

## TILLAGE IMPACTS ON SOIL WATER DYNAMICS REGARDING PHYSICAL PROPERTIES, CROP DEVELOPMENT AND CROP YIELD

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### Introduction

Tillage methods affect soil physical properties and, thus, have a direct influence on the soil water dynamics and soil water regime. Effects of different tillage systems on crop yield have been extensively studied under different conditions of soil and climate. In contrast, there is limited information about its effects on soil physical properties and water storage in the soil. This, together with the increase of process modelling of water balance in tillage experiments has imposed a demand of accurate measurements of soil physical properties, crop development and crop yield.

Work has been carried out in the last few years to study the soil water regime under different tillage methods in eastern Hungary and their influence on the development of field crops (NAGY, 1995; RÁTONYI and MEGYES, 2000; MEGYES et al., 2003; RÁTONYI et al., 2005; HUZSVAI et al., 2005). Although these experiments show some relationship between soil physical properties and soil water dynamics under traditional and conservation tillage, more detailed studies are needed on these tillage practices.

The objectives of this study were to evaluate the effects of different tillage methods, under rainfed conditions in eastern Hungary, on volumetric water content (VWC), to quantify the dynamics of the soil water regime and to test a battery-operated capacitive soil moisture sensor (BR-150) over the 2005 growing season.

### Methods

#### *Experimental Site, soil and weather characteristics*

This study was conducted in 2005 at the Látókép Experimental Station of the Centre of Agricultural Sciences, Debrecen University located in the north-eastern part of the Great Hungarian Plain (47° 30' N, 21° 36' E, 121 m elevation). The investigations were part of a multi-factorial (irrigation, tillage, fertilization, plant density) long-term field experiment. The investigated tillage treatments were winter plowing (WP) to a depth of 27 cm, spring plowing (SP) to a depth of 22 cm and disk tillage (DT) to a depth of 12 cm.

The soil of the experimental site was a lowland pseudomyceliar chernozem (Mollisol-Calciustoll or Vermustoll, silt loam; USDA taxonomy), which is one of the major soil types of the region. The climate is subhumid temperate continental, with a mean annual precipitation of 566 mm of which approximately 60 % (345 mm) occurs during the growing season (from April to September).

The weather conditions in 2005, just as in the previous year, was very favourable for maize, with sufficient precipitation both in the winter and in the vegetation period. Total precipitation for the 2005 growing season was 502.1 mm. The April to September precipitation was 46% more than the fifty-year average.

#### *Field measurement and sampling*

The examinations were carried out on unfertilized and unirrigated plots in all tillage treatments. Changes in the soil water profile during the experimental period were monitored using capacitive method. A battery-operated capacitive soil moisture sensor (BR-150,

RAJKAI, 2004) was used to determine the volumetric water content. Two open-ended tubes (plastic, 40 mm Ø) for the capacitive probe were installed in each individual plot of each treatment. Readings were taken to a depth of 200 cm in 10 cm increments. Soil water measurements were made five times at variable intervals from the end of July to harvest during the growing season.

#### ***Statistical evaluation***

The experimental data were evaluated with the 13.0 version of the SPSS for Windows.

### **Results and conclusions**

#### ***Soil water profiles***

Changes in the soil water profile are shown in Figure 1. The VWC profiles were significantly affected by tillage at all measurement dates. Increasing order of the moisture content of the soil in the 0-210 cm layer was as follows: WP < SP < DT. DT treatment proved to be the most favourable from the aspect of saving soil moisture content. The significantly greater VWC of DT plots exceeded the level of field capacity almost at the entire soil profile. This could be due to a better recharge of the profile in the deeper layers. It seems that the water recharge of the profile during the autumn and in winter period was more effective in the DT than in the plowed treatments. During the very wet soil conditions of 2005 growing season, depending on tillage treatments soil profiles generally had a maximum VWC at the upper 30-120 cm depth, declining slightly at greater depths. The characteristic shape of soil water distribution with depth was very similar for WP and SP. At the end of the vegetation period, water was depleted only from the lower soil profile, with the maximum plant extraction occurring from approximately the layer of 160-180 cm. This indicates that the potential rooting depth of maize in the experimental soil was about in this layer.

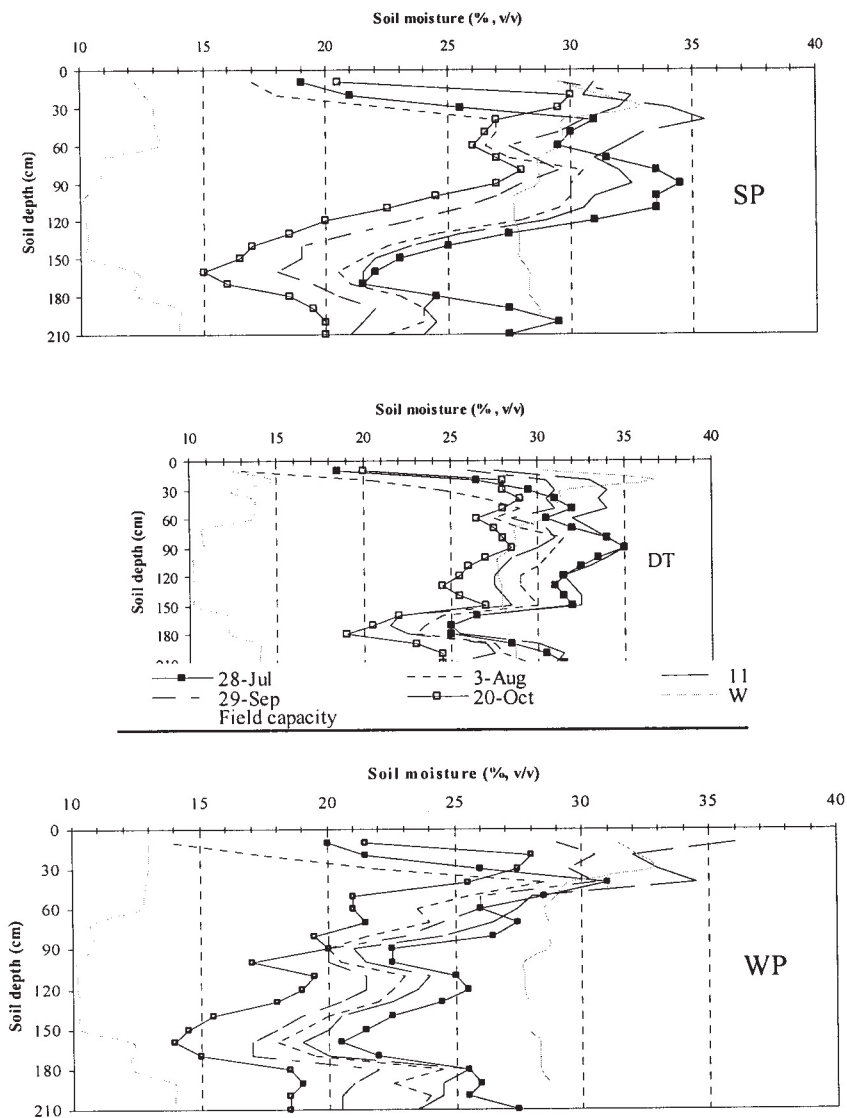


Figure 1. Water profiles in winter plowing (WP), spring plowing (SP) and disk tillage (DT) treatments during the crop season of 2005.

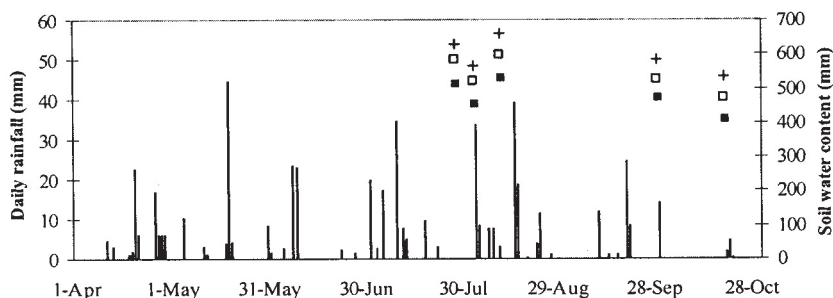


Figure 2. Seasonal change of the total soil water content in the 0-210 cm depth under different tillage treatments (■, WP; □, SP; +, DT) and the distribution of daily rainfall in the 2005 growing season.

#### *Seasonal changes of total soil water*

During the experimental period, significant differences between tillage treatments were observed in total soil water content at all sampling dates (Figure 2). From the beginning of measurements the soil water content was significantly higher in the DT than in the WP and SP treatments. Trends in total accumulated soil water affected by tillage systems were similar to those for VWC distribution in the soil profile described above.

#### **Acknowledgement**

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