# CHANGES OF YIELD, NUTRIENT CONTENTS OF RYEGRASS (LOLIUM PERENNE L.) DUE TO DIFFERENT ORGANIC FERTILIZERS APPLICATION

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**Abstract**

*Greenhouse pot experiment was set up to investigate the effects of different organic fertilizers (horse manure, cattle manure and food waste compost) on the dry biomass and nutrient content of ryegrass (Lolium Perenne L.). The experiment was set up on humic sandy soil with treatments of 1: control; 2:horse manure with straw; 3:horse manure with sawdust; 4: cattle manure; 5: food waste compost; 6. NPK fertilizer.*

*All treatments were set up with four replications. The effects of organic fertilizers were compared with the effect of mineral fertilizer. The dose of organic fertilizer was 30t/ha, while the amount of mineral fertilizer was counted on the base of plant demand and nutrient supply of soil.*

*The organic fertilizers and NPK mineral fertilizer changed the yield, the soil pH and nutrient uptake of plant by different way.*

*The most yield increasing organic fertilizer proved to be the horse manure with straw and the cattle manure. These organic fertilizers caused the same increased yield as NPK mineral fertilizer.*

*Both horse manures increased the pH of soil, while cattle manure and food waste compost did not cause any significant changes in soil pH. NPK fertilizer decreased the pH of soil. Horse manures increased the plant nutrients and enhanced the soil nutrients as well. Cattle manure and food waste compost resulted smaller changes in nutrient contents of soil and plants.*

**Keywords:** organic fertilizers, ryegrass, dry biomass, nutrient content

## INTRODUCTION

The importance of a sustainable agriculture and reduction of environmental problems are highly gained attentions (Mohammadi et al., 2015) nowadays. Application of organic fertilizers is recognized as a necessity in creating a sustainable agriculture (Alam, 2004). Organic fertilizers may improve the physical, chemical and microbiological properties of soil (Clark et al.,1998; Liebig and Doran, 1999)

These fertilizers can be animal wastes (manures with different origin), plant wastes from agriculture, treated sewage sludge or composts. Manure constitutes can be a nutrient resource for plants that should be efficiently recycled in agriculture. Manures for the agricultural application

may come from cow, sheep, poultry and horses. Horse manure consists of feces, urine, and varying amounts of various bedding materials (Eriksson, et al., 2016). The most common materials used as main or extra bedding can be wood shavings or pelleted straw (Keskinen et al., 2017; Sharpley and Moyer, 2000). The bedding materials absorb urine, moisture, and gases and increase the comfort, health, and well-being of horses (Saastamoinen, 2015). Bedding has effects on the volume and quality of manure. Horse manure contains valuable plant nutrients such as nitrogen, phosphorus, potassium, calcium, magnesium and different micronutrients, but the composition of horse manure highly depends on the bedding material as well. The effects of animal manures on soil properties depend on the amount and type of material applied (Lourenço et al., 2013)

Large amounts of food waste are produced in Hungary. Restaurants, food factories and canteens of schools produce million tons of commercial organic waste that may be composted. This compost is called food waste compost and it is a nutritionally rich and complex product that is low in toxic constituents (Eun-Young et al., 2013; Chang and Tin-En Hsu, 2008).

The objective of this study was to evaluate the effects of organic manures (Irshad et al., 2002) with different origin ( horse, cattle) and bedding materials (straw, sawdust) and the impact of food waste compost on the growth, nutrient content of ryegrass (*Lolium perenne* L.) and the chemical characteristic of soil. The effects were compared to the effects of NPK mineral fertilizer.

**MATERIALS AND METHOD**

The greenhouse pot experiment was set up on humic sandy soil. The experimental plant was ryegrass (Lolium Perenne *L.*).

The organic fertilizers were horse manures with different bedding materials, with straw and sawdust, cattle manure and food waste compost. Compost was obtained from composting of restaurant food residuals. Food residuals were mixed with wood waste and were composted for 90 days.

*Table 1*

The main properties of experimental soil

| | |
|---|---|
| pH ($CaCl_2$) | 6.01 |
| $K_A$* | 26 |
| Hu% | 1.3 |
| AL-$P_2O_5$ (mg/kg) | 274 |
| AL-$K_2O$ (mg/kg) | 286 |

*Plasticity index according to Arany, described (Buzás, 1993)

The effects of different organic manures were compared to the effect NPK fertilizers.

The main properties of experimental soil and the treatments of the experiment can be seen in the *Tables 1.* and *2.* All treatments were set up in four replications.

*Table 2*

The treatments of the experiment

| *Number of treatments* | *Name of treatment* |
|---|---|
| 1 | control |
| 2 | horse manure with straw |
| 3 | horse manure with sawdust |
| 4 | cattle manure |
| 5 | food waste compost |
| 6 | NPK mineral fertilizer |

2500 g sandy soil was thoroughly mixed with different organic fertilizers (at dose of 30t/ha) and mineral fertilizer solutions one month before starting the experiment and the fertilized soil was put into experimental pots.
The main characteristics of different organic fertilizers are described in *Table 3*. The age of all manures was at least 9 months, when we set up the experiment.

*Table 3*

The main characteristics of organic fertilizers applied

| | N<br>% | C<br>% | C/N | AL-$P_2O_5$<br>mg/kg | AL-$K_2O$<br>g/100g |
|---|---|---|---|---|---|
| horse manure with straw | 3.87 | 31.90 | 8.24 | 820 | 4.030 |
| horse manure with sawdust | 0.980 | 11.64 | 11.88 | 730 | 0.939 |
| cattle manure | 2.31 | 27.22 | 11.79 | 670 | 1.359 |
| food waste compost | 0.841 | 13.65 | 16.22 | 714 | 0.673 |

The doses of NPK fertilizer were 0.2 g $pot^{-1}$ N, 0.2 g $pot^{-1}$ $P_2O_5$ and 0.2 g $pot^{-1}$ $K_2O$, in the solution of $NH_4NO_3$, $KH_2PO_4$ and KCl, respectively. 2g ryegrass seeds were sown into all pots. Ion exchanged water was added to all pots to keep the soil at constant moisture, 60% of the field water-holding capacity, using daily weighing.

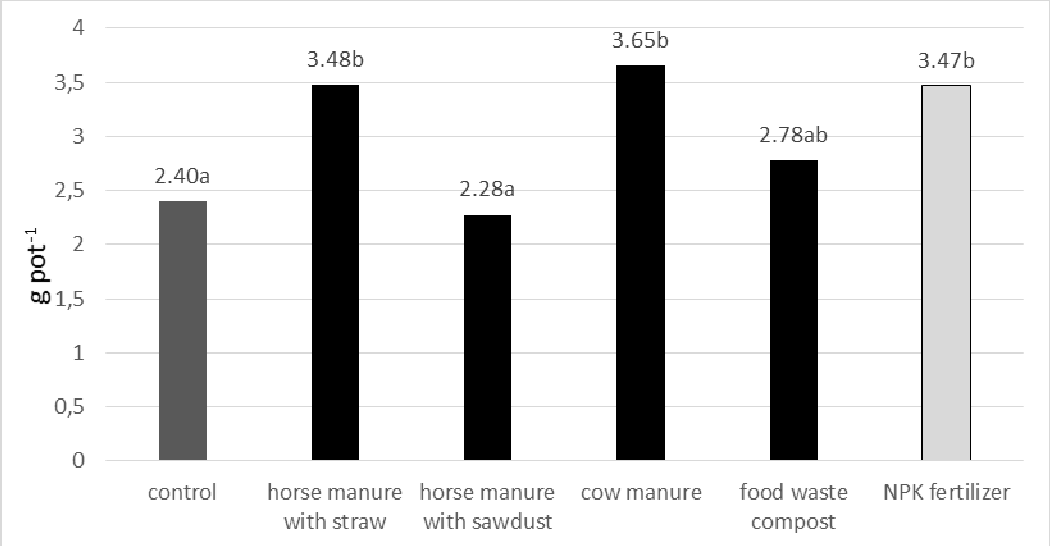
After four weeks of emerging of ryegrass the plants were cut and fresh weights and after drying at 60°C, dry biomass per pots were determined.
Leaves after drying were digested by $H_2SO_4$-$H_2O_2$ and $HNO_3$+$H_2O_2$ methods and phosphorus, potassium, calcium, magnesium and micronutrients, like manganese and zinc were measured. P was measured by spectrometry using the molybdenum blue colorimetric method, potassium was quantified by flame emission spectrophotometry, calcium, magnesium, manganese and zinc were determined by atomic absorption spectrometry.

Analysis of variance was carried out on the data by SPSS statistics 1.3 program to provide a statistical comparison between the treatment means. The mean differences among treatments were analyzed through Tukey post hoc test. Significant differences ($P < 0.05$) between treatments in figures are indicated by different letters.

**RESULTS AND DISCUSSION**

### 1.1. The dry biomass of ryegrass (g pot$^{-1}$)

The changes of dry biomass of ryegrass by the effects of different organic fertilizers and NPK mineral fertilizer are presented in *Figure 1*.




*Significant differences ($P < 0.05$) between treatments are indicated by different letters

Fig. 1. Means of dry biomass of ryegrass (g/pot) by the effect of different treatments

The dry biomass of ryegrass ranged between 2.28-3.65 g pot$^{-1}$. The highest values were measured due to horse manure with straw and cow manure application. These organic fertilizers caused the same yield as NPK mineral fertilizer. Horse manure with straw tended to decrease the dry biomass compared to value of control. The dry biomass a little bit, but not significantly increased when food waste compost was applied.

### 1.2. Changes of nutrient content of ryegrass influenced by different organic and NPK mineral fertilizers

The mean values of macronutrient (phosphorus, potassium, calcium, magnesium) and micronutrient (manganese and zinc) content of ryegrass as a function of different treatments are presented in *Table 4.*

The phosphorus content of plant varied in the range of 0.352-0.389%, but there were not any significant differences between values of different treatments and control.

*Table 4*

Means of phosphorus, potassium, calcium, magnesium, manganese and zinc content of ryegrass

| *Treatments* | *P* % | *K* % | *Ca* % | *Mg* % | *Mn* mg/kg | *Zn* mg/kg |
|---|---|---|---|---|---|---|
| *control* | 0.376a | 3.83a | 0.612a | 0.264a | 69.3ab | 37.7ab |
| *horse manure with straw* | 0.389a | 3.86ab | 0.675ab | 0.281ab | 73.8ab | 37.0ab |
| *horse manure with sawdust* | 0.371a | 4.44ab | **0.713b** | **0.305b** | 74.2ab | 40.7ab |
| *cattle manure* | 0.378a | 4.26ab | 0.657ab | 0.267ab | 59.0a | 35.8a |
| *food waste compost* | 0.352a | 3.76a | 0.664ab | 0.267ab | 78.8ab | 40.8b |
| *NPK mineral fertilizer* | 0.357a | **4.53b** | **0.732b** | 0.284ab | **112.8b** | 40.3ab |

*Significant differences ($P < 0.05$) between treatments are indicated by different letters

The potassium content ranged between 3.76% and 4,53 %. All the manures tended to increase the potassium content compared to control value, but significant enhanced potassium content was measured -as it was expected- due to NPK fertilizer application. We measured the same potassium content due to food waste compost application and in control.

Calcium and magnesium content of ryegrass ranged between 0.612-0.732%, and 0.264-0.305%, respectively. Horse manure with sawdust significantly increased both calcium and magnesium content of plant, as well. Other organic fertilizer a little, but not significantly enhanced these nutrient contents of plant. The NPK mineral fertilizer also significantly enhanced the calcium content of plant.

The micronutrients, like manganese and zinc content of ryegrass ranged between 59.0-112.8 mg $kg^{-1}$, and 35.8-40.8 mg $kg^{-1}$, respectively. NPK fertilizer caused twice manganese content of plant (112.8 mg $kg^{-1}$) compared to control (69.3 mg $kg^{-1}$). It was because it decreased the pH of soil, which resulted increased solubility of manganese. Organic fertilizers did not change the manganese content of plant significantly.

The zinc content of plant did not differ significantly due to different treatments compared to control.

### 1.3. Changes of AL-$P_2O_5$, AL-$K_2O$, AL-Ca, AL-Mg, 0.01 M $CaCl_2$-Mn and $CaCl_2$-Zn content of soil influenced by different organic and mineral fertilizers

The pH of soil and the AL soluble macronutrients and 0.01M $CaCl_2$ soluble micronutrient contents of soil can be seen in *Table 5*.

*Table 5*

Means of AL-$P_2O_5$, AL-$K_2O$, AL-Ca, AL-Mg, $CaCl_2$-Mn and $CaCl_2$-Zn contents of soil influenced by different treatments

| | $CaCl_2$ -pH | AL-$P_2O_5$ mg/kg | AL-$K_2O$ mg/kg | AL-Ca mg/kg | AL-Mg mg/kg | CaCl2-Mn mg/kg | CaCl2-Zn mg/kg |
|---|---|---|---|---|---|---|---|
| control | 5.72b | 241.5bc | 193.0b | 1100ab | 134.3b | 23.90bc | 0.81ab |
| horse manure with straw | **5.81d** | 247.2cd | **242.1c** | 1087ab | **146.3c** | ***19.63a*** | 0.71a |
| horse manure with sawdust | **5.79cd** | **252.8d** | **245.1c** | **1157c** | **146.0c** | ***19.26a*** | 0.94b |
| cattle manure | 5.74bc | 240.5b | 229.6bc | 1100ab | 136.7bc | ***20.64a*** | 0.99b |
| food waste compost | 5.71b | 242.1bc | 202.3b | 1113b | 132.3b | 21.44ab | 0.93b |
| NPK fertilizer | ***5.60a*** | ***228.7a*** | ***151.6a*** | 1070a | ***120.7a*** | 24.35c | **1.28c** |

*Significant differences ($P < 0.05$) between tr1eatments are indicated by different letters

Both horse manures caused significant pH increase compared to control, while NPK fertilizer decreased this value. Cattle manure and food waste compost did not change this value.

Horse manure with straw enhanced the AL soluble potassium and magnesium of soil, while might because of its pH increase effect, decreased the available manganese content. Horse manures did not alter the AL soluble zinc content of soil.

Cattle manure did not change the AL soluble nutrients of soil, but caused significant increased $CaCl_2$ soluble manganese of soil.

Food waste compost did not change the soluble nutrient content of soil compared to the control by the end of the experiment.

Due to NPK fertilizer application the AL soluble phosphorus, potassium and magnesium decreased in the soil. This effect was because of the yield increased and higher yield took up more nutrients. At the same time the NPK fertilization caused smaller pH of soil and that is why the $CaCl_2$ soluble zinc increased.

**CONCLUSIONS**

Studying our results it can be said that all organic fertilizers -except for horse manure with sawdust- in 30t/ha dose enhanced the growth of ryegrass. The most yield increasing organic fertilizer proved to be the horse manure with straw and the cattle manure. These organic fertilizers caused the same increased yield as NPK mineral fertilizer. Food waste compost slightly, but not significantly enhanced the yield, and horse manure with sawdust did not alter the growth of plant compared to control.

Horse manure with straw slightly increased the P, K, Ca, Mg content of plant and significantly enhanced the AL soluble potassium and magnesium of soil by the end of the experiment. This organic fertilizer significantly enhanced the pH, that is why might decrease the $CaCl_2$-Mn value of soil.

Horse manure with sawdust supplied high amount of macronutrients and that's why caused significantly higher calcium and manganese contents of plant and higher AL soluble macronutrients (P, K, Ca, Mg) in soil by the end of the experiment. Its pH increasing effect resulted lower $CaCl_2$ soluble manganese content of soil.

Cattle manure and food waste compost did not caused any significant changes in soil pH and in plant macronutrients but cattle manure resulted slightly decreased plant manganese content and significantly lower 0.01M $CaCl_2$ soluble Mn in soil compared to control.

NPK fertilizer resulted higher macro- and micronutrients of plant and that is why lower plant available macronutrients remained in the soil by the end of the experiment. NPK fertilizer decreased the soil pH, and thus increased the $CaCl_2$ soluble manganese of soil.

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