

Original Article

Bioeconomic Approach of *Alternaria Solani* Attack in Potato

OPINCARIU Adriana, Ioan OROIAN*, Antonia ODAGIU, Cristian MĂLINAȘ,
Bianca BORDEANU

¹Faculty of Agriculture, University of Agricultural Sciences and Veterinary Medicine,
3-5 Calea Manastur, 400372 Cluj-Napoca, Romania

Received 20 October 2015; received and revised form 29 October 2015; accepted 5 December 2015
Available online 31 December 2015

Abstract

Due to the big importance of potato cultures as food source worldwide, the phytosanitary protection of this vegetal crop is an important component of all managerial practices. In this context, we mention *Alternaria solani* Sorauer fungus attack as major threat in wet climatic conditions. The aim of our study is to emphasize the role of biostatistics in analyzing results of alternariosis control in potato cultures maintained in climatic conditions specific to Transylvanian Plane, which receive mineral a fertilization, and treated with specific phytosanitary products. A bifactorial trial (fertilization, treatment, 3 x 2) was installed in a private farm located in Poienii village with variants: control with no fertilization and no phytosanitary treatment (V1), fertilized with compost and treated with Alcupral 50 PU (V2), and fertilized with N₅₀P₆₀K₈₀ and treated with Alcupral 50 PU (V3). The attack degrees were weekly recorded during April up to September 2014. The climatic parameters were monitored with an automatic measuring station. STATISTICA 7.0 v. programme was implemented in order to assure the basis of biostatistical approach. The implementation of biostatistical tools demonstrate the importance of using this method, due to synthetic and accurate results. They demonstrate the superiority of treatment with Alcupral 50 PU in cultures fertilized with mineral fertilizer N₅₀P₆₀K₈₀.

Keywords: Alcupral 50 PU, *Alternaria solani* Sorauer, basic statistics, multiregression analyze.

1. Introduction

Due to the big importance of potato cultures as food source worldwide, the phytosanitary protection of this vegetal crop is an important component of all managerial practices [20]. In this context, we have to mention that one of the most important threat against this culture, in wet climatic conditions especially is *Alternaria solani* Sorauer fungus attack [2, 3, 15, 19]. In Transylvania region, located in the Western part of Romania, potato plays an important role in private farms production.

For this reason, research on potato crops is largely focused on climatic conditions, of the above mentioned specific area. The most important reason is the influence of temperature and humidity on the action of the most important fungi, which represent a threat for potato cultures, and among these, *Alternaria solani* Sorauer is of highest importance. In this respect, we mention the well-known effect of humidity in favourizing alternariosis development [13]. This issue has to be much carefully approached in future also due to the climatic changes effects 4, [10, 18]

Because, besides *Phytophthora infestans* Mont de Bary, *Alternaria solani* Sorauer is the second cause of potato crops deterioration in Transylvanian Plane, the identification of most important factors affecting fungus attack intensity and frequency is of major importance. In this context we also have to mention the importance of appropriate phytosanitary

* Corresponding author.
Fax: +40-264-593792
Tel: +40-264-596384
e-mail: neluoroian@gmail.com

management of the culture, which involves appropriate use of both fertilization and treatments [1, 5, 17, 20].

Several tools are available for analyzing conditions of disease manifestation, favorable factors, possibility of their mitigation, and also predicting the phenomenon evolution. Such a tool is biostatistics. It allows the accurate interpretation of the available data harvested from the field, using specific patterns [11]. Because in the specific area of fungal diseases action upon a vegetal culture we talk about large variation in their reaction against diverse exogenous factors, biostatistics may bring lot of help in identification of the variation [14, 21]. The implementation of its specific techniques allows to identify the distinction between causations and correlations, or to interpret, with accuracy, the influence of different factors upon the evolution of a system using multivariate techniques [8, 16, 19, 22].

The aim of our study is to emphasize the role of biostatistics in analyzing results of alternariosis control in potato cultures maintained in climatic conditions specific to Transylvanian Plane, which receive mineral a fertilization, and treated with specific phytosanitary products.

2. Materials and Methods

The trial was installed in a private farm located in Poienii village on a 1500 m² area, on argic chernozem soil. A bifactorial trial (3 x 2) was installed. The two factors were fertilization and treatment, respectively. Three experimental plots, 500 m² each were organized. They correspond to the experimental variants: Variant 1 (V1) – control, no fertilization and no phytosanitary treatment; Variant 2 (V2) - fertilized with compost and treated with Alcupral 50 PU; and Variant 3 (V3) - fertilized with N₅₀P₆₀K₈₀ and treated with Alcupral 50 PU. The attack intensity and attack frequency, respectively, were weekly recorded in order to calculate the attack degrees (Oroian, 2008). The climatic factors were daily recorded with a meteorological station placed on the experimental field. Because of their importance in alternariosis attack, only temperature and humidity were taken into account. Resdec potato variety was cultivated on experimental plots. It is a semi tardive variety, which exhibits moderate resistance against alternariosis. It was delivered by the Station of Reseach and Development Targu Secuiesc, the variety creator [12]. Treatments were performed with Alcupral 50 PU from Alchimex. The active substance is metallic copper as copper oxichloride – 50%. The administration dose is 5 kg/ha. Mineral fertilization was performed with mineral fertilizer N₅₀P₆₀K₈₀ from commerce, and

organic fertilization with compost prepared on farm. With the aim of emphasizing the role of scientific analyze of alternariosis attack reported in potato cultures, we used specific tools. STATISTICA 7.0 v. programme was implemented in order to assure the basis of biostatistical approach of data interpretations. The estimated parameters aims to both basic statistics (averages, dispersion parameters, Skewness, Kurtosis), and multiple regression tools (regression lines, multiple correlations, variance analysis).

3. Results and Discussions

The results of using bioinformatics in analyzing the development of *Alternaria solani* Sorauer attack on potato crops obtained in climatic conditions of Transylvanian Plane are emphasized by the outputs of each approach.

Thus, basic statistics shows that, in conditions of no fertilization and no phytosanitary treatment, was reported the biggest *Alternaria solani* Sorauer average attack degree, 16.74%, by entire experimental period, April – September 2014, respectively. The smallest *Alternaria solani* Sorauer average attack degree, 5.36%, was recorded in variant fertilized with N₅₀P₆₀K₈₀ mineral fertilizer and treated with Alcupral 50 PU (V3), while in variant (V2) fertilized with organic fertilizer, compost the *Alternaria solani* Sorauer average attack degree was of 7.03% (Table 1).

These results were recorded within climatic conditions specific for the Transylvanian Plane, and characterized by average temperature of 16.89 °C, and by high average humidity of 74%, expressed by experimental period, April – September 2014. Our results are consistent with those reported by Escuredo et al. in 2010 [4].

The dispersion parameters emphasize the homogeneity of the sample, and normal distribution. The coefficient of variability, which has values lower than 30% for of *Alternaria solani* Sorauer average attack degrees recorded in control variant and variant fertilized with N₅₀P₆₀K₈₀ and treated with Alcupral 50 PU, but also for average temperature and humidity (Table 1), confer high representativeness to this analyze. Similar results were obtained in previous research performed in the same area by Fleşeriu et al., 2012, and 2013, and by Iederan et al, 2011 [6, 7, 9]. The value of the coefficient of variability obtained in Variant 2, which is slightly above 30%, 30.25%, respectively, may be explained by the fertilization option, which being an organic one, without homogenous composition, may have different effects on crop resistance against fungus attack (Table 1).

Table 1. Basic statistics for *Alternaria solani* Sorauer attack degrees within each fertilization variant, temperature (°C), and humidity (%) during experimental period, April – September 2014

Issue	AD(%)1	AD(%) 2	AD(%)3	t (°C)	H (%)
N	24	24	24	183	183
Mean	16.74 ^a	7.03 ^{ab}	5.36 ^{ab}	16.89	74.00
Standard error of mean	0.36	0.99	0.09	0.31	0.70
Standard deviation	1.80	2.13	0.45	4.22	9.55
Coefficient of variability	10.92	30.25	8.43	24.99	13.78
Skewness	1.10	1.28	0.26	0.18	0.27
Kurtosis	1.27	0.51	1.23	0.58	0.26
ANOVA	p < 0.001	p > 0.05			

Note 1: AD(%)1 – attack degree recorded in Variant 1 unfertilized and untreated; AD(%)2 – attack degree recorded in Variant 2 N₅₀P₆₀K₈₀ fertilized and treated with Alcupral 50PU; AD(%)3 – attack degree recorded in Variant 3 organic fertilized and treated with Alcupral 50PU.

Note 2: a – p < 0.001; b – p > 0.05.

The *F* ratio of 10.259 significant at 5% significance level, suggests a difference between fertilization variants as regards the value of the *Alternaria solani* Sorauer attack degree in potato cultures, within climatic conditions of Transylvanian Plane (Table 2). This assessment is consistent with basic statistics outputs, and results of significance of differences testing, which

emphasized very significant differences The response area patterns between attack degrees recorded in experimental variants, average temperature and average humidity within experimental period, April – September 2014, emphasize correlations of different intensities, function of fertilization option and phytosanitary treatment (Fig. 1 a – c).

Table 2. The analyze of variance applied to fertilization variants V1, V2, and V3 used in experimental design

Source of variation	SS	DF	MS	<i>F</i> ratio	p value
Between fertilization variants	2.382	2	1.191	10.259	0.047
Within fertilization variants	13.780	3	4.593		
Total	16.163				

Note 1: Variant 1 – unfertilized and untreated; Variant 2 – N₅₀P₆₀K₈₀ fertilization and treatment with Alcupral 50PU; Variant 3 – organic fertilization and treatment with Alcupral 50PU.

Note 2: SS - Sum of squares; DF - Degrees of freedom; MS - Mean square.

The results of multiregression analyze show that the biggest correlation between the *Alternaria solani* Sorauer attack degree in Roclas potato variety, temperature, and humidity recorded in experimental field located in Transylvanian Plane, was identified in variant fertilized with compost and treated with Alcupral 50 PU, *R* = 0.950, representative for 90.40% of sample (Fig. 1b).

The smallest correlation was reported in variant 2, fertilized with N₅₀P₆₀K₈₀ and also treated with Alcupral 50 PU, *R* = 0.383, representative only for 14.70% of sample (Fig. 1c), while in control variant not fertilized and not phytosanitary treated, intermediary values resulted, *R* = 0.687, representative for 47.20% of sample (Fig. 1a).

Thus, the use of biostatistics and meta-models involved, as shown by previous research performed in this area [12], led to valuable output, with important consequence on practice.

Our research shows that best results, in fight against *Alternaria solani* Sorauer attack upon potato

cultures in climatic conditions of Transylvanian plane, were obtained when fertilization was performed with mineral fertilizer and phytosanitary treatment was performed with Alcupral 50PU.

This assessment is confirmed not only by the lowest attack degree reported, 5.36% (Table 1) but also by the weak multiple correlation with climatic factors taken into consideration of 0.383 (Fig. 1c), which emphasize the smallest influence of these factors upon fungus attack and enhanced efficacy of this management solution.

The use of fertilization with compost, in combination with treatment with Alcupral 50 PU, and affordable homologated phytosanitary product, 7.03% (Table 1) the cheapest solution, even led to a small *Alternaria solani* Sorauer attack degree, comparable with average attack degree reported in previously discussed solution, 5.36% (Table 1), and much smaller compared to that reported in control variant untreated and unfertilized, 16.74% (Table 1), is not recommended.

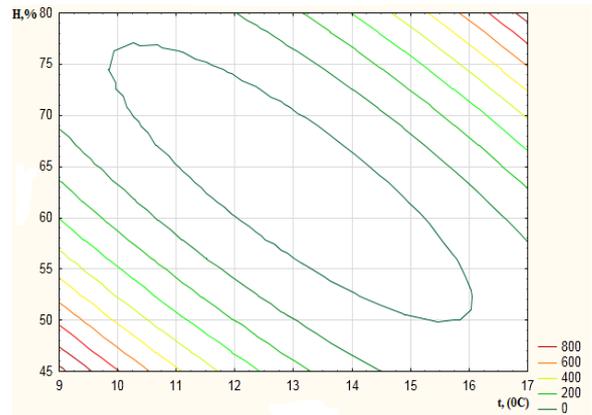
Note 1: a – response area graph concerning interaction between attack degree recorded in Variant 1 (unfertilized and untreated), average temperature and average humidity of experimental period (April – September 2014).

b – response area graph concerning interaction between attack degree recorded in Variant 2 (N₅₀P₆₀K₈₀ fertilized and treated with Alcupral 50PU) average temperature and average humidity of the experimental period (April – September 2014).

c – response area graph concerning interaction between attack degree recorded in Variant 3 (organic fertilized and treated with Alcupral 50PU) average temperature and average humidity of the experimental period (April – September 2014).

$$AD (\%)_3 = 33.469 - 1.061 t(^{\circ}C) - 1.194 H(\%)$$

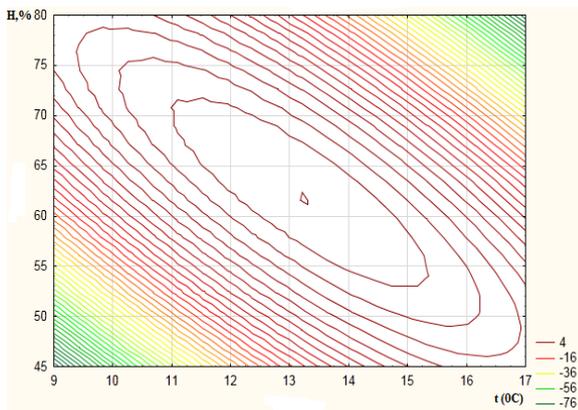
$$R = 0.687, R^2 = 0.472$$



a

$$AD (\%)_2 = 6.002 + 0.397 t(^{\circ}C) - 0.597 H(\%)$$

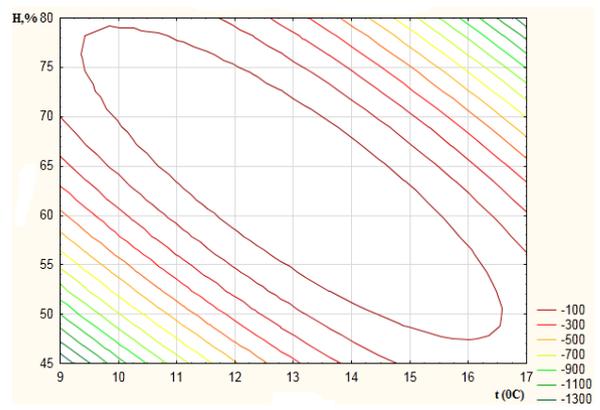
$$R = 0.9507, R^2 = 0.904$$



b

$$AD (\%)_1 = 4.512 + 0.671 t(^{\circ}C) + 0.546 H(\%)$$

$$R = 0.383, R^2 = 0.147$$



c

Figure 1. a - c: The response area patterns concerning interaction between attack degrees recorded in experimental variants, average temperature and average humidity within experimental period, April – September 2014

The reason is the very strong correlation with climatic factors, $R = 0.950$ (Fig. 1.b), which increase the vulnerability against their action. This assessment is also consistent with significance of the value of the coefficient of variation (Table 1), bigger than 30%, which signify the low representativeness of the results.

4. Conclusions

The implementation of biostatistical tools demonstrate the importance of using this method, due to synthetic and accurate results. They

emphasize, in a concise and accurate manner, the superiority of treatment with Alcupral 50 PU in cultures fertilized with mineral fertilizer N₅₀P₆₀K₈₀.

Thus, in specific climatic conditions of the year 2014, characterized by high average atmospheric humidity within analyzed area (74%), which advantages *Alternaria solani* Sorauer attack, the lowest average attack degree was reported in above mentioned experimental variant, potato culture treated with Alcupral 50 PU in cultures fertilized with mineral fertilizer N₅₀P₆₀K₈₀ – 5.36%, while the biggest attack, as expected was identified in untreated and unfertilized control – 16.74%.

References

- [1] Christ, B.J., and Maczuga S.A. (1989) The effect of fungicide schedules and inoculum levels on early blight severity and yield of potato. *Plant Dis.*, 73. 695-698.
- [2] Coakley, S., Scherm H., Chakraborty, S. (1999) Climate change and plant disease management. *Annual Review of Phytopathology*, 37. 399 – 426.
- [3] Deahl, K.L., De Muth, S.P., Sinden, S.L., Rivera-Pena, A., Stevenson, W., Loria, R., Franc, G., Weingartner, D. (2001) *Compendium of Potato Diseases*. Second Edition. APS Press. St. Paul Minnesota. USA, 106.
- [4] Escuredo, O., Seijo M., Fernández-González. M., Iglesias, I. (2010) Effects of meteorological factors on the levels of *Alternaria* spores on a potato crop. *Int J Biometeorol.* 1 – 10.
- [5] Feng, W., and Zheng, X. (2007) Essential oils to control *Alternaria alternata* in vitro and in vivo. *Food Control*, 18. 1126-1130.
- [6] Fleşeriu, A., Oroian, I., Braşovean, I., Mihai - Oroian, C., Bordea, D. (2012) Disease Risk Assessment in Potato Cultures. *Bulletin UASVM serie Agriculture*, 69(2). 183 – 188.
- [7] Fleşeriu, A., Oroian, I., Mălinaş C., Braşovean, I., Iederan, C. (2013) Study upon the *Alternaria solani* Sorauer Attack Degree on Potato Cultures function of Climatic Conditions in Transylvania. *ProEnvironment*, 6(16). 615 – 618.
- [8] Hougaard, P. (2014) Multivariate Interval-Censored Survival Data: Parametric, Semi-parametric and Non-parametric Models. In: *Statistical Modelling in Biostatistics and Bioinformatics*, MacKenzie, G., Peng, D. (Eds.). Springer. 9-21.
- [9] Iederan, C., Oroian, I., Braşovean, I., Fleşeriu, A. (2011) Considerations upon the Interactions Temperature - Rainfall - *Alternaria solani* Sorauer Attack Degree, in Potato. *ProEnvironment* 8 (4). 287 – 290.
- [10] Jones, J.W., Pickering, N.B., Rosenzweig, C., Boote, C.J. (1997) Simulated impacts of global change on crops. University of Florida, Gainesville, Florida, U.S.A., *Technical Bulletin*, 100. 411 – 434.
- [11] Kriticos, D.J., Watt, M.S., Withers, T.M., Leriche, A., and Watson M. (2010) A process-based population dynamics model to explore target and non-target impacts of a biological control agent. *Ecological Modelling*, 220. 205 – 213.
- [12] Mălinaş, C., Oroian, I., Odagiu, A., Braşovean, I., Iederan, C., Suci, A. (2013) Meta-Models Efficiency in Assessing the Vegetal Pathogens Attack. *Bulletin UASVM, Series Agriculture*, 70(2). 347 – 351.
- [13] Mendelsohn, R., Dinar, A., Sanghi, A. (1994) The effect of development on the climate sensitivity of agriculture. *Environment and Development Economics*, 6, 85 -101, 2001.
- [14] Rosenzweig, C., Iglesias, A. (1994) Implications of climate change for international agriculture: crop modelling study. Environmental Protection Agency (EPA) Washington D.C. U.S.A. 94 – 103.
- [15] Oroian, I., Florian, V., Holonec, L. (2006) *Atlas of Phytopathology*. Romanian Academy Publishing House, Bucureşti, Romania. [In Romanian]
- [16] Oroian, I. (2008) *Plant protection and environment*, Todesco Publishing House Cluj-Napoca, Romania. [In Romanian]
- [17] Oroian, I., Brasovean, I., Petrescu-Mag, V. (2011) *Compost and organic agriculture*, Bioflux Publishing House Cluj-Napoca, Romania. [In Romanian]
- [18] Rosenzweig, C., Parry, M. (1994) Potential impact of climate change on world food supply. *Nature*, 367. 133 – 138.
- [19] Sonoda, A. (1988) Analysis of spatial pattern of plant pathogens and diseased plants using geostatistics. *Phytopathology*, 78. 221 – 226.
- [20] Stevenson, W.R. (1993) Management of early blight and late blight. In: *Potato Health Management*. Rowe, R.C. (Eds), APS Press, St. Paul, MN. 141 -147.
- [21] Warren J.E. and Gregory R.G. (2005). *Statistical Methods in Bioinformatics: An Introduction*. Second edition. Springer. 111-155.
- [22] <http://www.roinno.ro/>

“This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution and reproduction in any medium, provided the original author and source are credited.”