THE USE OF COMPOST TO REDUCE LEAKAGE OF MINERAL NITROGEN – LYSIMETER EXPERIMENT

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ABSTRACT

This paper presents first results from long term pot experiment, which is focused on influence of addition of compost on leaching of mineral nitrogen. Twenty one lysimeters were prepared in the area of our interest. This area is a protection zone of underground source of drinking water (Březová nad Svitavou). These lysimeters were filed with topsoil and subsoil collected in this area and divided into two groups.

The content of mineral nitrogen was measured in soil solution (percolate), which was collected from each lysimeters. First results confirm the hypothesis that the addition of organic carbon (in form of compost) has positive effect on mineral nitrogen leaching. The highest leaching of mineral nitrogen was measured in variant with 100 % of N addition and the lowest in the variant with the 200 % addition of compost.

Key words: compost, leaching of mineral nitrogen, lysimeter, nitrogen

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INTRODUCTION

Application of compost in agriculture is very desirable worldwide. In the Czech Republic, compost is the most often used to improve soil structure and increase the content of soil organic matter, but the effects of compost addition on the fate of mineral nitrogen are only scarcely described (ELBL *et al.* 2013, PLOŠEK *et al.* 2013).

The largest part of global nitrogen pollution stems from agricultural activities (GALLOWAY *et al.* 2003). Reduction of fertilizing is not satisfactory to prevent losses of mineral nitrogen from agricultural systems (TAMM 1991). It will be necessary to change the method of farming. One option is to support the microbial activity in humus horizon (rhizosphere). Microbial activity can be supported by the addition of carbon (SUTTON 2011). Microbial processes supported by added carbon increase the capacity of the soil for capturing of mineral nitrogen. Nitrogen is subsequently stored in soil organic matter. The deposited organic nitrogen can be used later by plants or soil microorganisms and cannot be easily lost from arable land (DIAZ *et al.* 2007, SUTTON 2011).

Leaching of mineral nitrogen (consisting of NH_4^+-N and NO_3^--N) from arable land is a major threat to the quality of drinking water from underground reservoirs in the Czech Republic [9]. In the present paper, effect of compost addition on leaching of mineral nitrogen from arable land was investigated in field lysimetric experiment.

MATERIAL AND METHODS

Experimental design

Influence of compost addition on mineral nitrogen leaching was tested by pot experiment. Twenty one lysimeters have been used as experimental containers and located in the area. The experiment was conducted in the protection zone of underground source of drinking water Březová nad Svitavou, where annual climatic averages (1962-2012) are 588.47 mm of precipitation and 7.9 °C mean of annual air temperature (ELBL *et al.* 2013). The lysimeters were made from PVC (polyvinyl chloride). Each lysimeter was the same size and was filled with 25 kg of subsoil and 25 kg of topsoil (arable soil). See Figure 1.

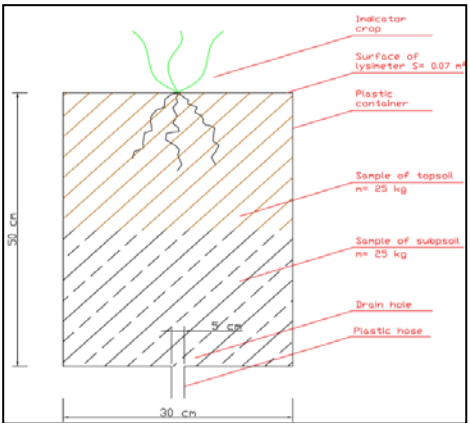

Fig. 1: Design of experimental container - lysimeter (ELBL *et al.* 2013)

Topsoil and subsoil were collected from a field in the area. Soil samples were sieved through a sieve (grid size of 10 mm) and homogenized. Topsoil and subsoil were prepared separately. Each lysimeter had one drain hole and PVC hose for collecting soil solution. Hose leads into the plastic bottle. All lysimeters were buried into the ground. Collection of soil solution and monitoring of the lysimeters was carried out in the control shaft. Lysimeters were completed and filled in October 2012. Winter wheat (*Triticum aestivum*) was used as a model plant to determine the effect of fertilizers and on plant production. The model crop was planted into each lysimeter in October 2012.

Seven variants (C1, C2 and K1 - K5) were prepared: C1 (control - without fertilization), C2 (control - with 100 % of recommended doses of N), K1 (100 % of recommended doses of compost), K2 (100 % of compost, 25 % of N), K3 (100 % compost, 50 % of N), K4 (100 % of compost, 100 % of N), K5 (200 % of compost).

Information on the applied fertilizers: Compost was applied in recommended doses of 50 Mg/ha from Central composting plant in Brno (Compost Černý drak). Nitrogen was applied as a liquid fertilizer DAM 390 converted in dose of 140 kg/ha of N.

Determination of mineral nitrogen

Soil solution was collected into plastic bottles, which were placed in the control shaft. The amount of the solution was monitored three times per week. If a solution was found in a bottle, it was taken for the determination. Samples were stored at 4°C before the determination.

Concentration of mineral nitrogen (N_{min}) was measured using distillation-titration method by (PEOPLES *et al*. 1989). Ammonium nitrogen was determined by distillation-titration method in an alkaline solution after the addition of MgO. Nitrate nitrogen was determined in the same manner using Devard´s alloy. Concentration of NH_4^+-N and NO_3^--N was calculated:

$$\text{mg } NH_4^+ \text{ or } NO_3^- - N = \left(\frac{\text{normality of standart HCl}}{0{,}03571}\right) \text{x } 0{,}5, \text{xtitration} \quad \text{(BROOKES } \textit{et al.} \text{ 1985)}$$

The value of N_{min} was calculated as the sum of the detected ammonium and nitrate forms.

Determination of N_{min} was performed after each sampling of the soil solution and in each sample. The results obtained from the analyses of soil solution were expressed in mg of N_{min} per m^2 (mg/m^2).

RESULT AND DISCUSSION

Leaching of mineral nitrogen

From January to July 2013, the concentration of mineral nitrogen (N_{min}) was measured in soil solution. The solution was captured from individual lysimeters. The Figure 2 shows concentration of N_{min} in individual variants. This graph indicates a significant difference ($P<0.05$) in content of N_{min} before and after application of fertilizers in soil solution.

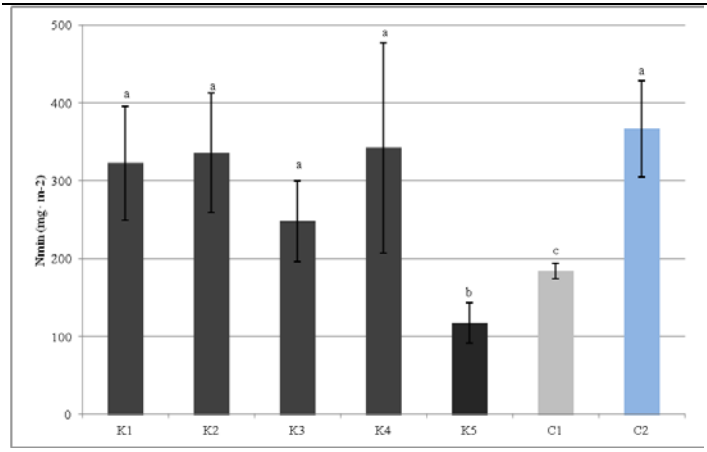

Fig. 2: Concentration of N_{min} n soil solution (mean ± SD, n = 3)

The highest concentration of N_{min} was measured in variant with 100 % of recommended doses of N (C2 = 367 mg N/m^2) and the lowest in the variant with 200 % doses of compost (K5 =117 mg N/m^2). Reduce leakage of mineral nitrogen in variants with the addition of compost can be explained by the addition of available organic carbon (Corg) in the form of compost. The possotive effect of Corg on soil microbial activity and decreasing of mineral nitrogen leaching confirm for example Elbl *et al.* (2013), Plošek *et al.* (2013) and Sutton (2011).

CONCLUSIONS

This contribution presents the first results of a long-term pot experiment. The measured values indicate the influence of addition of compost and mineral nitrogen fertilizer on leaching of mineral nitrogen. Based on the results, that the high addition of compost has positive effect on leaching of mineral nitrogen.

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