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EVALUATING SEEDLING ESTABLISHMENT OF TOMATO *(LYCOPERSCUM ESCULENTUMMILL.*) VARIETIES AS INFLUENCED BY NACL STRESS

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A B S T R A C T

Tomato (Lycopersicon esculentum Mill.) is one of the most important, widely grown and consumed vegetable crops next to potato in the world. However, salinity stress now days is becoming the most important problems in all crops including tomato productivity. Thus, finding salt tolerance varieties at different developmental stages is better option to overcome such problems. Therefore the effect of salt concentration (0.1%, 0.3%, 0.4%, &0.6% of NaCl) on the growth of tomato varieties (Bishola, Miya, melkashola, Cochoro, chali & Eshete) was studied with the objective of investigating the effects of NaCl on seedlings establishment of different tomato varieties. The experiment was conducted at JUCAVM, Horticulture greenhouse from February 2011 to May 2011. The tomato seedlings were transplanted to sterilized soil on pots and salinity treatment was started five days after transplanting. All varieties were maintained under different salt concentrations and one control throughout their growing period under greenhouse condition. The result showed that the level of NaCl salt concentration increases, root and shoot length, leaf number root fresh and dry weight of tomato varieties decreased. Among six different varieties tested Melkashola showed better tolerance to the given salt concentrations in terms of root length, root fresh weight and root dry weight, while for Bishola variety as salt concentration level increases it was observed a significant reduction in root fresh and dry weight as well as leaf number. Hence Melkashola variety could be used in the area where salinity is main problems. However, further investigation is needed to test these tomato varieties at higher salt level than used in this experiment. Moreover, it needs more research to identify the variety which will give higher yield under higher salinity.

INTRODUCTION

Tomato (*Lycoperscum esculentum Mill*) is one of the most important widely grown and consumed vegetable crops next to potato in the world with the total area and production of 5 million ha and 129 million tones in the year 2008 (FAO, 2009).

It is the most frequently consumed vegetable in many countries, becoming the main supplier of several plant nutrients and providing an important nutritional value to human diet (high vitamin A, C and E as well lycopene content). It is also an important cash crop widely produced by small farmers and commercial growers under irrigated conditions. It is extensively produced in the rift valley and lakes region both for fresh market and processing industries and also expanding in different production belts for its diverse economic benefits (Selamawit and Lemma, 1992)

Tomato is a warm season crop requiring a soil temperature of 10ºC, 30ºC and 35ºC as minimum, optimum and maximum, respectively for germination. It can be grown on almost any moderately drained soil type from deep sand to a clay loam. A highest production is usually achieved on a well drained loamy soil and at the soil pH between 6.0 and 7.0 for successful growing (Decoteou, 2000).

In spite of the above importance the current productivity under farmer's condition is 9 ton ha^{-1}, which is very low as compared to 25 ton ha^{-1} and 40 ton ha^{-1} in demonstration and research plots respectively (Lemma, 2002). But a number of constraints have been contributed to the lower yield and yield components of tomato under farmer's condition in developing countries like Ethiopia including lack of improved varieties that tolerate different stresses. Among them, salinity at different stages is the most important contributing factors. Soil salinity adversely

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affects plant growth through its ionic and osmotic effects caused by toxic ions (Na^{+} Cl^{-} etc.).

Salinization plays a major role in soil degradation. It affects 19.5% of irrigated land and 2.1% of dry land agriculture existing on the globe (FAO, 2009). In many crop production areas, use of low quality water for irrigation and application of excess amounts of mineral fertilizer are the major reasons for increased salinity problem in cultivated soils. Due to very rapid accumulation of salts in soil under greenhouse conditions, salinity problem is also a critical constraint to vegetable production (Shannon and Grieve, 1999). Salinity effects are more conspicuous in arid and semiarid regions, where limited rainfall, high evapotranspiration and high temperature associated with poor water and soil management contribute to the salinity problem and become of great importance for agriculture production in these regions.

Salinity stress depresses plant growth and development at different physiological levels. The reduction in plant growth by salinity stress might be related to adverse effects of excess salt on ion homeostasis, water balance, mineral nutrition and photosynthetic carbon metabolism (Zhu, 2001; Munns, 2002). Salinity can damage the plant through its osmotic effect, which is equivalent to a decrease in water activity, through specific toxic effects of ions and by disturbing the uptake of essential nutrients (Marschner, 1995; Dorais *et al.*, 2001).

The response and growth of plants to saline conditions vary at different stages of growth depending upon the genotype. All plants tolerate salinity up to a certain threshold level without any yield reduction. After which, an increase in salinity level significantly reduces yield (Ahmet *et, al.*, 2004). Seed germination and seedling establishment are the most sensitive developmental stages to salinity effect compared to other stages (flowering, fruiting). This indicates the potential importance of seed germination and seedling establishment to be used as selection criteria to measure salinity tolerance in crops (Selamawit and Lemma, 1992). At this stage tomato exhibits sensitivity even to low concentration of salts (about 75 m M NaCl) (Foolad and Lin, 1999).

According to Kassaye *et al.* (2010 un published) six tomato varieties (Chali, Miya, Melkashola, Eshet, Bishola and Cochoro) were tested under 0%, 0.1%, 0.2% and 0.3% concentration of NaCl for seed germination capacity. As the result showed Bishola and Miya gave 98% and 97% germination, respectively under the higher level of salt (0.3% NaCl) while the rest (Chali, Melkashola, Eshet and Cochoro) showed low germination percentage. Hence it is very important to find better tomato varieties which adapted under saline stress at seedling establishment stage and thereby to increase the production and productively of the crops. Therefore the objective of the study was to investigate effects of NaCl on seedlings establishment of different tomato varieties.

MATERIAL AND METHODS

The experiment was conducted at JUCAVM greenhouse from February 2011 to May 2011. The area is situated in the south western parts of Ethiopia at the altitude of 1710 m.a.s.l, latitude of 7^{0}4''N and longitude of 36^{0}50''E. The mean minimum and maximum temperature are about 11.4^{0}C and 28^{0}C, respectively. The average annual rainfall was about 1530mm, which occurs from April to October and has relative humidity of 37.92% and 94.4% as a minimum and maximum, respectively (BPEDORS, 2000).

Seedlings of six tomato varieties (Bishola, Chali, Cochoro, Eshet, Melkashola and Miya) which were obtained form Melkassa Agricultural Research Center were raised and transplanted to pots to which five different NaCl concentrations (0, 0.1,0.3 0.4 and 0.6%) were applied in irrigation form in two days . The experiment was arranged in a completely randomized design with four replications. Data on shoot and root dry weight, shoot and root fresh weight, shoot and root length and other parameters were collected and the results were subjected to Genstat statistical software (11^{th} ed.) with two - way analysis of variance (ANOVA). LSD derived from ANOVA was used to carry out mean separation for the significant unit.

RESULT AND DISCUSSION

Significant difference was observed for the main factor (varieties and salt) ($P < 0.001$) on shoot and root length of tomato seedlings. However, the interaction effect did not show any statistically significant difference.

Shoot length decreased with increasing salinity level from 0.0% to 0.6% (Fig 1). Shoot and root length were adversely affected at the higher salinity level (0.6%) as compared the other concentrations. The reduction in root and shoot development may be due to toxic effects of NaCl used as well as unbalanced nutrient uptake by the seedlings (Hajibagheri, 1989).

In addition high salinity inhibits root and shoot elongation due to slowing down the water uptake by the plant (Werner and Finkelstein, 1995). Neumann (1995) also found similar result indicating that salinity can rapidly inhibit root growth and hence capacity of water uptake and essential mineral nutrition from soil.

In tomato seedlings, salt stress inhibited root growth than shoot growth. Demir and Arif (2003) also obtained similar results in which root growth of safflower was adversely affected than shoot growth by salinity. The result of this experiment was also similar with the findings of Hussain and Rehman (1997). They found that the roots of seedlings were more sensitive than the shoots.

In this experiment the increase in level salinity affected the seedling establishment for all varieties. The shoot and root length of the seedlings were varied among varieties indicating that the varieties responded differently to the different level of salt (Fig. 3). Melkashola variety had longer shoot and root length being followed by Eshet. Cochoro and Bishola, on the other hand, gave the lowest root and shoot length, respectively (Fig 2and 4). The differences among varieties in their root and shoot length might be attributed to their difference in genetic makeup.

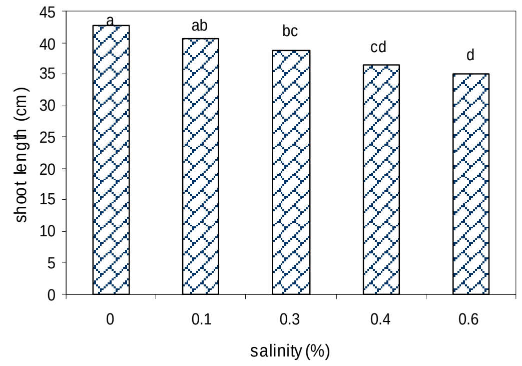

Fig 1. Effect of different salinity levels on shoot length of tomato seedlings. α = 0.05, LSD=3.6.

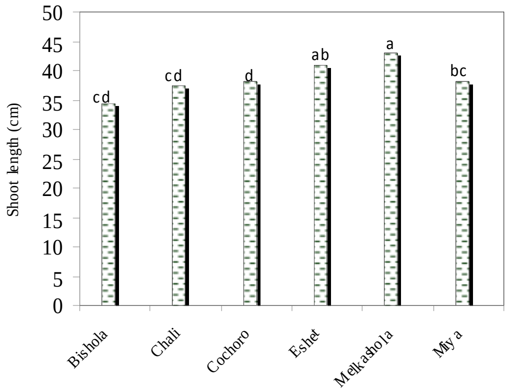

Fig 2. Difference in shoot length tomato seedlings due to diffenrence in variety. α = 0.05, LSD=3.9.

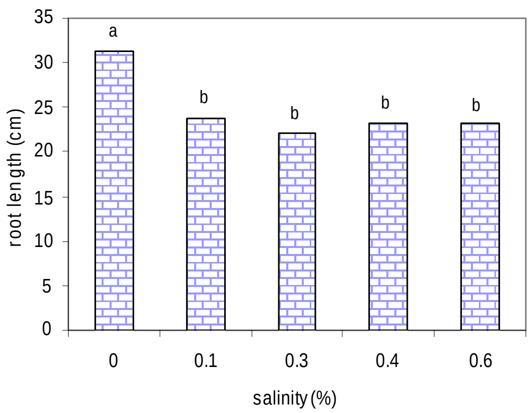

Fig. 3 Effect of salinity on root length of tomato seedlings. α = 0.05, LSD=3.6

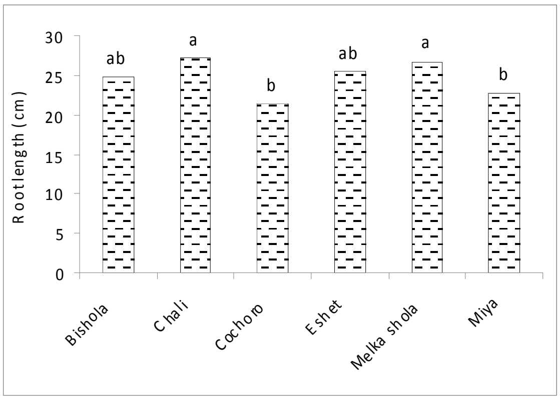

Fig. 4 Difference in root length of tomato seedlings due to diffenrence in variety. α = 0.05, LSD=3.9.

The effects of salt concentrations on the leaf number showed significant difference (*P<0.001*). The highest leaf number was obtained from control as compared to the other treatments (Fig. 5). The reason for lower number of leaves at higher salinity was due to the restriction in the movement of water from root to shoot resulting to the reduction in leaf growth. This result coincides with the finding of Mohd and Burrage (1994). From different varieties treated under different NaCl concentration, Melkashola gave higher leaf number (Fig. 6). Bishola variety on the other hand gave lower leaf number.

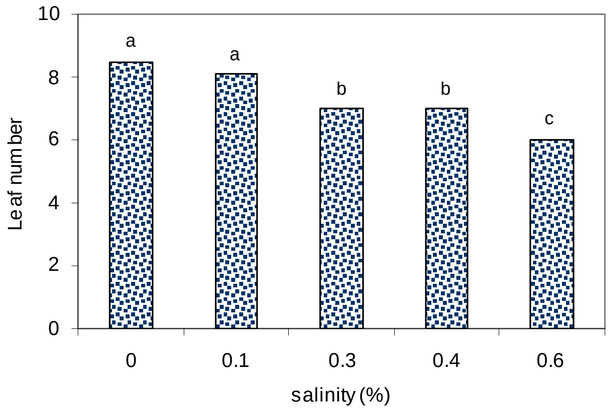

Fig. 5 Effect of salinity onleaf number of tomato seedlings. α = 0.05, LSD=0.64

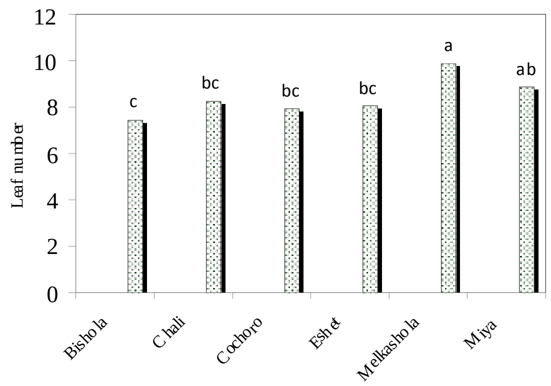

Fig. 6 Difference in number of leaves of tomato seedlings due to diffenrence in variety. α = 0.05, LSD=1

Significant difference was observed between salinity level (*P<0.001*) with respect to root fresh and dry weight (Fig.7). But, no significant differences were obtained for interactions with respect to these parameters. Moreover, there was no significant difference observed between varieties, salinity level and their interaction (P=0.052, P=0.78 and P=0.228, respectively) for shoot fresh and dry weight. From the result, root fresh and dry weight decreased as salinity level increases form control to the highest level. The seedlings which were grown under high salinity level (0.6%) showed lower fresh and dry weight compared to the other (Fig.7). Hajer *et al.* (2006) and Khateb *et al* (2005) also observed similar results. Adler and Wilcor (1987) also found that salinity adversely affected the vegetative growth of the tomato like root length and thereby reduced root fresh and dry weight.

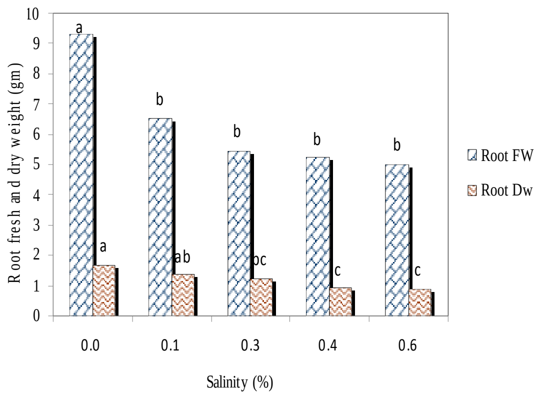

Fig. 7 Effect of salinity on root fresh and dry weight of tomato seedlings. α = 0.05, LSD=0.4

Transpiration rate, stomata conductance and photosynthetic rate play important role in growth and development of any plants. The present study showed that increasing salinity level decreased the stomata conductance and the reduction was greater at the highest level (0.6%) (Fig.8). However, no significant differences were observed among varieties for their stomata conductance at different salinity level. The reduction of the stomatal conductance under salt stressed conditions result to the lower photosynthetic rate which in turn leads to lower total yield of the crop.

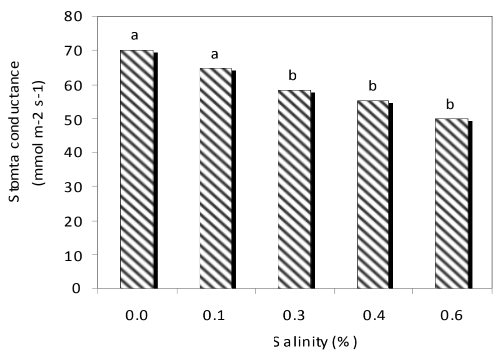

Fig. 8 Effect of salinity on stomatal conductance of tomato seedlings. α = 0.05, LSD=6.5

CONCLUSIONS

The result of this study showed that salinity stress leads to changes mainly in the growth, morphology and physiology of the plant that in turn change water and ion uptake. The whole plants are then affected when roots are growing in saline medium. The results also indicate that salt affect the growth shoot and leaves. Generally, it can be concluded that salinity stress can affect both seed germination and seedling establishment but seedling stage can tolerate more as compared to the germination. In addition, the present study revealed that the varieties responded differently to the different levels. For instances, Melkashola variety showed high tolerance to the salinity stress in respect to all parameter tested (root length, shoot length, leaf number, and root fresh and dry weigh and stomata conductance). Hence, Melkashola variety could be used in the area where salinity is the main problem.

However, further investigation is needed to test these tomato varieties at higher salt concentration level than used in this experiment. Moreover, it needs more research to identify the variety which will give higher yield under high salinity. Thus an understanding of the effect of salinity is important for improving yield and yield component of tomato plant.

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