

## Development of High Baking Quality Winter Wheat Annie

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### Abstract

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Annie is a medium-early winter wheat developed at the Plant Breeding Station, Stupice, SELGEN, a.s., Czech Republic and registered in the Czech Republic in 2014. In the Official Variety Trials this variety showed very high baking quality class E combined with higher grain yield than in the check variety Akteur with similar grain quality. It carries *Pch1* gene conferring resistance to eyespot and possesses combined resistance to most diseases together with excellent frost resistance.

**Keywords:** baking quality; cultivar description; disease resistance; *Pch1* gene; *Triticum aestivum* L.; winter hardiness

**Breeding method – pedigree.** Annie was developed from the cross (Meritto × CH111.12772) × Eurofit. The first crossing was done in 2001 and crossing of F<sub>1</sub> to Eurofit in the next year. Single plant selection started in F<sub>2</sub> generation and it was performed in F<sub>3</sub> again. Yield trials started in F<sub>5</sub> generation. At the same time disease resistance to yellow rust, leaf rust and powdery mildew was evaluated in special nurseries with artificial infection and under natural field conditions. In F<sub>6</sub> generation yield trials were extended by increasing the number of replications and artificial infection tests for resistance to leaf blotch and Fusarium head blight were performed. Grain quality parameters were examined since F<sub>1</sub> generation; in early generations for protein content and SDS sedimentation volume, later also for gluten index, % gluten, falling number, test weight and mixograph index and in late generations in baking tests. Disease resistance, grain quality, frost resistance and yield were found to be satisfactory in the selected F<sub>7</sub> line, which was submitted to the Official Trials under the code SG-S1731-09. The line was registered as Annie in 2014 after three years of testing.

**Yield performance.** The Official Variety Testing was conducted using two growing systems. In system 1, no fungicide and plant-growth regulator treatments were used. In system 2, intensive growing technology was used (plant-growth regulator and fungicide treatments).

The field tests were conducted across the Czech Republic; the number of localities was 16 in 2011, 12 in 2012, 19 in 2013.

The lines were planted in plots of 10 m<sup>2</sup> with three replications.

The grain yield of Annie was medium under system 1 in three-year tests (8.98 t/ha on average; i.e. 98.6% of the check varieties Akteur, Cubus and Selandon), and lower under system 2 (10.40 t/ha, i.e. 96.4% of the check varieties) (Table 1). In comparison with the check variety Akteur of similar grain quality the average grain yield of Annie was higher by about 0.5 t/ha in system 1 and by 0.2 t/ha in system 2.

**Grain quality and resistances.** In the Official Trials the baking quality of Annie was classified as E. Quality parameters were as follows (Table 2): Zeleny sedimentation test 62 ml, % N 14.8, falling

Small quantities of seeds for research and breeding purposes can be obtained from the variety's breeder and maintainer.

Table 1. Yield results during variety testing under two growing systems in the Official State Trials (sugar beet zone)

Variety	Baking quality class	2011		2012		2013		Average	
		(t/ha)	(%)	(t/ha)	(%)	(t/ha)	(%)	(t/ha)	(%)
System 1									
Annie	E	9.97	97	8.50	95	8.46	105	8.98	98.6
Akteur	E	9.71	95	8.62	96	7.01	87	8.45	92.8
Cubus	A	9.66	94	8.95	100	8.15	101	8.92	98.0
Seladon	B	11.41	111	9.41	105	9.01	112	9.94	109.2
System 2									
Annie	E	11.47	95	9.19	95	10.54	100	10.40	96.4
Akteur	E	11.44	94	9.41	97	9.59	92	10.18	94.4
Cubus	A	11.66	96	9.72	100	10.75	102	10.71	99.3
Seladon	B	13.22	109	9.99	103	11.21	106	11.47	106.4

E – elite quality wheat; A – high quality wheat; B – complementary bread wheat

Table 2. Important agronomic data on the Annie variety and the check varieties Sultan and Genius (according to Central Institute for Supervising and Testing in Agriculture, Brno, 2011–2013)

	Annie	Sultan	Genius
<b>Quality characteristics</b>			
1000-kernel weight (g)	49.1	47.2	43.5
Falling number (s)	365	299	373
Protein (%)	14.8	14.0	13.9
Test weight (g/l)	814	797	800
Zeleny test (ml)	62	48	59
Water absorption (ml)	66.3	60.9	63.0
Bread volume (ml)	630	614	639
<b>Disease resistance on 9–1 scale (9 – without symptoms)</b>			
Powdery mildew – leaf (DC 37)	6.1	7.0	7.9
Leaf spots	5.6	5.7	5.1
Leaf rust	6.3	5.9	6.6
Stem rust	7.8	7.0	7.2
<b>Agronomic characteristics</b>			
Lodging (9–1; 9 – high resistance)	7.6	6.8	6.9
Frost resistance test (% survival)	74	50	67
No. of days from 1.1. to heading	148	150	149
No. of spikes per square meter	634	671	680
Plant height (cm)	93	97	88

number 365 s, specific weight 814 g/l and bread volume 630 ml. It has medium high thousand grain weight (45.0 g). The glutenin subunits are: (1) (17+18) (5+10).

Table 3 shows the reaction of the Annie variety to artificial inoculation with *Fusarium culmorum*. Resistance of this variety to Fusarium head blight could be classified as medium (average content of mycotoxin DON was 46.5 ppm).

The reaction of wheat varieties to artificial infection with *Oculimacula yallundae* and *O. acuformis* (causal agent of eyespot) was studied in a small plot trial in Prague-Ruzyně. A high level of resistance to eyespot was detected in the Annie cultivar, which was also tested by marker *Xorw1* for the presence of *Pch1* gene and the presence of this gene was confirmed (DUMALASOVÁ *et al.* 2013).

Annie is a cultivar with combined resistance to the majority of fungal diseases. It is resistant to yellow rust *Puccinia striiformis* (8 R) and stem rust *Puccinia graminis* (7–9 R) and moderately resistant to leaf rust *Puccinia triticina* (6–7 MR) and to powdery mildew (6 MR). In artificial infection tests performed in 2014 at Prague-Ruzyně the resistance of Annie to yellow rust, stem rust and leaf rust was classified by the scores 8, 8.5 and 7.5, respectively.

Table 3. The reaction of Annie variety to artificial infection with *Fusarium culmorum* in comparison with moderately resistant variety Arina and susceptible variety Biscay (results of 2012–2014 testing in Crop Research Institute, Prague-Ruzyně)

Variety	Visual symptom score (1–9)	% of <i>Fusarium</i> damaged kernels	DON content (mg/kg)	Reduction of thousand grains weight (%)	Reduction of grain weight per spike (%)
Annie	3.8	48.4	46.5	33.9	51.7
Arina (moderately resistant)	2.9	26.1	26.8	22.4	37.9
Biscay (susceptible)	5.8	70.0	109.4	49.0	67.4

Table 4. Genotyping score of winter wheat Annie

Gene	Genome		
	A1	B1	D1
<i>Vrn</i>	winter/long	winter	winter
<i>Ppd</i>	sensitive	sensitive	sensitive
<i>Rht</i>		wildtype	wildtype

Annie has a winter growth habit and GA (gibberellic acid) sensitive reaction.

We report here the genotyping score of *Vrn*, *Ppd* and *Rht* genes (Table 4). Detailed molecular analysis is available by request.

Annie is characterized by high level of winter hardiness at level 8, similarly to the winter wheat variety Bohemia. Annie was also included in artificial frost tests (methods described by PRÁŠIL *et al.* 2007) in Stupice in 2013 and 2014 (Table 5). The plant survival was high after freezing at temperatures of  $-16^{\circ}\text{C}$  and  $-15^{\circ}\text{C}$ , with 85% and 52%, respectively.

**Other characteristics.** Annie is a medium early variety (2 days earlier in heading than Sultan variety). Plant length of Annie is medium to long (93 cm) and its lodging resistance is high (7–8). The ear is white, of tapering shape, medium dense, with long awns. Ear, stem and flag leaf have medium to strong glaucosity.

Table 5. Plant survival (%) in field-laboratory frost resistance tests with different freezing temperatures (Plant Breeding Station Stupice, 2012–2013 and 2013–2014)

Variety	2013				2014			
	$-12^{\circ}\text{C}$	$-14^{\circ}\text{C}$	$-16^{\circ}\text{C}$	average	$-11^{\circ}\text{C}$	$-13^{\circ}\text{C}$	$-15^{\circ}\text{C}$	average
Annie	90.2	74.9	84.6	83.2	84.1	74.5	52.3	70.3
Bohemia	98.0	92.2	84.3	91.5	95.2	91.2	59.3	81.9
Sultan	75.4	73.2	40.2	62.9	41.3	45.2	20.2	35.5
Hermann	65.0	58.5	36.1	53.2	20.2	14.5	0.0	11.3

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