EFFECT OF DIFFRECT DOSES OF COMPOST ON SOIL PROPERTIES

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Abstract

The paper is the result of experiments carried out within the research project on the application of compost biodegradable waste for erosion-affected soils. Measurements were carried out at two sites: on permanent grassland (PG) and arable land (AL,) and batches of compost were on three sites: 0 T.H.$^{-1}$ as a control batch, 80 T.H.$^{-1}$ and 150 T.H.$^{-1}$. From the gained results a positive effect on the incorporation of compost retention capacity of the soil was proved, as well as the reduction in penetration resistance.

Key words: experiment, compost, retention, penetration resistance.

INTRODUCTION

The quality and quantity of compost incorporation into the soil affect the physical, chemical and biological properties of the soil. Among the important features of soil belong the retention capacity, which also varies according to a habitat, crops and tillage, and a total penetration resistance, which has got a favorable effect on the soil regime too.

HEJDUK (2009) found out that there is a higher retention on farmed soils than the one on permanent grassland. There was a faster reduced retention rate on soils without plowing, and this reduction was more intense than on mellow soil after plowing. CROHN (2011) also dealt with the retention capacity of the soil using compost and he demonstrated the connection between different kinds of compost and retention. LUKAS ET AL. (2009) were in their experiments concerned with the processing of soil and how it effects the retention capacity, and recorded higher water infiltration when using minimization technologies for tillage and also when measuring after harvesting crops.

The aim of this study is to find out, effect of compost of biodegradable waste to the erosion affected soils.

MATERIALS AND METHODS

In addressing the issue over a period of five years the retention capacity of the soil at two different sites was monitored, namely on the permanent grassland (PG) in the village of Ocmanice, and on the arable land (AL) of town Náměšťˇnad Oslavou. Monitoring was done as an experiment on a pilot scale stationary.

Measurement of the retention properties of the soil were performed at the beginning and at the end of the vegetation with a concentric cylinder, 28 and 54 cm in diameter. The outer cylinder eliminates spilling of water in the soil to the sides, and the principle of measuring don in the inner cylinder was to monitor the volume of a water loss over time. The measurements were performed for at least 2 hour period on the surface layer of soil. From the measured values of cumulative infiltration it was subsequently calculated the speed of retention rate expressed in mm.min^{-1} (l.h^{-1} m^{-2}).

The same period of time needed for the retention measurement was dedicated to a soil cementation thanks to a mechanical compaction penetrometer. The measurements were performed in five to ten repetitions. The measurement was based on detecting the force required to push a standard steel cone into the soil. Its advantage was the high expedition with instant evaluation of the results for the reference profile.

There were established three variants of the experiment with comparative doses of compost at both sites:

stand A - permanent grassland (PG):

Option 1 - breaking the sod without incorporation of compost,

Option 2 - disposable incorporation of compost at 80 T. H^{-1},

Option 3 - disposable incorporation of compost at 150 T. H^{-1}

stand B - arable land (AL):

Option 1 - stubble without incorporation of compost,

Option 2 - stubble, disposable incorporation of compost at 80 T. H^{-1},

Option 3 - stubble, disposable incorporation of compost at 150 T. H^{-1}

The compost made to ensure the experiment was produced with a controlled microbial composting technology in the belt heaps on the loose, on water secure area. The main raw materials in compost fillings were a cut grass from the maintenance of municipal green and the airport, biological waste from gardens and vegetable scraps.

Arable crops packages were sown under the following **crop rotation:**

1. year - rye tufted (Secalecereale) - spring sowing,
2. 2nd year - winter pea (Pisumsativumsubsp. Arvense) + triticale (Triticale)
3. 3rd year - Oats (Avenasativa)
4. 4th year - spelled (Triticumspelta)
5. 5th year - clover mixed bag

Soil and climatic characteristics of the stands:

stand A - permanent grassland (TTP) is characterized as soil type cambisol litica with a compact solid - reinforced rock, grain composition of loamy, with a high content of skeleton, tread depth of topsoil reaches max. 0.20 m. Located at an altitude of 320 m.

stand B - arable land is soil type cambisol modal grain composition sandy loam, containing less skeletal depth of humus horizon is max. 0.40 m. Located at an altitude of 365 m.

Both units belong to a slightly warm and humid region, with the long-term average rainfall of 594.4 mm long and a long-term average temperature of 7.2 ºC.

RESULTS AND DISCUSSION

Infiltration

The speed of infiltration was detected in the amount of water seeped per unit area for each repetition, and subsequently averaged for the individual variants. Infiltration was calculated as infiltration coefficient in liter per hour per m^2. This way the quantity of water that had soaked into the soil and its speed was determined Tab. 1 shows that the infiltration capacity of the soil was dependent on the reference year, a date of the measuring, and the measurement station. The results from the Tab. 1 are shown in Fig. 1 and Fig. 2.

Tab. 1. – Infiltration water at different sites in variants with comparative doses of compost in monitored years

Term of measurement	Stand	Variant	Infiltration [l.h^{-1}.m^{-2}]				
			1. year	2nd year	3rd year	4th year	5th year
Start of vegetation	**PG**	1	0,61	0,82	1,21	1,60	2,31
		2	0,67	1,70	1,58	1,45	1,88
		3	0,70	2,20	1,81	4,87	2,50
		average	0,66	1,57	1,53	2,64	2,23
	AL	1	4,92	0,63	4,10	2,04	1,36
		2	6,86	1,08	5,17	2,62	2,83
		3	6,78	1,35	5,26	3,30	2,28
		average	6,19	1,02	4,84	2,65	2,16
End of vegetation	**PG**	1	0,75	1,32	0,75	3,15	2,85
		2	1,00	3,22	2,07	4,83	2,43
		3	2,10	5,13	1,31	4,98	2,85
		average	1,28	3,22	1,38	4,32	2,71
	AG	1	1,24	1,60	1,08	2,35	2,66
		2	2,76	2,21	1,31	5,36	1,70
		3	3,00	1,89	3,28	7,98	2,36
		average	2,33	1,90	1,89	5,23	2,24

During the five-year monitoring of soaking water at different sites was found out that there it was mostly lower retention capacity at the station of permanent grassland compared to arable land. This was due, among other things, to a different soil type and profile of habitat. At the station with the PG there were on average higher values of retention factor at the end of the growing season, except the 3rd year of monitoring, which was atypical in rainfall and temperature. A strong soil compaction was found on grassland this year at the end of the growing season due to prolonged drought that affected the infiltration of the soil. Resulted variants with varying amounts of compost indicate that it was significantly higher infiltration in the variant with the highest amount of incorporated compost (variant 3), at the beginning and end of the growing season and at both sites. The differences among variants decreased by and by monitored years, namely in the fifth year at the end of the PG and vegetation on AL and at the beginning of vegetation.

At the station of arable land the values of the infiltration coefficient were higher at the beginning of the growing season in the first and the third year of tracking, and in the following years, the values were higher at the end of vegetation. According to the size of water infiltration into the soil and other factors, the retention capacity of the soil is estimated. Retention at this habitat was affected by a crop grown in a given year, which was also found out by other authors (HEJDUK AND KASPRZAK, 2010; BEVEN AND GERMANN, 1982; BLACKWELL, GREEN AND MASON, 1990). Otherwise, the retention is caused by a number of factors, which can be classified into four groups - soil characteristics, characteristics of the soil surface, the method of land management and natural conditions (Lal, 2002).

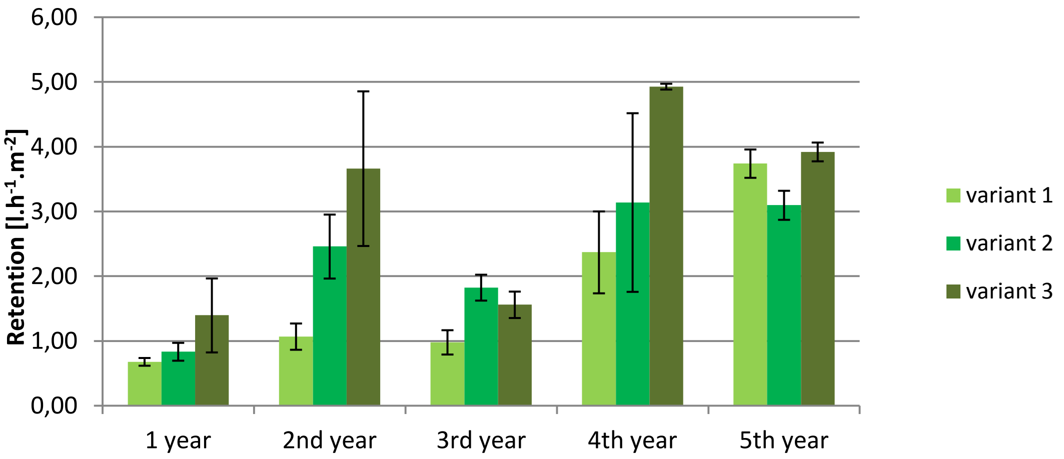

Fig. 1. – Infiltration of water on permanent grassland

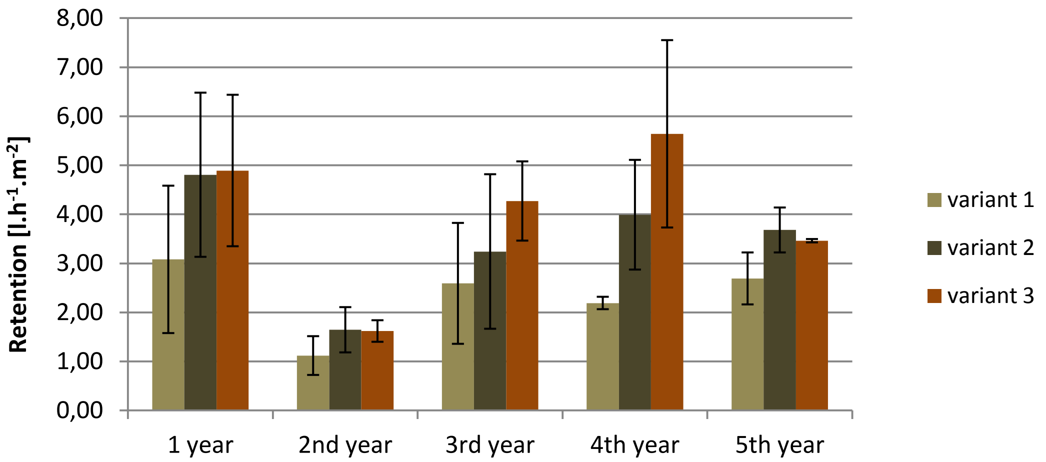

Fig. 2. – Infiltration of water on arable land

Penetration

As showed in previous measurements, infiltration was influenced not only by saturation of soil water, but also by its compaction. In this context, the penetration resistance of the soil was measured. The results for the five year monitoring of two field trials are presented in Tab. 2.

Tab. 2. – Penetration resistance at different sites in variants with increasing doses of compost over monitored years

Stand	**Variant**	**Deep [m]**	Penetration resistance [**MPa**]				
			1. year	2nd year	3rd year	4th year	5th year
PG	**1**	0 – 0,05	0,776	1,034	1,112	1,086	2,28
		0,05 – 0,10	1,293	1,189	1,525	1,525	2,80
		0,10 – 0,20	1,344	1,499	1,810	1,965	3,06
	2	0 – 0,05	1,034	0,776	1,163	1,112	2,53
		0,05 – 0,10	1,344	0,931	1,396	1,654	3,29
		0,10 – 0,20	1,654	1,241	1,551	1,965	3,81
	3	0 – 0,05	1,189	0,776	1,034	1,086	2,28
		0,05 – 0,10	1,189	0,742	1,551	1,551	3,30
		0,10 – 0,20	1,706	1,241	1,706	1,810	3,56
AL	**1**	0 – 0,10	0,517	0,827	1,086	1,034	3,03
		0,10 – 0,20	0,517	1,137	1,189	1,706	2,79
		0,20 – 0,30	0,724	1,213	1,086	2,016	3,31
		0,30 – 0,40	0,931	1,654	1,189	2,016	3,31
	2	0 – 0,10	0,517	1,034	0,827	1,034	2,78
		0,10 – 0,20	0,517	1,052	0,931	1,370	2,54
		0,20 – 0,30	0,672	1,448	1,189	2,016	3,06
		0,30 – 0,40	0,982	1,810	1,293	2,016	3,06
	3	0 – 0,10	0,517	0,776	0,879	1,034	2,53
		0,10 – 0,20	0,517	0,845	0,879	1,344	2,54
		0,20 – 0,30	0,672	1,551	1,034	1,810	2,80
		0,30 – 0,40	0,982	1,551	1,241	1,913	3,06

Tab. 3. – Measured values of electrical conductivity of LAD 27 fertilizer for the air stream of 115 $m^3.h^{-1}$

Time [h]	**Electrical conductivity[$m^{-2}.kg^{-1}s^3.A^2$]**						**Average**
	Sieve 2.00 mm			**Sieve 3.15 mm**			
0,5	46,80	47,80	45,40	46,80	47,80	45,40	46,67
1,5	74,10	76,20	78,70	74,10	76,20	78,70	76,33
2,5	85,70	84,50	86,40	85,70	84,50	86,40	85,53
3,5	88,60	89,80	91,50	88,60	89,80	91,50	89,97
4,5	94,40	95,00	95,70	94,40	95,00	95,70	95,03
5,5	95,70	95,30	96,70	95,70	95,30	96,70	95,90
6,5	96,40	96,10	97,80	96,40	96,10	97,80	96,77
7,5	99,40	99,70	99,80	99,40	99,70	99,80	99,63
8,5	99,80	100,50	100,20	99,80	100,50	100,20	100,17
9,5	101,30	102,20	102,10	101,30	102,20	102,10	101,87

Penetration resistance values from Tab. 2 are plotted in Fig. 3 to 7 on a permanent grassland, and in the in Fig. 8 to12 on arable land. It all applies again for the variants 1 to 3.

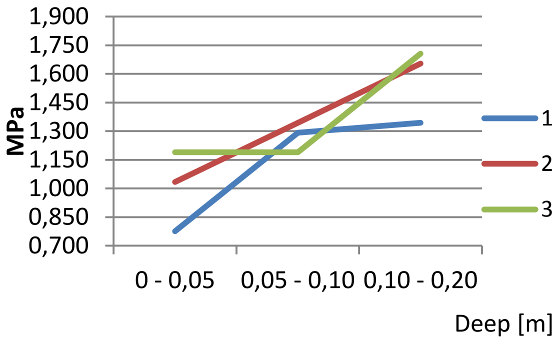

Fig. 3. – Penetration resistance of the soil to PG in the 1st year

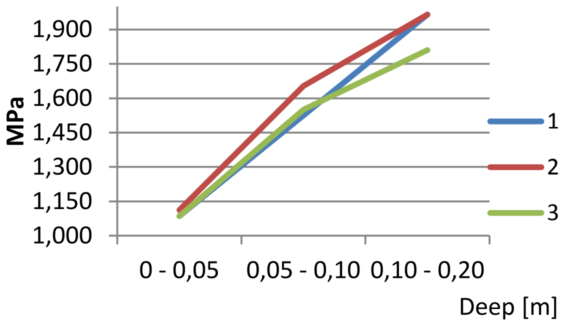

Fig. 6. – Penetration resistance of the soil to PG in the4th yearr

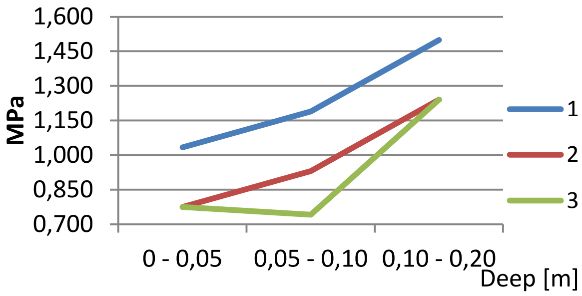

Fig. 4. – Penetration resistance of the soil to PG in the 2nd year

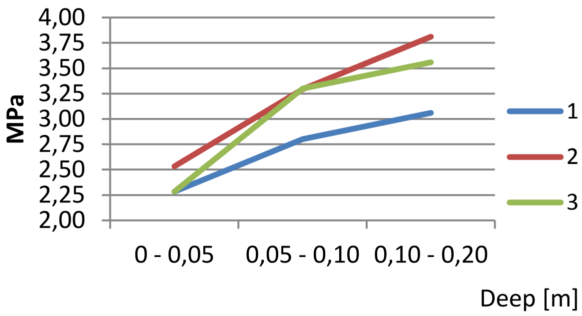

Fig. 7. – Penetration resistance of the soil to PG in the 5th year

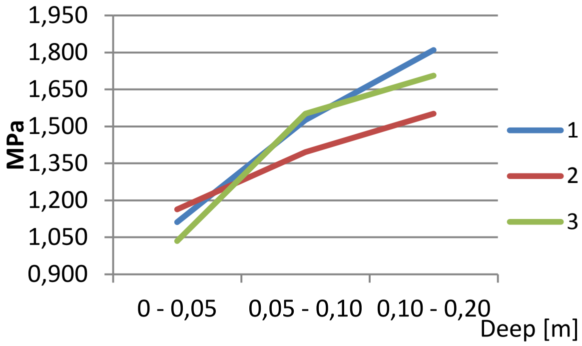

Fig. 5. – Penetration resistance of the soil to PG in the3rd year

From the curves shown in Fig. 3 to 7 of the station PG it is apparent the increasing soil compaction with increasing depth. Also, of the measurement showed the highest soil compaction in the fifth year of measurement. Outside of the initial values of the first year of the experiment, there was a clear effect of the variants with sunk mulch to reduce soil penetration resistance. No measurement in the first four years exceeded the critical value indicating compaction (above 3 MPa). That was exceeded for the fifth year in all variants in the deeper layer of soil.

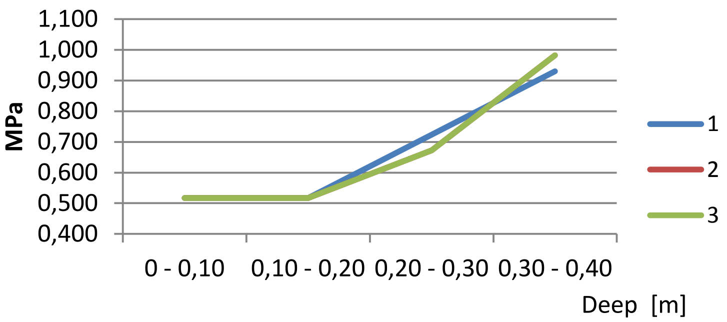

Fig. 8. – Penetration resistance of the soil to AL in the 1st year

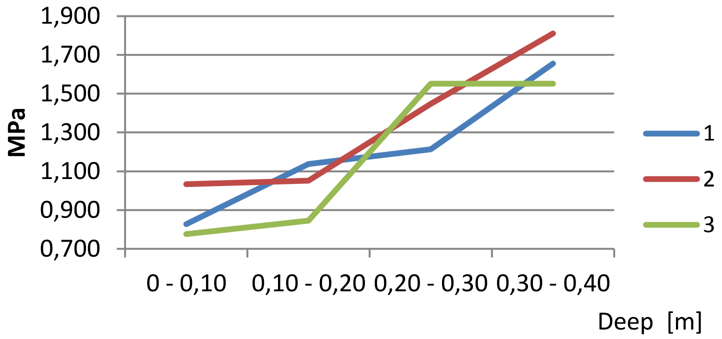

Fig. 9. – Penetration resistance of the soil to AL in the 2nd year

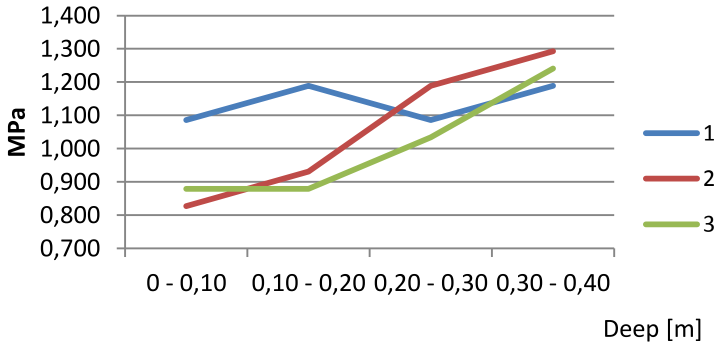

Fig. 10. - Penetration resistance of the soil to AL in the3rd year

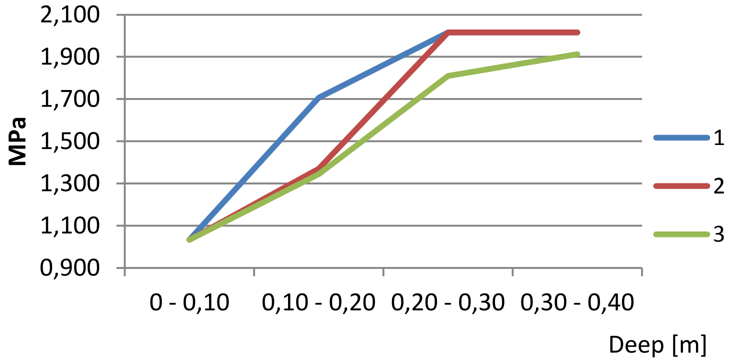

Fig. 11. - Penetration resistance of the soil to AL in the 4th year

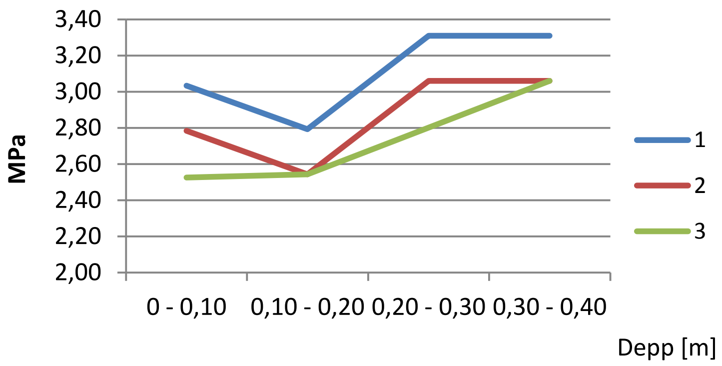

Fig. 12. - Penetration resistance of the soil to AL in the 5th year

The curves in Fig. 8-12 show the progress of penetration resistance values in the soil profile on arable land. In the first year of the experiment the values of options 2 and 3 were almost identical, therefore, there are shown only two curves. As at the previous station, the lowest resistance while measuring the soil profile at the surface layer of soil was found at the variation 3 with the highest dose compost. The highest values for the entire period were measured at all variants in the fifth year of measurement, when there was an apparent a deficiency of organic matter in the soil leading to a reduction in the infiltration capacity of the soil in the upper layers of the soil. Again, as in the pasture soil, the critical value indicating compaction was exceeded (above 3 MPa) only in the fifth year of measurement. In the first four years the value was not exceeded.

DISCUSSION

From the example of both stations it is clear that incorporation of compost has got its purpose in terms of increasing the organic matter in the soil and thereby lightening the topsoil profile. There are known cases where the compost is being applied on the sandy soil with humus deficiency in order to improve the water regime and sorption properties. It is also the main measure in changing the culture to arable land, which is applied in the reclamation (HORN ET AL., 2006; STOFFEL AND KAHN, 2001), or in the protection and creation of permanent grassland. Morse also used compost as void material to improve the structure of heavy soils. KROULÍK ET AL (2010) also found out that application of compost increases the amount of organic matter in soil which has a long-lasting beneficial effect on infiltration and water retention in the soil.

Supplying well matured compost into the soil it delivers prepared humus creating material, and thus making the process of restoring soil fertility much faster. To ensure a level balance of humus in the soil we must annually supply about 1.5 tons of pure organic matter by fertilizing on average 1ha of arable land equivalent to 9 t of medium-quality manure.

Usefulness of incorporation of compost into the soil was commented on by many authors abroad. Depositing compost as an organic matter not only has a positive effect on preserving moisture in the soil, on soil structure (KUTÍLEK, 1978), on a gradual release of nutrients, and on a biological activity in the soil, but it is also important for soil protection against water erosion especially from the point of view of a higher retention water in soil.

CONCLUSIONS

The results obtained showed the positive impact of incorporation of compost on the soil infiltration rate while lowering soil penetration resistance. There were found significant differences in permanent grassland in a case of incorporation of a higher dose of compost. Embedding medium and even higher doses of compost into the soil (80, 150 T. H^{-1}) resulted in a higher retention capacity, where the soil incepted more water compared to the control variant without a compost, on permanent grassland and on arable land. It is therefore concluded that the organic material incorporated into the soil as compost is beneficial in terms of absorption capacity of the soil and reducing its consolidation, as well as erosion protection. It is important to provide soil with well matured quality compost at regular intervals.

ACKNOWLEDGEMENTS

These results were obtained within the framework of the project of CULS Prague IGA No. 2015:31180/1312/3115 and QJ1210263 supported by National Agency of Agricultural Research, Ministry of Agriculture of the Czech Republic.

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