INFLUENCE OF THE APPLICATION OF ORGANIC FERTILIZERS IN ASSOCIATION WITH DIFFERENT FUNGICIDES ON THE LATE BLIGHT (*PHYTOPHTHORA INFESTANS*) ATTACK IN POTATO

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Abstract: Challenges related to adaptability to the new climatic conditions and to the efficiency of the use of inputs by different potato varieties are permanent. The experience carried out in 2017 aimed to determine the effect of some organic fertilizers on potato plants, by reducing the intensity of late blight attack and to observe the influence on yields level. The classical cultivation technology was used, including a normal fertilization regime (800 kg NPK / ha), over which foliar treatments were applied simultaneously with those for potato late blight control (*Phytophthtora infestans*). Treatments were applied to the potato variety Brasovia, created to NIRDPSB Brasov. The experience included 3 variants, a control one (untreated) to which no fertilizers were applied, a variant to which fertilizers and recommended doses of fungicides were applied and a variant with fertilizers and only 50% of the recommended fungicides doses. The results obtained with foliar treatments combined with fungicides applied for late blight control determined yield increase, 3.4 t / ha, compared to the untreated. The yield increase as a result of foliar fertilization may be due to the increase in tubers weight and the number of tubers/plant. The data obtained will be supplemented with the results of the following years so that farmers reach complex technological solutions that will contribute to the increase of the economic efficiency of the potato crop.

Key words: *potato, late blight, foliar fertilizer, yield*

INTRODUCTION

Potato is one of the world major crops. Potato is a plant with high ecological plasticity with an important role in the food security. It is well situated in different environmental conditions, being able to enter easily in rotation with plants like wheat, maize and soya. For most of the 20th century, Europe was the undisputed world leader in potato production. While that honour has now passed to Asia, seven European countries are among the top 10 global producers. The continent also has the highest level of potato consumption in the world (almost 90 kg per capita per year). Many western European countries are shifting from potato growing to processing and production of seed tubers for export (International Year of the Potato, 2008). The total world potato production is estimated at 388,191,000 tonnes in 2017 (FAOSTAT, 2019)

Late blight, caused by *Phytophthora infestans*, is the most important disease of potato and can destroy leaves, stems and tubers. *P infestans* has a hemibitrophic lifestyle, with both a biotrophic phase and a nectrophic phase (Perfect & Green, 2001; Van der Zweep, 2014). The development of late blight epidemics depends greatly on the prevailing humidity and temperature during the different stages of the life cycle of the fungus. The fungus can complete many reproductive cycles in a season, accounting for the rapid increase of disease once it becomes established in a field (Tsedaley, 2014).

Fertilizer application has important effects on the quality and yield of potato (Westermann, 2005). Uptake of fertilizer nutrients (NPK) by potato per unit area and time is high because of the rapid rate of early growth and tuber bulking. Foliar fertilization has potential for an important role in potato production.

This study was conduct to determine the effects of fungicide and fertilizer application rates on the management of late blight on potatoes in field conditions. The results of this study were expected to provide data for integrating fertilizer and fungicide in disease management of late blight.

MATERIALS AND METHODS

Trial was performed in the experimental field of the Technology and Good Agricultural Practice Laboratory to the National Institute for Research and Development for Potato and Sugar Beet Brasov in 2017.

Lay out of the plots of the field trial: randomized complete block design with 4 replicates. The experimental design included: A - one cultivar, B - two levels of foliar fertilization and C - late blight control with different fungicides (Table 1). Solid NPK:15:15:15 (800 kg/ha) fertilization was applied to the soil.

Planting was made in 1st April 2017. Chemical plant protection in the fight: weeds, Colorado beetle and late blight as well as the dose, timing of application and the choice of products were in line with current good agricultural practice.

Late blight assessment: plots were assessed for the extent of blight spots on the leaves. Each plot was assessed as a whole for percentage disease severity using a standard accepted severity key (Anonymous, 1947; Cruickshank et. al., 1982).

First symptom of late blight observation: daily check for all plots after emergence till first symptom observed in one of the plots (June 12nd 2017).

Yield assessment: two rows in the centre of each plot were harvested mentioned the number and the weight of tubers with blight.

The obtained data were subjected to the analysis of variance procedure and treatment means were compared to the L.S.D. using statistical MSTATC program.

Table 1. Treatments application

Application data/ Product	12.06. 2017	23.06.2017	05.07.2017	15.07.2017	25.07.2017	04.08.2017
Untreated (control)	-	-	-	-	-	-
Fertilizer + 100%fungicide	Refined Seaweed Extracts + Mn 8% 2l/ha + Ridomil Gold Mz 68WG 2.5 kg/ha	Refined Seaweed Extracts + Mn 8% 2l/ha + Valis M 2.25 kg/ha	Refined Seaweed Extracts + Si + trace elements 2 l/ha + Infinito 87,5SC 1.4 l/ha	Refined Seaweed Extracts + Si + trace elements 2 l/ha + Antracol 70WP 2.5 kg/ha	19% copper, 11% organic matter from complexing sugars 0.5 l/ha + Revus 250 SC 0.6 l/ha	19% copper, 11% organic matter from complexing sugars 0.5 l/ha + Shirlan 500SC 0.4 l/ha
Fertilizer + 50% fungicide	Refined Seaweed Extracts + Mn 8% 2l/ha + Ridomil Gold Mz 68WG 1.25 kg/ha	Refined Seaweed Extracts + Mn 8% 2l/ha + Valis M 1.125 kg/ha	Refined Seaweed Extracts + Si + trace elements 2 l/ha + Infinito 687,5SC 0.7 l/ha	Refined Seaweed Extracts + Si + trace elements 2 l/ha + Antracol 70 WP 1.25 kg/ha	19% copper, 11% organic matter from complexing sugars 0.5 l/ha + Revus 250 SC 0.3 l/ha	19% copper, 11% organic matter from complexing sugars 0.5 l/ha + Shirlan 500 SC 0.2 l/ha

RESULTS AND DISCUSSIONS

In 2017, the first late blight observations were made relatively early due to the favorable conditions of June, the appearance of dew on the leaves in the morning and rains.

July with rains not very high quantitatively as at short intervals was favorable to the development of the epidemic, which resulted in strong attack during which the cycles of infection followed one another at 7 days intervals, which caused the epidemic threshold of the disease to be reached at the end of the month. In August the weather was less favourable for the epidemic development, plants going to senescence (Table 2).

Table 2. Air temperature and rainfalls during the experiment

Year	Month					
	May	June	July	August	September	
	Air temperature (°C)					Average
2017	14.3	19.1	19.4	20.0	14.8	17.5
MMA	13.6	16.5	18.1	17.5	13.6	15.9
	Amount of rainfall (mm)					Total
2017	84.2	74.2	111.6	67.6	68.4	406.0
MMA	82.0	96.7	99.8	76.4	52.5	407.4

In 2017, the treatments were carried out between 12th June and 4th August, during which the assessment for late blight attack on the untreated (control) variant (V1) evolved from 1.3 to 9.0. To the treated variants, the first signs of attack were sporadic on 12th June. Based on the treatments performed, all observation data were significantly lower than the untreated plot. Data presented in Table 3 showed that length of vegetation period increase as results of fertilizer used in association with the fungicides comparative with the untreated plot. At the end of the observations in August 4th, the late blight of the treated variants was reduced between 1.6 and 2.4 as against 9.0 in the untreated plot. Among the studied treatments, the lowest scores during the observation period (between 0 and 1.6) were found in treatment with Fertilizer + 100% Fungicide, with the insignificance that statistically ensured differences were recorded only at the second and the last treatment. On June 23th, the late blight attack assessed in variant with Fertilizer + 100% Fungicide was significantly lower than that noted for variants with AlgoMel + 50%Fungicide.

Table 3. Effectiveness of different formulations of AlgoMel +fungicides program in late blight control (Braşov 2017)

No.	Treatment	Disease severity data					
		12nd June	23rd June	5th July	15th July	25th July	4th August
1	Untreated (control)	1.3 a	2.0 a	3.5 a	5.5 a	7.8 a	9.0 a
2	Fertilizer + 100% Fungicide	0.0 b	0.1 c	1.3 b	1.8 b	1.9 b	1.6 d
3	Fertilizer + 50% Fungicide	0.3 b	0.8 b	1.8 b	2.4 b	2.6 b	2.4 cd
	LSD	0.4	0.5	0.8	0.7	0.7	0.7

No phytotoxicity symptoms have been shown in the experimental plots. No symptoms such as chlorosis, necrosis and deformation of leaves as well as reduction of height plants, distortion and delay of the flowering were observed in the treated plots.

Regarding the yield (Table 4) the difference between Fertilizers + 100% fungicides and Fertilizers + 50% fungicide was not statistically assured. The difference occurs in the case of blighted tubers, % of affected tubers being smaller, statistically assured (0.3669 t/ha).

Table 4. The effect of fertilizers and late blight treatments on the yield to Brasovia variety (Braşov, 18.09.17)

No	Name	YLDCA1 28-40 mm tuber size	YLDCA2 40-65 mm tuber size	YLDCA3 65-85 mm tuber size	YLDTOT		Tubers with blight	
					t/ha	Dif. t/ha	t/ha	% yield of blighted tubers
1	Untreated (control)	1.552 a	10.63 a	25.47 a	38.12 a (100%)	-	0.468 a	1.342a
2	Fertilizer + 100% Fungicide	1.768 a	12.66 a	27.02 ab	41.53 a (108.94 %)	+3,4	0.088 ab	0.215 b
3	Fertilizer + 50% Fungicide	1.516 a	10.82 a	26.52 ab	39.13 a (102.64%)	+1,0	0.27 ab	0.627 ab
LSD (P=.05)		0.7186	3.388	6.746	8.722		0.3669	1.002

CONCLUSIONS

Application of foliar fertilizer in addition to late blight treatments brought an increase of yield of 3.4 t/ha.

It could be concluded that increasing productivity of potato plants as a result of foliar fertilizer may be due to increase in weight and numbers of tuber/plant which in turn increased the total tubers yield (t/ha).

The data from one year will be completed by the results obtained in the years to come, so that the potato farmers have alternative and complex solutions for the diseases control.

In the future, an integrated pest management (IPM) which combine the selective use of fungicides with the resistance of potato varieties, methods of forecasting and cultural practices management it will prove to be the most effective option.

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