Scientific Papers. Series A. Agronomy, Vol. LVIII, 2015
ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785

# FERTILIZERS FORMULAS WITH EXTRAROOT APPLICATION - PHYSICO-CHEMICAL AND AGROCHEMICAL CHARACTERISTICS

**Daniela MIHALACHE, Carmen SÎRBU, Traian Mihai CIOROIANU, Olga GAȚE**

National Research and Development Institute for Soil Science, Agrochemistry and Environmental Protection - ICPA Bucharest, 61 Mărăşti Blvd., District 1, 011464, Bucharest, Romania, Phone: +40213184349, Fax: + 40213184348, Email: office@icpa.ro

Corresponding author email: ddobrinescu@yahoo.com

***Abstract***

*Development of new formulas of extra-radicular fertilizers applied by irrigation, drip irrigation or by soil incorporation is a priority both for manufacturers and for users in agriculture.*
*At worldwide level it was observed a major development of the fertilizers which consist of natural organic substances or synthetic integrated in NPK type structures with/without trace and meso elements, products which can be applied conventional of extra-radicular type. Adding of the organic substances have the role to stimulate the absortion of the nutrients and to provide a balaneced nutrition. The most commonly used organic substances are protein hydrolysates of vegetal or animal origin and various aminoacids.*
*In order to obtain a new range of fertilizers it was defined the composition of a type NPK with mezo and micronutrients, such as Fe, Cu, Zn, Mn, Mg, S, Co, Mo, and in which protein hydrolysate of vegetal or animal origin were introduced.*
*The experimental fertilizers were characterized from physico-chemical and agrochemical point of view within the National Network for Fertilizers Testing for authorization for agricultural use.*
*This paper presents the obtained experimental fertilizers and the results of the agrochemical tests carried out by the National Network for Fertilizers Testing, fertilizers which were applied to maize, sugar beet, eggplant and tomatoes crops. These extra-radicular fertilizers represent modern technologies of fertilization and have quantitative and qualitative significant effects, but also with a positive impact on the economy and environment.*

***Key words***: *extra-radicular fertilizers, organic substances, protein hydrolysate.*

## INTRODUCTION

The analysis of the data existing in the specialized literature regarding the conventional fertilizers of extra-radicular type or those with substances having a stimulating effect of growth indicates the fact that the exclusive use of certain substances in the category of bio-stimulators for the treatment of agricultural crops often does not lease to obtaining significant effects (Cioroianu et al., 2011). In such cases the “explosive” vegetative development of the plant is not supported by an additional contribution, fast, of macro and micro-elements necessary for the nutrition (Iovi et al., 2000). This phenomenon strongly occurs in case of a poor basic fertilization, on degraded soils, as well as in case of unbalanced macronutrient fertilization.
In practice, it is known a wide range of liquid fertilizers, complex solutions with extra-radicular application, having as nutrients nitrogen, phosphorus, potassium, meso and micro-elements that may also contain synthetic organic substances, humic substances, fulvic substances, plant extracts, peptides or protein hydrolysates of animal origin or glycoproteins of plant origin, naphthenates, introduced in order to stimulate the metabolization of nutrients, or to facilitate the absorption of ionic species or molecules (Mihalache et al., 2014).
It is well known that the use of microelements like iron, copper, zinc, calcium, magnesium and manganese chelated with natural organic substances are more easily absorbed by plants, and their presence may destroy or reduce bacteria, viruses, fungi or other pathogens when applied as fertilizing substances to plants.
In the field of agriculture it is recommended the use of extra-radicular fertilizers not only in treating certain nutrition diseases of plants, but also to prevent them, for increased yields, for increased quality of products and to reduce the negative impact on the environment of conventional fertilizers (Dorneanu et al., 2003).
Also, the plants treated with fertilizers

containing natural organic substances with chelating role are more resistant to frost, drought, to biotic and abiotic stress factors (Sîrbu et al., 2010; Trandafir et al., 2007)

## MATERIALS AND METHODS

The experiments carried out for obtaining of extra-radicular fertilizers aimed at:

- defining the compositional structure of the fertilizers and establishing of the raw materials;
- establishing the experimental design at laboratory level and of the operating paramenters;
- establishing of the control at different phases and at the final phase;
- verifying of technologies at the laboratory phase;
- sample preparation for physico-chemical characterisation and for agrochemical testing.

The extra-radicular fertilizers experimentally obtained, for physico-chemical characterisation and agrochemical testing, were:

- of NPK type with trace and meso elements and organic substances of animal nature (collagen hydrolyzate), ***VFHA*** variant;
- of N type with trace and meso elements and organic substances of plant nature, ***VFHV*** variant.

In Table 1 the characteristics of experimental fertilizers are presented.

Table 1. Characteristics of experimental fertilizers applied in Network

| Estimated composition, g/l | VFHA | VFHV |
|---|---|---|
| total N | 120 | 215 |
| $P_2O_5$ | 70 | - |
| $K_2O$ | 60 | - |
| B | 0.3 | 0.15 |
| Co | 0.01 | 0.005 |
| Cu | 0.2 | 0.15 |
| Fe | 0.5 | 0.3 |
| Mg | 0.35 | 0.25 |
| Mn | 0.3 | 0.2 |
| Mo | 0.01 | 0.005 |
| $SO_3$ | 2 | 1.1 |
| Zn | 0.15 | 0.1 |
| Hydrolyzate of animal nature | 14 | - |
| Hydrolyzate of plant nature | - | 30 |

The agrochemical study was conducted within some single-factorial experiences with extra-radicular fertilizers (and compared with a control variant - unfertilized), arranged in randomized experimental variants and in four replicates.

All the researches concerning the extra-radicular fertilizers efficiency and role which are pending for approval, were conducted based on chemical unfertilized variant.

The experiments were placed on the following soil types:

- cambic chernozem (haplic chernozem) located at Ezăreni-Miroslava-Iaşi farm field and at V. Adamachi Iaşi horticultural farm;
- hortic antrosol (hortic anthrosol) in greenhouses, orchards and vineyards.

Energy efficiency (Mcal/ha), as indicator of production intensification, was calculated according to the specified methodology (Teşu and Baghinschi, 1984).

The main quality and fertility characteristics of the soils are given in Table 2.

Table 2. Main physical, chemical and biological properties of the soil resources

| Property | Depth (cm) | Field farm Ezăreni *cambic chernozem* | Greenhouse *hortic anthrosol* |
|---|---|---|---|
| Soil texture (% colloidal clay) | 0-20 | 35.7 | 35.6 |
| | 20-40 | 37.9 | 36.8 |
| | 40-60 | 39.8 | 38.9 |
| Seazonal consistence | 0-20 | moderately cohesive | moderately cohesive |
| | 20-40 | hard | hard |
| | 40-60 | very hard | very hard |
| Aeration porosity (PA%) | 0-20 | 18 | 15 |
| | 20-40 | 11 | 10 |
| | 40-60 | 9 | 7 |
| Soil reaction ($pH_{H2O}$) | 0-20 | 6.83 | 7.11 |
| | 20-40 | 6.61 | 7.25 |
| | 40-60 | 6.58 | 7.41 |
| Humus (%) | 0-20 | 3.386 | 3.664 |
| | 20-40 | 1.924 | 2.613 |
| | 40-60 | 1.202 | 1.342 |
| Total content of nitrogen Nt (%) | 0-20 | 0.192 | 0.253 |
| | 20-40 | 0.163 | 0.172 |
| | 40-60 | 0.118 | 0.112 |
| Mobile phosphorus content (ppm) | 0-20 | 71 | 78 |
| | 20-40 | 62 | 81 |
| | 40-60 | 54 | 88 |
| Mobile potassium content (ppm) | 0-20 | 257 | 277 |
| | 20-40 | 213 | 245 |
| | 40-60 | 183 | 239 |
| Degree of base saturation V (%) | 0-20 | 92 | 94 |
| | 20-40 | 90 | 92 |
| | 40-60 | 88 | 87 |
| Soil respiration (mg $CO_2$) | 0-20 | 28.32 | 28.62 |
| | 20-40 | 17.32 | 14.56 |
| | 40-60 | 6.65 | 5.87 |
| Dehydrogenase (mg TPF) | 0-20 | 19.45 | 18.23 |
| | 20-40 | 9.34 | 8.89 |
| | 40-60 | 4.45 | 5.21 |

## RESULTS AND DISCUSSIONS

The use of organic substances which contain protein and free aminoacids bonded in a complex matrix with chelated macro and trace elements lead to obtaining of physico-chemical stable fertilizers solutions. Besides the chelating properties, the used protein hydrolyzate acts as a protective colloid which helps to maintain the stability of the applied fertilizer by its components having a molecular weight smaller than 10000 Da that forms films at the surface of plant tissue.

These films have the ability to gradually release in time of chelated trace elements on the collagen polypeptides, acting both as hydrophilic protection to environment factors and as well as biostimulator.

Agrochemical testing of the experimental fertilizers was done at the Biological Research Institute from Iasi (experimental field of USAMV Iasi). The extra-radicular fertilizers were applied at crops, such as maize, sugar beet, eggplants and tomatoes, and in three treatments in concentration of 0.5%.

The agrochemical tests results are presented in Tables 3-6.

Table 3. Productive and energetic efficiency of extra-radicular fertilization at the maize crop (Hybrid DK 4685) *Single factor experiment placed in* storeyed blocks *and with randomized experimental variants*

| Nr. crt. | Experimental variants | Average production (kg/ha) | Productive efficiency | | | Energetic efficiency - Mcal/ha | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Dif. kg/ha | % | sm. | Output | Input | Balance | Dif. | % | sm |
| 1 | *Control NoPoKo* sprinkled with water (500 l/ha) | *5023* | - | *100* | - | *19690* | *6891* | *12798* | - | *100* | - |
| 2 | VFHV - 0.5% | 6825 | 1802 | 135.88 | xxx | 26754 | 10702 | 16052 | 3254 | 125.43 | xxx |
| 3 | VFHA - 0.5% | 6716 | 1693 | 133.71 | xxx | 26327 | 10531 | 15796 | 2998 | 123.42 | xxx |

DL 5% - 654 kg/ha
DL 1% - 817 kg/ha
DL 0.1% - 1265 kg/ha

DL 5% - 1261 Mcal/ha
DL 1% - 1733 Mcal/ha
DL 0.1% - 2315 Mcal/ha

Table 4. Productive and energetic efficiency of extraroot and soil fertilization, at the sugar beet crop (Diamant variety). *Single factor experiment placed in storeyed blocks and with randomized experimental variants*

| Nr. crt. | Experimental variants | Average production (kg/ha) | Productive efficiency | | | Energetic efficiency - Mcal/ha | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Dif. kg/ha | % | sm. | Output | Input | Balance | Dif. | % | sm |
| 1 | *Control NoPoKo* sprinkled with water (500 l/ha) | *22413* | - | *100* | - | *22413* | *7845* | *14568* | - | *100* | - |
| 2 | VFMV - 0.5% | 31031 | 8618 | 138.45 | xxx | 31031 | 12412 | 18619 | 4051 | 127.81 | xxx |
| 3 | VFHA - 0.5% | 30887 | 8474 | 137.81 | xxx | 30887 | 12355 | 18532 | 3964 | 127.21 | xxx |

DL 5% - 2718 kg/ha
DL 1% - 3851 kg/ha
DL 0.1% - 5824 kg/ha

DL 5% - 1328 Mcal/ha
DL 1% - 1956 Mcal/ha
DL 0.1% - 2711 Mcal/ha

Table 5. Productive and energetic efficiency of extraroot fertilization at the eggplants crop cultivated in greenhous (Pana Corbului variety), first cycle, drip irrigation. *Single factor experiment placed in storeyed blocks and with randomized experimental variants*

| Nr. crt. | Experimental variants | Average production (kg/ha) | Productive efficiency | | | Energetic efficiency - Mcal/ha | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Dif. kg/ha | % | sm. | Output | Input | Balance | Dif. | % | sm |
| 1 | *Control NoPoKo* sprinkled with water (500 l/ha) | *34524* | - | *100* | - | *7940* | *2779* | *5161* | - | *100* | - |
| 2 | VFMV - 0.5% | 46752 | 12228 | 135.42 | xxx | 10752 | 4300 | 6452 | 1291 | 125.01 | xxx |
| 3 | VFHA - 0.5% | 47549 | 13025 | 137.73 | xxx | 10936 | 4374 | 6562 | 1401 | 127.14 | xxx |

DL 5% - 3628 kg/ha
DL 1% - 5144 kg/ha
DL 0.1% - 7813 kg/ha

DL 5% - 311 Mcal/ha
DL 1% - 464 Mcal/ha
DL 0.1% - 526 Mcal/ha

Table 6. Productive and energetic efficiency of extraroot fertilization at tomatoes first crop cultivated in greenhouse (Precos cultivar), drip irrigation. *Single factor experiment placed in storeyed blocks and with randomized experimental variants*

| Nr. crt. | Experimental variants | Average production (kg/ha) | Productive efficiency | | | Energetic efficiency - Mcal/ha | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Dif. kg/ha | % | sm. | Output | Input | Balance | Dif. | % | sm |
| 1 | *Control NoPoKo* sprinkled with water (500 l/ha) | *30123* | - | *100* | - | *8133* | *2847* | *5286* | - | *100* | - |
| 2 | VFHV - 0.5% | 41102 | 10979 | 136.45 | xxx | 11097 | 4438 | 6659 | 1373 | 125.97 | xxx |
| 3 | VFHA - 0.5% | 41455 | 11332 | 137.62 | xxx | 11192 | 4476 | 6716 | 1430 | 127.05 | xxx |

DL 5% - 3544 kg/ha
DL 1% - 5412 kg/ha
DL 0.1% - 6106 kg/ha

DL 5% - 354 Mcal/ha
DL 1% - 487 Mcal/ha
DL 0.1% - 566 Mcal/ha

## CONCLUSIONS

Within this research study there were obtained and physico-chemically characterized two fertilizers which are extra-radicular fertilizers applied, and they are distinguished by a complex composition in which the NPK or N type matrix are associated with trace elements (e.g. Fe, Cu, Zn, Mn, Mg) as well as with protein hydrolysates which have the role of chelating and biostimulation.

Application in agrochemical testing of some fertilizers which contain hydrolyzed structures of animal or plant nature led to increasing production yileds ranging from 133.71% at maize crop to 138.45% at sugar beet crop, when were applied solutions of 0.5% concentration.

In all crops analyzed the outcom energy indicators (OUTPUT and energy balance) have higher values than those allocated to factors (INPUT). This resulted in very significant energy increases of agricultural products as a result of extra-radicular fertilizers application. The energy production (OUTPUT), the energy consumption (INPUT) are considered the most important indicators for intensification of agricultural production.

## REFERENCES


Cioroianu T., Sîrbu C., 2011. Caracterizarea şi testarea agrochimică a unor fertilizanți extraradiculari cu substanțe proteice. Sitech Publishing House, p. 92-93.

Cioroianu T., Sîrbu C., Oprica I., Grigore A., Mihalache D., Dumitrascu M., Anton I., Soare M., 2011. Fertilizers with protein substances, technology, agro-chemical and physical charcacteristics. International Scientific Symposium, Sustainable Rural Development, Timişoara, Lucrări Ştiinţifice ale Simpozionului, Seria I, Vol. XIII, p. 449-454.

Cioroianu T., Dumitru M., Sîrbu C., 2012, Fertilizant cu hidrolizate proteice cu aplicare extraradiculară, procedeu de obținere şi metodă de aplicare. Brevet RO 126939/2012.

Mihalache D., Sîrbu C., Grigore A., Cioroianu T., 2014. Protein hydrolysates and amino-acids fertilizers - physicochemical characteristics. Lucrări Ştiințifice, seria Agronomie, Iaşi, Vol. 57(2), p. 47.

Sîrbu C., Cioroianu T., Dumitru M., Dorneanu A., Negrila M., Mihalache D., Angelescu L., 2008. New structures of biofertilizers with chelate proteinic substances with role of biostimulator and protection for sustainable agriculture. Lucrari Stiintifice USAMV, Seria Agronomie, Iasi, Vol. 51(2), p. 189-194.

Sîrbu C., Cioroianu T., Cojocaru I., Trandafir V., Albu M.G., 2009. The fertilizers with the protein chelated structures with the biostimulator role. Revista de chimie, Vol. 60, nr. 11.

Sîrbu C., Cioroianu T., Dumitru M., 2012. Fertilizanți cu substante proteice. Sitech Publishing House, p. 211-212.