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Six-row Winter Barley Lancelot

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Abstract

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The Lancelot variety is a late to semi-late six-row feeding winter barley. It was developed at the Breeding Station, Lužany, SELGEN a.s. and registered in the Czech Republic in 2013. Lancelot has very good resistance to winter stresses in combination with resistance to BaMMV/BaYMV (*Barley mild mosaic virus*/*Barley yellow mosaic virus*) based on the gene *rym4*.

Keywords: *Barley mild mosaic virus*; *Barley yellow mosaic virus*; cultivar description; *Hordeum vulgare* L.; winter hardiness

Breeding method – pedigree. Lancelot was developed from the cross Carola/Okal. The crossing was done in 2000. The progenies of F_1 grains (harvest of single plants) were seeded into separate plots (F_2). Single ear selection began in the F_2 generation. Grains from separately harvested ears were grown in single row F_3 progeny. Single ear selection was also carried out in the F_4 generation.

Disease resistance to pink snow mould, Typhula blight, powdery mildew, brown rust of barley, net blotch, spot blotch, scald and Ramularia leaf spot was evaluated under natural field infection starting from the F_4 generation. Homogeneous and healthy F_4 progenies were harvested and used for sowing in the first yield test in F_5, followed by yield trials in four replications (two under low input system and two under high intensity system) in F_6 and F_7. Since the F_8 generation the selection of progenies from separately harvested ears was carried out continuously in order to attain the required stand homogeneity. Maintenance breeding was launched at the same time. The selected line SG-L 00/015/G9/A/09 was tested in the company trials in F_9 and F_{10} generations at four locations with four replications in two systems of growing intensity. In the F_9 generation the line was included in the pot test of winter hardiness, in the field-laboratory frost resistance test, vernalization test and in the test of resistance to virus diseases. The testing of resistance to *Barley yellow dwarf virus* (BYDV) was performed in the Crop Research Institute in Prague-Ruzyně under conditions of artificial infection. The resistance to BaMMV/BaYMV was evaluated in fields infected with these mosaic viruses in Julius Kühn-Institute, Institute for Resistance Research and Stress Tolerance in Quedlinburg, Germany.

The line SG-L 00/015/G9/A/09 was tested in the Official Variety Trials of the Czech Republic by the Central Institute for Supervising and Testing in Agriculture (CISTA) in three years (2011–2013). The line was registered as Lancelot in the Czech Republic in 2013 and Plant Breeders Rights were granted on September 1, 2014.

Grain yield and quality. Official Variety Trials were run in two growing systems. In system 1, no fungicide and plant-growth regulator treatments were used. In system 2, intensive growing technology was applied. In both systems the Lancelot variety showed the yield level of the check variety Semper (Table 1).

The Lancelot variety is mainly used for feeding purposes. The kernels are medium- to large-sized, the grain has a medium weight of thousand seeds (50 g) and percentage of kernels graded above 2.5 mm was 93%.

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

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Table 1. Important agronomic data for the Lancelot variety and the check varieties Sylva, KWS Meridian and Semper (according to Central Institute for Supervising and Testing in Agriculture, Czech Republic, 2011–2013)

	Lancelot	Sylva	KWS Meridian	Semper
Grain yield in system 1 (t/ha)	7.01	6.73	7.09	6.98
Grain yield in system 2 (t/ha)	8.16	8.25	8.22	8.06
Quality characteristics				
Grading of kernels above 2.5 mm (%)	93.2	94.1	96.1	93.3
1000-grain weight (g)	49.7	51.6	50.7	51.7
Test weight (kg/m^3)	668.4	659.1	670.1	677.1
Crude protein content (%)	11.4	11.6	11.3	11.4
Starch content (%)	61.3	60.5	60.7	60.5
Disease resistence on 9–1 scale (9 – without symptoms)				
Powdery mildew (DC 37)	6.3	8.1	6.6	7.2
Powdery mildew (max.)	6.3	7.7	6.3	7.4
Brown rust	8.0	7.7	7.8	8.1
Complex of leaf blotches	5.9	6.1	5.7	5.2
Scald	7.2	7.4	7.2	7.3
Non-specific leaf spots	6.7	7.4	6.5	6.0
Fusarium head blight	6.2	6.0	6.3	6.8
Pink snow mold	8.1	8.2	8.4	8.8
Agronomic characteristics on 9–1 scale (9 – high resistance)				
Winterhardiness 2011/12	7.8	5.9	7.4	6.9
Undergrowth	8.4	7.4	7.9	7.7
Brittleness of straw	7.0	6.8	6.9	6.9
Lodging at heading	6.0	7.6	8.6	8.5
Lodging at harvest	6.1	6.8	7.0	7.7
Plant length (cm)	92	92	88	91
No. of ears per squere meter	571	568	585	594
No. of days from 1.1. to heading	140	136	136	135
No. of days from 1.1. to maturity	195	195	195	195

Disease resistances. Lancelot is resistant to *Barley mild mosaic virus* (BaMMV) and strain 1 of *Barley yellow mosaic virus* (BaYMV-1). The resistance to BaMMV/BaYMV based on *rym4* was detected by ELISA in field tests lasting for two years in Germany (Table 2). The presence of the gene *rym4* was confirmed by the simultaneous use of molecular marker Bmac0029 and duplex CAPS marker (Sedláček *et al*. 2010). Lancelot showed susceptibility to BYDV in field tests performed in Prague-Ruzyně.

It can be implied from Table 1 that Lancelot is moderately resistant to the complex of leaf blotches (*Pyrenophora teres teres*, *P. teres maculata*), scald (*Rhynchosporium secalis*), powdery mildew (*Blumeria*

Table 2. Results of tests of resistance to BaYMV-complex (performed for two years in infected fields in Germany)

Genotype	ELISA extinction		Field test		Resistance gene
	BaMMV/BaYMV-1	BaYMV-2	BaMMV/BaYMV-1	BaYMV-2	
Lancelot	0.03	1.63	R	S	*rym4*
Tokyo (*rym5*)	0.03	0.04	R	R	*rym5*
Uschi (none)	1.23	1.55	S	S	none
Carola (*rym4*)	0.03	1.60	R	S	*rym4*

BaMMV – *Barley mild mosaic virus;* BaYMV – *Barley yellow mosaic virus;* R – resistant, S – susceptible

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Table 3. Results of field-laboratory frost resistance tests of winter barley varieties; Lužany 2011–2014

Variety	Winter 2011/12				Winter 2012/13				Winter 2013/14				Three-year average			
	SF%	BNo	LT_{50}	FRp	SF%	BNo	LT_{50}	FRp	SF%	BNo	LT_{50}	FRp	SF%	BNo	LT_{50}	FRp
Lancelot	81.7	59.3	–14.2	5.6	84.2	58.3	–14.4	6.0	56.5	38.5	–12.4	5.2	74.1	52.1	–13.7	5.6
Lester	88.3	65.3	–14.4	6.5	78.3	59.3	–14.3	5.7	63.7	42.1	–13.4	6.0	76.8	55.6	–14.1	6.1
Fridericus	70.0	52.7	–13.6	4.1	72.5	49.0	–14.0	4.3	60.1	39.0	–13.1	6.0	67.5	46.9	–13.6	4.8
Semper	70.0	49.3	–13.9	4.3	68.3	47.3	–13.9	4.0	50.1	34.6	–12.6	4.5	62.8	43.7	–13.5	4.3
KWS Meridian	75.0	52.7	–14.0	4.9	61.7	43.7	–13.6	2.9	50.6	33.0	–12.0	4.2	62.4	43.1	–13.2	4.0
Sylva	56.7	33.3	–13.2	1.6	57.5	35.7	–13.5	2.3	35.1	23.2	–10.1	1.3	49.8	30.7	–12.2	1.7
Saffron	61.7	35.3	–13.3	2.0	58.3	32.0	–13.5	2.0	39.6	26.1	–10.8	2.0	53.2	31.1	–12.5	2.0

SF% – average survival in the frost test (the percentage of living plants); BNo – assessment of survival that takes into account non-lethal damage (Prášil *et al.* 2007); LT_{50} – the lethal temperature at which 50% of plants are killed (Janáček & Prášil 1991); FRp – final frost tolerance rating on a 9–1 scale (9 – high)

graminis) and barley brown rust (*Puccinia hordei*). It has resistance to pink snow mould (*Microdochium nivale*) and Typhula blight (*Typhula itoana*).

Winter hardiness and frost resistance. Lancelot is one of the varieties with high resistance to winter stresses. After the winter 2011/2012 its winter survival was at the level of the Lester variety. It also has resistance to drought during spring regeneration.

It has medium to high resistance to frost; from the recommended variety assortment in the Czech Republic only the Lester variety possesses a slightly higher resistance. The results of field-laboratory frost resistance tests are shown in Table 3.

Other characteristics. Lancelot is a late (in the time of ear emergence) to medium-late (in the full maturity time) six-row feeding winter barley. It has medium plant height (92 cm) and moderate resistance to lodging. The length of ear is medium, of parallel shape, with looser density of spikelets. The colour of grain is yellow-grey; the aleurone layer is strongly coloured. The awns are long; anthocyanin colouration of tips is absent or very weak.

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