The influence of roots of perennial legumes on the water retention of soil

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Introduction

The soil compaction by tractor wheels is one of the most important factors, which decrease plant yielding (DOMZAL et al., 1987; FRAME and MERRILEES, 1996). It is especially important on grasslands and perennials species because there are not ploughing and other opening operations. The soil compaction accumulates during many years and cause to plant yielding. However, the roots of perennial plants especially legumes influence the physical properties of soil on strongly compacted soils and they can be used to recultivate soils that had previously suffered the physical degradation (DOMZAL at al., 1997).

The aim of this study was to show the influence of the growth of perennial legumes roots on water retention of soil in relationship to different soil compaction.

Materials and methods

The study was carried out as a pot experiment in 2002-2004. The pots were filled with silty soil in different levels of bulk density in four replications. The volume of pots was approximately 30 dm³. The soil compaction in pots is described by degree of compactness. The degree of compactness is defined as the dry bulk density in percent of reference bulk density obtained by a standarized uniaxial compression test (Proctor test) at stress of 200 kPa (HAKANSSON, LIPIEC, 2000). Three soil compaction treatments were applied, where degree of compaction was as follows:

- I - 70%
- II - 80%
- III - 90%

Three species (*Trifolium repens, Trifolium pratense, Medicago sativa*) were sown in pots with density 16 plants per pot.

Table 1: **Air-water properties of compacted soil in 2002 and 2004**

Degree of compactness %	Bulk density g cm^{-3}	Total porosity cm³ cm^{-3}	Available water retention cm³ cm^{-3}	Productive water retention cm³ cm^{-3}
Autumn 2002				
70 (I)	1,20	0,52	0,19	0,18
80 (II)	1,36	0,48	0,20	0,19
90 (III)	1,54	0,38	0,23	0,22
Autumn 2004				
70 (I)	1,24	0,52	0,19	0,17
80 (II)	1,31	0,49	0,19	0,18
90 (III)	1,37	0,47	0,19	0,18

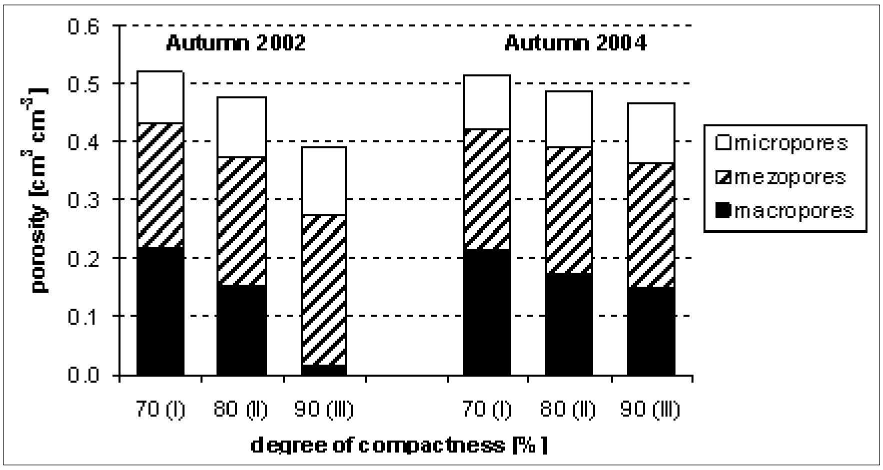

Figure 1: **Differential porosity of compacted soil in 2002 and 2004**

In autumn 2002 and autumn 2004 soil samples (volume 100 cm³) were collected from pots. The prepared samples were saturated with water on a suction plate (according to Richard's method) and then air-water properties were determinated.

Results and discussion

The initial bulk density and total porosity of soil, in autumn 2002, is presented in *Table 1*. After two years the roots of legumes significantly changed the bulk density and porosity. In pots with 70% degree of compactness (I) the difference between bulk density in autumn 2002 and in autumn 2004 is only 0,04 g cm^{-3}, but in pots with 90% degree of compactness (III) the difference is 0,17 g cm^{-3}.

In autumn 2002 difference between bulk density of pots with the lowest compaction (I) and the highest (III) was 0,34 g cm^{-3}. However, in 2004, this difference was only 0,13 g cm^{-3}. The roots of legumes make the physical properties of soil more homogeneous.

The growth of roots results in increase in total porosity of the most compacted soil (III) from 0,38 cm³ cm^{-3} in 2002 to 0,47 cm³ cm^{-3} in 2004. This changes are connected with increase in volume of macropores. The volume of macropores in compacted objects significantly increased in 2004 (*Figure 1*). The greatest differences were noticed in the object III

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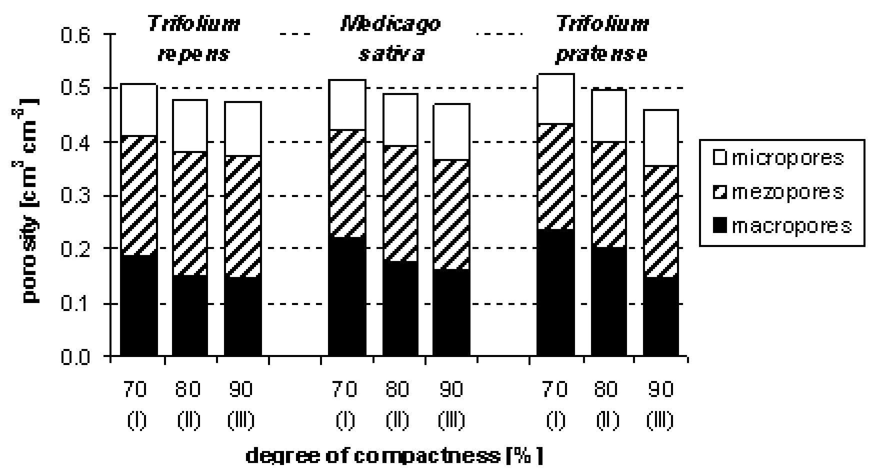

Figure 2: **Differential porosity of compacted soil under three species of legumes**

Table 2: **Air-water properties of compacted soil under three species of legumes**

Degree of compactness %	Bulk density g cm^{-3}	Total porosity cm^3 cm^{-3}	Available water retention cm^3 cm^{-3}	Productive water retention cm^3 cm^{-3}
Trifolium repens				
70 (I)	1,26	0,51	0,20	0,19
80 (II)	1,33	0,48	0,21	0,20
90 (III)	1,35	0,47	0,21	0,19
Trifolium pratense				
70 (I)	1,21	0,53	0,18	0,17
80 (II)	1,29	0,50	0,18	0,16
90 (III)	1,39	0,46	0,18	0,17
Medicago sativa				
70 (I)	1,25	0,51	0,18	0,17
80 (II)	1,31	0,49	0,19	0,18
90 (III)	1,36	0,47	0,19	0,17

(0,01 cm^3 cm^{-3} in 2002 and 0,15 cm^3 cm^{-3} in 2004). In 2004 the lowest volume of macropores was noticed under *Trifolium repens* (*Figure 2*). There were no significant differences between macroporosity of soil under *Trifolium pratense* and *Medicago sativa*. However, the volume of mezopores under *Trifolium repens* was significantly higher in comparison with two other species. It also results in differences in water retention. *Trifolium repens* characterised higher both available and productive water retention (*Table 2*). There were no differences in volume of micropores. This fraction is resistant to influence of soil compaction, it was also shown in previous researches (KOPEC, GLAB, 2003).

This result in air-water properties of soil prove the point of successive legumes growth in order to recultivate soils that had previously suffered the physical degradation imposed upon them through the means of intensive exposure to compression from wheels of agricultural machines.

Conclusions

- The roots of legumes make the physical properties of soil more homogeneous after two years since the compaction.
- The roots of *Trifolium repens* cause better result in improving of water retention of compacted soil than *Trifolium pratense* and *Medicago sativa*.

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