AGRICULTURAL SCIENCES

PARAMETERS OF WATER REGIME AND DETERMINATION OF PHOTOSYNTHETIC PRODUCTIVITY IN WINTER TRITICALE SAMPLES UNDER CONDITIONS OF WATER DEFICIENCY

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Abstract

In 24 winter triticale samples, the parameters of the water regime (water deficiency, relative water content, water-holding capacity) and the content of photosynthetic pigments were determined. It has been established that with a lack of water, the water-holding capacity increases, water deficiency increases, and the relative water content decreases. The highest stability of water regime indicators, which practically did not change under conditions of irrigation and water deficit, was noted for the TRL-63 sample. The content of photosynthetic pigments in the leaves of triticale samples was determined by the SPAD method. In most samples, chlorophyll degradation occurred to varying degrees. Samples TRL-1, TRL-9, TRL-25, TRL-41, TRL-52, TRL-54, TRL-56, TRL-58, TRL-60, TRL-77/2 can be considered more stable compared to others samples in terms of water holding capacity and relative water content, and the TRL -25 and TRL -60 variants also showed an increase in the content of photosynthetic pigments.

Keywords: triticale, water regime, water-holding capacity, chlorophyll

The current task of agriculture is the selection of varieties of cereal plants that are resistant to adverse environmental factors and are capable of producing high yields and high-quality grain in various climatic and soil conditions. In difficult environmental conditions, the productivity of agricultural plants decreases and their quality decreases. Therefore, for the production of high-quality products, an important condition is to obtain stable varieties and forms that can withstand extreme environmental conditions. Triticale is a hybrid of wheat and rye. This plant combines the grain quality of wheat and the resistance of rye to adverse environmental conditions [1]. Not much research has been done on the stress tolerance of triticale, an evolutionarily new grain crop. Drought tolerance has been studied even less. The development of drought-resistant and productive varieties and lines based on determining the parameters of the water regime deserves special attention. As is known, the water regime of plants is the most important indicator of their resistance to soil and climatic conditions [8]. By studying the water regime of cultivated plants, it is possible to determine the degree of their adaptation to agroclimatic factors [5]. The characteristics of the water regime of triticale, together with photosynthetic productivity and resistance to unfavorable conditions, have not been sufficiently studied.

Since the parameters of the water regime characterize the resistance of plants to water deficiency, in this regard, the purpose of the research work was to determine photosynthetic activity and study the parameters of the water regime under conditions of water deficiency.

Materials and methods

Triticale accession seeds were provided by the Department of Molecular Cytogenetics and grown under irrigated conditions (soil moisture 70%) and water deficiency (soil moisture 35%) under field experiment conditions of the Institute of Genetic Resources. For 24 triticale samples: TRL-1, TRL-4, TRL-7, TRL-9, TRL-16, TRL-24, TRL-25, TRL-26/2, TRL-29/2, TRL-41, TRL -43/1, TRL-44/2, TRL-47, TRL-48, TRL-50, TRL-52, TRL-54, TRL-55/1, TRL-56, TRL-58, TRL-60, TRL -63, TRL-70, TRL-77/2 parameters of the water regime (water deficiency, relative water content, water-holding and water-absorbing capacities) were determined according to the method of N.N. Kozhushko. [4, p.49].

The level of chlorophyll in the leaves of the upper tier of triticale samples was determined using a portable device SPAD-502PLUS. The device determines spectral absorption in two ranges and, based on the data obtained, determines the total indexed value of chlorophyll in the leaves. The ratio of the content of photosynthetic pigments in experimental and control plants was determined as a percentage, and this ratio was taken as the unit of measurement when identifying stress-resistant samples: the higher the indicators, the more resistant the sample was considered.

Results and its discussion

The parameters of the water regime were determined under the conditions of Absheron, characterized by long, hot summers. The hottest months are July and August with an average monthly air temperature of 30°C, reaching 42°C on some days. Annual precipitation on irrigated fields falls mainly in autumn, winter and spring. In summer there is almost no precipitation, and the need for water in the agricultural zones of the republic is satisfied only through irrigation. Based on weather conditions and the impact of water deficiency on crops, studying the parameters of the water regime makes it possible to predict the resistance of plants to water stress.

Determining the magnitude of water deficiency in the leaves of plants grown under irrigated conditions showed that the level of water deficiency in most of the studied varieties under these conditions is lower than under conditions of water deficiency. Water deficiency in control triticale plants grown under irrigation conditions (70% soil moisture) was 3-18%, and in experimental plants (35% soil moisture) it was within 8-23% (Fig. 1).

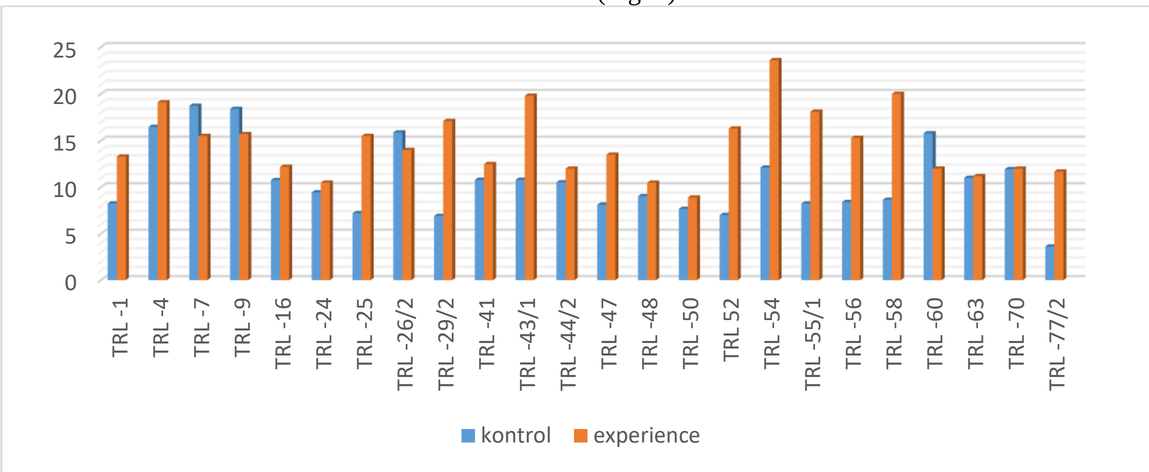

Figure 1. Water deficiency in leaves of triticale samples.

Plants exposed to identical drought conditions and maintaining higher tissue water content create better conditions for the occurrence of all physiological processes in plants [7]. Determination of the water content of leaves of plants grown under irrigated conditions showed that the level of relative water content in most of the studied genotypes under these conditions is higher than under conditions of lack of water. The relative water content in triticale plants was 81.0-96.0% in the control and 76.0-91.0% in the experimental variants. This parameter was 9.0-11.0% lower in experimental plants: TRL – 54 (11%), TRL – 43/1 (9%), TRL – 54 (11%), TRL –55/1 (10 %), TRL –58 (11%) compared to control. However, in some experimental variants an increase in the relative water content was observed. In genotypes TRL – 7, TRL – 9, TRL – 26/2, TRL – 60 this figure was higher by 2.0-3.0%. According to Ionova et al., under conditions of water shortage, the relative water content in the leaves of winter wheat decreased by 3.0-18.0%, while in our study the decrease in this indicator in triticale plants was 3.0-11.0% [7].

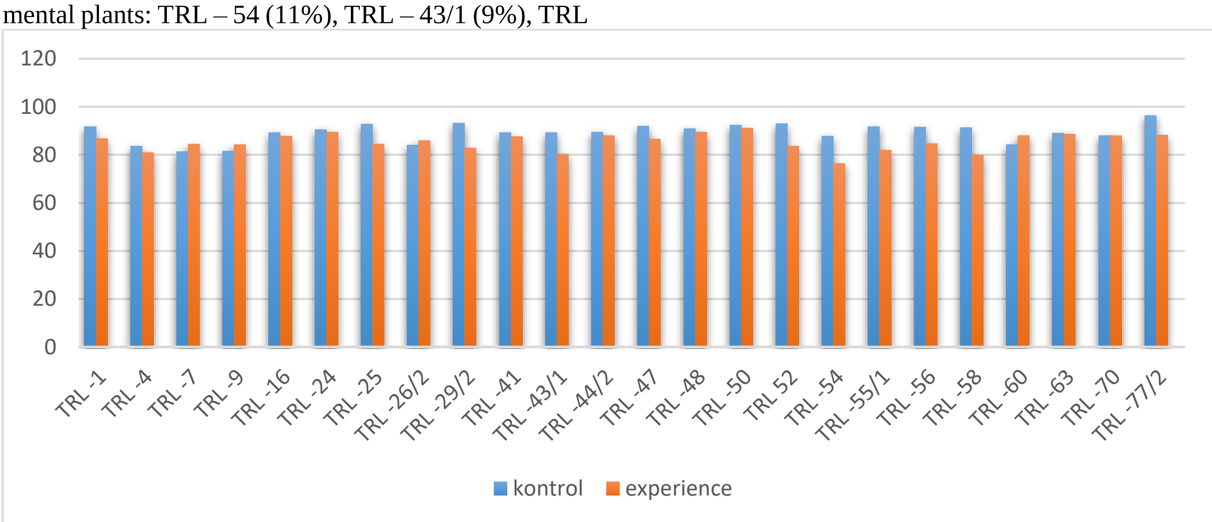

Figure 2. Relative water content in leaves of triticale samples.

The water-holding capacity of plants plays an important role in the regulation of water metabolism and reflects the plant's resistance to drought and high temperatures, since its value is determined by the amount of osmotically active substances collected in the cell, the ability of colloids to swell due to bound water, and the permeability of membranes [2]. When water is scarce under drought conditions, the amount of water bound to osmotic substances (such as proline) increases and water holding capacity increases. As water deficiency increases, water-holding capacity increases rapidly in more resistant samples [3].

Determination of water-holding capacity in our studies showed that for most samples grown under irrigation conditions, this indicator is lower than under conditions of water deficiency (Fig. 2). Under irrigation conditions, the water-holding capacity of control plants ranged from 41.78 to 84.48%. In case of water shortage, this indicator increased and varied in the range of 49.0 - 92.5%.

In some experimental triticale varieties, the retention of a significant amount of water in the cells was observed: the water-holding capacity increased by 40.0% in triticale samples TRL -54; by 39.0% in the experimental version TRL -43/1; by 28.0% in the TRL -9 option; by 20.0% in TRL -41 and by 17.0% in TRL-70. The remaining genotypes were characterized by an increase in water retention by 4.0-15.0% compared to the control. Along with this, according to various sources, in wheat, which is one of the parent forms of triticale, under water stress the ability to retain water increases by 8.0-29.0% and 8.0-13.0% (6,8). However, in our experiment there were samples in which the water-holding capacity decreased: 65.3% (in the control 69.2%) for TRL - 26/2, 49.0% (in the control 67.33%) for TRL - 29/2, 78.2% (in control 84.48%) for TRL – 55/1.

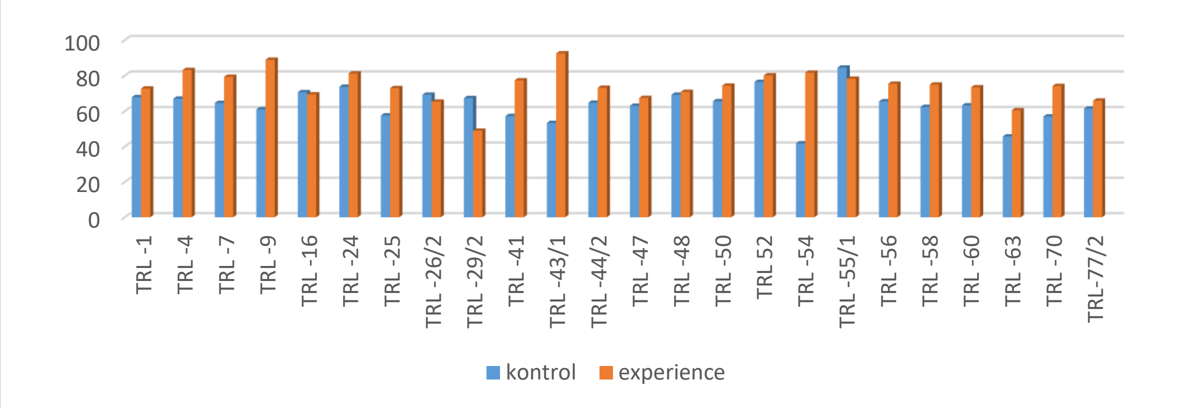

Figure 3. Water holding capacity in leaves of triticale samples.

The content of photosynthetic pigments in the leaves of triticale samples was determined by the SPAD method. With the exception of experimental variants TRL -24, TRL -29/2, TRL -58, most samples exhibited chlorophyll degradation to varying degrees. Under conditions of water deficiency, xl (a+b) in control plants ranged from 33.8 to 57.8, and in experimental plants - from 36.5 to 55.2.

In more drought-resistant varieties and accessions of various plant species, an increase in the content of green pigments is observed against the background of water deficiency [2]. In experimental triticale varieties TRL -24, TRL -29/2, TRL -58, an increase in the content of photosynthetic pigments by 4-17% was observed. However, as water stress continues, degradation of chlorophyll in leaves occurs.

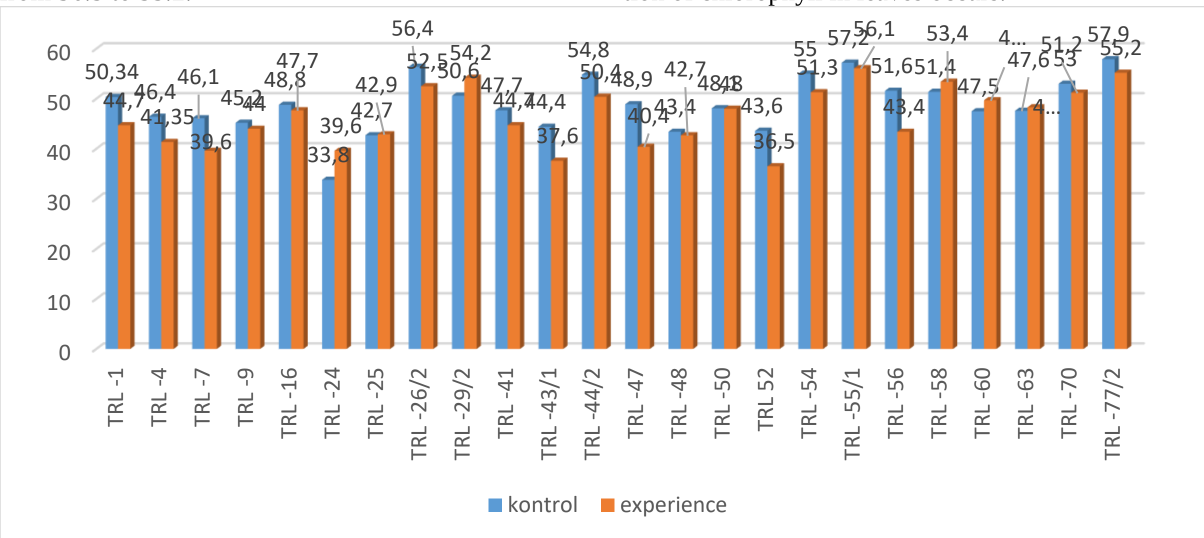

Figure 4. Chlorophyll content in leaves of triticale samples.

The physiological parameters of triticale samples under conditions of irrigation and water deficiency are shown in Table 1. Under conditions of water deficiency, an increase in water-holding capacity indicators indicates a high resistance and ability to self-heal under stress of the studied triticale samples. An increase in water-holding capacity under stress was observed in samples TRL -1, TRL - 9, TRL - 25, TRL - 41, TRL - 52, TRL - 54, TRL - 56, TRL - 58, TRL - 60, TRL - 77 /2. The water deficit in these samples did not exceed 20.0%. The exception was the triticale sample TRL - 54, whose water deficit was 23.6%. A minimal water deficit was observed in the experimental version TRL - 77/2. In two triticale genotypes (TRL - 25, TRL - 60), under conditions of water deficiency, along with an increase in water regime indicators, an increase in the content of photosynthetic pigments was noted.

Table 1

Physiological parameters of triticale samples under conditions of irrigation and water deficiency: WHC – water holding capacity, RWC – relative water content, WD – water deficiency, K – control, LW – lack of water

Samples	chlorophyll		WHC		RWC		WD	
	К	LW	К	LW	К	LW	К	LW
TRL -1	50,34	44,7	67,84	72,7	91,74	86,7	8,25	13,3
TRL -4	46,4	41,35	67,01	83,1	83,53	81,0	16,47	19,1
TRL -7	46,1	39,6	64,61	79,3	81,27	84,5	18,73	15,5
TRL -9	45,2	44,0	61,0	88,9	81,61	84,2	18,39	15,7
TRL -16	48,8	47,7	70,64	69,4	89,23	87,8	10,77	12,2
TRL -24	33,8	39,6	73,72	81,2	90,54	89,5	9,45	10,5
TRL -25	42,7	42,9	57,56	72,9	92,8	84,5	7,2	15,5
TRL -26/2	56,4	52,5	69,19	65,3	84,11	86,0	15,88	14
TRL -29/2	50,6	54,2	67,33	49,0	93,1	82,8	6,91	17,1
TRL -41	47,7	44,7	57,22	77,3	89,2	87,5	10,8	12,5
TRL -43/1	44,4	37,6	53,38	92,5	89,19	80,2	10,81	19,8
TRL -44/2	54,8	50,4	64,72	73,1	89,45	88,0	10,54	12
TRL -47	48,9	40,4	63,0	67,4	91,87	86,5	8,13	13,5
TRL -48	43,4	42,7	69,2	70,8	90,95	89,5	9,04	10,5
TRL -50	48,1	48,0	65,6	74,3	92,33	91,1	7,67	8,9
TRL 52	43,6	36,5	76,41	80,1	92,99	83,7	7,01	16,3
TRL -54	55,0	51,3	71,78	81,6	87,87	76,3	12,12	23,6
TRL -55/1	57,2	56,1	84,48	78,2	91,75	81,9	8,25	18,1
TRL -56	51,6	43,4	65,49	75,4	91,58	84,7	8,41	15,3
TRL -58	51,4	53,4	62,34	74,9	91,34	79,8	8,65	20
TRL -60	47,5	49,7	63,23	73,4	84,21	88,0	15,79	12
TRL -63	47,6	48,3	45,7	60,5	88,98	88,7	11,01	11,2
TRL -70	53,0	51,2	57,0	74,1	88,1	88,0	11,95	12
TRL -77/2	57,9	55,2	61,4	65,9	96,38	88,2	3,62	11,7

Conclusions: 1. It has been established that the water-holding capacity of leaves of drought-resistant triticale plants increases with a lack of water.

2. Samples: TRL-1, TRL-9, TRL-25, TRL-41, TRL-52, TRL-54, TRL-56, TRL-58, TRL-60, TRL-77/2 included in the study, can be considered more stable compared to other samples in terms of water holding capacity and relative water content, and the TRL -25 and TRL -60 variants also demonstrated an increase in the content of photosynthetic pigments. The triticale sample TRL -63 showed high stability; the water regime of this sample did not change under conditions of irrigation and water deficiency. The remaining samples can be classified as moderately resistant.

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