



# Detection of leaf rust resistance genes *Lr24*, *Lr25*, *Lr28*, *Lr34* and *Lr35* in winter wheat cultivars

Paweł Cz. Czembor, Magdalena Radecka-Janusik, Piotr Słowacki  
Plant Breeding and Acclimatization Institute-National Research Institute,  
Radzikow, 05-870 Blonie, Poland

## Objective

The aim of the study was evaluation of molecular markers specificity for a five *Lr* genes and their detection in winter wheat cultivars.

## Materials and methods

A set of 150 European winter wheat cultivars collection (WWCC) comprising 83 cultivars registered on national list of COBORU (Research Centre for Cultivar Testing, Poland) and other European cultivars (Germany, France, United Kingdom, Austria and Czech Republic) were used. The specificity of molecular markers was analyzed on NILs of cv. ‘Thatcher’ (TcNILs) carrying known *Lr* resistance genes (standard *Lr* differential set). DNA of WWCC and TcNILs was amplified in PCR using specific markers linked to the *Lr* genes: *Lr24* (wPt8845-3, PCR product 370bp- green colour in a table), *Lr25* (combination of markers gwm6 – no PCR product and gwm251 – 124bp), *Lr28* (SCS421<sub>570</sub>-1/ SCS421<sub>570</sub>-2 – 570bp), *Lr34* (cssfr5 – 751bp) and *Lr35* (Sr39-F2/Sr39-R3 – 900bp).

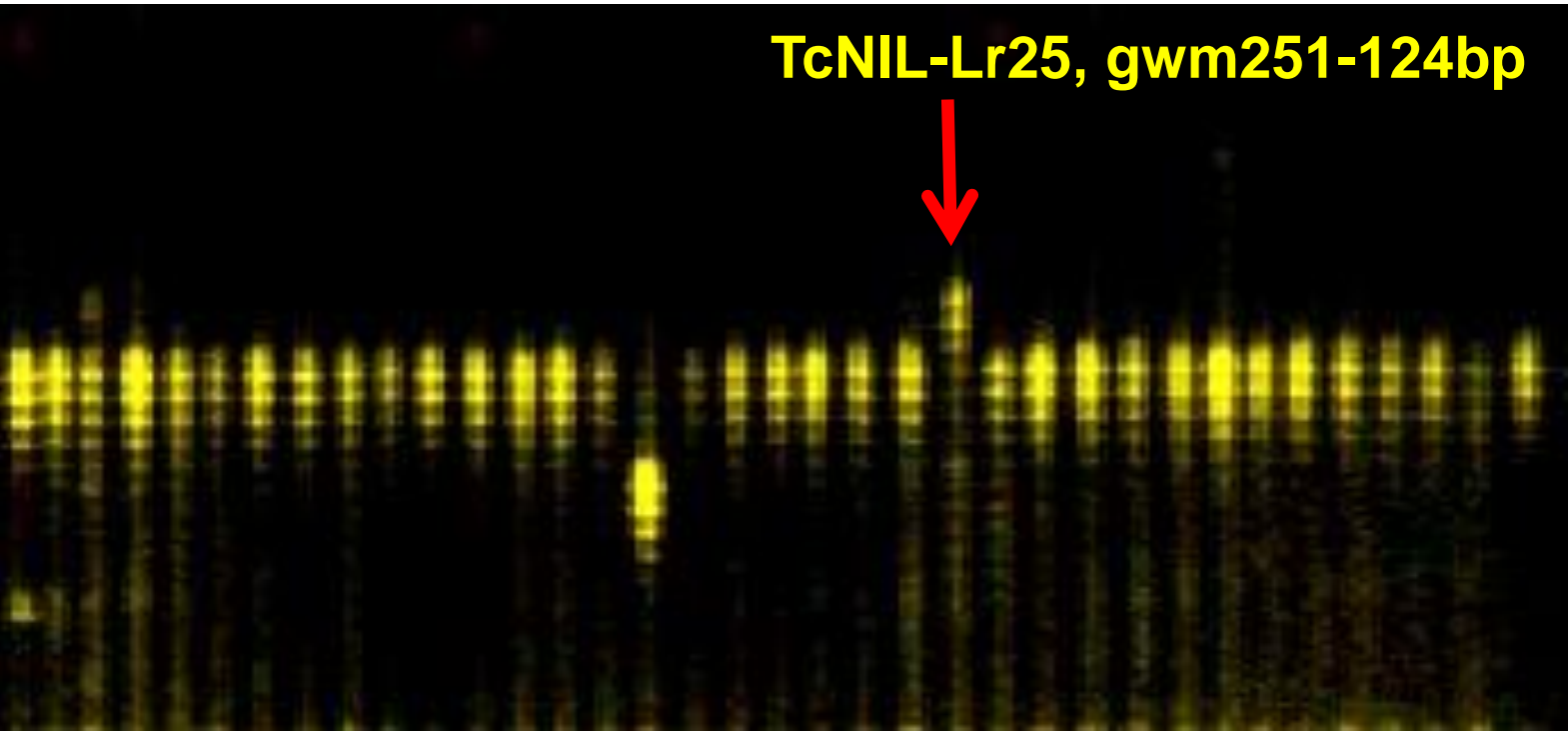
## Results

Table. Molecular analysis in a set of 192 winter wheat cultivars/lines (blue colour – cultivars registrated on national list of COBORU, purple – European cultivars, green – TcNILs).

All markers were specific on *Lr* differential set comprising 42 lines, i.e. for a given resistance gene above mentioned PCR product (amplified from closely linked marker locus) was detected only in the line carrying this gene. Among 150 wheat cultivars amplification of specific markers gave the following results:

- *Lr24* was detected in cultivars: Caroll, Desamo, Elixer, Lithium, Memory, Tentation, Waxy and Xantippe
- *Lr28* was detected in cultivars: Addict, Belepi, Capone, Elixer, Ennsio, Eron, Fermi, Gordian, Heros, Ionesco, Kredo, Lear, Matheo, RGT Djoko, Pengar, Speedway, Scout, Tabasco, Terroir, Tobak and Zappa
- *Lr34* was detected only in cultivar Baletka
- *Lr25* and *Lr35* were not detected in WWCC

Figure. Amplification products of marker gwm251 specific to *Lr25* on TcNILs.



## Acknowledgements

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No	Cultivar/Line	Registration country	gene/marker name					
			Lr24	Lr25		Lr28	Lr34	Lr35
			wPt8845-3	gwm251	gwm6	SCS421-570	cssfr5	Sr39F/R
1	Akteur	Poland	0	113	194	0	523	0
2	Alcazar	Poland	0	117	200	0	523	0
3	Arkadia	Poland	0	124	200	0	523	0
4	Arktis	Poland	0	113	194	0	523	0
5	Arist	Poland	0	124	205	0	523	0
6	Askalon	Poland	0	112	200	0	523	0
7	Astoria	Poland	0	112	0	0	523	0
8	Bagon	Poland	0	112	200	0	523	0
9	Baletka	Poland	0	80	201	0	751	0
10	Bamberka	Poland	0	113	192	0	523	0
11	Banderola	Poland	0	112	200	0	523	0
12	Batuta	Poland	0	112	205	0	523	0
13	Belenus	Poland	0	112	200	0	523	0
14	Bockris	Poland	0	109	200	0	523	0
15	Bogatka	Poland	0	109	200	0	523	0
16	Boomer	Poland	0	107	200	0	523	0
17	Bystra	Poland	u	111	194	0	523	0
18	Dorota	Poland	0	113	200	0	523	0
19	Elipsa	Poland	370	124	194	0	523	0
20	Estivus	Poland	0	113	194	0	523	0
21	Fakir	Poland	0	113	200	0	523	0
22	Fidelius	Poland	0	124	200	0	523	0
23	Figura	Poland	u	118	0	0	523	0
24	Forkida	Poland	0	113	194	0	523	0
25	Forum	Poland	u	124	205	0	523	0
26	Fregata	Poland	0	113	194	0	523	0
27	Garanus	Poland	0	113	200	0	523	0
28	Henrik	Poland	0	113	200	0	523	0
29	Jantarka	Poland	u	124	200	0	523	0
30	Junga	Poland	0	124	200	0	523	0
31	Kampana	Poland	0	113	205	0	523	0
32	Kopler	Poland	0	106	205	0	523	0
33	Kobiera	Poland	0	113	194	0	523	0
34	Kohella	Poland	0	109	200	0	523	0
35	Kranich	Poland	0	113	200	0	523	0
36	Kredo	Poland	0	124	200	570	523	0
37	Kris	Poland	0	108	200	u	523	0
38	KWS Dacanto	Poland	0	113	200	0	523	0
39	KWS Livius	Poland	0	124	200	0	523	0
40	KWS Magic	Poland	370	113	200	0	523	0
41	KWS Ozon	Poland	0	113	200	0	523	0
42	Lavantus	Poland	0	113	200	0	523	0
43	Legenda	Poland	0	113	200	0	523	0
44	Litus	Poland	0	108	200	0	523	0
45	Look	Poland	0	108	200	0	523	0
46	Ludwig	Poland	0	124	200	0	523	0
47	Markiza	Poland	0	124	200	0	523	0
48	Meister	Poland	0	113	200	0	523	0
49	Meteor	Poland	0	114	200	0	523	0
50	Mewa	Poland	0	u	200	0	523	0
51	Mikula	Poland	0	124	194	0	523	0
52	Mulan	Poland	u	113	194	0	523	0
53	Muszelka	Poland	0	113	200	0	523	0
54	Muza	Poland	0	124	200	0	523	0
55	Naridana	Poland	0	110	194	0	523	0
56	Natula	Poland	0	124	200	0	523	0
57	Nutka	Poland	0	124	200	0	523	0
58	Olivin	Poland	0	108	200	0	523	0
59	Operetka	Poland	0	124	200	u	523	0
60	Osika Strzelecka	Poland	0	124	200	0	523	0
61	Ostroga	Poland	u	113	200	0	523	0
62	Oxal	Poland	u	113	200	0	523	0
63	Patras	Poland	0	108	200	0	523	0
64	Pengar	Poland	0	124	194	570	523	0
65	Platin	Poland	0	113	200	0	523	0
66	Praktik	Poland	0	113	205	0	523	0
67	Rapsodia	Poland	0	124	200	0	523	0
68	Rywalka	Poland	0	113	200	0	523	0
69	Sailor	Poland	u	113	194	0	523	0
70	Satyna	Poland	0	124	200	0	523	0
71	Skagen	Poland	0	113	196	0	523	0
72	Smaragd	Poland	0	113	200	0	523	0
73	Smuga	Poland	u	113	200	0	523	0
74	Speedway	Poland	u	110	200	570	523	0
75	Sukces	Poland	0	124	200	0	523	0
76	Tonacja	Poland	0	124	200	0	523	0
77	Torrild	Poland	0	113	200	0	523	0
78	Tulecka	Poland	0	108	200	0	523	0
79	Turkis	Poland	0	116	194	0	523	0
80	Turnia	Poland	0	124	200	0	523	0
81	Wydma	Poland	0	113	194	0	523	0
82	Zawisza	Poland	u	113	194	0	523	0
83	Zyta	Poland	0	124	200	0	523	0
84	Addict	France	0	108	205	570	523	0
85	Agape 192	Italy	0	113	200	0	523	0
86	Akratos	Germany	0	108	200	0	523	0
87	Armada	France	0	108	200	0	523	0
88	Artagnan	France	0	124	200	0	523	0
89	Astardo	Austria	0	108	194	0	523	0
90	Avalon	United Kingdom	u	110	194	0	523	0
91	Avenir	Austria	u	116	200	0	523	0
92	Belepi	France	0	124	200	570	523	0
93	Calumet	France	0	108	205	u	523	0
94	Capone	Germany	0	124	200	570	523	0
95	Caroll	Czech Republic	370	108	200	0	523	0
96	Celebration	United Kingdom	u	108	200	0	523	0

No	Cultivar/Line	Registration country	gene/marker name					
			Lr24	Lr25		Lr28	Lr34	Lr35
			wPt8845-3	gwm251	gwm6	SCS421-570	cssfr5	Sr39FR
97	Cocoon	United Kingdom	0	110	194	0	523	0
98	Desamo	Germany	370	112	205	0	523	0
99	Dickens	United Kingdom	0	106	205	0	523	0
100	Diderot	France	0	110	200	0	523	0
101	Edelrun	Austria	u	112	185	0	523	0
102	Eliser	Germany	370	112	202	570	523	0
103	Ennsio	Austria	u	110	194	570	523	0
104	Eperon	France	0	112	200	u	523	0
105	Eriwan	Austria	0	112	200	u	523	0
106	Eron	Austria	0	112	200	570	523	0
107	Estevan	Germany	u	110	0	u	523	0
108	Etana	Czech Republic	0	112	200	0	523	0
109	Event	Germany	0	112	200	0	523	0
110	Fermi	Czech Republic	0	108	200	570	523	0
111	Genius	Germany	0	108	194	0	523	0
112	Gordian	Germany	0	111	205	570	523	0
113	Granamax	France	0	115	196	u	523	0
114	Grapeli	France	u	101	205	0	523	0
115	Hermann	Germany	0	113	205	0	523	0
116	Heros	France	0	113	205	570	523	0
117	Ionesco	France	0	115	200	570	523	0
118	Joker	Germany	0	115	205	0	u	0
119	Julius	Germany	u	111	205	0	523	0
120	Justinus	Austria	u	111	200	0	523	0
121	Kantao	France	0	113	205	u	523	0
122	KWS Cashel	United Kingdom	0	108	194	0	523	0
123	KWS Erasmus	Germany	0	111	198	0	523	0
124	KWS Kielder	United Kingdom	0	109	200	0	523	0
125	KWS Pius	Germany	u	111	200	0	523	0
126	Lahertis	Germany	0	107	198	0	523	0
127	Lear	Germany	0	124	200	570	523	0
128	Lithium	France	370	107	200	u	523	0
129	MV Lucilla	Germany	0	111	198	0	523	0
130	Matheo	France	0	115	200	570	523	0
131	Memory	Germany	370	111	200	u	523	0
132	Modern	France	u	108	194	0	523	0
133	Muskat	Germany	0	108	200	0	523	0
134	Nocibe	France	u	108	200	0	523	0
135	Pamier	Germany	0	113	200	0	523	0
136	Pionier	Germany	0	115	200	0	523	0
137	Rebel	Austria	0	113	205	0	523	0
138	RGT Djoko	France	u	108	194	570	523	0
139	Scout	United Kingdom	0	115	200	570	523	0
140	Solky	France	0	108	185	u	523	0
141	Sorokk	France	0	115	196	0	u	0
142	Stadium	France	u	108	194	0	523	0
143	Tabasco	Germany	0	110	205	570	523	0
144	Tentation	France	370	115	194	0	523	0
145	Terroir	France	u	124	200	570	523	0
146	Thalys	France	u	112	200	0	523	0
147	Tobak	Germany	0	115	200	570	523	0
148	Waxy	Germany	370	106	205	u	523	0
149	Xantippe	Germany	370	124	200	0	523	0
150	Zappa	Germany	0	110	205	570	523	0
151	Thatcher-Tc		0	110	200	0	523	0
152	TcNIL-Lr1		u	110	200	0	523	0
153	TcNIL-Lr2a		0	110	200	0	523	0
154	TcNIL-Lr2b		0	110	200	0	523	0
155	TcNIL-Lr2c		0	u	200	0	523	0
156	TcNIL-Lr3a		0	110	200	0	523	0
157	TcNIL-Lr3bg		0	110	200	0	523	0
158	TcNIL-Lr3ba		0	110	200	0	523	0
159	TcNIL-Lr5		0	110	200	0	523	0
160	TcNIL-Lr10		0	110	200	0	523	0
161	TcNIL-Lr11		0	80	200	0	523	0
162	TcNIL-Lr14a		0	110	200	0	523	0
163	TcNIL-Lr14b		0	110	200	0	523	0
164	TcNIL-Lr15		0	110	200	0	523	0
165	TcNIL-Lr16		0	110	200	0	523	0
166	TcNIL-Lr17a		0	100	200	0	523	0
167	TcNIL-Lr18		0	110	200	0	523	0
168	TcNIL-Lr19		0	110	200	0	523	0
169	TcNIL-Lr20		u	110	200	0	523	0
170	TcNIL-Lr21		0	110	200	0	523	0
171	TcNIL-Lr23		0	110	200	0	523	0
172	TcNIL-Lr24		370	110	200	0	523	0
173	TcNIL-Lr25		0	124	0	0	523	0
174	TcNIL-Lr26		0	110	200	0	523	0
175	TcNIL-Lr27+Lr31		0	100	200	0	523	0
176	TcNIL-Lr28		0	100	200	570	523	0
177	TcNIL-Lr29		0	110	200	0	523	0
178	TcNIL-Lr30		0	110	200	0	523	0
179	TcNIL-Lr32		0	100	200	0	523	0
180	TcNIL-Lr33		0	110	200	0	523	0
181	TcNIL-Lr34		0	110	200	0	781	0
182	TcNIL-Lr35		0	110	200	0	523	990
183	TcNIL-Lr36		0	110	200	0	523	0
184	TcNIL-Lr37		0	110	200	0	523	0
185	TcNIL-Lr38 (TMR)		0	110	200	0	523	0
186	TcNIL-Lr38 (Kohn)		0	110	200	0	523	0
187	TcNIL-Lr44 (8404)		0	110	200	0	523	0
188	TcNIL-Lr44 (Traspet)		0	110	200	0	523	0
189	TcNIL-Lr46		0	108	200	0	523	0
190	TcNIL-LrB (Carina)		0	114	200	0	523	0
191	TcNIL-LrB (Pi)		0	114	200	0	523	0
192	TcNIL-Lr52 (LeW1)		0	110	200	0	523	0