

Effects of the use of novel organic-mineral nitrogen fertilizers on maize crop

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Introduction

There is an increasing number of people in the planet, living in underdeveloped countries, facing hunger and poverty. Thus, it seems necessary to increase a productivity of the agriculture. The need to intensify crop production is an urgent and humanitarian measure, which brings the threat of losing millions of hectares of fertile land, due to the loss of organic matter in the soils, associated to wrong agricultural practices. On the other hand, the growing production of organic wastes leads to the urgent necessity of protecting the environment, by finding an economically sound strategic destination for wastes disposal (Cordovil, 2004). Moreover, an increase of crops yield production should not be accompanied by increase of free nitrates in the harvested products. This is possible only by using the organic mineral fertilizers (Kiladze pers. com., 2008). On the other hand, these fertilizers also have a positive effect on the recovery of degraded and low organic matter soils, on the short term. Production of organic-mineral nitrogen novel fertilizers is an innovative revolutionary technique that uses a pilot technological reactor for mechanochemical synthesis of these complex organic-mineral substances. This discharge-pulse technology uses physical effects at the high-voltage discharge in the liquid environment. Reaction of synthesis is carried out in a stream of a water pulp which contains peat, sapropel and other organic materials. Thus, it is possible to make ecologically clean organic-mineral fertilizers by the means of this technology of new generation. Such fertilizers increase productivity, improve quality of production and increase fertility of soil. The new fertilizers can also be produced in the form of pastes, allowing its use for leaf spraying with the purpose of plant protection against diseases and pests. This will open new perspectives in the field of production of the referred novel fertilizers.

With the objective of evaluating the immediate effect of the application of these novel complex organic-mineral fertilizers, on the uptake of nitrogen (N) by maize crop, as well as on nitrogen leaching losses, one lysimeter experiment was carried out.

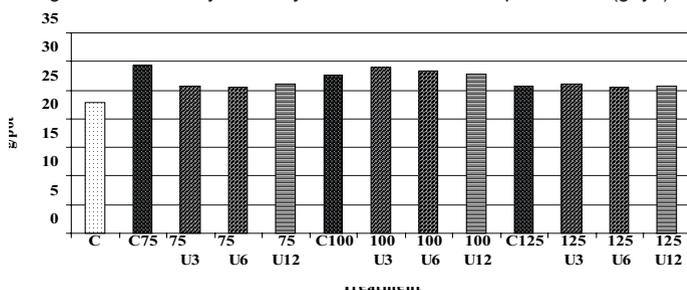
Materials methods

A lysimeter experiment was carried out under semi controlled environment conditions, using a Cambic Arenosol (FAO), with 0.34 g kg⁻¹ total Kjeldahl N and 5.8 g kg⁻¹ organic matter. Three urea based organic mineral novel fertilizers, with different N concentrations (3, 6 and 12% N), were used in triplicate. A basal dressing was performed with mineral nitrogen fertilizer at different rates, with amounts of NH₄NO₃ equivalent to fertilizations of 75, 100 and 125 kg N ha⁻¹. One month after plant growth, at tillage, a 100 kg N ha⁻¹ top dressing using urea and the three novel fertilizers, was performed. Plants were periodically watered to keep soil at approximately 60 % WHC, and nitrate leaching losses were measured along the experiment. Two months after seed germination, plants were cut, dried and analysed for nitrogen content. Nitrogen was determined in a segmented-flow auto-analyser spectrophotometer, after extraction with a 2M KCl solution, according to Mulvaney (1996). At the end of the experiment, soil samples were also taken for N determination. Anova and significance test Newman Keuls was performed on the data obtained.

Results discussion

Maize dry matter yield obtained in the experiment is shown in figure 1. Plant production in treatment C lysimeters with soil that did not receive any fertilizer, was significantly lower than that of all the other treatments performed in the experiment ($p < 0.05$). When the amount of N applied to the soil was 75 kg N ha^{-1} , conventional urea top dressing was more efficient in terms of plant growth than novel fertilizer urea. On the contrary, at 100 and 125 N levels, no statistically significant differences were observed between urea and urea based novel fertilizers (figure 1). This fact is probably due to the short time that has overlapped between application and harvest. It is expected that this novel fertilizers act not only as nitrogen suppliers but also as organic matter enhancers. On the other hand, some of the organic materials characteristics may pass on to the fertilizer itself. It is worth mentioning the salts of humic acids. Such salts are characterized by a stimulating, curing and immunizing effect. In fact, humus materials are more efficient in the first growing stage of plants, during seed germination and first roots formation. For this reason, the granulated organic-mineral fertilizers have a better performance when used for basal dressing at sowing. After germination, and during the growing stage of the crops, these fertilizers promote a higher resistance against plant diseases and pests. Finally, an increase in sugars, oils and fats is to be expected as a result of the use of these organic-mineral fertilizers (Ramazashvili, 1997, 2000).

Figure 1. Maize dry matter yield in all treatments performed (g/lys)



For treatments where 75 kg N ha^{-1} were applied to the soil, there was a higher N uptake by plants that only received mineral inputs of nitrogen. When novel fertilizers were used in top dressings, the uptake was significantly lower ($p < 0.05$). Considering the 100 kg N treatment, there was no significant difference between mineral fertilization, and novel fertilizer application when the 3% urea based product was used. On the other hand, the 6% and 12% urea based novel fertilizers were as efficient as mineral fertilization for 125 kg N treatment. In all the other treatments, plant N uptake was lower than controls with the same amounts of N applied to the soil, reported as kg ha^{-1} (figure 2.). Again, the testing of these materials seems to require higher amounts novel fertilizer applied to the soil as well as a longer cropping time and residual effect evaluation.

Novel organic mineral fertilizers were tested in west Georgia, on vegetable crops, maize and lilies. Results showed that all plants were developing faster than those of the control treatments. All the crops tested, produced higher yields, and had higher fruit and flower quality. A liquid form of the organic mineral fertilizers was also tested in Armenia, at the Institute of Agrotechnical Problems and Hydroponics, on tomato pastes and potatoes. As a result, a 35% increase in number of flowers was achieved, stalks height increased 1,5 times, and the volume of roots increase twice. Before sowing, potato tubers were treated with the fertilizer and potato leaves sprayed during growth. An increased resistance for pests, was observed. No Colorado beetles were found on the experimental plot, if compare with the control plot (Ramazashvili, 2000). For these reasons, the novel fertilizers have raised significant interest of farmers.

Figure 2. Nitrogen uptake by maize shoots (g N/lys)

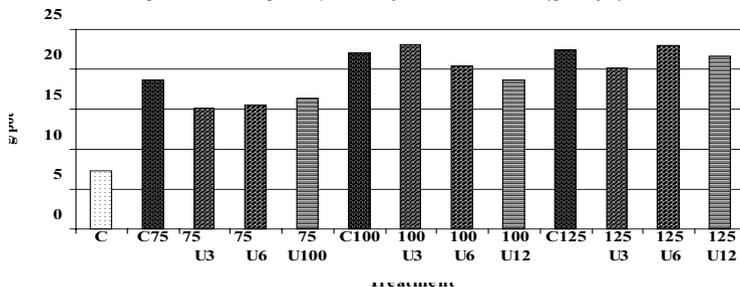
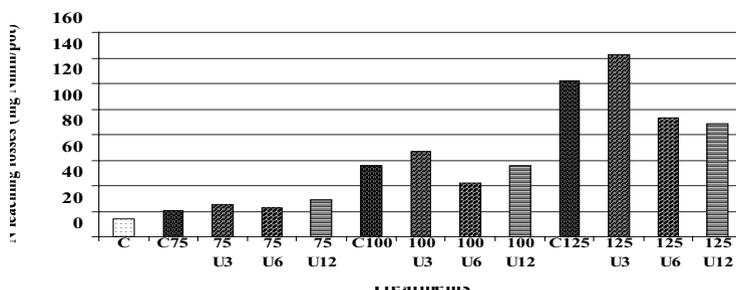


Figure 3. Total mineral nitrogen leaching losses (mg N/lys) (N-NO₃ + N-NH₄)



As expected, nitrogen leaching losses increased with the increasing amounts of N applied to the soil. In general terms, the 3% novel urea based fertilizer promoted higher mineral nitrogen leaching losses (figure 3). On the contrary, the higher concentration of the fertilizers depressed losses, which can be a positive environmental effect.

Conclusions

Apparently, the novel mineral organic fertilizers studied, did not lead to significant improvement in maize production, nor in plant nitrogen uptake. However, the significant and intense reduction of mineral nitrogen leaching losses was a very positive effect of its application. Taking into account that these organic-mineral fertilizers contain a lot of components, and that they can be synthesised from different organic waste materials, there is a wide possibility of creating fertilizers for different agricultural systems, different seasons and different soil types. This fact arises the possibility of considering the requirements of the farmers to produce fertilizers according to the needs. A new experiment on residual effect is going on and further results are expected.

Acknowledgements

This work was funded by Science and Technology Center in Ukraine (STCU). The authors thank Mrs Isabel Vaz de Carvalho for technical assistance.

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