THE ORGANO-MINERAL FERTILIZATION INFLUENCE AT CORN CROPS ON THE SOIL AGROCHEMICAL INDICATORS AND THE ACCUMULATION OF NUTRIENTS IN THE MAIZE AND IN THE CORN LEAVES FOR IDENTIFYING SOME NUTRITIONAL DISORDERS (POTASSIUM DEFICIENCY)

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Abstract: *The negative vegetation states concerning de absorption, translocation and metabolism of nutrients occur in connection with the manifestation of extreme states of supplying the plants with nutritional elements-deficiency or excess. The causes that determine these states are complex and multiple, in general they depend on the soil attributes (fertility conditions), on biological factors (nutritional attributes of the genotype), on technological factors and last but not least on the climatic conditions. This research conducted an analysis on the agrochemical indicators of chernozem soil (SRTS – 2003) which was organo-mineral differentially fertilized, in different doses and combinations, cultivated with corn and also an analysis on the content in nutritional elements of the plant (for maize and leaves). The soil and the plant analysis was motivated by the necessity for a comparison between the agrochemical attributes of the soil and the accumulations of nutrients in the plant because at a proper soil fertility, the nutritional process of the plant is also proper. However, during the blooming period of the corn, the nitrogen consumption decreases and the potassium consumption increases and on the corn leaves the potassium deficiency is highlighted (marginal necrosis of the leaves), but only for the fertilizations variants with the highest complex mineral fertilizer dose - NP ($N_{150}P_{150}$ – $N_{200}P_{200}$). The agrochemical analysis of the corn leaves that were affected by the potassium deficiency symptoms emphasized high accumulations of N_t (%) and low towards critically low accumulations of potassium (K_t%). These results determined us to develop a characterization of the soil agrochemical indicators and a determination of the nutrients content in maize (N, P, K, Ca). Following the analysis conducted on the soil we can conclude that this type of soil holds favorable indices for cultivating corn and the potassium deficiency and the low productions achieved in 2012 can be attributed to the unfavorable climatic conditions. As we mentioned earlier, the negative vegetation states, concerning the absorption, translocation and metabolism of nutrients are determined by various causes, among which, the unfavorable climatic conditions. Concerning the analysis results on the vegetal material in the maize, the nutrient accumulations took values that were specific for the genotype with genetic determination for the species and hybrid cultivated. The vegetation period in 2012 was characterized by climatic conditions that were less favorable for obtaining big, quality crop productions due to a low precipitation rate (much below the normal rate for that specific period) and high temperatures, facts that led to obtaining crop productions that were below the production potential of the hybrid used in the experiments (8-14 t/ha maize). The importance of this research results from the link between the nutrient accumulations in corn plants at different nitrogen doses and the climatic conditions during the vegetation period, even though the soil holds an optimum amount of nutrients from an agrochemical point of view. The detection and diagnosis of these nutritional disorders has a more preventive and corrective nature than the specific treatments for dealing with the intense symptoms.*

Key words**:** *nutrients, nutritional disorders, K deficiency, agrochemical indices*

INTRODUCTION

Agrochemical activity – studies and mapping – can be effective both for the prognosis of nutritional disorders symptoms, studying the triggering and manifestation causes and effects and also for making effective decisions through specific treatments.

Crop plants synthesize in capitalized harvests organic substances (proteins, nucleotides and nucleic acids, soluble sugars, cellulose, starch, vitamins, growing substances) from organogenic elements (C,O,H,N,P,S) and the energy required for the detachment of these elements from stable mineral compounds (water, carbon dioxide, nitrates and N_2 , phosphates, sulfates) and their pass in the above mentioned organic substances comes from a vital, physiological, biochemical, metabolic process and from photosynthesis. At this complex process of assimilating the organogenic elements and the synthesis of organic substances in plants and crops take part all the nutritional elements that have a role in fertilization - N, P, K, S, Mg, Ca, Fe, Mn, Cu, Zn, B, Mo, Co that have a native source in soil or they are applied through technologies. Rational fertilization harmonizes the native or technologic contribution of the nutritional elements in the soil with the crops needs, with the purpose of achieving vegetal productions (Marilena Mărghitaş et al, 2011).

MATERIAL AND METHODS

The results presented in this study were obtained through field and laboratory research. In the field, the experiments were located on a chernozem soil (SRTS 2003), which presents the next morphologic description:

Morphologic description of a typical chernozem in Cojocna (SRTS - 2003): The horizon sequence: Amp-Am-AC-C_1-C_2

Amp horizon (0 – 40 cm)
- Clay-loam
- Dark brown (10YR 3/2)
- Small gromerular structure, moderately developed
- Plastic, adhesive, wet

AC horizon (40 – 60 cm)
- Brown gray (10YR 4/1)
- Small prismatic structure, moderately developed
- Plastic, adhesive
- Obvious effervescence
- Gradual passage

C_1 horizon (60 – 80 cm)
- Brown yellow (10YR 5/4)
- Prismatic structure, well developed
- Clayey, plastic, dense

C_2 horizon (80 – 130 cm)
- Dark brown yellow (10YR 5/6)
- Big prismatic structure
- Plastic, adhesive

From a physical point of view, the soil exhibits a high quantity of clay, with a clayey texture from surface horizons. Thus, it has a high cation exchange ability, but also high water retention potential, which limits the airhydric regime of the soil. On the surface, the soil has an apparent low density, which reduces porosity and enhances compaction.

From an agrochemical point of view the soil exhibits a weal alkaline reaction, a high humus content, a low P and high K content. It shows good fertility and productivity.

The schemes and variants of field experiments included differentiated fertilization factors for maize crops, achieved through using complex NP (20-20) mineral fertilizers, organo-mineral fertilizers (with organic support consisting of partially fermented stable manure and poultry manure in interaction with complex NP mineral fertilizers) and organic fertilizers (consisting of partially fermented stable manure – 20t/ha and poultry manure) following the next scheme:

- V_1 = Unfertilized control;
- $V_2 = N_0P_0$+12t/ha poultry manure;
- $V_3 = N_0P_0$+20t/ha stable manure;
- $V_4 = N_{50}P_{50}$+12t/ha poultry manure;
- $V_5 = N_{50}P_{50}$+20t/ha stable manure;
- $V_6 = N_{50}P_{50}$;
- $V_7 = N_{100}P_{100}$;
- $V_8 = N_{150}P_{150}$;
- $V_9 = N_{200}P_{200}$;

The soil-plant analysis was conducted in the Soil-Plant Analysis Laboratory at USAMV Cluj-Napoca, Agrochemistry Department, using the methodology recommended by ICPA for agrochemistry and pedology laboratories:

For the soil samples: collected from a depth of 0-20 cm, the next analysis were conducted:

- pH-ul in aqueous suspension, through potentiometric method;
- humus – through wet oxidation method and dosage titration, according to Walkley-Black, Gogoaşă modification;
- mobile phosphorus and potentially accessible according to Egner – Riehm – Domingo colorimetric, in ammonium acetate-lactate extract (P-AL);
- Mobile potassium and potentially accessible according to Egner – Riehm – Domingo colorimetric, in ammonium acetate-lactate extract (K-AL);

For the plant samples: obtained from maize and/or leaves the next determinations in the acid extract of the vegetal ashes were conducted:

- Nt – through Kjeldahl method;
- Pt – through colorimetry in the presence of ammonium metavanadat;
- Kt – through flame photometry of the acid extract of vegetal ashes;
- Ca - through flame photometry of the acid extract of vegetal ashes.

RESULTS AND DISCUSSIONS

The differentiated fertilization systems applied to the soil, for different crops, especially for those that hold organic fertilization factors provide the soil with a lasting fertility through accumulations of organic matter that can easily turn into humus, that afterwards through the humus mineralization process provides the plant with the nutrients needed for obtaining big and quality productions.

The soil analysis conducted following the research of the differentiated fertilization effects (organo-mineral) show a beneficial effect brought to the soil's fertility and especially concerning the humus content, but also to the mobile phosphorus content which holds higher values, at a good towards very good supply threshold in comparison with the soil's initial supply (P-AL = 13 ppm) (table 1.)

Table 1.

The differentiated fertilizations influence on the soil's agrochemical indices – Chernozem from Cojocna

No.	Fertilization variant	The main agrochemical soil indices at a 0-20 cm depth			
		pH_{H2O}	Humus %	P - AL (ppm)	K – AL (ppm)
1	Control	7,60	4,52	52	230
2	12t/ha poultry manure	7,58	5,10	68	330
3	20t/ha stable manure	7,78	5,66	48	270
4	12t/ha poultry manure + $N_{50}P_{50}$	7,39	5,15	84	300
5	20t/ha stable manure + $N_{50}P_{50}$	7,60	5,70	56	280
6	$N_{50}P_{50}$	7,50	4,37	56	240
7	$N_{100}P_{100}$	7,51	4,97	64	270
8	$N_{150}P_{150}$	7,45	4,68	72	270
9	$N_{200}P_{200}$	7,25	4,45	84	260

The main agrochemical indices determined for the chernozem soil in Cojocna (SRTS 2003) cultivated with maize following the differentiated, organo-mineral fertilizations hold favorable values for maize and their modification depends on the dose and the fertilizer used. Regarding the soil's reaction, it doesn't develop significant modifications in comparison with the control variant and it maintains itself at a neutral, slightly alkaline level, only at an exclusive mineral fertilization it is observed a slight acidification of the soil as the NP active substance dose per hectare increases.

The humus content is significantly influenced at organic fertilization, especially when using partially fermented stable manure because in this case the organic matter accumulation is higher with more than 1% in comparison with the control variant.

The phosphorus level is also positively influenced and it's accumulation in the soil increases as the fertilization dose applied increases.

Regarding the potassium content, it maintains itself at high towards very high supply values, for field crops and at the variants that were fertilized with poultry manure it's content is significantly increasing in comparison with the control variant that is unfertilized.

The vegetal material analysis revealed nutrient accumulations in the maize, specific to the genotype for the species and the hybrid cultivated (table 2).

Table 2.

The differentiated fertilization influence on the nutrients accumulations in the maize

No.	Fertilization variant	N %	P_t %	K_t %	Ca %
1	Control	1,50	0,20	0,73	0,80
2	12t/ha poultry manure	1,65	0,28	1,30	0,80
3	20t/ha stable manure	1,5	0,20	0,94	0,50
4	12t/ha poultry manure + $N_{50}P_{50}$	2,10	0,30	0,98	0,90
5	20t/ha stable manure + $N_{50}P_{50}$	1,80	0,33	0,94	1,10
6	$N_{50}P_{50}$	1,80	0,35	0,92	1,05
7	$N_{100}P_{100}$	1,80	0,37	0,73	1,10
8	$N_{150}P_{150}$	1,80	0,45	0,73	1,20
9	$N_{200}P_{200}$	1,50	0,48	0,84	1,25

In general, the elements (N,P,K) content in the maize is represented by values that are specific to this genotype with genetic determination for this species and hybrid in comparison with the content from the vegetative organs that may present values of the same indicators in a certain dynamic (due to the photosynthesis)

In the leaves and the vegetative organs there usually exists a different repartition of these indicators, with concentration or dilution effects due to the differentiated doses or differentiated fertilization and also due to the climatic conditions during the vegetation period (table 3.).

Table 3.

The differentiated fertilization influence on the Nt (%) and Kt (%) content in corn leaves at identifying some visible symptoms on the leaves in case of nutritional disorders (K deficiency – marginal leaf necrosis)

N.	Fertilization variant	Normal values (according to different authors)		Obtained values	
		Nt %	K_t %	Nt %	K_t %
1	Control	0,8 – 1,3	1,1 – 1,6	1,5	1,2
2	12t/ha poultry manure			1,9	1,9
3	20t/ha stable manure			1,6	1,8
4	12t/ha poultry manure + $N_{50}P_{50}$			2,4	1,8

5	20t/ha stable manure + $N_{50}P_{50}$			2,3	1,7
N.	Fertilization variant	Normal values (according to different authors)		Obtained values	
		Nt %	K_t %	Nt %	K_t %
6	$N_{50}P_{50}$	0,8 – 1,3	1,1 – 1,6	2,0	1,6
7	$N_{100}P_{100}$			2,9	1,4
8	$N_{150}P_{150}^{*}$			3,6	1,05
9	$N_{200}P_{200}^{*}$			3,9	0,9

* - Variants for specific symptom potassium deficiency (marginal leaf necrosis)

The analysis conducted on the corn leaves (the beginning of blooming-to highlight the potassium deficiency) the N content shows increases first of all at organo-mineral fertilizations and higher increases at the NP doses increase, the two essential elements are mutually highlighting each other's absorption and accumulation.

In terms of potassium, the accumulation of this cation, although it systematically increases together with the organic fertilizations, organo-mineral and NP mineral fertilizations, marks a possible reduction due to very high NP doses. In general, the accumulation of potassium is close to the field of this element's deficiency (critical threshold = 1,5%) because the chernozem from Cojocna holds more than 45% clay in its content, this showing that this cation is able to participate in the soil, to accumulations in unchangeable forms and its mobilization in bio-accessible forms is more difficult also due to atmospheric and soil drought.

CONCLUSIONS

In conclusion, the analysis conducted on the soil and plant (maize and leaves) led to the next aspects:

Regarding the soil's agrochemical indices, they lie at an agrochemical optimum level for corn crops and they hold favorable values for obtaining big and quality maize productions.

The agrochemical analysis conducted on the vegetal material (maize) concerning the macro-elements accumulations in the maize, show that these lie in normal limits, in comparison with the ones determined in the corn leaves where the N/K ratio is favorable for the nitrogen at the variants that were fertilized with the highest NP doses and in the maize these are specific to the genotype with genetic determination for corn and the hybrid cultivated in the experiments (Hibrid - Monsanto Dekalb 4626).

The nitrogen content in corn leaves, for identifying some nutritional disorders (potassium deficiency) is increasing as the fertilizers doses are increasing, getting closer to the critical excess threshold at maximum NP doses and the potassium content for the variants with the highest NP mineral complex fertilizer doses, is at low levels, close to deficiency.

BIBLIOGRAPHY

1. BECKETT P., (1972), Critical cation activity ratios, Adv. in Agronomy, 24, 379-412;

2. MĂRGHITAŞ MARILENA, M. RUSU, TANIA MIHĂIESCU,(2005)-Fertilizarea plantelor agricole şi horticole (*Fertilization of Agricultural and Horticultural Plants* in Romanian), AcademicPres, Cluj-Napoca;
3. MĂRGHITAŞ MARILENA, I. RAZEC, MIHAELA MIHAI, C. TOADER, MOLDOVAN LAVINIA, ROMAN GABRIELA, (2011)-Manual de bune practici în tehnologia fertilizării plantelor agricole, Ed. AcademicPres, Cluj-Napoca;
4. RUSU M., MARILENA MĂRGHITAŞ, I. OROIAN, TANIA MIHĂIESCU, ADELINA DUMITRAŞ, (2005)-Tratat de Agrochimie, Ceres, Bucureşti;
5. RUSU M., MARILENA MĂRGHITAŞ, C. TOADER, MIHAELA MIHAI, (2010)-Cartarea Agrochimică – Studiul agrochimic al solurilor, Ed. AcademicPres, Cluj-Napoca;
6. TOADER C., MARILENA MĂRGHITAŞ, MIHAELA MIHAI, M. ŞANDOR, (2011) -Effect of differentiated fetilization systems on maize crop on nutrient production and accummulation in the soil and grains. Research Journal of Agricultural Science, 43 (1), 2011.