Acta Scientific NUTRITIONAL HEALTH (ISSN:2582-1423)

Volume 6 Issue 5 May 2022

Research Article

Diagnostics and Assessment of Salt Resistance of Tomato Varieties and Hybrids in The Republic of Karakalpakstan

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DOI: 10.31080/ASNH.2022.06.1039

Received: March 16, 2022

Published: April 11, 2022

Abstract

Growing tomatoes and obtaining high yields is associated with the use of varieties and hybrids resistant to stress conditions. Researches on the diagnosis of salt tolerance of 7 varieties and 3 hybrids of tomato by the method of germination in salt solutions of various concentrations were carried out in the Republic of Karakalpakstan. The following variants were tested: 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% Na_2SO_4; - 0.5% Na_2SO_4; - 0.7% Na_2SO_4; - 1.0% Na_2SO_4.

The tested varieties and hybrids of tomato turned out to be relatively resistant to chloride and sulfate salinization at the lowest concentrations (0.3%). A further increase in the concentration of salt solutions (from 0.5 to 1.0%) negatively affected the sowing qualities of seeds. The most resistant among the studied varieties and hybrids were varieties Volgogradsky 5/95; TMK-22; Rio Grande and Novichok, hybrids Solerosso F_1, Tristar F_1 and Sultan F_1.

Keywords: Tomato; Seeds; Germination; Germination Energy; Laboratory Experiment; Salt Tolerance; Saline Solutions; Sodium Chloride; Sodium Sulfate

Introduction

When solving particular and general problems of salt tolerance of plants, it often becomes necessary to apply methods that make it possible, under strictly controlled conditions, to determine the toxicity of salts and the degree of salt tolerance of plants.

The main direction of modern adaptively oriented breeding programs is selection for yield and resistance to stress [1]. There is a growth in needing to search for genetic sources for breeding, study the adaptive capabilities of the genotype, quick review of crop resistance and the introduction of promising varieties into production. This explains the actuality of developing effective methods for laboratory diagnosis of resistance [1,3,5].

The currently existing methods for determining the toxicity of salts and salt tolerance of plants can be divided into the following three groups: laboratory, vegetative and field. The most common method for determining the salt tolerance of plants is to take into account the energy of germination of plant seeds on 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. The decrease in the intensity of seed germination on salt solutions, compared with the control, is an indicator of the degree of salt tolerance of the tested seeds. In a similar way, it is easy to determine the degree of toxicity of individual ions and salts, as well as the flow of water into the seeds, depending on the concentration of salts. In addition, this method allows to identify the most

salt-tolerant varieties and compare the salt-tolerance of seeds of various crops. The basis of this method is the recognition that the reaction of seeds to salts during germination reflects the salt tolerance of the plant at subsequent stages of its development.

Salinity is mainly associated with increased sodium content in the soil. Depending on the predominant accumulation of individual sodium salts, salinization can be sulfate, chloride, soda or mixed. The most harmful effect is exerted by sodium and chlorine ions [9,10].

Salt tolerance is the ability of a plant to grow, develop and reproduce under saline conditions with the least damage. As you know, any organism is a self-regulating system. The variability of this system, the ability to adapt to external influences is the most important element in characterizing the general biological properties of a plant organism [8].

Salt tolerance is the inherited potential of plants to adapt to the salinity of the environment, which manifests itself only under conditions of increased salt concentration in the substrate. The signal for the realization of this is an increase in the concentration of ions in cells, and the adaptation itself proceeds over a significant period of time [9]. The effect of salinity on plant organisms is associated with two reasons: the deterioration of the water balance and the toxic effect of high salt concentrations [10]. As a rule, the influence of an unfavorable factor is most appeared in the depression of growth processes, which are an integral expression of all processes of plant metabolism [6].

In his studies in the conditions of Uzbekistan with vegetable crops (onions, carrots, cabbage and watermelon) on saline soils, V.I. Zuev [7] found that pre-sowing seed treatments with salt solutions, padlock in drainage water, solutions of boric acid and zinc sulfate increase seed germination, increase plant density, cell sap concentration, suction force, water-holding capacity of leaves, weaken the intensity of transpiration, enhance growth aerial parts of plants and increase their productivity. The highest salt resistance of plants and an increase in yield are achieved as a result of seed treatment with saline solution according to the method of P.A. Genkel [4] and padlocks in drainage water.

Growing tomatoes and obtaining high yields is associated with the use of highly productive, stress-resistant varieties and hybrids. According to the latest FAO data (2019), in the Republic of Uzbekistan, the area under tomato crops is 58.8 thousand hectares, the average yield is 36 t/ha and the gross harvest is 2120120 tons per year [12]. Taking into account the growth of the population of the republic, the task is to provide the population with fresh and processed products, as well as to increase the export potential.

The value of tomatoes is due to the exceptionally high taste and nutritional properties of the fruits of this crop. They contain a large number of important and very necessary substances for human health. Tomato fruits, which are high in many vitamins (B, C, PP, etc.), provitamin A (carotene), sugars (3-7%), minerals and organic acids, are among the most valuable species of vegetables in terms of nutrition and taste [2].

Very few studies have been carried out on the culture of tomato in the conditions of saline soils of the Republic of Karakalpakstan. With this in mind, we conducted experiments to diagnose and assess the salt tolerance of tomato seeds in the laboratory.

Methodology of the Research

Studies on diagnosing the salt tolerance of tomato varieties by the method of germination in salt solutions of various concentrations were carried out in the Nukus Branch of the Tashkent State Agrarian University. The following options were tested: - 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% Na_2SO_4; - 0.5% Na_2SO_4; - 0.7% Na_2SO_4; - 1.0% Na_2SO_4.

Laboratory experiments to determine the sowing qualities of seeds in order to diagnose salt tolerance were laid in the laboratory of the Center for Seed Control (Nukus, Republic of Karakalpakstan).

Studies to determine the energy of germination and growth of seeds were carried out according to SStUz 2823:2014 (Seeds of agricultural crops. Varietal and sowing qualities. Specifications) [11]. Seed germination was carried out in Petri dishes on filter paper, 100 seeds each, in 4-fold repetition, in thermostats at a temperature of +22…+25^{0}C. Observations were made daily and the number of germinated seeds was determined. By comparing the number of germinated seeds with the total number on the 5th day, the germination energy was determined, and on the 10th day, the laboratory germination of seeds was determined.

Results of the Research

Tests of tomato varieties in the conditions of saline soils of the Republic of Karakalpakstan were almost never carried out. With this in mind, we have diagnosed the salt tolerance of tomato varieties: Volgogradsky 5/95, TMK 22, UzMASH, Novichok, Rio Grande, Pridneprovsky Rozheviy and Yubileyniy Tarasenko, as well as hybrids: Sultan F_1, Tristar F_1 and Solerosso F_1.

Laboratory experiments to determine the effect of salt solutions (NaCl, Na_2SO_4) of various concentrations on germination energy and seed growing showed that with an increase in salt concentration (from 0.3 to 1%) in solutions, both germination energy (%) and growing rates of seeds decrease in all studied varieties and hybrids of tomato (Table 1).

It was found that the same varieties and hybrids of tomato differed in sowing qualities depending on the composition of solutions (NaCl and Na_2SO_4). Thus, chloride and sulfate salinity had a different effect on the germination energy and growth of tomato seeds of the studied varieties and hybrids.

Varieties	Sowing qualities	Variants of the experiment									
		Dry seeds (control 1)	Seeds soaked in water (control 2)	Seeds soaked in solutions, %							
				NaCL				Na_2SO_4			
				0,3	0,5	0,7	1,0	0,3	0,5	0,7	1,0
Varieties											
Volgogradskiy 5/95	Germination energy, %	60,9	58,9	79,2	54,4	50,9	43,9	81,3	65,9	60,8	54,7
	Growing, %	70,3	83,0	88,4	66,5	62,2	61,5	93,5	78,4	72,3	67,4
TMK 22	Germination energy, %	61,4	79,7	88,0	66,8	62,7	49,4	89,3	80,5	77,2	70,8
	Growing, %	70,9	90,2	94,8	88,4	82,7	59,4	98,5	91,0	88,8	83,9
UzMASH	Germination energy, %	63,0	74,4	80,2	63,2	54,1	51,4	74,5	60,9	51,9	48,4
	Growing, %	72,3	84,2	91,3	72,7	72,5	64,8	89,8	73,1	68,0	55,0
Novichok	Germination energy, %	64,4	65,3	80,9	59,5	53,9	50,4	78,0	66,4	60,3	56,6
	Growing, %	74,9	81,1	91,5	72,2	68,6	63,7	94,4	79,2	73,9	72,2
Rio Grande	Germination energy, %	65,2	87,0	93,2	83,4	70,3	58,3	82,2	71,5	60,2	50,8
	Growing, %	74,2	92,8	96,1	87,7	81,7	70,6	94,5	81,6	74,9	69,3
Pridneprovsky Rozheviy	Germination energy, %	59,8	70,0	75,8	64,8	58,8	56,5	86,0	67,0	54,0	46,5
	Growing, %	69,7	80,8	89,7	74,7	69,3	67,6	93,2	80,2	74,8	55,5
Yubileyniy Tarasenko	Germination energy, %	62,3	75,5	75,0	71,2	68,0	62,5	71,2	64,5	56,0	36,2
	Growing, %	71,4	84,0	84,0	79,5	75,5	72,0	90,6	87,7	78,3	70,0
Hybrids											
Sultan F_1	Germination energy, %	65,8	75,8	79,4	68,0	63,9	61,4	78,8	68,0	62,7	52,4
	Growing, %	74,2	82,3	91,9	79,3	75,3	70,3	95,9	79,4	74,4	67,1
Tristar F_1	Germination energy, %	62,6	83,1	84,8	74,7	66,8	60,3	78,8	66,0	58,6	53,5
	Growing, %	73,2	89,7	93,8	85,4	79,4	73,2	93,0	75,4	71,5	66,4
Solerosso F_1	Germination energy, %	65,1	85,0	89,3	79,6	77,8	62,2	85,0	63,0	59,4	52,3
	Growing, %	74,7	91,2	96,7	89,2	85,8	75,3	90,5	77,3	73,7	66,7

Table 1: Sowing qualities of seeds of tested tomato varieties in various salt solutions (NaCl, Na_2SO_4) in laboratory conditions.

When germinating seeds on solutions of sodium chloride (NaCl) and sodium sulfate (Na_2SO_4), it was found that varieties released in Uzbekistan turned out to be more resistant, and foreign varieties

and hybrids were more sensitive. In varieties TMK-22, Rio Grande, Yubileiniy Tarasenko and the hybrid Solerosso F_1, a noticeable decrease in seed germination was observed at a sodium chloride concentration of 0.7-1.0%. In all varieties and hybrids, a decrease in laboratory growing and seed germination energy was observed at a concentration of sodium sulfate of 0.3-0.5%.

Assessment of the sowing qualities of seeds of varieties and hybrids of tomato, soaked in a solution of Na_2SO_4 showed that the best results in terms of germination energy and seed growing were in varieties Volgogradsky 5/95; TMK-22; Rio Grande and Prydniprovsky rozhevy; and among the hybrids, Sultan F_1 and Tristar F_1 had the best performance with the lowest saline concentration (0.3%).

It was also found that, compared with dry seeds (control 1), seeds soaked in water (control 2) had relatively better indicators of germination energy and seed growing in all tested varieties and hybrids.

In varieties and hybrids of tomato, the best variant of padlock in NaCl solution (0.3%), compared with controls 1 and 2, had indicators that significantly exceeded the NSR. Only in variety Yubileyniy Tarasenko, the variant of seed padlock in 0.3% NaCl solution had a laboratory germination rate of 84%, which was the same as control 2 (seed padlock in water).

An analysis of the laboratory energy of germination and seed growing in NaCl solutions showed that among the studied varieties, the best varieties were Rio Grande, Novichok, UzMASH, TMK-22 and the Solerosso F_1 hybrid.

Conclusion

Summarizing the above, we can conclude that the tested varieties and hybrids of tomato were relatively resistant to chloride and sulfate salinity at the lowest concentrations (0.3%). A further increase in the concentration of salt solutions (from 0.5 to 1.0%) negatively affected the sowing qualities of seeds. The most resistant among the studied varieties and hybrids were varieties Volgogradsky 5/95; TMK-22; Rio Grande and Novichok, hybrids Solerosso F_1, Tristar F_1 and Sultan F_1.

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