EVALUATION OF FOLIAR RESISTANCE TO *PHYTOPHTHORA INFESTANS* IN SOME POTATO VARIETIES AND CLONES IN NIRDPSB BRASOV

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INTRODUCTION

Late blight caused by *Phytophthora infestans* is one of the most devastating diseases of potato. Growers controll the disease using a lot of fungicides, spraying between 8-16 times during the season (Schepers and Spits, 2006). To control late blight succesfully is important to abord a strategy that include new fungicides from the market and the level of resistance of involved varieties. Potato cultivar resistance to late blight plays a key role in the control of the disease.

There are two know resistance types: vertical and horizontal. The vertical resistance is race-specific, since it is related to dominant genes (R genes) which present in wild *Solanum* species (mainly *S. demissum* and *S. stoloniferum*) used by breeders in crossings (Kuznetsova et al., 2013). Field resistance or horizontal resistance (van der Plank, 1963) operates equally upon all pathogen races giving to the plant an incomplete, but permanent protection against disease, compared to vertical resistance, whose effects are not permanent, it can be canceled to compatible races.

Because of the virulent races the breeders use another type of resistance named horizontal or field resistance (Turkesteen, 1993; Colon et al., 1995).

This type of resistance control the development of the disease and das not suppress it completely. This type of resistance is polygenic and has a more stable and prolonged effect, than the race-specific resistance. In the case of field late blight resistance the effects are cumulative, a good variety is replaced by a better (superior) variety and field resistance to blight allow uniformity, which mean essential requirement of productivity.

Aims: Evaluate foliar resistance of the potato clones and varieties to find the most resistant to the late blight and thereby diminish the number of fungicide sprays required. Based on field information more resistant and suitable potato varieties could be recommended.

MATERIALS AND METHODS

Field trials were carried out at NIRDPSB Brasov. The soil type was clay loam and was used fertilizer NPK 700 kg/ha. In 2011 were cultivated 11 and in 2013 18 varieties and breeding lines. Planted were done manual in 6th May, respectively 25th April 2013 in variants of 5 rows with 10 plants per row separate by one row of Bintje, planted as infector. Planting distance was 75 cm between rows and 30 cm between plants per row. Planting was done manually. During the vegetation were applied the usual maintenance

works, including 2 treatments for Colorado beetle unless late blight control with fungicides.

Observations were performed from the beginning of July to the end of August once in 7-10 days. The disease development on foliage was assessed as percentage of foliage area damaged by *Phytophthora* infection.

The assessment is from the international literature using a key on whole plant (Malcolmson, 1976). It assess the overall amount of necrotic tissue per plant on a scale from 1 (highly susceptible) to 9 (highly resistant). Has not been interfered with artificial *Phytophthora infestans* inoculum sprayers, using only the natural pressure of infection.

Table 1

Scale for resistance against foliar blight

Score for resistance	Grade
1	Very low
2	Very low to low
3	Low
4	Low to medium
5	Medium
6	Medium to high
7	High
8	High to very high
9	Very high

RESULTS AND DISSCUSION

Late blight incidence depends on environmental conditions. In the two years tacking into study late blight appeared relatively early due to favourable climatic conditions.The data from 2012 couldn't be used because from the middle of June the drought has been installed. Drought has sdeepened with the emtremely hot days and without rainfall in July. In July very high temperatures surpassed nearly 5°C the multiannual average was combinated with almost total lack of rainfall reaching only 27.2% rainfall characteristic of the area.

In 2011 date of occurrence of the disease was 21st June the date up to which the volume of rainfall amounted to 56.6 mm and the humidity was 74%. From July to the end of the potato growing season rainfall was increasingly reduced, represented only 53.5-39.2% from the multiannual average.

The key factor of late blight is rainfall, because rainfall can change humidity directly. The temperature didn't influence major late blight during the growing season. A temperature average in both yeares between 16.7-20.4°C is suitable for epidemic. In 2013 first blight spots showed up in the same day as last year, 21st June when the volume of rainfall amounted to 53.8 mm and the humidity was 75%.

Alternating rainy periods with no rain and high temperatures caused the lush growth of the foliage. Also June rains accompanied by relatively high temperatures conducted to the presence of late blight in the second part of the month.

In 2011 most varieties presented blight symptoms in the last decade of June with more intensive development after heavy rainfall on 30 June. However infection rate remained low until the end of the season. The infection was low during the rapid growing

phase of the crop because the weather factor was not suitable for late blight, in August the rainfall was only 35.2 and relative humidity 70.1.

Table 2

Main meteorological factors June-August 2011 and 2013

Year	Month	Precipitation mm/m^2				Relative humidity mm/m^2				Temperature			
		DI	DII	DIII	Average	DI	DII	DIII	Average	DI	DII	DIII	Average
2013	June	40,6	13,2	45,0	**98,8**	80,9	77,7	78,9	**79,2**	14,8	19,7	19,1	**17,9**
	July	23,8	2,8	3,6	**30,2**	74,2	69,3	61,4	**68,3**	18,4	18,2	24,6	**20,4**
	August	6,0	22,2	48,0	**76,2**	57,4	70,6	79,9	**69,3**	22,9	20,2	17,7	**20,3**
2011	June	21,0	35,6	54,0	**110,6**	72,1	84,8	75,3	**77,4**	18,4	15,8	16,0	**16,7**
	July	7,2	21,8	24,8	**53,8**	72,1	73,1	73,5	**72,9**	18,0	22,0	18,6	**19,5**
	August	8,2	27,0	0,0	**35,2**	73,4	79,5	57,5	**70,1**	18,9	18,4	17,2	**18,2**

In both years the temperature average was between 16.7 and 20.4 suitable for late blight epidemic. The temperature was not dominant to influence late blight during the growing seson and dose not change the epidemic potential if is not accompanied by rainfall and high relative humidity. In 2013 June rains accompanied by high temperatures have led to a sporulation phase of late blight in early July, with a beginning of difference plots. Rain fallen on July 11th has contributed to maintaining a favorable environment for fungus development, observing blight in nearly all plots.

Table 3

Behaviour of varieties to *Phytophthora* 2011

No.	Clone/ variety	Score for resistance	Grade	Healthy tubers (no.)/10mp	% tubers with blight*	Yield t/ha
		2011				
1	Riviera	2	Very low to low	332	2.56	16.46
2	Sante	5	Medium	312	0	20.36
3	Christian	5	Medium	248	0.99	27.56
4	1557/1	5	Medium	234	0.78	21.22
5	1523/1	5	Medium	279	0.42	21.66
6	1605/2	7	High	235	0	18.80
7	1525/2	6	Medium to high	270	0.40	22.48
8	1525/3	6	Medium to high	438	0	23.47
9	1557/3	7	High	409	0	25.11
10	1605/1	6	Medium to high	356	0.61	22.62
11	1525/5	6	Medium to high	251	0	20.22

* Watched the percentage of blighted tubers relative to the total number of analysed tubers from each clone/variety, using the formula % tb = Ntb/Ntt*100

In 2011 most of clones present a medium resistance, 1605/2 and 1525/5 present a high resistance and variety Riviera a low to very low resistance. For Riviera is a normal grade being a early variety which in field conditions not resist wihtout treatments. Varieties Sante and Christian present a medium resistance, higher that in the literature due to the climatic conditions.

Also the procent of blighted tubers to all varieties and clones was low. Riviera present 2.56%, Christian 0.99 and some clones between 0.78 to 0.40. There were clones without blighted tubers.

Table 4

Behaviour of varieties to *Phytophthora* 2013

No.	Clone/ variety	Score for resistance	Grade	Healthy tubers (no.)/10 mp	% tubers with blight*	Yield t/ha
		2013				
1	Riviera	1	Very low	276	13.77	9,10
2	Sante	3	Low	306	0	8,69
3	Christian	4	Low to medium	182	0	31,81
4	13-1624-8	5	Medium	270	2.60	11,09
5	13-1541-15	5	Medium	253	2.77	26,13
6	13-1623-6	9	Very high	296	2.03	25,31
7	13-1527-2	2	Very low to low	439	1.35	21,44
8	13-1644-13	6	Medium to high	272	1.47	17,93
9	13-1629-18	2	Very low to low	332	0.30	18,18
10	13-1642-2	2	Very low to low	297	1.68	11,50
11	13-1623-5	9	Very high	334	0.30	12,48
12	13-1577-10	2	Very low to low	208	1.44	20,88
13	13-1622-3	9	Very high	237	0.84	28,36
14	13-1623-10B	9	Very high	300	0.67	27,63
15	13-1630-8	5	Medium	258	1.94	23,75
16	13-1642-16	5	Medium	225	0	15,58
17	13-1630-13	2	Very low to low	268	1.87	21,75
18	13-1623-6B	9	Very high	240	0	17,47

* Watched the percentage of blighted tubers relative to the total number of analysed tubers from each clone/variety, using the formula % tb = Ntb/Ntt*100

In conditions of 2013, very favorable for the disease, the varieties Riviera, Sante and Christian proved a low resistance to blight on foliage. It is important to say that in literature Riviera is quoted as susceptible, Sante and Christian as fairly susceptible. In return there were some clones with very high resistance (13-1623-6, 13-1623-5, 13-1622-3, 13-1623-10B, 13-1623-6B), what proves that the selection process is decisive improvement for the creation of new competitive varieties

In 2013 significantly more tuber blight was found in the highly susceptible variety Riviera. Varieties Sante and Christian didn't present tuber with blight and the different clones had a procent beween 2.77-0.30, what is a normality in a year with epidemic level of the disease.

It should be noted that tubers resistance, respective blighted tubers frequency, is not in accordance with foliage resistance. Frequency of attacked tubers is in direct linkage with the lenght of period in which the fungus sporulate. So, a variety with high resistance on foliage is possible to have more blighted tubers than a sensitive variety whose foliage is destroyed very quickly

Yield depends on repeatability and frequency of treatments because the majority of varieties are fairly susceptible and susceptible to late blight.

CONCLUSION

Based on two years observation data can concluded that most potato clones were susceptible to late blight. Breed varieties resistant to late blight and optimal strategy for the use of fungicides represents the common desire of researchers and farmers. Futher experiements are needed to find potato varieties and clones resistant to late blight in order to minimise the need for fungicide spraying.

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