EFFECT OF HIGH COMPOST RATES ON PHYSICAL AND HYDRAULIC PROPERTIES OF SOIL

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Abstract

In small-scale field trial there was assessed the effect of graded high compost rates on physical and hydro-physical properties of soil in the long period. The compost was incorporated into the soil in single operation and the soil in experimental variants was held for a period of four years without tillage and vegetation. Statistically significant decrease of soil bulk density by the compost incorporation was proved in the course of two years only in case of extremely high rates 165 and 330 $t.ha^{-1}$. In the case of variants without vegetation there was proved an increase of soil moisture and increase of soil retention capacity owing to high compost rates incorporated into the soil. The compost incorporation into the soil influenced favourably hydro-physical properties of soil albeit with timing interval, however with long-term effect. After a longer time from compost incorporation there was found out a linear dependence of increase of soil moisture on growing compost rate. The soil tillage had a considerably greater effect on physical than on hydraulic properties of soil.

Keywords: field trial, compost, reduced bulk density, rain simulation, surface runoff

Introduction

The monitoring of compost influence on soil properties in view of soil water regime stabilization is current issue. The use of compost on agricultural land gains also importance in relation to the necessity of effective handling with biologically degradable waste (Lalande et al., 2000; Masciandaro et al., 2000; Váňa, 2003). The necessity of preservation of soil environmental functions is particularly important, therefore it is necessary to deal with an effect of organic substances application into the soil on its properties (Bazzoffi et al., 1998).

The compost use leads thanks to an increase of organic matter in soil and enhancement of medium pores content to the improvement of soil retention ability (Mayer, 2004; Ahmad et al., 2008, Gil et al., 2008). Effect of soil tillage, vegetation and spontaneous or by man supported variability of structure and compaction of soil (in particular humus layer) is usually more considerable, than effect of organic matter addition. For example Hangen et al. (2002) mentioned that differences in infiltration are caused by the various ways of soil tillage as a possible cause of. In our contribution we are dealing with effect of single high rate of compost incorporated into the topsoil on reduced bulk density, soil moisture and surface water runoff during the rain simulation.

Material and Methods

For the realization of field trial with small plots there was selected an area in the premises of VÚRV, v.v.i. Praha – Ruzyně (Research Institute of Agricultural Engineering, p.r.i. Prague – Ruzyně). The climatic region of trial plot can be characterized as mildly warm, dry, with mild winter. The average annual temperature makes 8.2°C, average annual rainfalls makes 526 mm, the maximum of monthly rainfalls is recorded in July; average number of days with snow cover range from 35 up to 40; average layer of snow is 50 mm and altitude above sea level of trial plot is 330 m. The soil type is chernozem and pedogenic substrate is loess on chalk spongilite. The soil kind can be characterized by transition between loam soil and clay-

loam soil (standard ČSN 46 5302) – average content of particles smaller than 0.01 mm is 44.2 %.

The trial was designed as small plot field trial with repetitions of variants (see scheme on fig. 1). The particular plots had the dimensions of 3x3 m, gaps between trial squares were 0.5 m. Each variant had six repetitions. On measured plots there were withdrawed before incorporation of compost rates and during the existence of trial from autumn 2008 up to spring 2012 so-called „Kopecký´s small rings" from the depth of 50-100 mm. The withdrawal was taken place always in spring at the beginning of vegetation period and in autumn. From all soil parameters the reduced volume weight was selected for evaluation of physical changes in soil caused by compost incorporation.

On the trial plot there was applied compost in determined rates in April 2008 (tab. 1). The compost was incorporated into the soil during the overall tillage of trial area by rotary tiller equipped by horizontal knife rotor. The topsoil was cultivated during this work operation into the depth of 150 mm.

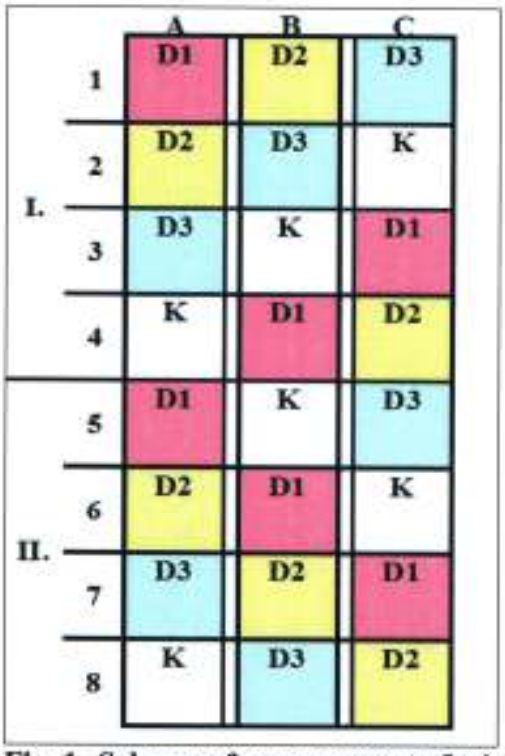

Fig. 1 Scheme of arrangement of trial variants with compost dosing, 6 repetitions (square plots 3x3 m)

Table 1 Variants of compost dosing in Ruzyně trial

Variant	Compost rate in dry matter ($t.ha^{-1}$)
K (control)	0
D1	85
D2	165
D3	330

Since 2010 there was evaluated the surface water runoff by means of rain simulator in dependance on compost rate (Šindelář et. al., 2008). Before every measurement of infiltration

there was determined volume soil moisture in topsoil 50-100 mm by means of the probe Theta Probe ML2x, always 6 stabs around every measuring area. During the rain simulation there was used the nozzle Lechler 466788 and spraying pressure 100 kPa. At the height of nozzle 1m over ground the intensity of simulated rainfall was constant during the whole time of measurement 1.46 $l.m^{-2}$.min. The rainfall intensity was kept in the course of all realized measurements. The surface slope of measuring areas was between 2 and 3°.

Results

After compost incorporation into the soil, the mechanic operation of soil tillage decreases significantly reduced bulk density. Changes caused by compost rate were smaller. Differences among values of reduced bulk density on control variants without compost before establishment of trial in spring 2008 and in autumn, 5 months after compost incorporation (fig. 2), we can explain with mechanical tillage and spontaneous subsiding of soil. The differences in reduced bulk density among variants of compost dosing in the following years are caused by changes in soil structure, which started after addition of organic matter. In spring 2010 the reduced bulk density on control variant without compost has returned to the original level before soil tillage. Statistically significant decrease of reduced bulk density by influence of supplied compost was recorded only in case of the dose 330 $t.ha^{-1}$. However, compost dose was several higher than doses used in practice.

On the trial variants there was evaluated since 2010 in regular spring and autumn deadlines volume soil moisture in topsoil layer 0 up to 100 mm. In spring 2012 the soil moisture was different owing to the weather conditions. In dependence on rate of incorporated compost the soil moisture was rising linearly (fig. 3). This dependence was slight, gradient of line 1.5 % of compost rate. In previous years the correlation between soil moisture and compost rate wasn´t statistically significant.

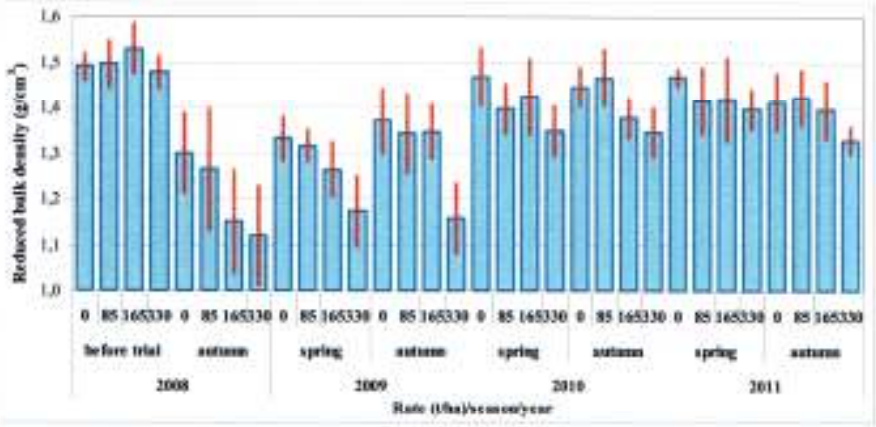

Fig. 2 Changes of reduced bulk density after incorporation of high compost rates

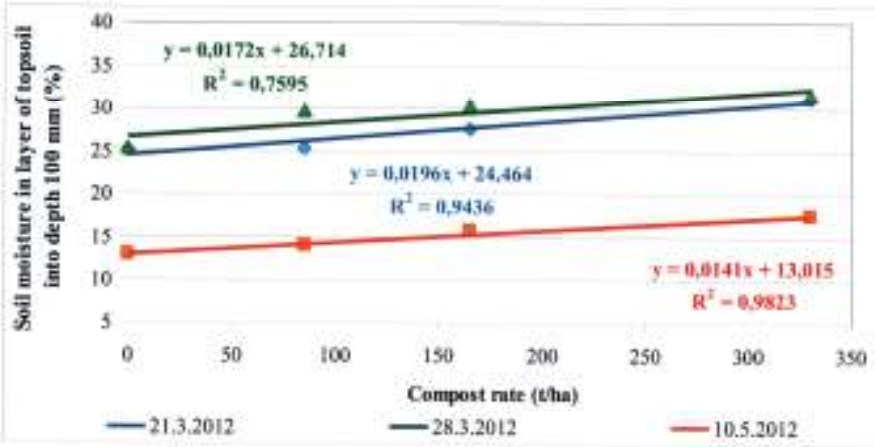

Fig. 3 Volume soil moisture on trial variants in spring months 2012

In 2010 we determined during the measurement of surface water runoff at simulated sprinkling the significant correlation with compost rates. The highest cumulated surface runoff was recorded on control plot without compost application (fig. 4). In variants with incorporated compost there was clear inversely proportional trend with compost rate, but difference between variants was minimal. The results of measurements realized by rain simulator in the end of trial on March 21, 2012, confirmed the hypothesis of positive effect of compost incorporation into the soil on water infiltration (fig. 5), dependence on compost rate was already distinct.

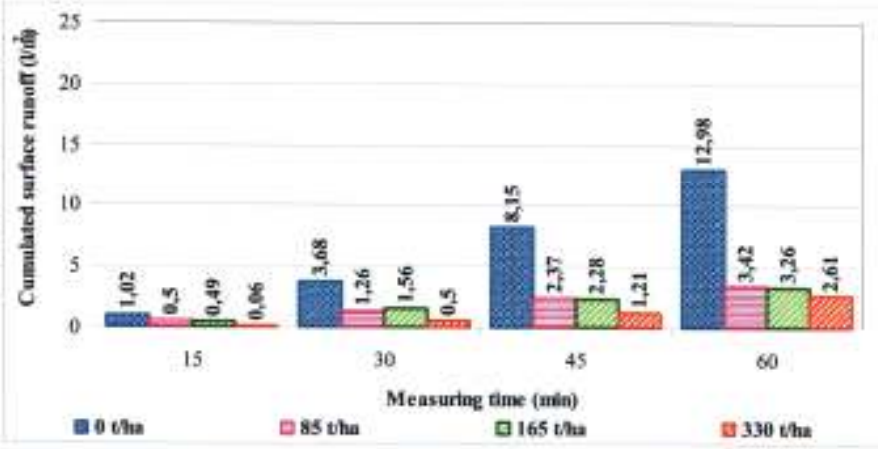

Fig. 4 Cumulated surface water runoff in 15 minutes lasting interval at simulated sprinkling, Ruzyně 12.5.2010

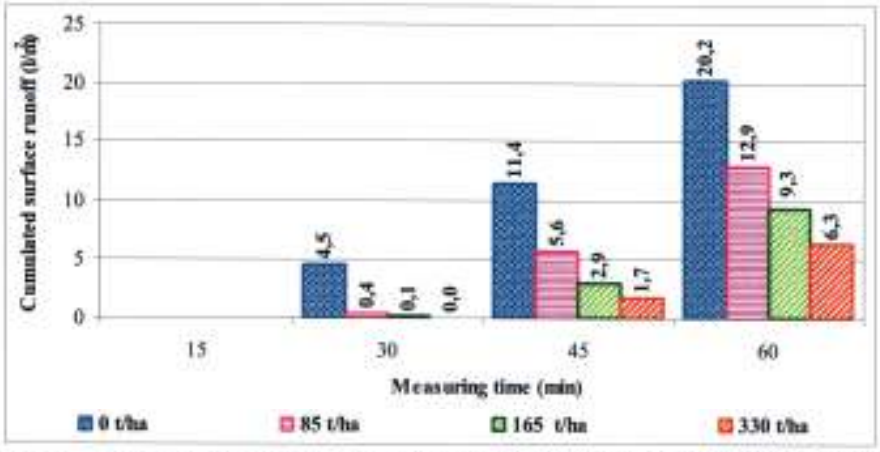

Fig. 5 Cumulated surface runoff in 15 minutes lasting interval at simulated sprinkling, Ruzyně 21.3.2012

Conclusion

Due to mechanical tillage of topsoil by tiller equipped by horizontal rotor in the depth of 150 mm there was recorded a decrease of reduced bulk density for 2 years. The change of reduced bulk density owing to the incorporated compost in the rate of 85 $t.ha^{-1}$ was seven times smaller than owing to the mechanical soil tillage. Three years after the compost incorporation there was a demonstrable change in reduced bulk density only in case of the variant with highest compost rate of 330 $t.ha^{-1}$.

Incorporation of compost into the soil influenced favourably hydraulic soil properties, but after longer time. In areas without vegetation after incorporation of high compost rates into topsoil there was demonstrated an increased soil moisture, it means also its increased water holding capacity. Two years after compost incorporation the surface water runoff during the simulated sprinkling decreased at all variants of dosage practically without depending on compost rate. The progressive dependency on compost rate was proved in spring 2012, it means 5 years after compost incorporation.

Acknowledgements

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