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NONCHEMICAL VERSUS CHEMICAL PROTECTION IN POTATO BLIGHT

György SZABÓ

The University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Mărășești, District 1, 011464, Bucharest, Romania, Mobile: +40744 538 025, Email: szabogyorgy68@yahoo.com

Corresponding author: szabogyorgy68@yahoo.com

Abstract

The purpose of the paper was to broadly present the specific issues connected to potato cultivation. There are approached aspects of those issues that are not examined enough or the issues which are not yet solved, namely plant nutrient disorders caused by plant protection. There is a specialised field of work concerned with the above topic, but the efficient solutions are few. The majority of solutions recommend chemical intervention, but this does not compile with the recent orientations regarding the EU new Common Agricultural Policy reform expresses in Green Deal that points out the need as production technologies to be environmentally friendly and products to be healthy for assuring food safety. For this reason, in the paper it is presented a biological environmental protection solution in potato cropping for Ila variety compared to chemical protection applied to Kloepatra variety.

Key words: *micro-elements, Ila variety, fungicide contact, systemic*

INTRODUCTION

Potato is an important food crop in the world and in Europe as well.

In 2020, potato was cultivated on 1.7 million ha from which there were harvested 55 million tons. Of the total surface, 76.8% is cultivated in Poland, Germany, France, Romania, Netherlands and Belgium [8].

In Romania, potato is a basic food a reason for which the plant is cultivated on an important surface and production was efficient to cover costs and assure a profit to producers till the moment on climate change started to affect yields and the potatoes imported from Poland to compete on the Romanian market [17, 18].

In 2020, in Romania there were cultivated on 166,000 ha representing 10 % of the EU area with potatoes, and in 2020, potato production accounted for 2,683 thousand tons, representing 5% of the EU output [8].

Potato crop is being affected by different pathogens such as: fungi, viruses and nematodes, which could cause important yield losses, if proper protection measures are not applied.

There are known various methods for disease management in potato crop, such as: chemical control, biological control, the use of resistant varieties, cultural control and physical control. As resistant varieties are the best, but they are break down their resistance over the years. For this reason, chemical management is considered the best alternative, but it has a negative impact on soil, water and final product quality due to the residues released and certain pathogens have showed resistance to a few classes of fungicides and bactericides. The biological control is more and more required as it is based on naturally occurring living organisms which could manage the diseases but also they could increase potato yield [13]. Potato blight is one of the most important diseases being caused by a fungus *Phytopthora infestans* which causes damages to many farmers from many European countries if the corresponding management control is not applied [6].

Many farmers are still dependent on chemical treatments using the products carried out by manufactures and distributed in the market of chemicals for agriculture [5].

For antifungal protection, the manufacturers and the trade offer many superior/high quality fungicides. The recommendations for the application and use of the chemicals offered don't mention that improper application may result in various nutrient disorders, thus affecting plant fertility. There are also scarce mentions of the heavy metals applied with the pesticides, as micro-elements, to what extent they are incorporated in the plant and to what extent is the plant enriched, leading to significant nutrient disorder.

Recently, many studies were oriented to the application of various biological methods against potato blight [7, 9].

Many scientists and practitioners affirm that that the presence of micro-elements in the soil and the micro-element content of the fungicide (Cu, Mn, Zn, B) are very important when antifungal protection management has to be applied to potato crop [1].

Blight prevention is often based on Cu-based chemicals.

The systemic contact element most frequently used in the combination of contact materials is also Cu.

Under conditions of intensive cultivation, it is necessary to provide protection against 10-12 fungi. The micro-element applied to the foliage through fungicides is incorporated in large quantities in the foliage, significantly altering the plant's nutrient ratio. For a long time, no attention was paid to this condition which acted to reduce the production/the yield.

In this context, the purpose of this paper was to present an original research work experiment regarding the antifungal protection in potato crop, taking into consideration that the presence of micro-elements in the soil and the micro-element content of the fungicide which could determine the emergence of blight-resistant varieties.

MATERIALS AND METHODS

The emergence of blight-resistant varieties, e.g. Ila, [4] was supposed to be connected to the micro-element enrichment caused by pesticides, to the alteration effected to an exaggerated extent on macro-elements [4].

The supplementation of nutrients on the areas under analysis was carried out based on a soil analysis report.

In the experiment, there were used two potato varieties: Ila cultivated on 1 ha and Kleopátra cultivated on 2 ha.

We have applied a similar quantity for each variety, thus the area can be considered homogeneous.

The varieties were planted in immediate proximity. The difference is that the Ila variety, because of its high blight resistance, was not treated with fungicides, while the other varieties were treated each according to their needs.

The cultivation was intensive [15] on a several ha area with the involvement of several farmers from Mórahalom, in Csongrád-Csanád county, in the Southern Great Plain region of Southern Hungary.

The foliage from the varieties used in this experiment on an area of 1 ha was comparatively analyzed in the stage of phenophase: the beginning of the flowering period.

RESULTS AND DISCUSSIONS

Non chemical protection - Ila variety

The results of the foliage analysis for potatoes of Ila variety, grown without any chemicals, are available in the attached Table 1 [19].

At a first glance, the excess of N seems to be a professional error, as a result of which the foliage grew up to 150-160 cm, there was a vegetative growth, and a relative lack of K was measured.

Chemical protection - Kleopatra variety

The results of the foliage analysis for potato plants that were protected by chemicals are presented in Table 2.

Kleopatra [4] was treated three times with Cu-based anti-blight pesticides. The foliage was around 50-60 cm, the rows did not fuse, the plant analysis showed an absolute and relative lack of N and P, the supply of K was excessive, the Cu level was 46 times higher than intended.

When the Ila and Kleopatra varieties were grown one next to the other, under similar soil and nutrient conditions, the foliage of the Kleopatra variety during phenophase did not fuse, its stalk grew up to 50-60 cm, while the Kleopatra stalk grew up to 150-160 cm, Ila was not treated with pesticides, **the only difference being the plant protection.**

Table 1. Results of plant analysis in Ila potato variety, untreated with any chemicals

Sample code	Dry matter %	N	P	K	Ca	Mg	Na Ppm	Fe ppm	Mn ppm	Zn ppm	Cu ppm	Mo ppm	B ppm
			Dry matter in %										
0001	0.0	5.48	0.51	4.86	1.46	0.53	0	160	59	20.7	9.9	0.00	26.00
Average:		5.48	0.51	4.86	1.46	0.53	0	160	59	20.7	9.9	0.00	26.00
Nutrient ratios:				N/P	N/K	K/P	Ca/P	K/Ca	K/Mg	Ca/Mg		P/Zn	
				10.7	1.1	9.5	2.9	3.3	9.2	2.8	KKOK N/Cu	246	

Graphic assessment of the analysis results	< Satisfactory supply	>
N	4.50	6.50
5.48		
P	0.30	0.50
0.51		>
K	4.50	6.00
4.86		
Ca	0.70	3.00
1.46		
Mg	0.30	0.80
0.53		
Mn	30.00	280.00
59		
Zn	25.00	40.00
20.7		
Cu	7.00	10.00
9.9		

Source: Own results.

Table 2. Results of plant analysis in Kleopatra potato variety, protected by chemicals

Sample code	Dry matter %	N	P	K	Ca	Mg	Na ppm	Fe ppm	Mn ppm	Zn ppm	Cu ppm	Mo ppm	B ppm
			Dry matter in %										
0001	0.0	3.59	0.21	6.21	2.78	0.63	0	294	96	35.0	460.0	0.00	18.90
Average:		3.59	0.21	6.21	2.78	0.63	0	294	96	35.0	460.0	0.00	18.90
Nutrient ratios:				N/P	N/K	K/P	Ca/P	K/Ca	K/Mg	Ca/Mg		P/Zn	
				17.1	0.6	29.6	13.2	2.2	9.9	4.4	TO N/Cu	60	

Graphic assessment of the analysis results	< Satisfactory supply	>
N	4.50	6.50
3.59		
P	0.30	0.50
0.21		
K	4.50	6.00
6.21		>
Ca	0.70	3.00
2.78		
Mg	0.30	030
0.63		
Mn	30.00	280.00
96		
Zn	25.00	40.00
35.0		
Cu	7.00	10.00
460.0		>

Source: Own results.

After carrying out an analysis of the plant foliage, we obtained the results presented in Table 3.

Table 3. The content of N, P, K and Cu in the plant foliage

Variety	N/ dry matter in %	P/ dry matter in %	K/ dry matter in %	Cu ppm
Optimal value limits	**4.5-6.5**	**0.3-0.5**	**4.5-6.0**	**7-10**
Kleopatra: /after five Copper sprays/	**3.59**	**0.21**	**6.21**	**460**
Ila without spraying	**5.48**	**0.51**	**4.5**	**9.9**

Source: Own results.

For the Kleopatra variety, the large Cu quantity prevented the absorption of N and P /antagonist effect/.

It also prevented the absorption of Zn, to a lesser extent than for the two aforementioned elements.

Following the change in nutrient ratios, the enzyme ratios in the plant also changed. The result was a smaller assimilated foliage area, a lower yield.

For the Ila variety, the stalk that grew too high is related to the fact that the quantity of N absorbed is higher than necessary. As a result of the excess of N, [16] the stalk was etiolated and it became sensitive to fungal infections, because a soft tissue was obtained. Another disadvantage is that the quality of the tuber has also decreased.

The applicable nutrient was determined based on the results of the soil analysis, according to the data generally accepted by the literature as shown in Table 4.

Table 4. Nutrient application based on the results of the soil analysis

A yield of 1 t required per nutrient kg	**N**	**P_2O_5**	**K_2O**
	5	2.2	8.2

Source: Own results.

The nutrient supplementation was carried out by 26 potato growers on an area of more than 280 ha. During phenophase, we requested 47 sets of plant analyses, the results of which were presented above. We obtained the results above in all cases, without exception.

The only difference was that a chemical combination increased the Cu level [2] to a larger extent than the other, but the larger Cu quantity prevented in all cases, without exception, the absorption of N and P and the development of the relevant assimilation area.

The Cu level measured in plants was between 200-640 ppm, compared to 7-10 ppm, which is the permitted limited for plants, i.e. 20-64 times higher.

It can also be concluded that some systemic chemicals significantly increase Cu absorption in plants.

The excessive Cu level decreased the N level by a third and the P level by half. Furthermore, the K level of the plants increased.

There is no doubt that the Cu-based pesticides applied offer an excellent protection against infection.

We did not carry out any measurements to determine whether the Cu level increased in the tuber, and if so, how much.

Four of the growers did not use Cu-based fungicides until the potato plants bloomed, on a total area of 72 ha. The protection of the plants on this 72 ha area was based on Mn-based fungicides or purely systemic chemicals.

Regardless of the land or of the variety, in all cases, without exception, the outcome was that the potato stalk grew up to 130-160 cm [3]. Furthermore, plant analysis, regardless of variety, showed a Cu content within the 9-17 ppm range. This small fluctuation may also be due to the differences between varieties. Based on the measurements carried out, as regards the use of Mn-based pesticides, no significant excess of Cu was seen, but an excess of N was measured in all cases.

As for the treatments, where the Cu level was not increased multiple times, the fertilisation using N carried out according to previous experiments resulted in excessive N.

The analyses were carried out on soils with the pH in the 7-8.6 range [10]. These are mainly soils poor in micro-elements, Mn, Zn, B. After the use of Mn-based fungicides, the plant's Mn level increased to an optimal level, therefore it had a fertilising effect on the foliage. It had a highly favourable effect on the yield.

In our case, Mn-based pesticides led to a significant vegetative growth of the potato stalk.

Therefore, the type of soil could influence and its content in minerals could cause plant nutrient disorders if the application of pesticides is unilateral. It is the case of alkaline soil containing Cu and of the acid soil containing Mn [11,12].

Also, Cu absorption could speed up in case of a combination of absorbable and contact materials [14].

Regardless of variety, the plant analysis revealed an excess of N, which is why the stalk grew taller than necessary. The Mn-based pesticide acted as a fertiliser for the foliage, and the Cu caused a ion antagonism that prevented the absorption of N and P.

CONCLUSIONS

1.To avoid the over-dosage of certain elements, plant protection must be based on nutrient analysis.

2. A quantity of 5 kg of N is not required for 1 t, a smaller quantity is sufficient.

3. The number of roots recommended so far must be reviewed.

4.The part of the pesticides containing heavy metals can be incorporated in the plant foliage, thus changing the plant's element ratio. This doesn't cause any growth disorders, unless the nutrient ratios are significantly altered.

5.In cases where the plant cannot absorb the desired quantity of an element in the soil because the soil doesn't contain enough of it, the part of the pesticide containing micro-element acts as a fertiliser for the foliage, improving the supply of nutrients.

6.If the elements applied to the foliage as pesticide are in sufficient quantities, this leads to excessive fertilisation, and some micro-elements are absorbed into the plant to an unwanted extent. The ratio of the elements thus altered, as a result of the ion antagonism, may lead to a reduced yield. In our case there was an over-dosage of Cu.

7.The unilateral application of pesticides, which cause plant nutrient disorders, may be also determined by the type of soil. It is the case of alkaline soil containing Cu and the acid soil containing Mn.

8.The combination of absorbable and contact materials could speed up the plant's Cu absorption.

9.In each case, with just one treatment, a quantity as much as forty times higher than the desired quantity may be introduced.

10.In my opinion, plant protection starts will an optimal supply of nutrients. The results of the soil analysis and plant analysis show what the plant is lacking, based on which the proper pesticide may be selected.

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REFERENCES

[1]Agraragazat.hu, 2019, A mikro- és mezoelemek szerepe a növénytermesztésben (The role of micro- and meso-elements in crop production), https://agraragazat.hu/hir/a-mikro-es-mezoelemek-szerepe-a-novenytermesztesben/, Accessed on January 10, 2022.

[2]Bohacs, A., 2021, Réztartalmú gombaölők - Mikor, mire, hogyan használjuk a kertben? (Copper fungicides - When, by, how to use in the garden), AGRARoldal, https://www.agraroldal.hu/reztartalmu-gombaoloszerek.html, Accessed on January 10, 2022.

[3]Borsos, J., Pusztai, P., Radics, L., Szeman, L., Tomposne, L.V., 1994, Szantoföldi növenytermesztestan (Field Crop Production),

University of Horticulture and Food Industry, Faculty of Horticulture, Budapest, Editor Dr. Radics Laszlo, https://mek.oszk.hu/01200/01216/01216.htm, Accessed on January 10, 2022.

[4]Certified varieties, http://www.obtt.hu/tudnivalok/minositett-fajtak, Accessed on January 10, 2022.

[5]Cohen, Y., Rubin, A.E., 2020, A new startegy for durable control of late blight in potato by a single soil application of an oxathiapiprolin mixture in early season, PLoS ONE, 15(8)E0238148.

[6]Cooke, L. R., Schepers, H. T. A. M., Hermansen, A., Bain, R. A., Bradshaw, N. J., Ritchie, F., Shaw, D. S., Evenhuis, A., Kessel, G. J. T., Wander, J. G. N., Andersson, B., Hansen, J.G., Hannukkala, A., Naerstad, R., Nielsen, B. J., 2011, Epidemiology and Integrated Control of Potato Late Blight in Europe, Potato Research, 54, 183-222,

[7]Cwalina-Ambroziak, B., Damszel, M., Glosek, M., 2015, The effect of biological and chemical control agents on the health status of the very early potato cultivar Rosara, Journal of Plant Protection Research, 55(4).

[8]Eurostat, 2021, The EU potato sector - statistics on production, prices and trade, https://ec.europa.eu/eurostat/statistics-explained/index.php?title=The_EU_potato_sector_-_statistics_on_production,_prices_and_trade#Potato_production_in_the_EU_is_highly_concentrated, Accessed on January 10, 2022.

[9]Evenhuis, A., Schepers, H.T.A.M., 2020, Efficacy to control potato late blight by applying biological crop protection products, Wageningen University and Research Foundation, https://edepot.wur.nl/541281, Accessed on January 10, 2022.

[10]Fazekas, S., Talajvizsgálatok végzése helyszíni gyorsviszgalattal (Carrying out soil tests with on - site rapid inspection), NSZFI, Name of the requirements module: Tasks of water and wastewater technologist and water technician Sándor Fazekas Carrying out soil tests by on-site rapid inspection, Requirement module number: 1223-06 Content item identification number and target group: SzT-023-50, (Vocational Training Documents/Input Competence Measurement Assessment System) https://www.nive.hu/Downloads/Szakkepzesi_dokumentumok/Bemeneti_kompetenciak_meresi_ertekelesi_eszkozrendszerenek_kialakitasa/14_1223_023_101115.pdf, Accessed on January 10, 2022.

[11]Gazigazito, 2022, It's not a disease, they're hungry. He is short of nutrients (Mode, page and content), http://gazigazito.hu/?modul=oldal&tartalom=1186198, Accessed on January 10, 2022.

[12]Kocsis, I., 2009, Talajtan és agrokémia (Soil science and agrochemistry), https://dtk.tankonyvtar.hu/bitstream/handle/123456789/3188/Talajtan_es_agrokemia.pdf?sequence=1&isAllowed=y, Accessed on January 10, 2022.

[13]Lal, M., Yadav, S., Singh, V., Nagesh, M., 2016, The Use of Bio-Agents for Management of Potato Diseases, IntechOpen, https://www.intechopen.com/chapters/52020, Accessed on January 10, 2022.

[14]Magro.hu, Agrarian News, 2020, A növény beszél hozzánk, aki érti, annak terméstöbblettel hálálja meg ezt (The plant speaks to us who understand it, thanks to its surplus fruit), https://www.magro.hu/agrarhirek/a-noveny-beszel-hozzank-aki-erti-annak-termestobblettel-halalja-meg-ezt-pro-, Accessed on January 10, 2022.

[15]MezoHir,hu, 2022, A burgonya termesztési lehetőségei (Potato growing opportunities), https://mezohir.hu/2019/12/26/a-burgonya-termesztesi-lehetosegei/, Accessed on January 10, 2022.

[16]Peremartoni Fertilizers, 2022, The role of nutrients in the physiological processes of plants with professional eyes, https://perefert.hu/tapelemek-szerepe-a-noevenyek-eletteni-folyamataiban-es-termeskepzesben-szakmai-szemmel-0-2022, Accessed on January 10, 2022.

[17]Pop, C., Popescu, A., 2012, Study on the Evolution of Potato Production in Romania during the period 1990-2009, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.12(2), 109-116.

[18]Pop, C., Popescu, A., 2012, Research regarding Gross Margin and Cost Analysis in Potato Cropping in Romania, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.12(2),103-108.

[19]Zoltán, O., 2012, Burgonyatermesztés amiről kevés szó esik (Potato production about which there is little talk).