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# GENETIC BASIS OF HYPERSENSITIVE RESISTANCE TO PUCCINIA TRITICINA IN NOVI SAD CREATED WHEAT VARIETIES

Zoran Jerkovic, Zeljana Micanovic, Radivoje Jevtic

Institute of field and vegetable crops – Novi Sad

Breeding program for the resistance to *Puccinia triticina* exists for more than 40 years. During that period few methods of finding effective genes were applied (Boskovic, 1966, Momcilovic, 1969, Jerkovic et al. 1992). Incomplete resistance was also involved for the gene accumulation. The focused resistance until ninety's have been hypersensitive. Even the genes from the wheat relatives were only single resistant to the population of the parasite in field and seedling stage, many genotypes without them reacted similar. The single gene basis was not approved in lot of investigation. The resistance was mostly dominantly inherited and the frequency of resistant plants was high in F2 progenies. The segregation ratios suggested the complementarily effect of two or three genes (Momcilovic and Jerkovic 1985, Jerkovic, 1992). The differentiation by monopustule cultures of isolates was not possible because of resistance sources choice. There is the high probability of presence of well-known genes transferred in Thatcher background (NIL) near isogonics lines, by the genealogies. The next idea was to check the influence of some of them like Lr 1, Lr 2a, Lr 3, Lr 10, Lr 13, Lr 16, Lr 26 on the present hypersensitive resistance. In the Msc thesis of Micanovic similar to the results published in the paper (Micanovic and Jerkovic, 2002), some of these genes transferred to NIL have the influence on increasing the frequency of hypersensitively resistant plants. All possible theoretical segregation ratios were related to experimental data by X2 test. The conclusion was that variety Anastasia possess the gene Lr 26 which single is not enough to react hypersensitively to isolate in the race type 2 (Lr 1 and the Lr 2 multiple allele series is resistant). The variety Selektta possesses the Lr 3 and Lr 10. Those genes are not enough to produce hypersensitivity (varieties that carry them are susceptible). The segregation ratios in the progenies of these varieties and susceptible ones like with Lr NILs leads to three hybrid inheritance solution.

According to mentioned investigation results, the aim of the study presented in this paper was to find the direct differences between the hypersensitively resistant varieties and additionally the partially resistant one (Jerkovic and Jevtic, 2001).

## Material and method

Varieties Pasma, Selektta and Anastasia were hypersensitively resistant at the seedling stage. Inoculation with the population was simultaneous with Lr NIL serial according to described method (Jerkovic, 1992). The temperature in the greenhouse was around 20°C.

The diallel crosses of the mentioned varieties including the partially resistant variety Renesansa were performed in 2000th. The testing of parents F1, F2 and NILs was in the greenhouse. The isolate of the race 2 type was applied by the same method of inoculation and the growing conditions were as previous. The resistance on Lr 1 and Lr 2 locus (race 2) is often in this region (Todorova and Jerkovic, 1996;1998). The border between hypersensitively resistant and susceptible genotype reaction was 3. The intensity of the attack in the field on parents and F1 was estimated in next year using the modified Cobb scale.

## Results and discussion

Resistance of the mentioned varieties was not complete as on Lr 1 and Lr 2 serial. In the field conditions the F1 progenies were moderately susceptible according to reaction type (Tabl. 2). The infection severity was transgressive when the Anastasia was a parent. In the greenhouse obtained results suggest the same genetic basis of the resistance in the varieties Selektta and Pasma. The all another varieties are different. The single dominant gene difference connected with segregation ratio in the F2 of the cross Anastasia x Renesansa can be explained by the identical gene in the both of the parents too (Tabl. 1).

The segregation ratio 3R:1S can be achieved in the case of the identical genes B or C of the resistant combination A\_B\_ or A\_C\_ or one of the A\_B\_. The frequencies of the resistant plants in the crosses of Anastasia with Selektta and Pasma are similar. The usual theoretical segregation ratio is 15R>1S suggest the difference in two single effective dominant genes. The 0,87 percent of resistant plants in the progenies of the cross Pasma x Renesansa is nearest to (54R:10S) A\_B\_ or A\_C\_ or B\_C\_ (or 57R:7S A\_ or B\_C\_). If we ignore that result we can explained the resistance of Selektta, Pasma and Anastasia on the single effective gene basis. The gene in Anastasia has to be different. Renesansa than do not possess genes for hypersensitive reaction. By the genealogies that is not probable. What happens if Renesansa possess gene not single expressible to the applied isolates (for the example\_Lr 26). Residual effect of the genes in NILs is well

known. Combinations of genes Lr 3 and Lr 10 are usual in many varieties like Victory, Redland, Neck, Pioneer selections ect., such as the those with Lr 26 as Longnom, Cowbird S, Sensor, Solaris, Veery ect. Their presence in the investigated resistant material is proven. According to mentioned investigations. Bezostaia 1 (Lr 3a, Lr 10 and Lr 34) is susceptible with reaction type 4.

Table 1

The segregation in F2 at seedling stage in the greenhouse (race 2 of *P. triticina*) and the infection severity in the field of F1 in 2001 (1 m<sup>2</sup> parcel, low density sown)

Combination	seg. ratio			
	F2	FR	theor. seg. ratio	inf.sever. F1
PESMA X SELEKTA	205 : 0	/		10
PESMA X RENESANSA	180 : 28	0,87	54R:10R or 57S:7S	10
PESMA X ANASTAZIJA	175 . 15	0,92	15R:1S	5
ANASTAZIJA X SELEKTA	193 . 13	0,94	15R:1S	0
ANASTAZIJA X RENESAN	122 : 38	0,78	3R:1S	0

Table 2

The infection severity in the field conditions of the wheat varieties grown on 9 m<sup>2</sup> (600 seeds on 1 m<sup>2</sup> sown near the in first table mentioned F1 under the natural infection)

Variety	Date of estimation 15.VI	React. type in field
Pesma	5	MS/S
Selekta	10	MS/S
Anastasia	20	MS/S
Renesansa	40	S
NSR 2	60	VS

The explanation, which activates all data, is that three genes, at least two same in both, control the resistance of Pesma and Selekta. Resistance of Anastasia is controlled with at least two genes from which the one is the same like one single not expressible in Renesansa. That gene is not in similar tested hypersensitively resistant varieties. That results are not comparable with some achieved on lines created in our programme, not only because the different infection types at seedlings, than also the segregation results from the crosses with same Lr lines (Micanovic, 2002). The future hypersensitive resistance is possible in these area avoiding the Lr 1, Lr 2, Lr 9, Lr 19 or Lr 24 genes (Jerkovic and Jevtic, 1994; Jerkovic and Jevtic, 2001; Micanovic and Jerkovic, 2002)

### Conclusion

The hypersensitive resistant varieties Pesma and Selekta have the at least two same genes for the resistance to applied culture from monopustule isolate in the race type 2 in the greenhouse at the seedling stage. They are not Lr 1 or some of Lr 2. At the field conditions in the F1 the difference between the progenies from the crosses Pesma x Renesansa and Selekta x Renesansa lead to the conclusion that they are not completely same corresponding to in the greenhouse at seedling stage of the F2 progenies testing result. The inheritance of the resistance is threehybrid (Pesma) or monohybrid (Anastasia) in the progenies from the crosses with Renesansa. Last one could be from several reasons in the case of separate observation. According to presented and previous investigation results, the Anastasia is different from Pesma and Selekta by the genetic basis of the resistance. Renesansa have the one to the applied isolate single at the seedling stage throw the hypersensitivity not expressible gene, same as one of at least two in Anastasia. In the field conditions, Anastasia crossed with Pesma or Selekta decrease the infection severity in F1 in comparison with F1 Pesma x Selekta in field.

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### Summary

The hypersensitive resistant varieties at seedling stage in the greenhouse (around 20°C) were crossed with partially resistant one *Renesansa*. According to F2 simultaneous tests with Lr Nils (Tatcher) and parents, *Pesma* and *Selekta* have the at least two same genes for the resistance to applied culture from monopustule isolate in the race type 2 in the greenhouse at the seedling stage. They are not Lr 1 or some of Lr 2 multiple allele serial. At the field conditions in the F1, the difference between the progenies from the crosses *Pesma* x *Renesansa* and *Selekta* x *Renesansa* lead to the conclusion that they are not completely same corresponding to in the greenhouse at seedling stage of the F2 progenies testing result. The inheritance of the resistance is tree hybrid (*Pesma*) or monohybrid (*Anastasia*) in the progenies from the crosses with *Renesansa*. Last one could be from several reasons in the case of separate observation. According to presented and previous investigation results, the *Anastasia* is different from *Pesma* and *Selekta* according the genetic basis of the resistance. *Renesansa* have the one to the applied isolate, single at the seedling stage throw the hypersensitivity not expressible gene, same as one of at least two in *Anastasia*. In the field conditions *Anastasia* crossed with the *Pesma* and *Selecta* decrease the infection severity in F1 in comparison with F1 *Pesma* x *Selecta*.