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The Effect of Salinity Levels and Anti-Stress Material Application on the Number and Weight of Savalan Potato Cultivar Mini -Tubers and Tolerance and Susceptibility Indexs to Salinity Stress

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Abstract. In agro-econcosystems, plants may encounter with high salt concentrations duo to accumulation salts in the soil by water is used for irrigation. In this study the effect of "Out salt" anti-stress material and four levels of salinity was investigated on weight and number of Savalan potato cultivar mini-tubers and the stress tolerance indexes to salinity stress were calculated. The experiment was carried out as factorial based on completely randomized design with three replications in a greenhouse in 2010. The first factor was anti-stress material at two levels (0 and 0.25%) and second factor comprised salinity at four levels (0, 20, 40 and 60 mMol. Nacl). After 70 days, mini tubers were harvested and their number, weight and size, plant height and stress tolerance and susceptibility indexes of TOl, SSI, MP, GMP, STI and MSTI were measured. Based on the results, salinity at low, moderate and severe levels reduced number of mini-tubers up to 25, 38 and 50 percentage, respectively. Salinity also reduced mini-tuber's weight per plant. Results revealed that anti-stress material application reduced adverse effect of salinity stress so that by its application, the number of mini-tubers per plant was reduced only 9, 10 and 10 percentage in low, moderate and severe salinity conditions, respectively. According to the values of MP, GMP, STI and MSTI indexes, Savalan may be considered as a tolerant potato cultivar to salinity.

Keywords: Mini-tuber, Potato, Salinity, Anti-stress.

1. Introduction

Potato is one of the most important, the cheapest and most valuable foods over the world. Potato is cultivated in 20 million hectares in 130 countries, where three-quarters of the world's population live. The annual production of potato is 288 million tons and it is considered as world's fourth main crop after wheat, corn and rice (Farahvash, 2007).

In agro-econcosystems, plants may encounter with high salt concentrations duo to accumulation salts in the soil by water is used for irrigation. Besides, evaporation takes pure water from the soil and so, increases the concentration of salts in the soil (Abrishamchi *et al.*, 1997). Rajashekar *et al.* (1995) assessed potato varieties resistace to salinity by transferring stem, petiole and root tissues of seedlings to a solution of 2 M. NaCl with a pink test after 24 hours at 2, 3, 5 chloride three phenyl tetrazolium. They showed that high concentrations of salt reduced the percentage of plant tissues survival. Some researchers reported that 5.9 ds/m salinity level may cause 50% potato yield reduction and 10 ds/m prevented plant growth and yield, at all. Irrigation waters containing NaCl affect potato tubers directly and distrupt the plants' growth (Sadegi *et al.*, 1996). Hardan (1976) revealed that tuber production in potato significantly decreased with increasing salinity levels. Levy *et al.* (1988) also studied the effect of three salinity levels (20.5, 34.2 and 51.3 mM.

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NaCl) on six potato cultivars and concluded that salinity reduced water potential, leaf and tubers' osmotic potential and increased tubers' prolin and dry matter.

The anti-stress material used in the present experiments, Out salt, is a product used for reducing soil salinity effects. It also is used for improving soil structure to facilate ventilation (Anonymous, 2010).

In the present study, the effect of salinity levels and 'Out salt' anti-stress material application on the number, size and weight of potato, *Solanum tuberosum* cv. Savalan mini tubers was investigated in a greenhouse and tolerance and susceptibility indexs to salinity stress were calculated.

2. Material and Methods

The experiment was carried out as factorial based on completely randomized design with three replications in a greenhouse in 2010. the first factor was anti-stress material at two levels (0 and 0.25%) and second factor comprised salinity at four levels (0, 20, 40 and 60 mM. sodium chloride). Potato seedlings were planted in pots and all the seedlings were irrigated immediately after the planting operation. Salinity was induced in three growth stages of 15 days after emergence (stolon production stage), 30 days after emergence (tubers production stage) and 45 days after emergence (mini tuber enlargation stage). Irrigation was performed regularly during growing season. After 70 days, mini-tubers were harvested and their size, numbers and weight was measured. Tolerance and susceptibility indexes of TOl, SSI, MP, GMP, STI and MSTI was also calculated. Data analysis by GLM procedure and mean comparison by Duncan's multiple range test was done using SAS software.

3. Results and Discussion

Results of the data analysis of variance showed that the effect of salinity and anti-stress material levels was significant on numbers, size and weight of mini-tubers and plant height at 0.01 probability level. The effect of salinity and anti-stress material levels interaction was also significant on all studied traits, except minituber numbers per plant (table 1).

Table 1: Mean squares of the traits studied in the experiment.

Source of variation	df	Mini-tuber numbers per plant	Mini-tuber weight per plant	Mean mini-tuber size	Plant height
Anti-stress material (A)	1	8.63^{**}	108.36^{**}	1.93^{**}	196.02^{**}
Salinity (B)	3	3.76^{**}	21.53^{**}	2.84^{**}	989.85^{**}
A*B	3	0.44^{ns}	8.2^{**}	1.91^{**}	82.02^{**}
Error	6	0.52	0.75	0.07	8.33
Coefficient of variation (%)		23.89	15.96	12.62	8.82

** and ns: significant at 0.01 probability levels and non significant, respectively.

3.1. Plant height

The results revealed that salinity stress also reduced plant height. Application of anti-stress material prevented adverse effects of salinity, and so increased plant height. The correlation between mini-tubers' average size and plant height and between mini-tubers' weight and plant height was positive and significant.

The same results has also been reported by Abdullah and Ahmad (1990), Barakat (1996), Karam *et al.* (1998), Marcony *et al.* (2001), Farhatullah and Raziuddin (2002), Djilianov (2003), Backhausen *et al.* (2005) and Kirk *et al.* (2006). According to Greenway and Munas (1980), Salinity dries leaves and reduces growth and metabolic processes in plants. Also, the plants affected by salinity are stunt with dark green leaves and in some cases have more thick and juicy tissues.

3.2. Number and weight of mini-tubers per plant

Salinity reduced mini-tuber number and weight per plant in Savalan potato cultivar. However. anti-stress material application preventrd adverse effects of salinity, and so increased the mentioned traits. In this experiment, application of anti-stress material increased mean number of mini-tubers per plant (3.42) in comparison to the treatment without that material application (2.63). Mini-tuber producers in Iran usually harvest the average of 2 mini-tubers per seedlings in the greenhouse. Thus, the results revealed that mini-tuber production could be increased by anti-stress material application. The positive significant correlation was observed between plant height and mini-tubers' size and weight. It seems that increasing plant height caused increased size and weight of mini-tubers, because it could result in new leaves production which increases light absorption and thus photosynthesis efficiency.

Barakat (1996) and Kirk *et al.* (2006) also reported that increased salinity, reduced the number and weight of mini-tubers per plant. Abdullah and Ahmad (1990), Farhatullah and Raziuddin (2002) also showed that salinity reduced the average size of mini-tubers.

3.3. Salinity tolerance indexes

Table (2) showes the estimates of salinity tolerance indexes for potato mini-tuber numbers per plant in low, moderate and severe salinity and normal conditions. Salinity stress intensity in low, moderate and severe salinity conditions were 0.25, 0.38 and 0.50 relative to the normal condition, respectively. In this experiment, low, moderate and severe salinity conditions decreased the number of mini-tubers per plant up to 25, 38 and 50 percentage, respectively. Anti-stress material application reduced adverse effect of salinity stress so that by its application, the number of mini-tubers per plant was reduced only 9, 10 and 10 percentage in low, moderate and severe salinity conditions, respectively.

According to the values of MP, GMP, STI and MSTI indexes, Savalan may be considered as a tolerant potato cultivar to salinity. Some researchers such as Rensink *et al.* (2005), Nasiruddin *et al.* (2005) and Omar (2003) have also used salinity tolerance indexes for evaluation tolerance of potato cultivars to salinity

4. References

[1]. Z. Abdullah and R. Ahmad. 1990. Effect of pre and post Kinetin Treatments on Salt Tolerance of Different Potato Cultivars Growing on Saline Soils. *J. Agron.* **165**:2-3.

[2]. C. A. Abrishamchi, R. Ahmadi Moghaddam, M. Asghari, M. Link and N. Adolescent. 2007. *Plant Physiology*. Khaneye Zistshenasi,, 752 pp.

[3]. Anonymous. 2010. *Salinity Stress*. www.armansabz.adinehgroup.com

[4]. J. E. Backhausen, M. Kelin, M. Klock, S. Jung and R. Scheibe. 2005. Salt Tolerance of Potato (*Solanum tuberosum* L.) Plants Depends on Light Intensity and Air Humidity. *Plant Sci.* **169**:229-237.

[5]. M. A. Barakat. 1996. Effect of Irrigation with Saline Water on Growth, Yield and Chemical Components of Potato under Calcareous Soil Conditions. *Alexandria J. Agric. Res.* **41**(2):389-397.

[6]. D. Djilianov, E. Prinsen, S. Oden, H. Onckelen and J. Muller. 2003. Nodulation under Salt Stress of Alfalfa Lines Obtained after *in vitro* Selection for Osmotic Tolerance. *Plant Sci.* **165**:887-894.

[7]. F Farahvsh. 2007. Effect of S*eed Size and Aerial Remove Timing on Yield and Yield Components of Agria Potato Variety*. Final Report, Islamic Azad University of Tabriz.

[8]. M. Farhatullah and R. Raziuddin. 2002. *In vitro* Effect of Salt on the Vigor of Potato. *Asian Network for Scientific Info. Biotechno.* **2**(4):73-77.

[9]. H. Greenway and R. Munas. 1980. Mechanisms of Salt Tolerance in Nonhalophytes. *Ann. Rev. Plant Physiol*. **31**:141-190.

[10]. A. Hardan. 1976. *Irrigation With Saline Water under Desert Conditions*. Univ. Lubbock, Texas. 169 pp.

[11]. F. Karam, N. Katrji, M. Mastrorilli, J. W. Van Hoorn, A. Hamdy and R. Munozcarpena. 1998. Effect of Irrigation Water Salinity and Soil Texture on Potato Growth and Production. *Acta Horti*. **458**:89-94.

[12]. W. W. Kirk, A. B. Rocha, S. I. Hollosy and P. S. Wharton. 2006. Effect of Soil Salinity on Internal Browning of Potato Tuber Tissue in Two Soil Types. *American. J. Potato Res.* **83**:223-232.

[13]. D. Levy, E. Fogelman and Y. Itzhak. 1988. The Effect of Water Salinity on Potatoe (*S. tuberosum* L.):

Physiological Indices and Yielding Capacity. *Potato Res.* **31**(4):601-610.

[14]. P. Marcony, M. Benavides and O. Caso. 2001. Growth and Physiological Characterization of Regenerated Potato *Solanum tubersum* Plants Affected by NaCl Stress. *New Zealand J. Crop Horti. Sci*. **29**:45-50.

[15]. K. M. Nasiruddin, S. Yasmin, S. M. Toma and A. Crescenzi. 2005. Screening of Potato Germplasm Against Abiotic Stress and Molecular Characterization by Randomly Amplified Polymorphic DNA Analysis. *Acta Horti***.** **684**:143-149

[16]. S. A. Omar, 2003. Agricultural Bio-Saline Research and Development in Kuwait. *Acta Horti*. **609**:75-80.

[17]. W. A. Rensink, S. Iobst, A. Hart, S. Stegalkina, J. Liu and C. R. Buell. 2005. Gene Expression Profiling of Potato Responses to Cold, Heat, and Salt Stress. *Functional and Integrative Genomics*. **5**(4):201-207.

[18]. A. Sadeghi, M. Butson, R. Asghari and D. Zakaria. 2006. *Evaluation of Promising Potato Varieties Tolerance to Ssalinity*. M.Sc. Thesis, Islamic Azad University of Ardabil, 92 pp.

Table 2: Means of tolerance and susceptibility indexes to salinity stress for Savalan potato cultivar in low, moderate and high salinity stress levels

Stress level	condition	M STI	S TI	S SI	G MP	M P	T OL
Low (20 mM Nacl)	Salinity stress without anti-stress application	2.22	0.90	0.20	4.47	4.5	9
	Salinity stress intensity: 0.25						
	Salinity stress with anti-stress application	2.93	1.44	0.001	5	5	10
	Salinity stress intensity: 0.16						
Moderate (40 mM Nacl)	Salinity stress without anti-stress application	1.35	0.94	1.07	3.87	4	8
	Salinity stress intensity: 0.38						
	Salinity stress with anti-stress application	2.04	1.15	0.71	4.47	4.50	9
	Salinity stress intensity: 0.28						
High (60 mM Nacl)	Salinity stress without anti-stress application	0.63	0.63	1.20	3.16	3.5	7
	Salinity stress intensity: 0.50						
	Salinity stress with anti-stress application	1.24	0.86	1	3.87	4	8
	Salinity stress intensity: 0.40						