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TECHNICAL AND CULTIVATION TECHNOLOGY RESEARCH AND DEVELOPMENT OF PRECISION CROP CULTIVATION ON THE SUBJECT OF CORN PLANTING

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Abstract: This publication describes a study that measured how much uneven corn emergence. This publication provides some management recommendations for what to do planting process. My research takes this approach as a basis when examining the different tillage systems and their impact on the environment. In this context, conventional and a variety of no-tillage systems are examined in this paper. As a next step, it is examined how the environmental conditions created by the different tillage systems influence the emergence of maize hybrids. The analyses are carried out in a multi-factorial, long-term tillage field experiment. The same batch of the same hybrid seed was sown in several crop years, and the effects of environmental conditions on the emergence process were examined. Environmental effects and emergence-related uptake were measured in the examined plots. The first emergence time measurements of the sown crop in the plots of each treatment were compared and relationships between these factors were investigated.

Keywords: corn, *emergence*, planter, *tillage systems*, *germinate*

1. Introduction

Precision agriculture is an integrated information based agricultural management system, with the intent to manage spatial and temporal variability associated with all aspects of agricultural production for optimum profitability, sustainability and protection of the environment (Robert et al. 1995).

One of the foundations of precision farming is the use of sustainable soil management systems that meet the needs of the crop. A better understanding of the impact of soil management systems on the crop production process is essential for production practice. As climate is gradually becoming more extreme, the exposure of crop production to the weather becomes increasingly severe. The condition created by the used tillage system has an impact in strengthening or even mitigating certain biotic and abiotic effects (Diaz 2002). Tillage and stubble management significantly affect soil physical properties, which greatly influence crop growth and productivity (Ranbir et al. 2018).

The basic element of tillage systems is the primary tillage practice. It determines to a large extent the type and form of the other cultivation practices used in the system. There are important differences between the various primary tillage practices. They differ from each other in terms of their operational characteristics, when classified according to the energy required for the process, and also in terms of the biological, chemical and physical properties of the soil structure they result in, lead to changes in soil use (Aziz et al 2013). Classification takes place most often in terms of the physical parameters of the soil structure or the amount of stem residue on the surface. These individual characteristic differences will be of crucial importance for the crop in the tillage system at different times. For maize, the characteristics of the soil section from the soil surface to the zone of sowing depth are of key importance in the period from sowing to emergence. In the later period, the deeper soil layers also have an influence on the development of the crop and the supply of nutrients, as well as water and heat.

The on-farm productivity of maize is determined mainly by climate, meteorological and soil conditions, and agrotechnological practices (Romaneckas et al. 2020). The sowing time of maize, followed by the emergence dynamics and the homogeneity of emergence, influence the development of the crop and yield. Maize emergence is strongly influenced by soil moisture and soil temperature at the sowing depth (Hayhoe 1987). These conditions, and their optimal level for emergence, are influenced by the applied tillage system.

The primary tillage used in the tillage system results in varying degrees of residual stalk cover on the soil surface. The stem residue affects the soil temperature, which influences maize emergence dynamics and subsequently influences the growth, development and morphology of maize leaves and, consequently, the grain yield of maize. Other influences also affect early plant development, such as soil compactness and soil moisture content (Hill 2000).

Several authors have addressed the relationship between maize emergence uniformity and yield ((Nafziger et al 1991, Nielsen 2001, Kovács and Vyn, 2014). A homogeneous maize stand is the basis for a favorable yield. By densifying the crop stand, emergence non-uniformity increases stand heterogeneity, causing yield losses, as plants adjacent to the missing crops can only slightly compensate for the missing production (Tollenar 1992, Duvick 1997, Fasoula & Fasoula 2000, Tokatlidis & Koutroubas 2004). Yield is based on the emerging number of plants adapted to the production site. The homogeneity of maize emergence and subsequent development is also important and it is of great importance in maximizing yield, since their joint development reduces competition between plants for available water, nutrients and sunlight (Karayel 2008). The uniformity of maize emergence can be evaluated in time and space, based on the time of emergence and the spacing of ears.

2. Materials and methods

2.1. Materials

This study was conducted in 2020 and 2021. The experiment was conducted in the eastern region of Hungary at Nádudvar (47°25'49.3 "N 21°12'33.5 "E). Four different tillage systems were established in autumn 2016 and have been continuously applied since then. In the first part of the field, a conventional tillage system was used, where the primary tillage machinery is a plough, the ploughing depth is 30 cm and there is no residual stalk on the surface. In the second part of the area, a reduced tillage system without tilling (Reduced) was used. In this part, the primary tillage implements are medium-depth cultivators equipped with a low-angle knife which had a mixing effect. In this primary tillage system, the entire surface is cultivated, with a depth of 30 cm for the loosening depth, and a maximum residual stalk residue of 15% on the surface. In the third area, the protective tillage system is used (Protect), using straight knife tillage with a maximum depth of 30 cm over the entire surface. After the primary tillage, a stem residue cover of over 30% remains. In the fourth area, a biological tillage system with strip-tillage was used as the primary tillage method. In this case, 40% of the total surface is cultivated at a width of 30 cm and a depth of 28 cm, with a residual stalk content of more than 30%. These primary tillage operations are carried out in the autumn, followed by sowing in the spring after a mulching/seedbed preparation operation.

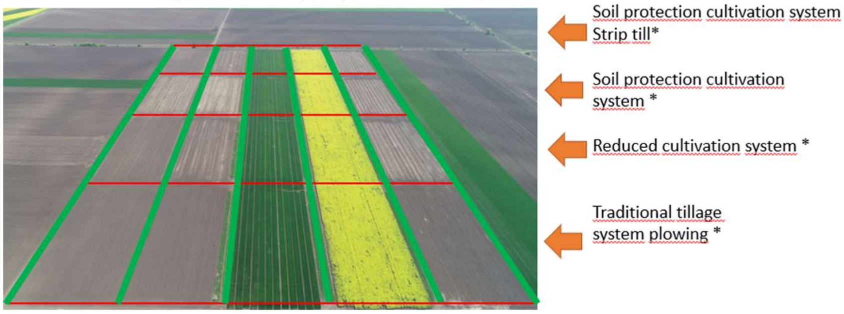


Figure 1: The experiment location

I used different planter downforce systems for the experiment. A mechanical spring or air bag or hydraulic loading unit on each row supplied downforce to each row unit. Downforce is important for maintaining correct seeding depth over varying terrain. I present the used systems in Figure 2.

Maize was planted in spring 2020 after rape as a previous crop and in spring 2021 after maize as a previous crop. In both years, Fornad (FAO-420) maize hybrids were sown.

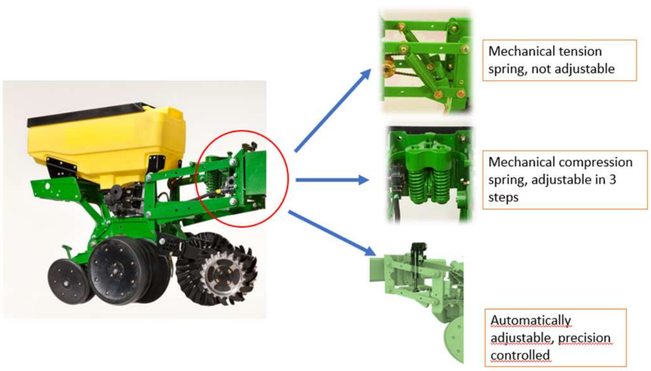


Figure 2: Experimental planter equipment variations

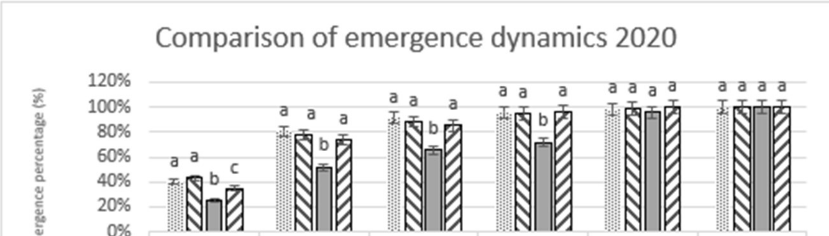
After sowing, an emergence survey was carried out. The first emerged crops were marked by sticking a colored stick into the soil next to the emerged plant. After

24 hours of this measurement, the recording was repeated, this time using a different color. This series of measurements was continued for six days.

3. Results

3.1. Results in 2020

Based on the obtained research results, emergence dynamics in the examined periods were analyzed. The 2020 season data for the plots of each treatment for were combined for comparability. The obtained data show that, within 24 hours after the first emergence, there is a significant difference ($P < 0.05$) in emergence dynamics between the conventional and reduced tillage crops, compared to the soil conservation and biological systems. From the second day of emergence, the results are not significantly different between the conventional, reduced and biological systems, but the percentage of emerged plants is significantly lower ($P < 0.05$) in the soil conservation system (Figure 3).



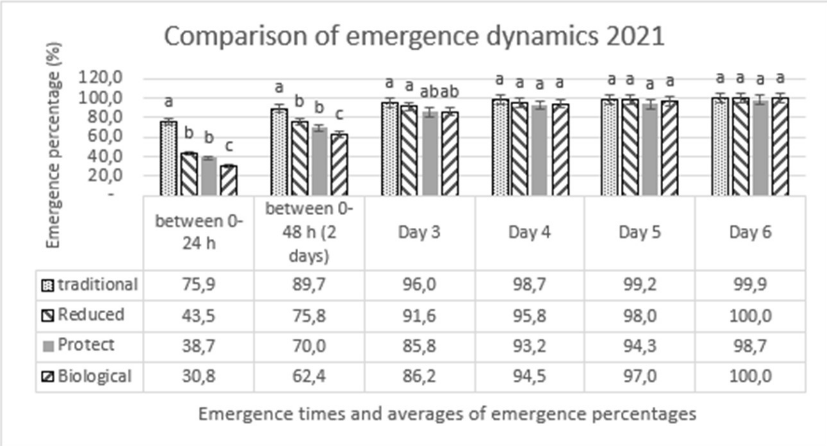
	between 0-24 h	between 0-48 h (2 days)	Day 0-3	Day 0-4	Day 0-5	Day 0-6
traditional	40%	81%	91%	96%	98%	100%
Reduced	43%	78%	88%	95%	99%	100%
Protect	25%	52%	66%	72%	96%	100%
Biological	35%	74%	85%	96%	100%	100%

Emergence times and averages of emergence percentages

Figure 3: Comparison of emergence dynamics 2020

3.2. Results in 2021

As the measurements for the 2021 crop year show, this period was colder than the 2020 crop year. For each tillage system, there is a significant difference ($P < 0.05$) between the emergence dynamics of the plants that emerged in the first 24 hours between the reduced and conservation tillage groups and the plants that emerged in the conventional tillage system, and the plants that emerged in the conservation tillage group. In the 0-24 h period, significantly lower numbers of plants emerged in each no-tillage group compared to tillage. This effect was also observed and similar for plants that emerged on day 2. There were no significant differences in the emergence dynamics of plants emerging on day 3 and subsequent days (Figure 4).



	between 0-24 h	between 0-48 h (2 days)	Day 3	Day 4	Day 5	Day 6
traditional	75,9	89,7	96,0	98,7	99,2	99,9
Reduced	43,5	75,8	91,6	95,8	98,0	100,0
Protect	38,7	70,0	85,8	93,2	94,3	98,7
Biological	30,8	62,4	86,2	94,5	97,0	100,0

Figure 4: Comparison of emergence dynamics 2021

4. Discussion

Karayel et al. (2008) found that the increased technological level of planting depth uniformity (which was used in our study), has led to a significant increase in the emergence dynamics of corn (shorter and more uniform emergence time). My test results confirm that the germination dynamics are improved when we use a precision system based on measurements. My measurements show different soil conditions (residue cover % and soil temperature) have an impact on germination dynamics of corn. Romaneckas et al. (2020) studied the germination response of corn in field experiment. They confirmed our results, Precision system give better results for without rotation cultivation systems. Nowadays, with increasing importance of precision farming. That results in the growing need for professional precision solutions of planter.

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