THE EFFECTS OF HUMIC ACID PRODUCT ON SOIL FERTILITY MEASURED BY RYEGRASS TEST PLANT

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Abstract: Soil fertility can be influenced by the use of humic acid. The humic acid that we used in our experiments originated from South Africa. It was produced by Farmfert Formulators INC. and registered under the code number of PCT WO 2006/092720AI. The extraction of the humic substances from mineral coal, organic compost or both involved three steps. During the first step, oxidizing reagent (HNO_3) was added to the raw material under atmospheric pressure in a reactor. This initiated an exothermic chemical reaction. The second step was to separate the fulvic acid from the intermediary product into a solution using pyroligneous acid. The remaining deposit in the bottom of the reactor contained the humic acid, which was extracted during the third step resulting from the treatment with potassium-hydroxide.
The effects of humic acid application were measured in three doses (0.075; 0.5; 10%) in laboratory in a pot experiment by ryegrass test plant. Dry matter yield and macro element content of ryegrass plants were measured. The highest yield was measured in case of the 0.5% treatment. The 10% dose caused yield depression, however, in this treatment the nitrogen uptake was the highest. The highest phosphorus uptake was measured in case of the lowest dose of humic acid application. The potassium uptake did not respond significantly to the humic acid treatment.

Keywords: soil fertility, humic acid, fertilisation

Introduction

By humic acid treatments, the increase of plant production is achieved by the positive influence of physiological processes (cell respiration, photosynthesis, protein synthesis, water and nutrient uptake, enzimatic activity) (Vaughan and Malcolm, 1985; Albuzio et al., 1986; Chen and Aviad, 1990; Concheri et al., 1994; Nardi et al., 1996, Chen et al., 2004, Traversa et al., 2013). This effect depends on the applied dose and it is especially effective in low concentration ranges (Chen and Aviad, 1990). An optimal concentration range can be determined (50-300 mg dm^{-3}), in which these treatments stimulate plant growth to the highest extent (Chen et al., 2004).
The raw materials of the humic acid based additives are mostly lignite or leonardite. Their positive effects on plant growth were mainly detected in experiments of hydroponic or sand culture (Chen et al., 2004). Relatively few experiments were carried out on the effects of humic acid based additives under field conditions. Their positive effects were mainly reported in case of soils with low organic matter content (Fagbenro and Agboola, 1993; Kunkel and Holstad, 1968; Lee and Bartlett, 1976). However, other results showed that the effects of these additives cannot be proved under real field conditions (Boyhan et al., 2001; Feibert et al., 2003; Duval et al., 1998). Hartz (2010) recognized that, in certain cases, humic acid products can have positive effects by enhancing the micro nutrient availability and microbiological activity, however, these benefits do not compensate for the extra costs related to the application of these additives under average production circumstances.
In the production of fruits and vegetables, the yield growth and quality improvement of the products can compensate for the extra costs. Hagagg et al. (2013) found significant

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improvement in the quality and quantity of „Aggizi" olive trees by the application of Actosol treatment.

Materials and methods

The humic acid that was used in our experiments is originated from South Africa. It was produced by Farmfert Formulators INC. and registered under the code number of PCT WO 2006/092720AI. The extraction of the humic substances from mineral coal, organic compost or both involved three steps. During the first step, oxidizing reagent (HNO_3) was added to the raw material under atmospheric pressure in a reactor. This initiated an exothermic chemical reaction. The second step was to separate the fulvic acid from the intermediary product into a solution using pyroligneous acid. The remaining deposit in the bottom of the reactor contained the humic acid, which was extracted during the third step resulting from the treatment with potassium-hydroxide.
In the experiment perennial ryegrass (*Lolium perenne*) was used as a test plant. The soil we used in our experiment was a young soil in early stage of weathering, originated from a sedimentary material, and developed under forest vegetation. The pH value of the soil was slightly-moderately alkaline, and the salt accumulation was low (*Table 1*).

Table 1. Soil chemical properties from the area of experiment

$CaCO_3$	P_2O_5	K_2O	NO_3-N	Salt	EC	pH(H_2O)	* K_A
%	mg dm^{-3}	mg dm^{-3}	mg dm^{-3}	%	mS cm^{-1}		
10.6	47	130	3.5	0.02	0.45	8.1	35

* K_A value stands for the upper limit of plasticity, ie. the amount of distilled water that can be taken up by 100g of soil (The value 35 means sandy loam texture).

The seeds were planted in small, 200 cm^3 plastic containers filled with soil. In each container, 200 seeds were placed. The dry soil was previously sieved, using 2 mm diameter sieve, and treated with humic acid in three different concentrations, 10%, 0.5% and 0.075%, respectively. Equal number of test and control samples had been used for each treatment. After five weeks of growing period the leaves had been removed from the root system and were analyzed for dry matter, nitrogen, phosphorus and potassium content. The leaf samples were dried at 70^{o}C, dry weights were determined and the samples were wet digested by using Kjeldhal method. The nitrogen was determined by Parnas-Wagner distillation. Phosphorus was determined by using spectrophotometer and the potassium content was measured by flame photometer.
We used a program for ANOVA which was made by Tolner in Microsoft Office Excel (Aydinalp et al., 2010).

Results and discussion

When examining the effects of humic substances, the impacts are evaluated, ie. the difference between the values resulting from the treatments and the control values are evaluated. *Figure 1*. shows the effects of humic acid products on dry matter (yield) and the nitrogen uptake by plants.

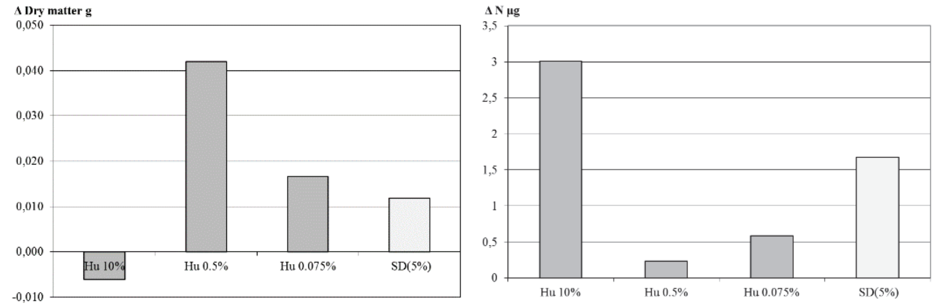

Figure 1. The effects of humic acid products on the dry matter production of ryegrass (left) and the nitrogen content taken up by the plants (right). (Δ: Treatment – Control)

When comparing the effects on dry matter content, we experienced that their average values differed more from each other than the SD(5%)=12 mg values. It can be seen on *Figure 1.* (left) that with 0.075% treatment, significantly higher effect (23 mg more) was gained compared to the effect of the 10% treatment. The 0.5% treatment resulted in even higher positive effect, which significantly exceeded the effects of the 0.075% treatment, with the difference of 25 mg. The 6 mg decrease for the 10% treatment compared to the control was not significant. This result indicated that the effects of treatments are dependent on the applied doses.

Analysing the data on nitrogen uptake by plants showed opposite tendency (*Figure 1.* right). There was not significantly higher N uptake in case of the 0.5 and 0.075% treatments. However, the N content taken up by plants increased in the 10% treatment pots compared to both values.

Figure 2. shows the differences in phosphorus and potassium uptake based on treatments.

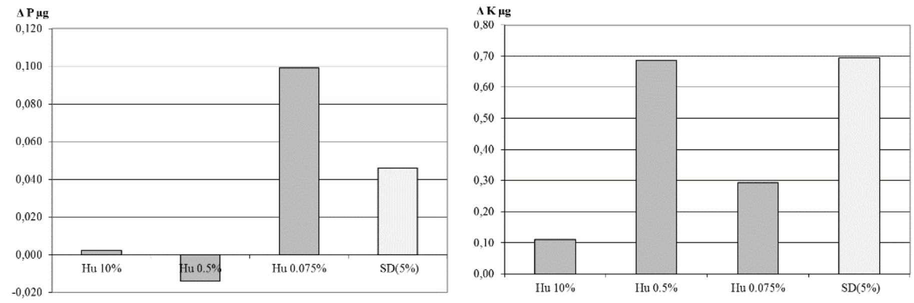

Figure 2. The effect of humic acid products on phosphorus (left) and potassium content (right) of ryegrass (Δ: Treatment – Control)

The P uptake under the 0.075% treatment (*Figure 2*. left) exceeded appreciably both the 10 and the 0.5% treatments. The difference between the effect of the 10 and the 0.5% treatment is not significant.

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In case of the K content (*Figure 2*. right), the tendency-like positive effect of the 0.5% treatment cannot be statistically justified due to the high deviation of data.

Conclusions

The effects of humic acid product treatments on the dry matter production (yield), and nitrogen, phosphorus and potassium content of ryegrass were examined. The highest yield was measured in the case of 0.5% treatment. The 10% dose caused yield depression, however, in this treatment the nitrogen uptake was the highest. The highest phosphorus uptake was measured in case of the lowest dose of humic acid application. The potassium uptake did not respond significantly to the humic acid treatment.

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