EFFECT OF DIFFERENT COMPOST DOSES ON SOME PROPERTIES OF AN EXTENSIVE GRASSLAND SOIL

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Abstract: *After the millennium the utilization of the Hungarian grasslands is particularly important. We considered the efficient utilization of the agricultural areas - including grasslands, pastures- by increasing the number of ruminants is the part of the rural strategy. The effective utilization of the by-product, the manure in croplands or pastures is particularly important, taking the increasing fertilizer prices within the continuously opening price scissor of the industrial-agricultural products into account. The patent of the Karcag Research Institute of CAAES RISF UD, the TERRASOL compost is a good alternative fertilizer for farmers. We have already published the primary results of our grassland fertilization experiment, where we investigated the utilization of different compost doses and evaluated these from economic point of view. In this paper we examined the changes of the properties of the soil in the different treatments. We visualized our results by using GIS methods. We measured the moisture content, the penetration resistance and the CO_2 emission of the soil of the four treatments. We determined that the 20 t/ha of compost dose was considered sufficient to improve the investigated properties of the grassland soils under the droughty conditions of 2012.*

Key words**:** *grass fertilization, soil moisture, CO_2-emission, penetration resistance, GIS interpretation*

INTRODUCTION

Hungary's grasslands are around 1004.2 thousand hectare, most of which lies in salt effected soils (KSH, 2009). In the Trans Tisza Region due to the unfavorable climatic and soil conditions the majority of grasslands are utilized as pastures because of the insufficient grass-yields. GIS interpretation of the results from grasslands (using GIS database, creating 3D DTM models: an innovative interpretation of some regularities of the salt accumulation etc.) is expected today (BLASKÓ ET AL., 2003). Since the total amount of biological value grass hay is unpredictable, the satisfaction of winter forage needs of ruminant livestock is based on field-grown hay (VINCZEFFY, 1993). Long-running attempts to farmyard manure grasslands, but according to researches by experts dealing with this subject farmyard manuring is not suitable on the grass. According to TAKÁTS's (1954) investigations from 100 kg farmyard manure only 31 kg green grass yield surplus received. MILKOVICH (1962) did not got significant hay yield surplus in irrigated salt effected grass fertilization experiment with 20 t/ha farmyard manure, compared to the control. NAGY (1964) recommends farmyard manuring for very poor grassland soils. According to BÁNSZKI (1993) well matured cattle manure is the best for farmyard manuring in 15-35 t/ha dose applied in autumn. The yield increment is 30-50%, on grassland soils with poor organic matter it can be 100-250%. KOVÁCS and CSÍZI (2004) emphasize increased activity of grasslands' mesofauna like one of the effect of farmyard manuring. After experimental results CSÍZI and MONORI (2007) recommended 20 t/ha of overripe sheep manure or composted sheep manure doses to farmers having grasslands with similar grassland association under similar conditions in order to increase the stock of legumes flowered plants, from the economic point of view.

Soil is the main source and at the same time the potential sink of greenhouse gases (e.g. CO_2, CH_4). These gases can originate both from the deeper horizons and from the layers, close to the soil surface. Studying the seasonal dynamics of gas emission from soils under field conditions can provide information on gas immission and emission processes. Both from the point of view of management and environmental protection it is very important that the humus enriching and decomposing processes can be influenced consciously by controlling the microbiological activities in the soil, so the favorable state of the soil can be maintained (GYURICZA, 2004).

The physical degradation problem (compaction and structural degradation) of arable lands became the problem of grasslands too.

Natural factors and human activities (especially improper tillage) both can trigger the physical degradation of the soil, its appearance is mainly due to improper soil tillage in arable- (BIRKÁS, 2002), while overgrazing in grasslands. Physical degradation results in increased soil compaction, decreased porosity which all lead to the unfavourable water and heat balance of the soil, the decreased nutrient support ability and microbiological activity (NYÍRI, 1997).

Our aim was to investigate the effect of different compost doses on the moisture content, the penetration resistance and the CO_2 emission of an extensive grassland soil.

MATERIAL AND METHODS

The measurements were carried out at the DU CAAES RISF Karcag Research Institute. The site of the measurements, called Rainer, is an extensive pasture utilised by grazing sheep.

The coordinates of the experimental area were 47°23' N and 20°56' E (WGS 84), the Baltic altitude is 83 m.

The digital mapping work is prepared in Hungarian Coordinate System (EOV) by using GIS software: DigiTerra Explorer 6.0, and ArcGIS 9.2. The used map overlays are from the AGROTOPO databases (1:100 000 scale), and from the GIS databases of our institute. Using the cadastral- and topographical map sections, we generated different overlapping shapes, for that the different soil properties were linked as attributive data of the studied experimental area (*Figure 1-2.*); so we have information about the soil type, the parent material, the texture of the soil, the soil water regime, and the pH of the soil. Of course, the own database further elucidated this map attributive data (on-site sampling, laboratory measurements, see *Table 1*.).

The Terrasol compost used in the experiment is a bio-compost, naturally produced, enriched with nutrients, sheep manure-based compost. It is odorless, free from pathogenic bacteria and weed seeds, homogenous product. It contains micro- and mesonutrients (*Table 1*.).

Table 1.

Parameters of Terrasol compost

Dry matter content (m/m%)	Organic matter content (m/m%)	$pH_{(H2O)}$	$N_{(m/m\%)}$	$P_2O_{5(m/m\%)}$	$K_2O_{(m/m\%)}$	$Ca_{(m/m\%)}$	$Mg_{(m/m\%)}$
at least	at least		at least	at least	at least	at least	at least
60	50	~8	2,5	1,9	5	1,8	0,7

Micro-relief, natural and artificial watercourses, landmarks (main and secondary roads, channels, forest belts, etc.) played an important role in the evolution of the grassland soil. We used for this mapping our database and OTAB (National GIS Database) digital database, and we added to our initial map overlays (cadastral- and our own overlays) the overlays of the soil types spots, highway, main- and earth roads and irrigation canals (*Figure 1*.).

Figure 1.: The soil map of KARCAG outskirts

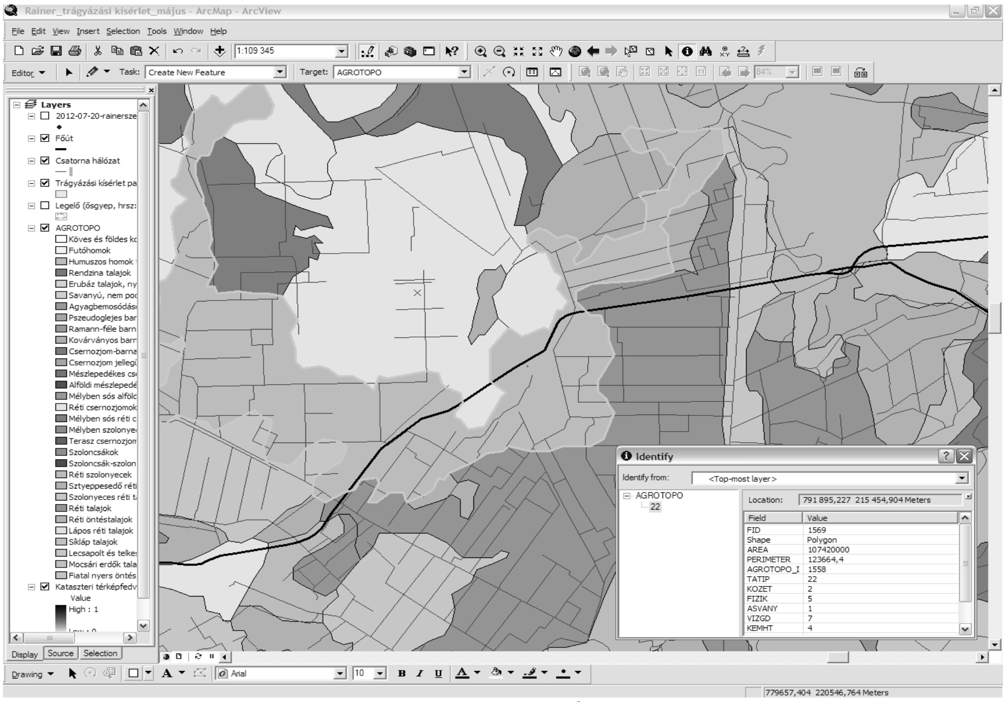


Figure 2.: Our GIS databases of Karcag outskirts

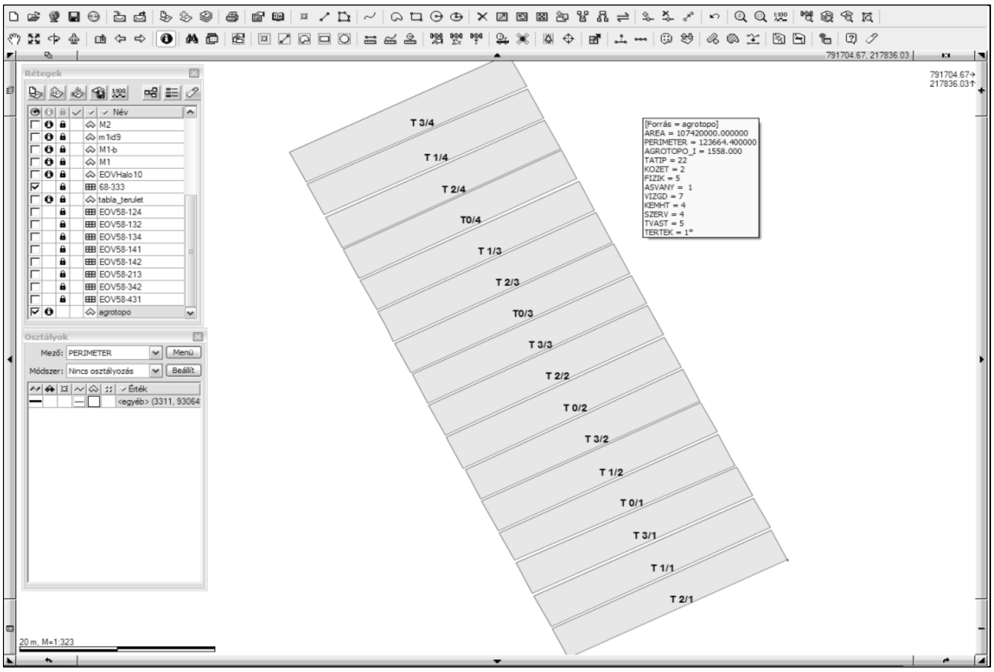


Figure 3.: The digitalized parcels of sampling area

Primary and secondary data sources were used in this article, we used the already available GIS databases and primary data recordings were carried out in the experimental area (*Figure 3*.). Therefore we generated by handheld GPS device an extra overlay.

After the digitalization of experimental plots the parcel-polygons and their nominations were added to the base map. And our attributive database contains the measurement results of the sampling points (moisture content, penetration resistance, CO_2-emission). The experiment was set up in four treatments, four replications, random block design. The area of each replication was 10 m^2.

The codes of the treatments (*Figure 3*.): T0 - control, T2 – 20 t/ha Terrasol dose, T3 – 40 t/ha Terrasol dose, T4 – 60 t/ha Terrasol dose.

The compost was distributed on the plots in 2010, so it had a second-year manure effect in 2012. The soil of the experimental site is a medium meadow solonetz. *Table 2*. shows the results of its chemical analysis.

Table 2.

Soil parameters of the investigated area (0 – 10 cm)

$pH_{(KCl)}$	y_1	K_A	Total salt content (%)	Hu (%)	NO_3-N (mg/100 g)	AL-P_2O_5 (mg/100 g)	AL-K_2O mg/100 g)
4.78	18.1	57	0.03	3.82	3.12	4.65	31.7

The experimental site is a *Achilleio-Festucetum pseudovinae,* which is classifiable in plant geography in the Pannonicum, within this Crisicum in the Eupannonicum (SOÓ, 1960).

The measurements were carried out at the end of May in 2012. The temperature and precipitation data of the previous period are summarized in the *Table 3*. The autumn and the early spring periods of 2012 were extremely dry in the region of Karcag, this made unfavorable condition for the fitomass production.

Table 3.

Climatic data of the investigated area

Months	Mean temperature (°C)			Precipitation (mm)		
	2011	2012	average of 50 years	2011	2012	average of 50 years
I.	-0.6	0.4	-2.5	12.7	16.8	28.4
II.	-1.1	-5.1	-0.6	15.0	18.0	26.5
III.	6.0	7.0	4.9	22.0	2.5	24.9
IV.	13.1	12.3	10.6	18.9	13.1	37.2
V.	16.9	17.1	16.3	46.9	61.9	54.2
VI.	20.9	*21.4*	19.4	49.3	*57.6*	71.3
VII	21.3	*24.3*	21.3	84.4	*38.1*	56.2
VIII.	22.6	*23.6*	20.3	28.4	*4.1*	48.7
IX.	19.6	*19.4*	15.9	31.7	*31.5*	40.9
X.	10.4	*11.8*	10.1	18.6	*40.6*	31.8
XI.	2.0	*6.9*	4.5	0.0	*18.7*	43.6
XII.	2.4	*-0.7*	0.1	57.8	*41.6*	39.7

Source: own meteorological database

According to the literature, the distributed compost (on the soil surface) has effect in the upper 30 cm soil layer, so we investigated the moisture content and the compaction of the

0-30 cm soil layer. Soil moisture content was determined with gravimetric method. The extent of soil compaction was deduced from the penetration resistance measured with a “3T SYSTEM” electronic soil layer indicator. A GasAlert Micro5 infrared gas analyser was used in order to measure the CO_2-concentration of the air above the soil surface before and after a 30 minute-long incubation period. For the delimitation of the measuring area a special metal frame with a matching bowl were used (ZSEMBELI ET AL., 2006).

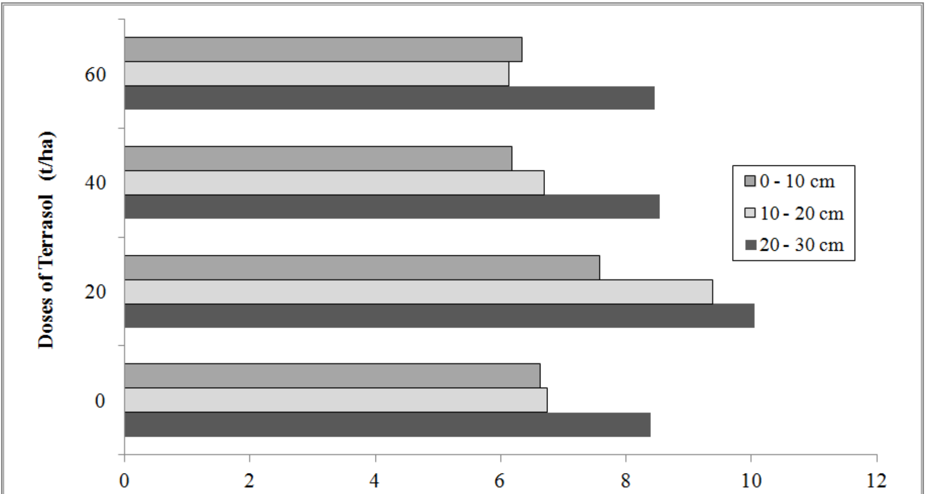
To calculate the CO_2-emission from soil the following formula was used:

$$F = d * (V/A) * (C2-C1)/t * 273/(273+T)$$

where F: CO_2-flux (kg m^{-2} s^{-1}), d: density of CO_2 (kg m^{-3}, 1.96 for CO_2), V: volume of head space of chamber (m^3) A: area of chamber (m^2), C1: CO_2-concentration at time of start (m^3 m^{-3}), C2: CO_2-concentration at time of end (m^3 m^{-3}), t: duration of measurement (s), T: air temperature (C°).

RESULTS AND DISCUSSIONS

Our investigations were carried out in an extra dry period, the shortage of precipitation was 120 mm compared to the 50 years average. Therefore the measured soil moisture contents were very low too (*Figure 4.)*. At the date of the measurement, the soil moisture content was the highest where 20 t/ha compost was applied in the upper 10 cm soil layer (growing of the grass is influenced by the upper 10 cm soil moisture content). In spite of the droughty weather, more available water was in the upper soil layer with 20 t/ha compost dose application.



	0	20	40	60
0 - 10 cm	6.6	7.6	6.2	6.3
10 - 20 cm	6.7	9.4	6.7	6.1
20 - 30 cm	8.4	10.1	8.5	8.5

Moisture content (m/m %)

Figure 4.: Soil moisture contents in the treatments

We established an inverse correlation is between the soil moisture content and the soil penetration resistance. Due to the extremely low soil moisture content, the penetration resistance values were rather elevated. The penetration measurements were done in 4 replications per plot. As *Figure 5*. shows, we found the most favourable penetration results in the upper 30 cm in the plots where 20 t/ha compost dose was applied. The soil of the control plot was the most compacted. In the upper 15 cm soil layer the applied 20 t/ha compost dose resulted in the most favourable values, in the deeper layers the applied 20 and 40 t/ha compost doses were also effective.

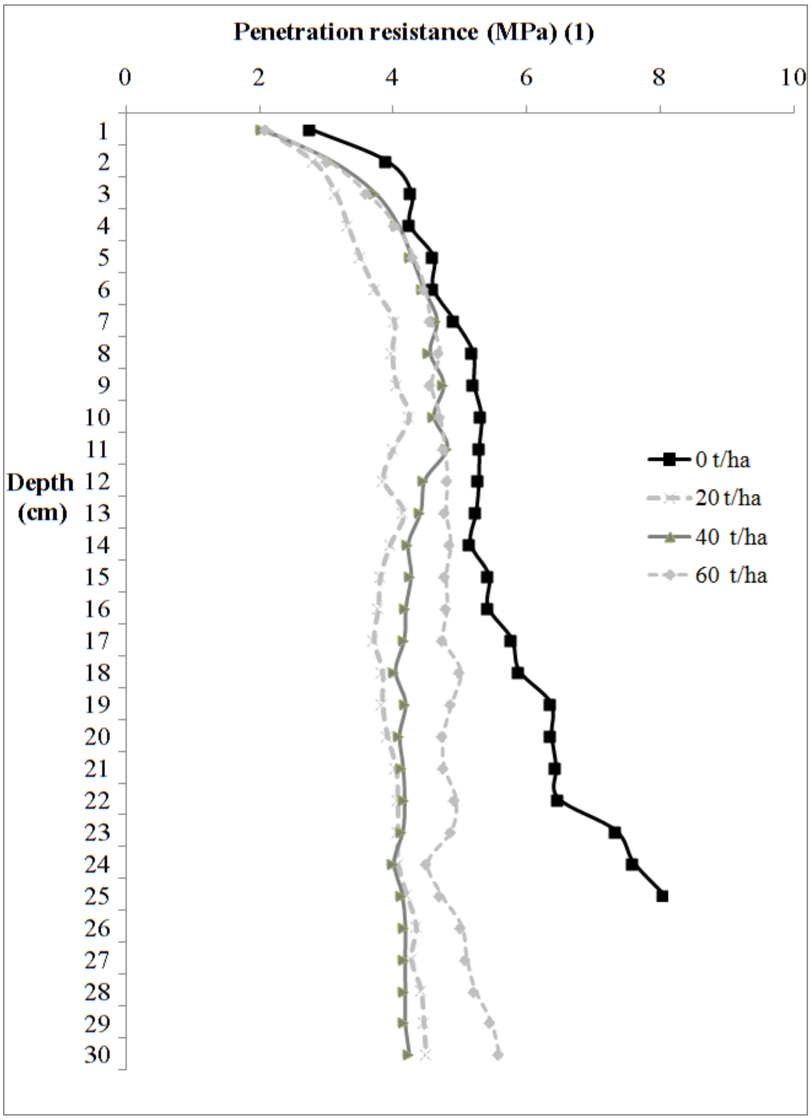


Figure 5.: The penetration resistance of the soil in the treatments

The CO_2 measurements were done after a rainfall event, due to this precipitation the differences disappeared. This dominancy was experienced several times in the previous years as well, and it is in correlation with the literature data (FRANZLUEBBERS *et al.*, 2000; FIERER and SCHIMEL, 2003). CO_2 measurements were carried out 3 replications in the treatments. We summarized the results in *Figure 6.* In the treated plots we detected higher values compared to the untreated plot. Nevertheless it is obvious that organic and inorganic matters added to the soil have significant influence on the microbiological activity in the soil. The highest values were observed in the 20 t/ha Terrasol application plot, and here was the highest soil moisture content too. There is close correlation between the degree and intensity of CO_2-emission from the soil and the structural state and organic matter content of the soil.

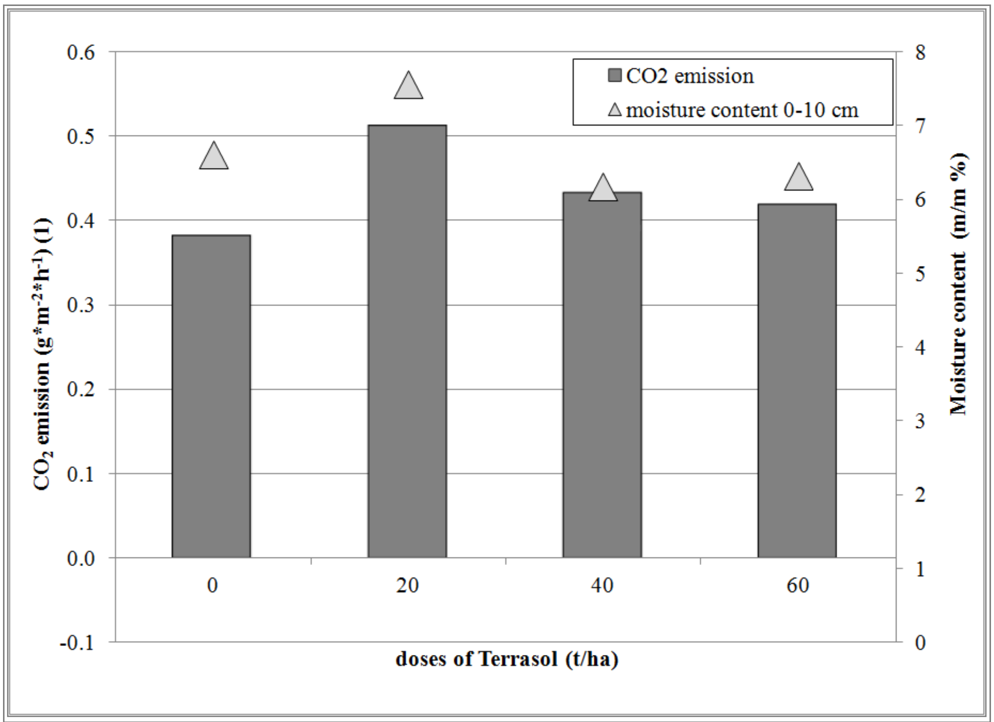


Figure 6.: A CO_2-emission in the treatments

It is in correlation with the results of CSÍZI and MONORI (2007), they recommended 20 t/ha composted sheep manure for the same grassland association with the same conditions in order to increase the stock of legumes flowered plants, from the economic point of view.

CONCLUSIONS

- We established that Terrasol compost improves the investigated physical and biology properties of the extensive grassland soil. Under the weather conditions during the experiment, the 20 t/ha compost dose (among the applied doses) has been proved to be the most effective in all aspects (moisture retention, soil compaction and CO_2 emission).

- The doses of 40 and 60 t/ha also improved the properties of the soil, but they have weaker effects (not to mention the economic aspects).
- The question arises how this compost can be effective after a shallow incorporation into the soil (by grass treating rollers),
- or from economic point of view, what kind of results we would get by applying lower doses (5-10-15 t/ha).

It is possible that a new experiment with smaller doses would be able to reproduce *similar results*, and it would reduce the biodiversity within the grassland association. We suggest to farmers working in similar conditions of farming (organic farming) to distribute compost on the mowing part of their grasslands.

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