International Journal of Academic Multidisciplinary Research (IJAMR)
ISSN: 2000-006X
Vol. 3 Issue 2, February – 2019, Pages: 38-42

Effect of Salinity and NPK Fertilizer on the Total Soluble Solids (TSS) and N, P and K in Tomato Plants (*lycoperisiconesculentum* L)

Awadia A . Ahamed[1], Ammar M. S. Abdalla[2*]

[1]Department of Crop production, Faculty of Agricultural Sciences, Dongola University P. O.Box 47, Dongola, Sudan, awadia1975@gmail.com

[2]Department of Crop Protection, Faculty of Agricultural Sciences (FAS), University of Dongola, P. O.Box 47, Dongola, Sudan, ammarsorag@gmail.com,dr.ammar@uofd.edu.sd

***Corresponding Author**: **Ammar M. S. Abdalla**, ammarsorag@gmail.com, dr.ammar@uofd.edu.sd

Abstract: *This Study was conducted during October- March 2011/2012 and 2012/2013, seasons at Ministry of Agriculture green house in Dongola, Northern Sudan, to investigate the effect of salinity levels (0,2,4,6,8,10 and12ds/m) and, 0, -75kg/ ha, -150kg/ha and -225kg/ha NPK fertilizer on the total soluble solids (TSS)and nitrogen, phosphorus and potassium in the plant leaves of tomato in clay –loam soil. A randomized Complete Block Design (RCBO) with three replicates was used for laying out the pot experiments. Immediately after the termination of the experiments fruits, and plant leaf samples were collected in both seasons from each treatment to determine the amounts of total soluble solids (TSS)and nitrogen, phosphorus and potassium in the plant leaves. The results clearly indicated that (TSS), were significantly reduced with increasing salt concentration, whereas they were significantly increased with increasing of NPK application rate. The results showed that the total soil nitrogen was very low, whereas appreciable percentages were found in the leaves. There were significant differences between salt concentration and NPK application rate,the N, P and K up taken by plants increased with an increase of NPK application rate and a decrease of salt concentration In contrast both P and K in plant leaves decreased with increase in salt concentration and decreased NPK application rate, portably due to their fixation in the soil.*

1. INTRODUCTION

Salinity is one of the major abiotic problems that affect the production of many lands and is still expanding, posing a threat to sustainable agriculture (Helal*et al.,* 1999). Tomato crop is intermediary in salinity tolerance; it can tolerate salinity up to the range of 2000-2500 ppm, equivalent to 3.1-3.3 ds/m electrical conductivity (EC). It was also noted that tomato can grow well under a higher EC up to 10 ds/m. However, the production is economically decreased at such higher (EC) levels (Lorenz and May Nar, 1980). Salts et al. (1994) reported that, the total growth of tomato crop is affected with increasing soil salinity, regarding the total weight of plant, height, number of leaves and average fruit weight Salinity is one of the most severe environmental factors limiting the productivity of agricultural crops. Most crops are sensitive to salinity caused by high concentrations of salts in the soil.

The effect of salinity on tomato juice has been studied by Badia (2000). He reported an increase in dry weight, total soluble solid (TSS), treatable acidity (TA), reducing sugars, and electrical conductivity (EC) of the tomato juice subjected to 3 and 6 grams of NaCl per liter of irrigation water.

Law Egharevba (2009) found that growing tomatoes at three planting densities and three levels of NPK fertilizer, the plots without fertilizer application had the least values in all the measured parameters(plant height ,number of leaves ,fresh and dry weights of the plant, Total and marketable yield, total chlorophyll and k contents and total soluble solid (TSS), However, as fertilizer application rate increases, all measured parameters also increased up to the highest level.

Rashid (2010) found that growing tomatoes under EC of 3 and 6 ds/m irrigation water produced the highest yield, whereas irrigation with 9 ds/m significantly reduced the final fruit number and fruit weight. He presented data on fruit quality and yield that suggests the best growing conditions for tomatoes were in pots irrigated with 6 ds/m water and supplied with fertilizer.

Alaa*et al* (2009) showed that all growth parameters such as plant height, leaf area, total chlorophyll and K contents, fresh weight of areal parts and percentage of dry weight of areal parts, as well as yield and some quality parameters responded negatively as the salinity level increased . Only Na contents in the leaves and total soluble solid (TSS) in the fruits responded positively to the increment in salinity level.

Law and Egharevba (2009) found that growing tomatoes at three planting densities and three levels of NPK fertilizer, and without fertilizer application had the least values in all the measured parameters (Total and marketable yield, total chlorophyll and k contents and total soluble solid (TSS)), However, as fertilizer application rate increases, all measured parameters also increased up to the highest level. Alaa et al (2009) showed that all growth parameters such as plant height, leaf area, total chlorophyll and k contents, fresh weight of areal parts and percentage of dry weight of areal parts, as well as yield and some quality parameters responded negatively as the salinity level increased . Only Na contents in the leaves and TSS in the fruits responded positively to the increment in salinity level. The effect of salinity on tomato juice has been studied by Badia,(2000) who reported an increase in dry weight, total soluble solid (TSS), titratable acidity (TA), reducing sugars, and electrical conductivity (EC) of the tomato juice subjected to 3 and 6 grams of NaCl per liter of irrigation water . Nutritional management of tomato through proper fertilization has been shown to improve tomato production (Solaiman and Rabbani,

Growth and absorption of nitrogen (N) by plants are limited under high salinity of soil or nutrient solution. A study on the interactive effect of salinity and fertility on yield of grains and vegetables, showed that reduced growth was due to decreased N uptake with increasing salinity level in soil solution (Bernteïn*et al.*, 1974). Nitrogen uptake by tomato plants was not affected at 70ppm sodium chloride, but at140 and200ppm it dropped to the third of that observed in non-saline media (Pessarkli and Tuker, 1988). It was reported that applying Ca, K or P to salt stress plants extremely decreased the intake of sodium due to competition in the leaves and roots and increase the capacity of durability of plants against stress (kaya *et al.*, 2001).

Phosphorus helps to initiate root growth of tomato and therefore aids in early establishment of the plants immediately after transplanting or seeding (Gould, 1983). Potassium is needed by virtually all crops and often in higher rates than phosphorus. Potassium regulates plant water relation. It is key in achieving good yield and quality in tomato (htty://yara).

Cramer (2002) reported that macro essential elements added to the nutrition solutions moved to the leaves in the plants grown in saline medium partly protect and reduce the stress effect. Since, nitrogen, phosphorus and potassium (NPK) are the most important macronutrients in plants , understanding the mechanisms of their uptake and transport is essential for revealing the limiting step of plant growth even under unfavorable growth conditions such as salinity (Tas and Bair, 2009)

Due to the importance of NPK fertilizer in improving crop productivity in saline soils, this study was undertaken to assess the amounts of N, P and K in the soil and plant tissue's just after fruits harvest of tomato plants grown in saline soil and fertilized with NPK.

2. MATERIALS AND METHODS

Factorial experiments were conducted at the green house of Ministry of Agriculture during (2011/10 and 2012/2011 October to March) seasons to investigate the effect of salinity and NPK fertilizer on the total soluble solids (TSS)and nitrogen, phosphorus and potassium in the plant leaves of tomato (*lycoperisiconesculentum* cultivar Strain B). The salinity treatments were 0,2,4,6,8,10 12ds/m) prepared by appropriate sodium chloride solution and control, 75kg/ ha, 150kg/ha and 225kg/ha NPK fertilizer. The experimental design used was Randomized Complete Block Design (RCBD), the weight of soil in each pot is 20kg. The NPKused in this study has the following composition 30%N, 10%P, 10%K and (Fe, Cu, Zn, B and MO in ppm).

Six seeds of tomato were sown in each pot, Three weeks after emergence, the
seedlings were thinned to three plants per pot. Before planting and for each treatment level, the NPK fertilizer was thoroughly mixed with the soil before potting.

Three marketable fruits were randomly picked from each pot,analysis was also carried out to determine the total soluble solids TSS in fruits. Immediately after fruit picking of tomato plant samples were collected from each pot to determine the amounts of nitrogen, phosphorus and potassium in the plant.

Total percentage nitrogen in the plants was determined according to the semi-micro kjeldhl method (Jackson, 1958).
Plant phosphorus was determined choloremeterically (Troug and Meyer, 1939). Whereas percentage plant Potassium was determined flame photometrically (Brown and Lillel,1946).

The data collected were subjected to analysis of variance (ANOVA) appropriate for randomized complete block design (Gomez and Gomez, 1984). Duncan's Multiple Range Test (DMRT) was applied to separate the treatment means. All statistical analyses were performed using SAS program computer package.

3. Results and Discussion

A significant difference in total soluble solids (TSS) among treatment means at different salt concentrations and fertilizer rates was found in both seasons (Table 1and 2). The data for the effect of salinity on total soluble solids (TSS) in tomato fruit (table 1) clearly indicated that for both seasons the percentage of TSS invariably decreased with increasing salt concentration. The highest values 5.4% and 5.24% were reported for the control treatment .Whereas the lowest percentage were found at the highest salt concentration in seasons 2011/2012 and 2012/2013 respectively. The decrease in TSS in the first season compared to the control was 8%, 13%, 16%, 20%, 28%and 34% at 2, 4, 6,8, 10 and 12ds/m ,respectively. In the second season TSS the values were 6%, 9%, 15%, 19%, 25%and 32% by 2, 4, 6,8, 10 and 12ds/m respectively . Generally increasing the rate of NPK application resulted in an increase in the percentage of TSS. In the first season values of TSS ranged from 4.12 % to 4.81 %, for the control and 225kg fertilizer/ha respectively whereas the values for the same treatments were 4.11% and 4.74%, respectively.

The result of the first season showed that the application of 75kg/ha, 150kg/ha and225 kg/ha NPK resulted in 12%, 7% and 17% significant increase in TSS over the control. In the second season the application of 75kg/ha, 150kg/ha and 225kg/ha gave 8%, 7% and16% respective significant increase in TSS over the control.

The result of this study revealed that TSS negatively responded to increasing salt concentration whereas, it positively responded

International Journal of Academic Multidisciplinary Research (IJAMR)
ISSN: 2000-006X
Vol. 3 Issue 2, February – 2019, Pages: 38-42

to increasing NPK application. This result suggested that TSS is positively related to the amount of assimilates produced by the plant. The quality of fruit responded negatively as the salinity level increased. Similar result were reported by Badia (2000).

Table 3, 4 and5 display the data for potassium uptake by tomato plants. The data revealed that percentage of K withdrawn by tomato plants was higher than percentage P but lower than N percentage .The highest salt concentrations gave the lowest means of K uptake (1.17% and 1.12%) for both seasons, whereas the highest percentage were given by the control treatment in both seasons.

In both seasons significantly higher K percentages were given by NPK fertilizer in comparison with the control. However, there was no significant difference among the NPK application rate treatment. The N, P and K up taken by plants increased with an increase of NPK application rate and a decrease of salt concentration .This is because increasing the NPK application rate would increase amounts of these essential macro essential elements to the growing plants. On the other hand, the saline growth medium exerts many adverse effects on plant growth due to low osmotic potential of soil solution (osmotic stress), specific ion effects (toxic stress) and/or nutritional imbalances (Ashraf, 1994). The present results were in agreement with the findings of many scientists (Bernteine*t a*l., 1974 .Kaya et al., 2001 and Tas and Bair, 2009.

Table(1). Mean of Total soluble solids(%)as affected by salinity levels (S), in the (2011/2012 to 2012/2013)seasons

Salinity levels	Total soluble solids(%)	
	Season1	**Season2**
S_0	5.41^{A}	5.24^{A}
S_1	4.98^{B}	4.92^{B}
S_2	4.73^{BC}	4.72^{B}
S_3	4.52^{CD}	4.43^{C}
S_4	4.32^{D}	4.22^{C}
S_5	3.90^{E}	3.93^{D}
S_6	3.55^{F}	3.58^{E}
C.V%	7.0	6.57
$Lsd_{0.05}$	0.2575*	0.2386*
SE±	0.09083	0.08416

S_0,S_1,S_2,S_3,S_4,S_5 andS_6= 0,2, 4, 6,8, 10 and 12 ds/m Levels of salinity respectively/ * significant at 0.05 and ** significant at 0.01/ means followed by the same letter(s) with in each row or Colum are not significantly different according to DMRT$_{(0.05)}$

Table(2). Mean of Total soluble solids (%) as affected by fertilizer dose (F), in the (2011/2012 to 2012/2013)seasons

Fertilizer levels	Total soluble solids(%)	
	Season1	**Season2**
F0	4.12^{C}	4.11^{C}
F1	4.41^{B}	4.44^{B}
F2	4.60^{B}	4.41^{B}
F3	4.81^{A}	4.78^{A}
C.V%	7.0	6.57
$Lsd_{0.05}$	0.1947*	0.1804*
s **E±**	0.847	0.06362

F_0,F_1,F_2, and F_3= control, 75,150 and 225 kg NPK/ha respectively fertilizer doses/ *significant at 0.05 and ** significant at 0.01/ means followed by the same letter(s) with in each row or Colum are not significantly different according to DMRT$_{(0.0}$

Table (3): Nitrogen plant uptake (%) of tomato in the two seasons

Salinity levels X fertilizer levels	Season I					Season II				
	F_0	**F_1**	**F_2**	**F_3**	**Mean C**	**F_0**	**F_1**	**F_2**	**F_3**	**Mean C**
S_0	2.31	2.59	2.59	2.81^{AB}	2.58	2.10	2.31	2.38	2.59	2.35^{A}
S_1	2.10	3.01	2.59	2.83$_{A}$	2.63	2.03	2.24	2.31	2.39	2.22^{A}
S_2	2.01	2.70	2.52	2.80$_{ABC}$	2.51	1.89	2.17	2.31	2.37	2.19^{AB}
S_3	1.89	1.89	2.31	2.66$_{BCD}$	2.19	1.89	1.89	2.17	2.17	2.03^{ABC}
S_4	1.69	1.79	2.03	2.59$_{D}$	2.03	1.75	1.96	2.17	2.09	1.99^{ABC}
S_5	1.61	1.68	2.89	2.30^{CD}	2.12	1.61	1.75	2.10	2.03	1.87^{BC}
S_6	1.40	1.47	1.6I	2.03^{E}	1.63	1.54	1.61	1.75	1.98	1.72^{C}
Mean F	1.86^{C}	2.16^{B}	2.36^{AB}	2.57^{A}		1.83^{C}	1.99^{AB}	2.17^{A}	2.23^{A}	

F_0,F_1,F_2, and F_3= control, 75,150 and 225 kg NPK/ha respectively doses fertilizer/ S_0,S_1,S_2,S_3,S_4,S_5 andS_6= 0,2, 4, 6,8, 10 and 12 ds/m salinity level respectively Means followed by the same letter(s) with in each row or Colum are not significantly different according to DMRT$_{(0.05)}$.

International Journal of Academic Multidisciplinary Research (IJAMR)
ISSN: 2000-006X
Vol. 3 Issue 2, February – 2019, Pages: 38-42

Table (4): phosphorus plant uptake (%) of tomato in the two seasons

Salinity levels X fertilizer levels	Season I					Season II				
	F_0	F_1	F_2	F_3	Mean C	F_0	F_1	F_2	F_3	Mean C
S_0	0.26	0.30	0.31	0.41	0.32^{A}	0.16	0.22	0.35	0.40	0.28^{A}
S_1	0.22	0.30	0.32	0.41	0.31^{A}	0.15	0.19	0.31	0.35	0.25^{AB}
S_2	0.22	0.27	0.42	0.32	0.31^{A}	0.11	0.18	0.22	0.35	0.22^{BC}
S_3	0.23	0.26	0.29	0.39	0.29^{A}	0.09	0.18	0.20	0.29	0.19^{CD}
S_4	0.17	0.22	0.25	0.31	0.24^{B}	0.10	0.15	0.21	0.25	0.18^{CD}
S_5	0.12	0.19	0.23	0.30	$0.21B^{C}$	0.08	0.17	0.19	0.22	0.17^{CD}
S_6	0.11	0.20	0.20	0.26	0.19^{C}	0.08	0.17	0.18	0.22	0.16^{D}
Mean F	0.19^{D}	0.25^{C}	0.29^{B}	0.34^{A}		0.11^{D}	0.18^{C}	0.24^{B}	0.28^{A}	

* F_0,F_1,F_2, and F_3= control, 75,150 and 225 kg NPK/ha respectively doses fertilizer / S_0,S_1,S_2,S_3,S_4,S_5 andS_6= 0,2, 4, 6,8, 10 and 12 ds/m salinity level respectively Means followed by the same letter(s) with in each row or Colum are not significantly different according to $DMRT_{(0.05)}$

Table (5): potassium plant uptake (%) of tomato in the two seasons

Salinity levels X fertilizer levels	Season I					Season II				
	F_0	F_1	F_2	F_3	Mean C	F_0	F_1	F_2	F_3	Mean C
S_0	1.11	2.07	2.46	2.65	2.07^{A}	0.98	2.05	2.54	2.61	2.05^{A}
S_1	0.95	2.03	2.02	2.34	1.84^{AB}	1.02	1.98	2,03	2.29	1.83^{AB}
S_2	1.68	1.89	1.88	1.88	1.83^{AB}	0.87	1.77	2.01	1.79	1.61^{BC}
S_3	1.72	1.46	1.73	1.95	1.72^{AB}	0.78	1.83	1.77	1.98	1.5^{9BC}
S_4	1.61	1.29	1.66	1.78	1.59^{ABC}	0.66	1.55	1.54	1.68	1.36^{CD}
S_5	1.53	1.11	1.34	1.43	1.35^{BC}	0.69	1.29	1.36	1.39	1.18^{D}
S_6	0.89	1.09	1.34	1.34	1.17^{C}	0.66	1.20	1.29	1.32	1.12^{D}
Mean F	1.36^{B}	1.56^{AB}	1.78^{A}	1.91^{A}		0.81^{B}	1.67^{A}	1.79^{A}	1.87^{A}	

* F_0,F_1,F_2, and F_3= control, 75,150 and 225 kg NPK/ha respectively doses fertilizer / S_0,S_1,S_2,S_3,S_4,S_5 andS_6= 0,2, 4, 6,8, 10 and 12 ds/m salinity level respectively Means followed by the same letter(s) with in each row or Colum are not significantly different according to $DMRT_{(0.05)}$

Conclusion:

The quality of t Tomato were significantly reduced in soils having salt concentration higher than 6ds/m. In this case soil reclamation and/or adequate management practices are essential to improve productivity of the crop.

Studies on the amount, method of application and time of application of fertilizer to saline soils are needed . All nitrogen added will be up taken by the plant with respective of the salt concentration and amount of nitrogen added. However, not all nitrogen added at the highest salt concentration was not in the plants. Progressively less and more percentage P was in the plant with increasing salt concentration and NPK application rate, respectively. The same trend as P was followed closely by potassium. Hence it seems that while nitrogen was not fixed in the soil, both P and K lower availability especially at high salt concentration.

References

1. Alaa, S.T, AbdelMawgoud R. M, El-Nemr A.M and Chamoun G. Y.2009. Allevation of salinity effect on tomato plants by application of amino acids and growth regulators. European Journal of Scientific Research. ISSN 1450-216X Vol. 30 No.3, pp. 484-494
2. Helal, H.M.A.Upenov, and G.J. Issa. 1999. Growth and uptake of Cd and Zn by Leucaenaleucocephla in reclaimed soils as affected by NaCl salinity. J. plant Nutr. Soil Sci., 162(6):589-592.
3. Rashid ,A,Y, Said, A. I and Salim, A. A. 2010.Growing Tomatoes under saline field conditions and the role fertilizers Aonograph on management of salt affected soil and Water for Sustainable Agriculture, 83-88.
4. Low. K. E; and Egharevba (2009). Effects of planting Density and NPK Fertilizer application on yield and yield components of tomato (Lycospericonesculentum) in forest loc

5. Lorenz, O.H.and D.N. Maynard. 1980. Knott's hand book for vegetable grows ation, world journal of Agricultural Sciences 5(2):152-158.
6. Badia, D. 2000. Potential nitrification rates of semiarid cropland soils from the Central Ebro Valley, Spain. Arid Soil Res. Rehabi., 14:281-292.
7. Tas, B. and H. Basar (2009). Effects of various salt compounds and their combinations on growth and stress indicators in maize (Zea mams L.). African Journal of Agricultural Research, 4(3) : 156-161 hysiol., 27(3-4) : 47-59.
8. Ashraf,M. (1994). Breeding for salinity tolerance in plants. Cril.Rrv.plant, Sci, 13: 17-42.
9. Brown, J.D. and I. Lilleland, 1964. Rapid determination of potassium and sodum in plant material and soil extacts by flame photometry Proc. Amer. Soc. Hort. Sci., 48:341-346.
10. Cramer,G.R.(2002). Calcium-sodium interactions under salinity stress. In : Salinity .Environment Plants-Molecules. Eds. A. liuchi and U . Luttge. Kluwer Acad. Pubishers. 95: 23-29.
11. Gould, W.A. 1983. Tomato Production, Processing, and Quality Evaluation.
12. Jachson, M.L. 1958. Soil Chemical Analysis. Prentice Hall. Inc. Engle-wood N.J.
13. Pessaraki, M.and T.C. Tucker .1988.Dry matter yield and nitrogen -15 uptake by tomatoes under sodium chloride stress, Soil Science Society of America Journal 52:698-700.
14. Richards, L.A. (1954). Diagnosis and improvement of saline and alkaline soils. Hand book 60, U.S.D.A.
15. Troug, e. and A. H. Meryer, 1939. Improvement in deinesscolormeticmethod for phosphorus and arsenic. Ind. Eng. Chem. Anal. Ed. 1: 136-139.
16. Tas, B. and H. Bair (2009). Effects of various salt compounds and their combinations on growth and stress indicators in maize (Zea mams L). African Journal of Agricultural Research, 4(3): 156-161
17. Ghassemi, F, Jakeman, A.J, and Nix, H.A. (1995)Salinization of Land and Water Resources. Univ. of NewSouth Wales Press, Ltd, Canberra, Australia
18. Satti.S.M.E.andM.Lopez. 1994. Effect of increasing potassium levels for alleviating sodium chloride stress on the growth and yield of yomato communications in soil science and plant Analysis 25(15-16):2807-2823.(c.a.Hort Abstr.65:4106.1995).