

THE DEVELOPMENT OF *ALTERNARIA SOLANI* SOR. ON POTATOES CULTIVATED IN MONOCULTURE

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Abstract

The purpose of the research was to determine the intensity of the development of early blight of potatoes (*Alternaria solani* Sor.) in different weather conditions and its influence on the yield formation of potatoes cultivated in monoculture over the years 2005–2007. The development of *A. solani* with 10 days interval was assessed in field trials on the variety 'Saturna' cultivated for industrial purposes. The intensity of potato early blight was affected by the weather conditions. The highest severity was observed under elevated air temperature and sufficient moisture in July, the lowest – under conditions of a long dry period. The increase of severity on leaves from 13.1% at the beginning of August in the first year of cultivation to 22.6% in the third year was observed that confirmed also a dependence of disease intensity on accumulation of infection in soil by monoculture. The disease causes a relatively moderate reduction of yield. The loss of yield associated with intensity of early blight on potato leaves during the active formation of tubers was described by the relationships: $y = -0.5398x + 26.187$ ($R^2 = 0.25$) or $y = -0.4268x + 17.197$ ($R^2 = 0.22$), the regressions were statistically significant ($P < 0.05$). The application of fungicides significantly limited the development of early blight on leaves and tubers of potatoes, but over all years of research just a moderate control of the disease was observed. The increase of damage of early blight over the last year was connected with insufficient activity of fungicides applied for the disease control on potatoes (mainly against *Phytophthora infestans*), thus indicating the possibility of another outbreak of the disease in the coming years.

Key words: potato, early blight, weather conditions, monoculture, yield loss, fungicides.

Introduction

The surveys of potato diseases showed that early blight caused by *Alternaria solani* is one of the major foliar diseases of potatoes, causing premature defoliation, and it is more severe in warmer than cooler environments /Rotem, 1998/. A heavy early infection can cause yield losses of 20–36% /ИВАНЮК, 1969/. Periodically *Alternaria solani* causes a severe incidence of early blight in potatoes in Nordic/Baltic region and the application of fungicides for the disease control is necessary /Salonen et al., 2001/.

In Latvia, the attack of early blight on potatoes differs very much by years, depending on both, the weather and agricultural conditions. In Latvia, over the recent years, growing of potatoes is concentrated on small farms. There are some difficulties to set up potato fields after a suitable previous crop within the rotation scheme. Potatoes for starch production are grown mainly in monoculture by a high nitrogen level. Therefore,

conditions are created for the accumulation of the primary inoculum of *Alternaria solani* in the soil, and low resistance of varieties to early blight under favourable environmental conditions can cause an important problem for potato cultivation.

This paper describes results of evaluations on development of early blight in potatoes planted in monoculture under different weather conditions and the derivation of equations relating the yield loss to disease during the growth period.

Materials and Methods

Trials were carried out on a commercial farm in Riga district on the field of starch potato variety 'Saturna' cultivated for industrial purposes in monoculture in the years 2005–2007. Treatments consisted of fungicidal sprays primarily to control *Phytophthora infestans* applied by a knapsack sprayer to plots of 25 m², which were randomly designed with four replicates. The early blight of potato (*Alternaria solani*) on 20 plants of each plot was evaluated with 10 days interval. The disease severities were recorded as the percentage of leaf area affected by symptoms of early blight. The total yield and the yield of marketable potato tubers were recorded within each plot.

The evaluations of the weather conditions in relation to occurrence of early blight in potato plantation were performed weekly during the vegetative season on the basis of data from HMS Skulte, Riga district. The data from field experiments were subjected to analysis of variance and the treatment means were separated at the 95% probability level using F-test with the program of variance analysis on system GenStat 9th Edition for Windows 2000. The data of assessment were pooled for analysis of the harmfulness of early blight for potato estimated by multiple regression of yield on levels of *Alternaria solani* during the vegetative season.

Results and Discussion

The occurrence evaluation of *Alternaria solani* in the trials showed that symptoms of the disease appeared at the end of June at GS 45–50 of potatoes in all years of investigation. At this time, the temperature regime is favourable for initial sporulation of *Alternaria solani*, which is within the 5–22.5° C /Bashi, Rotem, 1975/. A further intensity of early blight on potatoes depends on the meteorological conditions, mainly on lasting wet weather during the summer. The highest intensity of the disease was observed during elevated air temperatures and sufficient moisture after appearance of first symptoms on potatoes in June–July of 2007, when the air temperature was higher than the long-term parameters; frequent and heavy precipitation was recorded during this period (Table 1). Low intensity of the disease was observed in conditions of the long dry period in summer of 2006.

In the first year of cultivation after the previous cereal crop, in 2005, symptoms of early blight in potato plantings were observed at the beginning of July, at GS 50. During the course of the month, the level of infection in untreated plots increased up to 13.1% (Figure 1).

Table 1. Weather data divergence from the long-term average, 2005–2007

Month, ten-day period	Air temperature					Precipitation			
	Long-term °C	Divergence ±°C			Long-term mm	Divergence %			
		2005	2006	2007		2005	2006	2007	
June	I	13.3	- 1.3	- 2.4	+ 3.5	23.3	97.5	94.7	6.4
	II	14.7	- 0.1	+ 2.1	+ 1.0	26.1	45.2	8.0	57.5
	III	15.0	+ 0.5	+ 3.7	- 0.7	29.0	98.2	112.9	185.5
July	I	16.9	+ 1.5	+ 4.1	+ 0.6	29.8	35.2	20.0	291.3
	II	16.6	+ 3.3	+ 1.7	+ 0.6	31.7	138.1	3.0	57.7
	III	16.8	+ 0.7	+ 2.0	- 0.8	32.1	133.6	12.9	244.2
August	I	15.4	+ 2.0	+ 3.4	+ 2.2	30.0	419.2	112.6	21.0
	II	16.8	- 1.0	+ 1.7	+ 3.2	29.0	78.8	70.0	40.7
	III	16.3	+ 0.9	- 0.2	+ 1.0	27.0	113.5	93.8	191.1

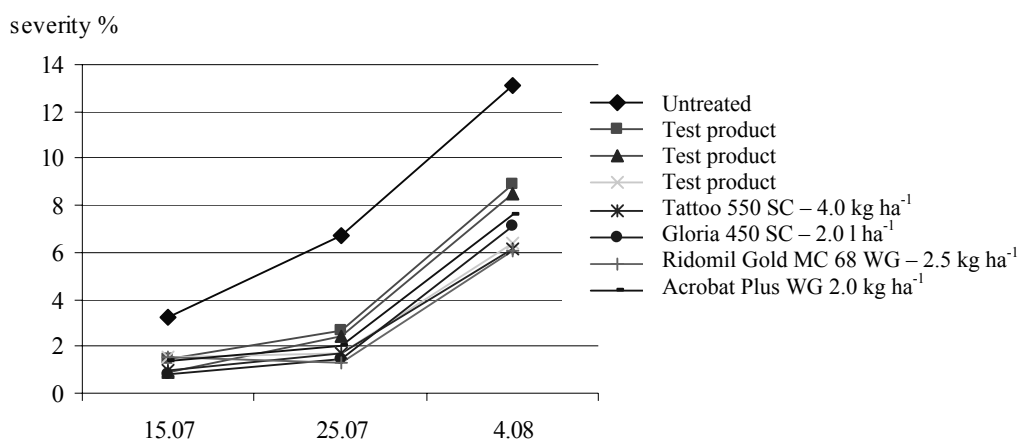


Figure 1. Development of *Alternaria solani* in field trial after three applications of fungicides in potatoes (2005)

Under the trial of 2005, all tested fungicides, which were applied to control of *Phytophthora infestans*, showed a moderate control of *Alternaria solani* after three applications with the interval of 10 days (Table 2). The aggregate effect of application of fungicides gave a significant yield increase in all treatments in comparison with the untreated material. The total yield of potatoes in the untreated plots was 26.52 t ha⁻¹, the yield of standard tubers was 19.51 t ha⁻¹ and the highest increase of yield by application of Gloria 450 SC (fenamidon 75, propamocarb 314.1 G L⁻¹) and Ridomil Gold MC 68 WG (mancoceb 64%, metalaxyl-M, 4%) was obtained (Figure 2).

Table 2. Efficacy of the fungicides for control of *Alternaria solani* in potato plantations (trial 2005)

Treatments, dosage l, kg ha ⁻¹ , time	<i>Alternaria solani</i> - in dynamics and efficacy of fungicides								
	15.07, GS 61			25.07, GS 69			04.08, GS 79		
	Spread %	Severity %	Efficacy %	Spr. %	Sev. %	Eff. %	Spr. %	Sev. %	Eff. %
Untreated	86.8	3.25	–	92.5	6.74	–	98.8	13.09	–
Tattoo 550 SC, 4.0 x 3	60.0	1.00	69.2	57.5	1.72	74.5	96.2	6.11	53.3
Gloria 450 SC, 2.0 x 3	50.0	0.80	75.4	63.8	1.46	78.3	97.5	7.13	45.5
Ridomil Gold MC 68, 2.5 x 3	66.2	1.55	52.3	47.5	1.27	81.2	90.0	6.10	53.4
Acrobat Plus WG, 2.0 x 3	65.0	1.40	56.9	72.5	2.02	70.0	96.2	7.61	41.9
LSD ₉₅	17.41	0.72	–	20.30	0.90	–	11.13	4.29	–

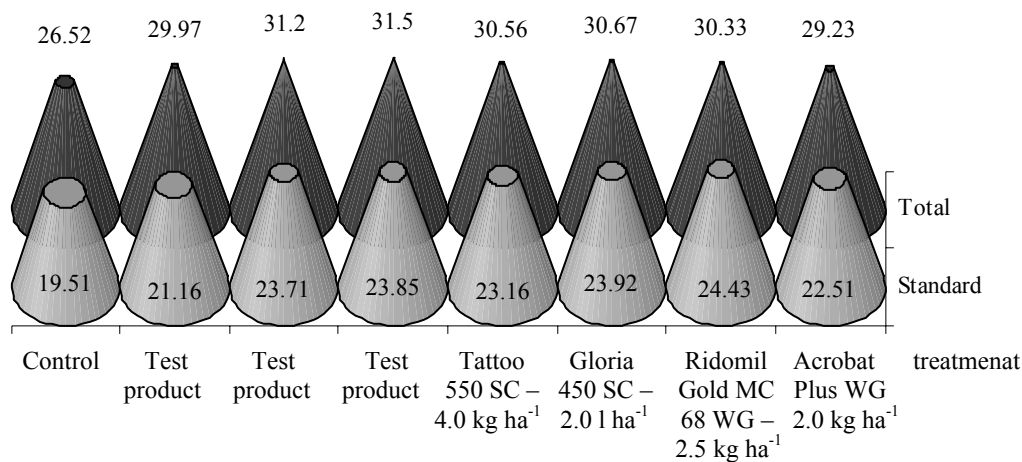


Figure 2. Yield of potato in field trial of 2005, t ha⁻¹

Meteorological conditions in the summer period of 2006 were unfavourable for infestation of *Alternaria solani* on potatoes in field trials. At the end of June, applying GS 50, the incidence of *Alternaria solani* was recorded on 12.0% of plants at severity level of 0.28%. A dry period during the next month was recorded reducing the level of infection with *Alternaria solani* and increasing the effect from fungicides' application against early blight.

Under the conditions of 2007, a severe infection of potato leaves with *Alternaria solani* was observed. Symptoms of the disease and sporulation of *Alternaria solani*

appeared at GS 45: incidence of *Alternaria solani* was recorded on 8.0% of plants at severity level of 0.04%. At the beginning of infection, two applications of fungicides with interval of 10 days gave a good effect on infestation of early blight in the trial: the application of the same products showed total control of *Alternaria solani* at the stage of full flowering of potato (Table 3). Meteorological conditions in the next period were favourable for a fast development and spread of *Alternaria solani* in potato plantation: over two weeks, the level of disease outbreak increased from 2.8 up to 20.6% in untreated plots (Figure 3). In this period, the application of fungicides showed a moderate control of early blight for all treatments (Table 3).

Table 3. Efficacy of fungicides for control of *Alternaria solani* in potato plantations (trial 2007)

Treatments, dosage, 1 ha ⁻¹	Severity of <i>Alternaria solani</i> in dynamics and efficacy of fungicides									
	29.06, GS 59–61		10.07, GS 63–65		20.07, GS 69–71		03.08, GS 75–79		13.08, GS 82	
	Sev. %	Eff. %	Sev. %	Eff. %	Sev. %	Eff. %	Sev. %	Eff. %	Sev. %	Eff. %
Test product	0.19	44.1	1.28	54.3	5.14	49.7	14.25	30.9	17.75	21.5
Test product	0.00	100	0.01	99.6	3.84	62.4	11.25	45.4	14.50	35.9
Test product	0.00	100	0.00	100	3.35	67.2	12.5	39.4	15.00	33.7
Test product	0.00	100	0.00	100	2.92	71.4	9.50	53.9	11.80	47.8
Tanos 50 WG, 0.6 x 5 times	0.00	100	0.01	99.6	4.66	54.4	11.25	45.4	17.25	20.5
Untreated	0.34	–	2.80	–	10.22	–	20.62	–	22.62	–
LSD ₉₅	0.30	–	0.64	–	2.16	–	2.92	–	5.90	–

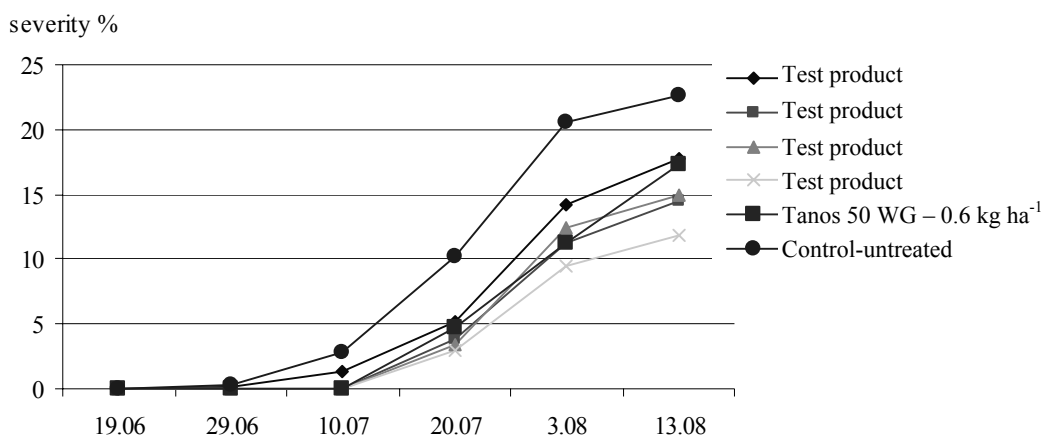


Figure 3. Development of *Alternaria solani* in field trial after five applications of fungicides in potatoes (2007)

The increase of severity of *Alternaria solani* on leaves at the time of tuber formation at the beginning of August from 13.1% in the first year of cultivation to 22.6% in the third year confirmed among other things, also a dependence of the disease intensity on the accumulation of infection in soil by monoculture. Investigations in Estonia showed that conidiophores of *Alternaria solani* may survive yearly in plant debris on the surface-soil and in depth 5–10 cm, where under favourable conditions in early spring conidia production for 0.8 thsd./cm² can be renewed /Кваснюк, 1986/. At Rotem J. (1998), at optimum temperatures, *Alternaria solani* may survive in the soil for over 10 years in debris. Therefore, cultivation of potatoes in monoculture can create the occurrence risk of new outbreak of the disease in the coming years. The increase of damages by early blight over the last year was related also to insufficient activity of fungicides applied for disease control (mainly against to *Phytophthora infestans*). The application of fungicides significantly limited the development of early blight on leaf and on tubers of potatoes, but over all years of research just a moderate control of the potato disease was observed.

Under the field trial conditions of 2005 and 2007, the disease caused a relatively moderate yet a significant reduction of yield. The damage of early blight is due to premature defoliation of the plants at the time of active formation of tubers exercising influence on the total yield of potatoes. The loss of yield associated with intensity of early blight on potato leaves during active formation of tubers could be described by the relationships: $y = -0.5398x + 26.187$ ($R^2 = 0.25$) (2005) or $y = -0.4268x + 17.197$ ($R^2 = 0.25$) (2007), the regressions were statistically significant ($P < 0.05$). According to the results of this study performed on the industrial variety 'Saturna', the early blight severity on leaf of 2.0–2.4% at the stage of active formation of tubers, in the end of July, caused the economical loss in the amount of 5% of the yield. The application of contact fungicides for the control of *Alternaria solani* under a severe disease attack conditions should be carried out at a shorter interval than they are usually applied against *Phytophthora infestans*. The increase of applications of the combined fungicides up to nine times against *Alternaria solani* showed good results under the conditions of epiphytotic development of the disease in Belarus /Иванюк и др., 2000/.

The infection level of *Alternaria solani* on potato tubers under trial conditions was not high: in the untreated plot, a month after potatoes were put in storage, 3.0–4.6% of tubers exhibited symptoms of the disease. Fungicides in all treatments gave a moderate control of tuber infection with *Alternaria solani* (46.4–66.7%), because the tuber infection associated with such factors as the harvest time, mechanical damage during harvesting and others, were clearly increased in further investigations.

Conclusions

1. In Latvia's climatic conditions, early blight of potatoes caused by *Alternaria solani* appeared every year, the occurrence and damage of the disease depended mainly on frequent rain and high moisture over the month after the appearance of the first symptoms of the disease. Cultivation of potatoes in monoculture for industrial purposes can provoke the risk of a new outbreak of the disease in the coming years.

According to the results of this study on 'Saturna', an industrial variety of potatoes, early blight severity on leaves of 2.0–2.4% at the stage of active forming of potato tubers caused 5% loss in the total yield.

2. The application of fungicides showed an insufficient activity on *Alternaria solani*.

The application of contact fungicides for the control of *Alternaria solani* under the conditions of severe attack of the disease should be done with a shorter interval than usual.

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REFERENCES

1. Bashi E., Rotem J. Sporulation of *Stemphylium botryosum* f. sp. *lycopersici* in tomatoes and of *Alternaria porri* f.sp.*solani* in potatoes under alternating wet-dry regimes // *Phytopathology*. – 1975, vol. 65, p. 532–535

2. Rotem J. The genus *Alternaria*: biology and pathogenicity. – St. Paul, Minnesota (USA): American Phytopathological Society Press, 1998. – 351 p.

3. Salonen J., Broman B., Nistrup Jørgensen L. Crop production in the Northern European Region with a special reference to crop protection. – Flakkebjerg, 2001. – 124 p.

4. Иванюк В. Г. Биологические особенности возбудителей ранней сухой пятнистости картофеля и некоторые меры борьбы с болезнью в условиях Белоруссии. Автореферат канд. дис. – Минск, 1969. – 27 с.

5. Иванюк В. Г., Брукиш Д. А., Ягнешко Д. И. Роль фунгицидов и кратности их применения в профилактике эпифитотий альтернариоза картофеля // *Защита растений*. Минск. – 2000, 24, с. 122–133

6. Кваснюк Н. Я. Влияние экологических факторов на перезимовку *Alternaria solani* (Ell. Et. Mart.) Sor. // *Микология и фитопатология*. – 1986, 20, 1, с. 60–63