Determination of salt tolerance of tomato varieties in laboratory conditions

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Abstract: The aim of the study was to study the effect of salt solutions of different concentrations on seed germination in 7 tomato varieties and 3 hybrids in the Republic of Karakalpakstan. The following options were studied in the studies: dry seeds (control 1); - seeds soaked in water (control 2); - seeds dissolved in solutions: 0.3% NaCl; - 0.5% NaCl; - 0.7% NaCl; - 1.0% NaCl; - 0.3% Na2SO4; - 0.5% Na2SO4; - 0.7% Na2SO4; - 1.0% Na2SO4. The experiment revealed that tomato varieties and hybrids are resistant to chloride and sulfate salinity at the lowest concentrations (0.3 %). It was proven that a further increase in the concentration of salt solutions (from 0.5 to 1.0 %) negatively affects the quality of sowing seeds. When determined the germination power and seed germination in NaCl solutions, varieties of tomato Rio Grande, Novichok, UzMASh-1, TMK-22 and Solerosso F1 hybrids were the best among the studied samples.

1 Introduction

Salinity is the accumulation of sodium, magnesium, and calcium soluble salts in the soil to the extent that it drastically reduces soil fertility. Salinity is one of the most serious environmental factors that limit the productivity of agricultural crops [1-10]. Most agricultural crops are sensitive to salinity caused by high concentrations of salts in the soil. The size of the affected areas is increasing day by day. The area of irrigated saline lands in Uzbekistan is 2 mln. It is 270.7 thousand hectares, including 1 million hectares of low salinity lands. 267.7 thousand hectares, moderately saline land is 711.2 thousand hectares, and highly saline land is 291.8 thousand hectares (Ministry of Finance of the Republic of Uzbekistan, 2018). The highest level of soil salinity is observed in Karakalpakstan (90-95%), Bukhara (96%) and Khorezm oasis (95-100%) [FAO; https://www.fao.org/faostat/ru].

V.I.Zuev [4] The research conducted in Uzbekistan on increasing salt resistance of vegetable crops shows that the most effective method is to soak seeds in saline solutions and drainage water. However, in terms of their effectiveness, they are inferior to the use of local reproduction for planting seeds. In the conditions of sulfate salinity of soils in

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Uzbekistan, 3% solutions of sodium chloride and sodium sulfate can be used equally effectively for pre-sowing seeds according to P.A. Genkel's method. The best results were achieved with sodium chloride solution under conditions of chloride-sulfate salinity.

P.A. Genkel determined the effectiveness of pre-sowing cleaning of seeds with 3% salt solutions in saline soils of Uzbekistan and soaking in drainage water in beets, onions, carrots, and cabbage [2]. is one of the extreme factors. Starting with a salt concentration of 0.9%, it significantly reduces the viability of seeds. A concentration of NaCl of 1.1% had a strong inhibitory effect on seed viability, while 1.5% practically stopped seed germination [1].

Soil salinity is one of the extreme factors spread over large areas in our country and throughout the world. Starting with a salt concentration of 0.9%, it significantly reduces the viability of seeds. A concentration of NaCl of 1.1% had a strong inhibitory effect on seed viability, while 1.5% practically stopped seed germination [1, 3].

Salt tolerance is the ability of a plant to maintain its growth, development and reproductive characteristics in salinity conditions [3, 6, 8, 10].

It is known that every organism forms a self-management system.

The variability of this system, its adaptability to external environmental influences is an important element of the general biological properties of the plant organism [5, 7, 9].

2 Research methods

Assessment of the level of salt tolerance of tomato variety samples was carried out by studying the germination capacity and germination of seeds in different concentrations of different saline solutions. Here are the following options: - dry seed (control 1); - seeds thawed in ordinary water (control 2); - seeds thawed in saline solutions: 0.3% NaCl; - 0.5% NaCl; - 0.7% NaCl; - 1.0% NaCl; - 0.3% Na2SO4; - 0.5% Na2SO4; - 0.7% Na2SO4; - 1.0% Na2SO4.

Germination capacity and fertility of seeds were determined based on the methodology of UzDSt 2823:2014 (Semena selskohozyaystvennyx kultur. Sortovye i posevnye kachestva. Teknicheskie usloviya) [10]. 100 seeds were placed in a Petri dish on a filter paper and placed in a thermostat at a temperature of +22...+250C in 4 cycles. Checked every day and germination capacity in 5 days. Fertilization was determined in 10 days.

3 Research results

Solving the specific and general problems of plant salt tolerance often requires the use of methods that allow the determination of the toxicity of salts and the degree of strictly controlled salt tolerance.

The currently available methods for determining the harmfulness of salts and salt resistance to plants can be divided into three groups: laboratory, vegetative and field. The most common way to determine the salt tolerance of plants is to consider the germination capacity of plant seeds in a saline substrate. Germination of seeds is carried out in salt solutions or on filter paper, sand, soil moistened with salt solutions of a certain concentration.

It is necessary to use varieties and hybrids resistant to stress conditions in the cultivation of tomatoes and to obtain a high yield from them. Almost no tomato varieties and hybrids have been tested in the saline soils of the Republic of Karakalpakstan.

We conducted laboratory experiments to substantiate the salt tolerance characteristics of tomato varieties and hybrids tested in the competition. We diagnose salt tolerance of tomato varieties: Volgogradsky 5/95, TMK-22, UzMASh-1, Novichok, Rio grande,

Prednekrovsiky Rozhevyy and Yubileynyy Tarasenko, as well as Sultan F1, Tristar F1 and Solerosso F1 researches were carried out on the salt tolerance of hybrids in salt solutions of different concentrations.

Options in the experiment: dry seeds (control 1); - seeds soaked in water (control 2); - seeds soaked in solutions: 0.3% NaCl; - 0.5% NaCl; - 0.7% NaCl; - 1.0% NaCl; - 0.3% Na2SO4; - 0.5% Na2SO4; - 0.7% Na2SO4; - 1.0% Na2SO4.

Laboratory experiments to determine the effect of salt solutions of different concentrations (NaCl, Na2SO4) on the germination capacity of seeds and its output show that with an increase in the salt concentration in the solutions (from 0.3 to 1%), the germination capacity (%) and the germination rate decrease was observed in the seeds of all investigated varieties and hybrids of tomato (see Table 1).

Table 1. The effect of saline solutions of different concentrations (NaCl, Na2SO4) on the laboratory germination and germination capacity of tomato varieties seeds (2019-2020)

Varieties and hybrids	Seed quality, %	Experience options										
		Dry seeds (1-control)	Heated in water seeds (2-control)	Seeds thawed in solutions, %								
				NaCL				Na_2SO_4				
				0,3	0,5	0,7	1,0	0,3	0,5	0,7	1.0	LSD_{05}
Volgogradsky 5/95	Connection power	60,9	58,9	79,2	54,4	50,9	43,9	81,3	65,9	60,8	54,7	4,4
	Connection power	72,8	80,0	86,5	68,0	62,8	65,5	94,0	78,5	72,3	65,0	4,7
TMK 22	Connection power	61,4	79,7	88,0	66,8	62,7	49,4	89,3	80,5	77,2	70,8	4,4
	Connection power	75,5	91,5	98,0	91,5	90,3	59,8	98,5	92,0	90,5	88,5	4,5
UzMASh-1	Connection power	66,3	88,8	91,5	85,3	75,0	59,0	98,5	90,0	87,0	79,3	3,5
	Connection power	70,9	90,2	94,8	88,4	82,7	59,4	98,5	91,0	88,8	83,9	4,0
Novichok	Connection power	67,5	76,5	82,0	62,0	49,3	47,0	74,0	64,3	51,3	49,0	5,1
	Connection power	58,5	72,3	78,3	64,3	58,8	55,8	75,0	57,5	52,5	47,8	4,6
Rio grande	Connection power	65,2	87,0	93,2	83,4	70,3	58,3	82,2	71,5	60,2	50,8	4,2
	Connection power	74,8	97,0	99,8	92,5	89,5	78,3	96,0	82,3	76,5	68,8	4,3
Prindo-provoski purple	Connection power	73,5	88,5	92,3	82,8	73,8	62,8	93,0	80,8	73,3	69,8	3,6
	Connection power	74,2	92,8	96,1	87,7	81,7	70,6	94,5	81,6	74,9	69,3	3,9
Yubileyniy	Connection power	61,5	70,0	77,5	65,3	57,5	55,5	87,0	67,0	54,0	46,5	5,5

Tarasenko	Connection power	58,0	70,0	74,0	64,3	60,0	57,5	85,0	67,0	54,0	46,5	4,4
Sultan F_1	Connection power	59,8	70,0	75,8	64,8	58,8	56,5	86,0	67,0	54,0	46,5	4,9
	Connection power	71,5	81,8	94,5	74,5	68,3	67,3	92,8	77,3	71,3	54,5	3,5
Tristar F_1	Connection power	32,7	39,9	41,8	36,3	34,4	30,4	39,4	34,0	31,7	28,8	2,5
	Connection power	71,3	91,3	91,5	86,8	78,5	75,8	92,0	71,8	67,0	58,0	3,9
Solerosso F_1	Connection power	75,0	88,0	96,0	84,0	80,3	70,5	94,0	79,0	76,0	74,8	4,5
	Connection power	73,2	89,7	93,8	85,4	79,4	73,2	93,0	75,4	71,5	66,4	4,2

It was found that the same varieties and hybrids of tomatoes differ in planting qualities depending on the content of solutions (NaCl and Na2SO4). Thus, chloride and sulfate levels have different effects on the germination capacity and germination of tomato seeds of the cultivars and hybrids studied.

When the seeds were germinated in sodium chloride (NaCl) and sodium sulfate (Na2SO4) solutions, it was found that varieties produced in Uzbekistan are more resistant, and foreign varieties and hybrids are more sensitive. In TMK-22, Rio Grande, Yubileynyi Tarasenko and hybrid Solerosso F1 varieties, a significant decrease in seed germination is observed when the concentration of sodium chloride is 0.7-1.0%. In all varieties and hybrids, a decrease in germination and seed germination capacity was observed in the laboratory at a concentration of 0.3-0.5% sodium sulfate.

Evaluation of planting qualities of tomato varieties and hybrids soaked in Na2SO4 solution shows that the best results in terms of germination capacity and seed germination are of Volgogradskiy 5/95 varieties; TMK-22; Sultan F1 and Tristar F1 had the best performance with the lowest salt concentration (0.3%) among Rio Grande and Pridneprovsky rozovy and hybrids.

It was also found that in all tested cultivars and hybrids, compared to dry seeds (Control 1), soaked seeds (Control 2) had relatively better germination capacity and seed germination rates.

When we determined the germination power and seed germination in NaCl solutions, Rio Grande, Novichok, UzMASh-1, TMK-22 and Solerosso F1 hybrids were the best among the studied varieties.

The decrease in the intensity of seed germination in salt solutions compared to the control option is an indicator of the degree of salt tolerance of the tested seeds. Similarly, depending on the concentration of salts, it is easy to determine the degree of damage of individual ions and salts, as well as water penetration to seeds. In addition, this method makes it possible to identify the most salt-tolerant varieties and to compare the salt tolerance of different crop seeds. The basis of this method is the reaction of seeds to salts during the germination period, which reflects the resistance of the plant to salt in the later stages of development.

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