{-1} soil salinity level and the inferior Mg contents (0.6800±0.01155%) was recorded at 0.55 dSm^{-1} soil salinity level. Salinity and magnesium levels have an impact on the development and physiological response of hydroponically grown sunflowers [23].

3.14. Impact of Salinity on the Amounts of Sulfur (S) in Sunflower Roots and Shoots



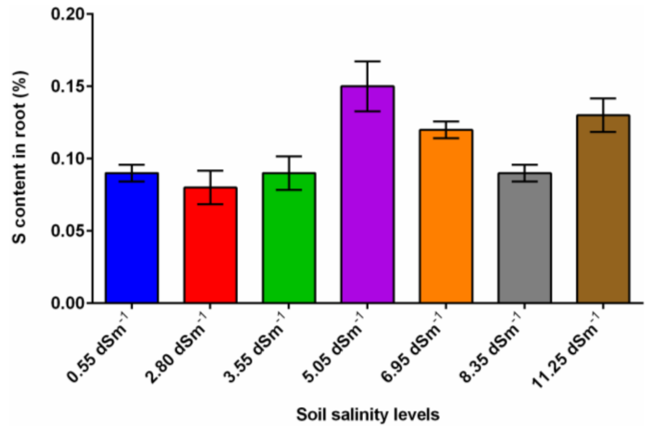
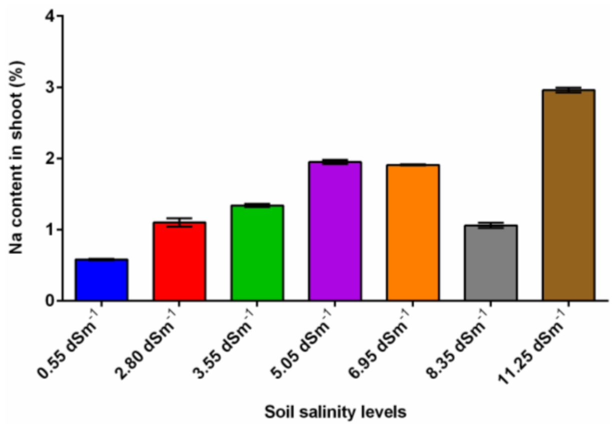


Figure 17. *Impact of diverse salinity levels on sulfur contents in shoot and root of sunflower.*

The S contents in shoot and root of sunflower growing on soils with different salinity levels were recorded after harvesting after harvesting showed significant decline of S contents occurs due to increased soil salinity levels from 11.25 dSm^{-1} onwards (Figure 17). The maximum S contents in shoot of sunflower (0.1900±0.01155 %) was observed at 8.35dSm^{-1} soil salinity level and the minimum S contents (0. 0.1100±0.01155 %) was noticed at 8.35 dSm^{-1} soil salinity level. However, the most S contents in shoot of sunflower (0.1300±0.01155 %) was noticed at 11.25dSm^{-1} soil salinity level and the least S contents (0.0900±0.005774 %) was observed at 0.55 dSm^{-1} soil salinity level. This result is similar to [24] of sulfur for under saline conditions

3.15. Impact of Salinity Sodium (Na) Substances Found in a Sunflower's Root and Shoot



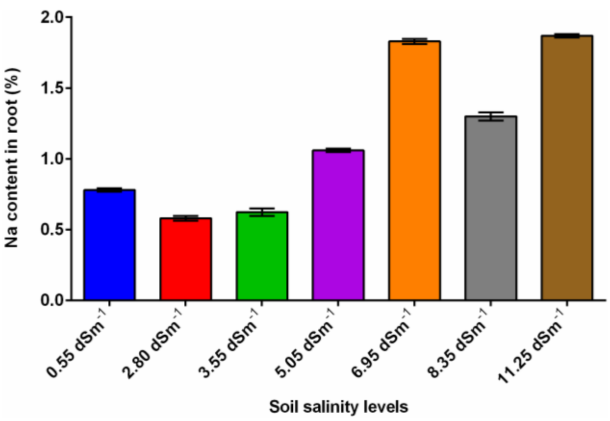


Figure 18. *Impact of various salinity levels on salt levels in sunflower shoots and roots.*

The amount of Na present in the sunflower's root and shoot growing on soils with different salinity levels were recorded after harvesting showed significant increase of Na contents occurs due to increased soil salinity levels from 0.55 dSm^{-1} onwards (Figure 18). The maximum Na contents of sunflower (2.960±0.03464 %) was noticed at 11.25 dSm^{-1} soil salinity level and the minimum Na contents (0.5800±0.01155%) was recorded at 0.55 dSm^{-1} soil salinity level. On the other hand the maximum Na contents in root of sunflower(1.870±0.01155%) was observed at 11.25 dSm^{-1} soil salinity level and the minimum Na contents (0.5800±0.01732%) was observed at 2.80 dSm^{-1} soil salinity level. Similar significant differences in salt tolerance have been observed by [25] for sunflower genotypes (FS1, FS2, and FS5) using 40, 80, and 120 mM NaCl.

4. Conclusion

Based on the conversation above it can be resolved that that significant variation remain due to the growth, yield and nutrient performance of a salinity tolerant sunflower cultivar on soils with different salinity levels. The current investigation revealed that there was no discernible variance was noticed among the germination percentage of sunflower at different levels of salinity and Significant decline of seedlings vigor index in elevated soil salinity level. Moreover all the Agronomic parameter and chemical analysis was significant variation of the salinity level.

5. Recommendations

It might be encouraged to conduct more research to repeat experiments in other locations are necessary to establish a recommendation for different area and soil for successful sunflower cultivation in Bangladesh.

Abbreviations

CRD	Completely Randomized Design
BAU	Bangladesh Agricultural University
BARI	Bangladesh Agricultural Research Institute

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Conflicts of interest

The authors declare no conflicts of interest.

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