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EFFECT OF HIGH SALT STRESS ON GERMINATION AND GROWTH OF SOME VARIETIES OF COMMON BEET

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ВЛИЯНИЕ ВЫСОКОГО СОЛЕВОГО СТРЕССА НА ВСХОЖЕСТЬ И РОСТ НЕКОТОРЫХ СОРТОВ СВЕКЛЫ ПОСЕВНОЙ

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Abstract. Information is provided on soil salinization as the most common abiotic stress that reduces the productivity and quality of agricultural plants. Salt stress is associated with lipid peroxidation in cell membranes, DNA damage, protein denaturation, carbohydrate oxidation, pigment breakdown and disruption of enzymatic activity, as well as metabolic adaptations, including primarily the accumulation of osmolytes. The growth of higher plants in saline soil depends on the salt tolerance of the plant species. Reduced plant growth due to salinity includes a reduction in plant leaf area. A pot experiment plant materials was carried out based on investigate the effect of salt stress on growth and state stomatal of three sugar beet (*Beta vulgaris*) cultivars, Cooper, Tarifa and Taltos which import from Denmark. Plants were harvested after 30, 45 and 60 days of salt treatment and were separated into leaf lamina, petioles, stem, and roots.

Аннотация. Приведена информации о засолении почв, как наиболее распространенных абиотических стрессов, снижающих продуктивность и качество сельскохозяйственных растений. Солевой стресс взаимосвязан с перекисным окислением липидов в клеточных мембранах, повреждением ДНК, денатурацией белков, окислением углеводов, распадом пигментов и нарушением ферментативной активности, а также метаболическими адаптациями, включающими преимущественно накопление осмолитов. Рост высших растений в засоленной почве зависит от солеустойчивости видов растений. Снижение роста растений из-за засоления включает уменьшение площади листьев растения. Эксперимент с растительными материалами в горшках был проведен на основе изучения влияния солевого стресса на рост и состояние устьиц трех сортов сахарной свеклы (*Beta vulgaris*): Cooper, Tarifa и Taltos, которые импортируются из Дании. Растения собирали после 30, 45 и 60 дней обработки солью и разделяли на листовую пластинку, черешки, стебель и корни.

Keywords: osmolytes, plant growth, soils, salt stress, sugar beet.

Ключевые слова: осмолиты, рост растений, почва, солевой стресс, сахарная свекла.

Many authors reported that salinity is considered as one of the most common abiotic stresses reducing the productivity and fruit quality of crop plants [1-3].

The major contributing factors to soil salinization include climate change, leading to land degradation and desertification [4], as well as the poor quality of irrigation water and irrational fertilization management, which results in reduced productivity in either irrigated or rain fed farming systems [5].

The compromised crop performance is the result of a combined osmotic and ionic stress that induces complex interactions at morphological, physiological, biochemical and molecular level [6, 7] thus leading to altered photosynthetic activity, detoxification capacity, energy state and plant cellular homeostasis [8-10].

In particular, salt stress is interlinked with lipid peroxidation in cellular membranes, DNA damage, protein denaturation, carbohydrate oxidation, pigment break down and impairment of enzymatic activity, as well as metabolic adaptations, mainly involving the accumulation of osmolytes [11].

Osmolyte accumulation acts in favor of cell water uptake and cell turgor maintenance, stabilization of membranes, enzymes and proteins and the reduction of oxidative damage due to decreased reactive oxygen species (ROS) levels, thereby contributing to redox balance [12].

Well known examples of metabolites with an osmoprotective function under salt stress conditions are certain amino acids, mainly referring to proline, and glycine betaine, belonging to the group of quaternary amines [13].

Growth of higher plants in saline soil depends on salt tolerance of the plant species. The decrease in plant growth due to salinity includes a reduction in the leaf area of the plant. The reduction in growth is a consequence of several physiological responses including modification of ion balance, water status, mineral nutrition, stomatal behavior and photosynthetic efficiency [14-16].

Materials and methods

A pot experiment plant materials was carried out based on investigate the effect of salt stress on growth and state stomatal of three sugar beet (*Beta vulgaris*) cultivars, Cooper, Tarifa and Taltos which import from Denmark. Chosen kinds according to preliminary information on their growth under saline conditions.

The growth conditions were temperature of 23-25ºC, a photoperiod of 14 hours, a relative humidity of 60-70% and a light intensity of 10-15 klx was created in the green house for planting and cultivation of plant. Seeds were sown deep 15 cm diameter in plastic containers filled with soils which were concentrate with 0,2 and 0,5% Na_2SO_4 and NaCl. salt stress. Growth was measured as leaf area, weight of leaves.

Plants were harvested after 30,45 and 60 days of salt treatment and were separated into leaf lamina, petioles, stem, and roots.

Results and Discussion

During the observation of the obtained sprouts, it was determined that the Tarifa variety is the first, the Cooper is the second, and the Taltos variety is the last in terms of the germination percentage of the seeds in different concentrations of both salts (Table 1).

Regardless of the variety, the percentage of germination in both concentrations of Na_2SO_4 was higher compared to NaCl. The highest germination percentage was observed in the Tarifa variety under the influence of 0.2% Na_2SO_4 salt. Wang found that high concentrations of NaCl inhibited the germination of cucumber seeds [17].

From this point of view, Bybordi [11] found in *Canola* rape plant that as a result of increasing salinity, seed germination, germination energy, root length and the number of young shoots decrease. Accumulation of mineral nutrients and proline increases height, leaf area, and dry biomass in rape seed. It is known that changes in the development and architecture of roots in halophytic plants depend on the salinity level, type and mineral content of the soil.

Table 1

GERMINATION PERCENTAGE AND GERMINATION INTENSITY
OF SUGAR BEET SEEDS

Varieties	*Variant*	*Number of seeds*	*Germ. energy*	*Germination, %*
Cooper	Control	20.0	20±2.38	90.0
	0.2% NaCl	20.0	25±3.67	60.0
	0.5% NaCl	20.0	12±1.48	50.0
	0.2% Na_2SO_4	20.0	18±1.76	70.0
	0.5% Na_2SO_4	20.0	16±1.42	55.0
Tarifa	Control	20.0	19±1.82	95.0
	0.2% NaCl	20.0	12±1.45	75.0
	0.5% NaCl	20.0	10±0.96	60.0
	0.2% Na_2SO_4	20.0	14±1.42	90.0
	0.5% Na_2SO_4	20.0	11±1.0	80.0
Taltos	Control	20.0	15±1.39	75.0
	0.2% NaCl	20.0	13±1.52	65.0
	0.05% NaCl	20.0	10±0.89	50.0
	0.2% Na_2SO_4	20.0	15±1.43	75.0
	0.5% Na_2SO_4	20.0	12±1.41	60.0

T. Pasternak et al. (2005) study the growth and development the roots of *Arabidopsis* seedlings under salt stress in the agar-agar solution, they concluded that the elongation of the main root due to the effect of stress slows down more than that of the lateral root, and the amount of the lateral root increases [18].

The effect of stress on the organs of plants, on the development of leaves and architecture, depends on the type of stressor, the duration of stress and the mineral content of the soil. Shows the results regarding the dynamics of leaf area (S_w), leaf mass (M_l), leaf length (L_l), plant mass (M_p) and root length (L_r) in sugar beet vegetative organs (Table 2).

Table 2

CHANGE DYNAMICS OF SOME BIOMETRIC INDICATORS DURING THE ACTIVE
DEVELOPMENT PHASES OF SUGAR BEET UNDER SALT STRESS

Variety	*Variant*	*Length leaf, mm*	*L_l, mm*	*L_l/L*	*S_y, cm^2*	*M_{plant}, g*
			30 days			
Cooper	Control	60.0 3.43	40.0±2.46	1.5	10.3±0.99	28.9±2.14
	0.2% NaCl	45.0±3.14	35.0±2.12	1.3	8.0±0.86	28.8±2.06
	0.5% NaCl	35.0±2.11	30.0±2.06	1,2	4.0±0.26	28.6±2.01
	0.2%Na_2SO_4	57.0±3.93	40.0±2.44	1.4	10.1±0.78	28.9±2.05
	0.5%Na_2SO_4	40.0±2.57	33.0±2.11	1,2	7.4±0.69	27.8±2.0
Taltos	Control	68.0±4.01	42.0±3.0	1.6	14.6±1.35	21.1±1.94
	0.2% NaCl	52.0±3.66	44.0±3.98	1,2	9.0±0.99	28.8±2.02
	0.5%NaCl	45.0±3.03	35.0±2.14	1.3	6.2±0.57	28.7±2.03
	0.2%Na_2SO_4	49.0±3.13	41.0±2.51	1,2	7.3±0.59	29.5±2.12

Variety	Variant	Length leaf, mm	L_l, mm	L_l/L	S_y, cm^2	M_{plant}, g
	0.5%Na_2SO_4	44.0±2.95	36.0±2.14	1,2	6.1±0.49	29.0±2.15
Tarifa	Control	70.0±4.51	40.0±2.43	1.8	16.1±1.79	32.3±2.18
	0.2% NaCl	64.0±4.28	41.0±2.49	1.6	11.8±0.97	31.9±2.19
	0.5% NaCl	48.0±3.21	36.0±2.13	1.2	6.8±0.49	30.6±2.49
	0.2%Na_2SO_4	60.0±3.48	45.0±3.16	1.3	11.8±0.97	33.2±2.58
	0.5%Na_2SO_4	58.0±3.22	40.0±2.41	1.5	10.1 ±0.86	29.9 ±2.13
			45 days			
Cooper	Control	85.0±6.78	60.0±5.87	1.4	21.0±2.67	81.0±7.34
	0.2% NaCl	80.0±6.54	50.0±4.33	1.6	11.8±0.98	79.1±6.87
	0.5% NaCl	51.0±3.03	43.0±3.11	1,2	7.7±0.56	79.0±6.88
	0.2% Na_2SO_4	72.0±5.93	57.0±4.63	1.3	15.0±1.21	79.4±8.65
	0.5% Na_2SO_4	55.0±4.32	42.0±3.03	1.3	9.5±0.82	78.9±6.56
Taltos	Control	81.0±7.13	57.0±4.88	1.4	19.2±1.45	70.9±6.46
	0.2% NaCl	69.0±5.14	56.0±4.47	1.2	13.7±1.03	78.4±6.73
	0.5% NaCl	60.0±5.14	55.0±4.44	1.1	9.6±0.86	78.1±6.73
	0.2% Na_2SO_4	62.0±5.15	54.0±4.90	1.2	11.3±1.0	71.4±6.44
	0.5% Na_2SO_4	56.0±4.62	49.0±4.87	1.1	8.5±0.67	79.0±7.0
Tarifa	Control	91.0±7.76	60.0±5.0	1.5	27.0±2.48	84.8±7.47
	0.2% NaCl	70.0±6.58	55.0±4.42	1.3	15.1±1.26	82.7±7.22
	0.5% NaCl	60.0±4.66	51.0±4.01	1.2	10.5±0.96	80.5±7.12
	0.2% Na_2SO_4	75.0±6.73	62.0±4.99	1.2	17.0±1.43	82.0±7.13
	0.5% Na_2SO_4	79.0±6.86	52.0±4.02	1.5	21.2±2.01	83.5±7.16
			60 days			
Cooper	Control	99.0±8.36	80.0±7.23	1.3	27.4±2.34	113.9±10.1
	0.2% NaCl	75.0±6.67	64.0±5.67	1.2	13.8±1.22	111.6±10.0
	0.5% NaCl	63.0±5.45	59.0±4.88	1.1	9.3±0.87	109.7±10.0
	0.2% Na_2SO_4	88.0±7.02	72.0±6.84	1.2	18.9±1.67	110.5±9.99
	0.5% Na_2SO_4	69.0±5.21	57.0±4.68	1.2	11.1±1.00	109.9±9.82
Taltos	Control	101.0±9.28	72.0±6.66	1.5	30.8±2.89	115.1±10.21
	0.2% NaCl	96.0±8.01	68.0±5.86	1.4	21.9±2.11	112.9±10.13
	0.5% NaCl	93.0±7.99	70.0±6.22	1.4	18.5±1.54	112.0±10.1
	0.2%Na_2SO_4	98.0±8.25	65.0±5.03	1.5	19.7±1.67	113.7±10.11
	0.5%Na_2SO_4	94.0±7.67	60.0±4.99	1.6	13.6±1.12	113.0±9.86
Tarifa	Control	95.0±7.87	71.0±6.74	1.4	24.7±2.23	112.8±9.98
	0.2% NaCl	94.0±7.91	71.0±6.83	1.3	18.0±1.67	111.1±9.94
	0.5% NaCl	72.0±6.73	63.0±5.42	1.2	11.1±1.01	110.0±9.78
	0.2% Na_2SO_4	91.0±8.44	83.0±7.64	1.1	19.0±1.89	112.5±9.85
	0.5%Na_2SO_4	92.0±8.56	67.0±5.81	1.3	20.0±2.0	111.9±9.79

As can be seen from the table, NaCl and Na_2SO_4 salts have different effects on the sugar beet plant, depending on their concentration. So, although all the parameters in the control options of all three varieties received high values compared to the experimental options, there were certain differences:

1) Biometric indicators gradually increase during the 60 days of active plant development in all three varieties;

2) Tarifa ranks first, Cooper second, and Taltos variety third in terms of salt resistance;

3) Na_2SO_4 salt at concentrations of 0.2% and 0.5% had a more effective effect compared to those concentrations of NaCl.

In addition, in the first 45 days of plant development, 0.2% concentrations of both salts (NaCl and Na_2SO_4) stimulated the development of the studied parameters, and in the later stages, such growth was accelerated by the effect of 0.5% Na_2SO_4 salt. was carried out. The analysis of the L_l/L_r ratio shows that this ratio is close to each other in all options, except for the control option, and ranges from 1.2 to 1.6. The obtained results show that the stress has a similar effect on the root and leaf of the plant [19]. As can be seen from the table, S_y and M_b increase similarly in both options. It can be said that the obtained results are related to the energetic exchange going on in the cell.

The obtained results show that the change of biometric parameters of the plant also depends on the nature of the stressor. So, our results and literature data show that NaCl salt has a higher toxic effect than Na_2SO_4. That is why the biometric indicators of the plant are not seriously damaged by the effect of Na_2SO_4 salt.

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