THE INFLUENCE OF TILLAGE ON SOIL WATER

DOBRE M., OSICEANU M., SĂLCEANU C., SUSINSKI M.
University of Craiova, Faculty of Agronomy

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ABSTRACT

The present paper presents the results of an experiment with different tillage referring to soil moisture in dynamics, the corn plants height and the grain yield. The variants have been: v1= plowed soil in autumn and drilled after seedbed preparation by harrowing, v2= plowed soil in autumn and drilled in the spring without seedbed preparation, v3= no till without mulch layer and v4= no till with mulch layer. The results show that the main role of tillage is to keep water into the soil for roots. No tillage condition determines the compaction of shallow soil layer of 3-5 cm which extracts the water from beneath and loses it by evaporation. Direct drilling requires the presence of the mulch layer which reduces evaporation.

INTRODUCTION

Lots of research have been devoted worldwide on the ammount of tillage needed for cropping. In fact, the soil has never encountered disturbance in its evolution. Most of ancient empires fell because of too much tillage and the losing of the most important substance of soil: its humus (Sprague M. and Triplett G.,1986; Elliot E.T. and Colleman D.C.,1988). It was formed by physical, chemical and biological phenomena during millenia but the most important fact was the presence of a layer of dead plants upon it. This layer played a crucial role in accumulating organic matter into the soil, in improving the most important features of its fertility as structure, humus content, water permeability and air exchange capacity (Soane B.D. and van Owerkerk C.,1990).

The new technique of direct drilling or no till requires the presence of a mulch layer upon the soil in order to prevent water lose by evaporation, to decrease the speed of plant residues decomposition and to improve the overall life of the soil. The thickness and the composition of this residue layer is very important because if it has a low C/N ratio, the fungi involved in its decomposition will take nitrogen from the soil in order to reach the level of C/N = 25 that is required for living cells for protein formation. Straw have a high C/N ratio of about 90 and this is why this kind of mulch composition need extra nitrogen for proper function. Otherwise, the less nitrogen level will decrease the plant growth and development. Other solution can be the cultivation of legumes as cover crops during late autumn and early spring till the time of drilling spring crops as corn, sunflower or soybean.

The thickness of the residue layer has a high importance, too. Most of crops do not leave enough plant residues. Every square centimeter of bare soil will determine the lose of soil water through evaporation instead of transpiration. The recommendation on the thickness of the residue layer is very simple: the thicker, the better (http://www.rolf-derpsch.com/en/no-till/historical-review/).

When the soil remains bare, without a residue layer upon it the shallow layer of 3-5 cm becomes compacted because of rainfall during the cool season. This layer extracts the water from beneath and loses it through evaporation. The speed of evaporation loss highly depends on the air temperature, the hotter the atmosphere, the higher the evaporation. For warm season crops as corn, sunflower or soybean this process unfolds in matter of hours. This is the reason why no till bare soil gives vary bad results in plant development and yield (Dobre M., 2002).

MATERIAL AND METHOD

The experiment was located at the Botanic Garden of University of Craiova in 2016 year and comprised four variants of soil tillage in 3 replications. The variants were: v1 = plowed soil in autumn and drilled after seedbed preparation by harrowing, v2 = plowed soil in autumn and drilled in the spring without seedbed preparation, v3 = no till without mulch layer and v4 = no till with mulch layer.

The tillage have been done manually as well as the sowing. During the vegetation period there were made soil moisture determinations at two dates: 10 of june and 15 of july. There were, also, made soil bulk density determinations and soil texture determination at the laboratory. At harvest the corn plants were measured as height. The yield was weighted by plots and the results have been statistically interpreted by Fisher analysis of variance.

RESULTS AND DISCUSSIONS

The soil moisture and bulk density at 10 of june and 15 of july are presented in the table below.

Table 1

The soil moisture and the bulk density in function of tillage and mulch layer in 2016

Treatment	Depth, cm	10 June		15 July	
		Soil moisture %	Soil bulk density g/cm^3	Soil moisture %	Soil bulk density g/cm^3
V1 – plowed, without seedbed preparation in spring	0-10 cm	21.2	1.26	18.2	1.30
	10-20 cm	21.5	1.34	18.8	1.35
V2 – plowed with seedbed preparation	0-10 cm	25.3	1.23	24.3	1.30
	10-20 cm	25.5	1.30	24.9	1.35
V3 – no till without mulch layer	0-10 cm	20.3	1.40	17.4	1.40
	10-20 cm	20.8	1.43	17.9	1.45
V4 – no till with mulch layer	0-10 cm	25.4	1.30	24.5	1.30
	10-20 cm	25.8	1.37	25.1	1.38

The soil moisture data at 10 june and 15 july show a lower moisture with the no till variant without residue layer because of the shallow layer of compacted soil which was created during the cool season. This phenomenon is produced with the variant which was plowed in the autumn but the drilling was made without seedbed preparation. This layer is shown in the figure below.

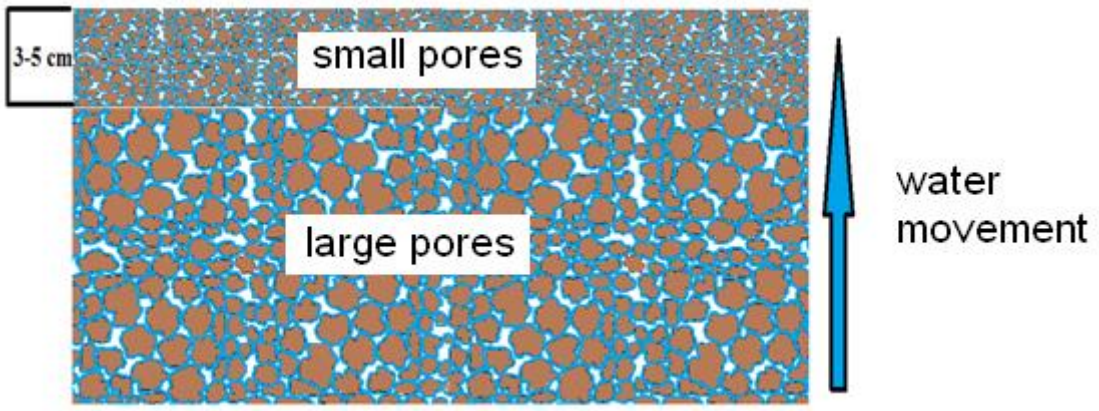

Figure 1. Shallow compacted layer in no till condition without residue layer

Table 2

Corn plant height at harvesting time and the yield in function of tillage and mulch layer in 2016

Treatment	Plant height, cm	Yield, kg/ha	%	Difference, kg/ha	Signification
V1 – plowed, without seedbed preparation in spring	52	325	21.3	- 1,203	000
V2 – plowed with seedbed preparation	180	1,528	100	control	-
V3 – no till without mulch layer	45	287	18.8	- 1,241	000
V4 – no till with mulch layer	161	804	52.6	- 724	000

DL 5%=158 kg/ha; DL 1%=253 kg/ha; DL 0.1%= 384 kg/ha

From these data we can notice that the second treatment has given the best results in terms of plant height as well as yield. Plants in this situation are much better supplied by water solution due to the influence of tillage that create larger pores than beneath. This way, the water do not easily moves toward the soil surface where is susceptible to evaporation. The explanation of this fact is that water is better kept in small pores than in large ones. In fact, the smaller the pores, the higher the pressure by which water sticks to the soil. By creating larger pore at the soil surface tillage prevent the water movement to the soil surface.

By leaving the soil without any tillage at the top of the soil there is created a shallow compacted layer because of rainfall during the cool season. This shallow and thin layer extracts the water from beneath because it has smaller pores, smaller than the ones from below. During hot days of summer water migrates toward the surface of the soil where it is easily lost through evaporation. This is the explanation why plants grown in these conditions give very poor results. Even when the soil is plowed in autumn, if the seedbed is not prepared before planting, there can be noticed the formation of this layer because of rainfall during the winter and spring.

No till technique relies on the presence of the residue layer upon soil. When not enough plant residues from the previous crop, it can be created by cropping a cover crop during the late autumn, winter and early spring.

CONCLUSIONS

1. The most important effect of tillage on soil is the influence on soil moisture. Tillage help creating a layer of soil with larger pores than the soil beneath. This fact decreases the access of water toward the soil surface where it can be lost through evaporation.
2. The no till bare soil forms a shallow layer with smaller pores of about 3-5 cm thickness. This layer extracts the water from beneath and loses it through evaporation during summer hot days. This layer can be formed even after autumn plowing, during winter and early spring if no seedbed preparation is made before planting.
3. Mulch layer is compulsory for no till condition due to its capacity to preserve soil water and increase its fertility in time.
4. The soil moisture determinations as well as bulk density values show better conditions with plowed followed by seedbed preparation and no till with mulch rather than no till bare or plowed without seedbed preparation in the spring. These differences are obviously seen in the corn plants height at harvest and the corn grain yield.

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