

EFFECTS OF PYRAMIDING GENES FOR PARTIAL RESISTANCE TO LEAF RUST (*Puccinia recondita*) ON WHEAT (*Triticum aestivum*)



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Wheat, one of the most widely grown crop globally and in Romania, is affected by numerous diseases, among which leaf rust, caused by the pathogen *Puccinia recondita*, is one of the most frequent and can lead to yield losses of up to 40%.

Genetic resistance is the most convenient way, both economically and ecologically, to reduce the impact of this disease, and many strong resistance genes, offering complete protection against leaf rust, are available. However, experience has shown that the pathogen can rapidly develop new races virulent to such resistance genes, if they are deployed on large areas, making this genetic protection against leaf rust short lived.

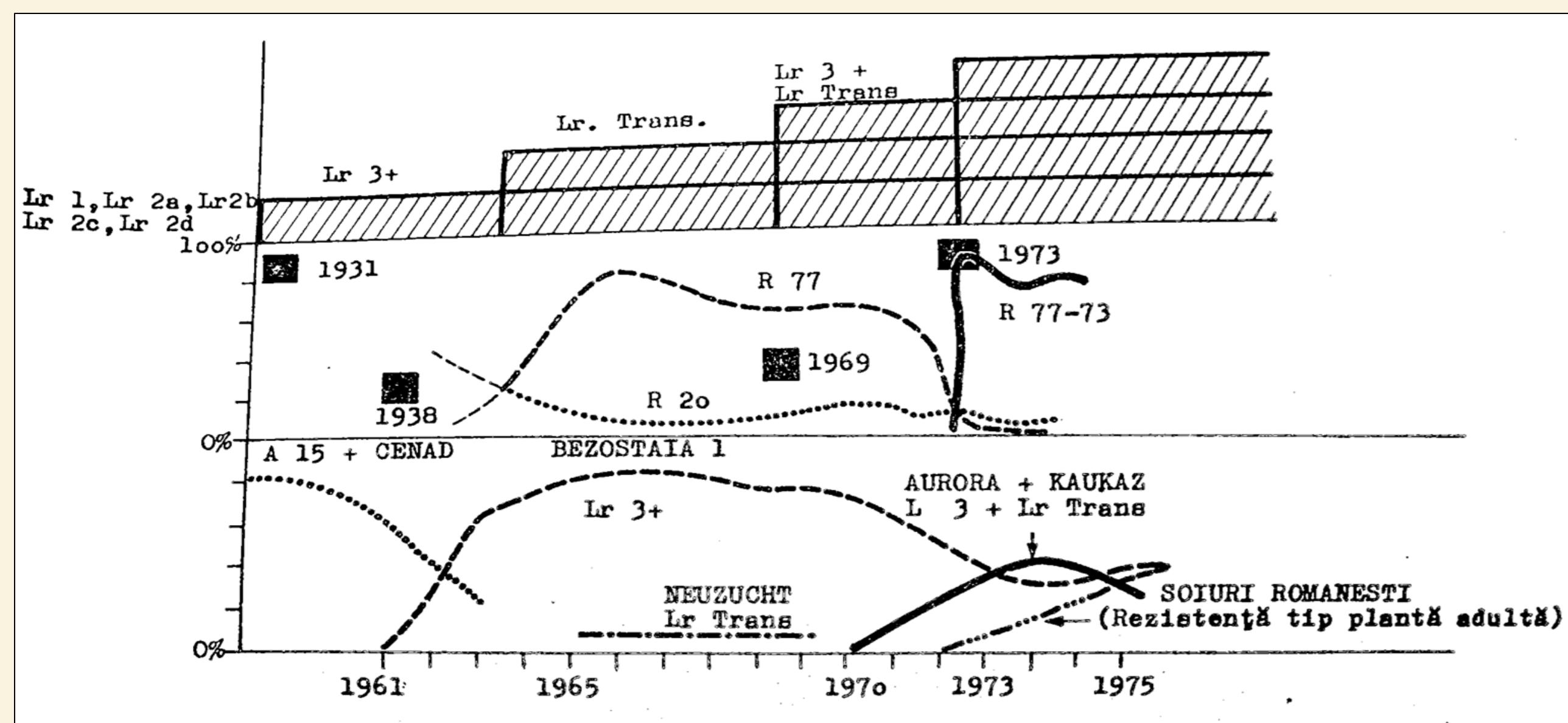
In this study molecular markers associated with genes *Lr34*, *Lr37*, *Lr46* and *Lr68* were used to identify genotypes carrying one to four of these resistance genes. The genotypes were tested at NARDI Fundulea, under artificial inoculation with a mixture of races prevalent in the area, during 2023 to 2025. Percentage of leaf area affected by rust was visually estimated. Averaged over three years and several genotypes carrying the same number of *Lr* genes, entries carrying one gene reduced the attack from 66,7% in susceptible genotypes to 20.0%, while entries cumulating two *Lr* genes showed 7,1% attack. In entries cumulating 3 or 4 *Lr* genes no leaf rust attack was observed. Presence of the *Lr46* gene alone reduced the attack from 66,7% to 26,7%. Adding to it the genes *Lr68* or *Lr37* further reduced the attack to 7,8% and 4,4% respectively, while adding both *Lr37* and *Lr34* provided complete protection against leaf rust.

Based on these results, which confirm, for the germplasm adapted to our environment, other results reported internationally, we routinely use marker assisted selection to increase the frequency of partial resistance genes in the breeding program and to attempt pyramiding these genes for more complete and durable genetic protection.

INTRODUCTION

Experience has shown that the pathogen can rapidly develop new races virulent to such resistance genes, if they are deployed on large areas, making this genetic protection against leaf rust short lived (Ionescu-Cojocaru and Negulescu, 1977).

Partial resistance genes, usually manifested only at adult stage, proved to offer a more durable but incomplete protection. Pyramiding such genes in one wheat genotype, was suggested and has been used in several breeding programs, to ensure adequate and durable resistance.



The evolution of the wheat-brown rust genetic system in Romania (1961-1975) (Ionescu-Cojocaru and Negulescu, 1977)

Genotype	Leaf rust response ^a (1994)	Additive genes for resistance
Jupateco 73S	100S(N)	-
Jupateco 73R	50MSS	<i>Lr34</i>
Nacozari 76	30MSS	<i>Lr34</i> + 1 gene
Sonoita 81	20MSS	<i>Lr34</i> + 1 or 2 genes
Frontana, Parula, Trap, Mango, Crow, EsmERALDA 86, Ocoroni 86, Tonichi 81	5MSS	<i>Lr34</i> + 2 or 3 genes
Pavon 76	30MSS	<i>Lr46</i> + 1 gene
Apache 81	40MSS	2 genes
Amadina	5MSS	3 or 4 genes

Some seedling susceptible bread wheats that carry good adult plant resistance to leaf rust (Singh and Rajaram, 2002)

MATERIALS AND METHODS

We used molecular markers associated with genes *Lr34*, *Lr37*, *Lr46* and *Lr68*, to identify genotypes carrying one to four of these resistance genes and tested them at NARDI Fundulea, under artificial inoculation with a mixture of races prevalent in the area, during 2023 to 2025.

RESULTS

%	Entry	Genealogy	Lr genes present	2023	2024	2025	3 years average
	No Lr genes		0	70	60	70	66,7
1	GLOSA	135U2-1/508U1-1//135U3-1	<i>Lr34</i>	0	0	40	13,3
2	COLUMNA	NOGAL/OTILIA	<i>Lr37</i>	0	10	30	13,3
3	ZOLOTOKOLOSA	?	<i>Lr46</i>	30	40	40	36,7
4	16286G3INC01	12141G0/2*OTILIA	<i>Lr46</i>	0	20	30	16,7
	Average of entries with 1 Lr gene			7,5	17,5	35	20
5	MUDRISKI OD.	?	<i>Lr34+46</i>	10	10	20	13,3
6	AMURG	MURGA/03124G//PITAR	<i>Lr37+46</i>	0	0	0	0
7	15149G	Mv. Zeke/10326G3	<i>Lr37+46</i>	30	10	0	13,3
11	18148G1-3	DURES118-1/BOGDANA	<i>37+46</i>	0	0	0	0
8	KATRUSEA	?	<i>Lr46+68</i>	40	10	20	23,3
9	18012G3-7	11248G2-1/BOGDANA	<i>46+68</i>	0	0	0	0
10	18012G3-11	11248G2-1/BOGDANA	<i>46+68</i>	0	0	0	0
	Average of entries with 2 Lr genes			11,4	4,3	5,7	7,1
12	17061G2-3	11248G2-2/13248G4	<i>34+37+46</i>	0	0	0	0
13	17061G2-4	11248G2-2/13248G4	<i>34+37+46</i>	0	0	0	0
14	18012G2-3	11248G2-1/BOGDANA	<i>34+37+46</i>	0	0	0	0
15	18148G1-4	DURES118-1/BOGDANA	<i>34+37+46</i>	0	0	0	0
	Average of entries with 3 Lr genes			0	0	0	0
16	17061G2-5	11248G2-2/13248G4	<i>34+37+46+68</i>	0	0	0	0
17	17061G2-6	11248G2-2/13248G4	<i>34+37+46+68</i>	0	0	0	0
18	17061G2-8	11248G2-2/13248G4	<i>34+37+46+68</i>	0	0	0	0
	Average of entries with 4 Lr genes			0	0	0	0

CONCLUSIONS

Our results confirm, for the germplasm adapted to our environment, the efficiency of pyramiding partial resistance genes for reducing damage caused by leaf rust.

In the NARDI Fundulea wheat breeding program marker assisted selection is routinely used to increase the frequency of partial resistance genes and to pyramide these genes for more complete and durable genetic protection.

References

IONESCU-COJOCARU M., NEGULESCU F. (1977) Cercetări genetice aplicate în ameliorarea rezistenței la rugina brună (*Puccinia recondita*) a grâului. Probleme de genetica teoretică și aplicată vol. 9 nr.1:27-54
LAGUDAH, E. S., KRATTINGER, S. G., HERRERA-FOESSEL, S., SIGH, R.P., HUERTAESPIÑO, J., SPIELMEYER, W., BROWN-GUEDIRA,G., SELTE,R L. L, KELLER, B., (2009) Gene-specific markers for the wheat gene *Lr 34/Yr 18/Pm 38* which confers resistance to multiple fungal pathogens. *Theor. Appl. Genet.*, 119: 889-898.
SINGH, R. P., & RAJARAM, S. (2002). Breeding for disease resistance in wheat. FAO plant production and protection series, 30.

