INFLUENCE OF ORGANO-MINERAL FERTILIZATION ON POTATO IN THE MOUNTAIN AREA, WITH RESPECT TO THE N, P, K TUBER CONTENT

Marilena MĂRGHITAŞ, M. RUSU, C. TOADER, Mihaela MIHAI

University of Agricultural Sciences and Veterinary Medicine, Faculty of Agriculture
3-5, Mănăştur Street, 400372, Cluj-Napoca, Romania Phone: +40-264-596384; fax: +40-264-593792;
Corresponding author: mmarghitas@usamvcluj.ro

Abstract: *The paper emphasizes the effect of organoo-mineral fertilization on tuber production and the content of the main mineral elements in the Semenic potato variety, under crop in the mountai region, in a rather harsh natural environment characterized by a damp and cold climate and the low quality of soils in the area. From a nutritional point of view, potato is considered a high-demand plant in terms of nutritive elements, as it forms and abundant plant mass and a high tuber quantity for the surface unit. It is a highly-consuming in nitrogen, phosphorus, potassium, magnesium and calcium, as well as microlements. The mineral element uptake in the soils for potato crop is high, thus determining the quick soil impovershment and requiring the proper fertilization of potato crop, which is adequate to the specific management system in the mountain area. Known as the basic occupation of the locals in the area, especially in animal breeding, thus obtaining a large quantity of organic fertilizers that, through a rational employment represent the mai fertilizing source for crops in the area. The cultivated assortment of crops in the area is limited to potato, rye, oat, certain fruit-trees and vegetables, while the rest of lands are covered with natural pastures and forests. For this assortment, potato shows he highest percentage, as it is an essential food product for locals and their animals, as the basic food support of people in the area. The organic matter formed in the soil on the basis of natural fertilizers positively influences the soil's physical traits, contributes to the decraese of wind and water erosion, diminishes nutrition imbalances and enhances the effect of mineral fertilizers applied to complete the necessary of nutritional elements for plants. The paper aims at a correct assessment of the organo-mineral fertilizer requirement on the basis of the uptake of the main nutritive elements in the soil alongside the harvests and the relevant values- agrochemical indices of the soil, towards maintaining and enhancing soil fertility in the mountain area.*

Key words**:** *soIl, fertilization, mineral elements, potato*

INTRODUCTION

The paper relies on the rigorous experiments on a Districamosoil in the Apuseni Mountains area, with differentiated fertilization systems: complex mineral, organic and organo-mineral in the semiearly potato variety Semenic.

Production results in the present paper certify the significat effect of all fertilization systems and forms, thus proving that the association of organic fertilization with the complex mineral one determines the highest production results. First and foremost, those production results can be considered relevant where the presence of the complex mineral combination (NPK), on a organic support presents the highest doses in optimum-balanced ratios between nutrients. Superior results, similar to the organo-mineral system, considered to be the most effective, are obtained in the case of complex NPK mineral fertilization with higher nutrient doses and an optimum nutritive balance that complies with the level of specific and global cosumption requirements of the potato.

Regarding the variation of the main mineral elements in potato tubers for the Semenic variety, the influence of the rising level of mineral fertilization on organic support on the

mineral element content in potato tubers is highly noticeable, compared to the unfertilized control variant and single-fertilized variants.

MATERIAL AND METHODS

The experiment was conducted in conditions similar to those employed to obtain the potato production in a mountai area, being placed during three experimental years on a brown acidic soil (Distrocambosoil) located in the high subrea of the Apuseni Mounntains, between the Găina Cruce (altitudes 1465 m) and Curcubăta Mare (altitude 1848 m) peaks, at the basis of the north-north western slope of the Arieşul Mic river basin. The experimental field was placed in the lower part of the mountain climate area (under the beech and mixed forest area). In these areas, soils underwent solification processes, dealkalinization and decarbonatation phenomena, as well as clayfication and acidic humus accumulation in „acidic mull" and „moder" forms, from a geomorphological and geologic point of view. The geolithologic substratum is formed of metamorphic rocks, crystalline schists, conglomerates, clay and ferruginous sandstone.

The experiment was polyfactorial with two factors, placed according to the subdivised lot method wih the flllowing graduations:

Factor A: potato variety with graduations: a_1 – Semenic;

Factor B: level of fertilization with graduations:

b_0 – 0N + 0 P_2O_5 + 0 K_2O (kg s.a./ha)+ 0 t/ha manure (M. unfertilized);
b_1 – 0N + 0 P_2O_5 + 0 K_2O (kg s.a./ha)+ 40 t/ha manure;
b_2 – 50N + 30 P_2O_5 + 50 K_2O (kg s.a./ha)+ 0 t/ha manure;
b_3 – 100N + 60 P_2O_5 +100 K_2O (kg s.a./ha)+ 0 t/ha manure;
b_4 – 50N + 30 P_2O_5 + 50 K_2O (kg s.a./ha)+ 40 t/ha manure;
b_5 – 100N + 60 P_2O_5 +100 K_2O (kg s.a./ha)+ 40 t/ha manure;

In the case of polyfactorial experiments with two factors, the first with a graduation and the second with two graduations, a number of 6 variants resulted (table 1).

The biologic material employed for the experimentation was the elite Semenic category, sorted before planting and employing only healthy tubers, with a 40-70 g weigth.

The potato variety under experiment is part of the precocious group of semiealry varieties, beig one of the most widespread varieties cultivated in the mountain region under study, due to its resistace to potato canker, mildly resistant to common canker, resistant to blight, to the Y virus, but sensitive however to leaf roll virus and its the suitability for the less favourable conditions of growth and devlopment for the majority of agricultural plants under crop. In choosing the cropping system for potato cultivation, its biologic traits were considered, as well as the high requirements for the preparation and structuring of the soil. As such, during the three experimental years, the previous crop was rye, which was early removed from the land, thus providing the opportunity for potato cultivation through summer ploughing at a 15-20 cm depth.

In autumn, more precisely October, organic fertilizers were applied, as well as chemical fertilizers with phosphorus and potassium, in the doses required for experimental variants.

Fertilizer soil incorporation was conducted through autumn ploughing at a 25-30 cm depth, with the PP-3-30 plough.

Land fertilization employing chemical nitrogen fertilizers was conducted in spring, namely March, using urea for the production of each experimental year, in the doses required for the exprimental variants.

The soil incorporation of these ferilizers was performed immediately after application, at a 17-18 cm depth.

For an increasingly aerated soil, which is both well structured and sufficiently aerated, the lasnd was prepared by cultivator, in order to achieve a 17-18 cm planting.

Tuber plating for the three experimental years was conducted manually, at the end of March, the beginning April, thus following the fertilization pattern .

Maintenace works during the vegetation period aimed at soil aeration, weed cotrol and the control of diseases and pests.

Disease and pest control was conducted over time, according to the moment of occurence and crop year, applying three treatments each experimental year to control the Colorado beetle, blight, both in a mixture with an insecticide, as well as by themselves, according to the attack severity, starting with the month of June, up to the physiologic maturation of potato plants.

Before harvesting, frontal and vaccial removals were conducted, as required by experimental tecique rules.

Harvesting was conducted manually, 10-15 days from the physiologic maturation of each variety, sufficiently enough for tuber periderma (peel) to suber.

Production determination was conducted by weighing for each variant, referencing tuber production to the surface unit (hectare), the production was transported, stored and capitalized in raffia sacks.

The chemical analysis of the main mineral elements from potato tubers was conducted according to the ICPA method for agrochemistry laboratories „Methodology for the analysis of the plant for the assessment of the mineral nutrition state". ICPA, 1980.

RESULTS AND DISCUSSIONS

The statistical processing of average tuber productions for the experimental period (2007-2009) allow for an assessment of the effects of differentiated fertilization for the Semenic potato variety under study in the pedoclimatic area of the Apuseni Mountains (table 1).

Table 1

The effect of differentiated organo-mineral fertilization on the average tuber production for the Semenic potato variety in the Apuseni Mts area, (2007-2009 period)

N.	Variety	Fertilization variant	Average production (t/ha)	%	Difference	Significance
1	Semenic	V0 – 0N+ $0P_2O_5$+ $0K_2O$ (kg s.a./ha)+ 0t/ha manure (Control)	15,21	100,0	0,00	Mt.
2		V1 – 0N+ $0P_2O_5$+ $0K_2O$ (kg s.a./ha)+ 40t/ha manure	20,84	137,0	5,63	**
3		V2 – 50N+ $30P_2O_5$+ $50K_2O$ (kg s.a./ha)+ 0t/ha manure	21,07	138,5	5,86	**
4		V3 – 100N+ $60P_2O_5$+ $100K_2O$ (kg s.a./ha)+ 0t/ha manure	24,33	160,0	9,12	***
5		V4 – 50N+ $30P_2O_5$+ $50K_2O$ (kg s.a./ha)+ 40t/ha manure	26,16	172,0	10,95	***
6		V5 – 100N+ $60P_2O_5$+ $100K_2O$ (kg s.a./ha)+ 40t/ha manure	27,78	182,6	12,57	***

DL (p 5%) 3,42
DL (p 1%) 4,61
DL (p 0,1%) 6,12

Average production results (table 1) , (fig, 1) for the three experimental years in the Apuseni Mts area for the Semenic variety were inferior to the variety's genetic potential (43 t/ha), which mostly expresses the negative effect of climate imbalances lately and the low soil

fertility in the mountain area, which hindered the expression the variety's productivity traits. The analysis of the differentiated effect of fertilization (organic, organo-mineral, complex-mineral) the experimental results obtained on a multiannual basis, shed light on the positive significance of increased fertilizer doses, as well as relevant differentiations determined by the nature and structure of fertilizing assortments applied.

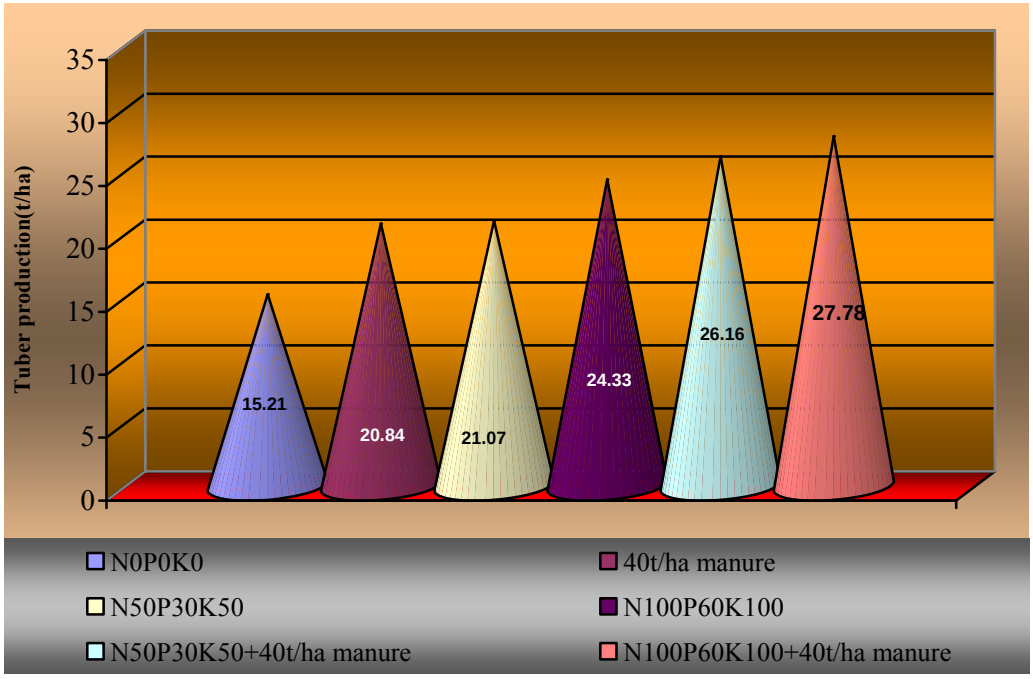

Fig. 1. Interaction of the differentiated organo-mineral fertilization levels on the average tuber production of the Semenic variety under crop in the Apuseni Mts area

First and foremost, a positive effect resides i the nutritive fertilizing value of organo-mineral combinations with an organic substratum (40 t/ha stable manure), as well as a mineral support of nitrogen, phosphorus and potassium, systems that reveal the summing up and synergic effect of these combinations for tuber production. This combied positive effect is due to the initial level of precarious soil fertility, which is representative for the area, as well as the potato crop capacity that can positively capitalize organo-mineral interactions.

Compared to the highly significant effects of differentiated fertilization systems based o the organo-mineral interaction of nutrients, single fertilizations, either mineral nitrogen, phosphorus or potassium based ones or solely organic ones with manure prove the limiting factor of these interventions and their inability to meet with normal production levels multi-annually apparent in diminished tuber productions.

Solely mineral fertilization, as well as the single character of the organic one prove to be partial in terms of their fertilizing effects and a limiting of the approach on these solutions for the potato cultivation technology in the Apuseni Mts. Area where this crop is relevant in obtaining basic food for the population in the area.

A through study of the complex approach on the efficiency of differentiated fertilization systems in potato crop for representative soils in the Apuseni Mts. Area, with

limited levels of fertility and productive capacity, requires for a rigorous control and study on the evolution of these basic soil traits, from a qualitative point of view, as well as establishing certain risk domains. Solutions of single fertilization, be it mineral or organic, can determine impact states of acidification and limited nutrient supply compared to the organo-mineral fertilization system, able to improve the soil's traits, its buffering capacity. In these conditions, an important agrochemical aspect is highlighted with reference to the application of complementary mineral fertilization, for potato crop in the mountain area, on a suitable organic substratum provided through systematic organic fertilization to the soil.

Table 2

The organo-mineral fertilization effect on the average NPK content in the tubers of the Semenic potato variety under crop in the Apuseni Mts. Area (Average values for 3 years, 2007-2009)

N.	Variety	Fertilization variant	Average content of mineral elements in potato tubers (% of S.U.)		
			N	P_2O_5	K_2O
1	Semenic	V0 – 0N+ $0P_2O_5$+ $0K_2O$ (kg s.a./ha)+ 0t/ha manure (Cotrol)	0,49	0,17	1,19
2		V1 – 0N+ $0P_2O_5$+ $0K_2O$ (kg s.a./ha)+ 40t/ha manure	0,59	0,20	2,69
3		V2 – 50N+ $30P_2O_5$+ $50K_2O$ (kg s.a./ha)+ 0t/ha manure	0,62	0,23	2,69
4		V3 – 100N+ $60P_2O_5$+ $100K_2O$ (kg s.a./ha)+ 0t/ha manure	0,80	0,25	2,71
5		V4 – 50N+ $30P_2O_5$+ $50K_2O$ (kg s.a./ha)+ 40t/ha manure	0,83	0,25	2,79
6		V5 – 100N+ $60P_2O_5$+ $100K_2O$ (kg s.a./ha)+ 40t/ha manure	0,88	0,27	2,83

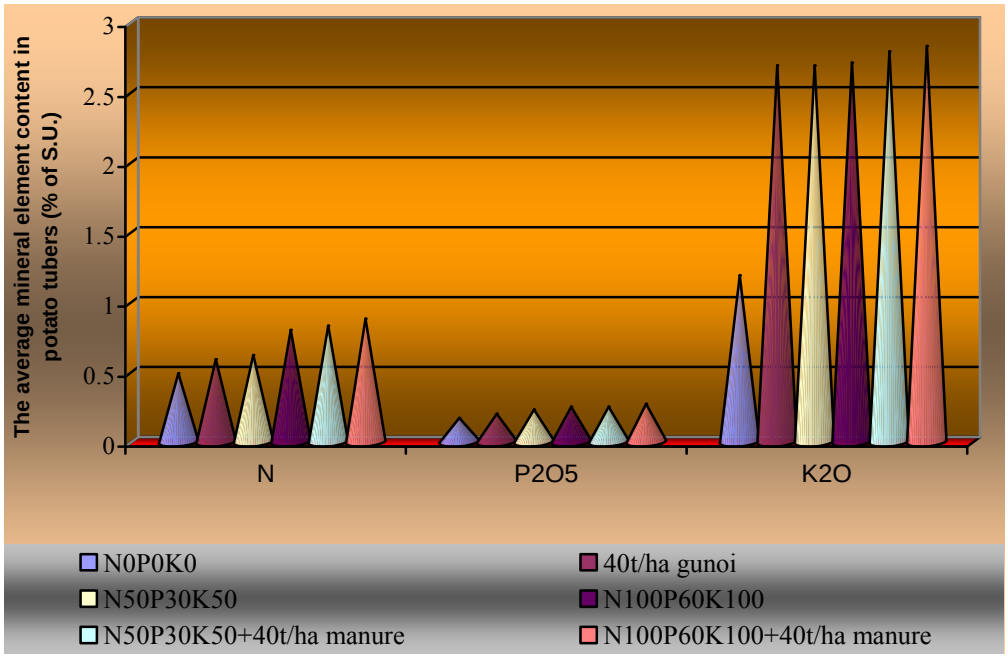

Fig. 2. Interaction of the differentiated organo-mineral fertilization level on the average NPK content from potato tubers for the Semenic variety, under crop in the area of the Apuseni Mts. (% of S.U.)

The organic support provided through the systematic application of manure in 40t/ha, providing the favourable and meliorating environment of soil physical and chemical traits. In this context, the complementary application of mineral fertilizers determines a higher bioavailability of nutrients and their better capitalization by potato plants.

The analysis conducted on the effect of differentiated organo-mineral fertilization on the average content of mineral elements in potato tubers (table 2), (fig. 2) manages to confirm the direct influence of exterior factors, climate, soil, crop technology and especially the easily-accessible nutrient requirement for plants during critical phenphases of potato crop.

As far as the average mineral element content in potato tubers is concerned after harvesting, generally small values of basic mineral element accumulation (N, P_2O_5, K_2O,) are visible and determined on the one hand by the negative influence of climate factors during certain growth stages critical for the potato crop in the mountain area, during the experimental phase, while on the other, by the faint participation of differentiated fertilization levels. Significant values of N (0,80 – 0,88), P_2O_5 (0,25 – 0,27) and K_2O (2,69 – 2,83) contents % of S.U were registered for organo-mineral fertilization values with an organic substratum (40 t/ha manure) ad a mineral nitroge, phosphorus and potassium substratum. This combined fertilization system reveals a precarious fertility level of the Districambisoil and brown acidic soil that are representative for the area, which is recommended to be systematically applied in the potato crop technology to achieve superior quantitative and qualitative productions for this plant under crop in the moutain area.

Compared to close values of the nitrogen and phosphorus contents in the potato tubers after harvesting, the higher values of the potassium content are significant for all fertilization variants, which explains the ultimate requirements of potato in terms of this important utritive element in the soil bringing the greatest contribution in starch accumulation. The normal potassium supply of the potato during the growing period provides it with an increased resilience to ufavourable climate conditions, specific to the Apuseni Mts. area, where the climate is damp, chilly and soils are low quality. Potassium fertilization systems, in optimum ratios with nitrogen and phosphorus on a provided organic substratum, achieves high qualitative and quantitative productions for potato crop.

CONCLUSIONS AND RECOMMENDATIONS

The brown acidic soil (districambosoil) characteristic to the Apuseni Mts, cultivated with potato and under differentiated organo-mineral fertilization with an annual organic substratum essentially modifies its chemism, thus complying with the high nutrient requirements of potato in the area;

Systematic organic fertilization for mountain area plants modifies positively and sustainably the acidic reaction (specific to mountain soils) through its neutralization, the coarse humus content, the nutritive element regime, the alkalinization of the adsorptive complex of the soil and implicitly its physico-chemical traits;

Mineral fertilization applied devoid of any organis support, although it positively modifies the nitrogen, phosphorus and potassium supply regime, proves to have negative effects through the acidification of the soil solution, enhancing humus mineralization, seriously damaging the bioavailability of plant nutritive elements;

Organo-mineral fertilization, which is the most compatible with the biologic and nutrition requirements of the potato, enhances the bioavailability regime of soil nutritive elements on a organic support background, meliorates the acidic reaction of the soil, maintains and enhances soil fertility in the mountain area;

It is highly recommended that on soils with limited fertility and productive capacity, basic natural fertilizers relying on a rational employment of plant and animal residues,

contribute to the enhancement of organic matter content in the soil and nutritive element content for the plants, supplemented with mineral fertilizers according to specific and global consumption requirements of cultivate plants;

Since organic fertilizers provide a real supply of essential fertilizing elements with a multi-annual effect and a series of crops and technologies, the direct or interactive application with mineral fertilizers. In order to make up systems of rational fertilization that evision the inputs that these fertilizers have directly in the soil or remanently for the years following the application;

Low values of productions and the accumulation of the main nutritive elements in potato tubers, emphasizes the negative influence of recent climate changes, as well as the less favourabe mountain climate, on the availability of soil nutrients during growth phases, when the maximum nutrient consumption is registered in potato plants;

In the mountain area, animals are bred in a household system, and the quantity of natural fertilizers obtained alongside mineral fertilizers, through a positive organo-mineral fertilization can provide the fetilization of important land surfaces in order to obtain ecologic agricultural productions, on the one hand ad maintain and enhance the fertility of soils in the area, on the other;

At present, there is an increasing requirement and a special interest for conservative agriculture, which involves a more efficient management of vegetal residues and natural resources, providing the long-term sustainable employing of the land, preventing soil and agroecosystem degradation and obtaining qualitatively superior plant products for consumption that comply with food safety and security standards.

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