INTERACTION BETWEEN SECONDARY INFECTION OF LATE BLIGHT AND YIELD QUALITY

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Abstract

Potato late blight caused by *Phytophthora infestans* (Mont) de Bary may occur and infect plants at any time during the growing season.

It is well known that potato tubers are the most important first sources of inoculum. Infection of tubers happens when sporangia or zoospores are washed from foliage through the soil to developing tubers. Secondary spread of late blight occurs when spores are produced on infected potato leaves. Spores from infected potato in neighboured fields or gardens can travel through the air.

Potato late blight field trials were carried out in 1999—2002 in Central, Eastern and Western parts of Latvia. The role of potato late blight secondary infection and yield quality in untreated and treated with fungicide fields was compared.

The first symptoms of late blight were observed approximately at the same time in the area and in the trial fields. The year 2001 was the most favourable for development of potato late blight. The disease severity at the end of season was 100% whereas only 1—19,6% in 1999 and 2002. Tuber infection at harvesting time varies 0—12,7% depending on the year.

Comparison of the disease development, tuber infection and yield between the years and between untreated and treated with fungicide fields showed significant differences.

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

Introduction

Potato plants in all stages of growth are susceptible to late blight caused by *Phytophthora infestans* (Mont) de Bary (Fry and Apple, 1986). Early infection of the crop can remarkably reduce the yield, but equally infection late in the season can be more destructive because of the increased risk of tuber blight.

Late blight survives from one season to the next season in infected tubers that are placed in storage or left in cull piles. Infected tubers sprout, spores are formed on the sprouts and are carried by wind or precipitation to healthy potato leaves (Andrivon, 1995).

When weather conditions are favourable, the fungus can spread rapidly through the foliage and is able to destroy potato plants in very short time. Late blight epidemic results from asexual reproduction of *P. infestans* in susceptible host tissue (foliage, stems and tubers) (Fry and Goodwin, 1997).

The asexual reproduction of the cycle involved the production of sporangia and the release and then germination of zoospores. Single sporangia or several sporangia often initiate potato late blight, each of which is able to produce leaf lesion. The lesion progress and new sporangia are formed in a few days after infection. The disease cycle (penetration, colonisation, sporulation and dispersal) can occur in less than five days (Harrison and Lowe, 1989). Development of potato late blight primarily depends on weather conditions. During the relatively warm summer with lot of precipitation the disease can be impossible to control. Other, more dry years, the disease can be completely absent. The optimum temperature for both the speed for formation of sporangia and their final quantity can vary from 16 to 22,5 °C (Harrison, 1995).

Aerial dispersal of *P. infestans* is the main process involved in spreading of late blight. Spores from infected potato in neighboured fields or gardens can travel through the air more than 100 kilometres (Mizubuti et al., 2000).

Sporangia produced in the foliage can be washed from leaves to infect the tubers. In the case of serious potato late blight attack in different countries, up to 25—50% of the harvest may be lost (Fry and Mizubuti, 1998; Turka, 1998). Some of the infected tubers may be destroyed before harvest, but other become diseased in storage (Fry and Goodwini, 1997). Soft rot of tubers can occur in storage following late blight tuber infection, in addition to the indirect losses from late blight.

The only way to protect the tubers is to keep the potato foliage free from late blight. Applying fungicides every year mainly does this. The fungicides used against *P. infestans* have a preventive effect and stop the pathogen from infecting the crop. Subsequent sprayings have to be done all through the growing season.

Materials and Methods

Potato late blight field trials were carried out in the growing seasons 1999—2002. The Latvia University of Agriculture Study and Training farm "Vecauce", Stende Plant Breeding and Experimental Station, Research Centre at Skriveri, Latvia State Plant Protection Service Units of Prognosis and Diagnostics at Priekuli, Saldus and Bauska and State Plant Protection Centre in Carnikava were involved in the monitoring of late blight.

Moderately susceptible variety 'Sante' was used in all experimental years, except in Carnikava (1999), when variety 'Asterix' was used. In the year 2002, Carnikava and Skriveri were not included in the experiment.

The role of potato late blight secondary infection on the yield quality in untreated and treated with fungicides fields were compared. Appearance of first symptoms, tuber infection and yield estimation was done during harvesting. Disease assessments during growing seasons were made in the years 2000, 2001 and 2002. Approximately one month after planting, every trial field was observed once a week but after row closing twice a week. ANOVA models were used to assess the effect of potato late blight severity and tuber blight and tuber yield.

Experimental design:

1. untreated control;
2. treated with fungicides — two first treatments with systemic fungicide and subsequent treatments with protective fungicide. First treatment was made during the row closing or according to prognosis when late blight was recorded in the region.

The weather conditions were different in growing seasons 1999—2002 (Fig. 1). The growing season 1999 was not favourable for disease development. The end of growing season 2000 was favourable but growing season 2001 was most favourable for development of late blight. The sum of temperatures and amount of precipitation were in optimum for disease development.

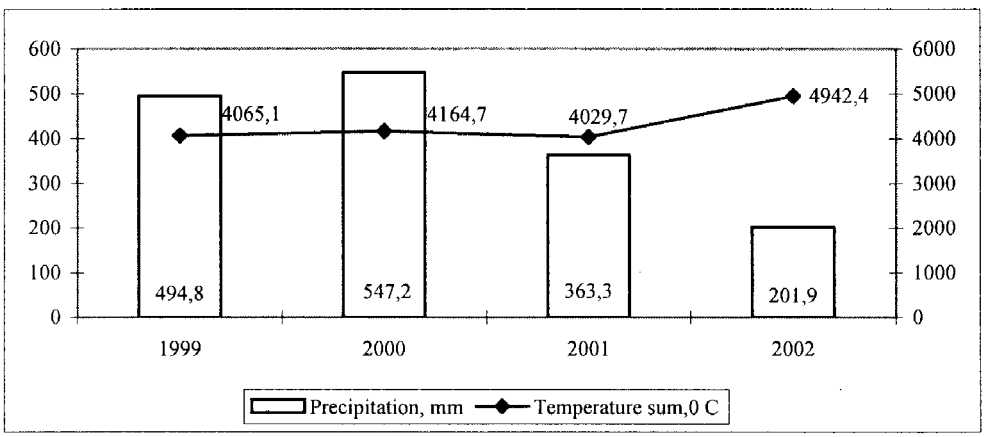


Fig. 1. Temperatures sum and amount of precipitation during growing season, 1999—2002

Whereas, the growing season 2002 was very hot and amounts of precipitation were less than other years. Development of potato late blight was decreased. August was dry and air temperature in some days exceeded 30 °C.

Results and Discussion

Secondary infection of late blight occurs when spores from infected potato leaves in neighboured fields or gardens can travel through the air. The home gardens are a major primary source of inoculum because here potatoes are growing in one place for a long period and certified seed material is not used. Interactions between secondary infection of late blight and yield quality depend on appearance of first symptoms and disease development.

The time of appearance of first symptoms of late blight was not very different between different places within in one year. Mostly, potato late blight spread in country within two weeks. In the years 1999 and 2001, the first symptoms were observed very early — 25th and 29th June and it was in Bauska. In others places in the year 1999 first symptoms appeared 7—28 days later, but in the year 2000 the first symptoms were observed approximately one month later. In 2001 and 2002, observation results of first symptoms were similar (except Bauska). Potato late blight symptoms were appearing at the same time in untreated and treated with fungicide fields (Table 1).

Similar tendencies were observed with disease development in different trial sites. The results from Vecauce were analysed for potato late blight development.

Disease development curves for untreated fields are shown in Fig. 2. The year 2001 was most favourable for disease development. After observation of first symptoms the disease developed very fast and at the end of July disease rating was 94%. In 2000, potato late blight development started at the second half of the growing season. In 2002, the situation was similar.

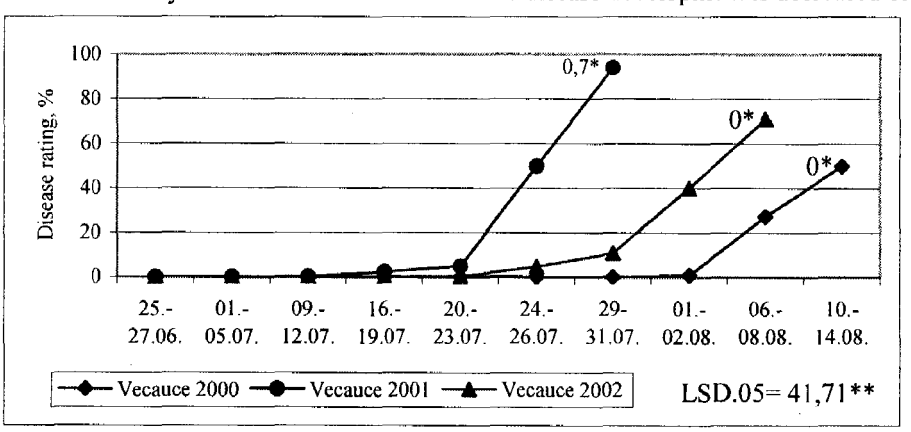
Disease development curves for treated with fungicides fields are shown in Fig. 3. Usage of fungicides was not effective for control of potato late blight in 2001, and disease rating at the end of the season was 83,5%. Whereas in 2000 and 2002, the disease ratings were 0,1 and 2,0%, respectively.

Table 1

Appearance of first symptoms and tuber infection in untreated and treated with fungicides fields, 1999—2002

Location	Appearance of first symptoms	Tuber infection, % at harvesting time	
		Untreated	Treated with fungicide
1999			
Vecauce	05.07.	0	0
Stende	16.07.	0	0
Skriveri	19.07.	0	0
Priekuli	19.07.	0	0
Saldus	27.07.	0,1	0
Bauska	29.06.	0	0
Carnikava	17.07.	0	0
2000			
Vecauce	31.07.	0	0,8
Stende	24.07.	3	2,6
Skriveri	24.07.	0,1	0
Priekuli	21.07.	5,7	4
Saldus	24.07.	1,1	2
Bauska	21.07.	1,1	0,1
Carnikava	19.07.	1,5	0,5
2001			
Vecauce	10.07.	0,7	0,3
Stende	02.07.	5,4	2,1
Skriveri	17.07.	0	0,1
Priekuli	28.07.	3,5	0,5
Saldus	17.07.	7,3	3,7
Bauska	25.06.	4,3	2
Carnikava	10.07.	12,7	14,5
2002			
Vecauce	12.07.	0	0
Stende	14.07.	0	0
Skriveri	–	–	–
Priekuli	02.07.	0	0
Saldus	02.07.	0	0
Bauska	31.07.	0,1	0
Carnikava	–	–	–
LSD		3,45	

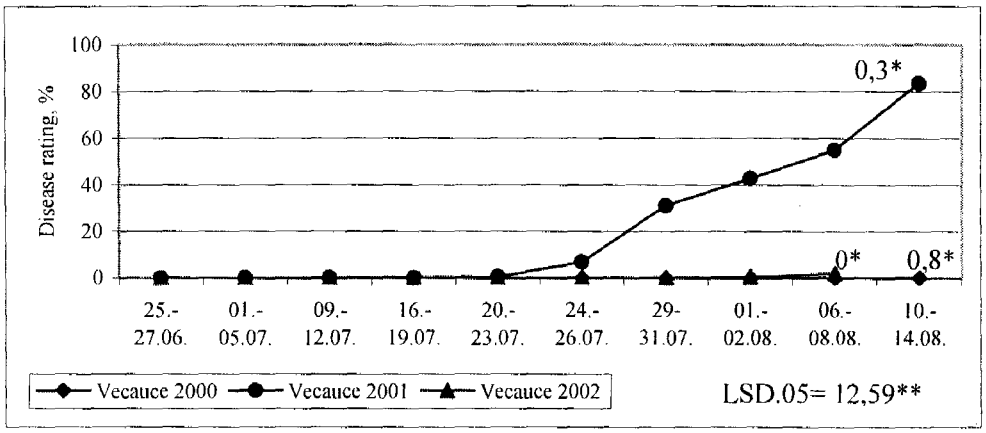
However, tuber infection not always depends on disease rating. In 2001, disease rating was high and tuber infection was 0,8% in untreated variant and 0,3% in treated with fungicides variant. But in the years 2000 and 2002, although disease rating was 50% and 71%, in untreated fields tuber infection was 0%. It could be explained by comparatively late appearance of first symptoms and disease progress. The potato foliage is nearly destroyed and if weather conditions are hot and dry the infection cannot occur. The disease development is decreased or stopped.



* tuber infection at harvesting time, %

** LSD for final disease rating

Fig. 2. Development of potato late blight in untreated fields in Vecauce, 2000—2002



* tuber infection at harvesting time, %
** LSD for final disease rating

Fig. 3. Development of potato late blight in treated with fungicides fields in Vecauce, 2000—2002

Situation was different in the variant treated with fungicides in the year 2000. The disease rating was low but tuber infection level was 0,8%. In this situation, disease level was constant for a long period and that affected the level of tuber infection, because on infected potato foliage *P. infestans* spores were present.

Development of potato late blight in the growing season has shown remarkable influence on the tuber quality and on tuber yield as well.

The total yields are given in Figures 4 and 5. Average lowest yield was obtained in the year 2001 if we compare different growing seasons. The yield was 25—65% less than in other growing seasons.

To compare untreated and treated with fungicides fields there were significant differences between locations and years. Usage of fungicides gave a 8—28% increase of yield in unfavourable year for development of potato late blight and 18—23% in favourable for development of late blight year.

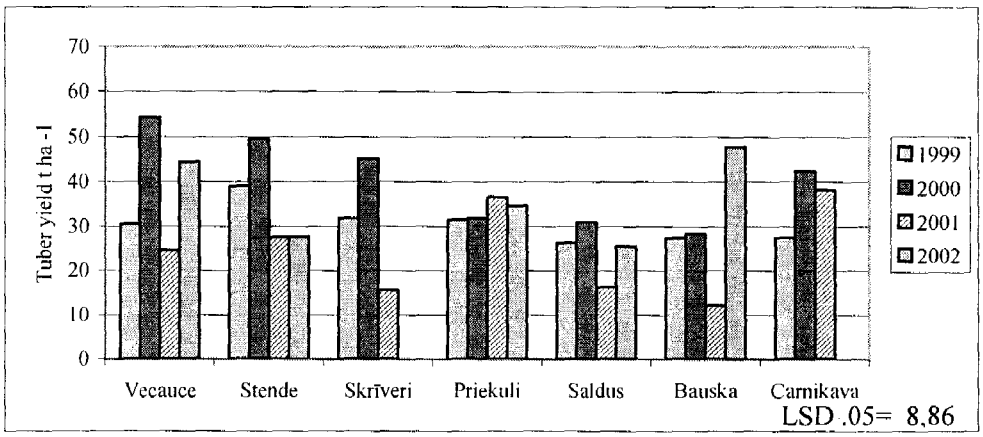


Fig. 4. Tuber yield in untreated fields, 1999—2002

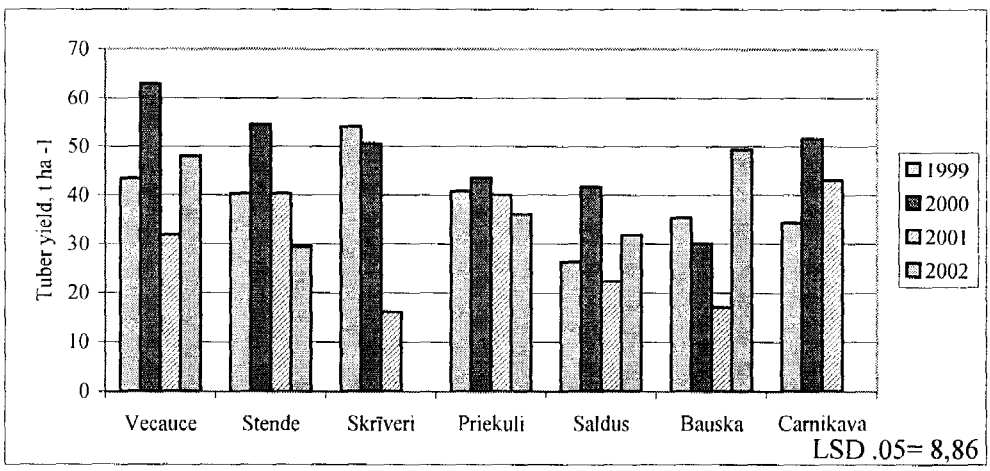


Fig. 5. Tuber yield in treated with fungicides fields, 1999—2002

Although potato late blight is observed every year, the relationships between yield and yield loss by *P. infestans* and weather conditions are still unclear. The biology of *P. infestans* has changed during recent years and the role of sexual reproduction cannot be excluded.

The monitoring of potato late blight may promote disease control, and monitoring information is an important component in all potato late blight forecasting system. This information about an earlier potato late blight appearance in neighbouring regions or countries is used to forecast its earlier appearance also in this country.

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