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THE DISTRIBUTION AND CHANGES OF *PHYTOPHTHORA INFESTANS* POPULATION IN LATVIA

ABSTRACT

Potato breeders and phytopathologists have been conducting the studies on *Phytophthora infestans* (Mont.) de Bary at the Priekuli Plant Breeding Station since 1962. The varietal resistance is very important in potato breeding programme. The trials in collaboration with the Institute of Phytopathology of Soviet Union (Russia) were done in 1974–1990. The investigations were focused on races of *P. infestans*. The changes of races were assessed using a "trap" method, according to the investigation programme, like in each of the republics of the Soviet Union.

At the beginning of investigations (1960s and 1970s) races 1, 4 and 1.4 of *P. infestans* were the predominant ones in Latvia, but in the 1980s complex races 4.10.11, 1.4.7.8.10.11, 1.3.4.7.8.10.11 and 1.2.3.4.7.8.10.11 were more widely distributed.

Different foreign varieties, mostly from the Netherlands, were introduced in Latvia in the 1970s. This resulted in a very rapid differentiation of late blight races. The enhanced aggressiveness of *P. infestans* isolates was due to an increasing number of races in population. The earlier appearance of infection in potato fields was recorded. The presence of a mating type A2 was stated in Latvian samples in 1987. Because all tested races had been recognized in a population, and the conception of resistance breeding had been modified, the trials were stopped in 1990. The resistance based on specific resistance genes was the main direction in the 1960s and 1970s. From the 1980s, impor–tance of the field resistance has greatly increased and this type of resistance is the most significant in the current breeding programme. The trials in organic field proved the acceptable level of field resistance to *P. infestans* of three medium late varieties: Sigunda (previous name Undine), Bete and Zile. These varieties have been bred at the Priekuli Plant Breeding Station and included into the Latvian Plant Varieties Catalogue.

Key words: control, late blight, potato, race, resistance

INTRODUCTION

The meteorological conditions (air humidity and temperature) during potato growing in Latvia are mostly favourable for development of fun–gus–like *Phytophthora infestans* (Mont.) de Bary, the causal agent of late blight. The development of late blight in the field starts usually at the beginning of July, although in some years the first damages are ob–

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served in the second part of June. The yield losses in the field with no fungicide treatment could reach 50%. One of important ways of late blight control is resistance of potato variety to late blight. However, the variability and changeability of late blight races make difficult breeding of new resistant potato varieties. Beside simple races, different complex races in populations of *P. infestans* have been identified. The variation could be explained with existing two mating types of *Phytophthora* (Umaerus *et al.* 1983, Schober–Butin *et al.* 1995).

At the beginning of 1960s there was an opinion among breeders that resistant varieties could restrict development and distribution of late blight. The variety resistance was mainly carried with specific genes, so called specific resistance (Kameraz *et al.* 1973). It is known that several wild species have resistance genes. New varieties containing those genes were obtained by hybridisation. In most cases, potato varieties contain only one *R*–gene: *R1*, *R3* or *R4*, sometimes two: *R1R4*, *R3R4*, *R1R3*, and very rarely three or four genes, for instance cv. Pentland Del (*R1R2R3*). The presence of dominant genes provides the resistance to appropriate pathogen races. In the next years breeders were more interested in field (horizontal) resistance that is known to be of polygenic character (Umaerus *et al.* 1983).

The identification of *P. infestans* races and evaluation of the dynamics of their development in a local population have been carried out at the Priekuli Plant Breeding Station since 1962. The research in collaboration with the Institute of Phytopathology of Soviet Union (Russia) was done in 1974–1990. In the Institute evaluation of dynamics of races development was performed using one method and a set of genotypes (varieties and wild species), like in each of the republics of former Soviet Union.

The aim of studies was to investigate *P. infestans* population in Latvia. The main goal was to improve breeding for resistance to *P. infestans* in potato breeding programme.

MATERIALS AND METHODS

A composition of *Phytophthora* races was investigated on a set of potato genotypes presented in Table 1. After the late blight development on leaves had started, samples of damaged leaves from about 200 different genotypes were collected every year at defined intervals. The content of *Phytophthora* races was analysed in a laboratory using Black's and Schick's differentials (Black *et al.* 1953, Schick and Schick 1959) containing single *R*–genes from *R1* to *R11*, presenting *Solanum demissum* and *S. stoloniferum* species. The dynamics of late blight development was assessed in the field at 10–day intervals. A percentage of a damaged area on the foliage was determined.

In 1999 mating types were determined using A1 and A2 standard isolates according to the method described by Hermansen and Amundsen

(1995). Potato leaves of five *P. infestans*–infected varieties differing in their maturity were collected. The isolations were made on rye B agar (Caten and Jinks 1968).

Table 1

Genotypes and resistance genes

Genotypes without *R*–genes	Agrie Dzeltenie, Laimdota, Ora, Priekulu Visagrie
Genotypes with one resistance gene	Ambasadeur (*R3*), Izstades (*R4*), Kameraz (*R1*), Loshitskiy (*R4*), Patrones (*R3*), Stoloviy (*R4*), Veselovskiy (*R2*)
Genotypes with two resistance genes	Anko (*R1R3*), Epoka (*R3R4*), Lawa (*R3R4*), Olev (*R1R4*), Rector (*R2R3*), Remona (*R1R3*), Susanna (*R1R4*), Uralskiy (*R3R4*), Vertifolia (*R3R4*), Virginia (*R1R4*), Vita (*R1R4*)
Genotypes with three resistance genes	Greta (*R1R3R4*), Karpatskiy (*R1R2R4*), Pentland Del (*R1R2R3*)
Black's differentials used in testing	*R2, R4, R5, R1R3, R1R4, R3R4, R7, R8, R10, R11*
Shick's differentials used in testing	*S. demissum*: *r, R1, R2, R3, R1R2, R1R3, R1R4, R2R4, R3R4, R1R2R4, R1R3R4, R1R2R3R4* *S. stoloniferum*: *R2, R6*
Genotypes without known *R*–genes with high horizontal resistance	Advira, Amsel, Ariadna, Astra, Atzimba, Belorusskiy Krahmalistiy, Denis, Dorita, Gibridniy 14, Fytoftoroustoychiviy, Elenita, Foran, Isola, Letniy 92, Pribrezhniy, Sentyabrskiy, Specula, and 30 clones

The date of the beginning of *P. infestans* symptoms was observed in the experimental potato field in Priekuli, where the collection of about 500 potato varieties of different origin and maturity has been maintained. No chemical control against late blight was applied.

The field resistance to *P. infestans* of eight potato varieties was evaluated in organic field where neither fertilizers nor chemical control was applied in 2003. The trial was performed in sandy clay loam soil, organic matter (Tyurin's method) – 21 g × kg^{-1}, plant available phosphorus (P_2O_5) – 147 mg × kg^{-1} and exchangeable potassium (K_2O) – 179 g × kg^{-1}. The oil radish was grown as green manure in the year preceding planting of potato. The dynamics of late blight development was assessed as a percentage of damaged leaf area at 7–day intervals.

RESULTS AND DISCUSSION

The changes within *P. infestans* population in the period of investigations (1965–1990) were as follows:

- from 1965 to 1970: races 1, 4, 1.4 (dominant 1.4);
- from 1971 to 1978: races 1, 2, 3, 4, 1.4, 1.3.4, 1.2.3.4 and various combinations (dominant 1.4);
- from 1979 to 1990: all the above races and 5.6*, 7, 8, 9*, 10, 11, completed race complexes 1.2.3.4.7.8.10.11 and 1.2.3.4.6*.7.8.9*.10.11

(* virulence factors in isolates from Priekuli were detected at the Institute of Phytopathology of Soviet Union).

The involvement of a greater number of resistance genes in potato genotypes yielded the appearance of new *P. infestans* virulence factors and new races both on varieties with *R*–genes and on those without *R*–genes (Table 2).

Table 2

Proportions of *Phytophthora infestans* races identified at the Priekuli Plant Breeding Station [%]

Races	Average 1965–1969	Average 1970–1974	Average 1975–1979	Average 1980–1984	Average 1985–1989
1	10.6	2.9	0	0	0
2	0	0	0.3	0	0
3	0	0	0.6	0	0
4	20.5	17.2	14.7	0.3	0
1.2	0	0	0	0	0
1.3	0	2.7	7.2	0	0
1.4	48.8	46.5	49.1	0.3	0
2.3	0	0	0.4	0	0
2.4	1.9	0	2.7	0	0
3.4	3.1	2.1	1.6	0	0
1.2.4	0.4	0	0.9	0	0
1.3.4	14.7	22.2	8.9	2.1	0
1.2.3.4	0	6.4	12.7	11.2	0
7	0	0	0	0	0
8	0	0	0.4	0	0
10	0	0	0	0	0
11	0	0	0	0	0
4.10.11	0	0	0	21.3	0
1.4.10.11	0	0	0	8.1	0
1.4.7.8.10.11	0	0	0	25.0	1.7
1.3.4.10.11	0	0	0	0.9	0
1.3.4.7.8.10.11	0	0	0	8.8	18.3
1.2.4.7.8.10.11	0	0	0	0	14.9
1.2.3.4.10.11	0	0	0	9.0	0
1.2.3.4.5.7.8.10.11	0	0	0	0	16.0
1.2.3.4.7.8.10.11	0	0	0	13.0	49.1
Total number of races	7	7	12	11	5

The breeders from the Priekuli Plant Breeding Station released two varieties with identified *R*–genes: Izstades *(R4)* and Vita (*R1R4*) in 1965 and 1974, respectively. About 10 races of *P. infestans* were identified each year in the fields of the Station. As new races had appeared and virulence factors accumulated in a local population, elevated requirements were determined for varieties to be released: several dominant *R*–genes and high horizontal (field) resistance.

The mating type A2 was identified in *P. infestans* isolates from Latvia in 1987 by researchers from the Institute of Phytopathology of Soviet Union. Both differentiation of races and the appearance of A2 mating type could be connected with importing in Latvia potato varieties Sante, Anosta, Cardinal and Diamant from the Netherlands at the beginning of 1970s. The trials done in 1999 in collaboration with the Department of Applied Plant Protection at Swedish University of Agricultural Sciences revealed the existence of two mating types in Latvian population of *P. infestans*. Since the late 1980s late blight infection has also been observed on potato stems.

The aggressiveness of late blight has considerably changed. The infection starts earlier, compared to the 1970s and 1980s. In the latter, first lesions caused by late blight on early and medium early varieties appeared in the 3rd decade of July or at the beginning of August, whereas in the 1990s these symptoms were recorded as early as the first decade of July or the end of June (Table 3).

Table 3

The date of first appearance of lesions caused by *Phytophthora infestans* in potato fields in the years 1978–2003 (data from the Forecasting Department in Priekuli)

June			July			August	
11–20	21–30	1–10	11–20	21–31	1–10	11–20	21–31
			1978				
			1979				
			1980				
	1981		1982				
			1983				
			1984				
		1985					
		1986	1987				
	1988						
	1989		1990				
			1991				1992
			1993				1994
			1995				
		1996					
		1997					
1998	1999	2000					
	2001	2002					
		2003					
1 year	5 years	7 years	11 years				2 years

The effective late blight control includes integration of variety resistance with suitable fungicide treatment. To control late blight in Latvia, the information from the Forecasting Department of diseases and pests of State Plant Protection service has been used. The method based on relative air humidity and temperature was used for warning of late blight till 1999. The data from local meteorological stations were utilised. In 2000,

the aforementioned Forecasting Department together with Latvian University of Agriculture introduced NegFry program in Latvia. It is based on the database containing information on weather conditions and varietal resistance for scheduling crop treatment during a vegetation period (Hansen *et al.* 1995, Hansen 1997).

The list of fungicides has been substantially changed in the last ten years. In 2003, 14 fungicides from the List of Plant Protection Register were accepted for late blight control: Acrobat MC (dimethomorph and mancozeb), Acrobat Plus (dimethomorph and mancozeb), Champion (Cooper hydroxide), Dithane NT (mancozeb), Dithane M45 (mancozeb), Electis 75 (zoxamid and mancozeb), Pencozeb 80 (mancozeb), Ridomil Gold (metalaxyl and mancozeb), Ridomil MC 72 (metalaxyl and mancozeb), Sandofan 25 (oxadixyl), Sandofan M8 (oxadixyl and mancozeb), Shirlan 500 (fluazinam), Tanos 50 (phamoxalon and cymoxanil) and Tattoo 550 (propamocarb hydrochlorine and mancozeb).

Varietal resistance to late blight is of increasing importance for development of organic farming. Within each earliness group of potato varieties differences in the level of resistance under local growing conditions are observed. Among the varieties described in the Latvian Catalogue of Plant Varieties, early varieties Planta (Germany) and Borodyanskiy Rozoviy (Ukraine) are relatively more resistant than the others. Second early variety Lenora (Latvia) as well as medium late varieties Zile, Sigunda, Lauma and Bete (all from Latvia) are more resistant than other varieties in the respective earliness groups. The evidence is accumulated that it is possible to succeed in producing potatoes in organic farming when resistant varieties are cultivated and agrotechnical treatments preventing late blight are performed. However, no much success in creating potato genotypes expressing sustained resistance to late blight has so far been gained due to the pathogen viability and variability. Only three of eight varieties grown in the organic fields in 2003 were found to be resistant enough – medium late varieties Sigunda, Bete and Zile (Table 4).

Table 4

The development of late blight infection in organic potato field 2003

Variety	Maturity	Damaged leaf area [%]				
		July 21	July 28	August 4	August 11	August 18
Laimdota (Latvia)	second early	1	15	60	70	95
Sante (The Netherlands)	second early	1	10	60	70	95
Lenora (Latvia)	second early	0.1	8	25	40	80
Bete (Latvia)	medium late	0	1	20	30	60
Brasla (Latvia)	medium late	0	1	25	60	90
Magdalena (Latvia)	medium late	0	1	25	55	90
Sigunda (Latvia)	medium late	0	0	1	5	10
Zile (Latvia)	medium late	0	0	5	15	55

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