RESPONSES OF DIFFERENT POTATO LATE BLIGHT CONTROL TECHNOLOGHIES TO THE USE OF NONINVASIVE METHODS

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Abstract

The present study was conducted to investigate potato late blight influence on leaf chlorophyll level. Field experiments were carried out in the years 2014-2016 to the National Institute of Research and Development for Potato and Sugar Beet – Brasov, Romania. It was used a complet randomized block design with four replicates, two planting distance between plants on row and different fungicides.

At measurements in early July in 2014 and 2016, the varieties had close SPAD values (SPAD 39.5 and 40.1 for Roclas variety, SPAD 41.9 and 37.5 for Christian variety), which were lower at all varieties compared to the values measured in 2015, at which the SPAD average values were 47.8 at Riviera, 48.0 at Roclas and 49.4 at Christian.

In 2014, following the measurements made to Roclas and Christian varieties, there was a close correlation between the SPAD values and the number (0,752 *), respectively the weight of the tubers at nest (0,882 **), while the correlation was negative between the SPAD values and the weight of the aerial part of plants (-0,722) *. In this year correlations between SPAD average values, total yield and commercial one were insignificant. The only year of the experimental cycle in which SPAD average values from variants correlated significantly was 2016, the year leading to the highest SPAD correlation coefficients - totalyield (0,706 *) and SPAD - commercial yield (0,656 *)

Key words: potato, late blight, fungicides, SPAD, nonivasive methods

In the last years there have been a lot of changes in both *Phytophthora infestas* and it's control. Changes refer to late blight populations considering the earlier occurance of the disease and increased of aggresiveness accompanied by a more pronounced attack on the strains (Plămădeală et al., 1998).

Late blight control and potato breeding for resistance are now absolute necessary due to the races diversity and adaptation to the sexual reproduction and due to the changes in the epidemiological scheme caused by the longevity of the oospores.

Knowing how fungicides work and how to use them in the field can help to reduce yield losses. Currently, there are a number of non-invasive methods that determine the chlorophyll concentration at leaf or plant level. It is well established that the measured values provide a good estimate of the chlorophyll value present in the leaf of the potato plant, confirming the accuracy of the measurements (Vos and Born, 1993).

The sources of variation are related to the environment (soil type, climatic conditions, foliage diseases, intensity of light), variety (very early varieties show higher variations of chlorophyll than late ones, even if were planted on the same date), culture management (irrigation, residues from the previous crop) (Goffart et al., 2008).

MATERIAL AND METHODS

Field experiments were carried out in the years 2014-2016 to the National Institute of Research and Development for Potato and Sugar Beet – Brasov, Romania. It was used a complet randomized block design with four replicates, two planting distance between plants on row (25 cm and 30 cm) and different fungicides control technologies (only contact fungicides, both contact and sistemic fungicides).

Planting was made in 1st April 2014, 27th April 2015 and in 31st March 2016. In all cases, cultivation and maintenace was in line with current good agricultural practice.

Potato cultivars: Riviera (Dutch very early potato variety), very susceptible to late blight, Christian and Roclas (Romanian medium early potato varieties), moderately susceptible to late blight.

First symptom of late blight observation: daily check for all plots after emergence till first

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symptom observed in one of the plots (2014, June 17th, 2015, July 1st and 2016, 30 May).

Late blight assessment: plots are assessed for the extent of blight spots on the leaves. Each plot is assessed as a whole for percentage disease severity using a standard accepted severity key. (Cruickshank G. et. al., 1982).

SPAD 502 Plus (Chlorophyll Meter) determinations: 3 plants on each plot with 3 readings. For interpretation of chlorophyll results is used the formula of nitrogen index (Shapiro et al., 2006): N index = readings average/control average* 100%.

RESULTS AND DISSCUSIONS

The climatic conditions from 2014 and 2016 allowed the potato to be planted in the optimum period, which is the first part of April for this climatic zone. In this years plants emergence was determined in 13 and 12 May for Riviera variety (42 days after planting) and in 20 and 15 May for Roclas and Christian varieties (49 and 45 days after planting). For measurements the plants were harvested in 2014 at 94 and respectively 122 after planting and in 2016 at 92 and 116 days after planting.

In 2015 due to the unfavorable conditions of temperature and soil humidity the planted was performed in 25 April. Traditionally, this date is considered to be close to the end of the optimum period for potato planting. For the first measurements the plants were harvested at 66 days after planting and for the second at 94 days (*table 1*).

Table 1

Number of vegetation days till the plant measurements

Year	Variety	Date		Number of days after planting (DAP)			Number of days after emergence (DAE)	
		Planting	Emergence	Emergence	Harvest 1-4 July	Harvest 25 iulie –1 august	Harvest 1-4 July	Harvest 25 July- 1 August
2014	Riviera	1 April	13 May	42	94	122	52	80
	Roclas		20 May	49	94	122	45	73
	Christian		20 May	49	94	122	45	73
2015	Riviera	27 April	21 May	24	66	94	42	70
	Roclas		23 May	26	66	94	40	68
	Christian		23 May	26	66	94	40	68
2016	Riviera	31 March	12 May	42	92	116	50	74
	Roclas		15 May	45	92	116	47	71
	Christian		15 May	45	92	116	47	71

SPAD values, as indicators of nitrogen content of plants, are of particular importance in comparing plant vegetation in different years.

To the measurements done at the beginning of July in 2014 and 2016, the varieties had close SPAD values (SPAD 39.5 and 40.1 at Roclas, SPAD 41.9 and 37.5 at Christian). These were lower in all varieties compared to the values measured in 2015, when the SPAD medium values were 47.8 at Riviera, 48.0 at Roclas şi 49.4 at Christian. The differences between varieties at this time are closely related to the phenological differences and the accumulation of yield (*table 2*).

Table 2

Effects of interaction between variety, density and late blight technology on SPAD plants values in early July (2014-2016)

No.	Variety	Density thousands palnt/ha	Late blight control technology	SPAD values		
				July, 2nd 2014	June, 31 2015	July, 8th 2016
1	Riviera	44,4	1	-	49,5 abc	31,8 e
2			2	-	46,7 d	32,8 e
3		53,3	1	-	47,8 cd	37,2 bcde
4			2	-	47,3 cd	33,7 de
Mean				**-**	**47,8 b**	**33,9 c**
5	Roclas	44,4	1	40.6 ab	47,2 d	39,7 ab
6			2	40.1 ab	48,3 bcd	42,0 a
7		53,3	1	38.9 b	47,6 cd	38,9 abc
8			2	38.5 b	48,8 abdc	39,6 ab
Mean				**39,5 -**	**48,0 b**	**40,1 a**
9	Christian	44,4	1	42.9 a	50,5 a	37,5 bcd
10			2	42.2 a	50,1 ab	39,7 ab
11		53,3	1	41.7 ab	48,8 abcd	37,2 bcd
12			2	40.8 ab	48,0 bcd	35,4 cde
Mean				**41.9 ***	**49.4 a**	**37.5 b**
Experimental mean (CV)				**40.7** (4.8%)	**48.4** (8.3%)	**37.1** (6.7%)
LDS 5% (Variety)				1.0	0.7	1.3
LDS 5% (Variety*Dens*TECH)				3.0	1.9	3.7

Reducing the nutrition space by planting from 44.4 thousand hill per hectare to 53.3 thousand hill per hectare resulted in significant decreases of SPAD values, with an average of 1.0 units in 2014 and 0.7 units in 2015 (*table3*).

Table 3

Effects of interaction between variety and density on plants SPAD values to the beginning of July

Variety	Density thousand plants/ha	SPAD values		
		2014	2015	2016
Riviera	44.4	-	48.1 b	32.3 c
	53.3	-	47.5 b	35.5 bc
Roclas	44.4	40.3 ab	47.8 b	40.9 a
	53.3	38.6 b	48.2 b	39.3 ab
Christian	44.4	42.6 a	50.3 a	38.6 ab
	53.3	41.2 ab	48.4 b	36.3 b
Mean	**44.4**	**41.4**	**48.7**	**37.2**
	53.3	**40.4 o**	**48.0 o**	**37.0 ns**
Dl 5% (Dens)		1.1	0.5	1.5
LDS 5% (Soi*Dens)		2.5	1.3	3.7

The effects of different late blight treatments on SPAD values were reduced, so the average at TECH1 was 41.0 in 2014, 48.6 in 2015 and 37.0 in 2016, and to TECH2 at 40.4 in 2014, 48.2 in 2015 and 73.2 in 2016, the differences between the two technologies not being statistically assured (*table 4*).

Table 4

Effects of interaction between variety and late blight control technology on plants SPAD values to the beginning of July

Variety	Late blight control technology	SPAD values		
		2014	2015	2016
Riviera	TECH1	-	48.6 ab	34.5 c
	TECH2	-	47.0 c	33.3 c
Roclas	TECH1	39.7 bc	47.4 bc	39.3 ab
	TECH2	39.2 c	48.5 ab	40.8 a
Christian	TECH1	42.3 a	49.7 a	37.3 b
	TECH2	41.5 ab	49.0 a	37.6 b
Mean	**TECH1**	**41.0**	**48.6**	**37.0**
	TECH2	**40.4 ns**	**48.2 ns**	**37.2 ns**
Dl 5% (TECH)		1.1	0.5	1.1
LDS 5% (Soi*TECH)		1.4	1.3	2.6

Table 5

Correlations of SPAD values with plants biomass components in early July and with final yield/ha (Braşov, 2014 - 2016)

SPAD correlations with:	Pearson correlation coefficients		
	2014	2015	2016
- total yield t/ha	-0.196	+0.172	+0.706*
- commercial yield t/ha	-0.208	+0.259	+0.656*
- aerial plant g/plant	-0.722*	-0.243	+0.600
- roots+stolons g/plant	+0.537	+0.502	+0.270
- tubers number /plant	+0.752*	+0.404	-0.251
- tubers weight g/plant	+0.882**	+0.517	-0.460

*Correlation is significant at the 0.05 level (2-tailed). **Correlation is significant at the 0.01 level (2-tailed).

In 2014, following the measurements made to Roclas and Christian varieties, there was a close correlation between the SPAD values and the number (0,752 *), respectively the weight of the tubers at the hill (0,882 **), while the correlation was negative between the values SPAD and the weight of the aerial part of plants (-0,722) *.

This year correlations between SPAD, total and commercial yield were insignificant.

The only year of the experimental cycle in which SPAD average values varied significantly was 2016, the year leading to the highest correlation coefficients SPAD - total production (0.706 *) and SPAD - commercial production 0.656 *) (*table 5*).

CONCLUSIONS

According to the results of this study it could be concluded that an optimal density accompanied by phytosanitary treatments applied on time and of quality ensures that foliage is kept as much as possible green so as to achieve high yields.

From the results of the years 2014-2016 it can be observed that the occurrence of rainy days is more important than the amount of rainfall, although precipitation influences the intensity of late blight.

In years with late blight favorable conditions the degree of attack was significantly higher to Riviera variety, sensitive to blight, than to Roclas and Christian varieties.

SPAD values, as indicators of nitrogen content of plants, are of particular importance in comparing plant vegetation in different years.

The differences between varieties were closely related to the phenological differences and the degree of accumulation of production.

Studies of combinations of cultural practices are very important for determining optimal management techniques.

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