RESISTANCE OF ALLOPLASMIC WHEATS TO BROWN LEAF RUST

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Abstract. The reaction of alloplasmic and euplasmic lines of wheat on brown leaf rust was studied in the condition of field infectious nursery in 2002, 2004, 2006 and 2007. The influence of cytoplasmic genome on resistance of the investigated lines varied for years and probably was mainly specific to race. However the positive effect of alloplasm from *Aegilops squarrosa* var. *typica* on resistance to pathogene was stable and universal.

Keywords: brown leaf rust, resistance, alloplasmic wheat, euplasmic wheat, *Aegilops* sp., *Triticum* sp.

INTRODUCTION

The wide crosses today are widely used at creation of an initial material for wheat breeding. However this results in essential alteration of gene balance and, hence, to infringement of adaptability of created genotypes. The important role in this process belongs to the cytoplasmic factor. In particular the alloplasm effects are revealed in the attitude of crossability and cytogenetic stability of the genotypes which was created by the wide crosses [1, 20].

Moving of wheat nucleus in alien cytoplasm can cause changing of quantitative trait and biological properties of plants, in particular under influence of mitochondrial genome the resistance of a plant to pathogens is changing [22]. Influence of cytoplasm on resistance to same diseases – septoriose [13], powdery mildew [23], brown rust is essential. The brown leaf rust is the basic disease of bread wheat in all zones of Ukraine [18, 10]. The genes of resistance to brown leaf rust have been entered into wheat by wide crosses from nuclear genomes, for example from *Aegilops umbellulata* [9], *Aegilops geniculata* [8], and from cytoplasmic genomes. The data about the cytoplasm influence on resistance to various races of the brown rust, which has been received from studying series of the alloplasmic lines with nuclear genomes of the varieties Chris, Selkirk and Selection 56-1 [25]. The variability in the ratio phenotypes of different classes of resistance to the leaf rust activator is shown. It depends on the donor of cytoplasm, age of sprouts and type of inoculums [16].

Studying of resistance to a brown leaf rust of alloplasmic lines of the bread wheat with nuclear genomes of the varieties Belarusskaya 12, Belarusskaya 60 and Leningradka with cytoplasm from *Aegilops* spp. and *Triticum* spp. allowed to determine cytoplasms, which modifies interaction of a pathogene and the plant-owner at early stages of ontogenesis [24].

However the available data are limited to a set of nuclear genomes. The variety of pathogenes and dynamic of resistance are limited, also. The purpose of this paper was studying the alloplasmic effects on resistance of bread wheat to a local population of races of brown leaf rust.

MATERIALS AND METHODS

For the investigation were used alloplasmic lines of two varieties of winter bread wheat – Donskaya poluintensivnaya and Mironovskaya 808, kindly given by their author – V.A. Vlasenko (the department of biotechnology and phytopharmacology of Sumy National Agrarian University). The species of the genus *Aegilops* L. and *Triticum dicoccoides* Schweinf. served as donors of alloplasm, the euplasmic lines had cytoplasm from *Triticum aestivum* L. cv. Chinese Spring (Table 1).

The resistance of alloplasmic lines has been studied at artificial infection in field infectious nursery in 2002, 2004, 2006 and 2007. For infection was used a population of races of a brown leaf rust (*Puccinia recondita* Rob. ex. Desm. *f.* sp. *tritici* Erikss. et Henn.), which meets in a southwest of Ukraine. In a population physiological races 77 (the most aggressive race) and 144 have prevailed. Races are designated on the qualifier by definition of races [15]. The ratio of races has varied on years. As the store of infection were used *Triticum aestivum* L. cvs. Odesskaya 26, Odesskaya polukarlikovaya and *Triticum compactum* Host. The level of defeat of these varieties achieved 100 % (corresponds to 1-2 points of a used scale). A degree of resistance estimated on a nine-mark scale according to a technique of an estimation of wheat resistance to diseases [2]. Thus took into account a single estimation at the maximal development of disease. Points 9-6 has characterized a different degree of resistance, points 5-1 – a different degree of a susceptibility. They corresponded to the following quantity of the struck plants in percentage: 1-100%, 2-90%, 3-65%, 4-40%, 5-25%, 6-15%, 7-10%, 8-5%, 9-0% [4]. Statistical processing has carried out by the method of the two-factorial analysis of variance [19] after preliminary transformation of percentage estimation under the formula:

$$\varphi = 2\arcsin\sqrt{p}\,.$$

As the factor A was considered cytoplasm, the factor B – nuclear genome or year of research. The data of each year or nuclear genome served as repetitions.

RESULTS

Results of studying the wheat resistance to the activator of a brown leaf rust are given in Table 1.

During the period of researches both alloplasmic lines with cytoplasm *Aegilops squarrosa* var. *typica* have shown rather stable resistance to a rust. The other alloplasmic and euplasmic lines have shown a weak degree of resistance in separate years only. The falling of resistance was observed in 2006 and 2007 at euplasmic lines and alloplasmic line with cytoplasm *Triticum dicoccoides*. The results of the variance analysis of resistance to a brown leaf rust in the investigated material are resulted in Tables 2 and 3.

Table 1. The resistance of alloplasmic and euplasmic lines of the wheat to a brown leaf rust (in points).

Source of cytoplasm	Nuclear genome							
	Donskaya poluintensivnaya				Mironovskaya 808			
	2002	2004	2006	2007	2002	2004	2006	2007
Aegilops squarrosa L. var. *typica*	6	7	7	8	7	6	7	8
Aegilops cylindrica Host.	7	5	5	5	6	5	6	6
Aegilops variabilis Eig.	4	2	5	4	5	3	5	5
Aegilops ventricosa Tausch.	7	3	5	5	4	3	6	7
Aegilops vavilovii Chen.	4	6	5	4	5	4	6	5
Triticum dicoccoides Schweinf.	6	6	3	3	5	5	3	4
*Triticum aestivum cv.*Chinese Spring	5	6	3	3	6	5	4	4

Table 2. The variance analysis of resistance to a brown leaf rust in alloplasmic and euplasmic wheat lines (the factors are cytoplasm and nuclear genome).

Source of a variation	SS	df	mS	F_{fact}	F_{table}	
					P=0.05	P=0.01
Total	10.84	55	–	–	–	–
Factor A (cytoplasm)	3.52	6	0.59	3.47**	2.34	3.29
Factor B (nuclear genome)	0.14	1	0.14	0,82	4.08	7.31
Interaction A and B	0.20	6	0.04	0,24	2.34	3.29
Random deviations	6.98	42	0.17	–	–	–

** – difference significant at P≤0.01

Table 3. The variance analysis of resistance to a brown leaf rust in alloplasmic and euplasmic wheat lines (the factors are cytoplasm and testing year).

Source of a variation	SS	df	mS	F_{fact}	F_{table}	
					P=0.05	P=0.01
Total	10.50	55	–	–	–	–
Factor A (cytoplasm)	3.47	6	0.58	11.6**	2.45	3.53
Factor B (testing year)	0.59	3	0.20	4.0*	2.95	4.57
Interaction A and B	5.18	18	0.29	5.0**	2.00	2.68
Random deviations	1.26	28	0.05	–	–	–

* – difference significant at P≤0.05
** – difference significant at P≤0.01

At the analysis of action of cytoplasmic and nuclear genomes was found out significant (P≤0.01) influence of the cytoplasmic factor (Table 2). At the analysis of influence of cytoplasm and testing year (Table 3) was revealed significant influence not only cytoplasms, but conditions of testing year and interaction of these factors too.

DISCUSSION

The expression of wheat resistance genes to a brown leaf rust can vary depending on nuclear and cytoplasmic genetic background of the plant-owner, and also pathogenic features of clones of a fungus. In most cases observed decrease *Lr*-genes expression at the presence of alien plasmone in comparison with euplasmic variety [7]. In our research was found the positive effect of cytoplasmic genome of *Aegilops squarrosa* var. *typica*. As to a various degree of the resistance, it has shown by investigated lines in different years, which, besides visible effect of fluctuation of weather conditions an essential role, in our opinion, has played also a condition of local population *Puccinia recondita* Rob. ex. Desm. *f.* sp. *tritici*.

The long-term researches in a southwest of Ukraine of a department of phytopathology and entomology of Plant Breeding and Genetics Institute (Odessa) have shown that the pathogene population consist of many races, however over it is dominated annually with one – two races. Till 1997 it was dominated with the most aggressive race 77. In 1997-1998 there was a change of racial structure and the race 144 became dominating. However, since 2003, the role of race 77 in a population started to grow again. The race 77 has come dominating again by 2007 [3, 5, 6]. In parallel with this process is observed a sharp strengthening of a susceptibility to a brown leaf rust of euplasmic lines and the majority allopasmic lines (for exception lines with cytoplasm from *Aegilops squarrosa* var. *typica* and *Aegilops cylindrica*). The domination of race 77 in a population of a brown rust in a southwest of Ukraine the phenomenon is not exclusive. The results of researches in 1971-1975 have shown that in a Volga region population of pathogene 77 race prevailed. Frequently there are 122 and 21 races, and they were allocated within with dry and hot summer. Next years (1976-2004) in population 77 race prevailed also. The share of them in different years varied from 73.4 up to 100 % [14].

The connecting of changing of resistance only with dynamics of patogene racial structure is incorrect. The role of weather conditions is important also. At 7-years studying 409 samples from 34 countries on resistance to a brown leaf rust in Plant Production Institute named after V. Ya. Yuriev a high background of development of disease is marked in 2001, 2003-2005 (affection of susceptible standards of 40-100 %) [17]. Studying resistance to a brown leaf rust of the spring bread wheat of 5 varieties generation of southeast of Russia has shown fluctuations of a degree of defeat on years: in 2006 average affection was 43.7 %, in 2007 – 29.8 %, in 2008 – 18.4 % [26].

It was marked, that the essential role in pass the winter and renewal of an infection is played the winter hardiness of a variety [11, 12]. On winter-hardy and susceptible to a brown rust varieties of winter wheat Donetskaya 48 and the Kharkovskaya 105 restoration of an infection occurs earlier and more intensively, than on less winter-hardy varieties Prichernomorka and Kuyalnik. The main reason of less intensive renewal of an infection on less winter-hardy varieties in conditions of forest-steppe of Ukraine considered their significant affection with fusariose. The leaves have struck with fusariose, in most cases decay, that conducts to destruction of mycelium *Puccinia recondita f.* sp. *tritici.* Similar regularity was observed and in our research. The lines with cytoplasm from *Aegilops squarrosa* L. var. *typica* had the least winter hardiness from the investigated lines (26.2±6.2 %), whereas at the others alloplasmic lines winter hardiness changed from 36.2±6.9 % at lines with cytoplasm from *Aegilops variabilis* up to 70.9±6.4 % at lines with cytoplasm from *Triticum dicoccoides* [21]. It is necessary to note, however, that the winter 2002/2003 has shown all spectrum of affecting factors: low negative temperatures without a snow and with a snow, which were unexpectedly replaced by long thawing weather. It was a reason of formation pools on a field. Short-term thawing weather in turn with the subsequent sharp decrease in temperature formed ice crust. Therefore absolute values of winter hardiness are not typical, but, nevertheless, allow estimating relative winter hardiness of lines.

On the basis of the resulted data it is possible to make conclusion that influence of cytoplasmic genome on resistance of the investigated lines was mainly specific to race. The positive effect of alloplasm from *Aegilops squarrosa* var. *typica* on resistance to pathogene was stable and universal.

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