

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 F₁ grains (harvest of single plants) were seeded into separate plots (F₂). Single ear selection began in the F₂ generation. Grains from separately harvested ears were grown in single row F₃ progeny. Single ear selection was also carried out in the F₄ 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 F₄ generation. Homogeneous and healthy F₄ progenies were harvested and used for sowing in the first yield test in F₅, followed by yield trials in four replications (two under low input system and two under high intensity system) in F₆ and F₇. Since the F₈ 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 F₉ and F₁₀ generations at four locations with four replications in two systems of growing intensity. In the F₉ 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.

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 resistance 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 square 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 | <i>rym4</i> |
| Tokyo (<i>rym5</i>) | 0.03 | 0.04 | R | R | <i>rym5</i> |
| Uschi (none) | 1.23 | 1.55 | S | S | none |
| Carola (<i>rym4</i>) | 0.03 | 1.60 | R | S | <i>rym4</i> |

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 | SF% | BNo | LT ₅₀ | SF% | BNo | LT ₅₀ | SF% | BNo | LT ₅₀ | FRp | | | |
| Lancelot | 81.7 | 59.3 | -14.2 | 84.2 | 58.3 | -14.4 | 6.0 | 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 | 78.3 | 59.3 | -14.3 | 5.7 | 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 | 72.5 | 49.0 | -14.0 | 4.3 | 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 | 68.3 | 47.3 | -13.9 | 4.0 | 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 | 61.7 | 43.7 | -13.6 | 2.9 | 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 | 57.5 | 35.7 | -13.5 | 2.3 | 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 | 58.3 | 32.0 | -13.5 | 2.0 | 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); LT₅₀ – 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 utoana*).

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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