A New Eco - friendly Foliar Fertilizer with Bone Glue Suitable for Crops of Maize and Sunflower

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The main objective of the present work was the preparation and characterization of a new foliar fertilizer which contains bone glue as an organic physiologically active source. The association of the bone glue with macro and micronutrients from the common foliar fertilizer ensures a synergic effect on the production and quality of maize and sunflower. The survey of the evolution of each crop together with the qualitative and quantitative analysis of the physical and chemical characteristics of the leaves and seeds showed that the new foliar fertilizer increased the nutrients uptaken by plants. Moreover, the analysis of soils involved in this experiment revealed that this new fertilizer acts as an eco-friendly one.

Keywords: bone glue, foliar fertilization, maize, mineral nutrients, sunflower

The Romanian geographical conditions offer a wide range of soil types, most of them having a good and medium fertility. Considering these natural conditions, agriculture has been largely developed being the main branch of the naţional economy. Accordingly, the production is focused mainly on grains, oil seeds crops, vegetables, potatoes, forage plants, and fruits. Among the grains, maize is the largest cultivated crop, covering more than half of the total cultivated area, followed by wheat and sunflower crops [1].

The increased demand for healthy and good quality agricultural products constitutes a major goal for the research focused on plant cultivation. Usually, the native soil properties are not enough to ensure the quantity of nutrients for the plants to grow. In order to supply plant nutrients, fertilizers, both natural and synthetic ones, were used all over the world as an adjuvant for the plant nutrients. Yet, not only the crop production represents a major goal of fertilization, but also the environmental risks related to fertilization practices. Lately, a variety of fertilizers have been produced and applied by means of modern equipment in order to minimize the environmental damages and maximize their utilization [2]. Basically, the efficiency of such products depends both on their composition and their application procedure [3]. Firstly, an important attention should be given to the chemical composition of the fertilizer in order to obtain the maximum efficiency on providing macro and micronutrients necessary to balance and handle stressful situations. Secondly, the application procedure must ensure the spreading of the nutrients evenly all over the plant. Actually there are two important ways of fertilization namely soil and foliar, the latest being known as more effective. The efficiency of the foliar fertilizer is related to its capacity to penetrate the cuticle and stomata into the leaf and after that the cell membrane prior to become a part of the metabolic pathways [4]. Even if the cuticle is a waxy hydrophilic layer which opposes resistance to all exogenous nutrients to reach the cell, it is generally considered as being the major route taken by these compounds in their way from the surface of the leaf to the cytoplasm [5, 41].

Usually, the main components found in a foliar fertilizer formula are both macronutrients such as: nitrogen, phosphorus, potassium and micronutrients such as: iron, copper, zinc, manganese. The additive of other compounds or mixtures of compounds (animal bone glue) was used for obtaining the new foliar fertilizer [6, 7] or to study the environmental impact of meat meal fertilizer vs. chemical fertilizer [8].

The novelty and complexity of the new foliar fertilizer are represented by the possibility of the macro and micronutrients association of the common foliar fertilizer with bone glue. The bone glue is a natural compound, which contains a series of organic macro and micronutrients, as well as compounds with a bio role. According to the European legislation the bone glue is an animal by - product Category 3 which can be used for the manufacturing of organic fertilisers or soil improvers [9].

Therefore, the bone glue is used in this formula as a primary source of phosphorus, nitrogen, potassium, calcium and micronutrients and as a protein additive. It also contains bioactive substances, growth and development stimulators [10, 11] . These components are basic substances in the cells nucleus and the protoplasm [12]. The bone glue has the property to adhere to the leaf surface and it provides an early infusion of nutrients. It confers an improved cation exchange capacity, has an influence on the plant growth, the production quality and it increases the uptake of the nutrients, and the stability of the foliar fertilizer applied on the plant [7].

Accordingly, the main objective of this study was the preparation and agrochemical assessment of a new foliar fertilizer that includes bone glue as original component. Once prepared, this new fertilizer was firstly chemically characterized, secondly applied on two major crops, maize and sunflower cultivated in the house of vegetation and finally evaluated based on agronomic and chemical analysis. The bone glue included in this formula represents an important natural source of nitrogen compounds, being

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Table 1
ANALYTICAL FEATURES OF THE SOIL ON WHICH THE EXPERIMENTS WERE CARRIED OUT

pH^a	Nt^b, %	Organic carbon (humus), %	P_{AL}^d, $mgKg^{-1}$	K_{AL}^e, $mgKg^{-1}$	Cu^f, $mgKg^{-1}$	Zn^f, $mgKg^{-1}$	Fe^f, $mgKg^{-1}$	Mn^f, $mgKg^{-1}$	Texture [g]			CEC^h, %
									Clay %	Silt %	Sand %	
7,67	0,13	3,44	113,53	106,66	3,57	5,57	6,53	24,30	27,4	37,6	35	24,43

[a] Determined in distiled water with a glass electrode (soil:$H_2$0 ratio 1:2.5);

[b] Determined by Kjeldhal digestion;

[c] Determined by titrimetric method STAS 7184/21-82;

[d] Determined according to a standardized procedure STAS 7184/19-82;

[e] Determined according to a standardized procedure STAS 7184/18-80;

[f] Determined according to a standardized procedure SR ISO 14870:2002

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well known the role of nitrogen fertilizer in increasing growth and photosynthesis of plants. The study was carried out in accordance with the current legislation described by the ministerial order for testing the fertilizers [13].

Experimental part

Materials and method

Preparation of the new fertilizer

Properties

The new foliar fertilizer was prepared by mixing the stock solution of macroelements with that of micro-elements. The stock of macronutrients solution was prepared by treating 30 g bone glue with 570mL nitric acid. The mixture was stirred for 3 h at 65-70 degrees Celsius.

There were also dissolved 42 g of potassium carbonate, phosphoric acid and ammonia. The macroelements stock solution contained nitrogen, potassium and phosphorus and bone glue. The stock of micronutrients solution was prepared by dissolving 20 g of EDTA, 3 g of iron sulfate, 2.1 g of copper sulphate, 1.37 of zinc sulphate, 1.2 of manganese sulfate, 0.24 g of cobalt nitrate, 0.36 g of sodium tetraborate, 0.12 g of ammonium molybdate. The stock solutions of macronutrients and micronutrients were mixed so that the final solution of foliar fertilizer should contain 50.3g/L nitrogen, 13g/L phosphorus, 24.06 g/L potassium, 0.59 g/L iron, 0.31 g/L zinc, 0.45 g/L copper, 0.23g/L manganesse. The *p*H of the final formula of the foliar fertilizer was measured. The microelements stock solution contained iron, copper, zinc, manganese, boron, cobalt, molybdenum. Various formulae of foliar fertilizer were prepared and applied in the green house.

Reagents

All reagents used in this study were of analytical purity.

Equipment

Atomic absorption spectrometer

The atomic absorption spectrometer, model GBC Avanta, was used for the determination of the microelements such as: iron, copper, zinc, manganese according to a standardized procedure [14].

Molecular absorption spectrometer

The molecular absorption spectrometer, model CECIL 1011, was used for the phosphorus determination according to a standardized procedure [15]. The CECIL spectrometer has a standard software. Standard rectangular cells have been used.

Atomic Emission Spectrometer (flamphotometer)

The atomic emission spectrometer, model M410, was used for the potassium determination according to a standardized procedure [16]. The spectrometer has a single channel with a low temperature for the potassium determination.

System for Kjeldhal distillation

The system composed from a distillation unit and a digestion system TTM was used for the total nitrogen determination according to a standardized procedure [17]. The total nitrogen was determined by the Kjeldhal digestion according to a standardized procedure. The ammonia nitrogen was determined according to a standardized procedure [18, 19].

NMR spectrometer

The NMR spectrometer, model Varian EM 390, was used for the determination of the sunflower seeds oil content according to a standardized procedure [20].

pH-meter Mettler Toledo. The pH-meter Mettler Toledo was used for the determination of the *p*H of the foliar fertilizers solutions according to a standardized procedure [21].

Conductometer

The conductometer, model Seven Easy Mettler Toledo, was used to determine the conductivity, the total dissolved solids and the salinity of the solutions of the foliar fertilizers according to a standardized procedure [22].

Experimental layout and treatments

The experimental study was carried out in 2010, in the greenhouse of the National Research - Development Institute for Soil Science, Agrochemistry and Environment Protection, Bucharest. The soil of the experiment was Vermic Chernozems provided by SC Agrofam Holding SRL Feteşti. The general properties of this soil (0-25 cm) are shown in table 1.

The experiment was carried out in Mitscherlich pots each containing 20 kg of soil. Mitscherlich pot is special plant container having a double bottom, into which excess liquid fertiliser flows. This means that the amount of nutrients provided to the plants can be measured accurately. All the variants received soil fertilization with 50 mg N/kg soil, 50 mgP_2O_5/kg soil, 50 mg K_2O/kg soil, except the control unfertilized in soil. Two foliar fertilizers were tested: the foliar fertilizer with bone glue and the foliar fertilizer without bone glue on 24 plants of each crop. The variants of the experiment were: VI-control unfertilized in soil, sprayed with water (3 plants), V2 - control fertilized in soil, sprayed with water (3 plants), V3-fertilized with 1% solution (3 plants), V4-fertilized with 0.5% solution (3 plants), V5-fertilized with 0.25 % solution (fertilizer with organic substances, (3 plants)). The variants V6, V7, V8 were fertilized with a foliar fertilizer without bone glue (9 plants).

Three treatments were used (three replicates per variant). The treatment was applied every 10 days, in various foliar fertilizer concentrations on the leaves of each plant. The first treatment consisted of an application of the fertilizer solution on six leaves of the healthy plant.

The whole experiment lasted 60 days, leaves and soil samples being collected and analyzed. The soil samples were collected before the first treatment and three days after each treatment. The control variants were sprayed with water. The foliar fertilizer was applied using a sprayer, as diluted solutions 1, 0.5 and 0.25% concentrations. A volume of 30 mL solution/pot was used for each experiment. Maize and sunflower were chosen as test crops. Two hybrids were tested: PR 38A24 (maize) and 63A86 (sunflower).

Plant analysis

Leaves samples were collected at four different growth stages from June and August, before the first treatment and ten days after each treatment. The samples were collected from all replicaţions of the same treatments at the same growth stage.

The samples of leaves were analyzed according to a method validated in house, during this study [23]. The leaves were washed with distilled water (500mL). The harvested leaves were dried prior at 70°C for 72 h. The amount of leaves put to dry in the oven was 500g. Samples of the dried leaves were chopped and ground. The amount of 0.2g of sample was mineralized with 5.5 mL sulpho-perchloric mixture. After mineralization, the sample was transfered quantitatively to a 100 mL volumetric flask and was subject to the following analyses: nitrogen by the Kjeldahl method, phosphorus by molecular absorption spectrometry, potassium by atomic emission spectrometry.

The determination of microelements (iron, copper, zinc, manganese) was made on the ash obtained after leaves calcination. For this purpose a quantity of 1 g of leaves sample was calcinated at 450 ± 25°C and the ashes obtained were treated with hydrochloric acid 0.5 N. The residue was transfered quantitatively to a 50 mL volumetric flask. The samples were subject to the following analyses: Fe, Cu, Zn, Mn by atomic absoption spectrometry.

Seeds analysis

The maize seeds were harvested and dried at 70°C according to a standardization procedure to determine humidity [24]. The sunflower seeds were harvested and dried at 70 °C according to a standardization procedure to determine humidity [25]. Dried samples were analyzed according to a method validated in house. After drying, the samples were grounded and an amount of 0.2g of them was digested with a 5.5mL sulpho-perchloric mixture. After mineralization the sample was transferred quantitatively to a 100 mL volumetric flask. In the solution obtained the following nutrients can be determined: nitrogen, phosphorus, and potassium [23].

Determinations of macronutrients (nitrogen, potassium, phosphorus) and micronutrients (iron, copper, zinc, manganese) were perfomed according to a method validated in house [23].

The oil content was analyzed according to a standardization procedure.

Soil analysis

The soil samples were collected according to a standardized procedure [26]. The humidity was determined according to a standardized procedure [27].

The organic carbon (hummus) was determined according to a standardized procedure [28]. The total nitrogen content was determined according to a standardized procedure [29]. The exchangeable phosphorus content of soil was determined according to a standardized procedure [30]. The exchangeable potassium content of soil was determined according to a standardized procedure [31]. The microelements were analyzed according to a standardized procedure [32].

The total cation exchange capacity (T) is the total amount of cations that a soil can retain or change. The total cation exchange capacity is determined as the sum of the basic cation exchange content and hydrolytic acidity.

Sum of basic cation exchange analysis

A quantity of 10 g of soil was introduced in an Erlenmeyer flask (250-300 mL) equipped with a stopper. The quantity of soil was treated with 100 mL hydrochloric acid 0.1N and stirred mechanically for 1 hour. After shaking it, the vial content was filtered through a fllter paper. A volume of 50 mL of the filtrate was titrated with sodium hydroxide until it reached a stable pink color in the presence of phenolphthalein .

Hydrolytic acidity analysis

The hydrolytic acidity was extracted from the soil by a single extraction at equilibrium, ratio: 1:2.5 soil extraction solution, with a 1N solution of sodium or potassium acetate, buffered to *p*H 8.3.

The acetic acid resulted from the exchange of sodium or potassium with hydrogen ions was titrated with sodium hydroxide 0.1N in the presence of phenolphthalein. The values obtained for titratable acidity multiplied by the factor 1.75 (experimental set Kappen) are hydrolytic acidity (Ah).

A quantity of 40 g the soil was introduced in Erlenmeyer flask (250-300 mL) with a stopper. The quantity of soil was treated with 100 mL sodium acetate and stirred mechanically for 1 h. After shaking it, the vial content was filtered through a filter paper. Before filtration, the suspension was stirred vigorously. After a complete filtration, a volume of 50 mL of the filtrate was titrated with sodium hydroxide until it reached a stable pink color in the presence of phenolphthalein according to a standardized procedure [33].

Statistical analysis

The efficiency of the new foliar fertilizer was determined by calculating the recovery of the N, P, K. They were calculated knowing the recovery of the variant with glue and the recovery of variables without glue [34] The agrochemical parameters were statistically analysed using STATIS software, that had been developed in house. The Student's t-Test (P=95%) was used for testig the difference of means.

Results and discussions

For this experiment there were used two hybrids of maize and sunflower. The sunflower and maize hybrids were created by Pioneer Hi-Bread Services GmbH company. Both hybrids have good resistance to heat, drought and parasites

Fertilization	Variants	Maize crop			Sunflower crop		
		N total (%)	P_2O_5 (%)	K_2O (%)	N total (%)	P_2O_5 (%)	K_2O (%)
Control sprayed with water, *unfertilized in soil*	V1	-	-	-			
Control sprayed with water, *fertilized in soil*	V2	9.79	0.54	1.55	8.29	0.42	1.5
Fertilized in soil; foliar fertilized * 1%	V3	15.65	2.29	4.05	28.43	3.70	9.17
Fertilized in soil; foliar fertilized * 0.5%	V4	13.25	1.88	3.10	23.45	2.95	7.22
Fertilized in soil; foliar fertilized * 0.25%	V5	11.39	1.43	2.23	19.29	2.41	5.17
Fertilized in soil; foliar fertilized without bone glue 1%	V6	13.75	1.94	3.12	23.81	3.06	7.38
Fertilized in soil; foliar fertilized without bone glue 0.5%	V7	11.55	1.50	2.31	20.82	2.55	5.95
Fertilized in soil; foliar fertilized without bone glue 0.25%	V8	8.90	0.81	1.52	16.67	2.03	3.99

* Foliar fertilizer with bone glue

Table 2
THE DEGREE OF RECOVERY BY APPLYING FOLIAR

such as Orobanche Cumana, Plasmopara helianti rasa 304, 710 and Ostrinia nubialis [35, 36, 42]. Sunflower seeds are rich in oil, ranging between 40-50%. The PR38A24 and 63A86 hybrids present an early development. Both the hybrids used in this study revealed a high potential for them to be grown in the South-Eastern region of the Romanian Plain [37-39]. Before the experiment the foliar fertilizers were analyzed. Swietlik and Faust [40] believe that the optimum *p*H for the foliar fertilizer must be located in the weak acid - neutral interval.

During the experiment there were also analyzed the plant fruits (seed) and soil samples. The leaves were washed before analysis to remove any contamination from the surface. The leaves were dried before analysis to report the result at dry mass. The samples of dried leaves were digested for to oxidize organic matter.

The agronomic analysis of maize and sunflower production has shown differences between the control and those fed with the new foliar fertilizer. Thus, the average length of cobs was higher for all the fertilized variants (15.33±0.41 cm) than for the control (11.12±0.56 cm). The corn plant fertilized has an average of 153±2 g kernels/variant (fertilized with 1% solution), 144.6±1.52g kernels/variant (fertilized with 0.5 % solution), 137±1.73g kernels/variant (fertilized with 0.25% solution) while the control has only 76 ± 2.6 g kernels/variant. For sunflower, the results were as it follows: 121 ± 3,46 kernels/variant (fertilized with 1% solution), 112.6±2.51g kernels/variant (fertilized with 0.5% solution) and 104±2g kernels/variant (fertilized with 0.25% solution), while the control has only 59±4,35 g kernels/variant.

The grain yield, calculated considering both control 1 and 2 as being 100%, ranged between 148 and 175% (figure 3) and between 134 and 161% respectively. For sunflower the yield ranged between 142 and 162% (compared with control 1) and between 135 and 155% (compared to control 2-fi.4). One can observe for both crops significant increase in all agronomic parameters evaluated.

The foliar treatments applied on the plant did not influence the soil composition.

Research showed that plants were assimilating nutrients during the three treatments. The macro and micronutrients concentrations during the three foliar treatments were constant in the soil. The zinc concentration was smaller during the foliar treatments. The data were processed by correlating the number of plants that are grown/ha, with the production obtained in the greenhouse from g/variant in kg/ha. Production was calculated in g/ plant too, knowing the production and plants cultivated on the variant.

The accumulation of the N, P, K nutrients in the harvest was calculated knowing the production obtained and the concentration of each element in the [34].

In this study, it was observed that the degree of accumulation of the N, P, K from the applied foliar fertilizers applied was higher in the variant fertilized with bone glue compared with the control.

There must be added that, the accumulation of the nutrients was higher than in the variant without bone glue. The presence of the bone glue in foliar fertilizer leads to an improved assimilation of nutrients by the plants in all stages of development [40].

Table 2 shows the percentages of the N, P, K recovered by the contribution of bone glue applied to foliar fertilizer. The recovery was calculated using the formula: Fertilizer Recovery (%)= (N uptake in harvest-N uptake in control)*100/rate of NPK fertilizer in soil and represents the content of nutritive elements assimilated by plant and supplied by bone glue.

The N, P, K concentrations was higher in the foliar fertilization with bone glue variants compared with the variants without bone glue and control.

During the experiment, the evolution of microelements was observed in leaves in order to maintain plants to a normal nutrition and to see if deficiencies occur during plant growth and development. The largest proportion of micronutrients was absorbed in the first half of the growing season.

During the whole vegetation, the microelements concentration in leaves was higher than in the controls. The concentrations were reduced when the plant reached maturity due to translocation of this element in the seeds. The iron, manganese, zinc, copper concentrations were higher in in the foliar fertilized variants compared with the two controls.

In the mature stage of the sunflower (tabel 3) and the maize (tabel 4), there was analyzed the nutrients content, oil of sunflower seeds, and humidity (fig. 1). From both table 3 and 4 it could be seen that all the foliar fertilizers have influence on the N,P, K and the micronutrients (Fe, Cu, Zn, Mn) of the seed plants.

Figure 1 presents moisture content which varied between 12.8-13.2% (sunflower). For maize seeds, the

Agrofond	Variant	Total nitrogen (%)	P_2O_5 (%)	K_2O (%)	Cu ($mgKg^{-1}$)	Fe ($mgKg^{-1}$)	Mn ($mgKg^{-1}$)	Zn ($mgKg^{-1}$)
Control sprayed with water, *unfertilized in soil*	V1	2,56	0.40	1.08	9.12	70.00	2.80	**8.00**
Control sprayed with water, *fertilized in soil*	V2	3,42	0.41	1.17	10.20	73.00	2.86	**11.60**
Fertilized in soil; foliar fertilized * 1%	V3	3,98	0.50	1.32	13.70	86.00	3.26	17.30
Fertilized in soil; foliar fertilized * 0.5%	V4	3,90	0.48	1.27	13.10	81,8	3.17	16.40
Fertilized in soil; foliar fertilized * 0.25%	V5	3,84	0.47	1.19	12.80	80.00	3.03	15.70
Fertilized in soil; foliar fertilized without bone glue 1%	V6	3,86	0.48	1.26	13.40	84.30	3.21	16.70
Fertilized in soil; foliar fertilized without bone glue 0.5%	V7	3,79	0.46	1.20	12.96	79.00	3.13	15.90
Fertilized in soil; foliar fertilized without bone glue 0.25%	V8	3,72	0.45	1.12	12.75	76.80	2.96	15.20

***** *Foliar fertilizer with bone glue*

Table 3
CONCENTRATION OF THE NUTRIENTS IN SUNFLOWER SEEDS

Agrofond	Variant	Total nitrogen (%)	P_2O_5 (%)	K_2O (%)	Cu ($mgKg^{-1}$)	Fe ($mgKg^{-1}$)	Mn ($mgKg^{-1}$)	Zn ($mgKg^{-1}$)
Control sprayed with water, *unfertilized in soil*	V1	1.68	0.51	0.55	6.16	18.70	2.25	8.70
Control sprayed with water, *fertilized in soil*	V2	3.34	0.54	0.77	7.20	19.00	2.29	12.90
Fertilized in soil; foliar fertilized * 1%	V3	3.85	0.59	0.94	8.68	30.70	2.83	19.40
Fertilized in soil; foliar fertilized * 0.5%	V4	3,79	0.58	0.88	7.91	30.20	2.76	18.90
Fertilized in soil; foliar fertilized * 0.25%	V5	3,74	0.55	0.81	7.53	29.50	2.67	18.20
Fertilized in soil; foliar fertilized without bone glue 1%	V6	3,80	0.58	0.87	7.45	30.40	2.79	18.80
Fertilized in soil; foliar fertilized without bone glue 0.5%	V7	3,76	0.56	0.82	7.76	29.90	2.68	18.10
Fertilized in soil; foliar fertilized without bone glue 0.25%	V8	3,71	0.51	0.78	7.48	29.10	2.59	17.88

***** *Foliar fertilizer with bone glue*

Table 4
CONCENTRATION OF THE NUTRIENTS IN MAIZE SEEDS

moisture content varied between 11.16-11.60%. There were observed higher nutrients concentrations in the foliar fertilized variants, variations compared with the two controls, at the two crops: maize and sunflower. Research has shown that plants were assimilating nutrients during the three treatments.

Figure 2 shows the percentage of oil content. This has values between 45.10 and 48.4% for the foliar fertilized variants. The controls have values: 42.90 and 44.30%. the higher values were in the variant foliar fertilized with foliar fertilizer -bone glue compared with the variant fertilized without bone glue and controls.

Yield increases were significantly higher in foliar fertilized plants compared with control variants (fig. 3. and fig.4.). The lowest values were in the plots without foliar fertilizer.

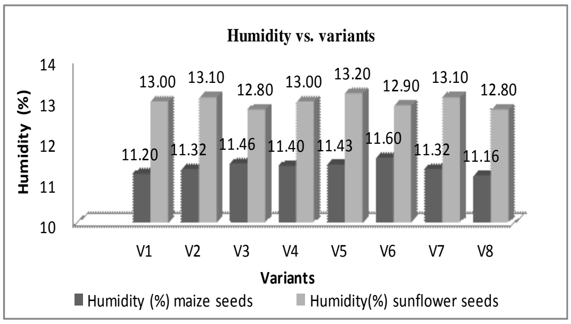

Fig. 1. Humidity (moisture content) in maize and sunflower seeds

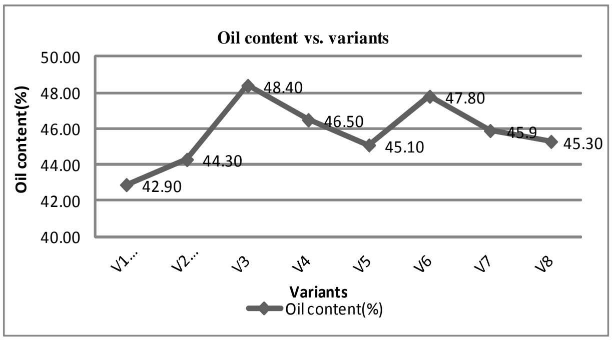

Fig. 2. Oil content in sunflower seeds

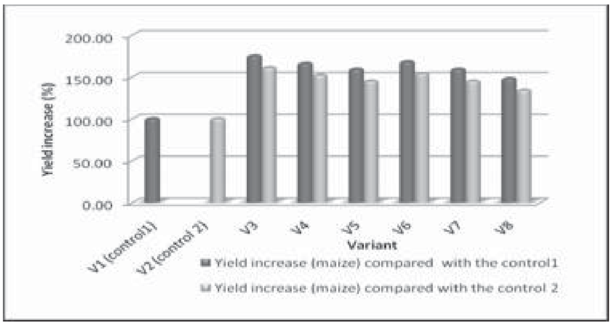

Fig. 3. Effect of foliar fertilizers on yield was increased on maize plant compared with the controls

Figure 5 shows that in variant 5 (sunflower crop), the cation exchange capacity in soil was higher during TI (initially-before experiment) than during T2 (after the foliar treatments). In variant 7 (sunflower crop) in soil cation exchange capacity decreased during T2 compared to TI. The total cation exchange capacity in maize has not varied greatly during the experiment.

Conclusions

It can be concluded that under experimental conditions studied, the foliar fertilizer with bone glue produced a high increase of the nutrients and grain quality compared with controls. Quality is probably caused by an increase in the uptake of the N, P, K, Fe, Cu, Zn, Mn and other organic substances.

The foliar fertilizers have a positive effect on the macro and micronutrients, the uptake of maize and sunflower plants as compared to both controls.

The foliar treatments applied on the plant did not influence the soil composition.

The iron, manganese, zinc, copper concentrations was higher in the foliar fertilized variants compared to the two controls.

The nitrogen, phosphorus and potassium concentrations recovered were higher in the foliar fertilization with bone glue variants compared to the variants without bone glue and controls.

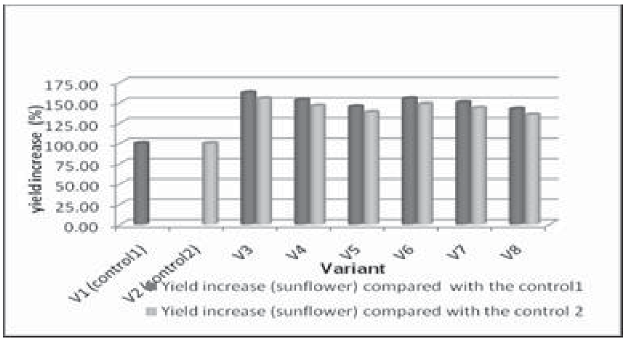

Fig. 4. Effect of foliar fertilizers on yield was increase on sunflower plant compared with the controls

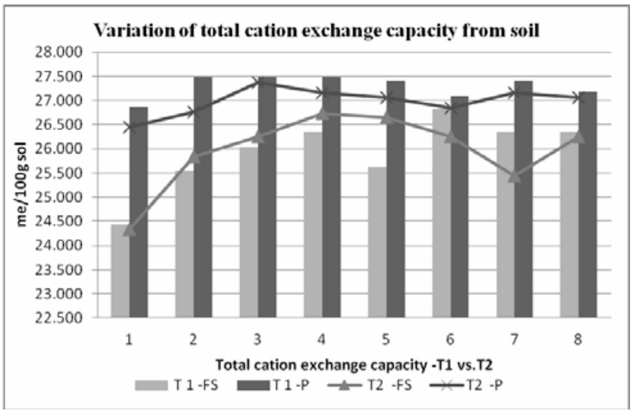

Fig. 5. Variation of total cation exchange capacity from soil

The bone glue has an influence on the stability of the foliar fertilizer applied on the plant. Yield increases were higher in foliar fertilized plants compared to control variants.

From the data presented in figures 3 and 4 it can be observed that all the foliar fertilizers have determined an increase of the dry mater yield as compared with both controls.

The foliar fertilization is an easy and rapid correction method of the primary and secondary nutritional disorders in plants.

During the experiment the soil does not change its properties by the foliar fertilizers treatments. The sunflower and maize plants assimilated nutrients from the foliar fertilizers and very little from the soil.

The purpose of the foliar analysis is to evaluate the nutrients status and to identify a diagnosis of nutrient deficiency or toxicity and/or a prediction of fertilization response. The results of this study show conclusively that three sprays of 1, 0.5 and 0.25% foliar fertilizer with bone glue, combined with regular fertilization, prevent the depletion of leaf nutrients, accelerate the maturity and improve the quality of fruit in greenhouse.

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