## 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; Škorpík *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

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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* | | |
|---|---|---|---|---|---|---|---|
| | | | *Rht1* gene | *Rht2* gene | of all varieties | of *Rht 1* varieties | of *Rht 2* 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 $F_2$ 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**** |
|---|---|---|---|---|---|---|---|
| **Varieties with *Rht1* gene** | | | | | | | |
| 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 |
| **Varieties with *Rht2* gene** | | | | | | | |
| 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 |
| *t*-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 1st 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.

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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 $F_2$ 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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