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# Salt Tolerance and Productivity of Winter Wheat Varieties in the Conditions of Karakalpakstan

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## Annotation

The article presents the results of laboratory and field experiments carried out screening the world collection of some samples of soft wheat Triticumaestivum of different ecological - geographical origin in relation to salt stress.

In the sharp climate of Karakalpakstan, during the entire ontogenesis, wheat plants are constantly exposed to extreme stress factors (soil salinity, freezing winters, spring - summer dry winds). Therefore, the metabolic processes in wheat plants that occur under these conditions, especially at noon hours, are mainly aimed at self-preservation, i.e. for survival.

At the initial stages during the period of germination, the resistance of wheat samples to salinity is clearly determined by the activity of growth and development of seedlings. A saline environment inevitably leads to inhibition of seedling growth, while root growth is inhibited to a greater extent than seedling height.

On a saline agricultural background, all elements of the yield structure are quantitatively reduced, but salt-tolerant forms are less suppressed and form a high yield. They are distinguished by greater bushiness, size and illumination of the ear and the mass of 1000 grains.

On the saline soils of Karakalpakstan, the regularities of the growth of development and the formation of productivity of salt-tolerant forms were revealed with a description of economically useful signs and properties. On their basis, salt

tolerant donors were identified with positive characteristics of productivity. The highest salt tolerance was observed in the Avoset-s samples; GAN-91 and 040609.

On the basis of a long-term study, a new high-yielding salt-tolerant variety of soft winter wheat "Utkir" was developed from the collection sample 040609 by the method of individual selection. As a result of the SCV (State Control of Varieties) data, the variety was zoned in 2020, and is being intensively distributed in farms of Karakalpakstan.

**Key words:** Selection, winter wheat, saline background, salt tolerance, variety samples, vegetation period, standing density, productivity, sustainable, yield.

## Introduction

In Karakalpakstan, wheat crops are mainly located on saline desert lands in a zone of sharply continental climate. After sowing winter wheat, the soil gradually cools down and reaches a certain value, the air temperature, according to long-term data, in some years reaches -21-260C, a harsh winter sets in. Spring and summer are also characterized by unfavorable weather conditions, primarily a large number of windy days and the onset of drought. Wheat plants grow and develop in a complex of stressful conditions. The metabolic processes that occur in wheat plants are mainly aimed at self-preservation. To obtain high yields and the formation of an appropriate amount of dry matter, a large amount of water and nutrients is required.

The varieties cultivated in the zone, more than 70% of the area are imported, created in other temperate regions. Therefore, under these conditions, the genotype of the created variety should have a high adaptive potential (soil salinity, low temperature and drought).

Consequently, the problem of resistance of varieties to stress factors for agriculture in Karakalpakstan is very relevant and requires its solution. The adaptation of plants to stressful conditions is important in the study of plant resistance [Udovenko G.V. 1995].

In the process of evolution and selection, stable associations of genes are created, which determine the adaptation of genotypes to specific environmental conditions [Sozinov A.A. 1985]. When a significant part of the hybrids is split in the offspring, these associations are passed on to the offspring. Therefore, valuable gene associations can arise in the process of selection [Sechnyak LK; Lyfenko S.F. 1986].

Samofalova N.E. and. others [2010] note that of the many requirements for modern varieties, resistance to yield-limiting environmental factors is in the first place. The saline environment inhibits the growth and development of plants and the activity of their metabolism. In the conditions of Karakalpakstan, the most harmful abiotic stresses include a high concentration of chloride and sulfate salts in the soil [Abdullaev B.U. and. others 2013]. Soft wheat lends itself particularly well to genetic improvement in terms of resistance to salinity [Kuchiev Kh.Kh. 2009].

The objectives of our research are aimed at finding a salt-tolerant starting material, studying and identifying the main regularities in the formation of productivity in salt-tolerant forms with a description of economically useful indicators and properties of the isolated donor forms.

## Materials and research methods

To create salt-tolerant varieties that combine a number of positive indicators and properties, we studied more than 300 varieties of the world collection of soft winter wheat.

As the object under study, 6 of the most highly productive donors of winter soft wheat were taken, combining the signs of stunting with the productivity of ears.

Evaluation of collection varieties of winter wheat during the period of seedling was carried out in laboratory conditions at various concentrations of saline solution [0; 0.35; 0.70; 1.0; 1.5; 2,0] sodium chloride (NaCl), and studied in the field by the type of competitive variety testing in 4-fold repetition. The standard variety was the zoned variety "Tanya"

As a selective factor in the field, we used a saline agrophone, a saline agrophone was created in the field with a one-time washing of the soil, and a non-saline background with the use of two repeated flushing of the fields, where the chlorion content in the upper arable horizon at a depth of 0-30 cm varies 0.071 - 0.089% and in a non-saline background 0.043-0.071%.

At the same time, the content of sulfate ion corresponded to 0.132-0.192 and 0.012-0.014%.

Agrotechnical measures in the experiment were carried out according to agricultural recommendations adopted in the region.

## Research results

The influence of the saline agrophone on the studied varieties of soft winter wheat shows that they react differently to the salt content in the soil, depending on the genotype.

At the initial stages during the period of germination, the resistance of plant varieties to salinity is clearly determined by the activity of growth and development of seedlings. The characteristic differences of the varieties on the saline concentration of NaCl varied depending on their salt tolerance (Table 1).

The level of salinity has a significant effect in the stage of seed swelling and seedling formation, as a result of which seedlings are obtained on a saline agricultural background. lasts 2-3 days than in a conventional non-saline agricultural background, making them vulnerable at this time to contamination by soil microorganisms. However, this delay between accessions does not occur equally. The most depressing effects on germinating seeds were observed in the saline agricultural background in unstable varieties.

Depending on the different concentrations of sodium chloride, the sizes of both the aerial part and the root system of seedlings change. With an increase in the concentration of saline solution, there is a sharp decrease in seedling indicators and, ultimately, laboratory germination decreases sharply.

**Table 1**

**Influence of different concentrations of saline solution on the growth and development of seedlings of the world collection of winter wheat during the period of seedling**

| № | Number of varieties | Concentration of saline solution, % | Laboratory germination, % | The height of seedling, cm | The length of roots, cm | Amount of roots, piece |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | Tanya | K | 96,0 | 17,7 | 12,6 | 5,0 |
| | | 0,35 | 84,6 | 15,8 | 12,9 | 4,9 |
| | | 0,70 | 73,2 | 8,4 | 8,9 | 4,6 |
| | | 1,0 | 33,0 | 7,2 | 5,7 | 4,5 |
| | | 1,5 | 8,9 | 3,4 | 4,4 | 4,9 |
| | | 2,0 | - | - | - | - |
| 2 | AVOSET | K | 96,0 | 13,4 | 13,0 | 5,0 |
| | | 0,35 | 94,0 | 12,2 | 10,7 | 5,0 |
| | | 0,70 | 83,0 | 12,4 | 10,5 | 5,0 |
| | | 1,0 | 77,0 | 10,7 | 9,8 | 4,9 |
| | | 1,5 | 66,0 | 8,0 | 6,2 | 5,0 |
| | | 2,0 | 27,0 | 6,5 | 4,6 | 4,8 |
| 3 | 040609 (F-77/Clk) x 86035*BB -24 D – 144 | K | 96,3 | 14,8 | 14,1 | 5,0 |
| | | 0,35 | 93,6 | 14,7 | 14,0 | 5,0 |
| | | 0,70 | 83,0 | 13,9 | 12,0 | 4,9 |
| | | 1,0 | 73,5 | 13,2 | 11,0 | 5,0 |
| | | 1,5 | 51,2 | 8,5 | 6,9 | 4,8 |
| | | 2,0 | 23,2 | 5,5 | 4,6 | 4,7 |
| 4 | Uz 00124934 uzbekistan D – 107 | K | 96,2 | 14,5 | 15,1 | 4,7 |
| | | 0,35 | 84,5 | 14,7 | 12,1 | 4,8 |
| | | 0,70 | 76,5 | 14,4 | 11,1 | 4,5 |
| | | 1,0 | 43,0 | 11,8 | 11,6 | 4,8 |
| | | 1,5 | 18,5 | 6,5 | 6,7 | 4,6 |
| | | 2,0 | - | - | - | - |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 5 | GAN – 91 №12-Super Seri Sr 25 | K | 95,7 | 15,7 | 15,4 | 4,9 |
| | | 0,35 | 86,5 | 12,1 | 8,6 | 5,1 |
| | | 0,70 | 76,0 | 11,4 | 8,7 | 5,0 |
| | | 1,0 | 47,2 | 4,7 | 3,5 | 4,6 |
| | | 1,5 | 36,0 | 4,6 | 3,9 | 4,3 |
| | | 2,0 | 22,7 | 3,0 | 3,5 | 4,5 |
| 6 | 030965-72-T 67/x84 | K | 96,7 | 17,4 | 13,9 | 5,0 |
| | | 0,35 | 92,5 | 16,7 | 13,9 | 5,2 |
| | | 0,70 | 86,0 | 15,2 | 12,6 | 5,1 |
| | | 1,0 | 64,2 | 12,3 | 10,1 | 5,0 |
| | | 1,5 | 43,0 | 7,9 | 6,4 | 4,8 |
| | | 2,0 | - | - | - | - |
| 7 | Grekum bel.osti Uzbekistan D – 256 | K | 97,0 | 13,8 | 14,7 | 3,4 |
| | | 0,35 | 86,7 | 12,9 | 12,9 | 3,7 |
| | | 0,70 | 69,5 | 12,6 | 13,2 | 3,5 |
| | | 1,0 | 63,7 | 10,0 | 9,5 | 3,4 |
| | | 1,5 | 47,5 | 4,7 | 5,4 | 3,4 |
| | | 2,0 | 21,0 | 4,1 | 4,4 | 3,4 |

Measurement of the length of the seedling and roots showed that salinization inevitably leads to inhibition of seedling growth. In this case, the growth of roots was inhibited to a greater extent than the height of the seedling. A decrease in the seedling root system is considered the primary response to salt stress (Robinson et el 1997).

Each variety has its own sensitivity to the studied salt concentrations, while the most variable trait under salinity conditions in the studied wheat varieties were the height of the seedling and the length of the roots, and the least variability was observed in terms of the number of roots.

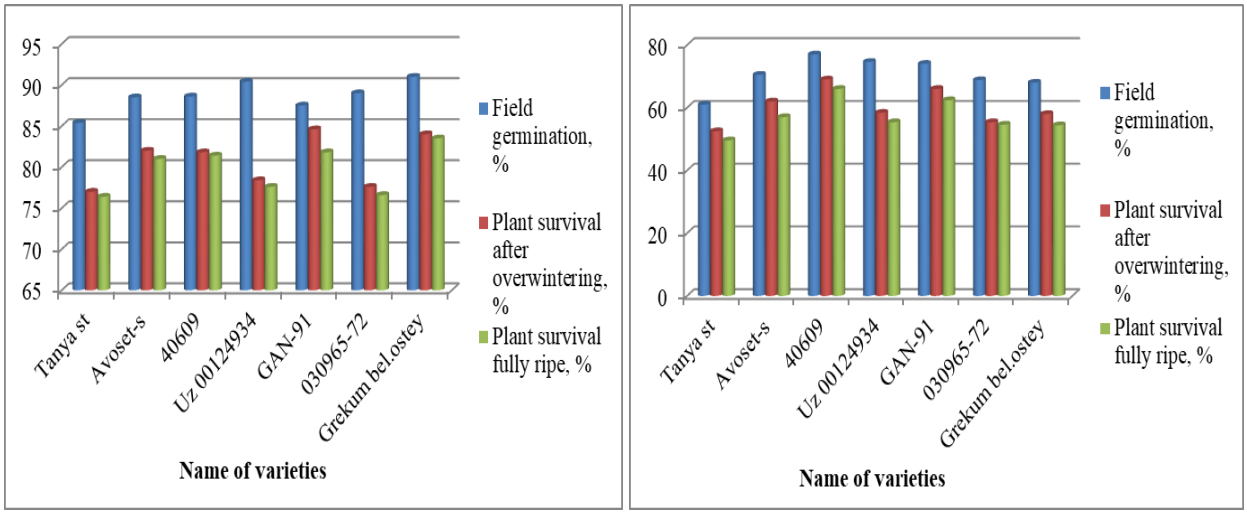
Even a low concentration of sodium chloride (0.35%) adversely affects seedling root growth. Plants of the salinity-resistant varieties have successfully coped with the preliminarily unpleasant action of salts. Some varieties (GAN - 91;

Avoset; 040609; Grekumbel.ost) even at 2.0% concentration of sodium chloride solution formed seedlings (13.2 - 23.2%).

The results of the laboratory experiment make it possible to state that the laboratory germination and the size of winter wheat seedlings decreased to a lesser extent in plants characterized by higher salt tolerance than in varieties sensitive to salinity.

Determination of plant density enables breeders to assess how the tested varieties meet the requirements of cultivation conditions in terms of their biological properties.

When evaluating varieties, we took into account the indicators of field germination, plant safety after overwintering and until the grain is fully ripe. Taking into account the density of seedlings (despite the laboratory germination of seeds, they belong to the original seeds), the studied varieties differ greatly from each other. In a saline background, field germination and plant survival after overwintering of varieties are greatly reduced. (graph 1). Salt-tolerant varieties have the highest field germination capacity, in which this indicator is 3.1-17.5% higher than the standard “Tanya” variety.




***Non-saline agricultural background*** ***Saline agricultural background***

**1-fig. The effect of soil salinity on the field germination and plant survival of various winter wheat varieties**

Consequently, under the influence of various unfavorable internal and external environmental factors, the dying off of plants of varieties of soft winter wheat occurs. These data show that their winter hardiness and resistance to soil salinization are not uniformly dependent on the genotype.

The main criterion for evaluating varieties for salt tolerance, we took the indicators of structural elements of productivity (table-2).

The studied varieties differ in terms of plant height, length, density and illumination and the mass of grain from one spike. But the difference between the varieties on a saline background is on different level. The highest productivity in the saline agro-soil was observed in the Avoset-s; 040609 and GAN-91. They mainly belong to the soon-to-mid-season forms, are characterized by high stability, ear productivity and a weight of 1000 grains per year, which allows them to maintain a high grain weight in the harvest under stress conditions.

**Table 2**

**Influence of saline agricultural background on the formation of some elements of productivity of promising varieties of winter wheat**

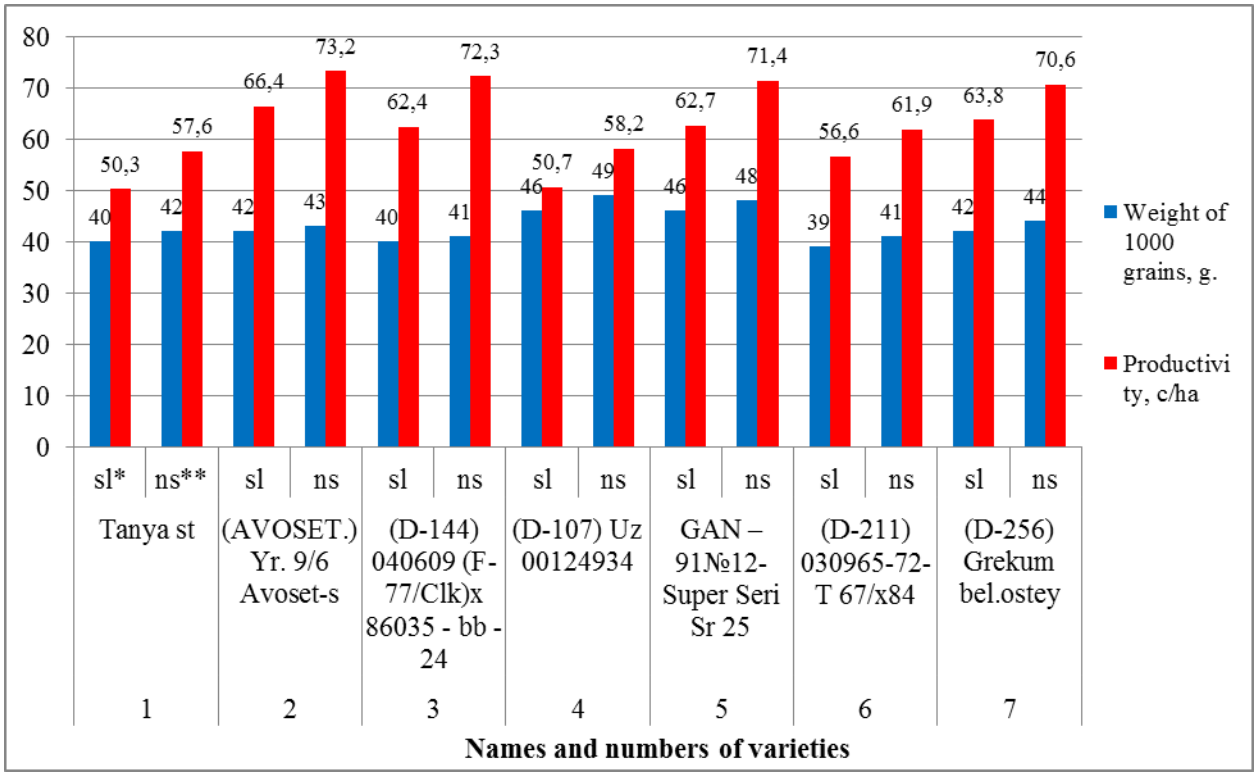
| № | Name and number of varieties | The length of plant, cm | | The length of ear, cm | Ear productivity | Amount of grains on ear, piece | Weight of grains on ear, g |
|---|---|---|---|---|---|---|---|
| 1 | Tanya st | Sl.* | 62,6 | 8,5 | 2,6 | 27 | 1,09 |
| | | Ns.** | 71,2 | 9,1 | 3,3 | 34 | 1,35 |
| 2 | (AVOSET.) Yr. 9/6 Avoset-s | Sl. | 68,7 | 9,0 | 3,3 | 32 | 1,30 |
| | | Ns. | 73,7 | 9,8 | 3,8 | 39 | 1,51 |
| 3 | (D-144) 040609 (F-77/Clk)x 86035 - bb -24 | Sl. | 75 | 9,2 | 3,3 | 28 | 1,10 |
| | | Ns. | 81,4 | 10,2 | 3,6 | 38 | 1,40 |
| 4 | (D-107) Uz 00124934 | Sl. | 73,9 | 9,4 | 3,0 | 29 | 1,30 |
| | | Ns. | 80,5 | 10,0 | 3,2 | 31 | 1,43 |
| 5 | GAN – 91№12-Super Seri Sr 25 | Sl. | 68,1 | 8,2 | 3,2 | 27 | 1,20 |
| | | Ns. | 74,8 | 9,3 | 3,7 | 34 | 1,48 |
| 6 | (D-211) 030965-72- | Sl. | 72,5 | 8,5 | 3,0 | 31 | 1,2 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | T 67/x84 | Ns. | 78,9 | 9,7 | 4,0 | 35 | 1,35 |
| 7 | (D-256) Grekum bel.ostey | Sl. | 83,6 | 8,0 | 3,3 | 27 | 1,00 |
| | | Ns. | 88,5 | 9,2 | 3,7 | 31 | 1,25 |

Sl. * - saline agricultural background;

Ns. ** - non-saline agricultural background;

All selected varieties exceed the standard variety "Tanya" in yield by 5.4 - 7.1 c/ha, and are characterized by a good combination of elements of the yield structure (Fig. 2). Each of the listed forms has a number of individual characteristics that must be taken into account when using them in selection and production.




Sl * - saline agricultural background;

Ns ** - non-saline agricultural background;

**Figure: 2. Influence of saline agricultural background on the formation of productivity of promising varieties of winter wheat**

As a result of long-term study, from the collection variety 040609 (F-77) CLKJ x 86035 * - BB -24 by the method of individual selection, we have developed and transferred to the SCV a winter wheat variety called "Utkir". The variety is suitable for cultivation on saline soils of Karakalpakstan. According to the SCV, the variety was recognized as promising in 2019.

## Results

1. The results of the conducted studies indicate that salt tolerant varieties of soft winter wheat are characterized by different norms of reaction to changes in the degree of soil salinity, depending on genetic inheritance.

2. In the initial stages during the period of seedling, the resistance of varieties of soft winter wheat to salinity is clearly determined by the activity of growth and development of seedlings, each variety has its own amplitude of sensitivity to salinity, in terms of the value of laboratory germination indicators, the length of seedlings, and root growth is inhibited more than a degree.

3. The main sign of salt tolerance is their ability to successfully overcome the adverse effect of salinity and form a relatively high yield with a good combination of elements of the yield structure.

4. As a result of the research, the highest-yielding salt-tolerant varieties GAN-91; 040609; Avoset-s were identified; possessing a number of individual characteristics, which should be taken into account when using them in breeding as salt tolerance donors.

5. From the collection variety sample (040609 –F-77-GLKJ X 85035 * -BB-24), a new high-yielding salt-tolerant variety “Utkir” was bred by the method of individual selection and transferred to the SCV. According to the test results, the variety was recognized as promising and entered into the State Register in 2019.

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