Effect of genotype on distribution of diseases and viruses in potato

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A great number of potato seedlings and cultivars are tested for resistance to the main diseases such as late blight, rizoctonia, common scab and some kinds of scabs, black leg, wet and dry rots during storage. Spread of viruses was tested in many potato reproductions. The presence of potato viruses PVX, PVY and carlaviruses and their quantity in different potato seed reproductions was determined.

Key words: potatoes, potato cultivars, potato diseases, potato viruses

INTRODUCTION

Potatoes are one of the widely grown agricultural crops in Lithuania. Lithuanians still use over 100 kg per person of table potatoes. On more than 100,000 ha commercial potatoes are grown in Lithuania annually. Potato yields are increasing slightly from year to year and are approaching 17 tons per hectare. In comparison with other European Union countries, Lithuanian potato yields are very low.

The reasons for low potato yields in Lithuania are diseases, viruses and pests. They, alongside bad meteorological conditions, decrease potato yield by 10–20 tons per hectare [5]. Vegetative potato seed multiplication, high quantities of potato seed per land area, vast seed plots needed for growing potatoes for consumption favour a wide spread of fungal, bacterial and virus diseases in potato fields. Potato diseases decrease the world potato yield by 20–25% [1].

The spread and harmfulness of potato diseases depend not only on the agrotechnical and phytopathological measures, but also on the peculiarities of genetic potato cultivars [4]. A very important role in fighting against bacterial and fungal diseases and viruses, especially in ecological farming, belongs to the breeding, producing reasistant potato cultivars and certified, high class potato planting material [6].

Viruses, depending on their spread, can cause greater damage than fungal and bacterial diseases. There are characterized 17 kinds of potato viruses [8]. In the plants they are found mostly in latent form and may show their resistance only under favourable conditions. Virus diseases not only induce potato crop losses, but also decrease the quality of infected plants [7]. Most widely spread and harmful to potato crops in Lithuania are six viruses: potato leafrole virus, PVA, PVS, PVX, PVY and PVM viruses. In one plant often 2–3 kinds of viruses are found. Plants injured by viruses cannot be treated, infection is multiplied by seed tubers [10]. The only way to stop virus spreading is breeding of potato cultivars resistant to one or several viruses and potato seed production from meristem tissue [3, 8, 9].

MATERIALS AND METHODS

The study was done at the Voke Branch of the Lithuanian Institute of Agriculture, in the Breeding Department crop rotation field. Trials were performed on soddy podzolic sandy loam soil. Ploughing depth was 20–25 cm. The potato field was fertilized with organic manure (50 t/ha) and with mineral fertilizers ($N_{90}P_{90}K_{90}$) during land cultivation in spring. Such fertilization was used till 1994. Then the complex fertilizer Kemira Cropcare 10–10–20 was used (500 kg/ha). Its composition is $N_{10}P_4K_{17}$ with microelements: MgO 4.1, S 11.0, B 0.15, Cu 0.1, Fe 0.1, Mn 0.7, Mo 0.01, Zn 0.1, Se 0.0006%. Soil natural fertility was medium: humus amount was low (1.8–2.0%), with low acidity (pH_{KCl} 5.1–5.5), high phosphorus content (P_2O_5 180–240 mg/kg) and potassium content K_2O 150–190 mg/kg.

Potatoes were grown applying a usual potato growing technology. One spraying was applied against late blight. Seed potatoes were stored during wither season in the potato storage (air temperature (+2)–(+3) °C, humidity 80–90%).

Examination for fungal and bacterial diseases was done in the field during vegetation period and after potato harvesting. The adapted methods of inves-

Table 1. **Average percentage of damaged potato plants and tubers (T. Vokė, 1987–2000)**

Cultivar	Late blight		Rhizoctonia, tubers	Common scab, tubers	Black leg, plants	Wet rot, tubers	Dry rot, tubers	Wart, plants
	plants	tubers						
Mėta	55	0.2	41.0	60.8	0.1	3.2	2.6	0.0
Vilnia	65	0.4	62.4	70.4	0.3	4.8	4.3	0.0
Vokė	75	0.3	36.86	67.3	0.1	4.2	1.5	0.0
Aistės	20	0.2	32.0	19.0	0.2	2.0	1.2	0.0
Nida	65	0.3	28.5	62.0	0.2	2.6	3.0	0.0
Mirta	50	0.3	12.6	30.6	0.1	2.9	4.1	0.0
Venta	70	0,3	16.2	25.2	0.1	3.2	2.1	0.0
Goda	55	0.2	12.8	20.8	0.1	1.4	2.3	0.0
Vaiva	65	0.2	9.6	0.5	0.0	1.2	1.0	0.0
Vilija	70	4.0	38.6	20.2	0.1	5.8	3.4	0.0

tigation were used. The number of virus diseases was very low, the symptoms were registered only during separate years. Virus infection was determined gathering potato leaves from separate plants. Tests were done by electron microscopy at the Virology Laboratory of the Institute of Botany. Immunity to wart disease was tested at the Belarus Plant Protection Institute.

RESULTS AND DISCUSSION

Ten potato cultivars selected in Lithuania (first early 'Venta', second early 'Vokė', 'Vaiva' and 'Goda', maincrop 'Nida' and 'Mirta', late 'Vilija' and 'Aistės', very late 'Vilnia' and 'Mėta') were examined. In field conditions we determined resistance to black leg (*Pectobacterium phytophtorum* (Appel.)) and late blight (*Phytophthora infestans* (Mont.)). After potato harvesting in the storage we examined potato tubers for infection by different kinds of scabs (*Streptomyces Scabies* (Thaxt.) and *Spondiliocladium atrovires* (Harz.)), rhizoctonia (*Rhizoctonia solani* (Kuhn.)) and also late blight. Infection of dry and wet rots was determined at the end of storage in March. The results are presented in Table 1. All cultivars were immune to potato wart.

On changing the agrotechnical means, using complex fertilizers instead of organic manure, more efective systemic fungicides, the number of fungal and bacterial diseases as well as their harmful influence on the potato plant decreased. The mean data of fourteen years of research show that most resistant to late blight was c. 'Aistės'. Disease symptoms were found only on 20% of plants. A Less resistant to late blight were first early and second early cultivars 'Venta', 'Vokė', 'Goda', 'Vaiva'. In the cultivars the infected plants comprised from 55 to 85%.

In potato breeding work great attention was paid to the resistance to rhizoctonia and common scab. In the last bread cultivars 'Goda' and 'Mirta' the level of infection was low. An extremely high resistance to these diseases was exhibited by the redskin cultivar 'Vaiva'. All cultivars showed good resistance

Table 2. **Virus infection of Potato cultivars (T. Vokė, 1995–2000)**

Cultivar	Maturity group	Reproduction	PVX	PVY	Carlaviruses
Venta	first early	supersuperelite	–	+	+
Venta	first early	superelite	–	+	+
Venta	first early	elite	+	+	+
Venta	first early	class A	++	++	++
Venta	first early	class B	+++	+++	+++
Vokė	second early	supersuperelite	–	–	–
Vokė	second early	superelite	–	+	+
Vokė	second early	elite	++	++	+
Vokė	second early	class A	+++	+++	+++
Vokė	second early	class B	+++	+++	+++
Nida	maincrop	supersuperelite	–	–	–
Nida	maincrop	superelite	–	–	–
Nida	maincrop	elite	–	–	+
Nida	maincrop	class A	++	+	+
Nida	maincrop	class B	++	++	++
Mirta	maincrop	supersuperelite	–	–	–
Mirta	maincrop	superelite	–	–	–
Mirta	maincrop	elite	–	–	–
Mirta	maincrop	class A	+	–	+
Mirta	maincrop	class B	++	+	+
Aistės	late	supersuperelite	–	–	–
Aistės	late	superelite	–	–	–
Aistės	late	class A	++	++	+
Aistės	late	class B	+++	+++	++

(+) – virus infection level; (–) – no virus infection.

to black leg, as during selection the susceptible seedlings were rejected. The level of wet and dry rot depends on potato cultivar genotype, potato diseases during vegetation period. Potato storage is influenced by agrotechnical, meteorological and harvesting conditions. The best storage properties were found in cultivars 'Vaiva', 'Goda' and 'Aistės'. All potato cultivars were resistant to potato wart disease.

The spread of viruses in potatoes depends on the cultivar genetic resources, earliness group and seed material quality. The virus infection level was higher in the first early c. 'Venta' and the second early c. 'Vokė'. Potato cultivars with longer maturity show better resistance to viruses. In the maincrop potatoes 'Nida', 'Mirta' and late 'Aistės' the level of virus infection was lower (Table 2). The number of viruses in potato plants also depended on the year of reproduction. Virus infections were directly connected with potato reproduction. In the higher reproductions no virus infection at all or very low levels were registered. When the reproduction was lower, virus infection is higher in all potato cultivars of different maturity groups. The maincrop cultivar 'Mirta' showed the highest resistance to viruses. The first viruses were found only in the lower potato reproductions (classes A and B).

CONCLUSIONS

The level of fungal and bacterial infection depends on the potato cultivar genotype. The highest resistance to late blight was shown by the cultivar 'Aistės' and the lowest by early maturity cultivars 'Venta', 'Goda', 'Vokė'. Rhizoctonia infection was lower in cultivars 'Vaiva', 'Mirta' and 'Venta'. Tubers of c. 'Vaiva' exhibited highest resistance to common scab. The best storage properties (resistance to wet and dry rot) were shown by cultivars 'Vaiva', 'Goda' and 'Aistės'. The genotype of cultivars 'Goda', 'Vaiva', 'Mirta' and 'Aistės' is best resistant to diseases. They are recommended as most promising for ecological farming. Spread of virus infection in potatoes depends also on the cultivars earliness group and reproduction. The early cultivars 'Venta' and 'Vokė' are less resistant to viruses in comparison with late maturity cultivars (maincrop 'Nida', 'Mirta' and late 'Aistės'). Earlier maturity potato cultivars, even in low reproductions, show a tendency to higher levels of virus infection.

References

1. Asiedu S, Colmans S, Haliburton T et al. Atlantic Canada Potato Guide. Advisory Committee on Potatoes, 1994: 3–47.
2. Brunt A, Crabtree K, Dalwitz M et al. Viruses of Plants. CAB Internation. Cambride, U. K. 1996: 1484.
3. Bujauskas AV. Atsparių bulvinei nematodei bulvių veislių selekcija ir meristeminė sėklininkystė. Vilnius, 2000: 84.
4. Jundulas J, Ražukas A. Bulvių biologija ir jų auginimas. Vilnius, 1997: 6–13.
5. Lazauskas J. Augalininkystė Lietuvoje. Vilnius, 1987: 20.
6. Rosenberg V, Kotkas K, Sarchanno M. The technology of growing the first generation seed tubers in the field: an effective way for getting initial seed material. 13th EAPR triennale Conference. Sorrento, Italy. 1999: 430–1.
7. Spaar D, Kleinhempel H. Bekamfung von Virus Krankheit der kultur Pflanzen. 1986: 38–70.
8. Букасов С, Камераз А. Селекция и семеноводство картофеля. Ленинград, 1972: 359.
9. Камераз А, Яшина И, Склярова Н. Генетика картофеля. Москва, 1973: 115–30.
10. Соболь Я. Вирусные болезни сельскохозяйственных культур и меры борьбы с ними. Москва, 1988: 115.

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BULVIŲ GENOTIPO ĮTAKA LIGŲ IR VIRUSŲ PAPLITIMUI

S a n t r a u k a

Lietuvos žemdirbystės instituto Vokės filiale 1987–2000 metais tirtas bulvių veislių 'Mėta', 'Vilnia', 'Vokė', 'Aistės', 'Nida', 'Mirta', 'Venta', 'Goda', 'Vaiva' ir 'Vilija' atsparumas labiausiai paplitusioms Lietuvoje bakterinėms ir grybinėms bulvių ligoms bei virusams. Skirtingo genotipo bulvių veislėse šių ligų ir virusų paplitimas yra nevienodas. Bulvių fitoftorai atspariausia veislė yra 'Aistės'. Mažiau atsparios yra ankstyvos, trumpos vegetacijos bulvių veislės 'Venta', 'Goda', 'Vokė'. Rizoktoniozė mažiausiai pažeidžia, 'Vaivos' 'Mirtos' ir 'Ventos' bulvių veisles. Veislės 'Vaiva' gumbai labiausiai atsparūs paprastosioms rauplėms. Sandėliavimo metu šlapiuoju ir sausuoju puviniais mažiausiai pažeidžiamos veislės 'Vaiva', 'Goda' ir 'Aistės'. Atliktų tyrimų rezultatai rodo, kad bulvių veislių 'Goda', 'Vaiva', 'Mirta' ir 'Aistės' genotipas pasižymi aukščiausiu atsparumu ligoms. Šios bulvių veislės yra rekomenduojamos kaip pačios perspektyviausios ekologiniams ūkiams.

Virusinės infekcijos paplitimą bulvių pasėliuose lemia bulvių veislės genetiniai ypatumai ir auginamos sėklos reprodukcija. Ankstyvos bulvių veislės 'Venta' ir 'Vokė' yra mažiau atsparios virusams, lyginant su vėlyvesnės vegetacijos bulvių veislėmis 'Nida', 'Mirta' ir 'Aistės'. Ankstyvos vegetacijos bulvių veislėms ir esant žemai reprodukcijai būdinga didesnio pažeidimo virusais tendencija.