EFFECT OF PRP-SOL SOIL CONDITIONER ON A HEAVY TEXTURED SOIL

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Abstract:The effect of PRP-SOL soil conditional on soil compaction, moisture content and bulk density is studied in a long-term soil cultivation experiment from 1997 on a heavy textured meadow chernozem soil, in reduced and conventional tillage at Karcag Research Institute. Our investigations were made in the vegetation period of corn, in June and after harvesting, on stubble. Soil compaction was measured with a penetrometer, the actual moisture content was determined by gravimetric method. The bulk density values of the regularly cultivated soil layer of 0-10 and 10-20 cm depths were defined from undisturbed soil samples. The examinations were made on 2 test plots in 5 replications in the case of each tillage system. We established that after 3 years the application of the soil conditioner has positive effect on soil compaction and moisture status of the top layer in the reduced tillage system. We could not figure out this positive effect in the case of conventional tillage.

Keywords: soil conditioning, tillage systems, soil compaction, moisture preservation, penetration resistance

Introduction

Good quality soil is one of the most important natural resources of Hungary and essential condition of sustainable agriculture and food production, therefore it is important to sustain the versatile functions and good status of our soils, or even to improve if it is necessary (VÁRALLYAY, 1996).

Soil reclamation is a chemical, physical or biological intervention that means significant and long lasting change of some soil in order to improve its fertility (MEGYES, 2006). According to STEFANOVITS (1999), the goal of soil reclamation is to change unfavourable soil features (physical and/or chemical) influencing its fertility in a negative way, or to mitigate the effect of unfavourable soil forming processes (STEFANOVITS, 1999).

Among the negative processes threatening our soils all over the world, physical degradation is the most extended and hardly avoidable causing the most serious problems. Due to texture degradation and soil compaction, the biological activity and the productivity of the soil are decreasing (STEFANOVITS, 1975; TAYLOR, 1987). Because of soil compaction, the increase of the mechanical resistance of the soil, harmful disfunctions in the water-, air- and heat regime of the soil can be detected (STEFANOVITS, 1992; BIRKÁS, 2002). These unfavourable effects can be moderated by soil conditioning meaning the improvement of the physical, chemical features of agricultural soils. Soil conditioning can be carried out by tillage or adding different substances like synthetic soil conditioners, organic manures or polysaccharides of microbiological origin.

Our research is based on the investigation of the efficiency of a soil conditioner named PRP-SOL. The first use of PRP-SOL in Hungary is taking place in a long-term soil cultivation experiment at Karcag Research Institute of University of Debrecen from

2010. Soil conditioner PRP-SOL – according to the producer's description – increases the biological activity of the soil. Due to the more active biological life in the soil, soil compaction is decreasing, the structure of the soil is improving hence the infiltration- and aeration conditions of the soil are getting better. One consequence of the positive effects is the increase of soil fertility.

During our investigation soil conditions PRP-SOL was tested whether it enhances the positive effects of reduced tillage, and what effects can be detected in the case of conventional tillage if PRP-SOL is applied.

Materials and methods

The experiment involving the application of PRP-SOL was set on plot H-1 of Karcag Research Institute using maize as indicator crop in 2013. Two cultivation systems are used on this plot: conventional (based on ploughing) and reduced (regular deep loosening without ploughing, less tillage operations). This soil cultivation experiment provides a good chance to examine the effect of PRP-SOL in the cases of both tillage systems. Meadow chernozem soil type is characteristic for the investigated area, which is a heavy textured soil with high clay content.

150 kg/ha PRP-SOL was applied spread on the soil surface in the autumns of 2010, 2011 and 2012, then it was worked into the soil according to the cultivation system: shallowly without rotation in the reduced, and ploughed into the soil in the conventional tillage system.

PRP-SOL is a pellet containing a matrix of calcium and magnesium carbonates via a natural binder, the PRP ingredients dissolve after application and are dispersed in the soil solution. PRP-SOL changes the composition of the microorganism population in the soil, it functions as a catalyst in biological and enzymatic processes. Under laboratory circumstances the crop biomass was doubled when PRP-SOL was applied.

We tested PRP-SOL whether the positive effects figured out under laboratory circumstances could be justified under field conditions too. We assumed that the higher biological activity induced by the soil conditioner probably affects on the structure, cultivability, compaction and moisture regime of the soil.

Our investigations focussed on the measurement of the moisture content and the penetration resistance of the soil and the determination of soil bulk density. The measurements were done in both cultivation systems two times a year (in crop stand in June, and after harvest in October). Two sampling areas were delimitated, 100 m^2 each. The geographical coordinates of the sampling areas were recorded by means of a MobileMapper CE portable GIS data logger for the further traceability.

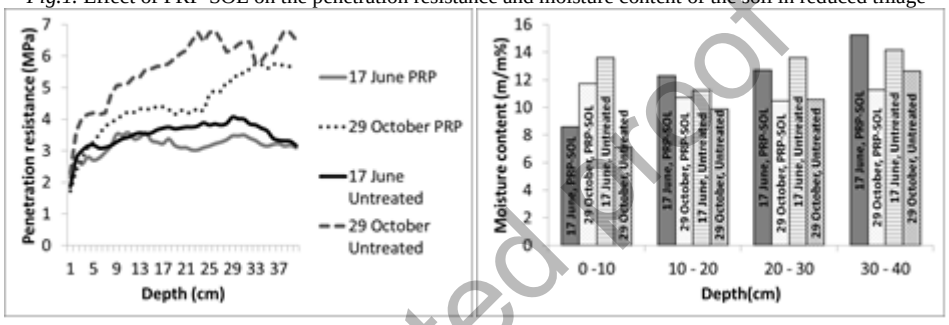
The degree of soil compaction was determined by means of a penetrometer (3 T SYSTEM soil tester). Parallel to the penetration resistance measurements, disturbed soil samples were taken from each 10 cm down to 40 cm in order to determine the moisture content of the soil. The actual moisture content was determined by gravimetric method.

Data processing was done by means of Microsoft Excel programme,while the statistical analyses by means of RStudio software (R CORE TEAM, 2013).

Results and discussion

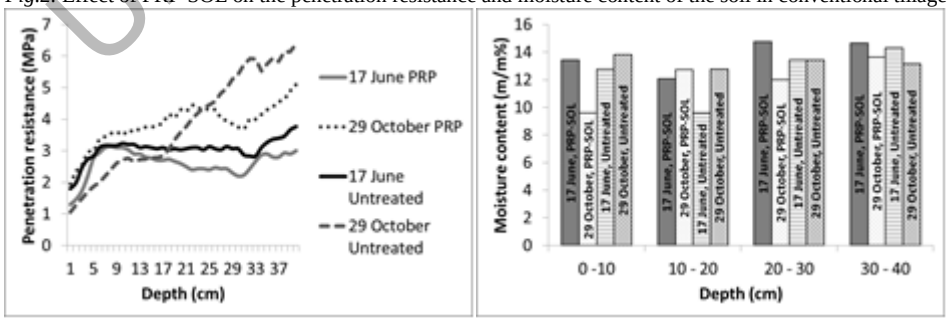
It can be established that in the case of reduced tillage less degree of compaction was characteristic to the soil of the plots treated with PRP-SOL during the vegetation period (*Figure 1*.). In June similar penetration resistance values were measured both in the treated and untreated plots. The values measured in October were averagely 4 MPa in the upper 25 cm soil layer, where the soil conditioner was applied. Contrary to this, the penetration resistance was above 5 MPa even at the depth of 10 cm in the untreated plot. Regarding soil moisture content, we detected higher values in the upper 10 cm soil layer, where we expected the most expressed effect, due to the PRP-SOL application, while even the topsoil dried out in the case of the untreated plot during the vegetation period.

Fig.1. Effect of PRP-SOL on the penetration resistance and moisture content of the soil in reduced tillage



While little differences were experienced between the penetration resistance values measured in the whole investigated layer of the treated and untreated plots of the conventionally cultivated soil in summer, an expected increase of the resistance could be figured out in the plot where PRP-SOL was applied by autumn time (*Figure 2.*). The lower penetration resistance values measured in the upper 18 cm deep layer of the untreated plot can be only explained with the higher actual moisture content. In the deeper layers (25-40 cm) of the untreated soil, compaction increased, it reached the extremely high value of 7 MPa at the depth of 40 cm, which means a harmful degree of compaction.

Fig.2. Effect of PRP-SOL on the penetration resistance and moisture content of the soil in conventional tillage



In order to justify the results of the penetration resistance and moisture content measurements statistically, we applied the method of paired t-test at significance level of 5 %. In our case, the p-value, which represents whether the null-hypothesis was true or false, was considerably below 5%, except for one measurement carried out in the conventional tillage in autumn (*Table 1.*). We could figure out the effect of PRP-SOL in the case of the reduced tillage system, while the differences were significant only in summer in the case of conventional tillage. No statistically justified differences were found between the soil moisture contents of the treated and the untreated soils.

Table 1. Results of paired t-test

	Reduced tillage		**Conventional tillage**	
	17 June	**29 October**	**17 June**	**29 October**
p-value (penetration resistance)	9.109e-09	6.561e-16	2.195e-14	0.8189
p-value (moisture content)	0.5708	0.4509	0.2276	0.3699

Conclusions

On the base of our experiment it can be established that the effect of PRP-SOL on the investigated soil features was not the same in the investigated cultivation systems. In the plot of reduced tillage no ploughing has been applied since 1997, only shallow cultivation, therefore the soil conditioner remaining in the top layer of the soil had stronger effect. The positive effect of PRP-SOL could be not figured out in the case of conventional tillage as the soil conditioner was distributed deeper (in the depth of ploughing). According to the producer of the soil conditioner, the positive effect of PRP-SOL is manifested in the quantity of yield and crop biomass even after the first year of application, but only after a few years regarding the soil parameters. We could not figure out the favourable effects of PRP-SOL applied in the conventional tillage system as the soil conditioner ploughed into the soil is distributing in a lower concentration in a thicker soil layer compared to the shallow affected layer of reduced tillage.

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