PPO – SPECIAL REPORT NO 16 – 2014, 153-158

Changes in epidemiology and population structure of *P. infestans* in Finland 1847-2011

HANNUKKALA A.O.

MTT Agrifood Research Finland, Planta 31600 Jokioinen, Finland

SUMMARY

The history of potato late blight occurrence was studied from 1845 to 2011. The first blight epidemics were most probably reported in Finnish newspapers in 1847. Thereafter the disease has been regularly present causing severe epidemics few times per decade. The onset of blight until late 1980s was relatively stable, usually in August. Before 1980s, there were only very few years when late blight was present in July. In 1990s the outbreak of the disease rapidly came 4 to five weeks earlier and the epidemics nowadays start at the last week of June or the first week of July. The early starting epidemics have considerably increased the number of fungicide applications needed to control the disease. In the average 5 to 6 applications in conventional growing are currently the normal practice.

KEY WORDS

Phytophthora infestans, epidemiology, fungicides

INTRODUCTION

Potato late blight, caused by *Phytophthora infestans* (Mont.) de Bary, is one of the most destructive diseases of potato globally, including Finland (Fry 2008, Zadoks 2008). The disease is present in Finnish potato fields almost annually but severe crop failures have been relatively rare due to late onset of epidemics. The obvious change of aggressiveness of epidemics in late 1980s awoke interest to study the disease in more detail. Also new control strategies were needed to keep the late blight in control again.

The first indication of possible changes in the potato late blight population was the rapid selection of phenylamide resistant *P. infestans* strains at the beginning of the 1980s, soon after commercialisation of the group of phenylamide fungicides. The next indication of some serious change in potato late blight was the discovery of A2 mating types in potato fields in 1981 in Switzerland. A2 mating type had never before been reported in potato stands outside Mexico. Also the importance of oospores as a source was raised to discussions.

It is characteristic of *P. infestans* that prior to the 1980s the population outside Mexico was dominated by one clonal lineage, US-1. Thereafter populations have become more diverse, undergoing rapid seasonal changes. Moreover, in certain regions populations have become almost clonal, or consist of very few dominant clonal lineages. Particularly in northern Europe, current *P. infestans* populations consist of numerous unique or almost unique genotypes among which no obvious clonal lineages exist (Cooke *et al.*, 2011).

Potato late blight can be effectively controlled by several fungicides. However the public pressure to reduce use of agricultural chemicals has made development of integrated control strategies very important subject in potato late blight management. Also the risk of development of fungicide resistant strains of *P. infestans* has forced to target the fungicide applications more carefully than before.

The aim of this article is to summarise historical and recent migrations of *P. infestans* into Finland. The changes due to the migrations in disease epidemiology and phenotypic traits of the pathogen are emphasised. The article is based on Doctoral thesis in Plant Pathology defended in University of Helsinki May 4th 2012 (Hannukkala 2012). The opponent was Prof. William Fry from Cornell University, US.

MATERIALS AND METHODS

The history of late blight occurrence in Finland from 1845 to the 1980s is described based on newspaper articles (from 1845 to 1900) and scientific reports (from 1910 to 1982). The occurrence and severity of potato late blight from 1982 to 2011 is based on monitoring untreated plots of cv. "Bintje" in annual variety trials and untreated plots in fungicide efficacy trials at 6 to 9 Research Stations of MTT Agrifood Research Finland, and similar experiments at the Potato Research Institute. The effect of climatic factors on first late blight outbreaks was modelled for the period 1993–2002. From 1999 to 2002 aspects of suspected soil-borne epidemics were studied in detail. In total 4927 *P. infestans* isolates were collected from 1990 to 2010. Mating type (2703 isolates), R-gene virulence race (1100 isolates) and response to fungicides metalaxyl (3912 isolates) and propamocarb-HCl (2541 isolates) were determined. Haplotype based on mitochondrial DNA was determined for 154 isolates collected from 1992 to 2000. Development in fungicide use from 1953 to 2010 is described based on statistics for fungicide sales and the area devoted to potato growing in Finland.

RESULTS AND DISCUSSION

Leaf and tuber symptoms on potato most probably caused by the late blight pathogen were first described in eastern Finland in 1845. In 1847 and 1848 the disease was widespread, occurring in various parts of the country. During 1850s there were several extremely dry summers when the disease seemed to be absent (Figure 1).

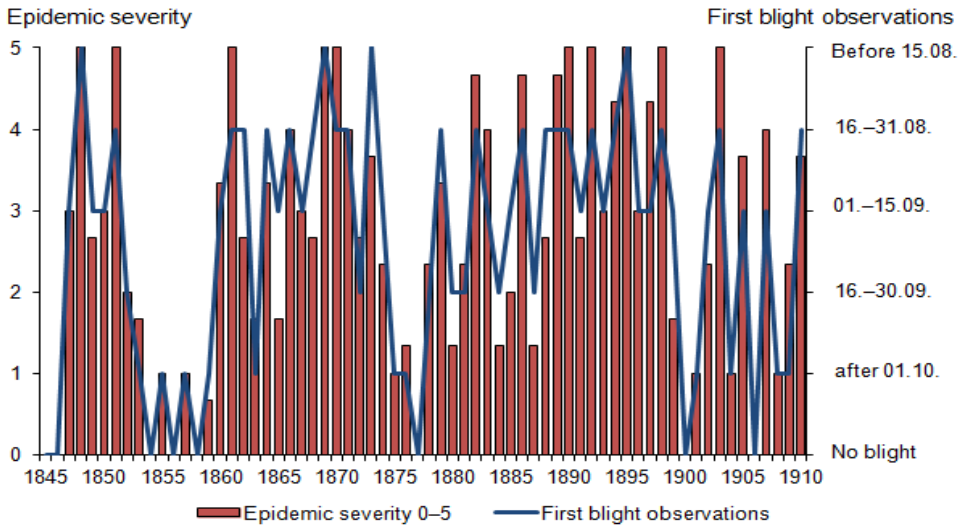

Figure 1. *Dates of first blightobservations and estimated severity of epidemics in Finland in 1845–1910*

From 1849 to the 1980s one to five severe late blight epidemics were reported per decade. During this period late blight usually appeared in the fields during the latter part of August or early September. From 1930s to late 1980s the onset of epidemics was relatively stable, usually at the latter half of August (Figure 2).

At the end of the 1990s there was a rapid shift towards early outbreaks of late blight and since then the first late blight outbreaks have been reported at the end of June or during the first week of July (Figure 3). The shift towards early epidemics coincided with the increase of A2 mating type of *P. infestans* in the Finnish late blight populations. This indicates that oospores as primary source of inoculum are involved. In Finnish table and starch potato production growers mostly have very short crop rotations or potato is grown in almost continuous monoculture. This enables accumulation of oospores into soil especially when many growers at the end of season often become somewhat careless with continuing fungicide applications. It is very typical that occasional late blight lesions are present in crop at the end of season.

The chemical blight control was very rare in Finland until second half of 1970s. Until 1990s the total potato acreage was theoretically sprayed less than once based on fungicide sales and area under potato cultivation. The control was fully based on dithiocarbamate products. Metalaxyl product as pre packed mixture with mancozeb was introduced to markets at the latter half of 1980s. At that time metalaxyl product was recommended to be applied only after numerous blight lesions had appeared to crop. Moreover no straight mancozeb product was applied after metalaxyl application. It was no wonder in light of current knowledge that in the beginning of 1990s the *P. infestans* population was fully resistant to metalaxyl in Finland.

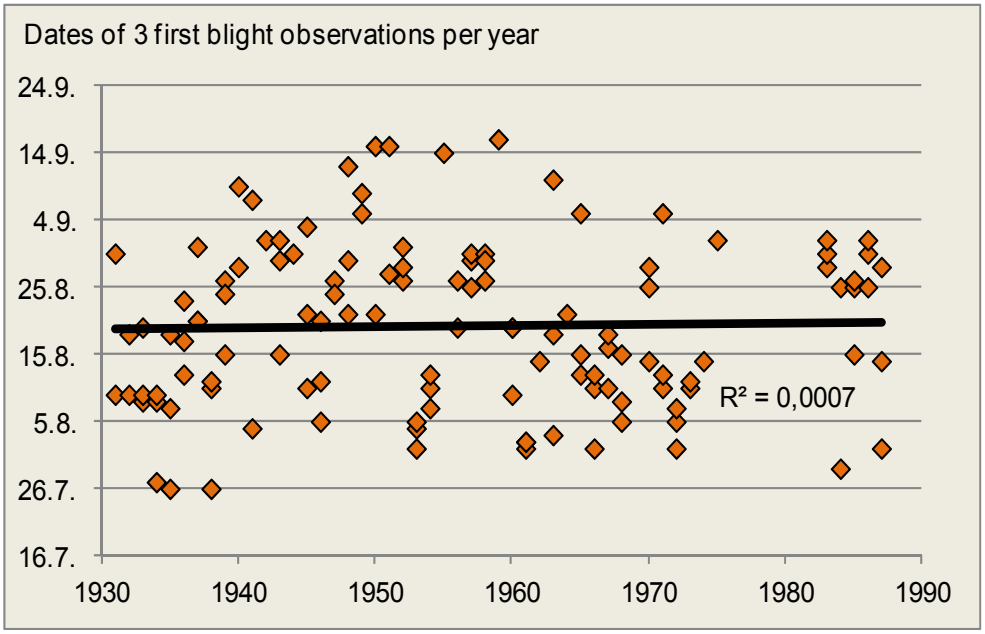

Figure 2. *Dates of first blight observations and in Finland in 1930–1983*

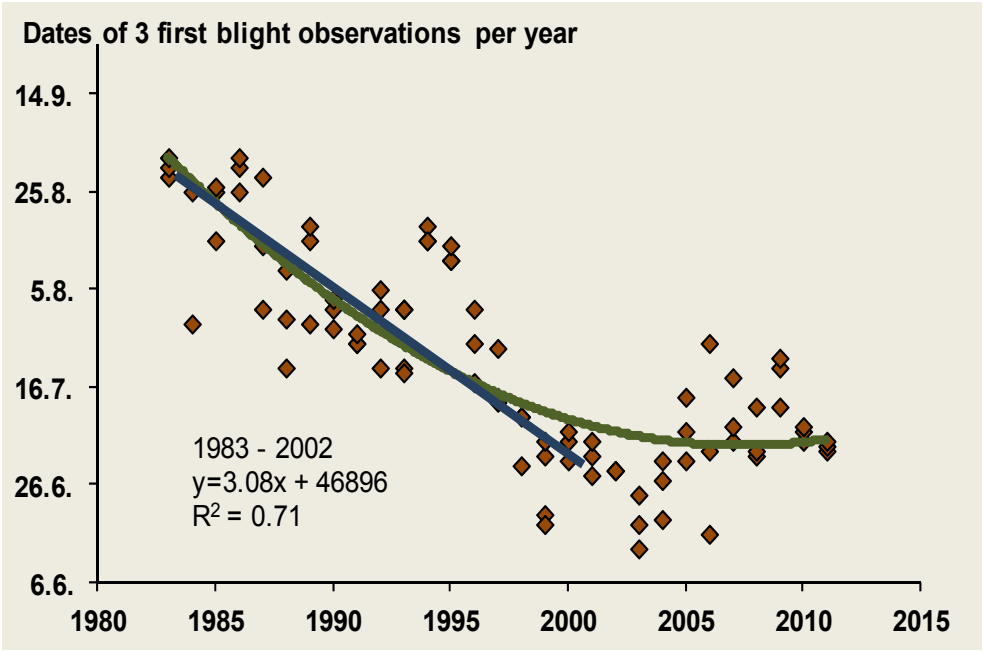

Figure 3. *Dates of first blight observations and in Finland in 1983–2011*

Strict anti-resistance strategies were introduced and followed in 1990s. Also novel fungicides with different modes of actions were registered. Until the end of 1990s the metalaxyl resistant strains had almost disappeared from the Finnish *P. infestans* populations.

Towards the end of 1990s it became obvious that the prevailing practice to start fungicide applications against late blight at the beginning of August was not valid any more. The rapid increase in the number of annual fungicide applications during 1990s (Figure 4) was simply due to the fact that most growers started their spray program in the beginning of July instead of August. Currently the theoretical number of annual blight fungicide applications is between 4 and 5 based on fungicide sales and acreage under potato cultivation.

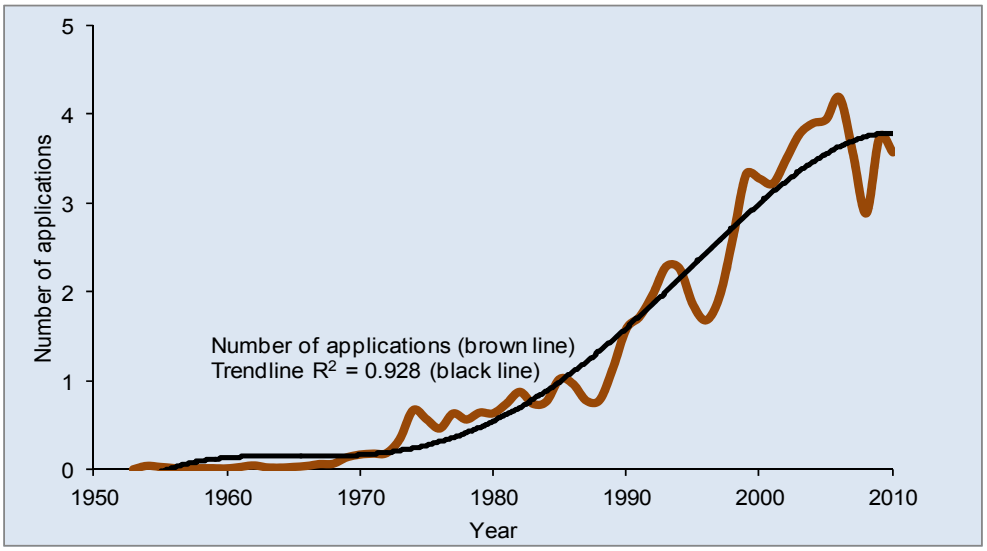

Figure 4. *Average number of sprays against potato late blight in Finland from 1953 to 2010*

In 1990s and especially during 2000s the number of different active ingredients registered for potato late blight control in pre-packed mixtures and straight products has increased considerably. It seems again that onset of potato late blight epidemics has stabilized to first week of July and growers have learned to live with the current sexually reproducing *P. infestans* population.

REFERENCES

Cooke, L.R., Schepers, H.T.A.M., Hermansen, A., Bain, R.A., Bradshaw, N.J., Ritchie, F., Shaw, D.S., Evenhuis, A. Kessel, G.J.T., Wander, J.G.N., Andersson, B., Hansen, J.G., Hannukkala, A., Nærsyad, R. & Nielsen, B., 2011. Epidemiology and integrated control of potato late blight in Europe. Potato Research 54: 183–222.

Fry, W.E., 2008. Plant diseases that changed the world. *Phytophthora infestans*: the plant (and R gene) destroyer. Molecular Plant Pathology 9: 385–402.

Hannukkala, Asko O., 2012. History and consequences of migrations, changes in epidemiology and population structure of potato late blight, *Phytophthora infestans*, in Finland from 1845 to 2011. MTT Science, MTT Science 18: 82 s. Diss. : Helsingin yliopisto, 2012. http://jukuri.mtt.fi/bitstream/handle/10024/438308/mtttiede18.pdf

Zadoks, J.C., 2008. The potato murrain on the European Continent and the Revolutions of 1848. Potato Research 51: 5–45.