DOI: 10.17707/AgricultForest.64.4.02

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EFFECT OF THE 1BL.1RS WHEAT-RYE TRANSLOCATION ON QUALITATIVE TRAITS IN BREAD WHEAT

SUMMARY

Despite the positive effect on yield and resistance under stress conditions, cultivars carrying the 1BL.1RS wheat-rye chromosome translocation have a critical drawback, i.e. the deterioration of the end-product quality of the host cultivar. In order to study this deterioration, four bread wheat cultivars carrying and six without the aforementioned translocation, were evaluated in the field for two successive years. The experiments were established in the farm of the Western Macedonia University of Applied Sciences, which represents a rather cold and wet area. Each experiment consisted of four replications and every effort was made to grow the plants under optimum conditions. The following traits were studied: yield, 1000 kernel weight, hectoliter weight, protein %, moisture %, starch %, Zeleny test.

The results indicated that there was not any specific effect of the translocation on yield because two cultivars without the translocation were ranked first, although they did not differ from the following two cultivars carrying the translocation. On the other hand, there was no negative effect of the translocation in most of the qualitative traits in bread wheat. Furthermore, one of the cultivars carrying the translocation (cvr. Acheron) performed equally sufficient with the cultivars without the translocation in 1000 kernel weight. A similar performance was observed in the rest of the examined traits: cvr. Acheron was ranked first in protein content, wet gluten and Zeleny test. Cultivar Elissavet, also carrying the translocation, performed equally well with Acheron in protein content (%) and was ranked first in hectoliter weight. It could be concluded from all the aforementioned results that the translocation had no negative effect on bread wheat quality. However further study is needed to confirm the above results.

Keywords: yield, quality, 1000 kernel weight, protein, gluten, Zeleny test.

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Paper presented at the 9th International Scientific Agricultural Symposium "AGROSYM 2018".
Notes: The authors declare that they have no conflicts of interest. Authorship Form signed online.

INTRODUCTION

One of the main problems in releasing new cultivars is that this new germplasm has to be grown on marginal environments due to the irrational waste of territorial resources noticed in previous years. Furthermore, the drought conditions prevailing in spring is the crucial obstacle of agricultural production in the southern regions of Europe (Yau and Saxena, 1997). Thus, one of the most decisive factors in all breeding programs is the identification and integration of genes into cultivated varieties that confer resistance or tolerance to drought (Blum, 1988). This led breeders and especially those working on wheat, to look for new gene pools to face the problem (Fehr, 1987). According to various reports bread wheat *(Triticum aestivum* L em Thell) cultivars carrying the 1BL.1RS wheat-rye chromosome translocation are characterized among other traits by high yield potential (Kim *et al*., 2004; Xynias *et al.*, 2007) and resistance to drought (Hoffmann, 2008). The 1BL.RS translocation is originated from cv. Kavkaz/Cgn, and according to Weng *et al*. (2007) possesses resistance genes to different biotic and abiotic stress conditions. The unique traits of the translocation are attributed to genes located on the short arm of the first chromosome of rye (Schlegel and Meinel, 1994; Xynias *et al*., 2007).

Despite the previously mentioned advantages of the 1BL.1RS translocation, there is a serious disadvantage: the short arm of the first chromosome of rye genome carries genes that decrease the quality of the end product (Graybosch et al. 1993; Fenn et al. 1994). There are certain parameters that determine quality in bread wheat: the 1000 kernel weight mark the maturity of the seeds, the hectoliter weight is an essential index of flour production seeds. Also, the protein content is desirable to be high enough and the same holds for the wet gluten content.

The aim of the present study was to investigate the effect of the 1BL.1RS wheat-rye chromosomal translocation on six qualitative traits and elucidate how they affect the performance of the host plants.

MATERIAL AND METHODS

Plant material

For the purpose of this study nine Hellenic bread wheat cultivars (eg. Acheron, Elissavet, Orfeas, Apolonia, Acheloos, Vergina, Doirani, Nestos and Strymonas) that were developed at the Cereal Institute of Thessaloniki (Anonymous, 1985) and the Russian cultivar Kavkaz/Cgn, one of the donors of the 1BL.1RS wheat-rye chromosome translocation (Xynias et al., 2006; Weng et al., 2007), were used. Three of the Hellenic cultivars were found to carry the 1BL.1RS wheat-rye chromosome translocation (cvs. Acheron, Elissavet and Orfeas) whereas the other six cultivars, were not carry this specific translocation (Xynias et al., 2006; Peros et al., 2015).

Method

The experiments were established for two successive years 2015-16 and 2016-17 in the main Farm of the School of Agricultural Technology & Food

Technology and Nutrition, in Florina (40°46′ N, 21°22′E, 707 m asl), in a sandy loam soil with pH 6.3, organic matter content14.0 g kg^{-1}, N-NO_3 100 mg kg^{-1}, P (Olsen) 50.3 mg kg^{-1} and K 308 mg kg^{-1} and water holding capacity 21.8% (0 to 30 cm depth). Seedbed preparation included mouldboard plough, disc harrow and cultivator. Nitrogen and P_20_5 at 80 and 40 kg ha^{-1}, respectively, were incorporated into the soil as diammonium phosphate (20-10-0) before sowing. The crop was kept free of weeds by hand hoeing when necessary. The 1000 kernel weight was estimated by the mean weight of four random samples of 100 seeds and hectoliter weight using a hectolitre balance. The traits grain protein content, starch percentage, wet gluten and Zeleny value were measured with the Infratec 1241 Near Infrared Transmittance Grain analyzer (Foss, Denmark) using the standard grain network model for quality traits in wheat. A seed sample size of approximately 350 g was used. The NIT instrument analyses subsets of each sample (10 aliquots) before registering an average output reading.

The Randomized Complete Blocks (RCB) experimental design was applied (fixed model), with four replications (Steel and Torrie, 1960). The plots were consisted of five rows (plot area 3 m^2) of which the three inner were threshed (harvest area 1.8 m^2).

The means were compared according to the L.S.D. method. The data obtained were analyzed statistically with Mstat-C (Freed and Eisensmith, 1986).

RESULTS AND DISCUSSION

No significant superiority of the cultivars with the translocation over the respective without was observed in yield (Table 1).

Table 1. Analysis of variance of bread wheat with and without the 1BL.1RS wheat-rye chromosomal translocation regarding yield and six qualitative traits.

Source	df	Yield	1000 kernel weight	Hectoliter	Protein %	Starch %	Wet gluten	Zeleny test
		MS	MS	MS	MS	MS	MS	MS
Environment	1							
Factor (A)	9	**	**	ns	ns	ns	ns	ns
E x A	9	**	*	ns	**	ns	**	**
Error	54							
CV		15.8	7.37	17.55	12.08	49.42	7.77	15.25

Source: Author s' elaboration based on the obtained results.
*,** significant differences at $p \leq 0.05$ and $p \leq 0.01$ respectively

All the examined cultivars were classified into four groups according to their yield performance (Table 2). The cultivar (cv Orfeas) with the translocation, did not perform well and along with cultivar Yecora (a cultivar sensitive to low

temperatures) were ranked in the last position. The top group, marked as "A" consisted of three cultivars with and three more without the translocation.

Table 2. Ranking of the bread wheat cultivars according to yield and 1000 kernel weight.

Cultivar	Yield	Cultivar	1000 kernel weight
Acheloos	a	Apollonia	a
Doirani	a	Strymonas	a
Elissavet	a	Acheron	ab
Acheron	a	Nestos	ab
Apollonia	ab	Doirani	b
Kavkaz/Cgn	ab	Acheloos	b
Strymonas	bc	Kavkaz/Cgn	b
Nestos	c	Yecora	c
Orfeas	d	Orfeas	c
Yecora	d	Elissavet	c
LSD	135.2		4.77

Source: Author s' elaboration based on the obtained results
Cultivars followed by different letters are significantly different at p=0.05 level

According to this observation one could conclude that there is no any visible effect of the translocation on yield performance. This is in disagreement with the results of Kim *et al*., (2004) who reported a positive effect of the translocation on yield. The different performance of the cultivars carrying the translocation could be explained by the proposal of Lisova et al (2005) and Lazaridou et al. (2017) who studied the effect of the translocation on disease resistance and another culture response. They both concluded that the presence of the translocation does not guarantee any advantage and that the genetic background of the host cultivar is also important.

Regarding the qualitative traits, differences were recorded only in 1000 kernel weight (Table 1) whereas no significant differences were obtained in all other qualitative traits. In this case the cultivars were classified into three groups according to their 1000 kernel weight value: the top, marked as "A" consisted of three cultivars without and only one with the translocation (Table 2), cv Kavkaz/Cgn was classified last in the second group (marked "B") and the other two cultivars carrying the translocation were ranked in the last (marked "C"). The above results suggest the genetic background of the host cultivar is also important and that there is not any negative effect of the presence of the translocation on the quality of the host cultivar. Cultivar Acheron who was ranked in the top group and performed well in yield and 1000 kernel weight is a quite interesting cultivar, since it was found to respond well and in another culture (Lazaridou et al. 2017).

CONCLUSIONS

The results of the present study suggest that there is no negative effect of the presence of the 1BL.1RS wheat-rye translocation on the qualitative traits studied. However, due to the fixed model used, this conclusion is valid only for the cultivars and environments studied.

For this reason, more research is needed in order to use the random model and become to conclusions that apply generally to all environments and cultivars despite the presence of the translocation.

ACKNOWLEDGEMENT

Financial support of this project (project code 80163) by the Special Account for Research Grants of the Western Macedonia University of Applied Sciences, Greece is gratefully acknowledged.

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