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Phytophthora infestans POPULATIONS IN LATVIA

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Potato late blight caused by Phytophthora infestans *(Mont.) de Bary is one of the most investigated plant pathogens. However, problems with disease control have increased in recent years, which plant pathologists have explained by its ability of forming oospores in potato leaves. Consequently, the* P. infestans *population over the world has become more aggressive and virulent and late blight on potato stems is common. Oospores could be found in field conditions in potato leaflets with two or more separate spots. In Latvia the* P. infestans *mating type A2 was found in the 1980s. A laboratory experiment on the formation of oospores in Latvia was started in 2002. The total number of collected samples was 215. The samples were collected from potato trial fields, conventional fields and from private gardens in different regions of Latvia. Many potato leaflets with two spots were observed at the end of the growing season when the disease severity exceeded 50%. The results showed that the formation of oospores on potato leaflets in the field took place in the* P. infestans *population in Latvia. Oospores were found in 80–94% of the investigated cases. The occurrence of oospores means that plant rotation and certified seed material are important measures for potato late blight control and the usage of fungicides may not be effective.*

Key words: Phytophthora infestans*, oospores, potato late blight.*

INTRODUCTION

Phytophthora infestans (Mont.) de Bary is perhaps the best known of *Oomycota*. The description of this pathogen has radically changed since 1845 when it was first described as *Botrytis infestans* Montagne (see Bourke, 1991). *Oomycota* are now generally regarded as kingdom separate from the true fungi, plants, animals and prokaryotes. Some plant pathologists suggested that they belong to the Kingdom *Protoctista*, but others place them in the Kingdom *Chromista*. There is more support for the latter choice as they have similarity with brown algae (Erwin and Ribeiro, 1996).

P. infestans is heterothallic and either of the mating types (A1 and A2) can reproduce asexually. Sexual reproduction occurs only between opposite mating types (Pittis and Shattock, 1994; Drenth *et al*., 1995). Until the late 1980s, only one mating type (A1) was present in countries outside Mexico, and *P. infestans* populations appear to remain stable (Shaw *et al*., 1985; Spielman *et al*., 1991). Both mating types (A1 and A2) in approximately equal frequency were found only in the highlands of central Mexico. The first report about mating type A2 in Europe came from Switzerland in 1981. Since then, the mating type A2 has been recorded in numerous locations in Europe, Asia, Middle East and South America (Spielman *et al*., 1991). The first report on formations of oospores in Latvia was in the 1980s, but the research was not continued. Similarly, in the other Baltic countries, mating type A2 has been observed during the last ten years (personal communication).

There are several hypotheses about the distribution of mating type A2 throughout the world: (1) the mating type A2 is the result of mutations, which appeared after fungicide applications or due to meteorological changes; (2) mating type A2 was always present in Europe, but at a low level and was not detected; and (3) mating type A2 migrated from already occupied regions to other regions (Spielman *et al*., 1991).

In areas where *P. infestans* populations are formed by only one mating type, the pathogen overwinters as mycelium in potato seed tubers in storage, in potato tubers in cull piles and in plant debris. If populations contain both mating types, sexual reproduction produces oospores—hardy, thick walled spores, with diameter 24–35 μm (Niederhauser, 1991; Erwin and Ribeiro, 1996). Oospores can survive for many years (up to ten years) in the soil without a susceptible host (Andrivon, 1995; Drenth *et al*., 1995). Under high moisture conditions, oospores present in the soil surface germinate and infect lowest potato leaves. The appearance of the first disease symptoms is difficult to establish (Drenth *et al*., 1995).

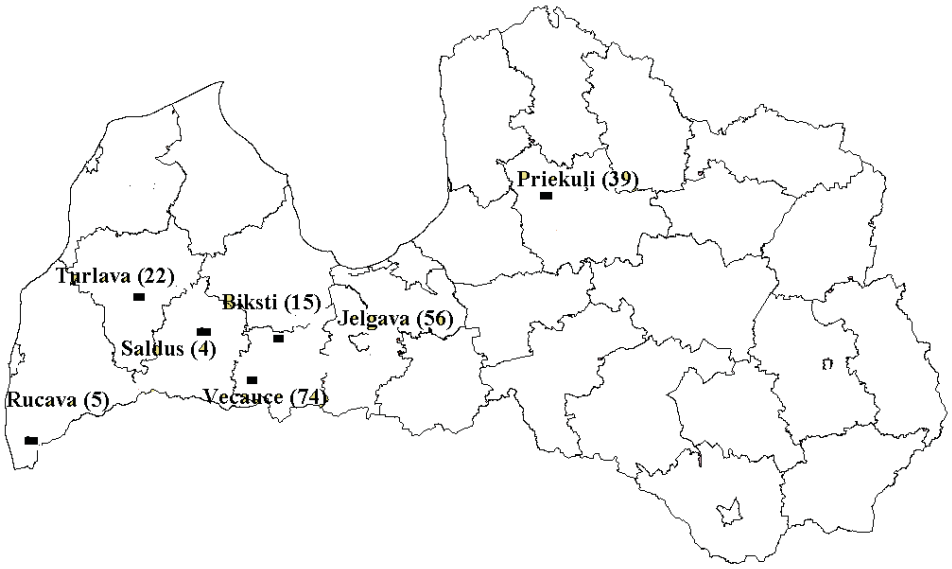

Fig. 1. Sampling locations and number of samples in 2002–2004.

To detect the occurrence of *P. infestans* oospores, it is needed to develop alternative and more durable potato late blight control strategies, as disease epidemics occur earlier and spread faster, and disease development is difficult to forecast (Goodwin, 1997; Turkensteen *et al*., 2000).

The aim of this work was to conduct an inventory of the *P. infestans* population in Latvia by assessing the presence of mating type A2 and formation of oospores.

MATERIALS AND METHODS

Laboratory experiments on occurrence of oospores in Latvia were conducted at the Institute of Soil and Plant Sciences, Latvian University of Agriculture, during 2002–2004. The method was adopted from the Finland Agriculture Science Centre, Department of Plant Protection in Jokioinen (Hermansen *et al*., 2001; Levin *et al.,* 2001).

Potato leaflets with two or more separate spots were collected in different regions. In 2002, samples were taken from NegFry adaptation trials in Vecauce and Priekuļi and potato variety observation trials in Vecauce. In 2003, samples were collected from potato variety observation trials in Priekuļi and from conventional fields in regions of Liepāja, Kuldīga and Dobele, and in 2004 from a certified organic field in Vecauce, from home gardens in Jelgava and from a conventional field in Saldus region. The total number of samples was 215 (Fig. 1).

After collection, each potato leaflet was placed in a 10-cm diameter Petri dish containing 20 ml distil water. Leaflets were incubated at controlled conditions for 2–4 weeks and examined under a microscope under 100× magnifications for the presence of oospores.

RESULTS

During recent years, late blight on potato stems can be observed more often, which can be explained by changes in the *P. infestans* population. Potato late blight on stems appears more in growing seasons when weather conditions are more favourable for disease development. This form is difficult to control with fungicides.

Formation of oospores requires opposite mating types. If the spots develops from opposite mating types (A1 and A2) the formation of oospores will be possible, but not when both are either A1 or A2 mating type. More potato leaflets with two or more spots (Fig. 2) were observed at the end of the growing season (July, August) when late blight severity exceeded 50%.

In 2002, the number of collected samples was 79 (Table 1) and in both trial locations—Vecauce and Priekuļi—the number of samples with oospores was high, reaching 96% and 86% cases.

The weather conditions were not favourable for potato late blight development in 2003. Therefore, the number of the collected samples was smaller than in other years, and it was difficult to collect potato leaflets with two or more late blight spots. For example, in Vecauce potato late blight was

Fig. 2. Leaflets infected by potato late blight (two separate spots).

Table 1

COLLECTED SAMPLES

Year	Number of samples	Samples with oospores	
		number	%
2002	79	74	94
2003	59	47	80
2004	77	57	74
Total number	**215**	**178**	**83**

not found at all. Samples in 2003 were taken from potato variety observation trials in Priekuļi and from conventional fields in regions of Liepāja, Kuldīga and Dobele. Compared with 2002, oospores were found on average in 80% cases (Table 1). Comparing different locations, more oospores were found in Liepāja District among the collected samples.

In 2004, most leaf samples were taken from private gardens in Jelgava and from the certified organic field in Vecauce. The number of samples was 77 (Table 1) and oospores were found in 74% cases. The lowest amount of oospores was found in samples from the organic field, only in 29% of the samples. The reason for this was that potatoes in this field had not been cultivated for more than 20 years. In all samples from private gardens, the frequency of oospores formations was high (80–100%), as potato cultivation in one filed over many years is common, which results in accumulation of *P. infestans* in the soil.

Formations of oospores (Fig. 3) occur in the *P. infestans* population in Latvia and oospores were found in 83% of cases. Therefore, both mating types (A1 and A2) are found in the *P. infestans* population in Latvia.

DISCUSSION

Formation of *P. infestans* oospores in the field has become a reality in many countries, also in Latvia. Oospores allow pathogen survival where the asexual form fails, and they may be a source of initial inoculum. The investigation on spread of *P. infestans* mating type A2 needs to be continued, as it is necessary to determine which factors influence production, survival, germination and infectivity of oospores (Drenth *et al*., 1995).

"New" populations (inclusive mating type A2) of the pathogen show high levels of resistance to the fungicides, and become more virulent and aggressive compared with "old" populations (Goodwin, 1997).

One hypothesis about the appearance of mating type A2 in Europe is that mating type A2 is the result of mutations, which appeared after intensive fungicide application. However, many plant pathologists consider that mating type A2 in Europe is similar to the mating type in the highlands of central Mexico, which means that the only way for distribution was migration (Spielman *et al*., 1991; Erwin and Ribeiro, 1996).

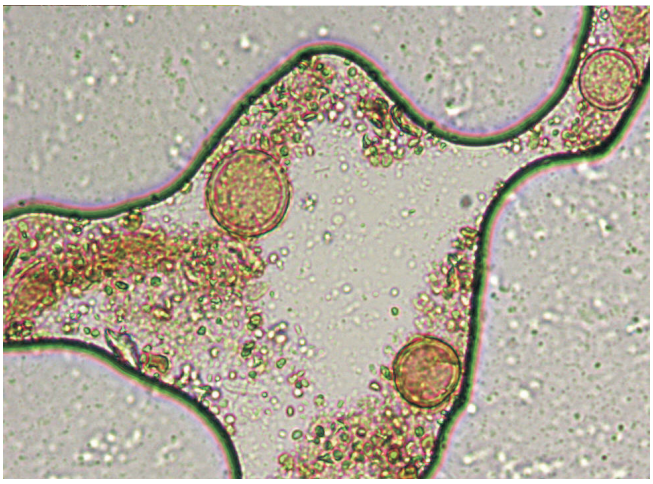

Fig. 3. Oospores of *Phytophthora infestans.*

There are observations that *P. infestans* in leaflets formed more oospores in cultivars which were more resistant to potato late blight (Hanson and Shattock, 1998; Stromberg *et al*., 2001). In samples collected in Latvia, this was not observed, as oospores were recorded from different cultivars with different resistance to potato late blight. Oospore presence was associated with location. The highest frequency of oospores formation was in private gardens where potatoes were cultivated for many years, and the lowest in a certified organic field where potatoes had not been grown for more than twenty years. The results show that crop rotation is one of the best measures for potato late blight control.

Oospore formation is favoured by a proportion of mating types A1 and A2 of 1:1 (Zarzycka and Sobkowiak, 1999), but formation of oospores in the field was possible also if the proportion of A1 and A2 is low, for example only 1 : 3 or even 1 : 9 (Turkensteen *et al*., 2000).

The used method allows establishing cases when formation of oospores occurs, but does not show the ratio between mating type A1 and A2. Further investigation is necessary to clarify the proportion of mating type A1 and A2 in the *P. infestans* population in Latvia.

The occurrence of oospores means that crop rotation is one of the important measures for potato late blight control and usage of fungicides might not be effective.

REFERENCES

Bourke, A. (1991). Potato blight in Europe in 1845: The scientific controversy (pp. 12–24). In *Phytophthora.* Lucas, J.A., Shuttock, R.C., Shaw, D.S., Cooke, L.R. (eds.).). Cambridge: Cambridge University Press.

Erwin, D.C., Ribeiro, O.K. (eds.) (1996). Phytophthora *Disease Worldwide.* St. Paul: American Phytopathological Society. 262 pp.

Pittis, J.E., Shattock, R.C. (1994). Viability, germination and infection potential of oospores of *Phytophthora infestans*. *Plant Pathol.*, **43**, 378–396.

Drenth, A., Jassen, E.M., Govers, F. (1995). Formation and survival of oospores of *Phytophthora infestans* under natural conditions. *Plant Pathol.*, **44**, 86–94.

Shaw, D.S., Fyfe, A.M, Hibberg, P.G., Abdel-Sattar, M.A. (1985). Occurrence of the rare A2 mating type of *Phytophthora infestans* on imported

Egyptian potato and the production of sexual progeny with A1 mating type from the U.K. *Plant Pathol.,* **34**, 552–556.

Spielman, L.J., Drenth, A., Davidse, L.C., Sujkowski, L.J. Gu, W., Tooley, P.W., Fry, W.E. (1991). A second world—wide migration and population displacement of *Phytophthora infestans*? *Plant Pathol.*, **40**, 422–430.

Goodwin, S.B. (1997). The population genetic of *Phytophthora*. *Phytopathology*, **87**, 462–473.

Andrivon, D. (1995). Biology, ecology and epidemiology of potato late blight pathogen *Phytophthora infestans* in soil. *Phytopathology*, **85**, 1053–1056.

Turkensteen, L.J., Flier, W.G., Wanningen, R., Mulder, A. (2000). Production, survival and infectivity of oospores of *Phytophthora infestans*. *Plant Pathol.*, **49**, 688–696.

Hermansen, A., Hannukkala, A., Hafskold Nærstad, R. and Brurberg, M.B. (2001). Variation in populations of *Phytophthora infestans* in Finland and Norway: Mating type, metalaxyl resistance and virulence phenotype. *Plant Pathol.*, **49**, 11–22.

Levin, A., Baider, A., Rubin, E., Gisi, U. and Cohen, Y. (2001). Oospore formation by *Phytophthora infestans* in potato tubers. *Phytopathology*, **91**, 327–336.

Zarzycka, H. and Subkowiak, S. (1999). Sexuality of *Phytophthora infestans* and the role of oospores as a primary infection source of potato late blight. *J. Plant Protect. Res.*, **39**(2), 9–15.

Stromberg, A., Bortström, U., Hallenberg, N. (2001). Oospore germination and formation by late blight pathogen *Phytophthora infestans in vitro* and under field conditions. *Phytopathology*, **149**, 659–664.

Hanson, K., Shattock, R.C. (1998). Formation of oospores of *Phytophthora infestans* in cultivars of potato with different levels of race-nonspecific resistance. *Plant Pathology*, **47**, 123–129.

Niederhauser, J.S. (1991). *Phytophthora infestans*: The Mexican connection (pp. 25–45). In Lucas, I.A., Shattock, R.C., Shaw, D.S, Cook, L.R. (eds.). *Phytophthora* Cambridge: Cambridge University Press.

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Phytophthora infestans POPULĀCIJA LATVIJĀ

Kartupeļu lakstu puve *Phytophthora infestans* (Mont.) de Bary ir viena no pētītākajām augu slimībām. Tomēr problēmas saistībā ar šīs slimības ierobežošanu ar katru gadu palielinās. Augu patologi to skaidro ar *P. infestans* spēju veidot oosporas. Līdz ar to patogēna populācija kļūst daudz agresīvāka un virulentāka, un biežāk ir novērojama lakstu puves stublāju forma. Lauka apstākļos oosporu veidošanās parasti ir novērojama uz tām inficētajām lapām, kur ir divas vai vairākas lēzijas. Latvijā *P. infestans* patogēna tips A2 jau tika atrasts divdesmitā gadsimta 80. gados, bet pētījumi par oosporu veidošanos uzsākti 2002. gadā. No kartupeļu izmēģinājumu un ražošanas laukiem, kā arī no mazdārziņiem ievākti 215 inficēto lapu paraugi. Lapas ar divām lēzijām visvairāk novērotas audzēšanas sezonas beigās, kad lakstu puves attīstības pakāpe pārsniedza 50%. Ievākto paraugu analīze pierādīja, ka Latvijā uz kartupeļu lapām lauka apstākļos veidojas *P. infestans* oosporas. Tas nozīmē, ka arī Latvijā ir sastopami abi *P. infestans* patogēnitātes tipi (A1 un A2). Oosporas atrastas 80–94% gadījumu. Oosporu sastopamība nozīmē to, ka kartupeļu audzētājiem lielāka uzmanība jāpievērš augu maiņai un sertificētam stādāmajam materiālam.