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THE EFFECT OF WHEAT-RYE TRANSLOCATION 1Bl.1Rs IN A DIFFERENT QUALITY GENETIC BACKGROUND ON BIOLOGICAL TRAITS IN WHEAT

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A sample of 139 varieties of common wheat (*Triticum aestivum L.*), predominantly Serbian winter wheat varieties originated in the Institute of Field and Vegetable Crops in Novi Sad, has been examined for presence of 1BL/1RS wheat-rye translocation. Two genotype groups consisted of varieties possessing and lacking the translocation have been compared. Stem rust, leaf rust, powdery mildew as well as, winter hardiness were studied. The influence of 1BL/1RS translocation was also studied in a light of wheat seed storage protein (glutenin and gliadin) genetic background composition. Genotypes having the translocation appeared to be more tolerant to stem rust, and leaf rust, but more susceptible to powdery mildew. These effects were slightly modified

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depending on the examined genetic background, but the effect of the rye 1RS translocated chromosome arm was the main cause for the observed differences.

Key words: 1BL/1RS translocation, biological properties, gliadin, glutenin, wheat.

INTRODUCTION

Gene introgression from wheat relatives, wild species and other genera into wheat (*Triticum aestivum L.*) genome has long been a well-established process to broadening wheat genetic variability in order to achieve improvements. Rye (*Secale cereale L.*) has been found as a useful source of genes, and the introgression of rye chromosomal parts, carrying useful genes by means of wheat-rye translocations has brought some very good results. Particularly a chromosome arm translocation between the short arm of 1R from rye and the long arm from the wheat chromosome 1B, resulting in a 1BL/1RS wheat-rye translocation. The rye chromatin in question has been shown to influence the enhancement of grain yield in wheat varieties possessing the translocation up to 10% (CARVER and RAYBORN, 1994). Some resistance genes to stem rust (*Puccinia graminis*) - *Sr31*, leaf rust (*Puccinia recondita tritici*) - *Lr 26*, as well as, powdery mildew (*Erysiphe graminis*) - *Pm 8* are used as markers for 1BL/1RS translocation as they are located on the translocated 1RS chromosomal part (MCINTOSH *et al.*, 1995). According to previous investigations, the 1BL/1RS translocation is known to express deleterious effects on wheat quality formation leading, in severe cases, to dough stickiness (ZELLER *et al*., 1988). Since the wheat genetic background can influence the effect of the translocation, quality genes in particular, a good approach could be to screen for its effects in different genetic background. Wheat-rye translocation 1BL/1RS in former Yugoslavian wheat breeding programs was introduced from the Russian varieties 'Aurora', 'Kavkaz', and 'Skorospelka 35' (PETROVIĆ *et al*., 1988). In 139 wheat varieties, DIMITRIJEVIĆ (1997) reported about 40% of them contained the 1BL/1RS translocation.

The aim of the study was to examine the allelic variation in seed storage proteins, namely high molecular weight (HMW) glutenin subunits, as well as, gliadins in conjunction with the presence of the 1BL/1RS-translocation on some biological traits: stem rust, leaf rust, powdery mildew and winterhardiness.

MATERIAL AND METHOD

A collection of 139 wheat genotypes, predominantly winter wheat varieties originated in a wheat-breeding program of the Institute for Field and Vegetable Crops in Novi Sad, was screened for presence of the 1BL/1RS wheat-rye translocation using 10% SDS-PAGE and C-banding technique (SINGH AND

SHEPHERD, 1985; LUKASZEWSKI and GUSTAFSON, 1983). HMW glutenin subunit composition was determined using 18% SDS-PAGE, while gliadin allelic variation was analyzed using 6% A-PAGE (NG *et al.*, 1988) (Fig. 1).

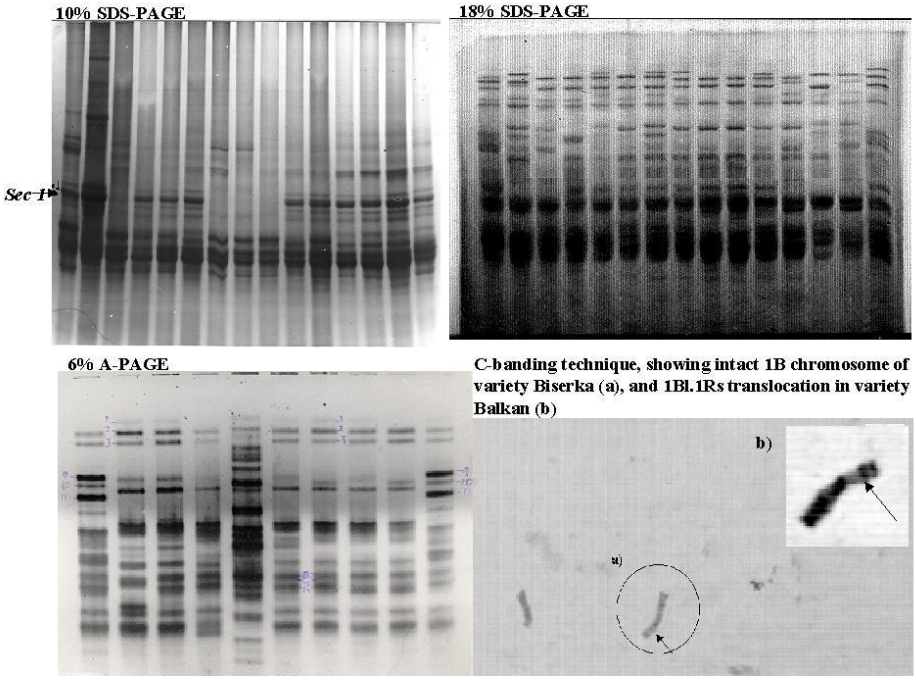

Figure 1. Techniques being used to follow HMW Glu and Gli allelic variation of examined wheat genotypes. The 1BL/1RS translocation was established using 10% SDS-PAGE screening for the presence of the *Sec-1*, gliadin marker located on 1RS.

Technical details are given in DIMITRIJEVIĆ (1997), as well as, in the cited references. In the gliadin class of seed storage proteins, the two most frequent gliadins we observed were *Gli D1b* and *Gli D2b*. Wheat varieties with established genetic constitutions for the characters studied allelic variation were grouped according to their genotypes and compared using test of variance homogeneity and t-test (STEEL and TORRIE, 1960). Biological trait data were obtained from the Yugoslavian Federal Committee for Varieties Releasing. Disease tolerance data is given in percentage of affected plants percentages, and the winterhardiness data is given in the percentage of survived plants.

RESULTS AND DISCUSSION

According to the results, the 1BL/1RS wheat/rye translocation contributed to a higher level of stem rust tolerance where 16% of affected the varieties contained the translocation, and about 34% of the affected cultivars lacked the translocation (tab. 1). The effect of stem rust *Sr31* gene present on rye chromosome arm 1RS was the most probable cause of increased tolerance. BARTOŠ *et al.* (1985) reported that the *SR31* gene was been established in Aurora and Kavkaz, Russian varieties, widely used in the Novi Sad wheat breeding program as parents. Increased resistance to leaf rust was observed just as a trend, being slightly higher in 1BL/1RS genotypes.

Table 1. Two groups of wheat varieties, grouped according to presence (+)/absence (-) of the 1BL/1RS translocation, and compared for biological trait differences. Abbreviations stand for the number of genotypes (n), and mean values ($\overline{x}$). Significant differences are labeled with an asterisk.

Biological traits	+1BL/1RS			-1BL/1RS	
	n	$\overline{x}$		n	$\overline{x}$
Stem rust	39	16.05	*	96	37.45
Leaf rust	39	10.82		96	13.66
Powdery mildew	39	29.74	*	96	23.76
Winterhardiness	39	85.69		96	85.64

According to MCINTOSH *et al.*, (1995) the 1BL/1RS translocation also introduced the *Lr 26* resistance gene into wheat genome from 1RS, but the *Lr 26* gene appeared to be not so effective in this study. Quite opposite to expectations, wheat's missing the translocation appeared to be more tolerant to powdery mildew, which was surprising because of the presence of *Pm8* resistance gene on 1RS. The explanation of the powdery mildew results, as well as, leaf rust resistance to some extent, could be favoring other resistance genes present in the wheat breeding program. Anyway, further investigations are necessary in order to answer that question.

Screening for the behavior of genotypes containing the 1BL/1RS translocation jointly with HMW glutenin allelic variation on the long arm of wheat chromosome 1D, gave almost the same pattern. It is well known that HMW glutenin subunit composition determined by alleles on 1D plays an important role in seed storage protein formation. Glutenin combination *Glu 5+10* has been considered as a better quality genetic background, comparing to subunit combination *Glu 2+12* (PAYNE *et al.,* 1987). According to the results obtained in the study, the translocation effects involving rust resistance, as well as powdery mildew tolerance were more expressive in the better quality HMW Glu subunit

genetic background of *Glu 5+10* (tab. 2). This particularly concerned stem rust tolerance being in favor of the 1BL/1RS wheat genotypes with a better HMW glutenin subunit combination.

Table 2. Two groups of wheat varieties, grouped according to presence(+)/absence(-) of the 1BL/1RS translocation, and compared for biological trait differences in a different HMW glutenin subunits composition (Glu 5+10, and Glu 2+12) coming from 1D wheat chromosome. Abbreviations stand for the number of genotypes (n), and mean values ($\overline{x}$). Significant differences are labeled with an asterisk.

Biological traits	Glu 5+10				Glu 2+12			
	+1BL/1RS		-1BL/1RS		+1BL/1RS		-1BL/1RS	
	n	$\overline{x}$	n	$\overline{x}$	n	$\overline{x}$	n	$\overline{x}$
Stem rust	30	14.54 *	56	42.67	8	22.49	36	29.68
Leaf rust	30	10.29	56	13.74	8	14.09	36	13.02
Powdery mildew	30	30.18	56	25.05	8	27.45	36	21.69
Winterhardiness	30	86.60	58	87.30	8	84.18	34	83.66

According to the results obtained comparing wheat genotypes grouped for the 1BL/1RS translocation and *Glu A1* HMW glutenin subunit variation, the study revealed that the enhancement of the translocation effect took part in a *Glu 2** genetic background. Significant differences were observed for stem rust tolerance and. powdery mildew susceptibleness in all the genotypes having the translocation and *Glu 2**. Leaf rust tolerance was higher for translocated wheat genotypes, but only as a trend, being slightly more expressed in a *Glu 1* genetic background, and in the absence of HMW glutenin subunit from 1A chromosome marked as *null allele* – N (tab. 3).

Table 3. Two groups of wheat varieties, grouped according to presence (+)/absence (-) of 1BL/1RS translocation, and compared for biological trait differences in a different HMW glutenin subunits composition (Glu 2, Glu 1 and Null allele) coming from 1A wheat chromosome. Abbreviations stand for the number of genotypes (n), and mean values ($\overline{x}$). Significant differences are labeled with an asterisk.*

Biological traits	Glu 2*				Glu 1				N			
	+1BL/1R		-1BL/1RS		*+1BL/1RS*		-1BL/1RS		*+1BL/1RS*		-1BL/1RS	
	n	$\overline{x}$	n	$\overline{x}$	n	$\overline{x}$	n	$\overline{x}$	n	$\overline{x}$	n	$\overline{x}$
Stem rust	16	13.57 *	29	42.55	22	19.96 *	7	33.34	16	16.82 *	42	36.20
Leaf rust	16	14.86	29	14.81	22	7.73	7	12.87	16	8.14	42	13.13
Powdery mildew	16	33.86 *	29	22.83	22	28.27	7	26.15	16	26.26	42	23.38
Winterhardiness	16	81.69	30	88.52	23	86.81	7	82.00	16	89.19	39	86.49

The results are in agreement with previously observed expressiveness of 1BL/1RS wheat-rye translocation in a better quality genetic background. According to PAYNE *et al.* (1987), *Glu 2** was marked as beneficial for seed storage protein quality formation. Those results also revealed that the same held for *Glu 1* subunit. However, investigations of DIMITRIJEVIĆ (1997) favored *Glu 2**, being of slightly more beneficial influence to quality parameters under Serbian conditions and wheat backgrounds.

As ROGERS *et al*. (1990) reported, allelic variation of *Glu B1* loci did not have as significant influence on quality as allelic variation on *Glu D1*. PAYNE *et al.* (1987), considered *Glu 7+8*, and *Glu 7+9*, better HMW glutenin subunit combinations, than *Glu 7* or *Glu 6+8*. The results of the present study affirmed the pattern of 1BL/1RS translocation influences on the investigated traits, previously observed in the background of HMW glutenin allelic variation on 1A and 1D wheat chromosomes. In particular this concerned stem rust tolerance, and to some extent powdery mildew tolerance (as a trend). The stem rust tolerance was steadily in favor of wheat varieties possessing 1BL/1RS wheat-rye translocation, being significantly more tolerant in a better *Glu B1* quality background (*Glu 7+8*, and *Glu 7+9*), tab. 4.

The examination of rye chromatin in a complex HMW glutenin genetic background showed that the 1BL/1RS translocation exhibited greater differences in effects on biological traits as compared to normal non-translocated wheat genotypes, being in a good HMW Glu quality background of *Glu 2*, 7+9, 5+10* subunit combination. Wheat varieties with 1RS rye chromatin were more tolerant to stem rust than normal non-translocated varieties, and were generally, more susceptible to powdery mildew. Higher leaf rust tolerances in the translocated genotypes appeared mostly as a trend, (tab. 5).

Significantly higher survivability under a low temperature treatment could not be ascribed to the influence of the 1BL/1RS translocation. Comparison of two quality groups, according to PAYNE *et al*. (1987), scored 8-10 (better quality HMWGlu subunit composition) and 5-7 (lower quality HMWGlu) supported that observation. The differences between two subgroups, 1BL/1RS -genotypes vs. non-translocated genotypes, appeared to be greater in a better quality background, scored 8-10. Stem rust tolerance, as well as, powdery mildew susceptibility was significantly higher for translocated genotypes in the group of varieties where glutenin quality scored 8-10. In the lower quality group, which scored 5-7, a significant difference was only observed for stem rust tolerance of the 1BL/1RS genotypes. No significant differences for winterhardiness were observed (tab. 6).

The role of complex genetic tolerances as a whole, were quite obvious regarding the translocation influencing leaf rust tolerance effect. Resistance gene *Lr26* introduced from 1RS by the translocation, obviously was not a significant advantage for translocated genotypes. Even as a trend, leaf rust tolerance was higher in a lower quality background (tab. 3, 5, and 6).

Table 4. Two groups of wheat varieties, grouped according to presence(+)/absence(-) of the 1BL/1RS translocation, and compared for biological trait differences in a different HMW glutenin subunits composition (Glu 7+8, Glu 7+9, Glu 7 and Glu 6+8) coming from wheat chromosome 1B. Abbreviations stand for the number of genotypes (n), and mean values ($\overline{x}$). Significant differences are labeled with an asterisk.

	Glu 7+8				**Glu 7+9**				**Glu 7**				**Glu 6+8**			
Biological	*+1BL/1RS*		-1BL/1RS		*+1BL/1RS*		-1BL/1RS		*+1BL/1RS*		-1BL/1RS		*+1BL/1RS*		-1BL/1RS	
	n	$\overline{x}$	n	$\overline{x}$	n	$\overline{x}$	n	$\overline{x}$	n	$\overline{x}$	n	$\overline{x}$	n	$\overline{x}$	n	$\overline{x}$
Stem rust	3	16.30*	11	29.88	29	15.54*	65	40.59	2	15.10	8	28.53	2	20.95	5	37.94
Leaf rust	3	10.00	11	9.05	29	10.56	65	14.67	2	20.40	8	11.23	2	15.20	5	13.96
Powdery mildew	3	17.10	11	21.01	29	30.42	65	25.33	2	40.70	8	21.23	2	36.20	5	19.00
Winterhardiness	3	88.33	11	84.10	29	85.53	67	87.07	2	78.25	7	78.07	2	87.35	5	87.72

Table 5. Two groups of wheat varieties, grouped according to presence(+)/absence(-) of the 1BL/1RS translocation, and compared for biological trait differences in a different HMW glutenin subunits composition, jointly from 1A, 1B and 1D wheat chromosomes. Abbreviations stand for the number of genotypes (n), and mean values ($\overline{x}$). Significant differences are labeled with an asterisk.

	Glu 2*, 7+9, 5+10				**Glu 1, 7+9, 5+10**				**Glu N, 7+9, 5+10**				**Glu N, 7+9, 2+12**			
Biological traits	*+1BL/1RS*		-1BL/1RS		*+1BL/1RS*		-1BL/1RS		*+1BL/1RS*		-1BL/1RS		*+1BL/1RS*		-1BL/1RS	
	n	$\overline{x}$	n	$\overline{x}$	n	$\overline{x}$	n	$\overline{x}$	n	$\overline{x}$	n	$\overline{x}$	n	$\overline{x}$	n	$\overline{x}$
Stem rust	14	12.79*	22	45.41	2	16.35	10	38.43	9	15.34*	13	48.99	2	17.45	15	28.35
Leaf rust	14	13.80	22	14.20	2	5.65	10	13.36	9	5.28*	13	17.93	2	6.25	15	9.50
Powdery mildew	14	33.16*	22	22.66	2	31.90	10	29.62	9	26.33	13	29.76	2	23.60	15	21.96
Winterhardiness	14	81.15*	22	91.16	2	95.50	10	80.47	9	91.70	13	86.93	2	89.00	15	89.11

Table 6. Two groups of wheat varieties, grouped according to presence(+)/absence(-) of the 1BL/1RS translocation, and compared for biological trait differences in a different HMW glutenin quality background. Abbreviations stand for the number of genotypes (n), and mean values ($\bar{x}$). Significant differences are labeled with an asterisk.

Biological traits	Glu score 8-10*				Glu score 5-7			
	+1BL/1RS		-1BL/1RS		+1BL/1RS		-1BL/1RS	
	n	$\bar{x}$	n	$\bar{x}$	n	$\bar{x}$	n	$\bar{x}$
Stem rust	20	14.06	* 43	39.80	16	18.44	* 44	35.70
Leaf rust	20	12.47	43	12.72	16	8.23	44	13.59
Powdery mildew	20	31.75	* 43	23.82	16	26.86	44	25.34
Winterhardiness	20	84.72	46	86.94	16	87.88	40	85.64

* HMW Glutenin quality scoring has been applied according to Payne et al. (1987).

With respect to gliadin allelic variation, two gliadins, *Gli D1b* and *Gli D2b*, were studied and have been established as the most frequent in Serbian wheat varieties (KNEŽEVIĆ, 1992; DIMITRIJEVIĆ, 1997). Even though, gliadin allelic variation does not have as great influence on quality formation as HMW glutenin composition, gliadin *Gli D1b* could be considered as a good quality genetic background (DIMITRIJEVIĆ *et al.*, 1998).

There were no apparent effects in respect to winterhardiness and the presence or absence of the 1BL/1RS wheat/rye translocation (tab. 7).

Table 7. Two groups of wheat varieties, grouped according to presence(+)/absence(-) of the 1BL/1RS translocation, and compared for biological trait differences in a gliadin block quality background. Abbreviations stand for the number of genotypes (n), and mean values ($\bar{x}$). Significant differences are labeled with an asterisk.

Biological traits	Gli D1b				Gli D2b			
	+1Bl.1Rs		-1Bl.1Rs		+1Bl.1Rs		-1Bl.1Rs	
	n	$\bar{x}$	n	$\bar{x}$	n	$\bar{x}$	n	$\bar{x}$
Stem rust	12	15.06 *	30	38.85	6	11.92 *	22	39.69
Leaf rust	12	14.08	30	13.36	6	9.25	22	13.78
Powdery mildew	12	28.61	30	22.41	6	30.92	22	20.44
Winterhardiness	12	85.48	32	88.15	6	79.65	21	82.87

CONCLUSION

According to the results of the present study, the following conclusions could be drawn:

- Stem rust resistance gene *Sr31*, introduced into the Serbian wheat breeding programs via the 1BL/1RS wheat-rye translocation from the Russian varieties Aurora and Kavkaz, appeared to be very effective.
- Leaf rust tolerance was observed only as a trend in the 1BL/1RS wheat varieties. The tolerance gene *Lr26*, presented on 1RS, was not very effective.

- Opposite to expectations, the powdery mildew tolerance gene *Pm8* effect was not noticeable, and non translocated wheat varieties were in some cases even significantly more tolerant than the 1BL/1RS varieties.
- No effect of the 1RS rye chromatin on winterhardiness was observed.

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EFEKAT PŠENIČNO-RAŽENE TRANSLOKACIJE 1Bl.1Rs NA BIOLOŠKE OSOBINE PŠENICE U RAZLIČITOJ KVALITETNOJ GENETIČKOJ OSNOVI

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I z v o d

Uzorak od 139 sorti hlebne pšenice (*Triticum aestivum L.*), pretežno srpske ozime pšenice oplemenjenu u Institutu za ratarstvo i povrtarstvo u Novom Sadu, su ispitane na prisustvo pšenično-ražene translokacije 1Bl.1Rs. Upoređene su dve grupe sorti, one koje su translokaciju posedovale i one koje su bile bez ove translokacije. Praćene su osobine otpornosti na stabljičnu rđu, lisnu rđu, pepelnicu i otpornost na niske temperature. Uticaj translokacije je praćen u genetičkoj osnovi koja je varirala u pogledu konstitucije gena za rezervne proteine zrna pšenice (glutenine i glijadine). Genotipovi koji su imali ispitivanu translokacije su iskazali veću toleranciju na lisnu i stabljičnu rđu, kao i manju toleranciju na pepelnicu. Ovi efekti su bili u manjoj meri modifikovani u zavisnosti od varijacije gena kvaliteta, ali je efekat 1RS translokacije bio osnovni razlog primećenih razlika.

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