Evaluation of strip tillage systems in maize production in Hungary

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Abstract. Strip tillage is a form of conservation tillage system. It combines the benefits of conventional tillage systems with the soil-protecting advantages of no-tillage. The tillage zone is typically 0.25 to 0.3 m wide and 0.25 to 0.30 m deep. The soil surface between these strips is left undisturbed and the residue from the previous crop remain on the soil surface. The residue-covered area reaches 60-70%. Keeping residue on the surface helps prevent soil structure and reduce water loss from the soil. Strip tillage is most common with crops on 0.76 m row spacing. Maize, sunflower and rapeseed have all been successfully strip tilled in Hungary. Automatic steering with RTK (Real Time Kinematic) is requirement for the strip tillage systems.
The objective of this study is to evaluate the effects of conventional (moldboard ploughing) and conservation (spring strip tillage and ripping) tillage systems on soil conditions and on yield of maize. In order to achieve the objective we examined the tillage effects in the polyfactorial long-term field experiment at the trial site of the University of Debrecen (Hajdúság loess plateau, 47° 30' N, 21° 36' E, 121 m elevation) in 2015-2017. The experiment was arranged split-split-plot, on the main plots there were three tillage and two irrigation varieties. The investigated tillage treatments were moldboard ploughing (MP) to a depth of 0.3 m, strip tillage (ST) to a depth of 0.3 m and ripping (RP) to a depth of 0.45 m. Long-term field experiment included three maize hybrids in 2015-2017: Armagnac (FAO 490), Loupiac (FAO 380), Sushi (FAO 340). Soil penetration resistance and soil moisture content were measured by a hand operated static cone penetrometer (Penetronik) combined with moisture sensor until 0.65 m depth. The yield of maize in experimental field was determined by plot harvester.
Penetration resistance of the soil in strip tillage (ST) treatment inter-rows were significantly higher than is moldboard ploughing (MB) and ripping (RP) treatment, soil moisture content in ST treatment exceeded the moisture content of the upper soil layer of MP and RP treatments.

Reduction of the tillage intensity with no use of inversion (ploughing) tillage shows benefit for saving moisture in the soil profile. Maize yield in conservation ST treatment can reach the yields resulted by conventional MB tillage treatment. It can be concluded, that strip tillage can be alternative way of tillage systems beside the conventional moldboard ploughing on chernozem soils under hungarian conditions of plant production.

Keywords. Maize, Strip tillage, Penetration resistance, Soil moisture

Introduction

Strip tillage is a form of precision conservation tillage system. The method has been widely used in the US for several decades and became more popular in Hungary. It combines the benefits of conventional tillage systems with the soil-protecting advantages of no-tillage. The tillage zone is typically 0.25 to 0.3 m wide and 0.25 to 0.30 m deep. The soil surface between these strips is left undisturbed and the residue from the previous crop remain on the soil surface. The residue-covered area reaches 60-70%. Strip tillage is most common with crops on 0.76 m row spacing. Maize, sunflower and rapeseed have all been successfully strip tilled in Hungary. Automatic steering with RTK (Real Time Kinematic) is requirement for the strip tillage systems. Strip-tillage has the potential advantages of providing a suitable seedbed for maize production and maintained yield level with minimum energy expenditures, while leaving surface residues in the interrow area to reduce soil erosion, water loss from the soil and improved soil structure (Vyn et al. 1992; Mullins et al. 1998; Ványiné 2012; Rátonyi et al. 2014; Busari et al. 2015). The greatest benefit is the propellant savings: in case of different soil types these were above 50% compared to conventional tillage system (Husti et al. 2015).

Materials and Methods

The objective of this study is to evaluate the effects of conventional (moldboard ploughing) and conservation (spring strip tillage and ripping) tillage systems on soil conditions and on yield of maize. In order to achieve the objective we examined the tillage effects in the polyfactorial long-term field experiment at the trial site of the University of Debrecen (Hajdúság loess plateau, 47° 30' N, 21° 36' E, 121 m elevation) in 2015-2017. The soil type of the experimental site is a lowland calcareous chernozem, which is one of the major soil types of the region. The experiment was arranged split-split-plot, on the main plots there were three tillage and two irrigation varieties. The investigated tillage treatments were moldboard ploughing (MP) to a depth of 0.3 m, strip tillage (ST) to a depth of 0.3 m and ripping (RP) to a depth of 0.45 m. Long-term field experiment included three maize hybrids in 2015-2017: Armagnac (FAO 490), Loupiac (FAO 380), Sushi (FAO 340). Soil penetration resistance and soil moisture content were measured by a hand operated static cone penetrometer (Penetronik) combined with moisture sensor until 0.65 m depth. The yield of maize in experimental field was determined by plot harvester.

Results

The tillage effects on penetration resistance of the chernozem soil were significant in the upper layer 50 cm soil (Figure 1/a). The penetration resistance, in all three treatments, increases from

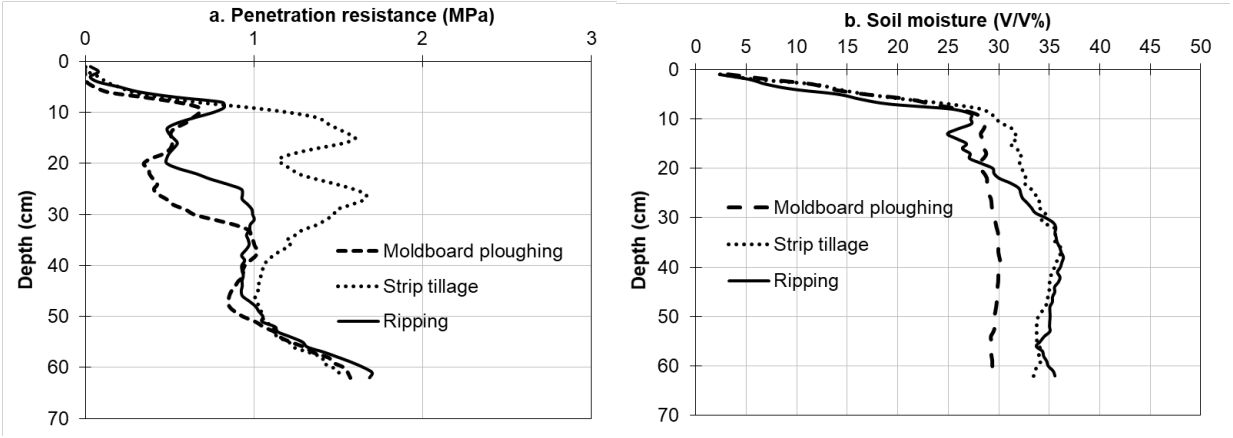

Figure 1. Effects of tillage systems on the penetration resistance (a) and moisture content (b) of calcareous chernozem soil (Debrecen, 2016)

the soil surface until the depth of compacted hard pad-layer, which was developed in previous crop years and situated at the depth of 35-46 cm on MP treatment plots and at the depth of 25-45 on ST treatment plots and at the depth of 30-45 cm on RP plots. Penetration resistance of the soil in strip tillage (ST) treatment inter-rows were significantly higher than is moldboard ploughing (MB) and ripping (RP) treatment. Soil moisture content in ST treatment exceeded the moisture content of the upper 30 cm soil layer of MP and RP treatments (Figure 1/b.). Reduction of the tillage intensity with no use of inversion (ploughing) tillage shows benefit for saving moisture in the soil profile. Maize yield in conservation ST treatment can reach the yields resulted by conventional MB tillage treatment. In non-fertilized treatments, there were significant differences on maize grain yield between strip tillage and mouldboard ploughing treatment. On the more fertile plots significant yield differences cannot be detected.

Conclusion

It can be concluded, that strip tillage can be alternative way of tillage systems beside the conventional moldboard ploughing on chernozem soils under hungarian conditions of plant production.

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