The Effect Of Rye Translocation *T1BL.1RS* on economically valuable traits of winter common wheat varieties

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Abstract. There have been studied new promising winter common wheat varieties 'Ambar', 'Premiera' and 'Ermak', the leading variety according to the area occupied in the Rostov region. The variety 'Don 107' was used as a standard according to reserve protein loci to identify introgression of genetic material from rye, and there has been studied the effect of the translocation *T1BL.1RS* on the severity of grain quality traits. The samples were grown in a competitive variety testing conducted in the department of winter wheat breeding and seed production of the ARC "Donskoy" in 2017-2019. Estimations, records, and observations were carried out in accordance with the methodological instructions of the State Variety Testing of agricultural crops. In order to identify rye translocations, there has been used the method of electrophoresis of alcohol-soluble reserve proteins in an acidic medium in a starch gel. There has been determined that the mean productivity of the new promising variety 'Ambar' over the years of study exceeded the standard by 6%, and the variety 'Ermak' by 7%. The excess of maximum productivity was 5% and 23%, respectively, over the standard and the leading variety. The variety 'Premiera' has had mean productivity higher by 13 and 14% compared to the standard 'Don 107' and the variety 'Ermak', respectively. There has been established a maximum productivity excess to the standard and the leading variety by 3% and 9%. At the same time, their flour strength and SDS-sedimentation were 63% and 60%, 102% and 97%, respectively. According to protein and gluten percentage in grain, the varieties 'Ambar' and 'Premiera', like 'Don 107' and 'Ermak' have fallen into the same quality group of class 3, being characterized with valuable grain. An important advantage of the 'varieties Ambar' and 'Premiera' is resistance to brown rust, yellow rust, stem rust and powdery mildew, since the translocation contains resistance genes to these diseases.

1 Introduction

One of the most important global problems is to provide the population with food. World breeding science is currently working both to improve productivity potential of grain crops

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and to develop varieties that are resistant to various biotic factors, which in some years result in significant losses in the gross grain yield [1, 2].

Winter common wheat (*Triticum aestivum* L.) is the main food crop not only in Russia, but also in other countries. Currently, all breeders note that the genetic potential of common wheat productivity is almost exhausted. A yield size significantly depends on the developed varieties' resistance to abiotic and biotic environmental factors. The genetic resources of common wheat are not enough to solve these problems [3].

The use of introgressive material in wheat breeding has given an opportunity for a new stage of the "green revolution", which, first, will affect the problems of productivity, quality, and plant resistance to abiotic and biotic stressors. One of the methods for enriching the gene pool of common wheat is the introgression of genetic material from related species. The wheat-rye translocation *T1BL.1RS* with the allele *Gli1B3*, which controls the synthesis of rye proteins, is often found in the varieties of domestic breeding [4,5]. The presence of the translocation *T1BL.1RS* promotes improved productivity, drought resistance, the formation of larger kernels, more efficient moisture utilization by roots and the growth of above-ground biomass [6]. This is due to the fact that translocation *T1BL.1RS* contains the leaf rust resistance gene Lr26, as well as resistance genes to yellow rust Yr9, stem rust Sr31 and powdery mildew Pm8. Thus, the presence of one resistance gene in a variety that is part of a linkage group indicates the presence of other genes from it [1,3,7].

Several researchers have found that the presence of the translocation *T1BL.1RS* in the common wheat genome has a negative effect on baking qualities [8].

The purpose of the current study was to identify the translocation *T1BL.1RS* and study the effect of its presence on economically valuable traits in the new winter common wheat varieties 'Ambar' and 'Premiera'.

2 Materials and methods

For the current study there have been new promising winter common wheat varieties 'Ambar', 'Premiera' and 'Ermak', the leading variety according to the area occupied in the Rostov region. The variety 'Don 107' was used as a standard. The varieties were grown in a competitive variety testing in the department of winter wheat breeding and seed production according to the generally accepted technology in conditions typical for the southern part of the Rostov region in 2017-2019 and were sown after maize for grain. The area of the plot was 10 m2 with a sixfold repetition.

Grain quality traits were evaluated in accordance with the methodical recommendations of the State Variety Testing Commission (1988). In order to identify rye translocations, there has been used the method of electrophoresis of alcohol-soluble storage proteins in an acidic medium in a starch gel [9,10]. The prolamins' symbols were given according to E.V. Metakovsky [11,12] and F.O. Poperel [13].

3 Results and discussion

The winter common wheat variety 'Ambar' was developed by hybridizing the varieties 'Yuzhanka' and 'Slavyanka', it was sent to the State Variety Testing in 2018 and was included in the List of Breeding Achievements in 2020. This is a highly productive winter common wheat variety with a high environmental adaptability. 'Premiera' is the variety of a universal type that combines high grain productivity with an increased level of drought and frost resistance. The variety was sent to the State Variety Testing in 2019. It was developed by the method of intervarietal hybridization, the varieties 'Vassa' and 'Blagodarka odesskaya' were used as the initial forms.

The presence of translocation in the maternal forms of 'Yuzhanka' and 'Vassa' was confirmed by the study carried out at the NGC named after. P. P. Lukiyanenko [14]. In the 'Blagodarka odesskaya' variety there was identified the translocation 1AL.1RS using molecular markers [1,15]. The presence of the translocation 1AL.1RS does not lead to such a sharp decrease in quality indicators as in the variant with the translocation 1BL.1RS [16].

In addition, the presence of the allele Gli1B3 in both the parental forms and the studied varieties was identified using starch gel electrophoresis in the laboratory for biochemical estimation of breeding material and grain quality and confirmed using molecular markers in the laboratory for marker breeding of the FSBSI "ARC "Donskoy".

During the studied period, there has been found out that the winter common wheat varieties 'Ambar' and 'Premiera' contain the allele Gli1B3 as part of gliadins, and it was taken from the mother varieties 'Yuzhanka' and 'Vassa' (Table 1).

Table 1. Genotypic gliadin formulas in the winter common wheat varieties

variety	Origin	Gliadin formulas						
		1A	1B	1D	6A	6B	6D	estimation
Ambar	Russia (Agricultural Research Center "Donskoy")	3	3	1	3	1	1	C^+
♀ Yuzhanka	Russia ("National Grain Center named after P.P.Lukiyanennko)	3	3	1	3	1	1	C^+
♂ Slavyanka	Ukraine	4	1	4	3	2	2	Ex.
Premiera	Russia (Agricultural Research Center "Donskoy")	4	3	1	3	1	1	C^+
♀ Vassa	Russia ("National Grain Center named after P.P.Lukiyanennko)	4	3	1	3	1	1	C
♂ Blagodarka odesskaya	Ukraine	4	1	5+1	3	1	1	X^+
Don 107, standard	Russia (Agricultural Research Center "Donskoy")	4+3	1	4+1	1+3	1	1	X^+
Ermak, a leading variety	Russia (Agricultural Research Center "Donskoy")	3	1	7+1	3	1	1	X^+
Note: C^+- strong; Ex. – Excellent; X^+- good								

In gliadin of the standard 'Don 107' and the variety 'Ermak', there was not identified the translocation T1BL.1RS. By comparing new promising varieties with them, it is possible to establish which traits the translocation's presence has a positive or negative effect on (Table 2).

Table 2. Comparative estimation of the promising variety 'Ambar' with the varieties 'Ermak' and 'Don 107', productivity of the years of 2017-2019

Traits		Ambar	Ermak, a leading variety	Don 107, standard	%	
					to a leading variety	to a standard
Productivity, t/ha	mean	8.29±0,9	7.73±0.8	7.85±0.75	107	106
	maximum	10.96±0.8	9.89±0.7	10.42±1.3	123	105
Number of productive stems, pcs./m^2		587±9.2	568±10.2	614±13.4	100	96
Vegetation period, days		255±1.5	249±1.0	249±2.0	102	102
Plant height, cm		82±1.8	84±8.0	86±5.1	98	95
1000-grain weight, g		45.4±1.1	46.6±1.4	41.0±1.0	97	111
Grain nature weight, g/l		823±1.7	818±1.0	840±2.1	101	100
Protein, %		13.0±0.8	12.1±0.9	12.4±1.2	107	105
Hardness, %		68±5.6	63±1.5	70±1.2	108	97
SDS-sedimentation, ml		50±3.7	52±3.3	57±2.1	96	88
Specific work of dough deformation, W, units		145±11.0	178±41.3	191±34.2	82	76
Gluten amount in grain, %		22.7±2.5	24.5±2.7	24.7±3.0	93	109
Gluten quality (GDI), units		57±4.2	63±5.0	66±6.6	90	86
Volume yield, cm^3		570±22.2	580±30.2	483±28.5	106	118
General baking assessment, point		2.9±0.4	3.3±0.3	2.4±0.5	88	121
Lodging resistance, point		5±0.4	5±0.3	5±0.5	100	100

There has been determined that the variety 'Ambar' exceeded the standard variety and the leading variety in terms of mean productivity by 6 and 7%, respectively. According to maximum productivity, the excess was by 5 and 23%. The specific work of dough deformation and SDS-sedimentation (an indirect indicator of flour strength) were lower with 88% and 96%. At the same time, the bread quality of the variety 'Ambar' was at the same level with the varieties 'Ermak' and 'Don 107'. According to protein percentage, gluten and its quality, these winter common wheat varieties fall into one quality group of class 3, or "valuable grain". The mean productivity of the variety 'Premiera' exceeded that of the standard 'Don 107' and the leading variety 'Ermak' by 13% and 14%. The maximum productivity values of the variety also exceeded that of the standard and the leading variety by 14 and 13%. (Table 3).

Table 3. Comparative estimation of the promising variety 'Premiera' with the varieties 'Ermak' and 'Don 107', productivity of the years of 2017-2019

Traits		Premiera	Ermak, a leading variety	Don 107, standard	%	
					to a leading variety	to a standard
Productivity, t/ha	mean	7.73±0.8	7.85±0.8	7.85±0.75	114	113
	maximum	9.89±0.7	10.42±0.7	10.42±1.3	109	103
Number of productive stems, pcs./m^2		546±9.3	568±10.2	614±13.4	96	89
Vegetation period, days		250±1.0	249±1.0	249±2.0	100	100
Plant height, cm		83±1.8	84±8.0	86±5.1	99	97
1000-grain weight, g		51.6±1.0	46.6±1.4	41±1.0	110	112
Grain nature weight, g/l		831±4.6	818±1.0	840±2.1	101	101
Protein, %		11.6±0.81	12.1±0.9	12.4±1.2	105	98

Hardness, %	62±2.4	63±1.5	70±1.2	108	98
SDS-sedimentation, ml	64±2.7	52±3.3	57±2.1	102	97
Specific work of dough deformation, W. units	112±11.5	178±41.3	191±34.2	63	60
Gluten amount in grain, %	23.1±1.8	24.5±2.7	24.7±3.0	100	98
Gluten quality (GDI), units	77±1.7	63±5.0	66±6.6	122	117
Volume yield, cm^3	527±22.3	580±30.2	483±28.5	102	112
General baking assessment, point	3.0±0.2	3.3±0.3	2.4±0.5	97	121
Lodging resistance, point	5±0.6	5±0.3	5±0.5	100	100

The flour strength determined by the specific work of dough deformation did not exceed 60% and 63% of their values, SDS-sedimentation was lower in comparison with the standard but was not inferior to the leading variety ‘Ermak’. According to protein percentage, gluten content and its quality, the varieties ‘Premiera’, ‘Don 107’ and ‘Ermak’ corresponded to the 3rd quality class.

4 Conclusion

Thus, the promising varieties ‘Ambar’ and ‘Premiera’ were characterized by gliadin-coding loci, there was identified the translocation *T1BL.1RS*, and there was studied the effect of its presence on economically valuable traits. The studied genotypes with the translocation *T1BL.1RS* from common rye were characterized by higher grain productivity compared to the varieties in which the translocation was not found. According to grain quality and other breeding traits, the varieties ‘Ambar’ and ‘Premiera’ were not inferior to the leading variety and the standard. An important advantage of the varieties ‘Ambar’ and ‘Premiera’ is resistance to brown rust, yellow rust, stem rust and powdery mildew, since the translocation contains resistance genes to these diseases.

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