SOIL PENETRATION RESISTANCE INFLUENCED BY DIFFERENT METHODS OF PRIMARY TILLAGE AND CATCH CROP

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Introduction

Catch crops are grown to protect and improve the soil, not just to harvest. Catch crops have the potential to improve soil tilth, control erosion and weeds, and maintain soil organic matter. They can reduce compaction and increase water infiltration which decreases leaching of nutrients. Catch crops retain and recycle plant nutrients (especially nitrogen) between crops, provide habitat for beneficial micro organisms, and increase plant diversity. There are some suitable species for use as a catch crop: lupines (*Lupinus* spp.), Austrian winter pea (*Pisum sativum* var. *arvense*(L.) Poiret), clovers (*Trifolium incarnatum* L., *Trifolium repens* L., *Trifolium pratense* L.), rye (*Secale cereale* L.), oat (*Avena sativa* L.), barley (*Hordeum vulgare* L.), winter wheat (*Triticum aestivum* L.), ryegrasses (*Lolium multiflorum* Lam, *Lolium perenne* L), fescues (*Festuca rubra* L. var. *commutata* Gaud.-Beaup., *Festuca rubra* L., *Festuca elatior* L.), mustard (*Brassica juncea* (L.) Czerniak), canola (*B. napus* L.), turnip (*B. rapa* L. Rapifera Group) etc. In this study the rye catch crop detrimental and favourable effects on the penetration resistance are discussed.

Methods

The experiment was set up in 2002 in Hatvan in Hungary, on the experimental site of Józsefmajor. The experimental site is silty soil, the type is Calcic Chernozem. The average precipitation is detailed in the Results and Discussion so that the Hungarian natural features and resources can be better understood. The size of the experimental site is 312 x 150 m =4, 68 ha, with 4 replications in split-plot design. Each block consists of vertical strips, which are the first factor of the experiment.
These are the methods of the primary tillage, which are the followings:
a1: ploughing (26-30 cm)
a2: direct drilling
a3: French cultivation (8-10 cm)
a4: cultivation (16-20 cm)
a5: disking (16-20 cm)
a6: loosening (35-40 cm) + disking (16-20 cm)
The crop sequence is as follows:
2002: white mustard (*Sinapis alba* L.) (catch crop)
2002/2003: winter wheat (*Triticum aestivum* L.)
2003/2004: rye (*Secale cereale* L.)(catch crop+ forage)
2004: pea (*Pisum sativum* L.)(forage)
The horizontal strips of the "Cover or no cover" refer to the second factor of the trial:
+: with catch crop
-: without catch crop
For catch crop production we sow rye on 25th of August into winter wheat stubble. To quantify the different soil tillage systems and catch crop effects on the soil condition and on the subsequent crop, the experimental site was cut into two parts. One of them was covered with the catch crop (2. 34 ha) while the other one was uncovered (2. 34 ha). Since the farm

DOI: 10.1556/CRC.33.2005.1.34

has livestock, the purpose of the production of the rye was double: to protect the soil, and at the same time to produce green-mass for forage. That is the reason why the rye was harvested just at the beginning of June. The crop residue was implicated into the soil by a cultivator except for the case of the direct-drilling where the residue was treated by chemicals.
For the examination of the soil condition, the penetration resistance of the soil was checked (depth: 0-50 cm) by Daróczi- Lelkes type electronic instrument. The data of the soil moisture and the soil temperature were registered by fixed probes to the depth of 80 cm.

Results and discussion

Evaluation of the precipitation data

In our experiment the possibility of the rye catch crop production and its adaptation into the crop rotation were examined being aware of the Hungarian precipitation circumstances. Józsefmajor (the experimental field) is characterized by a lower precipitation average compared to the Hungarian annual average. The distribution of the precipitation varies in the year of 2003 and 2004. For the rye seedling emergence and development, the abundant rainfall of November was favourable, which exceeded the monthly average precipitation with 44 mm. For the strengthening of the rye, the precipitation and the early establish date had an important role. It seems to be justified that the early sowing time influences the intensive development and the nitrogen uptake positively. The registered precipitation amount in Józsefmajor shows that the risk of nitrate leaching is very low. But considering the cereal's moisture keeping feature, the catch crop production plays an important role in the crop rotation.

Soil penetration resistance

The soil penetration resistance-which describes the condition of the soil- is influenced by the type of the tillage and the crop rotation as well (*Gyuricza*, 2000; *Birkás*, 2000; *Smith* et al. 1969). In our experiment we made a comparison between the covered (with rye) and non-covered field regarding soil penetration resistance. The registered data of the first measurement are shown in Figure 1. Two tillage treatments are highlighted since they are the most unlike considering soil disturbance.
In the case of ploughing (a1), the weed limitation seems to be the most effective, independently of the catch crop. Due to soil- turning, the uncovered plot is weed- and volunteer free. But the penetration data of the ploughing treatment without the catch crop shows smaller resistance, as the rye used the moisture of the soil in the upper 10 cm for its development. According to the measurement, the moisture content of the soil in the ploughing treatment with the catch crop in the upper 10 cm was 24.2 %, while without the catch crop this value was 29.2%.
In the case of direct drilling (a2) the penetration curve shows similar tendencies. The reason can be sought in the lack of the soil tillage which means no soil disturbance. The winter wheat volunteers created a similar soil condition to the rye-covered one. In certain cases even the weeds and the volunteers can be used as a catch crop. Our case justified this conception, but we have to take the possibility of weed appearance in the field of the subsequent crop into consideration. It can be observed in the case of the other four tillage treatments with the rye catch crop that the penetration values are always higher in the upper 10 cm. These tendencies are not described in the deeper layers. The reason is the water uptake by the roots of the rye. (Moisture content in the direct drilling with a catch crop is 31.6 % in the upper 10 cm, in direct drilling without the catch crop is 32.6 %)

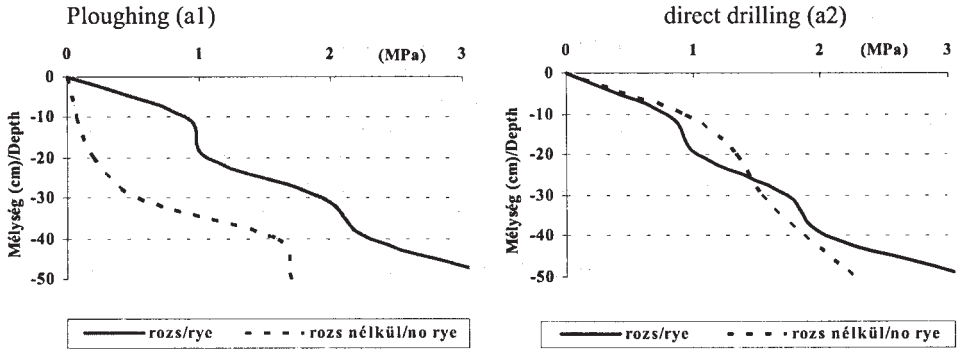

Figure 1. Soil penetration resistance with rye catch crop and without catch crop in the treatments of ploughing and direct-seeding. (Józsefmajor, March, 2004)

Figure 2. shows the result of the soil penetration resistance measurement which was taken in April 2004. The tendencies of the penetration curves are similar regarding the "cover-no cover" factor. The rye loosened the soil in the catch crop covered treatments. But the uncovered plots are covered by volunteers and weeds partially as well. The green-mass of weeds and volunteers created a similar soil condition to the catch crop covered ones as it was noted in March. It can not be observed significant difference between the covered and the uncovered plots in the case of ploughing treatment. A deviation can be detected between the tillage treatments which are visible in the upper 30 cm. The values of the penetration resistance are found between 0.1 and 1 MPa, while these values are higher in the case of the direct-drilling. Even from the upper 10 cm to the deeper layers these data indicate higher resistance (1-2 MPa).

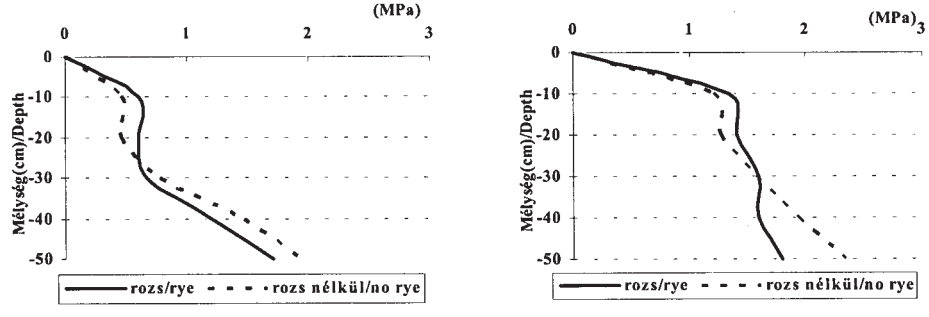

Figure 3. Soil penetration resistance with rye catch crop and without catch crop in the treatments of ploughing and direct-seeding. (Józsefmajor, March, 2004)

Conclusions

According to our results, the soil penetration resistance was influenced by the different tillage treatments, but not by the catch crop because the lack of suitable amount of herbicide in the uncovered treatments. The ploughing treatment without the catch crop is excluded, since the ploughing is more efficient against weed seedling emergence and weed-growth. The root of the rye interwove the upper 10 cm and used the moisture of the soil for its development. One month later, the root of the rye loosened the soil, and the penetration curve showed a similar tendency to that of the treatment without rye. Consistently, the precipitation and the suppression of the weed affect the resistance of the soil. Just "in time-harvest" keeps the soil loosened by the root of the catch crop; otherwise the catch crop consumes the moisture of the soil effecting soil compaction.

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