THE EFFECT OF INCREASING COMPOST DOSES ON THE CHANGES OF Ca- AND Mg CONTENT OF SOIL AND INDICATOR PLANT *(Lolium perenne L.)* IN POT EXPERIMENT

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Abstract
Significant proportion of side-products from household, food industry and agriculture get into the landfill having high macro- and micronutrient content, which can be an unusually good nutrient source for plant. Excellent quality of compost can be produced from non-toxic organic wastes completed by appropriate additives and applying suitable treatment technology. It was expected to use compost, which have positive effect, in our experiment set up in the greenhouse of the University of Debrecen Centre for Agricultural and Applied Economic Sciences, Institute of Agricultural Chemistry and Soil Science. It was used perennial ryegrass (Lolium perenne L.) as indicator plant. According to the experimental results the 10 % of compost dose was the most effective, which resulted the biggest biomass production. The optimal mixing ratio was between 10 and 25 % because there was not significant different among these treatments. The application of 50 % of compost ratio caused decrease in the yield, despite of the Ca- and the Mg content of soil, which was unusually good.

Key words: recycling, compost ratio, Ca- and Mg-content

INTRODUCTION

One of the basic goals of the sustainable agriculture is to minimize the application of artificial chemicals which have potential harmful effect on environment. As a result the yield will be protected and improved. The volume of organic wastes is getting bigger produced by industry and agriculture sectors creating opportunity for making good quality of compost. Using compost as an organic fertilizer in horticulture moderating the problem of emplacement of biological wastes and contributes the increase soil fertility (Elfoughi et al., 2010).

There are different opinions about the application of compost made by biological wastes having soil structure improving effect (Whalen et al., 2002), positive effect on soil fertility (Lee et al, 2003; Arancon et al., 2004) and the symptoms eliminating effect on nitrogen-deficient soils (Terman et al., 1972), furthermore positive effect on nutrient uptake (Maynard, 1995). The divided opinions come from the different and various compositions of compost and different treatment technology as well as the nutrient content of the collected source materials.

Pot experiment was set up to show the favourable effect of compost, which is before placing on the market. It was investigated the effect of compost on the Ca- and Mg-content of soil and plant biomass.

MATERIAL AND METHOD

The studied compost was produced and provided by one of the partners of the University of Debrecen in the summer of 2009. A pot experiment, under controlled conditions, was set up in the greenhouse of the Institute of Agricultural Chemistry and Soil Science. Compost was sieved (< 2 mm), because degradation of the large particles in the pots is slow. Composts were mixed with an acidic sandy soil in four proportions (5 %, 10 %, 25 % and 50 %), so with the control there were five treatments (including control) in four replications *(Table 1)*. After the volumetric mixture the pots were set up randomized.

Table 1.

The compost-soil ratio of treatments

Treatments	Compost ratio (%)	Sandy soil ratio (%)
1.	0	100
2.	5	95
3.	10	90
4.	25	75
5.	50	50

After one week maturation of wet compost-soil mixture in 7th of September perennial ryegrass *(Lolium perenne L.)* was sowed. This indicator plant grows quite fast, tolerates the greenhouse conditions well and it indicates the effect of treatments well. In the greenhouse the water supply of pots was independent from the weather conditions, because the pots were placed on cars, which is movable under roof. After the shooting of ryegrass (21st of September) the water supply were settled missing by daily evapotranspiration. The field water capacity of soil was carried out at 60 percent, because it is optimal, according to the previous researches of the Department of Agricultural Chemistry (Loch et al., 1992).

After a vegetation period of four weeks, in 15th of October, the ryegrass was harvested and air-dried. The drying was continued at 40 ^{o}C to constant mass of plant and the dry matter production was determined. According to Egner et al. (1960) the Ca- and Mg-content of soil was analysed by AL (ammonium lactate - acetic acid extractant) in 1:20

soil:extractant ratio and after nitric acid digestion (HNO_3–H_2O_2) the Ca- and Mg content of shoots were determined as well.

Soil samples were shaken for two hours, than were filtered (5-7 μm). The Mg- and Ca-concentration were measured by an atomic absorption spectrophotometer (Varian SpectrAA 20 Plus) at the laboratory of the Department of Agricultural Chemistry and Soil Science of the University of Debrecen.

Plant samples were harvested and dried at 105 ^oC to constant mass. After grinding, 0.5 g plant samples were digested with 5 cm^3 of H_2SO_4 (96 %) and 5 cm^3 of H_2O_2 (30 %) at 280 ^oC. Digested samples were made up to 50 cm^3 with distilled water at room temperature. The filtered solutions were analyzed.

All statistical analyses were performed by a Microsoft Excel Macro developed by L. Tolner (Aydinalp et al., 2008; Tolner et al., 2008; Vágó et al., 2008) according to Sváb (1981). This program made the determination of significant level between plant biomass and given compost doses possible as a result forced statistical consequences can be made. The significance level of the treatment effect and significant differences were determined at $P \leq 0.05$.

RESULTS AND DISSCUSIONS

The average values of the ryegrass dry mass in each treatment are represented in *Figure 1*, after harvest. According to the statistical analysis of the data, the dry matter production and Ca-content of ryegrass as well as the Ca- and Mg-content of the soil was affected by the compost treatments on a highly significant level ($P \leq 0.01$). Only the Mg-content of ryegrass was different from the other ($P \leq 0.05$).

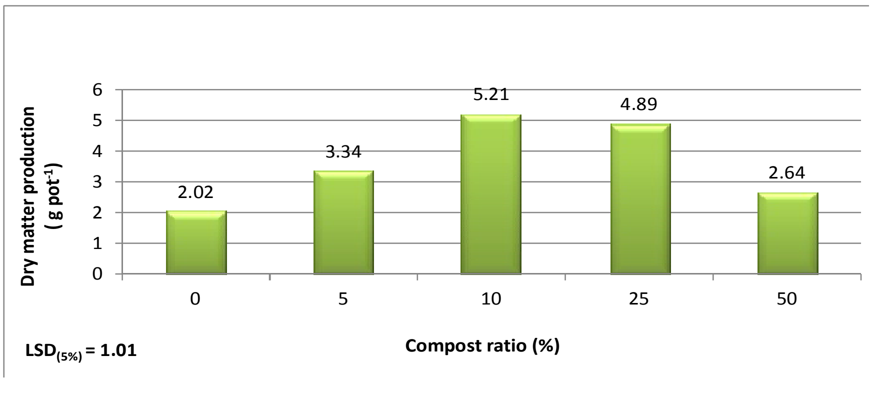

Fig. 1 Dry matter production of ryegrass in each treatment (g pot^{-1})

Figure 1 shows the increasing effect of compost on yield initially. The 10 % compost rate had the highest positive effect on dry mass. The effect of 25 % compost rate was moderately, but significantly positive. In contradict, compared to the control, the 50 % compost rate increased only non-significantly the yield. The possible reasons are the less favourable nutrient uptake conditions caused by the high organic matter content and the ion antagonism. The results confirmed that high rate compost treatments have unfavourable effects as well. The 10-25 % compost rate seemed to be optimal.

The amount of AL-extractable Ca-content of soil can be seen in the *Figure 2*. It was observed increase in the uptaken Ca-content in the line with increase of compost doses. As the *Figure 2* shows that there is source of Ca, which is not uptakeable beside the available Ca-content. The reason of the high value is the extracting solution was strong what able to mobilize the sparingly soluble forms (hidden sources) as well. The application of this extracting highlighted that the used compost has a substantial nutrient content having a very important characteristic trough continuous nutrient exploration.

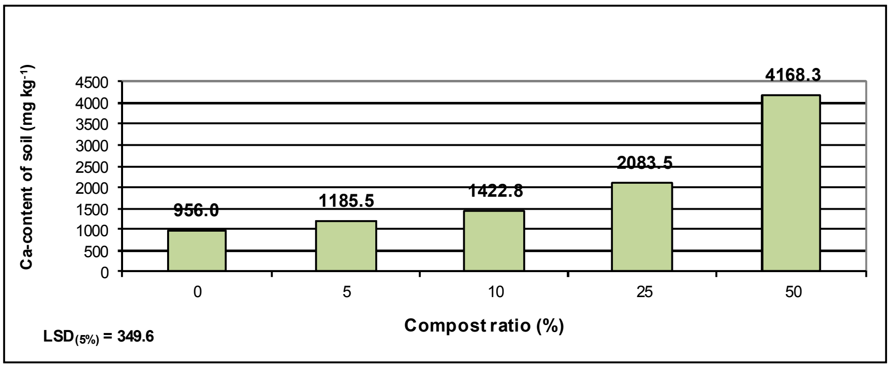

Fig. 2 Al-extractable Ca-content of soil (mg kg^{-1})

The Ca-content of plant samples were analysed *(Figure 3.)*. Significant decrease can be observed in the Ca-content of plant biomass in all case compare to the control, as well as in some cases in the doses next to each other. The reason of decreasing tendency is that Ca amount was bigger than the unit of ryegrass production. As a consequence, the nutrition-ratios shifted to an unfavourable range in order to the yield of the ryegrass decreased.

The *Figure 4* shows the AL-extractable Mg-content of soil (mg kg^{-1}). With the increase of compost doses the remained Mg-content of soil shows consistent increase. The amount of the applied compost into the soil is high (alike the Ca-content) showing the significant increase in the Mg-content compare to the control from the 5 % compost treatment.

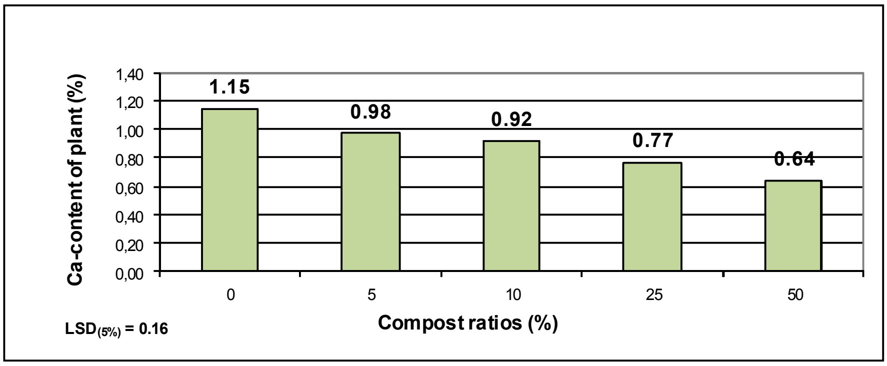

Fig. 3 Ca-content of plant (%)

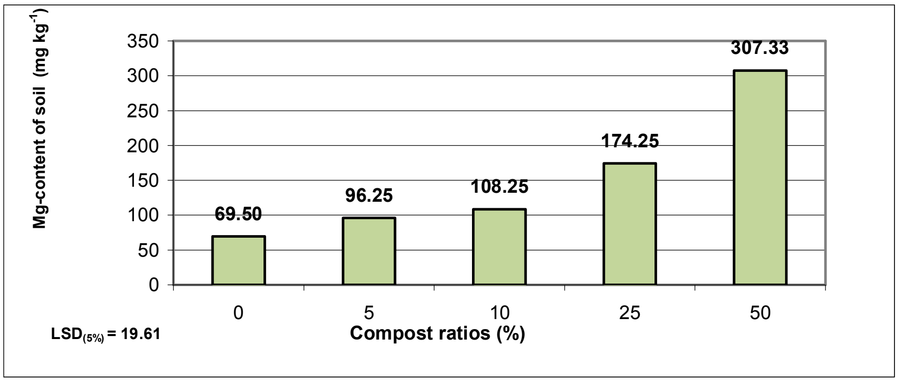

Fig. 4 AL-extractable Mg-content of soil (mg kg^{-1})

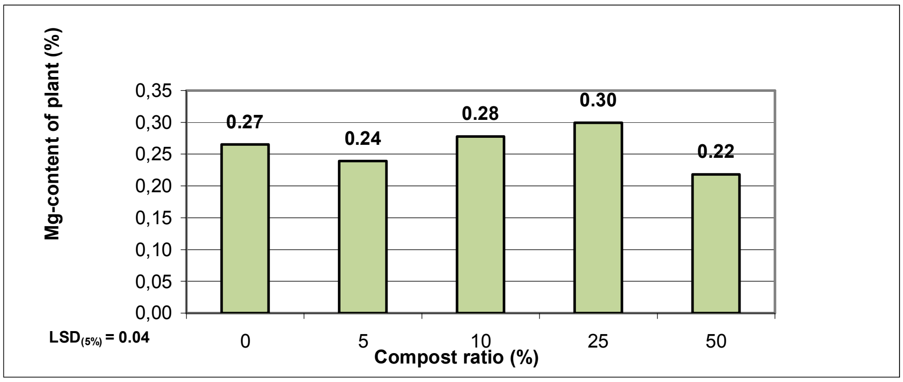

Fig. 5 Mg-content of plant (%)

The Mg-content of plant samples (%) were measured as well *(Figure 5)*. The measured values show differences, but there is no significant differences among the treatments (except of treatment 50 % compost). According to the experiment the Mg-content is independent from the changes of the soil Mg-content if minimal threshold is ensured.

CONCLUSIONS

According to the yield data and the plant nutrient uptake the optimal compost rate was 10 %. The Ca- and Mg-increasing effect of compost on soil resulted higher biomass. However the dominance of micronutrients caused decrease in the Ca-content and differences in the Mg-content of ryegrass.

REFERENCES

1. *Arancon, N. Q. – Edwards, C.A. – Bierman, P. – Metzger, J.D. – Lee, S. – Welch, C.* (2004): Effects of vermicomposts on growth and marketable fruits of field-grown tomatoes, peppers and strawberries. Pedobiologia. 47. 731–735.
2. *Aydinalp, C. – Füleky, Gy. – Tolner, L.* (2010): The Comparison Study of Some Selected Heavy Metals in the Irrigated and Non-Irrigated Agricultural Soils. Bulgarian Journal of Agricultural Science, 16: 754-768. IF: 0.153
3. *Egner, H. – Riehm, H. – Domingo, W.R. (*1960): Untersuchungen über die chemische Bodenanalyse als Grundlage für die Beurteilung des Nährstoffzustandes der Böden. II. K. LantbrHögsk. Ann 26. 199-215.
4. *Elfoughi, A. – Benedek, Sz. – Bayoumi, H.H.E.A.F. – Füleky, Gy.* (2010): Komposzttrágyázás hatásának vizsgálata a talaj tápelem-szolgáltató képességére. Agrokémia és Talajtan 59 (2010) 2
5. *Lee, J.J. – Park, R.P – Kim, Y.W. – Shim, J.H. – Chae, D.H. – Rim, Y.S. – Sohn, B.K. – Kim, T.H. – Kim, K.Y.* (2003): Effect of food waste compost on microbial population, soil enzyme activity and lettuce growth. Bioresource Technol. 93. 21–28.
6. *Loch, J. – Kiss, Sz. – Vágó, I.* (1992): A kálium-, kalcium-, magnézium- és vízellátás hatása az őszi búza szemtermésére és magnéziumfelvételére. 4. Magyar Magnézium Szimpózium, Balatonszéplak. In: Magnesium Research 5. Abstr. 238.
7. *Maynard, A.A.* (1995): Cumulative effect of annual additions of MSW compost on the yield of field-grown tomatoes. Compost Sci. Util. 3. 47–54.
8. *Sváb, J.* (1981): Biometriai módszerek a kutatásban. Mezőgazdasági Kiadó, Budapest.
9. *Terman, G.L. – Soileau, J.M. – Allen, S.E.* (1972): Municipal Waste Compost: Effects on Crop Yields and Nutrient Content in Greenhouse Pot Experiments. Journal of Environmental Quality. 2. 84–89.
10. *Tolner, L. – Vágó, I. – Czinkota, I. – Rékási, M. – Kovács, Z.* (2008): Field testing of a new, more efficient liming method. Cereal Research Communications. 36. 543 – 546.
11. *Vágó, I. – Tolner, L. – Eichler-Löbermann, B. – Czinkota, I. – Kovács, B.* (2008): Long-term effects of liming on the dry matter production and chemical composition of perennial ryegrass *(Lolium perenne L.).* Cereal Research Communications. 36. 103-106.
12. *Whalen, K.J. – Hu, Q. – Liu, A.* (2002): Compost Applications Increase Water-Stable Aggregates in Conventional and No-Tillage Systems. Soil Science Society of America Journal. 67. 1842-1847.