Short Communication

Late blight *Phytophtora infestans* (Mont.) de Bary resistance evaluation in ten Lithuanian potato cultivars

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INTRODUCTION

Potato blight, caused by the *Phytophthora infestans* (Mont.) de Bary, is one of the most devastating potato diseases (Schepers 2000), causing serious problems in countries with high relative humidity, cool nights and warm days in summer. Damaged potato foliage reduces the assimilation surface which results in reduced yield. Resistance to the blight is controlled by major R genes and an unknown number of genes expressing quantitative parameters of the resistance (Lara et al. 2006). *Solanum demissum* is characterized by the highest efficiency of polygenes (Ballvora et al. 2012).

Resistance of potato varieties to *P. infestans* is one of the most important breeding objectives. Potato varieties relatively resistant to *P. infestans* have been developed, but their resistance may weaken due to changes in pathogen race composition. Furthermore, as only a limited gene pool is used for breeding for potato blight resistance, the disease can affect large groups of varieties at the same time in different years. According to Hansen *et al*. (2005), in Europe, varieties initially classified as resistant are being severely infected by the disease as a result of shifts in pathogen populations.

MATERIALS AND METHODS

The evaluation was carried out at the Vokė Branch of the Lithuanian Research Centre for Agriculture and Forestry (LRCAF) from 2009 to 2011. Local potato cultivars used in the trials were: first early VB Venta, second early – Goda, VB Liepa, Vokė, Vaiva, maincrop – Nida and Mirta, and late – VB Rasa, Vilnia and VB Aista. Almost all these cultivars are immune to the destructive potato disease – potato wart (*Synchtrium endobioticum* Schilb.) and resistant to a local cyst nematodes pathotype Ro1 (*Globodera rostochiensis* Woll.).

The potato variaties were cultivated in a *Haplic Luvisol* with a sandy loam texture. Tillage and crop maintenance followed the cultivation technology used by LRC potato breeding. No fungicides were used.

Meteorological conditions influence the development of late blight disease. The weather conditions during the experimental years were diverse (Table 1).

Damage caused by potato blight and the degree of disease development were determined at the time of potato flowering (for each genotype tested). A total of 100 plants were used for the assessment (BBCH 61-69). Disease severity was measured using the scale

Table 1. Meteorological data 2009–2011. Long term average 1961-1990.

	Air temperature, °C				Precipitation, mm			
Month	**2009**	**2010**	**2011**	**Longterm average**	**2009**	**2010**	**2011**	**Longterm average**
April	8.7	7.6	8.7	5.7	6	37	31	45
May	12.4	13.8	12.9	12.5	46	113	79	60
June	14.9	16.8	18.3	15.8	129	142	41	77
July	18.0	22.4	19.6	16.9	107	208	155	78
August	16.4	15.5	17.3	16.3	68	117	155	68

approved and recommended by OEPP/EPPO (Schepers 2000).

The modified qualitative leaf blade method was used (Swiezynski et al 2000) to assess foliage susceptibility to late blight in controlled inoculations *in vitro*. Samples (leaves) were taken from the primary infection sources. For propagation of *P. infestans* 0.5 cm thick slices were cut from the tubers of the susceptible potato variety VB Venta. Microscopy was used to determine the number of sporangia in a suspension. The prepared suspension was stored in a refrigerator for 2–3 h to obtain zoospores (5°C). Infection-free leaves of 10 potato cultivars were sampled. For the control, a leaf (all of equal size) was placed (3 repetitions) bottom side up in a Petri dish (Ø 5 cm) containing sterile filter paper and sterile water (1 mL) was added. After 8–12 h the leaves were sprayed with the fungus suspension of 5000 zoospores/sporangia 1 per ml. The Petri dishes were then kept in an illuminated room at 15–16°C. The evaluation was performed after 6–7 days.

Assessment of tuber susceptibility to late blight in controlled inoculation was performed immediately after harvest. First the tubers were immersed in water to wash off the soil so that inoculum would not be contaminated. The tubers were bagged, immersed twice for one second in the inoculum suspension and the tuber bags placed in plastic bags. Incubation was carried out for 24 h at 95% relative humidity and 15°C. Later, 16–17 days after inoculation, the tubers were placed in a cultivation chamber for 8–14 days at 60–70% relative humidity and 15°C. The percentage of infected tubers and the degree of infection were assessed.

Assessment of tuber slice susceptibility to late blight in controlled inoculations *in vitro* was carried out in infection-free potato tubers which were cut into 0.5 cm thick cross-section slices and placed in Petri dishes (3 repetitions) with 1 ml of sterile water.

Statistical Analyses

Disease spread was calculated by the formula: $P = n \times 100 / N$, where P is the spread of disease (%), n is the number of infected plants/tubers, and N is the number of checked infection-free and infected plants/tubers.

Disease intensity was calculated using the following formula: $R = \sum (\times) / N$, where R is the disease intensity (%), $\sum (x)$ is the sum of the disease development in percent and the number of damaged plants/tubers in a certain percentile group, and N is the number of checked infection-free and infected plants/tubers.

The obtained data were assessed by dispersion analysis, employing ANOVA (LSD0.05) statistical data processing software (Tarakanovas 2002).

RESULTS

The tests revealed that among 10 Lithuanian potato varieties Vokė, VB Rasa and VB Aista were more resistant to blight under natural infection pressure (Figure 1).

Potato foliage is the part of the plant most susceptible to blight in the field. During the test period the foliage damage varied depending on air temperature, humidity, light intensity, and potato variety. The first signs of the disease are small, dark green to brownish, irregularly shaped blotches. Under controlled infection pressure they expanded rapidly, turn-

ing into dark grey or brown shapeless blotches.

Irregular, small or large, slightly sunken, grey leaden patches penetrating into the tuber flesh were observed on the surface of infected tubers. Yellowish brown granular rot penetrated about 1.5–2.0 cm into tubers; the depth varied depending on the variety.

Study of the resistance of Lithuanian potato varieties to blight spread and intensity in controlled inoculations showed that tubers of the varieties Vokė, VB Rasa, Nida and VB Aista were most resistant (Figure 2).

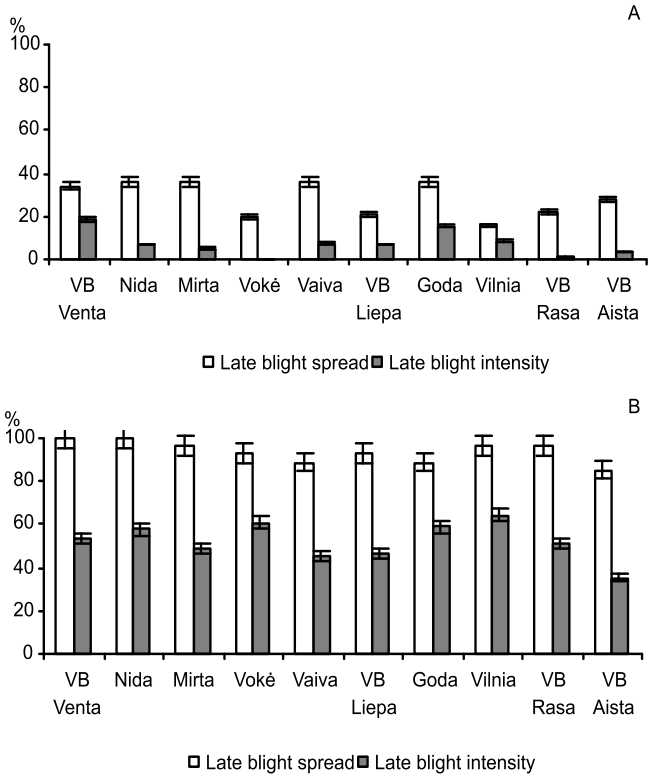

Figure 1. A. Resistance of the foliage of Lithuanian potato varieties under natural infection pressure; B. in controlled inoculations *in vitro* ($LSD_{0.05}$A – 3.287, $LSD_{0.05}$B – 1.205)

DISCUSSION

For long-term control, this form of resistance breeding based on a few "major resistance genes" seems destined to fail. Many plant breeders therefore now prefer to develop cultivars characterized by "polygenic" or "field resistance" to the pathogen. Such plants have combinations of several "minor" genes, none of which gives absolute resistance, but together they slow the rate of development of the fungus and enable the plant to tolerate in-fection (Kroon et al. 2011).

There is an opinion that several methods should be applied in order to determine cultivar susceptibility to late blight (Kroon et al. 2011). In future potato cultivars and hybrids of potato breeding programmes should be tested, not only under field conditions with the natural late blight infection, but also in the laboratory under controlled conditions (Lee et al. 2001; Razukas & Jundulas 2005).

Analysis of late blight incidence helps to determine disease development differences not only among potato cultivars of various susceptibility and maturity groups, but also year to year variation. Precipitation amount, average day temperature, humidity from the beginning of disease spread until the highest injury point are most important for the disease development process.

In the present study late blight development intensity in various potato cultivars depended not only on the maturity group but also on the genetic and biological features. Cultivars were divided into three groups according to their susceptibility to late blight: very susceptible (B1), medium susceptibility (B2) and medium resistance (B3). Cvs. Vilnia and VB Aista, both late, were the most resistant to late blight. Vokė, a second early, was an exception as it was also in the most resistant group.

Potato foliage, plant apexes, stems and tubers were damaged by *Phytophthora infestans* during the investigation in 2009-2011. The intensity of late blight spread was condi-

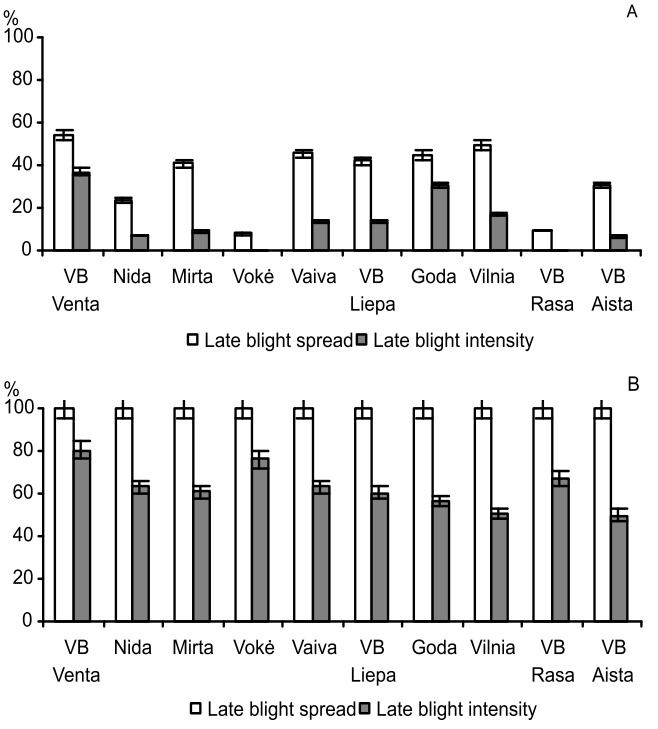

Figure 2. A. Resistance of the tubers of Lithuanian potato varieties under controlled infection pressure; B. in tuber cross-section slices *in vitro* ($LSD_{0.05}$A – 3.741, $LSD_{0.05}$B – 2.085)

tioned by the earliness of the variety and by its individual properties. Vokė, VB Rasa and VB Aista were more resistant to late blight, and VB Aista foliage showed higher resistance under controlled infection pressure. In early maturing potato varieties the disease spread more intensively, whereas in main crop varieties the spread was less intense.

These Lithuanian potato varieties can be grouped as follows: highly susceptible to late blight – VB Liepa, VB Venta and Vaiva; moderately susceptible – Goda, Vilnia, Nida and Mirta; moderately resistant – Vokė, VB Rasa and VB Aista.

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