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SEEDLING AND FIELD RESPONSE OF GENETICALLY DIFFERENT RESISTANT WHEAT LINES TO PUCCINIA RECONDITA TRITICI

REAKCIJE SEJANACA I ODRASLOG STADIJA GENETSKI RAZLIČITIH OTPORNIH LINIJA PŠENICE PREMA PUCCINIA RECONDITA TRITICI

Abstract

The paper presents the data of the results obtained by the study of interactions between genetically different sources of resistance of wheat lines to *Puccinia recondita tritici*, tested as well in International Leaf Rust Wheat field Nurseries (ILRWN).

Key words: wheat, leaf rust, resistance.

Izvod

U radu su prikazani rezultati ispitivanja interakcije između genetski različitih otpornih linija pšenice prema *Puccinia recondita tritici*, testiranih istovremeno i u ILRWN u epidemiološki širokom području.

Ključne riječi: pšenica, lisna rđa, otpornost.

INTRODUCTION

Since long distance dissemination of rust pathogens is well - established phenomenon (**Dinoor and Levi 1971, Watson and Butler 1984, Nagrajan and Singh 1975, 1990**) the best method of rust pathogens control is international co-operative studies which would cover large epidemiological **areas (Bošković 1976, Bošković and Bošković 1988, Stubbs 1972, Stubbs et al. 1974**). In European and some other regions analysis of *Puccinia recondita* Rob. ex Desm. *f. sp. tritici* Eriks. et Henn., population single resistant Lr genes used, have not shown satisfactory efficiency (**Bošković 1976, Bošković and Browder, 1976, Bošković 1980, Bošković and Bošković 1988**). It was become clear that these regions

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needed new more efficient resistance genes and large testing followed by crossing program.

Specially selected genetically different resistant winter wheat hybrid lines from this program as well as some selected spring wheat resistant genotypes, have been tested in seedling stage and in International Leaf Rust of Wheat Nurseries (ILRWN) on the large territories, during the period of three years.

MATERIALS AND METHODS

Fifteen winter wheat hybrid lines selected for ILRWN- nurseries, originated from our breeding program. In the beginning 18 donors of resistance had been selected after an extensive screening tests of several International Rust Nurseries, to be crossed with wheat varieties **Princ** and **Starke (Bošković and Momčilović 1979, 1984)**. These hybrid lines had been comparatively tested with twenty six Lr single gene lines using twenty specially virulent cultures of *P. recondita tritici*, in order to check the presence of these know resistance Lr genes in our hybrid lines. These testings proved that in those lines new resistant genes were present **(Bošković and Bošković 1990)**.

The spring wheat resistant varieties of ILRWN were composed by 8-10 genetically different entries selected after an extensive screening testing of International Rust Nurseries. Besides, in the ILRWN were included genetically different three backcross-derived, near-isogenic lines in a Thatcher background containing strong genes Lr 9, Lr 19 and Lr 24. These genes have shown, in our country as well as in some other countries, the largest spectrum of resistance compared to all other Lr lines **(Bošković 1976, 1980, 1985, Clifford 1980, Donchev 1979, Ionescu-Cojacaru et al., 1980, Paradies 1980, Pasquini and Zitelli 1979, Reddy and Rao 1979, Rizvi 1984, Saadaoui 1985, Statler et al., 1985)**. The line Lr 18 was included in the study as differentially resistant and Lr 14a as a susceptible control line.

In the field ILRWN nurseries were recorded, disease severity, the parcentage of the surface of the plant tillers affected, using the modified Cobb scale **(Peterson et al. 1948)**. The host response in the field was scored using "R" to indicate resistance or miniature uredinia, "MR" to indicate moderate resistance, expressed as small uredinia, "MS" to indicate moderately susceptible, expressed as moderate sized uredinia somewhat smaller than the fully compatible type, and "S"to indicate full susceptibility **(Roelfs et al. 1992)**. The reaction of each ILRWN entry in the field should be recorded by co-operators according to the instructions sheets, but some of them used other methods which had to be presented in the tables.

For greenhouse seedling tests individual cultures have been multiplied on susceptible variety NS-1439 After several transplantation and sporulation ILRWN lines have been inoculated with each culture. The seedlings were scored for infection tye after approximately two weeks according to a scale 0-9. In this case classical reaction types and their variations were classified within a 0-9 scale for easier computerisation **(Browder and Young, 1975)**. Reaction classes (R. I and S) comprised the following variation of infection types "R" - 1, 2, 3, 4, (0, 0, 1, 2-), then "I" - 5,6, (X-, X+) and "S" - 7,8 and 9 (3-,3+, 4). Very often segregation of the cultivar, expressed in different reactions of the plants, were probably due to genetic heterogeneity in a cultivar. In this case the infection types were separated with a comma. For example, a score of 1,8 in the Table 2. indicates segregation by plants with two reactions types. The first are dominant plants with resistant infections type (1), and second the plants with susceptible infections type (8). Similar detailed scoring system were recently applied (**Chilosi and Johnson, 1990**).

The ILRWN nurseries were composed of 15 genetically different winter wheat lines and 15 spring wheat genotypes. Field testings of ILRWN were realised in a three years period (1987-1989).

In 1987. ILRWN nurseries were located in West Germany, Czechoslovakia, Bulgaria, Austria, Switzerland and Syria. Seedlings were tested with six cultures: E.G.w.5/87; Bg.s.12/87; Yu.s.15/87; A.w.15/87; W.G.w.15/87 and Cz.s.11/87. The origin of each culture is designated by the first big letters of the country.

In 1988. ILRWN were in Holland, Italy, Spain, Bulgaria, Czechoslovakia and Syria. Six cultures of *P. recondita tritici* used in this year were: A.w.14/88, Bg.s.12/88, Nl.w.14/88, Cz.s.8/88, Sy.s.11/88 and I.w.13/88.

Location of ILRWN in 1989. were in Germany, Austria, Switzerland, Bulgaria, Italy, Czechoslovakia, Israel, Syria, Chile and Brazil. The cultures were: W. G.s.9/89, A.s.8/89, Bg.s.12/89, I.w.3/89, Cz.s. 5/89 and Is.w.8/89.

All listed cultures of *P. recondita tritici* originated from resistant wheat lines in previous ILRWN nurseries.

RESULTS

The results of the assessment of occurrence of leaf rust and other diseases for ILRWN 1986/87. nurseries were received from six countries. Leaf rust data are presented in Table 1, but in some assessment have not been done according to the instructions.

Tab.1. - International leaf rust wheat nursery - ILRWN 1986/87.
Tab.1. - Međunarodni rasadnici lisne rđe pšenice - ILRWN 1986/87.

Wheat lines	Field response - Reakcije u polju					
Linije pšenice	W.Ger.	Czech.	Bulg.	Austr.	Swiss	Syria
Winter wheat - ozima pšenica						
66/2*Pr	2	0	0	0	1	TR
66/4*St	2	0	0	0	1	TR
66/5*Pr	2	0	5R	0	1	TR
77/1*Pr	2	0	TR	0	1	TR
77/3*St	2	0	0	0	1	TR
26/2*St	2	0	0	0	1	25S
32/1*Pr	2	0	10MR	0	1	TR
32/2*Pr	1	0	10MR	0	1	TR
37/2*Pr	1	0	40 MR	5MR	1	TR
46/2*Pr	2	0	10 MR	0	1	TR
94/2*St	1	0	5 MR	0	1	TR
5/1*Pr	2	0	5 MR	0	1	TR
82/3*St	1	1R	5 MR	0	1	TR
Sava/1*Pr	1	0	5 MR	0	1	TR
Sava/2*Pr	3	0	10 MR	30S	1	TR
Spring wheat - jara pšenica						
Fr-81-3	2	0	0	0	1	-
647-CMA-14793	1	0	0	0	1	-
96-FR-81-15	2	0	0	0	1	-
648-CMA-14793	1	0	0	0	1	-
417-ND-600	2	0	0	0	1	-
11-FR-8118	2	0	0	T	1	-
2A-552	2	0	0	0	1	-
649-CNA-14793	2	0	0	0	1	-
81-ND-582	2	0	5 R	0	1	5 R
95-FR-81-11	2	0	10 R	0	1	-
Lr-9	2	0.60 S	10 M	0	6	-
Lr-19	2	0.60 S	5 MR	T	6	-
Lr-24	2	0	40 M	0	6	-
Lr-18	2	0.3 R	40 M	0	6	-
Lr-14a	2	0. R	20 MR	0	6	-

In West Germany, the tested winter and spring wheat lines displayed satisfactory resistance to *P. recondita tritici*. Resistance has been confirmed by date from Czechoslovakia accompanied only by segregation of the lines Lr9, Lr19, Lr18 and Lr14a. In Bulgaria resistance to *P. recondita tritici* was demonstrated by all lines except some higher severity of moderately resistance reactions of the lines 37/2 x Princ, Lr24 and Lr18. It is interesting only one susceptible reaction of the line Sava/2 x Princ in Austria. According to assessment in Switzerland some susceptibility was detected in the lines Lr9, Lr19, Lr24 and Lr14a. Only susceptible reaction of the line 26/2 x Starke have been found in Syria.

Seedling reactions to the six typical virulent cultures from different countries of ILRWN 1986/87 (Table 2). have shown resistant infection types (1,2,3 and 4) of the winter wheat lines, but with segregation of the lines 66/5 x St., 5/1 x Pr. and Sava/2 x Pr. Spring wheat lines have had much more susceptible infection types (5,6,7,8 and 9) and segregation. Resistant reactions were present in the lines: 647-CMA-14793, 648-CMA-14793, 649-CMA-14793 and 81-ND-582.

In Tab.3. leaf rust assessment of ILRWN 1987/88. entries in seven countries are presented. Again, winter wheat lines have shown good resistance. All lines were resistant in Holland, Italy, Bulgaria, Czeshlovakia and Syria including some low severity of moderately resistant (MR) reactions of particular wheat lines. Moderately susceptible reactions have been registered in Spain for the lines 5/1 x Princ and Sava/1 x Princ, as well as for the line 32/1 x Princ in Austria. Only one susceptible reaction (40S) have been found on the line 37/2 x Pr. in Austria.

Among spring wheat lines some ones were replaced by new resistant lines and leaf rust field evaluations have shown resistance in six or seven countries of the lines 647-CMA-14793, 417-ND-600, 81-ND-582, Verry 722, Nelekant "S", IL-48/86-29 and NSI-44/87. The other spring wheat lines have had susceptible reactions in some countries. In Table 4. seedling reactions to six cultures of *P. recondita tritici* with winter wheat hybrid lines have had again low resistant reactions and segregation to resistant and susceptible plants of the lines: 66/5 x St., 26/2 x St., 94/2 x St. and Sava/2 x Pr. In segregation of these lines resistant reactions on the plants were dominant. Spring wheat lines confirmed resistance of the first five lines with a few segregation. Among the next three wheat lines some better results of resistance have shown only the line NSI-44/87. Much more susceptibility and segregation were present in the line IL-4B/86-29 and variety Dugoklasa. The lines with strong resistant genes, Lr9, L19 and Lr24 reacted very badly to the cultures used. Mostly differential reactions and segregation with dominant susceptibility were present. The last two lines (Lr18 and Lr14a) have had clean susceptibility.

Tab.2. - Seedling reactions of ILRWN nursery 1986/87. to six cultures of *Puccinia recondita tritici*

Tab.2. - Reakcije sejanaca ILRWN rasadnika 1986/87. prema šest kultura *Puccinia recondita tiritici*

W. lines	Cultures of *P. recondita tritici* / Kulture *P. recondita tritici*					
Linije pšenice	E.G.w. 4/86	Bg.s 8/86	Yu.s. 14/86	I.w. 10/86	W.G.s. 15/86	Cz.s. 5/86
Winter wheat - ozima pšenica						
66/2*Pr.	1	1	1	1	1	1
66/4*St.	2	1	1	1	1	1
66/5* St.	1	1	1	1	1.5	1
77/1* Pr.	1	1	1	1	1	1
77/3* St.	4	1	3	1	1	1
26/2* St.	1	1	1	1	1	-
32/1* Pr.	1	-	1	1	1	1
32/2* Pr.	1	1	1	1	1	1
37/2* Pr.	1	1	3	1	4	1
46/2* Pr.	1	1	1	1	1	1
94/2* St.	1	1	1	2	1	1
5/1* Pr.	1	1	1	1.7	1	1
82/3* St.	1	1	2	1	1	1
Sava/1* Pr.	1	1	1	1	1	1
Sava/2* Pr.	1	1.8	1	1	1	1
Spring wheat - jare linije						
Fr-81-3	9	7	9	7	8	9
647-CMA 14793	1	1	2	1	1	1
96 FR 81-15	-	5	9	6	5.1	9
648CMA14793	1	1	1	1	1	1
417 ND 600	2	5	3	1.5	1	3
11FR 81-18	9	8	9	7	7	9
2 A 552	9	5	9	1	4	1
649CMA14793	1	1	-	3	1	1
81ND582	1	1	1	1	1	1
95FR81-11	9	8	9	8	7	9
Lr9	9	1	3	1.9	1.8	1
Lr19	9.1	1	8	8.1	1.9	8.1
Lr24	9.1	1.7	9	4	1.7	3
Lr18	9	7	9	6	9	7
Lr14A	9	8	9	8	9	7

Tab.3. - International leaf rust wheat nursery - ILRWN 1987/88.
Tab.3. - Međunarodni rasadnik lisne rđe - ILRWN 1987/88.

W. lines	Field response / reakcije u polju						
Linije pšenice	Hol.	Ital.	Spain	Austr.	Bul.	Cz.	Syria
Winter wheat - ozima pšenica							
66/2*Pr.	R-5	0	0	0	TR	0	TR
66/4*St.	R-15	20MR	10R	5MR	10MR	5	TR
66/5* St.	R-10	0	0	0	5R	0	TR
77/1* Pr.	R-1	0	0	0	5MR	5	TR
77/3* St.	0	0	0	10M	TR	10	TR
26/2* St.	R-1	0	0	0	5R	0	TR
32/1* Pr.	R-10	0	0	20MS	TR	0	5R
32/2* Pr.	R-10	0	0	0	5R	0	TR
37/2* Pr.	MR-1	0	0	40S	5R	0	5MR
46/2* Pr.	0	0	0	0	0	5	TR
94/2* St.	R-5	0	0	0	-	0	TR
5/1* Pr.	R-1	T	10MS	0	TR	20	MR
82/3* St.	R-20	10MR	10R	0	-	0	TR
Sava/1* Pr.	MS-10	0	20MS	0	5M	5	TR
Sava/2* Pr.	R-20	0,50	5MR	0	5MR	0	TR
Spring wheat - jara pšenica							
647-CMA 14793	0	0	0	0	-	20	TR
417ND-600	R10	0	0	0	10MR	0	TR
81ND-582	0	0	0	0	TR	5	15MR
Verry 772	-	-	0	0	-	0	TR
Nelekant "S"	-	0	0	0	5R	0	5MR
IL-4B/86-29	-	0	TR	0	10MR	0	5R
NSIR-44/87	-	0	TR	0	-	0	5MR
Dugoklasa	-	TR	20S	0	-	0	5MR
Lr9	MS-1	0	0	40S	5MR	1	TR
Lr19	MR-35	-	0	10M	5MR	10	TR
Lr24	0	0.70	50S	20MS	10MR	5	15MR
Lr18	R-5	30S	TR	40S	30M	5	TR
Lr14A	R-10	30S	10MS	40S	30M	10	TR

Tab.4. - Seedling reactions of ILRWN nursery 1987/88. to six cultures of *Puccinia recondita tritici*

Tab.4. - Reakcije sejanaca ILRWN rasadnika 1987/88. prema šest kultura *Puccinia recondita tritici*

Cultures of *P. recondita tritici* / Kulture *P. recondita tritici*						
	A.w. 14/88	Bg.s 12/88	Nl.w. 14/88	Cz.s 1/88	Sy.s 11/88	I.w. 13/88
Winter wheat - ozima pšenica						
66/2*Pr.	1	1	1	1	1	1
66/4*St.	1	1	1	1	1	1
66/5* St.	1.7	1.6	1	1.8	1	1
77/1* Pr.	1	1	1	1	1	1
77/3* St.	1	2	1	3	1	3
26/2* St.	1.8	1	1.6	1	1	1
32/1* Pr.	1	-	1	1	1	1
32/2* Pr.	1	1	1	1	1	1
37/2* Pr.	1	1	1	2	1	1
46/2* Pr.	1	1	1	1	1	1
94/2* St.	1	1	2	1.6	2	1.7
5/1* Pr.	1	1	1	1	1	1
82/3* St.	1	1	1	1	1	1
Sava/1* Pr.	1	1	1	1	1	1.6
Sava/2* Pr.	1	1.8	1	1	1	1
Spring wheat - jara pšenica						
647-CMA 14793	1	1	1	1	1	1.6
417ND-600	1	2	1	1	1	2
81ND-582	1.7	1.8	1	1	1	1
Verry 772	1	1	1.6	1	1	1
Nelekant "S"	1	1	1	1	1	1.7
IL-4B/86-29	7	6.1	7	8	7.2	8.2
NSIR-44/87	1	2	1	1	1	6
Dugoklasa	7	7	2	2.6	4	6
Lr9	8	1	1.8	1.9	1.8	7
Lr19	1.9	1.8	2	8.2	1	8
Lr24	9.2	8.1	1	2	9.1	1.6
Lr18	8	9	9	8	9	8
Lr14A	9	8	9	9	9	9

The results of leaf rust assessments of ILRWN 1988-89. have been received from ten countries and the data are listed in Table 5. The most of collaborators again, have not registered severity and reaction types according to our instructions.

In Germany the nursery was not assessed according to our instructions, but resistance to *P. recondita tritici* was satisfactory in winter wheat lines and the most spring wheat lines. The data were not reliable since the control susceptible line Lr14A was resistant.

Winter wheat lines displayed good resistance to pathogen in Austria, while spring wheat lines NSI 44/87, Lr9, Lr19, Lr18 and Lr14a showed susceptibility.

Resistant or moderately resistant were all winter wheat lines in Switzerland, Bulgaria and Italy. The most of spring wheat lines in these countries were moderately resistant, but in Bulgaria and Italy complete susceptibility, or in segregation with resistance in variety Dugoklasa and the lines Lr9, Lr19, Lr24, Lr18, and Lr14a were registrated.

Field response of the nursery in the other five countries is presented in continuation of Table 5. Again, very good resistance was demonstrated on our winter wheat breeding lines, with exception of susceptible reaction of the line Sava/2 x Princ in Syria. In Chile low severity of moderately sysceptible (MS) reaction was on the lines 6/4 x St. and 37/2 x Princ. In the same nursery some susceptibility was found on the three last lines, 5/1 x Pr., Sava/1 x Pr. and Sava/2 x Princ. In Brazil susceptible reactions was registered on the last two winter wheat lines, and trace susceptibility on the lines 66/4 x St. and 26/2 x Starke.

Good field resistance of spring wheat lines in the other five countries have shown the first four lines, 647-CMA-14793, 417-ND-600, 81-ND-582 and Verry 722. Moderately resistant, moderately susceptible and susceptible were the next three lines, Nelelekant "S", NSI-44/87 and IL-4B/86-29. The other spring wheat lines including strong genes Lr9, Lr19 and Lr24 have had complete susceptibility, or in segregation with resistance.

Seeding reactions of the nursery to another six international pathogen cultures were similar to the previous testings and are presented in Table 6. Resistant reactions were prevalent on winter wheat hybrid lines with segregation mostly in the some lines, as before. Again, only the first four spring wheat lines showed good resistance, and the other spring wheat lines have had very similar reactions, as in the last year.

Tab.5. - International leaf rust wheat nursery - ILRWN 1988/89.
Tab.5. - Međunarodni rasdnik lisne rđe pšenice - ILRWN 1988/89.

W. lines	Field response - reakcije u polju				
Linije pšenice	Germ.	Austr.	Swiss	Bulg.	Italy
Winter wheat - ozima pšenica					
66/2*Pr.	1	0	1	0	0
66/4*St.	1	0	1	10MR	0
66/5* St.	1	0	1	10MR	20MR
77/1* Pr.	1	0	1	10R	0
77/3* St.	1	0	1	0	0
26/2* St.	1	TR	2	0	0
32/1* Pr.	1	0	1	0	0
32/2* Pr.	1	0	2	0	00
37/2* Pr.	1	TR	2	0	-
46/2* Pr.	1	R	1	0	0
94/2* St.	1	0	1	0	-
5/1* Pr.	1	0	1	0	0
82/3* St.	1	0	1	0	0
Sava/1* Pr.	1	2R	1	5R	0
Sava/2* Pr.	1	0	1	10R	TR
Spring wheat - jare pšenice					
647-CMA 14793	1	TR	1	0	-
417ND-600	1	0	1	10 MR	0
81ND-582	1	TR	1	0	0
Verry 772	1	0	1	10 MR	TR
Nelekant "S"	1	T	1	20 MR	0
NSIR-44/87	1	20S	1	40 MR	0
IL-4B/86-29	1	TR	1	10 MR	0
Dugoklasa	2	10 MR	1	80S	TR
Lr9	3	70S	1	0.80S	20S
Lr19	2	60S	1	0.80S	20S
Lr24	1	2R	1	0	10S
Lr18	1	60S	1	80S	TR
Lr14A	2	20S	1	80S	TR

Tab.5.-International leaf rust wheat nursery - ILRWN 1988/89.
Tab.5.-Međunarodni rasdnik lisne rđe pšenice - ILRWN 1988/89.
(continue - nastavak)

W. lines	Field response - reakcije u polju				
Linije pšenice	Czech.	Israel	Syria	Chile	Brazil
Winter wheat - ozima pšenica					
66/2*Pr.	0	0	TR	0	-
66/4*St.	0	0	10MR	10MR-MS	10MR-S
66/5* St.	0	0	5R	0	0
77/1* Pr.	-	0	TR	5R-MR	-
77/3* St.	0	0	TR	TR-MR	TR-MR
26/2* St.	0	0	5R	TR	TR-S
32/1* Pr.	0	0	TR	0	R
32/2* Pr.	0	0	5R	TR-MR	R
37/2* Pr.	0	0	5R	5MR-MS	0
46/2* Pr.	0	0	TR	0	0
94/2* St.	0	0	5R	0	R
5/1* Pr.	0	0	5R	TR-S	R
Sava/1* Pr.	0	0	5R	5-30S	5-30S
Sava/2* Pr.	0	0	20S	30S	30S
Spring wheat - jare pšenice					
647-CMA 14793	0	0	TR	5S	5S
417ND-600	0	0	5R	0	R
81ND-582	0	0	TR	TR-MR	R
Verry 772	0	30MS	TR	10S	5S
Nelekant "S"	20M	20MR	45MS	TR-MR	TR-MR
NSI-44/87	0	20R	60MS	40S	40S
IL-4B/86	0	5R-MR	60MS	0	0
Dugoklasa	0	40MS	90MS	40S	80S
Lr9	0	0,40S	85S	20S	10S
Lr19	0	0,30S	65S	0,TR-MS	0,T-MS
Lr24	0	0,20MR	75S	10S	0,10S
Lr18	0	10MR	70S,TR	TR-MS	-
Lr14A	0	5MR	50S	10S	30S

Tab.6. - Seedling reactions of ILRWN nursery 1988/89 to six cultures of *Puccinia recondita tritici*

Tab.6. - Reakcije sejanaca ILRWN rasadnika 1988/89. prema šest kultura *Puccinia recondita tritici*

Cultures of *Puccinia recondita tritici* / Kulture *Puccinia recondita tritici*						
W. lines	W.G.w.	A.s.	Bg.s.	I.w.	Cz.s.	Is.w.
Linije pšenice	9/89	8/89	12/89	3/89	5/89	8/89
Winter wheat - ozima pšenica						
66/2*Pr.	1	2	1	2	3	1
66/4*St.	1	2	1	2	1,6	1
66/5* St.	1	2,5	1	1,6	2	1
77/1* Pr.	1	1	2	1	1	1
77/3* St.	1	2	1,6	2	1	2
26/2* St.	1	1	1,6	1	1,4	2
32/1* Pr.	2	1	1	1	1	1
32/2* Pr.	1	1,7	1	1	1	1
37/2* Pr.	1	1	1	1	1	1
46/2* Pr.	1	2	1	1	1	1
94/2* St.	3,5	1	2,5	1	2	1
5/1* Pr.	1	1	2	1	1	2
Sava/1* Pr.	3	1,4	1	1	1,6	1
Sava/2* Pr.	1	1,6	1	4	1,6	1
Spring wheat - jare pšenice						
647-CMA 14793	1	1	1	2	1	1
417ND-600	1	1	2,5	1	1	1
81ND-582	1	1	1	1,6	2	1
Verry 772	1	1	1	2	1,5	1
Nelekant "S"	2	3	1,6	1	2	1
NSIR-44/87	2	3	1	3	1	4
IL-4B/86-29	4	2	6	8	1	2
Dugoklasa	5	2	4	2,6	5	5
Lr9	8	1,8	1,7	1,9	1,6	2,7
Lr19	1	1,8	2,7	8	1,8	8
Lr24	8,1	8,2	1,6	2,7	8,1	1,8
Lr18	7	8	9	8	7	8
Lr14A	9	9	8	9	8	9

DISCUSSION

In a three years period of testings, fifteen winter wheat hybrid lines in ILRWN nurseries and seedling testings to virulent cultures *of P. recondita tritici*, have shown dominant good resistance. Partial susceptibility have had only two hybrids, Sava/1 x Pr. and Sava/2 x Pr. In our variety **Sava Bartoš et al. (1989)** found weak leaf rust gene Lr-3. It was a reason that variety Sava loosed resistance in Yugoslavia after two years of growing period. Several winter wheat hybrids showed some segregation with dominant resistant reactions. From the spring wheat lines the best results have shown only the lines: 647-CMA-14793, 417-ND-600, 81-ND-582 and Verry 722. It is known that the variety Verry 722 contains the Lr26 gene for resistance which is associated with a translocation between the short arm of rye chromosome 1R and long arm of wheat *(Triticum aestivum L.)* chromosome 1B **(McIntosh, 1983).** This variety developed at CIMMYT from the cross (Kavkaz x Buho) x Kalyansona x Bluebird), has inherited the 1BL/RS translocation from "Kavkaz" **(Marker, 1982).**

In ILRWN nurseries were tested the lines with strong resistance genes, namely Lr9 transferred from *Aegilops umbellulata* **(Soliman et al., 1963)**, Lr19 transferred from *Agropyron elongatum* in the variety Thatcher **(Browder 1972, Eizenga 1987)**, and Lr24 transferred from *Agropyron elongatum* **(McIntosh et al., 1976)**. This genes demonstrated very good resistance in many investigation **(Donchev, 1979, Bošković, 1976, 1980, 1985, Clifford, 1980, Statler et al., 1985).** Meanwhile, the results obtained in this testings have shown that this three genes expressed either susceptibility or segregation within the line on susceptible and resistant reaction.

This time our winter wheat hybrid lines showed so much advantage in comparation to the lines with strong resistance genes Lr9, Lr19 and Lr24. Since, these genes have had so good testing results in the past they have been used in our program of accumulation of resistance genes to *P. recondita tritici*. It was demonstrated that these genes in combination with the other resistance genes have shown very good testing results **(Bošković and Bošković, 1992).** The line Lr18 was included in the ILRWN nurser, because of the seedling differential reactions and full resistance of the adult stage **(Bošković, 1985, Bošković and Bošković, 1988)**. The negative testing results obtained with Lr18 probably came from extreme susceptibility of this gene to higher temperature **(Dyck and Johnson, 1983).**

It is necessary to point out original approach in these international testings and investigations. For the seedling tests virulent pathogen cultures from resistant ILRWN wheat genotypes have been used on the large epidemiological territory **(Bošković, 1988)**. In the most other international testings, field nurseries are used, but for the seedling tests always were used races selected from differential

testers (**Prescot et al., 1975, Bekele et al., 1988, Kilpatric and Harmon, 1980).** According to this new approach different specially virulent cultures of *P. recondita tritici* from resistant wheat genotypes of the large epidemiological territory were tested with genetically different sources of resistance. In such a way, more important practical results can be achieved in breeding for resistance, compared with classical analyses of pathogen population (**Bošković et al., 1990).** .

Conclusion

The best genetically different resistant winter wheat hybrid lines from our breeding program and some selected spring wheat lines have been tested in the stage of seedlings to different international cultures of *Puccinia recondita tritici*. The same material were tested in the adult stage in International nurseries (ILRWN) on the large epidemiological territory in Europe and some other locations in the world.

Field nurseries contained fifteen selected winter wheat hybrid lines and fifteen resistant spring wheat lines. Very good results have shown winter wheat hybrid lines with dominant resistant reactions in the seedlings to specially virulent cultures of *P. recondita tritici* and in the adult stage in the field nurseries on the large territories. Only less resistance were demonstrated by wheat hybrids Sava/1 x Princ and Sava/2 x Princ. Better combining abilities of resistant genes have shown the wheat hybrids with recurrent parent Princ, than in recurrent parent wheat variety Starke. That was mostly evaluated according to the presence of segregation to resistance and susceptible plants in the seedlings and adults stage.

All spring wheat resistant lines have had much more segregation in seedling and adult stage and more susceptible reactions, except the spring wheat lines 647-CMA-14793 and Verry 722.

In this investigations is applied original approach for seedling tests, using virulent cultures from resistant wheat genotypes from the large territory, and application of genetically, different resistance wheat sources in the nurseries. In such a way more important practical results can be achieved in breeding for resistance compared with classical analyses of pathogen population.

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REAKCIJE SEJANACA I ODRASLOG STADIJA GENETSKI RAZLIČITIH OTPORNIH LINIJA PŠENICE PREMA PUCCINIA RECONDITA TRITICI

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REZIME

Rđe pšenice su tipičan primjer neophodnosti internacionalnih kooperativnih istraživanja zbog epidemiološke prirode ovih problema. Širenje patogena na velike distance je dobro poznat fenomen. Vazdušne struje su nekontrolisani prenosioci inokuluma. U tom smislu za ova istraživanja formiran je međunarodni centar za žutu rđu pšenice u Holandiji, stabljikinu rđu pšenice u Portugaliji, za lisnu rđu pšenice još 1966. godine u Novom Sadu.

Odabrano je petnaest homozigotnih otpornih hibridnih linija pšenice uz ukrštanja izvora otpornosti prema *Puccinia recondita tritici* sa rekurentnim roditeljima Princ i Starke (**Bošković i sar. 1994**), koje su bile uključene u rasadnike (ILRWN) za testiranje u širokom epidemiološkom području Evrope i neikih drugih zemalja. Poslije višegodišnjeg testiranja u Centralnom rasadniku za rđe pšenice, u kojem su bili uključeni mnogobrojni materijali iz Internacionalnih rasadnika za rđe, izdvojeno je deset otpornih jarih genotipova za Evropski rasadnik. U rasadnicima su učestvovale izogene linije Lr9, Lr19, Lr24 i Lr18, pošto su neke ispoljavale potpunu otpornost, a druge diferencijalne reakcije, dok je osetljiva linija sa genom Lr14a služila kao kontrola. Tako je u rasadnicima ILRWN tokom tri godine (1987-1989) bilo uključeno 15 ozimih hibridnih linija pšenice i 13-15 jarih genotipova.

U poljskim ogledima (ILRWN) su registrovani: intenzitet zaraze, po modifikovanoj Coob-ovoj skali i tipovi infekcije (0-4). Ocjenjivanje reakcije sejanaca obavljeno je po skali 0-9 (1-4=R, 5-6=I i 7-9=S). Cijepanje na biljke sa osjetljivim ili otpornim reakcijama je označavano zapetom (9,).

Petnaest odabranih ozimih hibridnih linija iz ovih ukrštanja i deset do petnaest odabranih jarih genotipova pšenice, pokazali su u testiranjuu različito ponašanje. neke ozime linije su imale veće, a neke manje učešće cijepanja na otporne i osjetljive biljke, bilo u stadiju sijanaca ili odraslih biljaka. Kombinirajuće sposobnosti gena otpornosti u hibridnim linijama su bile znatno bolje sa rekurentim roditeljima Princ prema sorti Starke. Većina ozimih hibridnih linija u rasadnicima je potvrdila vrlo dobru otpornost, dok su jare linije imale mnogo više cijepanja i osjetljivih reakcija, a najbolje rezultate je ispoljavala jara linija 647-CMA-14793 i donekle linija Verry 722.