

Ligno-humate and Content of Nitrate Nitrogen in Soil

Krejčová J.

Crop Production Research Institute, v.v.i., Drnovská 507, 161 00 Prague 6 - Ruzyně
krejцова@vurv.cz

Executive Summary

The presentation of results of laboratory experiments involving lingo-humate AM ("LH AM") as a source microbial carbon and an evaluation of its effects upon the values of nitrate nitrogen in soil. The preparation LH AM was applied to thirty soil samples of common farming soil (Luvisols, Cambisols). The testing process was the aerobic incubation. The samples were incubated in an incubation chamber for one week at the temperature of 28 °C.

What was determined were positive effects of LH AM upon the immobilisation of nitrogen. An elevated content of nitrate nitrogen in soil after the application of LH AM as compared to incubated control reference samples was detected after the incubation in two only out of thirty tested soil samples.

Introduction

At the time being when we experience dropping capacities of livestock production (in particular dropping counts of cattle) and changing seeding patterns (for instance substitution of perennial fodder crops by corn), it is always more difficult to maintain a balanced composition of the humous soil that is a key factor for the sustainable productivity of soil. Lack of organic fertilisers and post harvest residua resulted into an increase of demand for the application of non-traditional sources of organic carbon-containing compounds that could be used in farming. One of them are ligno-humates (ligno-sulphates) extracted from paper mill waste.

The objective of the paper was to determine changes in the content of nitrate nitrogen in soil following the application of LH AM.

Material and methods

The Crop Production Research Institute Prague tested the effects of the preparation LH AM upon the content of nitrate nitrogen in soil. LH was used as a source of available microbial carbon (it contained 60 % C_{ox}, out of which 30 % in the form of fulvic acids). The aerobic incubation was executed for thirty soil samples of common farming soils of the Czech Republic (Cambisols, Luvisols).

Values characterising the set of used soil samples ranged as follows: carbon (C_t: 0,995 – 2.339 %), nitrogen (N_t: 0.112 – 0.244 %), ratio C_t : N_t: 8.43 – 10.65) exchange capacity (CEC: 78 - 183 mmol . kg⁻¹) and pH_{H2O} 5.95 – 6.93. The samples were identified by serial numbers from 1 to 30 depending on the values of ascending exchange capacity.

Soil samples (20 g) with an addition of LH AM (0.1 g) and reference control samples without any such addition were incubated for one week at 28 °C in an incubation chamber. After the incubation, soil extracts (1 % K₂SO₄) were checked for the content of the nitrate and ammonia nitrogen ((Tecator - FIAstar 5020) (HADAS et al 2004, HADAS, PORTNOY 1994, KREJČOVÁ 1996, KREJČOVÁ 2007).

Results and Discussion

Carbonaceous compounds including but not limited to their microbial utilisable portion (a source of energy for soil micro-organisms) affect the transformation of nutrients in soil including but not limited to the transformation of nitrogen to nutrients that is the most important from the point of view plant nutrition. If confronted with a drop in the level of nutrients in soil, the plant itself can, using root exudates (i.e. simple metabolically utilisable substrates), stimulate the activity of soil organisms and provide for the supply of nutrients during the vegetation period. The quantity of organic compounds as exuded by the plant to the soil is in average one third of the weight of rape crops, i.e. in order of several hundreds of $\text{kg}\cdot\text{ha}^{-1}$ (ČÍŽEK, KREJČOVÁ 1993).

A source of nitrogen in soil are organic substances from where nitrogen gets released by mineralisation. Ammonia ions accumulate in the soil environment. Simultaneously with this process, but in the reverse direction, there is an immobilisation process under way. The ammonia ions get immobilised in the soil to microbial mass or they get bound to clayous minerals. The plant receives only a limited quantity of ammonia contained nitrogen. The key source of nitrogen for the plant nutrition are nitrates generated by the oxidation of ammonia ions, so called nitrification. The intensity of the nitrification depends on the quantity of ammonia nitrogen in soil. The nitrogen immobilisation is limited by the quantity of microbial utilisable nitrogen (ŠIMEK 2000, OCIO et al.1991, COOKSON et al. 2004). Every soil is a complex heterogeneous system hosting a number of continuous often contravening processes and transformations the intensity of which is determined by specific values of every soil environment. The content and forms of nitrogen are influenced first of all by the quality of organic substances in soil (the C : N ratio) as well as humidity, temperature, aeration and pH. Should the C : N ratio value be high, the immobilisation process prevails. Vice-versa, should this value be low, mineralisation prevails (ŠIMEK 2000, HADAS et al. 2004).

What is a must in the event of an intensive farming utilisation of soil is the supply of sufficient nutrition. Therefore, what is to be addressed in connection with plant nitrogen nutrition is the study of carbonaceous compounds in the soil. What is applied to the soil with aim at preserving its high productivity are organic and mineral fertilisers. Following the application of nitrogen containing fertilisers, a sufficient quantity of microbial available carbon stimulates the accumulation of nitrogen from mineral fertilisers to microbial biomass (N mobilisation) (OCIO at al. 1991, ČÍŽEK, KREJČOVÁ 1993). After the remineralisation of dead microbial cells, the ammonia nitrogen gets gradually nitrified to nitrates and it is picked by plants from soil. This improves the usability of the fertilisers (reducing economic costs) and it reduces the risk of the washing of nitrate nitrogen away from the soil profile. This way, available carbonaceous substances can have favourable effect upon farming production and improve the environment.

The evaluation of the impacts of the LH AM upon the quantity of nitrate nitrogen in soil was based on results of the aerobic incubation of thirty various soil samples. The addition of LH AM shifted the equilibrium of the process of the nitrogen immobilisation/nitrification in the soil environment in favour of the immobilisation in most soil samples. If compared to the reference control samples free of any LH AM addition, only two such samples (1 and 23) out of the tested soil set showed a demonstrable increase of the values of nitrate nitrogen (Figure 1). The figure 2 shows differences of the content of ammonia nitrogen. Fifteen incubated soils showed an increase of the content of ammonia nitrogen after the application of LH AM, three soil samples have such changes poorly demonstrable (6, 7 and 23) and lower values were measure in other soil samples.

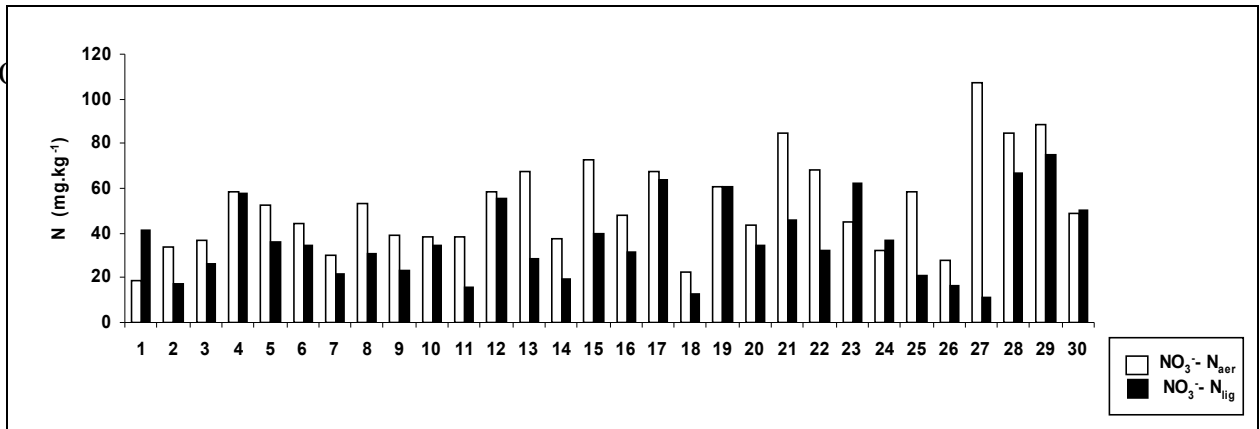
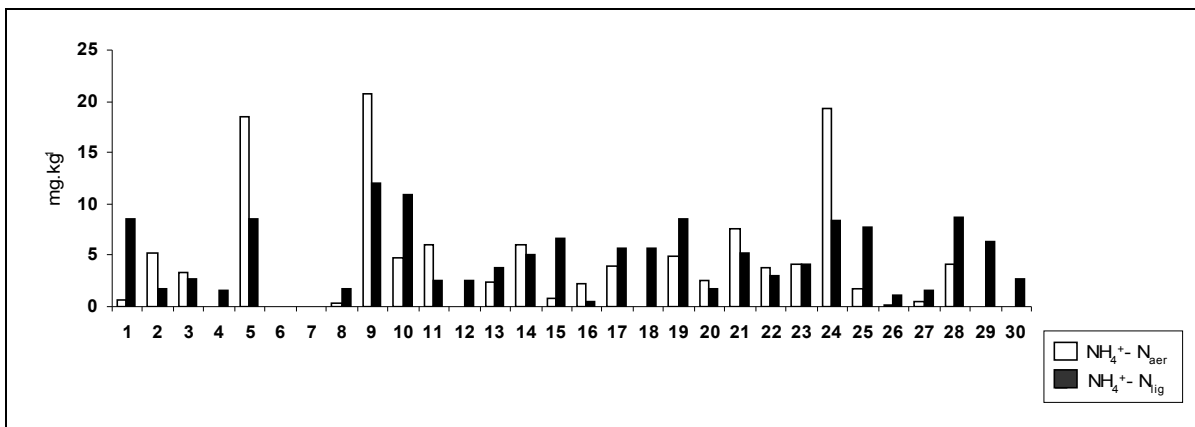


Figure 2: Content of ammonia nitrogen in soil samples (0 – 30 cm) incubated with (NH₄⁺-N_{lig}) and without LH AM (NH₄⁺-N_{aer})



Conclusion

The obtained results indicate that the tested preparation LH AM is a suitable alternative source of available carbon and its application in practical farming appears to be very promising. By shifting the equilibrium of the nitrogen immobilisation-nitrification process in favour of immobilisation, its application together with mineral fertilisers may extend the time of the utilisation of nitrogen by the plants and also reduce the risk of the washing of nitrate nitrogen away from the soil profile.

The possibility of its application should be conditioned by a thorough research of its properties and effects under specific soil conditions.

This paper was executed with the support of the project of the Ministry of Agriculture of the CR No. MZE 0002700601

Abstract:

The aim of this work was the determination of available nitrate nitrogen content in soil with and without Lignohumate AM application. Soils were collected from 30 localities of Czech Republic (Luvisols, Cambisols). We studied nitrate content changes under conditions of aerobic incubation (7 days, 28 °C). The Lignohumate AM addition enhanced N immobilisation and led to reduction of nitrification rate. The extensive increase of nitrate concentration was noted only in two soil from 30 tested soils.

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