UNIVERSITY OF AGRICULTURAL SCIENCES AND VETERINARY MEDICINE CLUJ-NAPOCA

THE USE OF META-MODELS WITH PREDICTORS IN FORECASTING THE RESPONSE OF POTATO CULTURES TO LATE BLIGHT AND ALTERNARIOSIS ATTACK, FUNCTION OF CLIMATIC CONDITIONS

Cristian Mălinaş, Antonia Odagiu*, Ioan Gh. Oroian, Ioan Braşovean, Cristian Iederan

INTRODUCTION

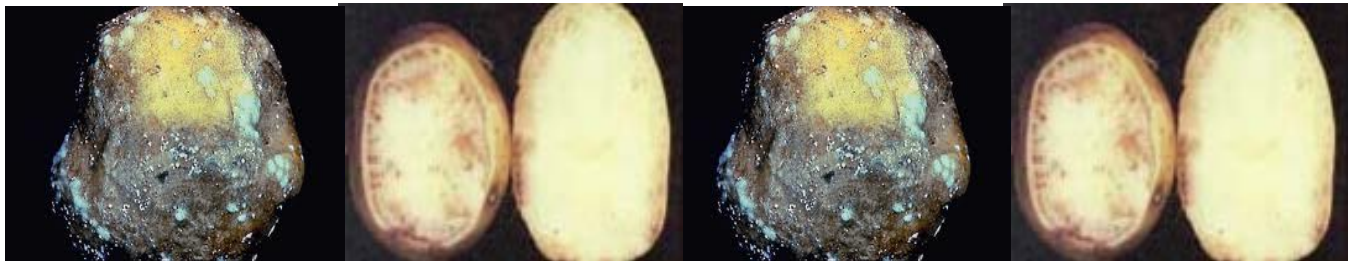
Potato is one of the most valuable food and food industry component worldwide. The importance of climatic conditions influence upon potato vulnerability against fungal diseases is a well known issue. It also is well known that *Phytophtora infestans* Mont. de Bary and *Alternaria solani* Sorauer are the most important threat for potato cultures.

Due to specific climatic conditions of our country, in early spring and early fall the attack degree of *Phytophtora infestans* Mont. de Bary and *Alternaria solani* Sorauer, early blight and alternariosis pathogens, is low because in specific climate average temperature is not more than 10 ^{0}C, and usually the rainfall supply is reduced; they increase in late spring and summer when average temperatures are around 20 ^{0}C and rainfall average more that 65 mm/month (1999, Deahl et al., 2001, Oroian et al., 2006; Puia, 2005).

As already shown, temperature and rainfall variations have serious action on early blight and alternariosis manifesting and evolution in time. Low research activity concerning the possibility of using meta-models with predictors in mapping risk against fungal diseases in potato was performed in conditions of Transylvanian Plain, Romania, where large potato cultures are a tradition.

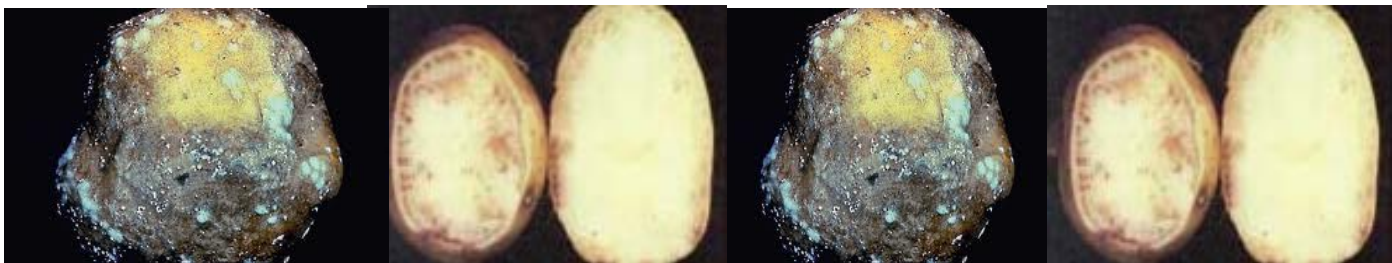
AIM

Deliverance suitable estimates, which can support decisions concerning efficient fight against fungal pathogens (*Phytophtora infestans* Mont. de Bary and *Alternaria solani* Sorauer), producing late blight and alternariosis in potato.



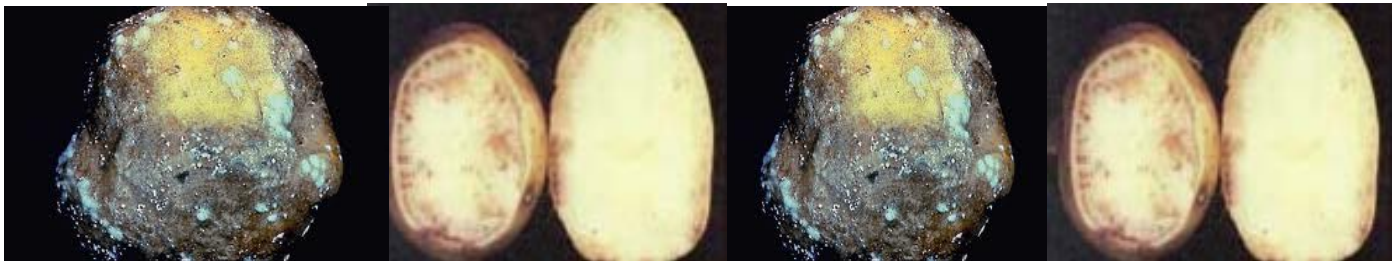
Material and Method

The study was performed in the experimental field of the University of Agricultural Sciences and Veterinary Medicine Cluj - Napoca, located in Jucu village, in neighborhood of Cluj - Napoca town.
The multiregression model was used, including 52 predictors, selected function of literature study.
According to previous published experimental data and past observed evolution of the clime in the studied area, we considered thermal, and moisture as most suitable predictors.



The thermal predictors were: minimum daily temperature in the morning, minimum daily temperature at noon, minimum daily temperature in the evening, maximum daily temperature in the morning, maximum daily temperature at noon, maximum daily temperature in the evening - in spring, summer, autumn, and winter; dew - point temperature, in spring, summer, autumn, and winter.

The moisture predictors were: minimum daily total rainfall, maximum daily total rainfall in spring, summer, autumn, and winter; minimum daily relative humidity, maximum daily relative humidity in spring, summer, autumn, and winter; minimum daily specific humidity, maximum daily specific humidity in spring, summer, autumn, and winter.



Results and Discussions

If we analyze the evolution of the interaction between attack degree of *Phytophthora infestans* Mont. de Bary in potato – temperature – rainfall, by experimental year 2012, the multiregression analyze of the monitored interactions (table 1), led to a very strong multiple correlation coefficient of 0.913 representative in share of 83.30%.

Table 1. The multiregression analyze of the *Phytophthora infestans* Mont. de Bary in potato function of temperature and rainfall during April - September 2012

Experimental year	Issue	Values
Phytophthora infestans Mont. de Bary	F	259.411
	p	0.0001
	R	0.913
	R^2	0.833
	$Y = 25.828 + 2.413X_1 + 0.119X_2$	
Alternaria solani Sorauer	F	146.013
	p	0.0001
	R	0.935
	R^2	0.874
	$Y = 22.315 + 0.121X_1 + 1.512X_2$	

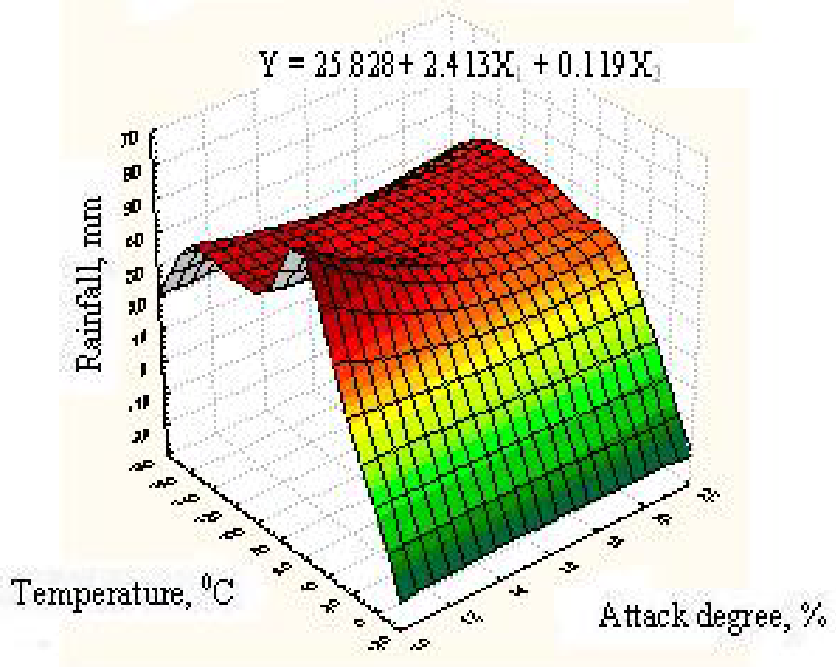
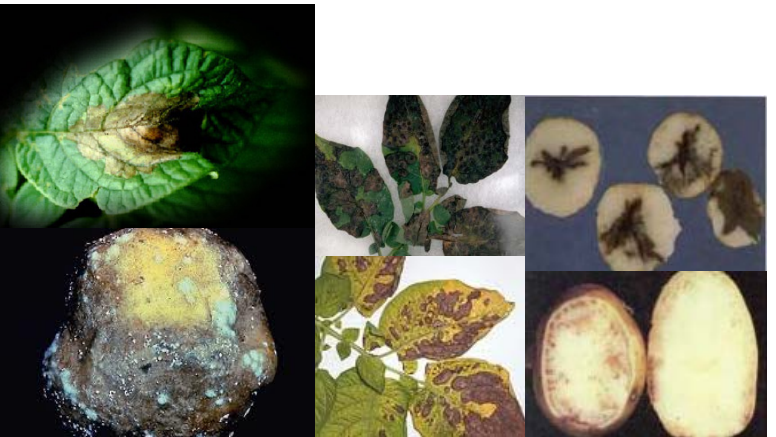


Figure 1. **The evolution of the attack degree of *Phytophthora infestans* Mont. de Bary in potato function of temperature and rainfall during April – September 2012**



The graphic representation of this complex interrelation attack degree – abiotic factors reflects a maximum intensity of the *Phytophthora infestans* Mont. de Bary attack degree by the entire year 2012 around 40 %, which is a value recorded when the rainfall average values begin with 70 mm and thermic conditions correspondent to values bigger than 17 0C (fig. 1). The analyze of the regression line,

$$Y = 25.828 + 2.413X1 + 0.119X2$$

shows by the assembly of the experimental year 2010 the much bigger influence of the thermic conditions on the *Phytophthora infestans* Mont. de Bary attack degree in potato, compared to rainfall influence on the same pathogen. In the climatic conditions of the analyzed year due to a normal rainfall regimen the rain influence was smaller.

The multiregression analyze of the monitored interactions attack degree of *Alternaria solani* Sorauer in potato – temperature – rainfall (table 1), led to a very strong multiple correlation coefficient of 0.935, representative in share of 87.40%. The analyze of the regression line, Y = 22.315 + 0.121X1 + 1.512X2 (table 1), show by the assembly of the experimental year 2012, the much bigger influence of the thermic conditions on the *Alternaria solani* Sorauer attack degree in potato, compared to rainfall influence on the same pathogen that is smaller.

Table 2. The multiregression analyze of the *Phytophthora infestans* Mont. de Bary in potato function of temperature and rainfall during April - September 2012

Experimental year	Issue	Values
Phytophthora infestans Mont. de Bary	F	259.411
	p	0.0001
	R	0.913
	R^2	0.833
	$Y = 25.828 + 2.413X_1 + 0.119X_2$	
Alternaria solani Sorauer	F	146.013
	p	0.0001
	R	0.935
	R^2	0.874
	$Y = 22.315 + 0.121X_1 + 1.512X_2$	

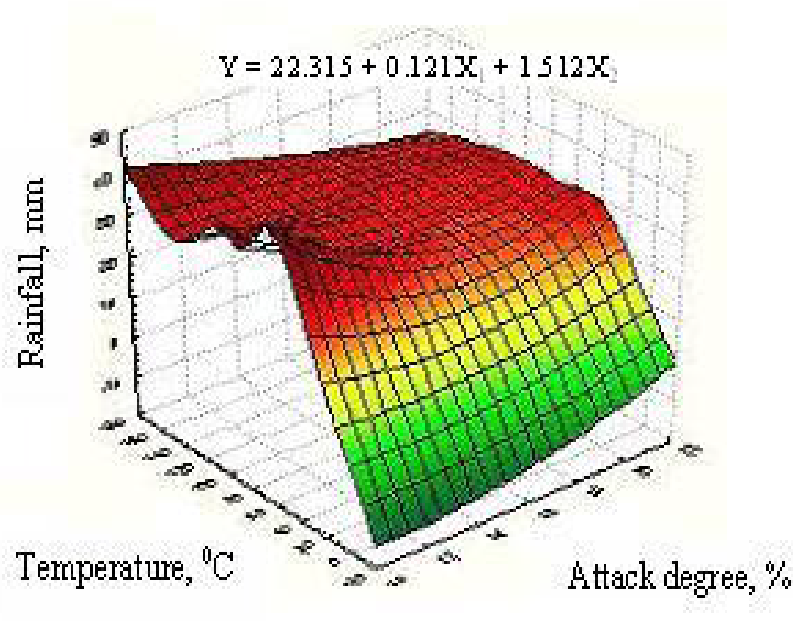
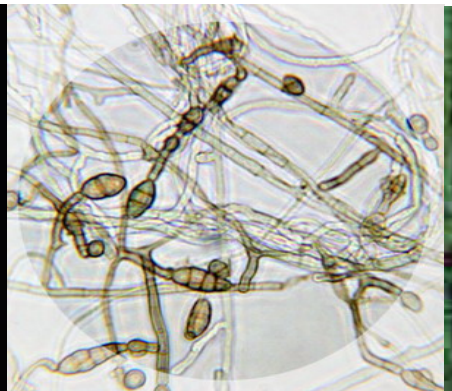
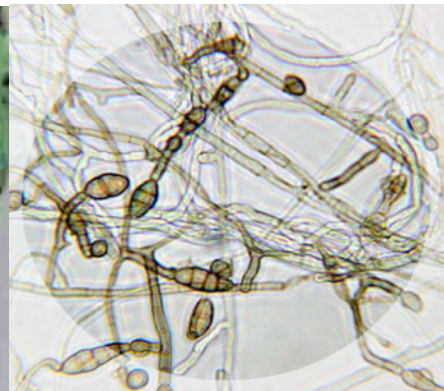


Figure 2. **The evolution of the attack degree of *Alternaria solani* Sorauer in potato function of temperature and rainfall during April – September 2012**

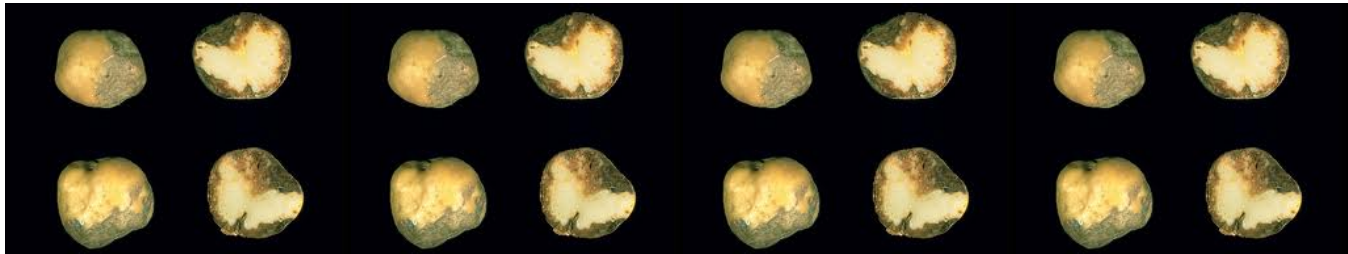
The graphic representation of this interrelation attack degree – abiotic factors reflects a maximum intensity of the *Alternaria solani* Sorauer attack degree by the entire year 2010 around 27 % recorded when the rainfall average values begin with 55 mm and thermic conditions correspondent to values bigger than 18 0C (fig. 2).





Similarly to practices used in previsional analyze concerning the influence of the abiotic factors upon productive processes in agriculture, in context of more and more obvious climatic changes, that we propose the discussion of several scenarios concerning the climatic influence on discussed pathogens attack degree.

Thus, within previsional analyze of the *Phytophthora infestans* Mont. de Bary in potato, based on he evolution of the temperature and rainfall regimen, during monitored period (April - September 2012) and regression line (Y = 25.828+ 2.413X1 + 0.119X2) we suggest the following scenarios:



The average temperature by entire predicted period increases

by 0,5 ^{0}C
AD = 26,21 %

THE RAINFALL QUANTITY INCREASES

by 50 %,
AD = 27,38 %

by 100 %,
AD = 28,54 %

by 150 %,
AD = 29,71 %

THE RAINFALL QUANTITY DECREASES

by 50 %,
AD = 20,39 %

by 100 %,
AD = 19,23 %

by 150 %,
AD = 18,06 %

by 1,0 ^{0}C
AD = 26,28 %

by 50 %,
AD = 27,45 %

by 100 %,
AD= 28,61 %

by 150 %,
AD = 29,77 %

THE RAINFALL QUANTITY INCREASES

by 1,0 ^{0}C
AD = 26,28 %

THE RAINFALL QUANTITY DECREASES

by 50 %,
AD = 20,46 %

by 100 %,
AD = 19,29 %

by 150 %,
AD = 18,13 %

by 1,5 ^{0}C
AD = 26,35 %

THE RAINFALL QUANTITY INCREASES

by 50 %,
AD = 27,51 %

by 100 %,
AD = 28,68 %

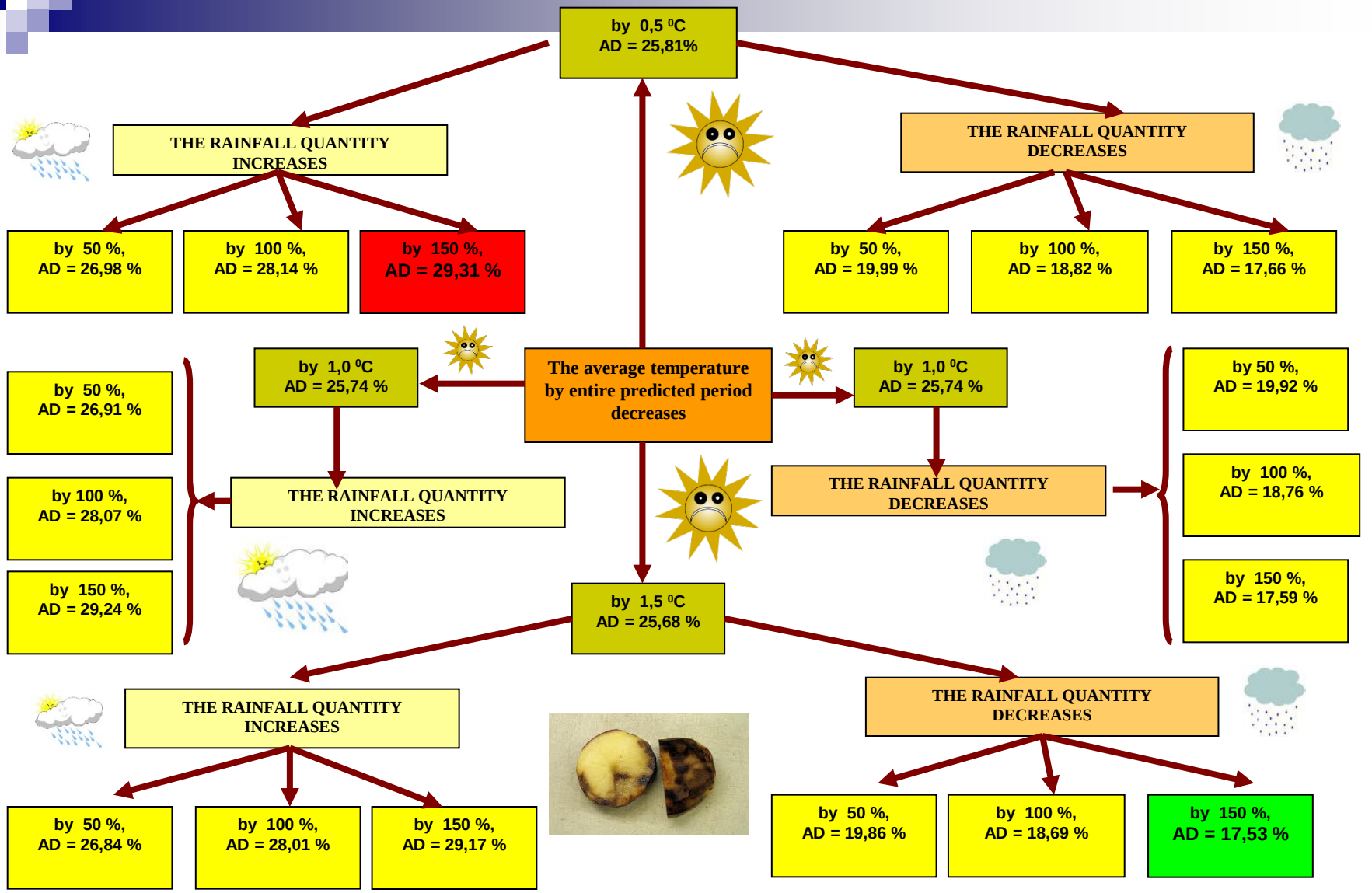
by 150 %,
AD = 29,84 %

THE RAINFALL QUANTITY DECREASES

by 50 %,
AD = 20,53 %

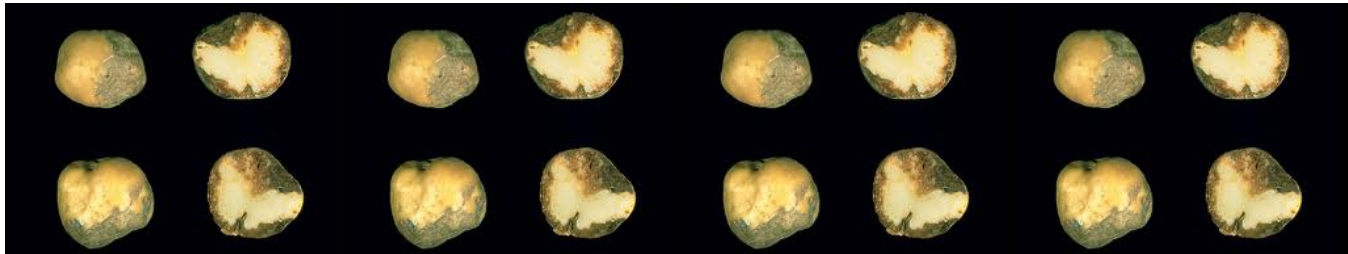
by 100 %,
AD = 19,36 %

by 150 %,
AD = 18,20 %



We find that according to applied scenarios that take into consideration the temperature variations with ± 1,5 ^{0}C and rainfall with ± 150 %, the foreseen attack degree of *Phytophthora infestans* Mont. de Bary in potato cultures from the monitored area, taking into account the regression line considered as basis for calculations, can have values framed in large interval (~ 12%), 17.53% - 29.84%, respectively.

Concerning the previsional analyze of the *Alternaria solani* Sorauer attack degree in potato, based on the evolution of the temperature and rainfall regimen, during monitored period (April - September 2012) and regression line (Y = 22.315 + 0.121X1 + 1.512X2) we suggest the following scenarios:



The average temperature by entire predicted period increases

by 0,5 ^{0}C
AD = 23,17 %

THE RAINFALL QUANTITY INCREASES

by 50 %,
AD = 24,17 %

by 100 %,
AD = 25,17 %

by 150 %,
AD = 26,18 %

THE RAINFALL QUANTITY DECREASES

by 50 %,
AD = 18,16%

by 100 %,
AD = 17,15%

by 150 %,
AD = 16,15 %

by 1,0 ^{0}C
AD = 23,21%

by 50 %,
AD = 24,21 %

by 100 %,
AD = 25,22 %

by 150 %,
AD = 26,22 %

THE RAINFALL QUANTITY INCREASES

by 1,0 ^{0}C
AD = 23,21 %

THE RAINFALL QUANTITY DECREASES

by 50 %,
AD =18,20 %

by 100 %,
AD = 17,22 %

by 150 %,
AD = 16,20 %

by 1,5 ^{0}C
AD = 23,25 %

THE RAINFALL QUANTITY INCREASES

by 50 %,
AD = 24,26 %

by 100 %,
AD = 25,26 %

by 150 %
AD = 26,27 %

THE RAINFALL QUANTITY DECREASES

by 50 %,
AD = 18,24 %

by 100 %,
AD = 17,24 %

by 150 %,
AD = 16,24 %

The average temperature by entire predicted period decreases

by 0,5 ^{0}C
AD = 22,91%

THE RAINFALL QUANTITY INCREASES

by 50 %,
AD = 23,92 %

by 100 %,
AD = 24,92 %

by 150 %,
AD = 25,93 %

THE RAINFALL QUANTITY DECREASES

by 50 %,
AD = 17,90 %

by 100 %,
AD = 16,91 %

by 150 %,
AD = 15,90 %

by 1,0 ^{0}C
AD = 22,85%

by 50 %,
AD = 23,87 %

by 100 %,
AD = 24,88 %

by 150 %,
AD = 25,88 %

THE RAINFALL QUANTITY INCREASES

by 1,0 ^{0}C
AD = 22,85 %

THE RAINFALL QUANTITY DECREASES

by 50 %,
AD = 17,86 %

by 100 %,
AD = 16,87 %

by 150 %,
AD = 15,86 %

by 1,5 ^{0}C
AD = 22,83 %

THE RAINFALL QUANTITY INCREASES

by 50 %,
AD = 23,83 %

by 100 %,
AD = 24,83 %

by 150 %,
AD = 25,84%

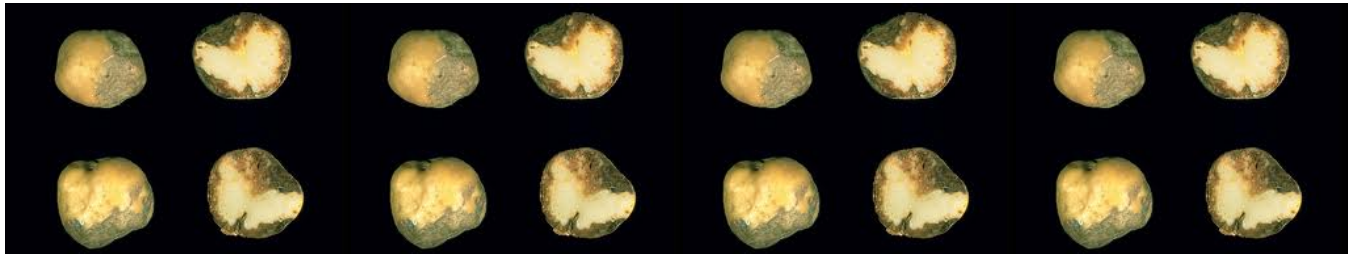
THE RAINFALL QUANTITY DECREASES

by 50 %,
AD = 17,82 %

by 100 %,
AD = 16,83 %

by 150 %,
AD = 15,82 %

Concerning the implementation of the scenarios that foresee the attack degree of *Alternaria solani* Sorauer in potato within monitored area, if we take into consideration the same domains of variation for temperature, ± 1.5 0C, respectively, and rainfall with ± 150 %, respectively, taking into account the regression line considered as basis for calculations, we find that it can have values framed in large interval (~ 10%), 15.82% - 25.48%, respectively. This interval is with 2% bigger compared to the interval calculated for the attack degree foreseen for *Phytophthora infestans* Mont. de Bary.



CONCLUSIONS

If we analyze the evolution of the interaction between the attack degree of *Phytophthora infestans* de Bary in potato – temperature – rainfall, in average, by studied period, we find that multiple correlation coefficient was of 0.913 (R^2 = 83.30%), and the analyze of the regression line, $Y = 25.828 + 2.413X_1 + 0.119X_2$, demonstrates that by the entire monitored period, the rainfall supply had a bigger influence on the attack degree compared to thermic conditions.

The predicted biggest recorded attack degree of *Phytophthora infestans* de Bary is of a 40 %, correspondent to a rainfall supply of 70 mm, and temperature of 17 ^{0}C.

The evolution of the interaction between the attack degree of *Alternaria solani* Sorauer in potato – temperature – rainfall is characterized by a multiple correlation coefficient of 0.935 (R^2 = 87.40%), and the analyze of the regression line, Y = 22.315 + 0.121X_1 + 1.512X_2, demonstrates that by the entire monitored period, the rainfall supply had a bigger influence on the attack degree compared to thermic conditions.



The predicted biggest recorded attack degree of *Alternaria solani* Sorauer is of a 27%, correspondent to a rainfall supply of 55 mm, and temperature of 18 ^{0}C.

Based on results obtained as consequence of putting into practice the foreseen scenarios, we consider that this model can be useful in strategies of protection of potato cultures, under preventive aspect, especially, because they supply the prediction possibility, in terms of foreseeing the early blight and alternariosis behavior function of abiotic factors prognosis. In this way, the phytosanitary management of potato cultures may be improved by adopting, in time, suitable measurement.




THANK YOU FOR YOUR ATTENTION