Volume 52(1):225-227, 2008
Acta Biologica Szegediensis
http://www.sci.u-szeged.hu/ABS

ARTICLE

Study of plant emergence by different cultivation

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ABSTRACT Field emergence of different crops significantly varies under Hungarian ecological conditions. Tillage systems may strongly affect the germination environment of seeds by changing temperature and moisture of the topsoil, seed-soil contact and the amount of crop residues. The objective of this experiment was to study the effect of soil cultivation on maize germination. Methods of soil cultivation were: conventional tillage (winter ploughed soil), spring tillage, conservation tillage (spring disk harrowing). Spring was particularly dry. Bulk density and water content in case of winter ploughed soil was higher and the placement of plant residues was lower compared to spring tilled soil. The highest germination percentage of maize was observed after winter tillage, the lowest was after spring disk tillage. The cultivation had a higher effect on germination than the differences of soil moisture or soil compaction in itself. Plant residues got into greater depths in the ploughed treatment and ploughing reduced the number of weed seedlings. In the effect of cultivation the changes of multiple soil conditions were cumulated. Results suggest an important effect of cultivation method on bulk density, on water holding capacity parameters of soils and finally on seedling emergence.
Acta Biol Szeged 52(1):225-227 (2008)

KEY WORDS

tillage method,
maize,
weed,
emergence

Field emergence of different crops significantly varies under Hungarian ecological conditions. Germination of seeds is determined by environmental factors: water, oxygen, light, temperature and chemicals (Bewley and Black 1985) that are connected with weather and soil. Soil water content is variable near to the surface (Ritchie and Johnson 1990), and plant emergence is strongly sensitive to drought (Máthéné Gáspár 1993; Máthé-Gáspár and Máthé 2000). Effect of plant density and weed control is well known for plant production, p.e. for maize (Molnár and Sárvári 2005; Sester et al. 2007).

Soil, being the environment of germination plays an important role in the formation of these conditions. Soil parameters as mechanical composition, compaction or bulk density, organic matter content determine soil water content and soil temperature, too.

Maize germinated best at about 30°C with a sharp decrease in germination < 10°C or in dry soil (Blacklow 1972; Hercegh and Marton 1986). Tillage systems may strongly affect the germination environment of seeds by changing temperature and moisture of the topsoil, seed-soil contact and the amount of crop residues (Collins et al. 1984; Nasr and Salles 1995). To reduce of weed pressure it is important to maize production (Lotz et al. 1995). Tillage method and depth determines weed seedling number and dynamics at the emergence time of cultivated plant (Blackshaw 1990; Sester et al. 2007), e.g. maize.

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The aim of the present work was to increase our knowledge on the effect of soil cultivation methods on the maize and weed germination.

Materials and Methods

The study was based on a long-term tillage experiments on chalcareous chernozem soil, using maize (type: Occitan) at the Experimental Station at Látókép in Debrecen, East-Hungary. Methods of soil cultivation were: conventional tillage (winter ploughing), spring tillage, conservation tillage (spring disk harrowing).

Maize was sown (5.2 seeds/m) on April 26th, 2003 at 8 cm depth, number of replications was 4 and size of elementary plots was 15 m^2. Total number of emerged corn plants was recorded at four replications in each of the tillage plots.

Spring was particularly dry, from the beginning of April until the time of observation (May 5) 13.7 mm of precipitation fell, instead of the usual 40-60 mm. The soil water content was at the time of emergence low, near to the lower limit.

Soil temperature (10 measuring/plot) was determined with thermometer in the sowing depth. Soil moisture content, bulk density, number of weed seedling, amount of plant residue at the depth of sowing was determined 10 samples/plot (depth: 8 cm, diameter: 8 cm) on May 5th. Soil water content was determined gravimetric.

Statistical analysis was made by variance analysis 'ANOVA.

Table 1. Maize emergence and soil parameters with different tillage methods.

Tillage method	Maize emergence and soil parameters			
	Number of maize seedling/m	Soil water content, w %	Bulk density g/cm^3	Soil temperature °C
Winter ploughing	3.5 [a]	13.96 [a]	1.25 [a]	23.70 [a]
Spring ploughing	3.0 [b]	12.29 [a]	1.15 [b]	25.15 [b]
Spring disk harrowing	0.7 [c]	9.67 [b]	1.02 [c]	23.75 [a]

a,b,c: the different letters in upper case mean different groups at 0.05 ANOVA probability level

Table 2. Number of weed seedling and plant residue in soil with different tillage methods in two soil layers.

Tillage method	Number of weed seedling / cm^3 * 10^3		Plant residue mg/ cm^3	
	0-3 cm	3-8 cm	0-3 cm	3-8 cm
Winter ploughing	2.5 [a]	7.5 [a]	0.08 [a]	0.48 [a]
Spring ploughing	10.0 [b]	30.0 [b]	0.33 [b]	0.86 [b]
Spring disk harrowing	80.4 [c]	62.5 [c]	2.21 [c]	1.84 [c]

a,b,c: the different letters in upper case mean different groups at 0.05 ANOVA probability level

Results and Discussion

The low germination rate (13.3-66.7%) could be explained by the weather parameters, especially precipitation. Spring was particularly dry, from the beginning of April until the time of observation (May 5) 13.7 mm of precipitation fell, instead of the usual 40-60 mm.

Bulk density of soil differed significantly depending on the date of tillage and method (Table 1). The highest value was in winter ploughed soil (mean: 1.25 g cm^{-3}) and the lowest after spring disk tillage (mean: 1.02 g cm^{-3}). Soil water content was similarly the highest in winter ploughed soil (mean: 13.96 w %), and lowest after spring disk tillage (mean: 9.67 w %). Soil water content in the winter ploughed soil compared to spring ploughed soil not differed significantly.

Higher soil temperature was observed after spring ploughing, but this difference was less important for maize emergence. Among the main weather factors (temperature and water) influencing germination, the role of precipitation proved to be decisive.

The lowest germination rate of maize was observed in the spring harrowing treatment. The benefit of winter ploughing was highlighted by the dry spring. Bulk density and water content in case of winter ploughed soil was higher compared to spring tilled soil. The highest germination percentage was observed after winter tillage, the lowest was after spring disk tillage. The cultivation had a higher effect on germination than the differences of soil moisture or soil compaction in itself. In the effect of cultivation the changes of multiple soil conditions were cumulated.

Significant differences have been found among the cultivation treatments concerning to the quantities of weed seedlings and the placement of plant residues in the topsoil. Plant residues got into greater depths in the ploughed treatment and ploughing reduced the number of weed seedlings (Table 2).

Tillage alters many soil physical properties including bulk density, porosity (Józefaciuk et al. 2001), soil water content and temperature, and it determines soil microbial dynamics (Spedding et al. 2004). The higher organic matter content of soil results in the higher water content and increases soil water capacity (Szili-Kovács et al. 2008), and water content determines (stimulates) processes of soil organisms, as microbial activity (Szili-Kovács and Elhottova 2007; Szili-Kovács et al. 2007) or plant growth. In this experiment the plant residue, which was no transformed to soil organic matter, it resulted in lower soil water content and inhibited the maize emergence.

The spring harrowed topsoil was characterized by the greatest quantity of plant residue and the lowest water content. The soil moisture content and the contact between the seed and soil and the root and soil determine water uptake by the seeds and the root seedlings. The later is an essential condition for germination. These contacts were declined and thus water uptake inhibited by great quantity of plant residue, too, and resulted the lowest emergence rate.

Results suggest an important effect of cultivation method on bulk density, on water holding capacity parameters of soils and finally on seedling emergence.

Acknowledgements

We gratefully acknowledge financial support from the Hungarian Scientific Research Fund (OTKA) (T 042778 and T 042929).

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