

## SHORT COMMUNICATION

# Detection of Norin 10 Dwarfing Genes in Winter Wheat Varieties Registered in the Czech Republic

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**Abstract:** Insensitivity to the applied gibberellic acid, indicating the presence of Norin 10 dwarfing genes, was detected in 20 of 57 (35.1%) winter wheat varieties registered in the Czech Republic in 2002. Hybrid analyses in  $F_2$  generation showed a prevalent occurrence of *Rht2* gene (in 14 varieties). Only 6 varieties were found to carry *Rht1* gene. Among the recently developed *Rht2* varieties, Clever possesses also a high bread-making quality which was not observed with the older materials. *Rht2* varieties were found, on average, less winter-hardy, later in heading and more resistant to lodging than *Rht1* varieties.

**Keywords:** winter wheat; registered varieties; dwarfing (*Rht*) genes

The Norin-10 dwarfing genes *Rht1* and *Rht2*, that can be selected for their insensitivity to the applied gibberellic acid (GA), have been widely used to reduce the plant height and to increase the grain yield in the wheat breeding programmes. It was reported (Li 1994) that dwarfing genes of 70.8% of wheat varieties were derived from Norin 10 (*Rht1* and/or *Rht2*). Table 1 shows that also in the Czech Republic the percentage of winter wheat varieties that carry Norin 10 genes has increased during the last ten years and now reaches 35.1% of the registered varieties. While in the older GA insensitive Czech and Slovak winter and spring wheat varieties predominantly gene *Rht1* was detected (Šíp *et al.* 1995), at present *Rht2* gene has become predominant. This may be explained by a successful exploitation of spring donors of *Rht1* gene in the past (e.g. Siete Cerros or Nadadores; Škorpiík *et al.* 1995) and, in the last couple of years, by a broader exploitation of *Rht2* germplasm from Western Europe. The results of the analyses of the hybrid material and the registered varieties that

carry Norin 10 *Rht* genes showed the importance of differentiation between *Rht1* and *Rht2* materials (Šíp *et al.* 1998a,b). Under Central European conditions, it appeared easier to obtain high yielding (intensive) medium-late genotypes by selecting for the *Rht2* gene, while the early, good bread-making quality genotypes resulted often from the selection for the *Rht1* gene.

Data about the presence of the dwarfing genes and other important characteristics were communicated to the wheat breeders by catalogues that were issued by Research Institute of Crop Production Prague-Ruzyně in 1991, 1998 and 2001. The main purpose of this study was to investigate the current set of registered winter wheat varieties for the presence of the GA insensitive dwarfing genes. Using the method described by Šíp *et al.* (1986), GA insensitivity was detected in 20 of 57 winter wheat varieties registered in the Czech Republic in 2002. GA insensitive varieties had normally short and erect leaves after the application of  $GA_3$  (10 mg/l) at 3-leaf plant stage, while sensitivity was

Table 1. Presence of Norin 10 *Rht* genes and winter hardiness data for registered winter wheat varieties in a ten year period in the Czech Republic

Year	Number of registered varieties	% of GA insensitive varieties	Number of varieties with		Winter hardiness*		
			<i>Rht1</i> gene	<i>Rht2</i> gene	of all varieties	of <i>Rht 1</i> varieties	of <i>Rht 2</i> varieties
1993	21	23.8	5	0	5.62	6.60	
1994	25	16.0	4	0	5.60	6.75	
1995	30	16.7	5	0	5.53	6.60	
1996	34	20.6	5	2	6.60	6.60	3.50
1997	36	19.4	3	4	5.44	6.66	4.25
1998	41	24.4	5	5	5.24	6.00	3.80
1999	49	30.6	5	10	4.92	6.00	3.70
2000	53	28.3	5	10	4.91	6.00	3.70
2001	52	30.8	5	11	4.77	6.00	3.45
2002	57	35.1	6	14	4.60	6.00	3.07

\*scale 9–1 (9 – very high winter hardiness)

displayed by the elongation of plants, deflection of leaves, and/or by plant falling. After crossing of insensitive varieties with *Rht1* and *Rht2* tester varieties, the GA response was classified in F<sub>2</sub> generation. Hybrid analyses – description of the method is available in the publications by ŠÍP *et al.* (1995) and ŠKORPÍK *et al.* (1995) – revealed the presence of *Rht1* gene in the varieties Astella, Elpa, Ilona, Rheia, Solara and Vlada, and that of *Rht2* gene in the varieties Athlet, Clever, Contra, Corsaire, Mladka, Record, Rialto, Ritmo, Sepstra, Šárka, Trend, Versailles, Vlasta and Windsor (Table 2). All the varieties that carry gene *Rht1* have the bread-making quality E–B. In the group of *Rht2* genotypes, very high yielding varieties that are not suitable for bread-making are still prevalent but it is necessary to mention that four varieties that carry *Rht2* gene can now be included into the bread wheat group B, and the variety Clever was classified as high quality wheat (A) on the basis of the results of the Official Trials.

The provocation pot method (PRÁŠIL & ROGALEWICZ 1989; PRÁŠILOVÁ & PRÁŠIL 2001) was used to assess winter hardiness in different genotype groups. Plants (cultivars) were grown in wooden boxes filled with earth and placed at two heights above the ground (5 and 50 cm) under natural

conditions during winter. In spring, plant survival was assessed in each experimental treatment. The data on overwintering of cultivars in the provocation trial in 1993 to 2002 were used to calculate the winter hardiness degree of each cultivar in the scale 9 (resistant) to 1 (sensitive) by weighted two-way analysis of variance for unbalanced series of trials. The average level of winter hardiness detected in 2002 was found significantly higher ( $t = 4.08$ ;  $P = 0.0007$ ) in *Rht1* varieties (6.00) than in *Rht2* varieties (3.07). It is, however, evident that high variance in winter hardiness level ( $s = 1.59$ ) was characteristic for *Rht2* varieties (Table 2). *Rht2* varieties Šárka, Vlasta and Sepstra showed a sufficient winter hardiness which documents the possibility to develop also winter-hardy *Rht2* varieties.

The data on the variety performance in other selected characteristics (plant height, resistance to lodging and days to heading) were obtained from the publications of the Central Institute for Supervising and Testing in Agriculture – Division of Plant Variety Testing. As shown in Table 2, the GA insensitive varieties carrying Norin 10 *Rht* genes were, on average, by appr. 7 cm shorter than the GA sensitive varieties but the difference between *Rht1* and *Rht2* varieties in the plant height was not significant ( $t = 1.32$ ;  $P = 0.2049$ ). *Rht2* varieties were

Table 2. Performance in the selected characteristics for *Rht1* and *Rht2* winter wheat varieties listed in the Czech Republic in 2002

	Year of registration	Country of origin	Bread-making quality*	Winter hardiness**	Plant height (cm)	Resistance to lodging***	Days to heading****
<b>Varieties with <i>Rht1</i> gene</b>							
Astella	1995	SVK	B	6	88	3	139
Elpa	1998	DEU	B	5	92	6	142
Ilona	1989	SVK	E	6	93	3.5	138
Rheia	2002	CZE	B	6	96	6.5	142
Solara	1998	SVK	B	5	90	6	141
Vlada	1990	CZE	A	8	80	6.5	138
Average				6.0	90	5.3	140
Standard deviation				1.09	5.53	1.57	1.90
<b>Varieties with <i>Rht2</i> gene</b>							
Athlet	1996	DEU	C	3	94	8	148
Clever	2002	GBR	A	2	81	7	146
Contra	1998	DEU	C	2	90	6	144
Corsaire	1999	FRA	C	2	86	7.5	145
Mladka	2002	CZE	C	2	88	7	142
Record	1999	DEU	C	4	91	7.5	144
Rialto	1999	GBR	B	2	84	7	144
Ritmo	1996	NLD	C	4	85	8	148
Sepstra	1999	DEU	C	5	87	6	145
Šárka	1997	CZE	B	6	88	6	141
Trend	2002	DEU	B	1	85	8	144
Versailles	1997	NLD	C	4	83	8	146
Vlasta	1999	CZE	B	5	93	5.5	145
Windsor	2001	DEU	C	1	83	7.5	145
Average				3.1	87	7.1	145
Standard deviation				1.59	3.90	0.87	1.93
<i>t</i> -statistic				4.08	1.32	3.35	5.11
Probability				0.0007	0.2049	0.0035	0.0001
Average of GA sensitive varieties				4.9	95	5.9	143

\* baking quality classes: E – elite, A – high, B – good, C – not suitable for bread-making

\*\* scale 1–9 (9 – very high winter hardiness)

\*\*\* scale 1–9 (9 – resistant to lodging)

\*\*\*\* from the 1<sup>st</sup> of January

found more resistant to lodging ( $t = 3.35$ ;  $P = 0.0035$ ) and later in heading ( $t = 5.11$ ;  $P = 0.0001$ ) than *Rht1* varieties. Differences of *Rht1* and *Rht2* alleles in

pleiotropic effects on characteristics examined were not reported (GALE & YOUSEFFIAN 1985; ŠÍP *et al.* 1998b) and, therefore, the differences detected

between both genotype groups are more likely caused by the effects of the genetic constitution (background) of *Rht* varieties exploited in the hybridisation programmes.

### References

- LI X.P. (1994): Studies on dwarf sources of major wheat varieties bred in Hebei. J. Hebei Agric. Univ., **17**: 59–63.
- GALE M.D., YOUSSEFIAN S. (1985): Dwarfing genes in wheat. In: RUSSELL G.E. (ed.): Progress in Plant Breeding. London, Butterworth Co.: 1–35.
- PRÁŠIL I., ROGALEWICZ V. (1989): Accuracy of wheat winterhardiness evaluation by a provocation method in natural conditions. Genet. a Šlecht., **25**: 223–230.
- PRÁŠILOVÁ P., PRÁŠIL I. (2001): Winter-hardiness scale of wheat cultivars of different geographical origin. Icelan. Agric. Sci., **14**: 35–39.
- ŠÍP V., ŠKORPÍK M., TÁBORSKÁ J. (1986): Metoda testování

- reakce na aplikovaný giberelin pro detekci genů zakrslosti u pšenice. Genet. a Šlecht., **22**: 133–141.
- ŠÍP V., ŠKORPÍK M., CHRPOVÁ J. (1995): Detekce genů zakrslosti u tří českých odrůd pšenice jarní. Genet. a Šlecht., **31**: 25–33.
- ŠÍP V., BOBKOVÁ L., ŠKORPÍK M., CHRPOVÁ J. (1998a): Use of Norin 10 dwarfing genes in breeding winter wheat for Central Europe. In: Proc. 9<sup>th</sup> Int. Wheat Genet. Symp., Saskatoon, Saskatchewan, Canada: 346–348.
- ŠÍP V., CHRPOVÁ J., ŠKORPÍK M., BOBKOVÁ L. (1998b): Characteristics of winter wheat varieties and lines carrying Norin 10 dwarfing genes. Czech J. Genet. Plant Breed., **34**: 81–85.
- ŠKORPÍK M., ŠÍP V., CHRPOVÁ J. (1995): Geny zakrslosti v českých a slovenských odrůdách pšenice ozimé vykazujících necitlivost na giberelin. Genet. a Šlecht., **31**: 91–98.

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### Abstrakt

CHRPOVÁ J., ŠKORPÍK M., PRÁŠILOVÁ P., ŠÍP V. (2003): **Detekce genů zakrslosti v odrůdách pšenice ozimé registrovaných v České republice.** Czech J. Genet. Plant Breed., **39**: 89–92.

U 35,1 % odrůd (20 z 57) pšenice ozimé povolených v ČR v roce 2002 byla zjištěna necitlivost na aplikovaný giberelin. Pomocí hybridologických analýz v generaci F<sub>2</sub> byla prokázána převažující přítomnost genu *Rht2* (u 14 odrůd). Pouze u šesti odrůd byla zjištěna přítomnost genu *Rht1*. Nově povolená odrůda s genem *Rht2* Clever má vysoký stupeň pekařské jakosti, což dosud u odrůd s genem *Rht2* nebylo zjištěno. Odrůdy s genem *Rht2* byly v průměru méně zimovzdorné, pozdější v metání a relativně odolnější k poléhání než odrůdy s genem *Rht1*.

**Klíčová slova:** pšenice ozimá; povolené odrůdy; geny zakrslosti (*Rht* geny)

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