

Józefa Kapsa¹, Jens G. Hansen²

¹ Plant Breeding and Acclimatization Institute (IHAR) Radzików, Department of Potato Protection and Seed Science, 76-009 Bonin, Poland; ² Danish Institute of Agricultural Sciences (DIAS), Department of Agroecology, Research Centre Foulum, 8830 Tjele, Denmark
Author for correspondence: J. Kapsa, e-mail: j.kapsa@wp.pl

ESTABLISHMENT OF A MONITORING NETWORK FOR POTATO LATE BLIGHT (*PHYTOPHTHORA INFESTANS*) IN POLAND

ABSTRACT

Changes in population of *Phytophthora infestans* can greatly influence the time of potato late blight appearance in potato crops. The late blight monitoring system makes it possible to evaluate reliability of the forecast provided by decision support systems that are applied in potato protection and in consequences defends in practice potato crops from early appearing infections.

The first steps in creating Polish internet monitoring system in potato protection against late blight were based on observations carried out by advisers from the Plant Protection Inspectorate in Lublin voivodeship in the years 2001–2002. The conducted evaluations were part of the Polish–Danish research project “Development of an Internet based DDS for Cereal Diseases and Potato Late Blight in Poland, 2001–2002”. In 2003, the observations were also conducted in four other voivodeships.

The collected results indicate that it is feasible to recognize primary early infections manifested as singular necroses on potato plants. The earliest infections were most frequently recorded on susceptible potato cultivars. In two cases in 2003, early attacks were recorded at plant growth stage of 30–31 (in 0–99 BBCH scale for potato). In most cases the first infection symptoms appeared at the growth stage exceeding 37. This indicates that very early infections caused by oospores from soil were not common in the inspected areas.

Key words: changes, late blight, monitoring, occurrence, pathogen population, potato

INTRODUCTION

A new population of *Phytophthora infestans* that has dominated in Europe for the recent 20 years has considerably affected both pathogen behaviour and disease epidemiology (Fry *et al.* 1993). This caused the increased number of more aggressive races which, in turn, yielded a more severe course of the disease and earlier appearance of epidemic outbreak of late blight. Certainly, the changes in epidemiology of *P. infestans* must result in serious implications for both late blight control and reliability of the currently applied systems of forecasting and warn-

ing, especially those based on the information established before appearance of new pathogen populations (Hansen *et al.* 2001).

Introduction and development of the Internet system of late blight monitoring in potato crops aims at general warning about early attacks of *P. infestans*. Additionally, monitoring information will be used as a supplement to investigations on consequences of a possible change in epidemiology of the pathogen and analysis of the causes of very early establishment of primary attacks for improvement of existing forecasting systems.

A special service for the Internet based late blight monitoring in the Baltic Sea region was developed by The Danish Institute of Agricultural Sciences (<http://www.web-blight.net>, Hansen *et al.* 2001). This system was adopted by Poland in 2001.

The first steps in creating Polish monitoring system in potato protection against late blight were observations carried out in the years 2001–2002 by advisers from the Plant Health and Seed Inspection Service in Lublin voivodeship under supervision of the faculty of Plant Breeding and Acclimatization Institute, as part of the Polish–Danish research project “Development of an Internet based DDS for Cereal Diseases and Potato Late Blight in Poland, 2001–2002” (Hansen *et al.* 2003, Kapsa *et al.* 2003, Kapsa and Gawińska–Urbanowicz 2004).

The late blight Internet monitoring network has been successively developed in Poland since 2001. As mentioned above, in 2001 and 2002 observations were only conducted in one voivodeship. In 2003 they were carried out in six voivodeships. This article presents the results of these investigations. Advantages and perspectives of the monitoring system are discussed.

MATERIAL AND METHODS

In the growing season 2003, monitoring was planned for selected potato fields in six voivodeships: Dolnośląskie, Lubelskie, Łódzkie, Małopolskie, Wielkopolskie and Zachodniopomorskie.

Scheme of late blight monitoring net in Poland

Polish version of late blight monitoring network for potato crops is based on a general program “Internet based monitoring system for potato late blight”, which was developed in Denmark for the Baltic Sea countries (Fig. 1).

The late blight monitoring network in Poland is based on co-operation of the Country Administrator (Plant Breeding and Acclimatization Institute at Bonin) and the Country Reporters (inspectors from Plant Health and Seed Inspection Service, PH&SIS). The country administrator (CA) is responsible for co-ordination of the national participants in the monitoring network, management of national database (information on national potato cultivars and their characteristics, regions and

user identification), appointment of national Country Reporters (CR) in the Pi-Monitoring-net and correcting the data entered by reporters to the Internet. The country reporters perform observations in the fields and enter data into the system via a PC-program called Pi-Monitoring. In the Web Blight system the data are subjected to a quality control and a statistic interpretation, and afterwards they are presented on maps, figures and tables on the Internet.

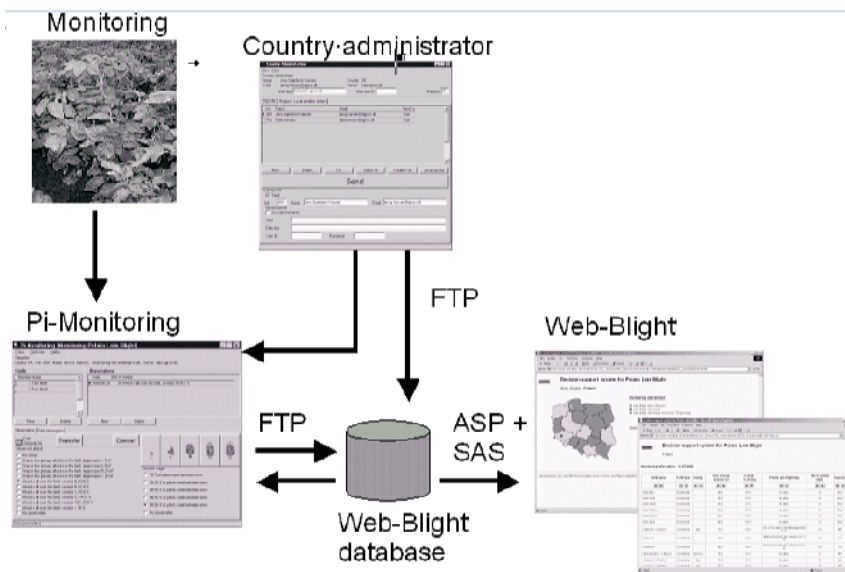


Fig. 1. Management and data flow in the web-blight monitoring system

Field recording of potato late blight in 2003

Three locations were selected for observations in each voivodeship. At each location, potato cultivars differing in ratings for resistance to late blight were planted in two fields. The differences between cultivars in the resistance level were at least two grades on a 1–9-grade international resistance scale. In general, observations were carried out by reporters once a week, in the period between potato plants emergence and the appearance of disease symptoms in surveyed fields. However, in the period when weather conditions were favourable for late blight development, observations were conducted more frequently, usually 2–3 times a week. The collected data were sent *via* the Internet to the Danish server using Pi-Monitoring software.

A special disease assessment key (Hansen and Lassen 2000) is used in a monitoring network for late blight and growth stage of plants according to BBCH scale. Additional data, such as localization and type of field, potato cultivar and its emergence date were entered into database. Severity of pathogen attack was evaluated using a 11-grade scale, where 1 – no attack, 2 – one or few infections in area $< 1 \text{ m}^2$, and 11 – late

blight attacks all over the field with more than 25% of the leaf and stem area infected (Table 1).

**Disease assessment key used in the monitoring network
(acc. Hansen and Lassen 2000)**

Table 1

Degree of infection	Potato Late Blight key
1	No attack
2	One or few spots in the field, largest spot < 1 m ²
3	One or few spots in the field, largest spot 1–5 m ²
4	One or few spots in the field, largest spot 5–25 m ²
5	One or few spots in the field, largest spot > 25 m ²
6	Attacks all over the field, severity 0.0–0.5%
7	Attacks all over the field, severity 0.6–1.0%
8	Attacks all over the field, severity 1.1–5.0%
9	Attacks all over the field, severity 5.1–10.0%
10	Attacks all over the field, severity 10.1–25.0%
11	Attacks all over the field, severity > 25%

Presentation of results on the Internet

The results are presented on a map of Poland in Web-blight (<http://www.web-blight.net>). Results for particular fields are shown as dots in three colours: green – field was inspected but late blight was not found, red – late blight was found, blue – late blight was found over 10 days ago. Each dot is linked with a small table that demonstrates basic information including a location name, cultivar name, date of crop emergence and field type.

RESULTS

The inspections arranged to be performed in 2003 were successfully carried out in four voivodeships: Dolnośląskie, Lubelskie, Małopolskie and Zachodniopomorskie. In these regions field monitoring was carried out in 27 potato fields in the period from May 16 till August 18. In these fields, 22 cultivars varying in a resistance level to late blight in a range from 2 to 8 (9-grade scale) were cultivated. The initial observations, also performed in Łódzkie and Wielkopolskie voivodeships, had been cancelled due to technical problems with transferring data to the Danish server.

The appearance of late blight was first recorded on May 23. Disease symptoms were found at Biskupice (Łódzkie voivodeship) in potato crop cultivated under a cover. The long lasting drought was unfavourable for late blight occurrence. In addition, the time of disease appearance var-

ied significantly (approximately 1.5–2 months earlier in southern Poland). At some locations the late blight did not appear at all. The first symptoms of late blight in production fields were found on June 11 on early and susceptible cv. Ruta in Uniejowice (Dolnośląskie voivodeship). The latest appearance (July 30) was recorded in Zachodniopomorskie voivodeship – see Table 2.

The earliest infections of late blight in potato crops in 2003

Table 2

Voivodeship	Cultivar	Maturity	Resistance ^A	Date of crop emergence	Date of late blight appearance	Plant growth stage ^B
Dolnośląskie	Ruta	very early	B1	12.05.	11.06.	30
Lubelskie	Irga	mid early	B1	13.05.	03.07.	69
Małopolskie	Mila	mid early	B2	20.05.	18.06.	31
Zachodniopomorskie	Bard	very early	B1	26.05.	30.07.	70

^A Resistance to late blight: B1 = 1–3 in 9–grade scale.; B2 – 4–5 in 9–grade scale

^B Growth stages were assessed according to the BBCH scale

The collected results were uploaded to the Web–blight. The data showing the late blight occurrence in Poland in 2003 are presented in Fig. 2. The basic information for each field, cultivar and recording is available in an additional table. In this table the data can be sorted ascending and descending for analyses and evaluation.

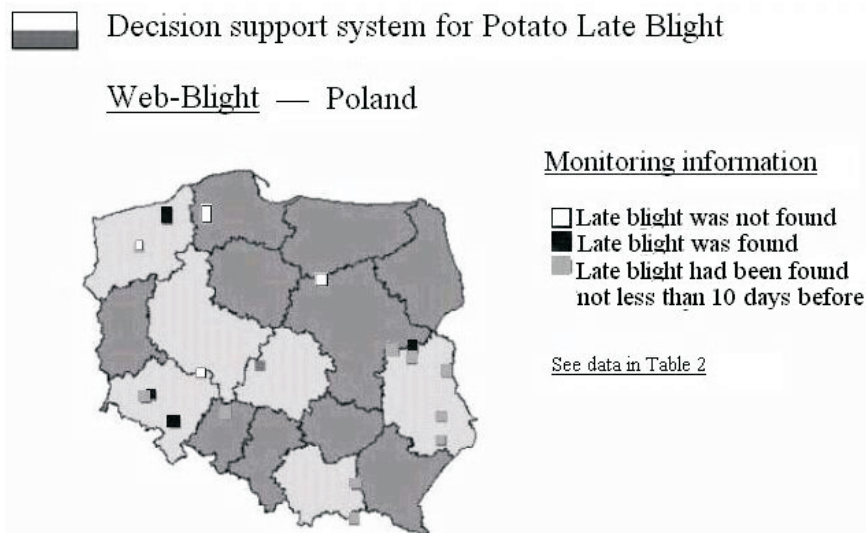


Fig. 2. Web–blight out for monitoring in Poland, 2003 – map of Poland with dots indicating where late blight was found on 4.07.2003 (example)

The monitoring conducted in potato crops in four voivodeships revealed that the earliest infection was recorded at the phase when plants growing in the neighbouring rows met (BBCH > 37), but most frequently at BBCH 59–69 (59 – first flower petals of first inflorescence visible; 69 – end of flowering in the first inflorescence). In the growing season 2003, two cases of late blight infection at a very early growth stage were recorded: on cv. Ruta in Dolnośląskie voivodeship (BBCH – 30) and on cv. Mila in Małopolskie voivodeship (BBCH – 31). It is possible that infection was caused by soil-borne oospores but no additional investigations to elucidate its origin were carried out. The monitoring performed in 27 fields did not reveal any infection in resistant cv. Bzura (resistance rating 8) nor in early cv. Drop (early harvest). The primary infections were diagnosed in 20 fields as “one or few spots in the field, the largest spot < 1 m²”. However, in some cases, no single spots were recorded but, instead, the plants were found infected at a higher rate, or the field had become infected completely.

Apart from the fields monitored in the years 2001–2003, also adjacent fields in which potato cultivars differing in resistance to late blight were grown, were surveyed. In the years 2001–2002, the late blight was mostly recorded first on susceptible cultivars and then on resistant ones (75%). In 2003 it referred to 100% of cases (Table 3).

Table 3
Level of late blight attack at time of first recorded infections on examined fields

Year	Number of fields	Percentage of fields with records of primary attack of late blight ^A			Percentage of fields entirely infested by late blight ^A			
		< 1 m ²	1–5 m ²	5–25 m ²	0–1%	1.1–5%	5.1–10%	10.1–25%
2001	32	50.0	15.6	6.3	18.7	6.3	3.1	0
2002	25	64.0	12.0	12.0	8.0	4.0	0	0
2003	25	84.0	12.0	4.0	0	0	0	0

^A Infection severity according to scale described in Table 1

DISCUSSION

In the recent years early appearance of diseases, especially of late blight, in potato crops has been observed. The occurrence of *P. infestans* on potato plants at their early growth stages indicates a possibility of existence of other infection sources, such as infected seed tubers or volunteer plants, and their increasing role in the disease epidemiology. Oospores are also believed to give earlier starts of epidemics (Andersson *et al.* 1998, Flier and Turkensteen 1999, Hermansen *et al.* 2000).

In cooperation with PH&SIS (previously the Plant Protection Inspectorate), analyses of occurrence and late blight severity have been conducted for many years in Bonin. Results of evaluation were collected throughout the country by means of inspections carried out by PH&SIS. It has been determined based on the analyses of results that under Pol-

ish climatic conditions the late blight occurs most frequently at the end of June or at the beginning of July. However, in 2002, in many regions the disease symptoms were found earlier. In the Wielkopolskie, Łódzkie and Śląskie voivodeships the first infections were recorded as early as May (on 21, 26 and 27, respectively) (Kapsa and Gawińska–Urbanowicz 2004).

The observations carried out in 2003 as part of the Internet monitoring system showed that some weather conditions, especially long lasting drought, were unfavourable for late blight. In some potato crops late blight appeared at the beginning of June, but these fields were located in southern voivodeships (Dolnośląskie, Małopolskie). In northern parts of Poland late blight was discovered unusually late i.e. at the end of July or the beginning of August.

Implementation and development of commonly accessible Internet monitoring system of late blight occurrence in potato crops makes possible to evaluate current health status of potato plants as well as to control late blight attacks in many regions. The system also allows to investigate consequences of changes in the disease epidemiology and to suggest on putative causes of early attacks, which can result in improving the forecasting system. In the countries with developed monitoring system, like Denmark, Latvia, Norway and Sweden, inspection of potato fields (production fields, experimental plots, home gardens, ecological cultivation) is conducted by advisers from extension services. Questionable cases are elucidated by specialists from agricultural research institutes.

In Poland, the system of late blight monitoring, nationwide accessible in the Internet, has been developed gradually in the recent years. In the initial survey carried out in Lubelskie voivodeship the primary and earliest infection of potato plants by late blight was found when the plants met between rows (BBCH > 37). This could suggest a small possibility of infection from soil. In contrast, in the growing season 2003, two cases of infection at very early growth stage were reported: on cv. Ruta in Dolnośląskie voivodeship (BBCH – 30) and on cv. Mila in Małopolskie voivodeship (BBCH – 31). It cannot be excluded that these infections were soil-borne. In the region of Baltic (Scandinavian) countries reports have provided the information on a high incidence of mating type A2, presence of oospores on lower leaves and a very differentiated population of *P. infestans* (Andersson *et al.* 1998, Brurberg *et al.* 1999, Hermansen *et al.* 2000). Since late blight infection mostly appeared after the plants had met between rows (BBCH > 37), simplified recommendations to start with chemical treatment in this phase of plant growth seem to be still valid.

The results of late blight monitoring in selected fields in several voivodeships in 2003 showed that it is feasible to detect initial single necroses caused by *P. infestans*. In the years 2001–2002, the proportions of recognized primary infestations manifested as singular spots ranged from about 66% to 76% (Kapsa and Gawińska–Urbanowicz 2004). In

2003, singular necroses (grade 2 in a 11–grade scale) were detected in 86.4% of cases. The accuracy of estimates depended on the effect of weather conditions upon the speed of disease development on potato plants. Similar results were obtained in 2003 in the Baltic region. Early infections of late blight were identified in 67–90% of cases (Hansen *et al.* 2003).

The above observations on the occurrence of first symptoms of late blight enable to value the benefits coming from monitoring of late blight appearance in potato crops. They also help to recognize and solve technical problems that can be encountered at establishing the network system.

The next step in building up the Polish network will be monitoring of late blight in potato crops in the growing season 2004 in 7 or 8 chosen voivodeships.

ACKNOWLEDGEMENTS

The authors wish to thank all the people involved in the investigations reported in this paper.

REFERENCES

- Andersson B., Sandström M., Strömberg E. 1998. Indications of soil borne inoculum of *Phytophthora infestans*. *Potato Res.* 41: 305–310.
- Brurberg M.B., Hannukkala A., Hermansen A. 1999. Genetic variability of *Phytophthora infestans* in Norway and Finland as revealed by mating type and fingerprint probe RG57. *Mycol. Res.* 103: 1609–1615.
- Flier W.G., Turkensteen L.J. 1999. Foliar aggressiveness of *Phytophthora infestans* in three potato growing regions in the Netherlands. *Eur. J. Plant Pathol.* 105 (4): 381–388.
- Fry W.E., Goodwin S.B., Dyer A.T., Matuszak J.M., Drenth A., Tooley P.W., Sujkowski L.J., Ko Y.J., Cohen B.A., Spielman L.J., Deahl K.L., Inglis D.A., Sandlan K.P. 1993. Historical and recent migrations of *Phytophthora infestans* chronology, pathways and implications. *Plant Dis.* 77: 653–661.
- Hansen J.G., Lassen P. 2000. Monitoring of potato late blight caused by *Phytophthora infestans* (Mont.) de Bary (Pi-Monitoring ver 1.1.1. User Manual). Danish Institute of Agriculture Sciences, 24 p.
- Hansen J.G., Lassen P., Koppel M., Valskyte A., Turka I., Kapsa J. 2003. Web-blight – regional late blight monitoring and variety resistance information on Internet. *J. Plant Prot. Res.* Vol. 43, 3: 263–273.
- Hansen J.G., Lassen P., Röhrig M. 2001. Monitoring of potato late blight based on collaborative PC – and Internet applications. (In:) Proc. 5th workshop European network for development of an integrated control strategy of potato late blight, PAV Special Report 7. Munich, Germany, 6–10 September 2000: 39–54.
- Hermansen A., Hannukkala A., Nærstad R.H., Brurberg M.B. 2000. Variation in populations of *Phytophthora infestans* in Finland and Norway: mating type, metalaxyl resistance and virulence phenotype. *Plant Pathol.* 49, 1: 11–22.
- Kapsa J., Gawińska-Urbanowicz H. 2004. Możliwości monitorowania występowania pierwszych infekcji zarazy (*Phytophthora infestans*) w uprawach ziemniaka. *Biul. IHAR* 232 (in press).
- Kapsa J., Gawińska-Urbanowicz H., Gryka M., Krzyszczyk E. 2003. Monitorowanie zarazy (*Phytophthora infestans*) na plantacjach ziemniaka. (In:) Nasiennictwo i Ochrona Ziemniaka. Konferencja. Kołobrzeg, 24–25.04.2003. IHAR Radzików, ZNiOZ Bonin: 18–20.