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PHYTOSANITARY PROTECTION AGAINST *PHYTOPHTORA INFESTANS* MONT. DE BARY ATTACK IN POTATO CROPS FROM TRANSYLVANIA, IN RESPECT WITH CROSS-COMPLIANCE

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ABSTRACT

Romania's status as full member of EU imposed the full adoption of cross-compliance requirements since 2014. In this context, our study aims to emphasize a methodology of phytosanitary protection against *Phytophtora infestans* Mont. de Bary attack in potato crops from Transylvania, taking into account the cross-compliance requirements. The experiment was developed during a three years period 2012 – 2014, in a private farm, located in Padurenii village, county of Cluj, within a three factorial experiment, with the following factors: potato variety (Redsec and Roclas), fertilization (no fertilization, $N_{50}P_{60}K_{80}$ mineral complex, compost), and treatment (Infinito 687.5 SC, Alcupral 50 PU, and Mimoten + Zytron mixture). Our study suggests that best solution for obtaining maximum potato production efficiency with respect of cross – compliance, is the use of Roclas variety, in field fertilized with $N_{50}P_{60}K_{80}$, and application of conventional treatment with Infinito 687.5 SC. Research allows us to recommend the main issues to be taken into consideration for an appropriate methodology of phytosanitary protection against late blight attack in potato crops from Transylvania.

Key words: late blight, fungi,cluster analysis, multiregression analysis.

INTRODUCTION

Potato has a great importance in human and even in animal nutrition. In our days, the cultivation of potato must face lots of challenges. This is the consequence of many reasons, and among the most important we may mention the demography, which exhibits a continuously increasing trend and climate change effects that have huge influence all over the world (Fleşeriu et al., 2013). Thus potato producers besides necessity of higher production, must face changing in climate that have huge importance on potato growing technology, but also in phytosanitary policies, both prophylactic and curative. In this respect, we have to mention that, even with an old history, the *Phytophtora infestans* Mont. de Bary fungi continues to represent one of the most important threats for potato producers. The most important reason is the lack of appropriate treatment to eradicate this mycotic disease it produces, late bligth, respectively, and of course its harmful effect on potato crop (Coakley et al., 1999, Deahl et al., 2001, Oroian et al., 2006, Sonoda, 1988). A very important issue connected to late blight fight is connected to the influence of climatic conditions characterized by high humidity and increased temperature (Berca, 2003; Oroian et al., 2006). This is the reason why in wet hot summers the incidence and intensity of *Phytophtora infestans* Mont de Bary attack increases. Lots of studies emphasized this behaviour characteristic to about mentioned mycotic agent (Mendelsohn et al, 2001, Rosenzweig et al., 1994, Rosenzweig and Parry, 1994).

If we analyse the particular socio-demographical and cultural conditions of Transylvania, region located in West of Romania, we find potato as one of the most important crops. In this way, it is obvious that maintaining healthy potato crops and appropriate expected production represent a particular challenge for farmers. They must practice the most suitable crop management, taking into account not only technological

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measures, but also issues directly connected to climate evolution.

In Transylvania, climatic conditions characterized by an average temperature of 8-9ºC, and rainfall of 500-600 mm, late blight occurrence during March – May records usually, low values. The problem is in mid and end of summer, months of July and August, respectively. In this period, the average temperature is about 20-22ºC, while precipitation may reach about 65 mm/month (Fleşeriu et al., 2013; Oroian et al., 2006).

Besides all mentioned, the Romanian farmer, and the one from Transylvania accordingly, must face another challenge. The system of payments in agriculture that begun to be implemented in Romania with EU accession, imposes for it a series of obligations, in order to preserve the environmental safeness. The most important of these is the cross-compliance (Berca et al., 2010).

According to EC Regulations no.73/2009 and 1122/2009, cross-compliance is an important mechanism for supplying environmental health. In Romania, according to the MADR/MMP Order no. 30/147/2010, since 2014 farmers who receive direct payments are subject to compulsory cross-compliance. In this respect they must accomplish both Statutory Management requirements, aiming to a series of legislative standards concerning environment quality, animal welfare, animal and plant health, food safety, and also Good Agricultural and Environmental Conditions (GAEC), which refers to standards related to soil and water management, in conditions of environmental protection.

Thus in our days, the Romanian farmer must pay special attention to phytosanitary products and fertilization management. In order to respect the cross-compliance regulations, an appropriate potato farm management must take into consideration appropriate measures in order to use only fertilization products and phytosanitary treatment products allowed by EU regulations, avoiding the spread of phytosanitary treatment substances and their penetration in underground water, as well as to adopt a fertilization plan.

Thus, the aim of our study is to emphasize a methodology of phytosanitary protection against *Phytophtora infestans* Mont. de Bary attack in potato crops from Transylvania, taking into account the cross-compliance requirements.

MATERIAL AND METHODS

The experiment was developed during a three years period 2012-2014, in a private vegetal farm, located in Padurenii village (47° 04’ 14 N, 24° 00’ 0E), county of Cluj. In the farm, potato is single cultivated vegetable.

A three factorial experiment was implemented each of three experimental years, with the following factors: potato variety, fertilization, treatment.

Two potato varieties were used within two experimental plots of 500 m^2 each, in faeoziom type soil. One potato variety was Redsec, created at Research Station Targu Secuiesc (http://fermieronline.ro/Soiuri+romanesti+de+cartofi#sthash.SYbOn6V7.dpuf), relatively resistant against late blight, and the other, Roclas variety is created at the Potato Institute Brasov (http://fermieronline.ro/Soiuri+romanesti+de+cartofi#sthash.FSX1eqIA.dpuf) with average resistance against late blight.

One experimental variant received no fertilization, one was fertilized using $N_{50}P_{60}K_{80}$ mineral complex, and the other using organic fertilizer, compost prepared in farm, respectively.

Treatments were performed with conventional products Infinito 687.5 SC from Bayern and Alcupral 50 PU from Alchimex, and unconventional with organic mixture Mimoten + Zytron from Holland Farming Agro.

Each experimental year, both potato varieties, not fertilized, or fertilized with mineral and organic fertilizers, received the above mentioned treatments. The *Phytophtora infestans* Mont. de Bary attack intensity and frequency were weekly recorded during April – August, in order to calculate the attack degrees. The observational monitoring was the approached methodology.

Taking into account that temperature and humidity have important role in late blight manifestation, these climatic parameters were also monthly recorded during entire experimental period (Table 1). During experimental period, temperature recorded the biggest average value in the first experimental year 18.44 ºC, respectively, the lowest was reported in the last experimental year 2014, 16.98 ºC, and 17.65ºC in 2013. The highest average humidity was reported in 2013, 70.31%, respectively, year characterized also by the highest rainfall of 620 mm, while the lowest humidity was reported in first experimental year, 2012, of 67.25%, year also characterized by the lowest rainfall of all experimental period, 570 mm, respectively (Table 1).

Table 1. Basic statistics for temperature and humidity within experimental field, during trial development, May – August 2013, and 2014, respectively

Issue	n	$\overline{X} \pm S_{\overline{X}}$	s	s^2	CV%	p
Temperature (ºC)						
2012	154	18.44 ± 0.14	4.58	20.97	24.83	-
2013	154	17.65^{ns} ± 0.39	4.78	22.83	27.07	0.569
2014	154	16.98^{ns} ± 0.35	4.35	18.93	25.63	0.821
Humidity (mm)						
2012	154	67.25 ± 0.67	8.37	70.05	12.44	-
2013	154	70.31^{ns} ± 0.58	7.25	81.36	10.31	0.729
12.36	154	68.57^{ns} ± 0.68	8.48	71.91	12.36	0.653

No significant differences were recorded between average temperatures and average humidity between experimental years at significance threshold of 5% (Table 1), and for this reason, *Phytophtora infestans* Mont. de Bary attack degrees and productions are reported for the entire experimental period 2012-2014.

Statistics

The averages, dispersion parameters, and coefficient of variability, for all analyzed variables were calculated using Basic statistics option. Significance of differences between average temperatures and average humidity were calculated with Student test. Analysis of variance, ANOVA, was implemented in order to emphasize the biggest source of variability, and cluster analysis in order to group the influence of experimental variables within the same variety, fertilization, and treatment, respectively. The multi-regression analysis was implemented for identifying the intensity of multiple correlations between the potato yields obtained when specific treatments against late blight were performed, with climatic conditions and fertilization type. STATISTICS for Windows, Version 7.0. was used for data processing.

RESULTS AND DISCUSSION

The *Phytophtora infestans* Mont. de Bary attack degrees recorded different values function of fertilization type, phytosanitary treatment and potato variety, in each experimental year (Table 2). In Redsec potato variety, when no fertilization was applied, within climatic conditions of experimental period, 2012-2014, the highest attack degree, of 27.09%, was reported in no fertilized variant when treatments were performed with Alcupral 50 PU, while the lowest when treatments were performed with Infinito 687.5 SC, 18.17%. Intermediary results (AD=23.63%), were reported when treatment was performed with organic Mimoten + Zytron mixture. When mineral fertilization ($N_{50}P_{60}K_{80}$) was applied, the conventional treatment performed with Infinito 687.5 SC, led to best results, smallest attack degree, respectively (AD=16.49%), followed by those performed with Mimoten + Zytron mixture (AD=21.68%), and Alcupral 50 PU

(AD=23.91%). In organic fertilized Redsec potato variety cultures, the biggest attack degree was reported when treatments were performed with Alcupral 50 PU (AD=24.96%), closely followed by experimental variant treated with Mimoten + Zytron mixture (AD=24.23%), and Infinito 687.5 SC (AD=18.63%).

In Roclas variety, cultivated within the same experimental conditions with respect of cross-compliance requirements, biggest attack degrees were recorded, compared to Redsec variety, even the same phytosanitary products were used. Thus, in no fertilized variant, the highest attack degree was recorded when treatment was performed with Alcupral 50 PU (AD=29%), and the smallest when Infinito 687.5 SC treatment was applied (AD=23.91%). We find that in both fertilization variants, mineral performed with $N_{50}P_{60}K_{80}$, and organic with compost, the best results were obtained when phytosanitary treatment was performed with conventional product Infinito 687.5 SC, and smallest attack degrees were reported, AD=22.98%, and AD=24.35%, respectively (Table 2).

The smallest efficacy was reported for Alcupral 50 PU treatments when late blight had the biggest attack degrees, AD=25.90% in mineral fertilized variant and AD=27.58% in organic fertilized variant, and intermediary when Mimoten + Zytron mixture was used against pathogen attack (Table 2).

The coefficients of variability with values between 6.13% and 21.40%, lower than 30% in all cases confirm the statistical results.

Table 2. Basic statistics for attack degrees (AD, %) of *Phytophtora infestans* pathogen identified in potatoes crops – Redsec and Roclas varieties, from the experimental field, during trial development, May – August 2012-2014

Fertilization	Treatment	n	$\overline{X} \pm S_{\overline{X}}$	s	s^2	CV%
Redsec potato variety						
No fertilization	Alcupral 50 PU	75	27.09 ± 0.23	2.01	4.04	7.41
	Infinito 687.5 SC	75	18.17 ± 0.12	1.02	1.04	5.61
	Mimoten + Zytron	75	23.63 ± 0.29	2.48	6.15	10.49
$N_{50}P_{60}K_{80}$	Alcupral 50 PU	75	23.91 ± 0.24	2.04	4.16	8.53
	Infinito 687.5 SC	75	16.49 ± 0.41	3.53	12.46	21.40
	Mimoten + Zytron	75	21.68 ± 0.49	4.22	17.81	19.46
Compost	Alcupral 50 PU	75	24.96 ± 0.40	3.45	11.90	13.82
	Infinito 687.5 SC	75	18.63 ± 0.25	2.20	4.84	11.81
	Mimoten + Zytron	75	24.23 ± 0.45	3.89	15.13	16.05
Roclas potato variety						
No fertilization	Alcupral 50 PU	75	29.00 ± 0.11	3.58	12.82	12.34
	Infinito 687.5 SC	75	23.91 ± 0.46	3.96	15.68	16.56
	Mimoten + Zytron	75	26.69 ± 0.46	4.02	16.17	15.06
$N_{50}P_{60}K_{80}$	Alcupral 50 PU	75	25.90 ± 0.26	2.21	4.88	8.53
	Infinito 687.5 SC	75	22.98 ± 0.32	2.75	7.56	11.96
	Mimoten + Zytron	75	25.37 ± 0.35	3.05	9.30	12.02
Compost	Alcupral 50 PU	75	27.58 ± 0.20	1.69	2.86	6.13
	Infinito 687.5 SC	75	24.35 ± 0.32	2.74	7.51	11.25
	Mimoten + Zytron	75	26.27 ± 0.37	3.22	10.37	12.26

Concerning yield, different results were obtained, function of fertilization type and phytosanitary treatment. In conditions of no fertilization, the lowest production was recorded in Redsec potato variety, when phytosanitary treatment was performed with Alcupral 50 PU, and biggest production when treatments were performed with Infinito

687.5 SC, 49.13 t/ha. Intermediary production of 48.15 t/ha, was reported when treatment was performed with organic Mimoten + Zytron mixture. When mineral fertilization with $N_{50}P_{60}K_{80}$ was applied, the best production was obtained for conventional treatment performed with Infinito 687.5 SC, 53.87 t/ha, respectively followed by those performed with Alcupral 50 PU (53.13 t/ha), and Mimoten + Zytron mixture (52.80 t/ha). The organic fertilization led to the following productions: 49.07 t/ha in experimental variants treated with Alcupral 50 PU, 51.40 t/ha when treatment was performed with Infinito 687.5 SC and 50.62 t/ha in experimental variant treated with Mimoten + Zytron mixture (Table 3).

The productions reported for Roclas variety in no fertilized variant, are the following: 62.65 t/ha in experimental variants treated with Alcupral 50 PU, 64.33 t/ha when treatment was performed with Infinito 687.5 SC and 63.13 t/ha in experimental variant treated with Mimoten + Zytron mixture (Table 3). When mineral fertilization with $N_{50}P_{60}K_{80}$ was applied, the best production was obtained for conventional treatment performed with Infinito 687.5 SC, 66.47 t/ha, closely followed by those performed with Alcupral 50 PU (66.40 t/ha), and Mimoten + Zytron mixture (64.10 t/ha). The organic fertilization led to similar productions: 63 t/ha in experimental variants treated with Alcupral 50 PU, 63.07 t/ha when treatment was performed with Infinito 687.5 SC and 63.47 t/ha in experimental variant treated with Mimoten + Zytron mixture (Table 3). Results are consistent with our previous research (Braşovean et al., 2008; Mălinaş et al., 2013). The coefficients of variability with values between 3.22% and 14.40%, lower than 30% in all cases confirm the statistical results.

Table 3. Basic statistics for potao yields – Redsec and Roclas varieties (t/ha), from the experimental field, during trial development, May – August 2012-2014

Fertilization	Treatment	n	$\overline{X} \pm S_{\overline{X}}$	s	s^2	CV%
Redsec potato variety						
No fertilization	Alcupral 50 PU	75	46.40 ± 0.24	2.10	4.40	4.52
	Infinito 687.5 SC	75	49.13 ± 0.19	1.68	2.84	3.43
	Mimoten + Zytron	75	48.15 ± 0.35	3.07	9.41	6.37
$N_{50}P_{60}K_{80}$	Alcupral 50 PU	75	53.13 ± 0.28	2.39	5.70	4.49
	Infinito 687.5 SC	75	53.87 ± 0.24	2.10	4.41	3.90
	Mimoten + Zytron	75	52.80 ± 0.25	2.18	4.74	4.12
Compost	Alcupral 50 PU	75	49.07 ± 0.18	1.58	2.50	3.22
	Infinito 687.5 SC	75	51.40 ± 0.20	1.72	2.97	3.35
	Mimoten + Zytron	75	50.60 ± 0.23	1.99	3.97	3.94
Roclas potato variety						
No fertilization	Alcupral 50 PU	75	62.65 ± 0.28	2.42	5.86	3.86
	Infinito 687.5 SC	75	64.33 ± 0.39	3.39	11.52	5.28
	Mimoten + Zytron	75	63.13 ± 0.25	2.13	4.52	3.37
$N_{50}P_{60}K_{80}$	Alcupral 50 PU	75	66.40 ± 0.35	3.06	9.36	4.61
	Infinito 687.5 SC	75	66.47 ± 0.36	3.11	9.70	4.68
	Mimoten + Zytron	75	64.10 ± 0.26	2.25	5.04	3.50
Compost	Alcupral 50 PU	75	63.00 ± 0.27	2.38	5.67	3.78
	Infinito 687.5 SC	75	63.07 ± 1.05	9.11	83.03	14.40
	Mimoten + Zytron	75	63.47 ± 0.26	2.24	5.02	3.53

The results obtained during the three years experiment, 2012-2014, were the direct consequence of conformation to cross-compliance, mainly with accent on fertilization and treatment products management, avoiding leakage on water resources, being well known the importance of these measures in preserving a healthy environment (Giupponi et al., 1999; Van der Werf et al., 2002).

The analysis of variance (Table 4) demonstrates that potato variety fertilization (B), and phytosanitary treatment (C), have very significant effect on potato production, while interactions between the above mentioned factors have no significant effect. Results show that potato variety has the largest importance on potato production, cultivated within experimental conditions.

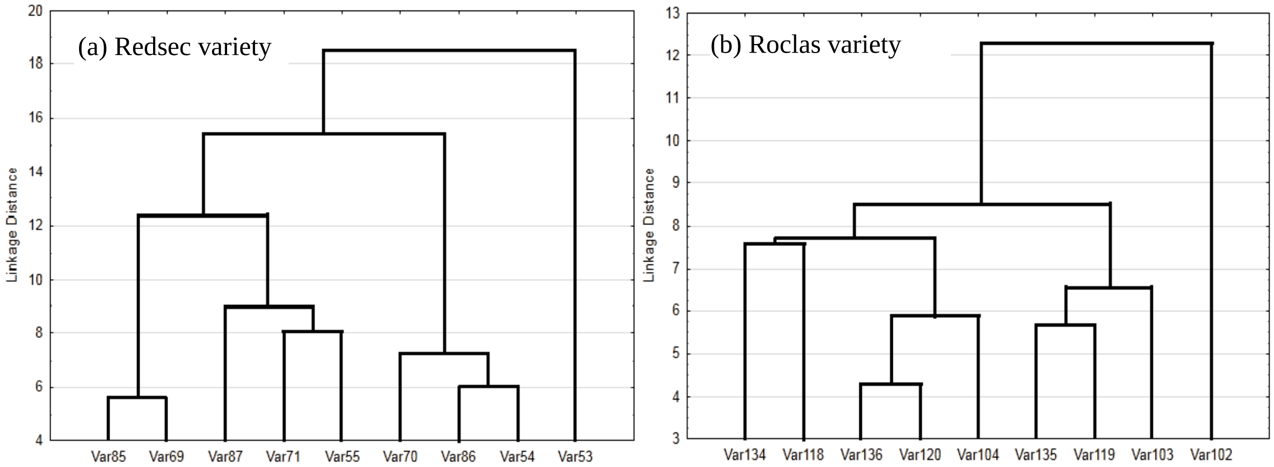
The cluster analysis (Figures 1-4) was implemented in order to emphasize the hierarchy of the results obtained as consequence of cultural practices (fertilization and phytosanitary treatments) in both potato varieties, in respect to cross-compliance within Transylvanian climatic conditions.

Table 4. The analysis of variance (ANOVA) of two potato varieties yields (t/ha) during 2012-2014, in 3 different conditions of fertilization and with three different treatments against *Phytophtora infestans* attack (Poienii, Cluj, 2012-2014)

Source of variation	The sum of squares (SS)	Degree of fredom (DF)	The mean square (MS)	F
Replications R	0.68	2	0.50	
A Factor – variety	532.55	1	404.53	481.49
A x B x C	0.70	4	0.17	0.51
Error – A	0.54	2	0.27	0.00
B Factor – fertilization	221,51	2	38.77	54.95
A x B	0.45	2	0.22	0.32
A x C	1.17	2	0.59	1.71
B x C	1.04	4	0.26	0.76
Error – B	1.83	8	0.23	0.00
C Factor – treatment	404.53	2	266.28	776.81
Error – C	2.66	24	0.12	
Total	1,023,702.01	53		

In Redsec variety, the cluster analysis emphasizes three clusters that divide the efficacy of treatments in three groups (Figure 1a). The less efficient is treatment with Alcupral 50 PU applied to unfertilised variant (Var 53), represented by a single, isolated cluster correspondent to the biggest *Phytophtora infestans* attack degree recorded by entire experimental period, 27.09%, respectively. The second group is subdivided in other two groups. One is composed by all variants treated with Infinito 687.5 SC, whatever fertilization option, and correspond to smallest attack degrees, and other by the rest of variants, where intermediary attack degrees were reported (Figure 1a).

In Roclas variety, the cluster analysis shows similar configuration to Redsec variety, emphasizing three clusters that divides the efficacy of treatments in three groups (Figure 1b). The less efficient is also the treatment with Alcupral 50 PU applied to unfertilised variant (Var 102), represented by a single, isolated cluster correspondent to the biggest *Phytophtora infestans* attack degree, 29%, respectively. The second group is subdivided in other two groups, one composed by all variants treated with Infinito 687.5 SC, whatever fertilization option, corresponding to smallest attack degrees, and other by the rest of variants, where intermediary attack degrees were reported (Figure 1b).



AD – attack degree; N – not fertilized; N – mineral fertilization with $N_{50}P_{60}K_{80}$; O – organic fertilization with compost;
1– treatment with Alcupral 50 PU; 2 – treatment with Infinito 687.5 SC; 3 – treatment with Mimoten + Zytron mixture.

Legend: (a) Var 53 – AD1N, Var 54 – AD2N, Var 55 – AD3N
Var 69 – AD1M, Var 70– AD2M, Var 71 – AD3M
Var 85 – AD1O, Var 86 – AD2O, Var 87 – AD3O

(b) Var 53 – AD1N, Var 54 – AD2N, Var 55 – AD3N
Var 69 – AD1M, Var 70– AD2M, Var 71 – AD3M
Var 85 – AD1O, Var 86 – AD2O, Var 87 – AD3O

Figure 1. The cluster analysis for *Phytophtora infestans* attack degrees (AD, %) yield - Redsec variety (a) and Roclas variety (b) within different experimental conditions, in period 2012-2014

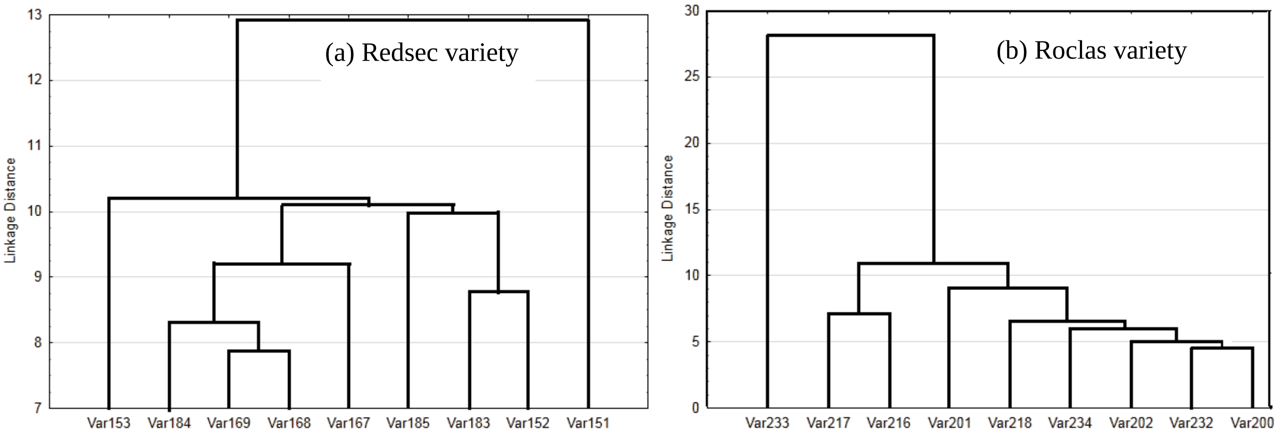
The cluster analysis applied for potato yield in Redsec variety, shows three clusters (Figure 2a). One, isolated, corresponds to the lowest production (Var 151), 46.40 t/ha, respectively. The other, is divided in two clusters, one also constituted of a single branch (Var 153) with low yield, 48.15 t/ha, respectively, while the other is also subdivided in other two branches, corresponding to higher yields. We note the subcluster represented by variants fertilized with $N_{50}P_{60}K_{80}$, whatever treatments applied against *Phyophtora infestans* attack, which corresponds to highest yield: 53.13 t/ha in variant treated with Alcupral 50 PU, 53.87 t/ha in variant treated with Infinito 687.5 SC, and 52.80 t/ha in variant treated with Mimoten + Zytron mixture.

If the cluster analysis is applied to Roclas yields (Figure 2b), during experimental period 2012-2014, we note different clusters, compared to those reported for Redsec variety (Figure 2a). One distinct cluster corresponds to variant not fertilized and treated with Acupral 50 PU, which exhibits the lowest yield, 62.65, respectively, while the other cluster is subdivided in a subcluster with two branches, corresponding to highest yields (Var 217 and Var 216), reported for variants fertilized with $N_{50}P_{60}K_{80}$, and treated with Acupral 50 PU, and Infinito 687.5 SC – 66.40 t/ha and 66.47 t/ha, respectively. The other subcluster has several subdivisions corresponding to the other yields (Figure 2b).

The multi-regression analysis (Table 5) was conducted in order to emphasize the intensity of influence of *Phytophtora infestans* Mont. de Bary attack degree (%), meteorological conditions, fertilization and treatment interaction upon potato yield function of variety.

Very strong multiple correlations were noted in three variants. One between Redsec potato yield obtained in variant not fertilized, treated with Mimoten + Zytron mixture, late blight attack degree, temperature and precipitation (R=0.771, R^2=0.595), another between Roclas potato yield obtained in variant not fertilized treated with Infinito 687.5 SC (R=0.739, R^2=0.547), and the last one between Roclas potato yield obtained in variant fertilized with compost and treated with Alcupral 50 PU (R=0.709, R^2=0.504).

The weakest correlations were also obtained in three experimental variants, but all in Redsec variety (Table 5). One between Redsec potato yield obtained in variant not fertilized, treated with Alcupral 50 PU, late blight attack degree, temperature and precipitation (R=0.135, R^2=0.018), another between Redsec potato yield obtained in variant fertilized with $N_{50}P_{60}K_{80}$, and treated with Infinito 687.5 SC (R=0.193, R^2=0.037), and the last one between Redsec potato yield obtained in variant fertilized with compost and treated with Mimoten + Zytron mixture (R=0.192, R^2=0.037).



AD – attack degree; N – not fertilized; N – mineral fertilization with $N_{50}P_{60}K_{80}$; O – organic fertilization with compost; 1 – treatment with Alcupral 50 PU; 2 – treatment with Infinito 687.5 SC; 3 – treatment with Mimoten + Zytron mixture

Legend:
(a) Var 151 – P1N, Var 152 – P2N, Var 153 – P3N
Var 167 – P1M, Var 168 – P2M, Var 169 – P3M
Var 183 – P1O, Var 184 – P2O, Var 185 – P3O

(b) Var 233 – P1N, Var 201 – P2N, Var 202 – P3N
Var 216 – P1M, Var 217 – P2M, Var 218 – P3M
Var 232 – P1O, Var 200 – P2O, Var 234 – P3O

Figure 2. The cluster analysis for potato yield - Redsec variety (a) and Roclas variety (b), within different experimental conditions, in period 2012-2014

Table 5. The multiple regression analyze applied to potato yields (t/ha) function of variety (Redsec and Roclas), type of fertilization, treatment against *Phytophtora infestans* attack (%), temperature (ºC) and precipitations (mm) levels

Issue	R	R^2	Regression line
Y1 – A1 – T – P	0.135	0.018	Y1 = 45.991 – 0.006A1 +0.032T + 0.128 P
Y2 – A2 – T – P	0.522	0.275	Y2 = 48.877 + 0.223A2 + 0.088T – 0.517P
Y3 – A3– T – P	0.771	0.595	Y3 = 54.320 – 0.260A3 – 0.236T – 0.551P
Y4 – A4 – T – P	0.294	0.086	Y4 = 51.965 – 0.061A4 + 0.154T + 0.267P
Y5 – A5 – T – P	0.193	0.037	Y5 = 53.477 + 0.054A5 + 0.0169T – 0.078P
Y6 – A6 – T – P	0.443	0.196	Y6 = 53.338 – 0.310A6 + 0.177T + 0.345P
Y7 – A7 – T – P	0.371	0.137	Y7 = 48.990 + 0.078A7 – 0.323T – 0.052P
Y8 – A8 – T – P	0.415	0.172	Y8 = 48.459 + 0.310A8 + 0.364T – 0.078P
Y9 – A9 – T – P	0.192	0.037	Y9 = 52.678 – 0.128A9 + 0.004T – 0.155P
Z1 – A1 – T – P	0.380	0.145	Z1 = 64.159 + 0.126A1 + 0.154T – 0.424P
Z2 – A2 – T – P	0.739	0.547	Z2 = 67.828 + 0.311A2 + 0.105T – 0.741P
Z3 – A3 – T – P	0.395	0.156	Z3 = 63.911 + 0.062A3 + 0.361T– 0.338P
Z4 – A4 – T – P	0.485	0.235	Z4 = 66.001 + 0.345A4 – 0.273T – 0.314P
Z5 – A5 – T – P	0.637	0.406	Z5 = 70.953 + 0.037A5 - 0.172T – 0.611P
Z6 – A6 – T – P	0.599	0.359	Z6 = 68.896 – 0.192A6 – 0.042T – 0.513P
Z7 – A7 – T – P	0.709	0.504	Z7 = 70.357 – 0.301A7 + 0.245T – 0.585P
Z8 – A8 – T – P	0.609	0.371	Z8 = 92.697 – 0.442A8 – 0.137T – 0.341P
Z9 – A9 – T – P	0.390	0.136	Z9 = 66.907 – 0.182A9 + 0.167T – 0.258P

Y – Redsec production (t/ha); Z – Roclas production (t/ha); T – temperature; P – rainfall; A1 – AD (%) variant not fertilized, treated with Alcupral 50 PU; A2 – AD (%) variant not fertilized, treated with Infinito 687.5 SC; A3 – AD (%) variant not fertilized, treated with Mimoten + Zytron mixture; A4 – AD (%) variant fertilized with $N_{50}P_{60}K_{80}$, treated with Alcupral 50 PU; A5 – AD (%) variant fertilized with $N_{50}P_{60}K_{80}$, treated with Infinito 687.5 SC; A6 – AD (%) variant fertilized with $N_{50}P_{60}K_{80}$, treated with Mimoten + Zytron mixture; A7 – AD (%) variant fertilized with compost, treated with Alcupral 50 PU; A8 – AD (%) variant fertilized with compost, treated with Infinito 687.5 SC;A9 – AD (%) variant fertilized with compost, treated with Mimoten + Zytron mixture.

According to multi-regression analysis, the production of Roclas variety is most sensitive to temperature, rainfall regimen and late blight attack degree, while Redsec variety is less influenced by the climatic conditions, as assessed by weak multi-regression coefficients (Table 5).

CONCLUSIONS

Concerning fertilization, our trial demonstrates that $N_{50}P_{60}K_{80}$ mineral fertilization has better influence on potato culture resistance against late blight attack degree and production, compared to compost fertilization or unfertilised practice, especially when phytosanitary treatments are performed with Infinito 687.5 SC and Mimoten + Zytron mixture, in both analysed potato varieties.

Our trial, also demonstrates that even if according to multi-regression analysis Roclas potato variety is more sensitive against Transylvanian climatic conditions represented by temperature and rainfall regimen and late blight attack, and late blight attack degrees are bigger in this variety compared to Redsec variety, it is the potato variety with biggest output, where lowest *Phytophtora infestans* Mont de Bary attack degrees are recorded in conditions of fertilization with Infinito 687.5 SC and Mimoten + Zytron mixture, and highest yields were obtained in conditions of mineral fertilization with $N_{50}P_{60}K_{80}$.

Thus, according to all analysis we performed, variance analysis, cluster analysis and multi-regression approach, we may suggest that best solution for obtaining maximum efficiency with respect of cross – compliance, is the use of Roclas potato variety, in field mineral fertilized with $N_{50}P_{60}K_{80}$, and application of conventional treatment with Infinito 687.5 SC.

The experimental trial we developed during a three years period, 2012-2014, in Transylvania, allows us to emphasize the main issues to be taken into consideration for an appropriate methodology of phytosanitary protection against *Phytophtora infestans* Mont. de Bary attack in potato crops from Transylvania, in conditions of satisfactory production, and taking into account the cross-compliance requirements.

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