

COMPARATIVE STUDY CONCERNING THE EFFICACY OF CONVENTIONAL AND UNCONVENTIONAL TREATMENTS AGAINST LATE BLIGHT IN POTATO CULTURE FROM TRANSYLVANIA

CRISTIAN MĂLINAȘ, IOAN GHEORGHE OROIAN, ANTONIA ODAGIU,
VASILE FLORIAN, IOAN BRAȘOVEAN¹

SUMMARY: *Our study aims to identify best combinations between treatments and fertilization type in fight against late blight in specific climatic conditions. The trial was developed according to a two factorial experiment, with $N_{50}P_{60}K_{80}$ and compost as fertilizers, and conventional and unconventional treatments. Bordeaux mixture and mineral fertilization led to lowest attack degree. According to cluster analyze, the combination unconventional products - mineral fertilization, had the highest efficacy.*

Key words: *basic statistics, mineral fertilization, compost, multiregression analyze*

INTRODUCTION

The potato cultures had huge importance worldwide due to multiple use as food and feeding. It is also one of the most valuable food industry component. For this reason, lot of preoccupation is focused on fight against the most harmful pathogens of this culture. Among these pathogens, *Phytophthora infestans* Mont. de Bary and *Alternaria solani* Sorauer are of most importance, because of damages they can produce in potato crops (Coakley et al., 1999, Deahl et al., 2001, Oroian et al., 2006, Sonoda, 1988), and also due to the influence that climatic factors have on their development. But, all over the world, the most important threat against potato remains the late blight produced by the pathogen *Phytophthora infestans* Mont. de Bary (Oroian et al., 2006). Lots of studies emphasized the importance of rainfall regimen and temperature upon the diseases produced by the above mentioned mycosis in potato (Mendelsohn et al, 2001, Rosenzweig et al., 1994, Rosenzweig and Parry, 1994). Because potato culture is a basic one in Transylvania, Romania, managing healthy cultures is a continuous challenge for farmers. Thus, the importance of controlling the disease produced by the above mentioned mushroom arise from the great influence of

¹ Doctoral Student Eng. Cristian Malinas, Prof.Dr. Ioan Gheorghe Oroian, Lecturer Dr. Antonia Odagiu, Lecturer Dr. Vasile Florian, Assistant Dr. Ioan Brasovean, University of Agricultural Sciences and Veterinary Medicine, Manastur st., no. 3-5, 400372 Cluj-Napoca, Romania
Corresponding author: Prof.dr. Ioan Gheorghe Oroian, e-mail: neluoroian@gmail.com, Tel: +40264596384

climate conditions (which cannot be controlled) on the extent of the late blight attack degree.

Due to specific climatic conditions of Romania, in early spring and early fall the attack degree of, late blight is low because in specific climate average temperature is not more than 10 °C, and usually the rainfall supply is reduced; it increases in late spring and summer when average temperatures are around 20 °C and rainfall average more than 65 mm/month (Oroian et al., 2006, Puia, 2005). Our study aims to identify the most suitable combinations of conventional and unconventional treatments in combination with different types of fertilization in fight against *Phytophthora infestans* Mont. de Bary (late blight pathogen agent) in climatic conditions of Transylvania region.

MATERIAL AND METHOD

Our trial was implemented on a private vegetal farm of 2,000 m² located in Top village, county of Cluj, Romania. Potato is the single vegetal culture practiced in the farm. Two experimental plots, 250 m² each, were organized. One was fertilized with N₅₀P₆₀K₈₀ mineral complex, while the other with compost. Resdec potato variety was cultivated on both plots, on argic chernozem soil. Conventional (Infinito 687.5 SC from Bayern) and unconventional (Bordeaux mixture prepared on farm, and Mimoten + Zytron mixture from Holland Farming Agro) were used. Each plot was treated according to the same treatment pattern. The following variants were obtained V1 – N₅₀P₆₀K₈₀ fertilized and treated with Bordeaux mixture (unconventional treatment), V2 – N₅₀P₆₀K₈₀ fertilized and treated with Infinito 687.5 SC (conventional treatment), V3 – N₅₀P₆₀K₈₀ fertilized and treated with Mimoten + Zytron mixture, V4 – N₅₀P₆₀K₈₀ fertilized and not treated, V5 – compost fertilized and treated with Bordeaux mixture (unconventional treatment), V6 - compost fertilized and treated with Infinito 687.5 SC from Bayern (conventional treatment), V7 - compost fertilized and treated with Mimoten + Zytron mixture (unconventional treatment), and V8 - fertilized with compost and not treated. Observations on the field were performed from April up to September 2013.

The *Phytophthora infestans* Mont. de Bar attack intensity (%) and frequency (%) were recorded three times a week, and function of them, the attack degree (AD%) was calculated (Oroian et al., 2006). The climatic factors (temperature and rainfall regimen) were also taken into account. They were recorded with a meteorological station placed on the experimental field. STATISTICA 7.0 v. programme was used for statistical data processing (averages, dispersion parameters, significance of differences, multiregression and cluster analysis).

RESULTS

Table 1 emphasize the results of the basic statistics. The lowest *Phytophthora infestans* Mont. de Bary attack degrees were recorded in V1 (N₅₀P₆₀K₈₀ fertilized and unconventionally treated with Bordeaux mixture) and V3 (N₅₀P₆₀K₈₀ fertilized and unconventionally treated with Mimoten + Zytron mixture). As table 1 and Box-plot diagram (fig. 1) emphasize, the biggest attack degree was recorded in V7 (fertilized with compost and treated with Mimoten + Zytron mixture). Similar average attack degrees were reported for treatment with Infinito 687.5 SC and in no treated plot,

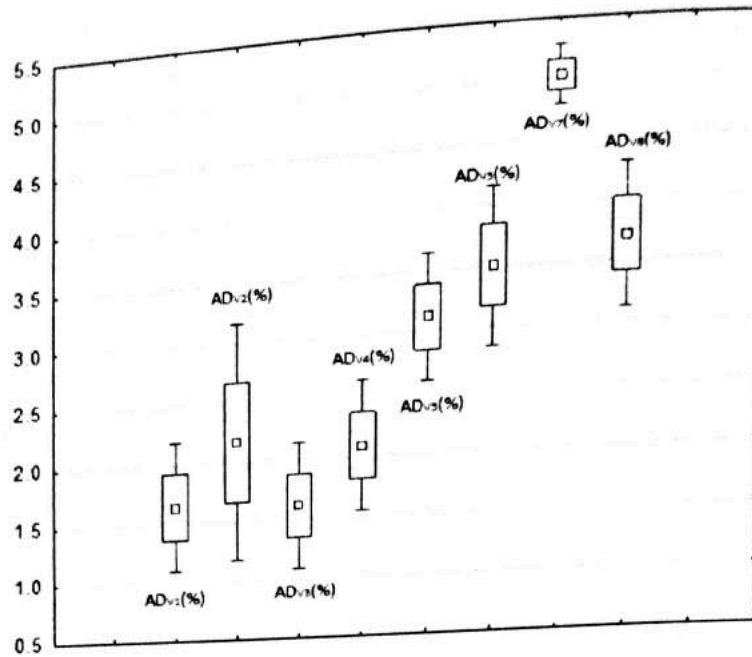


Figure 1. The Box-plot diagram of *Phytophthora infestans* Mont. de Bary average attack degrees (%) recorded in all experimental variants, V1 – V8

when both $N_{50}P_{60}K_{80}$ (2.17% and 2.09%, respectively) and compost (3.51% and 3.70%, respectively) were administered as fertilizers (table 1). The maximum value for *Phytophthora infestans* Mont. de Bary attack degree (AD%) was recorded in variant V7, fertilized with compost and unconventionally treated with Mimoten + Zytron mixture (5.25%), and minimum *Phytophthora infestans* Mont. de Bary attack degree in variants V1 and V3 (1.32%) fertilized with $N_{50}P_{60}K_{80}$ and unconventionally treated with Bordeaux mixture, and Mimoten + Zytron mixture (table 1).

Table 1. Basic statistics for *Phytophthora infestans* de Bary, attack degree (AD%) and meteorological data (precipitation regimen – Pp, mm, and temperature – $t^{\circ}C$) in all experimental variants (different treatments applied to mineral and organic fertilized potato cultures)

Issue	n	Mean	Minimum	Maximum	Standard deviation	Coefficient of variability	Standard error of mean	ANOVA p
AD _{V1} (%)	75	1.620	1.323	1.990	0.269	16.618	0.031	
AD _{V2} (%)	75	2.176	1.400	2.640	0.508	23.346	0.058	
AD _{V3} (%)	75	1.652	1.320	1.990	0.281	17.002	0.032	
AD _{V4} (%)	75	2.096	1.880	2.567	0.276	13.150	0.032	
AD _{V5} (%)	75	3.125	2.733	3.420	0.266	8.508	0.030	- 1.505***
AD _{V6} (%)	75	3.512	3.010	3.810	0.336	9.554	0.038	- 1.336**
AD _{V7} (%)	75	5.036	4.920	5.250	0.126	2.494	0.014	- 3.411***
AD _{V8} (%)	75	3.706	3.277	3.990	0.302	8.153	0.034	- 1.610***
$t^{\circ}C$	3527	18.044	17.290	18.440	0.465	2.578	0.008	
Pp, mm	3527	96.496	89.130	100.120	4.356	4.514	0.073	

*** - $p < 0.001$; ** - $p < 0.01$

The statistic analyze is representative for all sample (coefficient of variability < 30% in all cases), with greater variation in variant V2, N₅₀P₆₀K₈₀ fertilized and treated with Infinito 687.5 SC (23.34%), and lowest in variant V7 fertilized with compost and treated with Mimoten + Zytron mixture (2.49%). Average temperature (18.04 °C) and average precipitation regimen (96.49 mm) by analyzed period (April - September 2013) framed within multiannual averages, by 100 years recorded in Romania.

The multiregression analyze (table 2) conducted in order to emphasize the way meteorological conditions influence the *Phytophthora infestans* Mont. de Bary attack degree (%) in different conditions of fertilizing and treatment, demonstrates different interactions. Very strong and strong multiple correlations emphasized by the correlation coefficients were reported for variant fertilized with N₅₀P₆₀K₈₀ and treated with Mimoten + Zytron mixture (R= 93.90%), and Infinito 687.5 SC (R=73.61%), and also in variants fertilized with compost and treated with Bordeaux mixture (R= 83.40%), Infinito 687.5 SC (R=70.60%).

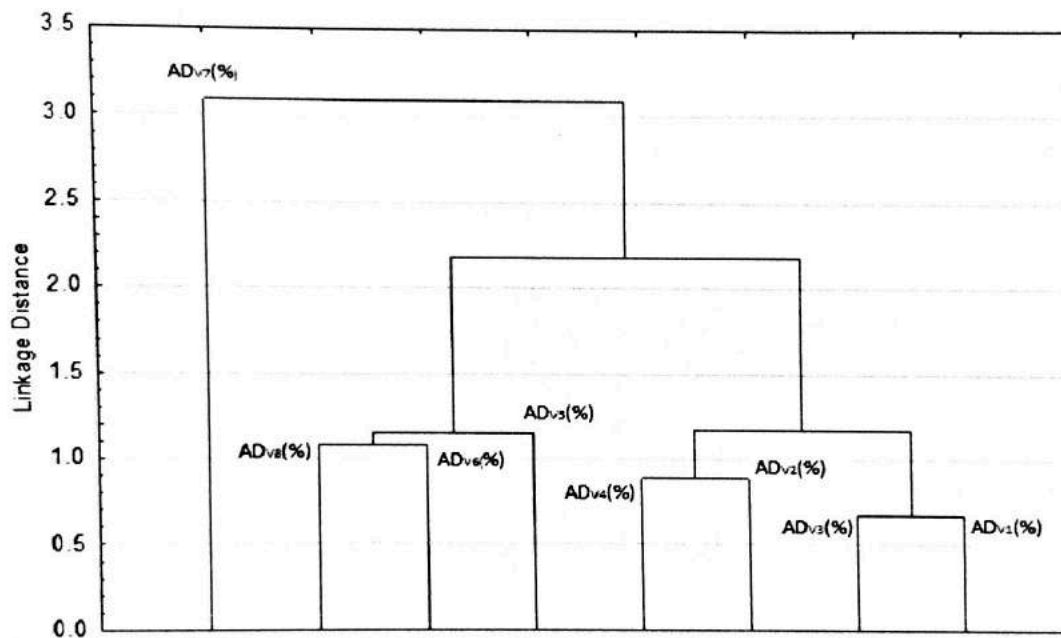


Figure 2. The cluster analysis applied to *Phytophthora infestans* Mont. de Bary attack degrees (%)

Table 2. The multiregression analyze applied in experimental variants for emphasizing the multiple correlations between *Phytophthora infestans* de Bary, attack degree (%) in potato cultures and climatic conditions data (precipitation regimen – mm, and temperature – °C)

Issue	R	R ²	Regression line
AD _{V1} (%) - t ⁰ C - Pp. mm	0.374	0.140	Y = 0.006 - 0.107X1 + 0.461X2
AD _{V2} (%) - t ⁰ C - Pp. mm	0.731	0.533	Y = 10.005 + 1.346X1 - 1.275X2
AD _{V3} (%) - t ⁰ C - Pp. mm	0.939	0.882	Y = 6.483 - 1.448X1 + 1.761X2
AD _{V4} (%) - t ⁰ C - Pp. mm	0.438	0.192	Y = 1.387 + 0.154X1 + 0.301X2
AD _{V5} (%) - t ⁰ C - Pp. mm	0.834	0.696	Y = 3.203 - 1.483X1 + 1.523X2
AD _{V6} (%) - t ⁰ C - Pp. mm	0.706	0.498	Y = 0.586 + 0.968X1 - 1.301X2
AD _{V7} (%) - t ⁰ C - Pp. mm	0.491	0.241	Y = 5.304 - 0.545X1 + 0.858X2
AD _{V8} (%) - t ⁰ C - Pp. mm	0.214	0.046	Y = 1.268 + 0.401X1 + 0.339X2

Moderate correlations were reported for the interaction *Phytophthora infestans* Mont. de Bary attack degree - temperature - precipitation regimen for the variants fertilized with $N_{50}P_{60}K_{80}$ not treated ($R=43.80\%$) treated with Bordeaux mixture ($R=37.40\%$), and fertilized with compost and treated with Mimoten + Zytron mixture ($R=49.10\%$). The weakest correlation was reported in variant ($R=21.40\%$) fertilized with compost and not treated (table 2).

The regression lines emphasize that the increase of the precipitation quantities determine the decrease of the *Phytophthora infestans* Mont. de Bary attack degree (AD%) in variants conventionally treated with Infinito 687.5 SC in both fertilization variants, mineral and compost, V2 and V6, respectively (table 2). The increase of the temperature negatively affects the *Phytophthora infestans* Mont. de Bary attack degree in variants unconventionally treated, with Bordeaux mixture and Mimoten + Zytron mixture in both fertilizing practices, with mineral fertilizer and compost, respectively.

DISCUSSION

The analyze of basic statistics shows differences between the *Phytophthora infestans* Mont. de Bary attack degrees reported in variants fertilized with $N_{50}P_{60}K_{80}$ mineral fertilizer and compost for all treated and also untreated variants. In all cases they are bigger in compost fertilized variants, differences being statistically distinct significant ($p<0.01$) and very significant ($p<0.001$), as shown in table 1. We note the biggest difference reported between variants unconventionally treated with Mimoten + Zytron mixture $N_{50}P_{60}K_{80}$ mineral fertilized and fertilized with compost (V3 and V7), and smallest between variants conventionally treated with Infinito 687.5 SC (variants V2 and V6). These results, all characterized by normal distribution (fig. 1), demonstrate that choosing NPK mineral fertilizing option, one obtains *Phytophthora infestans* Mont. de Bary lower attack degree on potato culture, whatever treatment, conventional, unconventional, and even in no treatment conditions.

The cluster analysis (fig. 2) implemented in order to emphasize the hierarchy of the results obtained as consequence of two pest fight managerial choices, confirm the findings above mentioned. As first option, the results of the fertilizing and treatments managerial methodology, may be divided in two groups. First, the biggest *Phytophthora infestans* Mont. de Bary attack degree recorded in potato culture fertilized with compost and unconventionally treated with Mimoten + Zytron mixture - AD_{V7} (%), and second with much lower attack degrees. This group can also be divided in two groups. One is represented by the lowest *Phytophthora infestans* Mont. de Bary attack degrees recorded in cultures $N_{50}P_{60}K_{80}$ fertilized, with two branches, AD_{V1} (%) and AD_{V3} (%), respectively, and the other, conventionally treated with Infinito 687.5 SC and not treated - AD_{V4} (%) and AD_{V2} (%), respectively (fig. 2). The recorded in variants fertilized with compost, and treated with Infinito 687.5 SC, Bordeaux mixture, and not treated.

The multiregression analyze also emphasize that meteorological conditions affecting the *Phytophthora infestans* Mont. de Bary attack degree have the biggest influence on untreated variants, both $N_{50}P_{60}K_{80}$ fertilized and with compost- V4 and V8, in conditions of weak correlation (21.40%), almost not representative between

interrelated factors (table 2). The interrelation between *Phytophthora infestans* Mont. de Bary attack degree, temperature and precipitation regimen are balanced in direction of enhanced influence of precipitation input in majority of variants. It contributes to increase of the *Phytophthora infestans* Mont. de Bary attack degree value in potato culture variants unconventionally treated in both fertilization practices, $N_{50}P_{60}K_{80}$ and with compost. The biggest contribution may be noticed in variant $N_{50}P_{60}K_{80}$ fertilized and treated with Mimoten + Zytron mixture -V3. In variant fertilized with compost and conventionally treated with Infinito 687.5 SC, balanced is also in advantage of precipitation regimen, but it contributes in a major manner to decrease of the *Phytophthora infestans* Mont. de Bary attack degree in potato (coefficient 1.301, compared to 0.968 for temperature), V6 (table 2). Temperature has bigger influence compared to precipitation regimen only in variant $N_{50}P_{60}K_{80}$ fertilized and conventionally treated with Infinito 687.5 SC, V2, respectively.

CONCLUSION

The comparative analyze of the influence of conventional and unconventional treatments applied in two different fertilization conditions upon the intensity of *Phytophthora infestans* Mont. de Bary attack degree in Resdec potato cultures demonstrates specific particularities. The $N_{50}P_{60}K_{80}$ mineral fertilization has better influence on potato culture resistance against the pathogen attack, compared to compost fertilization. The conventional and unconventional treatments have different efficacy, function of the type of fertilization. Unconventional treatments have enhanced efficacy in conditions of mineral fertilization. Three categories of *Phytophthora infestans* Mont. de Bary attack degree intensities are emphasized in our study: high (V7 – fertilized with compost and unconventionally treated with Mimoten + Zytron mixture), medium (all variants fertilized with compost - V8 untreated, V6 conventionally treated with Infinito 687.5 SC and V5 unconventionally treated with Bordeaux mixture), and low (all variants fertilized with mineral fertilizer – V4 not treated, V2 conventionally treated with Infinito 687.5 SC, V1 and V3 unconventionally treated with Bordeaux and Mimoten + Zytron mixtures, respectively).

Precipitation regimen (mm) is the most important climatic factor affecting the amplitude of the *Phytophthora infestans* Mont. de Bary attack degree in potato. According to our study we can state that best combinations of conventional and unconventional treatments reported to different types of fertilization in fight against (late blight in climatic conditions of Transylvania region, are represented by $N_{50}P_{60}K_{80}$ mineral fertilization and unconventional treatments, Bordeaux mixture and Mimoten + Zytron mixture, respectively, when, in our study lowest *Phytophthora infestans* Mont. de Bary attack degrees were obtained, 1.62% and 1.65%, respectively.

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