# APPLICATION OF BENTONITE ON ACIDIC HUMIC SANDY SOIL

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***Abstract***

*In the University of Debrecen, Institute of Agrochemistry and Soil Science in a pot experiment (2007-2010), the effect of increased doses [5; 10; 15; 20 g kg soil$^{-1}$] of bentonite was studied on some chemical proporties of an acidic ($pH_{H2O}$=5.34) humic sandy soil (Debrecen-Pallag), and the plant biomass production [perennial rye-grass (Lolium perenne L.)] of soil.*
*The $pH_{(H2O;KCl)}$ increased by the effect of doses of amendments significantly, with the increase of the pH, the hydrolytic acidity decreased. The soil nitrate-N content increased in a little measure, while the AL-solube phophorus and potassium content of soil increased significantly. The readily available phosphorus content was increased significantly by the effect of the middle-dose, while the readily available potassium content was increased by the effect of the small-, middle- and middle-large doses of betonite significantly. The largest value of the plant biomass was measured by the effect of the middle dose, where 8% biomass dry-production increase was determined compare to the control treatment.*

**Keywords:** bentonite, acidic, humic sandy soil, chemical proporties, plant biomass

## INTRODUCTION

A basic pillar of sustainable development is to utilize soils as natural resources in a rational way and to maintain their diverse functions (Várallyay, 2005). For preservation and sustainability the productivity of soil we have to take special regard to the sandy soils having unfavourable properties. These soils have very low colloid contents, their water management is extreme due to the weak structure with only transmission pores, and the nutrient management is also pour (Henzsel, 2008). Manure and green manure are among the oldest methods used for enriching the inorganic and organic colloid content of these soils and for improving their water- and nutrient management. Later, with intensive crop production, the application of artificial fertilizers started, where nowadays the main aim is the environmentally-safe and cost-effective application (Csathó et al., 2007).

Finally, the application of natural substances for soil improvement was started in the last years to meet the requirements of sustainable production. According to Lazányi, (2003) the natural soil amendments for acidic sandy soils can arrange into three groups: 1. green manure and other organic matter, 2. farmyard manure and different composts, 3. mining soil improving material originating from mining industry, e.g. alginite, zeolite, bentonite (Márton és Szabóné, 2002; Szeder és mtsai 2008; Szegi és mtsai 2008).

The bentonite is a rock containing clay minerals, mainly Smectites (Pártai et al., 2006). The primary effect of bentonite is to improve the water holding capacity and moisture content of soil and through this property contribute to the stimulation of biological activity (Shimmel & Darley, 1985; Usman et al., 2005, Lazányi 2005). When mix the bentonite with soil, increase the mineral nutrient content, the colloid content of soil, and with the higher colloid content decrease the leaching of different nutrients (Noble et al., 2000).

In the experiment of the University of München, where bentonite was mixed to the soil of salad seedlings, the 3% dose had a favourable effect on the fresh weight of seedlings, but a higher dosage had a depressing effect on plants (Schnitzler et al., 1994).

In the University of Debrecen, Institute of Agrochemistry and Soil Science in a pot experiment the effect of increased dosages of bentonite [5; 10; 15; 20 g kg soil$^{-1}$] was studied on some chemical properties and on a testplant's biomass (*Lolium perenne L.)* of an acidic ($pH_{H2O}$=5.34) humic sandy soil [WRB: Lamellic Arenosol (Dystric)].

## MATERIALS AND METHODS

The pot experiment was set up in 2007-2010 in the UD CASE Institute of Agrochemistry and Soil Science in three repetitions, in six kilogram pots, on acidic ($pH_{H2O}$=5.34) humic sandy soil. *Table 1* containes the treatments of bentonite doses. The water content of treatments was in the same level, as the 70% of the maximum water capacity. The pots were sprinkled in every day to the same weigh. The test plant was perennial ryegrass *(Lolium perenne L.).*

As basic treatment 100 mg nitrogen – $Ca(NO_3)_2$ solution – 100 mg $P_2O_5$ and 100 mg $K_2O$ solution of potassium dihydrogen orthophosphate and potassium sulphate to every pot. Soil samples were taken in the fourth, the eight week of the experiment in every year.

The pH of soil was measured in suspension of distilled water and M KCl [$pH_{(H2O)}$; $pH_{(KCl)}$] and the hydrolytic acidity (Filep, 1995), besides nitrate nitrogen content (Felföldy, 1987), further the ammonium lactate-acetate soluble phosphate and potassium content of soil was determined (Filep, 1995 cit. Gerei, 1970). The biomass of test plant also was measured in every sampling time. Statistical analysis of the data was done using the program SPSS 13.0. Means of the measurements, deviation, significance values (p=5) and correlation analysis were calculated (Huzsvai, 2004).

*Table 1*

Treatments and their designation in the tables (2007-2010)

| Treatments and doses | Doses |
|---|---|
| | BENTONITE |
| 1. Control | 0 |
| 2. Little dose | 5g $kg^{-1}$ |
| 3. Middle dose | 10g $kg^{-1}$ |
| 4. Middle-large dose | 15g $kg^{-1}$ |
| 5. Large dose | 20g $kg^{-1}$ |

**RESULTS AND DISCUSSION**

The results are discussed according to the average values of the four years of experiment.

In our small-pot experiment the $pH_{(H2O)}$ *(Table 2)* of control sandy soil was 5.34 in the average of the four years examined results, so it proved to be acidic soil. Our results proved that the bentonite - which have alkaline acidity – increased the $pH_{(H2O)}$ of soil. The significantly bigger pH-value was defined on the effect of the middle dose.

The $pH_{(KCl)}$ also significantly grew compared to the value of the control soil. But between the doses – except the treatment with a little dose – we were not able to manifest a difference which can be justified statistically. The potential acidity of the soils may influence the soil acidity substantially, so one of its forms was determined, there was the hidrolitic acidity. All of bentonite doses reduced its value, the decrease with a largest measure caused by middle-large dose, which its effect did not differ from the other dose statistically.

*Table 2*

Effect of treatments on the pH and the hydrolytic acidity (2007-2010)

| Number of treatments | $pH_{(H2O)}$ | $pH_{(KCl)}$ | $y_1$ |
|---|---|---|---|
| 1 | 5.34 a | 4.29 a | 12.10 a |
| 2 | **5.51** b | **4.42** b | **11.52** b |
| 3 | **5.66** c | **4.59** c | **11.45** b |
| 4 | **5.64** bc | **4.65** c | **11.42** b |
| 5 | **5.59** bc | **4.61** c | **11.76** bc |
| **$LSD_{5\%}$** | 0.15 | 0.11 | 0.31 |

Regarding the readily available nutrient content of soil *(Table 3)* in course of the four examination years, based on our results, that compare to the nitrate-N content of the control soil, the small-, medium-, and medium-large doses yielded a small-scale increase only. In the large-dose a similar nitrate nitrogen amount was measured compared with the control. The larger nitrate-N content of soil was determined in a small and medium dose of bentonite treatments. The readilily available phosphorus content of soil was increased by the little- and large-dose of bentonite slightly, but the medium-dose increased it significantly. The readily available potassium content of soil was increased by the small-, middle-, and middle-large doses significantly, the large-dose of bentonite produced - not significantly – increase its value.

*Table 3*

Effect of treatments on the easily available nutrients of soil (2007-2010)

| Number of treatments | Nitrate-N (mg 1000 $g^{-1}$) | AL-$P_2O_5$ (mg 1000 $g^{-1}$) | AL-$K_2O$ (mg 1000 $g^{-1}$) |
|---|---|---|---|
| 1 | 3.69 a | 89.33 a | 229.75 a |
| 2 | 4.42 a | 98.25 a | **270.83** b |
| 3 | 4.56 a | **104.75** ab | **275.54** b |
| 4 | 3.86 a | 90.76 a | **258.33** b |
| 5 | 3.60 a | 90.34 a | 243.75 ab |
| **$LSD_{5\%}$** | 1.07 | 10.28 | 24.49 |

The plant dry matter production on the effect of treatments increased also *(Figure 1)*. The amount of plant biomass changed in the examined experimental years between 2.43 and 2.69g $kg^{-1}$ $season^{-1}$. The bentonite doses not significantly raised the amount of plant biomass, there was no difference between the effects of treatments which justifiable statistically. Beside the medium dose compare to the control we were able to define an 8%- increase in amount of plant biomass production.

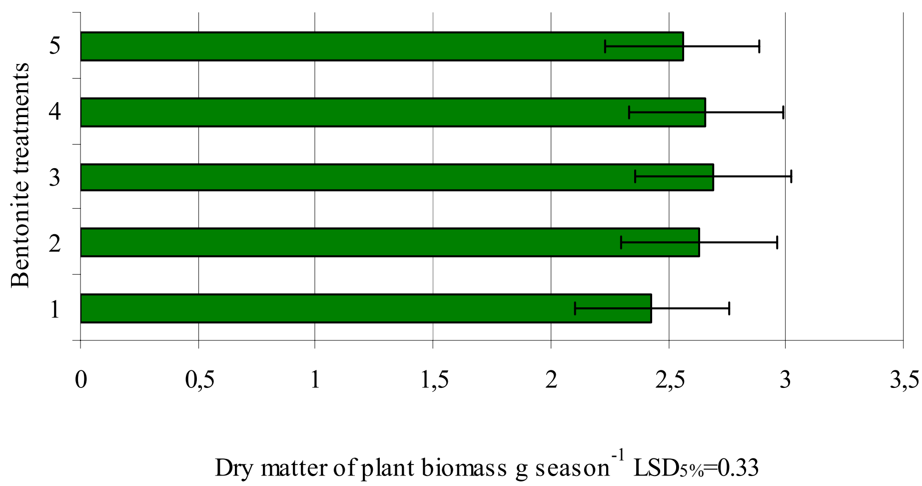


*Figure 1:* Effect of bentonite on the quantitative change of the test plant biomass (2007-2010)

Correlation analyses was made to seek the relations among the different examined soil chemical parameters (Pearson Correlation, Huzsvai, 2004) and the amount of plant biomass at the base of the results of the four experimental years (2007-2010). In our publication we emphasize the more important correlational rates between the examined parameters only *(Table 4)*.

Middle positive correlation was established between $pH_{(H2O)}$ and the AL-soluble potassium (r=0.573) content, the $pH_{(KCl)}$ and the readily available phosphorus (r=0.682) content, furthermore the amount of plant biomass (r=0.680). The change of the AL-solube phosphorus (r=0.595) and potassium (r=0.529) content of soil medium related with the amount of the dry matter of plant biomass. The $pH_{(H2O)}$ showed negative medium correlation with the hidrolitic acidity of soil (r=-0.638), and also negative medium correlation was established between the value of the hidrolitic acidity and the readily available potassium content (r=-0.522). We were not able to justify a tight relationships between the examined parameters.

*Table 4*

Correlation between the soil examined chemical parameters and the amount of plant biomass (2007-2010) (Pearson correlation)

| **Pearson correlation (n=24)** | | |
|---|---|---|
| **Examined soil parameters** | | **r-rates (P<0.05)** |
| $pH_{(H2O)}$ | $y_1$ | -0.638 |
| $pH_{(H2O)}$ | AL-$K_2O$ | 0.573 |
| $pH_{(KCl)}$ | AL-$P_2O_5$ | 0.682 |
| $pH_{(KCl)}$ | Plant biomass | 0.680 |
| $y_1$ | AL-$K_2O$ | -0.522 |
| AL-$P_2O_5$ | Plant biomass | 0.595 |
| AL-$K_2O$ | Plant biomass | 0.529 |

**CONCLUSION**

The bentonite treatments influenced positively the soil parameters examined and the amount of plant biomass.

The $pH_{(H2O;KCl)}$ increased by the effects of doses of amendments significantly, with the increase of the pH, the hydrolytic acidity decreased on the effects of treatments.

The soil nitrate-N content increased in a little measure, and the AL-solube phophorus and potassium content of soil increased significantly. The readily available phosphorus content was increased significantly by the middle-dose (10t $ha^{-1}$), while the readily available potassium content was increased by the effect of the small- (5t $ha^{-1}$), middle- (10t $ha^{-1}$) and middle-large (15t $ha^{-1}$) doses of betonite significantly.

The largest value of the plant biomass was measured by the effect of the middle-dose, where 8% biomass dry-production increase was determined compare to the control treatment.

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