# Salt Tolerance of Two Potato Cultivars

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**Abstract**

*Potato (Solanum tuberosum L.) is one of the leading crop plants used for food production globally. The varieties that are presently grown are greatly hampered productively by increased salinity. The repercussion of salinity stress on productivity of potato plant was assessed using Shangi and Unica varieties sourced from KALRO Tigoni. Potato tubers were grown in 4L polybags packed with coco peat media and kept under greenhouse conditions. A two-factorial experiment in CRD was used with factors being cultivar and treatments of salt concentrations. Twenty-one days after emergence, plants were subjected twice in seven days to six different treatments of salinity levels (0, 6, 8, 10, 12,14dS/m) of NaCl in solution form prepared. Measurements of height 30 days after start of salt application, tuber weight and number at harvest were recorded. At 0dS/m, the two varieties performed optimally. Salt concentration significantly affected cultivars performance in height, weight of tubers and number of tubers. Both shangi and Unica demonstrated better performance at between 6-8 dS/m with less yield decrease than the other salt concentration. At 10dS/m, Unica's performance was better as opposed to Shangi that was adversely affected by the salts though Shangi's performance decreased at a higher rate with increase in salt. (Table 3). The tubers had the highest weight at 6 dS/m concentration while Unica species produced tubers with the highest weight. (16g). Unica therefore performed better than Shangi indicating that it's more tolerant to salinity than Unica. This research was meant to identify a salt tolerant potato cultivar between Shangi and Unica which can be used for breeding for salt tolerant varieties. It was thus found that Unica is salt tolerant as had been found in other previous studies. Unica therefore is recommended for planting by farmers who cultivate in fields affected by high salinity incidences. In addition, Unica genes are recommended to breeders who can use them for breeding purposes to breed for salt tolerant cultivars.*

**Keywords:** Salinity, Salinity stress in potato, Salt tolerance, Salinity levels, Potato breeding.

## INTRODUCTION

Productivity in agriculture world over is under threat because of the challenges related to soil salinization (Chaves et al., 2006). Plant growth and proliferation in dry lands and other parts of the globe are majorly hampered by salinization that is occasioned by extra salts in the soil or irrigation water. Salinization affects 33% of the globe's arable land, 7% of the entire world land mass including half of the irrigated land (Zhu, 2001).

Salinized soils can be categorized into four, depending on the electrical conductivity of the extract (Ece) from the water drenched soil that is, slightly saline (Ece 2-4 dS/m), moderately saline (Ece 4-8 dS/m), highly saline (Ece 8-16dS/m), while extremely saline (Ece>16 dS/m) (Richards et al., 1954). Normally, saline soils are categorized as one with Ece value of ≥ 4dS/m or 40mmol/L of NaCl.

Ionic imbalance, osmotic stress, specific ion toxicity are some the greatest ramifications of salinity stress on plant growth and development (Munns, 2002) including molecular disorders (Munns, Tester, 2008). Salt stress inhibits cell turgor plus it strains rates of root and foliage elongation (Fricke et al., 2006) thus meaning that environmental saltiness affects majorly osmosis. In addition, ability of plants to soak up, carry and use nutrients needed for growth and development is transformed by increased salt accumulation with soil solution (Parida; DAS, 2005; Feijao et al., 2011). Furthermore, nutritional imbalance occasioned by salt stress majorly is because of decrease in take up together with utilization of important nutrients by plants for instance N, K, Ca (Zhu, 2001).

Different growth stages of potato are affected variedly by salinity. One of the most significant growth stages that determines plant vigour and tuber production in potatoes is the emergence. Thus, more brininess strain tolerance enhances crop initiation as well as potato productivity in saline soils.

Tuber growth is tarried, growth plus arid matter yield decreased when salinity increases. Furthermore, tuber number and weight are reduced per plant (Ghosh et al., 2001). Ordinarily, salinity stress in crops is hinged on concentration, time of exposure to the salt, genetic make-up of the crop plus environmental features.

Potato (*Solanum tuberosum* L.) is one of the most significant plant the world over with tuber productivity in present varieties highly hindered by increased salinity. Worldwide, potato farming is practiced in irrigated lands thus, bound to grow in salinity states because of insufficient irrigation control as well as application of salty water. This study focuses on the examination of the effects of salt stress on productivity of two potato cultivars (Shangi and Unica) under greenhouse conditions.

## MATERIALS AND METHODS

The experiment was conducted in a greenhouse at KALRO Tigoni 1’080S, 36’400E and altitude of 2100m above sea level. Sprouted shangi and unica tubers sourced from Kenya Agricultural and Livestock Organization (KALRO) were planted in 4l polybags filled with coco peat soil. The experiment was a factorial with two factors; cultivars and salt concentration. Two potato varieties (unica and shangi) were subjected to six different salt concentrations (0, 6, 8,10,12,14) $dSm^{-1}$ after 21days from emergence with ten replications. Salt was dissolved to make the different salt concentrations then the plants were irrigated twice a week with saline water. Treatments were applied 21 days after planting. (after complete emergence).

Data on plant height (cm) was measured 30 days after start of treatment application, tuber number and tuber weight(g) were also taken at harvest. Analysis of the data was done using stata version 14.2. The analysis done were descriptive and inferential analysis. Descriptive statistics generated were summary statistics while the inferential analysis conducted were two-way analysis of variance (ANOVA) and Post Hoc tests after anova. The post hoc tests were done using Tukey-Kramer pairwise comparisons test. The Tukey-Kramer was preferred since the replications were unbalanced. The tests were at 5% significance level. Multiple mean comparison was further done using Genstart version 2013.

## RESULTS AND DISCUSSION

Potato plants react variedly when subjected to diverse quantities of saltiness with plant characteristics remarkably impacted (table 1, 2). The result showed that plant height reduced with increase in saltiness. At 0 dS/m level of saltiness, the height of the plants varied significantly from those at 6-14 dS/m. Potatoes grown at 0dS/m have significantly more height. Similarly, potatoes grown in 6 dS/m salinity concentration have significantly greater height than those at 12 dS/m concentration. Furthermore, potatoes at 6 dS/m does better than those at 14 dS/m. Also, potatoes grown at 8 dS/m performed better than those at 14 dS/m salt concentration. Generally, potatoes at 0dS/m concentration have the greatest height (table 1). The results showed that both shangi and unica potato varieties performed better at between 6-8 dS/m salt concentration (Table 1).

**Table 1: Showing Means by Treatment**

| Treatment | Height | Tuber Weight | Tuber Number |
|---|---|---|---|
| 0 dsm | 119.55 | 15.628 | 6.3 |
| 10 dsm | 90 | 16.2635 | 3 |
| 12 dsm | 79.2 | 5.907273 | 2.8 |
| 14 dsm | 67.15 | 3.638421 | 2.25 |
| 6 dsm | 109.1111 | 16.805 | 5.6 |
| 8 dsm | 103.2105 | 12.704 | 3.55 |
| Total | 94.42241 | 11.79421 | 3.916667 |

Nevertheless, the performance of Shangi at 8 dS/m was slightly more inhibited compared to unica. This implied that Unica is more tolerant to salinity than Shangi (table 2). Increased salt amount plus lesser plant height demonstrated the deleterious consequences saltiness has on plant growth including physiological process under briny habitat. These findings concur with earlier done studies that indicated deleterious consequences of saltiness on plant height.

**Table 2: Means by Species and Treatment**

| | | Treatment | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Species | Variable | 0 dS/m | 10 dS/m | 12 dS/m | 14 dS/m | 6 dS/m | 8 dS/m | Total |
| SHANGI | Height | 119.60 | 77.56 | 84.30 | 63.70 | 102.13 | 100.11 | 90.93 |
| | Tuber Weight | 10.98 | 5.62 | 6.48 | 2.46 | 9.26 | 6.15 | 6.82 |
| | Tuber Number | 6.00 | 2.40 | 2.20 | 1.00 | 5.20 | 2.90 | 3.28 |
| UNICA | Height | 119.50 | 101.20 | 74.10 | 70.60 | 114.70 | 106.00 | 97.68 |
| | Tuber Weight | 20.28 | 26.91 | 5.34 | 4.94 | 24.35 | 19.26 | 16.85 |
| | Tuber Number | 6.60 | 3.60 | 3.40 | 3.50 | 6.00 | 4.20 | 4.55 |
| Total | Height | 119.55 | 90.00 | 79.20 | 67.15 | 109.11 | 103.21 | 94.42 |
| | Tuber Weight | 15.63 | 16.26 | 5.91 | 3.64 | 16.81 | 12.70 | 11.79 |
| | Tuber Number | 6.30 | 3.00 | 2.80 | 2.25 | 5.60 | 3.55 | 3.92 |

A reducing trend was noted in tuber quantity in each plant at increased salt degree in the two trialled potato cultivars. The number of tubers significantly varied between 0 dS/m to 12 dS/m and 0 dS/m to 14 dS/m. In both cases, potatoes grown at 0 dS/m concentration produced significantly higher number of tubers at 5% level. With the rise in salinity amount, (till 14 dS/m), the quantity of tubers produced by each plant reduced moderately. Increased saltiness amounts and decreased tuber quantity for each plant demonstrated the deleterious effects of brininess on tuber grown under saline conditions.

Tuber yield in terms of weight is inversely affected by salinity. The tuber weight is higher at 6dS/m (16.8050) than at 14 dS/m (3.6384), (Table 5). The difference is significant at 5% level. Increased salinity degree and reduced tuber weight for each plant demonstrated the adverse effects of salinity on the bulking as well as development in salty conditions.

**Table 3: Means of potato tuber weight (g), tuber number and stem height as affected by interaction with different salt (NaCl)concentration**

| Height | | | Tuber number | | | Tuber weight | | |
|---|---|---|---|---|---|---|---|---|
| **Treatment** | **Means** | | **Treatment** | **Means** | | **Treatment** | **Means** | |
| T12 | 63.70 | a | T12 | 1.500 | a | T12 | 3.26 | a |
| T6 | 70.60 | a | T11 | 2.200 | a | T5 | 6.27 | ab |
| T5 | 74.10 | ab | T10 | 2.900 | ab | T10 | 6.58 | ab |
| T10 | 79.80 | abc | T5 | 3.400 | ab | T11 | 7.02 | abc |
| T11 | 84.30 | abc | T9 | 3.400 | ab | T9 | 7.45 | abc |
| T9 | 100.10 | bcd | T6 | 4.100 | ab | T6 | 7.67 | abc |
| T8 | 100.20 | bcd | T3 | 4.200 | ab | T8 | 9.26 | abc |
| T4 | 101.20 | bcd | T4 | 4.400 | ab | T7 | 10.98 | abc |
| T3 | 106.00 | cd | T8 | 5.200 | ab | T3 | 19.26 | bcd |
| T2 | 114.70 | d | T7 | 6.000 | b | T1 | 20.28 | cd |
| T1 | 119.50 | d | T2 | 6.000 | b | T2 | 24.35 | de |
| T7 | 119.60 | d | T1 | 6.600 | b | T4 | 33.72 | e |

*Means followed by the same letter(s) are not significantly different at 0.05 level of probability under Duncan's Multiple range test

**Table 4: Showing what abbreviations in table 1 above stands for.**

| Abbreviation | Meaning (salt concentration) |
|---|---|
| T1 | Unica 0 $dSm^{-1}$ |
| T2 | Unica 6 dSm-1 |
| T3 | Unica 8 dSm-1 |
| T4 | Unica 10 dSm-1 |
| T5 | Unica 12 dSm-1 |
| T6 | Unica 14 dSm-1 |
| T7 | Shangi 0 dSm-1 |
| T8 | Shangi 6 dSm-1 |
| T9 | Shangi 8 dSm-1 |
| T10 | Shangi 10 dSm-1 |
| T11 | Shangi 12 dSm-1 |
| T12 | Shangi 14 dSm-1 |

**Table 5: Post Hoc for Treatment on Tuber Weight**

| grp | vs | grp | Group means | | mean dif | TK-test |
|---|---|---|---|---|---|---|
| 0 dsm | vs | 10 dsm | 15.6280 | 16.2635 | 0.6355 | 0.2011 |
| 0 dsm | vs | 12 dsm | 15.6280 | 5.9073 | 9.7207 | 3.1478 |
| 0 dsm | vs | 14 dsm | 15.6280 | 3.6384 | 11.9896 | 3.7443 |
| 0 dsm | vs | 6 dsm | 15.6280 | 16.8050 | 1.1770 | 0.3724 |
| 0 dsm | vs | 8 dsm | 15.6280 | 12.7040 | 2.9240 | 0.9251 |
| 10 dsm | vs | 12 dsm | 16.2635 | 5.9073 | 10.3562 | 3.3536 |
| 10 dsm | vs | 14 dsm | 16.2635 | 3.6384 | 12.6251 | 3.9428 |
| 10 dsm | vs | 6 dsm | 16.2635 | 16.8050 | 0.5415 | 0.1713 |
| 10 dsm | vs | 8 dsm | 16.2635 | 12.7040 | 3.5595 | 1.1261 |
| 12 dsm | vs | 14 dsm | 5.9073 | 3.6384 | 2.2689 | 0.7248 |
| 12 dsm | vs | 6 dsm | 5.9073 | 16.8050 | 10.8977 | 3.5289 |
| 12 dsm | vs | 8 dsm | 5.9073 | 12.7040 | 6.7967 | 2.2009 |
| 14 dsm | vs | 6 dsm | 3.6384 | 16.8050 | 13.1666 | 4.1119* |
| 14 dsm | vs | 8 dsm | 3.6384 | 12.7040 | 9.0656 | 2.8311 |
| 6 dsm | vs | 8 dsm | 16.8050 | 12.7040 | 4.1010 | 1.2975 |

**Figure 1**: **Picture of potatoes plants potted in the greenhouse**

**Figure 2: Picture of potatoes plants 30 Days after start of treatment Application**

The height at 0 dS/m significantly differs with the height of the potatoes at 10 dsm, 12 dsm and 14 dS/m. Potatoes grown at 0 dS/m have significantly more height. Similarly, potatoes grown in 6 dsm concentration have significantly greater height than those grown at 12 dS/m concentration. Also, potatoes at 6 dS/m does better than those in 14 ds/m. Similarly, potatoes at 8 dS/m are better than those in 14 dS/m concentration. Generally, potatoes at 0 ds/m concentration have the greatest height.

## CONCLUSION AND RECOMMENDATIONS

In conclusion, treatment significantly affects the height of the potatoes regardless of the species. The greatest height is achieved at 0 dS/m concentration. Both treatment and species significantly affect the weight of the tubers. The tubers have the highest weight at 6 dS/m concentration while Unica cultivar produce tubers with the highest weight. Lastly, variation in treatment significantly affect the number of tubers. The number of tubers is significantly higher at 0 dS/m concentration. Therefore, the study recommends that plant breeders wishing to improve salt tolerance in potatoes can utilize Unica variety to obtain salt tolerant genes to into progress into other cultivars.

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