Compost Treatment for a Sustainable Growth in Natural Grassland in Hungary

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Abstract
Grassland ecosystems can be found on every continent, except Antarctica thanks to their high tolerance and adaptability. Moreover the grassland based animal husbandry is an ancient and easy way for food production even in regions where other agricultural sectors cannot be effective. On the other hand these ecosystems are not only valuable because of their role in food production. Grasslands take their share in carbon sequestration, erosion controlling and the conservation of biodiversity and that is why the European Union made strict rules about grassland management. In our experiment we tested two different types of compost - what are officially allowed in organic farming - on natural grassland in Hungary. Three rates of compost (10 t/ha, 20 t/ha, 30 t/ha) were tested on 3m X 10m experimental plots in four replication. Both type had four control plots too, this way we had 32 experimental plots. We measured the botanical composition in May and September, what was followed by harvesting and the measurement of the yield. Samples for laboratory analysis were also taken. Dry matter yield of the pasture showed positive responses to the rates of compost but the protein yield per unit area only grows until a certain point and then it drops down. Our results indicate that the application of these composts is a sustainable method of increasing the productivity of natural grasslands.

Keywords: compost application, crude protein content, dry matter yield, grassland management, natural grassland, sward composition

1. Introduction

Grasslands are one of the largest ecosystems of the world covering 40.5 % of the terrestrial area – excluding Greenland and Antarctica [1]. With their adaptability and high tolerance they can be the fundament of animal husbandry and food production, but thanks to the international scientific researches, other benefits of the grasslands are known. Their role in carbon sequestration [2] erosion regulation [3] and ground water management [4, 5] are undisputable. Moreover the existence of many plant [6, 7] and animal species [8,9] are determined by the condition of these ecosystems, they have an important role in maintaining the flora and fauna biodiversity also. Thanks to their complex role, the grassland users are urged to apply environmental friendly methods by the regulations of the European Union. Hence the five-sixths of the world's grasslands are on low or zero quality soils [10] and in many cases the productivity and sustainability seem to be antagonistic, the farmers are in trouble when they try to manage their fields with environmental friendly low input methods. But with composting the on-farm generated manure they may increase their producibility and profitability in a sustainable way. It is well known that mowing and long-term grazing also causes soil nutrient loss, therefore the application of

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fertilizers would be favorable to perpetuate the nutrient balance. Dungait et al. [11] and Fangueiro et al. [12] stated that the utilization of organic fertilizers result in favourable conditions for production and soil respiration. These improving conditions generate faster growth and bigger yield which is desirable but as Borer et al. [13] reported, there may occur plant species loss thanks to the competition for light, however with intensified utilization this can be managed. Based on the studies of Čunderlík et al. [14] and Štýbnarová et al. [15] we can say that the utilization of organic fertilizers result in increased ground cover percentage (GC) what favors for erosion control and ground water management. Kádár and Ragályi [16] tested the effect of sheep manure on solonetz soil, in Hortobágy. Their results state that it increases the productivity of the grass even in such a poor condition. Moreover composts can increase the microbial biomass and microbial activity even in periods when water is limited [17].

2. Materials and methods

The experiment took place in the sheep farm of the Karcag Research Institute of University of Debrecen. As a natural grassland based on solonetz soil the richness in species is high (more than 40 species per hectare) but the dominant herbs are *Festuca pseudovina* and *Alopecurus pratensis.* The main goal was to receive data about the effectiveness of two different types of compost, produced by this certain sheep farm, made of sheep manure. The first is natural compost (marked with N), the second is enriched in phosphorus, with a minimum 1.9% DM of P_2O_5-content (marked with E). Both are officially allowed in organic farming, and have a minimum N-content of 2.5% DM. Three rates of compost (10 t/ha, 20 t/ha, 30 t/ha) were tested on 3m X 10m experimental plots in four replications. Both type had four control plots too (marked with Z), this way we had 32 experimental plots. We measured the botanical composition on the 17th of May and 8th of September, what was followed by harvesting and the measurement of the yield. Samples for laboratory analysis were also taken. For the coenological examination the Balázs-method was used and the ground cover percentage of every species was estimated, but we made plant groups as short grasses (below 30 cm), tall grasses (above 30 cm), leguminous plants and others. Following the botanical analysis, we collected samples from every plot and sent it to the laboratory of the university where dry matter (DM) content, crude protein (CP) content and net energy used for maintenance (NE_m) were defined, according to the accepted standards.

3. Results and discussion

Coenological changes

The results of the botanical analysis show that the application of compost favours the tall grasses at the expense of short ones (Figure 1.).

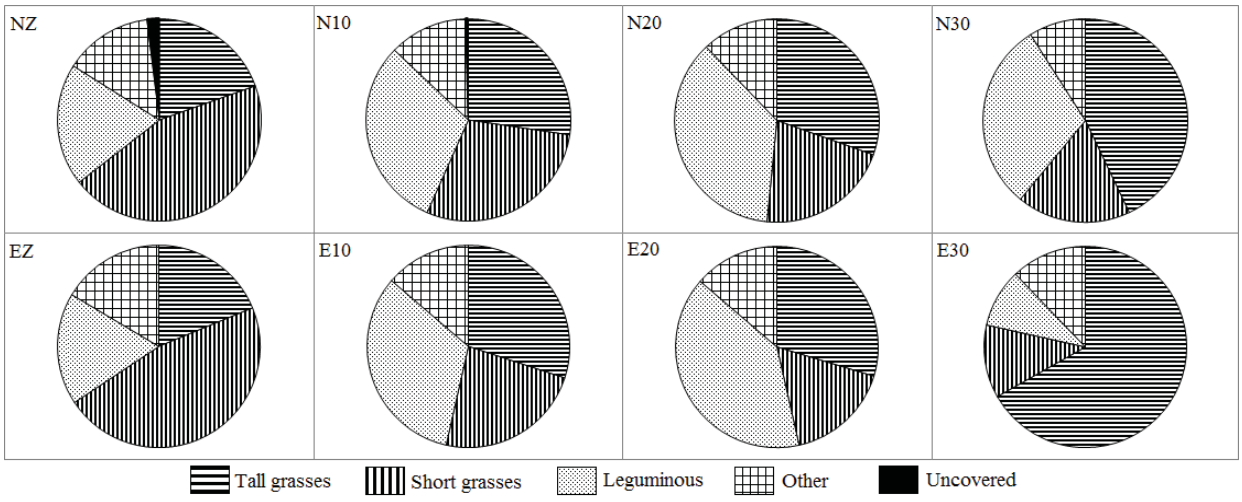

Figure 1. The representation of different plant groups in sward composition (17th of May, 2016)

On the control plots short grasses reached 40% of GC and the tall grasses covered only 20% of the surface whereas on treatment N30 (natural compost with 30 t/ha dose) the opposite occurred. Tall grasses covered 43% of the plots and short grasses could only reach 18%. The effectiveness of the E treatment was even better. In the average of E30 plots (enriched compost with 30t/ha dose) the tall grasses covered 67% of the surface whereas short grasses only 12%. For both types of compost it was noticed that the 30 t/ha dose is unfavourable for the leguminous plant species, however the 10 t/ha and 20 t/ha dose increased their spread. But with 30 t/ha dose the abundance of nutrition caused such a big growth in the grasses that they suppressed the leguminous plants. In treatment E30 the GC of leguminous species was only 9%. Regarding species composition, it was observed that *Alopecurus pratensis* and *Trifolium angulatum* showed the best reaction to the compost application. In treatment E30 90% of the tall grasses were *Alopecurus pratensis* and in treatment E20 92% of the leguminous plants was *Trifolium angulatum*.

DM yield responses

The year 2016 was rich in rainfall thus there was relatively high DM yield in every treatment. In the area of Karcag, the average rainfall between 1st of January and 30th of September – based on the data of the last fifty years – is 380 mm, but this year it was 486 mm. Therefore even the control plots could produce 1.5 t/ha DM yield what is the Hungarian average. With this high amount of precipitation the spread compost had better conditions to be decomposed and to be uptaken by the plants. After evaluating the results it could be stated that any type of compost in any dose causes significant growth in the DM yield (Figure 2.). Some difference between the effectiveness of the doses can be seen, but in some cases it is not statistically significant. Treatment N10 produced 2.23 t/ha DM whereas N30 produced 2.67 t/ha. E10 and E30 produced 3.19 t/ha and 3/69 t/ha respectively. Based on our results it can be said that the difference between the two composts is very remarkable. With the enriched compost the grassland can produce 1 t/ha DM more forage than the natural. In some cases the 20 t/ha plots may reach the productivity of the 30 t/ha dose but the standard deviation is high. For example the minimum and maximum of the DM yield of E20 plots were 2.74 t/ha and 4.09 t/ha.

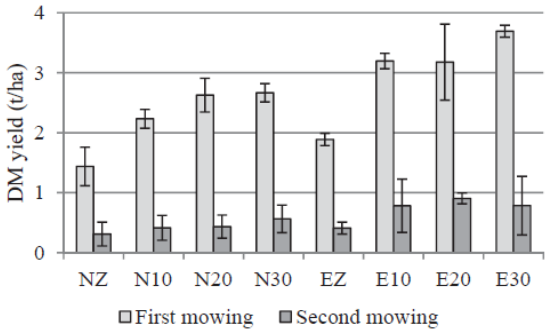

Figure 2. The average Dm yield of the treatments

CP yield responses

As protein is one of the most important macronutrients in livestock farming it is important to determine the crude protein yield per unit area. Our results show that the plots treated with compost had significantly higher CP yield than the control (NZ: 131 kg/ha; EZ: 159.95 kg/ha), but between the dose the difference was not statistically significant, thanks to the high standard deviation (Figure 3.).

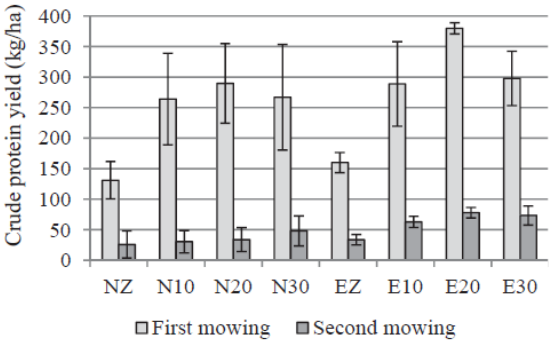

Figure 3. The average CP yield of the treatments

The only exception was the E20 treatment, what produced the most protein (379.83 kg/ha). It was followed by E30 (297.8 kg/ha), N20 (289.77 kg/ha) and E10 (288.83 kg/ha). If we compare this to the data of the botanical analysis it can be seen, that the amount of protein correlates with the GC of the leguminous plants.

As in the 10 t/ha and 20 t/ha treatments the GC of the leguminous plants raises, the CP yield also grows, but in plots where we spread 30 t/ha compost both the GC of leguminous plants and CP

yield per hectare decreased. The better effect of the E compost is due to their phosphorus content, as the leguminous plants show good reaction to phosphorus. On the other hand the higher DM yield does not mean higher CP yield. This gives the compost user the opportunity to adapt the doses to his own needs and preferences, thus he can focus on the protein content or the dry matter.

NE_m yield responses

Like it was experienced with the DM yield and CP yield also, the treated plots showed a significant better NE_m yield than the control ones (Figure 4.). The E compost showed better results than the N but the differences between the effectiveness of the certain doses are not significantly different.

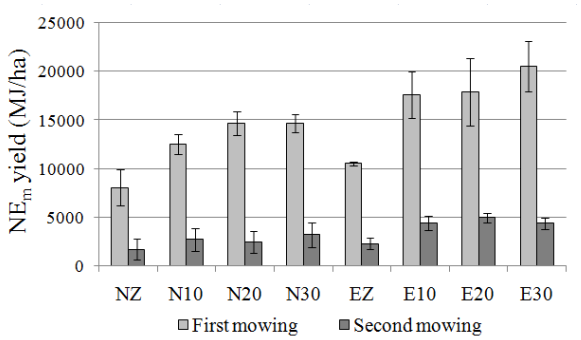

Figure 4. The average NE_m yield of the treatments

With the enriched compost we could almost double the NE_m yield per unit area. In NZ me measured 8040.45 MJ/ha whereas in N30 14675.19 MJ/ha and in EZ we experienced 10535.76 MJ/ha whereas E30 produced 20546.46 MJ/ha.

4. Conclusions

Based on our results we can say that the tested composts are a proper solution for increasing the yield of grasslands suited in unfavorable conditions. With the applied compost we can produce more and better forage on grasslands with low soil conditions and low rainfall, thus we can increase their yield potential. As these composts are allowed in organic farming their correct usage fit in the guidelines of sustainable farming, thus the growth in yield does not involve the degradation of nature. Moreover it uses on-farm generated materials thus these compost fertilizers also fit better in the nutrient cycle of a certain farm.

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