RESEARCH ON THE INFLUENCE OF TILLAGE SYSTEM ON THE PHYSICO-CHEMICAL PROPERTIES OF CHERNOZEM CULTIVATED WITH MAIZE FROM THE URZICUTA LOCALITY, DOLJ COUNTY, ROMANIA

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ABSTRACT

The influence of the applyed system of practices on the soil's properties gives indicators that are important for preserving soil fertility and for assessing the sustainability of the system. The preservation of te soil's fertility involves the application of a system of practices that corellates the cultivation requirements of the plant with the changes induced in the soil, while ensuring the improvement of the soil's properties, while also ensuring that large and constant yields are obtained. In order to analyze the influence of the cultivation technology on the properties of the soil cultivated with maize from the Urzicuța locality, Dolj county, Romania, in 2019 an experiment was made, in which A represents the applied soil practices (a1-conventional and a2 - minimum tillage) with control and fertilized variants, as following - b1-unfertilized, b2-$N_{100}P_{50}K_0$, b3-$N_{100}P_{50}K_{50}$, b4-$N_{150}P_{50}K_{50}$ and b5-$N_{100}P_0K_0$. The following soil chemical analyses were performed - the soil's pH reaction, humus content, total Nitrogen, Phosphorus, Potassium and Copper, Zinc, Iron and Manganese in mobile forms. To determinate the physical properties bulk density, total porosity and the degree of compaction. Applying the minimum tillage system practices showed that there are no significant changes in terms of bulk density, total porosity and degree of compaction, but the Chernozem on which the research was performed, has a high content of nitrogen, phosphorus and potassium compared to the conventional system variants.

INTRODUCTION

In order to obtain safe productions, while also taking into consideration the soil's properties, it is mandatory to choose cultivation technologies that will lead to the increase of agricultural production and to the conservation or improvement of the chemical and physical properties of the soils. Choosing the best cultivation technologies can be done only by undertaking experiments that should be based on long-term research and by taking into account the properties of the soil.

The decrease in the soil's fertility, which has repercussions on the health and on the quality of agricultural yield, should be a warning that must compel us to limit the degradation of soils and to rehabilitate them. Changing production technologies, by using high-performance machines, requires, as we all know, extensive research in order to understand their long-term effects on the physical, chemical and biological properties of soils. (Mihalache, M., 2008, 2012, 2015).

Tillage methods and soil surface management affect the sustainable use of soil resources through their influence on the soil's stability, resilience and quality. Here, by soil stability, understanding the susceptibility of the soil to change under natural or anthropogenic perturbations (Rattan L, 1993).

While particularly discussing the cultivation of maize, *Rusu et al.*

discovered that the soil tillage system hasn't significantly influenced maize yields, as they were almost equal in the two applied systems- no-tillage and minimum tillage. Maize production was influenced significantly by the climate conditions of the agricultural year, ranging between 5.392-6.102 kg/ha, while the economic efficiency of the minimum tillage system was discovered to be higher, as it results from the reduction of fuel consumption to 84.4 l/ha, compared to the conventional system, which needs 101.5 liters/ha for all the soil tillage. (Rusu, T., 2019)

Various scientific research done in this field makes us aware that currently, different tillage techniques are being used without evaluating their effects on the physical, chemical and mechanical properties of the soil. As a result, there is a substantial interest and emphasis on the shift to conservation and no-tillage methods. Thus, *Shahbaz et al.* conducted a study in order to determine the effect of different tillage strategies on the movement of nitrate in the soil profile and to check the response of some selected physical and mechanical properties of the soil (such as moisture content, bulk density and penetration resistance). (Khan, S., 2017.)

Additionally, some studies show that intensive tillage in conventional tillage systems reinforces water stress effects on crop growth, limiting yields obtained from dryland agriculture. The minimum tillage system, also known as the conservation tillage system, can reduce soil evaporation and conserve more soil water in fields, but long-term, mono-conservation tillage may lead to low crop yields. It is, therefore, presumed that the rotation of conventional tillage with conservation tillage may offset some of the defects generated by the mono-tillage practices of either conventional or conservation tillage methods, may improve crop yields and provide better soil conditions. (Zhang,Y., et al., 2018.)

MATERIAL AND METHOD

In order to analyze the influence of the cultivation technology on the properties of the soil cultivated with maize from the Urzicuța locality, Dolj county, Romania, in 2019 an experiment was made, in which A represents the applied soil practices (a1-conventional and a2 - minimum tillage) with control and fertilized variants, as following - b1-unfertilized, b2-$N_{100}P_{50}K_0$, b3-$N_{100}P_{50}K_{50}$, b4-$N_{150}P_{50}K_{50}$ and b5-$N_{100}P_0K_0$. The following soil chemical analyses were performed - the soil's pH reaction potentiometrically determinated in water, humus by wet oxidation, total Nitrogen by using the Kjeldal method, extractable Phosphorus in ammonium lactate acetate, extractable Potassium in ammonium lactate acetate, dosing by atomic absorption spectrophotometry of Copper, Zinc, Iron and Manganese in mobile forms. To determinate the physical properties, metal cylinders with a volume of 100 cm^3 were extracted to determinate the bulk density, total porosity and the degree of compaction.

RESULTS AND DISCUSSIONS

The representative soil in the Urzicuța area is the Chernozem (**Fig. 1**) with a loamy texture having a neutral pH reaction between 7.10-7,50, Humus content of 3.14%, total Nitrogen 0.100%, P_{AL} 15 mg/kg, K_{AL} 89 mg/kg, Zn 0,4 mg/kg, Cu 1.5 mg/kg, Fe 25.3 mg/kg and Mn 33.7%.

Figure.1. Chernozem profile – Urzicuta locality, Dolj county

Table 1. Characterization of the main chemical properties of the soil in the conventional system

Variant	pH	H %	N t %	P_{AL} mg/kg	K_{AL} mg/kg
Control	7.12	3.40	0.135	15	94
$N_{100}P_{50}K_0$	7.53	3.37	0.122	12	92
$N_{100}P_{50}K_{50}$	7.34	4.20	0.146	107	202
$N_{150}P_{50}K_{50}$	7.24	2.51	0.120	12	100
$N_{100}/P_0/K_0$	7.57	3.56	0.124	20	92

The soil's pH reaction is neutral to slightly basic with a pH between 7.12, in the control variant, and 7.57 in the variant fertilized with $N_{100}/P_0/K_0$, the humus content is medium, with the highest value of 4.20 recorded in the $N_{100}P_{50}K_{50}$ variant. The content of mobile phosphorus and potassium is low in all variants, except in the variant with $N_{100}P_{50}K_{50}$, which has a high phosphorus and potassium content, while the humus content is higher (Table 1).

Table 2. Characterization of the main chemical properties of the soil in a minimum tillage system

Variant	pH	H %	N t %	P_{AL} mg/kg	K_{AL} mg/kg
Control	7.51	3.32	0.107	30	92
$N_{100}P_{50}K_0$	7.25	3.85	0.137	16	100
$N_{100}P_{50}K_{50}$	7.25	4.14	0.152	20	102
$N_{150}P_{50}K_{50}$	7.24	3.79	0.152	14	99
$N_{100}/P_0/K_0$	7.61	3.73	0.145	14	96

In the minimum tillage system, the soil's pH reaction is slightly alkaline, the humus content is medium and the total nitrogen, phosphorus and potassium content is small to medium. In the minimum tillage system, compared to the conventional system, a higher content of total nitrogen and phosphorus was recorded in most variants where mineral fertilizers were applied (Table 2).

Table 3. The influence of technological practices on the content of zinc, copper, iron and manganese

Variant	Zn Mg/kg	Cu Mg/kg	Fe Mg/kg	Mn Mg/kg
Conventional system				
Control	1.1	1.6	24.9	24.3
$N_{100}P_{50}K_0$	1.6	1.7	20.6	39.3
$N_{100}P_{50}K_{50}$	0.6***	1.5	15.5	17.8
$N_{150}P_{50}K_{50}$	0.6***	1.6	20.6	23.6
$N_{100}/P_0/K_0$	0.6***	1.5	19.9	21.4
Minimum tillage system				
Control	1.1	1.5	15.5	26.9
$N_{100}P_{50}K_0$	0.6***	1.6	20.9	24.0
$N_{100}P_{50}K_{50}$	0.7***	1.4	16.9	23.3
$N_{150}P_{50}K_{50}$	0.5***	1.5	18.3	22.3
$N_{100}/P_0/K_0$	0.4***	1.4	12.3	17.9

The determinations made for microelements in the conventional system, compared to the minimum tillage system, showed a higher amount of iron in conventionally worked soils, with values ranging from 15.5 mg/kg to 24.9 mg/kg, in the control variant. The zinc content is very low to extremely low in many variants, with the content being below the zinc detection limit of 0.95 mg/kg (Table 3).

The influence of the soil practices on the bulk density (BD) for the depth of 0-20 cm did not show any changes in the application of the conventional system or minimum tillage system. The differences between the variants are insignificant in the case of the two applied systems (Table 4).

Table 4. The influence of soil practices on the bulk density for the depth of 0-20 cm

Variant	Conventional system			Minimum tillage system		
	BD g/cm^3	Dif.	S	BD g/cm3	Dif.	S
Control	1.533	Cont.	-	1.533	Cont.	-
$N_{100}P_{50}K_0$	1.366	-0.166	ooo	1.433	-0.1	ooo
$N_{100}P_{50}K_{50}$	1.466	-0.066	ooo	1.433	-0.1	ooo
$N_{150}P_{50}K_{50}$	1.400	-0.133	ooo	1.400	-0.133	ooo
$N_{100}/P_0/K_0$	1.400	-0.133	ooo	1.533	0	
LSD 5%	***0.131***			***0.198***		
LSD 1%	***0.180***			***0.385***		
LSD 0,1%	***0.248***			***1.031***		

The bulk density increased for the depth interval of 20-40 cm in the case of the minimum tillage system, compared to the conventional system, but there are no significant differences in the applied variants for this research (Table 5).

Table 5. The influence of soil practices on the bulk density (BD) for the depth of 20-40 cm

Variant	Conventional system			Minimum tillage system		
	BD g/cm^3	Dif.	S	BD g/cm3	Dif.	S
Control	1.600	Control	-	1.633	Control	-
$N_{100}P_{50}K_0$	1.466	-0.133	ooo	1.500	-0.133	ooo
$N_{100}P_{50}K_{50}$	1.533	-0.066	ooo	1.500	-0.133	ooo
$N_{150}P_{50}K_{50}$	1.566	-0.033	ooo	1.533	-0.100	ooo
$N_{100}/P_0/K_0$	1.466	-0.133	ooo	1.566	-0.066	ooo
LSD 5%	0.102			0.120		
LSD 1%	0.141			0.206		
LSD 0,1%	0.193			0.468		

The degree of compaction (DC) for the depth interval of 0-20 cm is significant only in the case of the $N_{150}P_{50}K_{50}$ variant in the conventional system. As in the case of the bulk density and the degree of compaction, there are no significant differences regarding the applied system of practices and the doses of fertilizers applied (Table 6).

Table 6. The influence of soil practices on the degree of compaction for the depth of 0-20 cm

Variant	Conventional system			Minimum tillage system		
	DC %	Dif.	S	DC %	Dif.	S
Control	-19.433	Control	-	-19.867	Control	-
$N_{100}P_{50}K_0$	-8.833	10.6	-	-10.2	9.666	-
$N_{100}P_{50}K_{50}$	-12.00	7.433	-	-11.5	8.366	-
$N_{150}P_{50}K_{50}$	-7.766	11.666	*	-8.8	11.066	-
$N_{100}/P_0/K_0$	-10.266	9.166	-	-20.466	-0.6	ooo
LSD 5%	***11.622***			***14.010***		
LSD 1%	***16.013***			***24.447***		
LSD 0,1%	***22.012***			***56.714***		

Significant values were recorded for the degree of compaction at a depth of 20-40 cm for the $N_{100}P_{50}K_0$ and $N_{100}/P_0/K_0$ variants, in the conventional tillage system, and for most variants in the minimum tillage system (Table 7).

Table 7. The influence of soil practices on the degree of compaction for the depth of 20-40 cm

Variant	Conventional system			Minimum tillage system		
	DC g/cm3	Dif.	S	DC g/cm3	Dif.	S
Control	-25.433	Control	-	-28.0	Control	-
$N_{100}P_{50}K_0$	-16.166	9.266	*	-17.433	10.566	*
$N_{100}P_{50}K_{50}$	-19.266	6.166	-	-16.400	11.600	*
$N_{150}P_{50}K_{50}$	-23.033	2.400	-	-17.666	10.333	*
$N_{100}/P_0/K_0$	-14.966	10.466	*	-21.266	6.733	
LSD 5%	***7.772***			***9.279***		
LSD 1%	***10.709***			***16.101***		
LSD 0,1%	***14.721***			***37.033***		

The total porosity (TP) of the soil for the depth interval of 0-20 cm is 38.83%, in the conventional system, with the highest value of 44.43% recorded for the variant fertilized with $N_{150}P_{50}K_{50}$. In the case of the minimum tillage system, at a depth interval of 0-20 cm, no significant changes were registered (Table 8).

Table 8. The influence of soil practices on the total porosity for the depth of 0-20 cm

Variant	Conventional system			Minimum tillage system		
	TP %	Dif.	S	TP %	Dif.	S
Control	38.833	Control	-	38.666	Control	-
$N_{100}P_{50}K_0$	43.933	5.100	-	43.233	4.566	-
$N_{100}P_{50}K_{50}$	42.466	3.633	-	42.633	3.966	-
$N_{150}P_{50}K_{50}$	44.433	5.600	*	43.933	5.266	-
$N_{100}/P_0/K_0$	43.300	4.466	-	38.333	-0.333	ooo
LSD 5%	5.612			6.751		
LSD 1%	7.732			11.768		
LSD 0,1%	10.629			27.253		

Changes in total porosity values were observed at a depth interval of 20-40 cm in the variants where $N_{100}P_{50}K_0$ and $N_{100}/P_0/K_0$ were applied, in the case of the conventional system, and significant changes in variants b2, b3 and b4, in the minimum tillage system (Table 9).

Table 9. The influence of soil practices on the total porosity for the depth of 20-40 cm

Variant	Conventional system			Minimum tillage system		
	TP %	Dif.	S	TP %	Dif.	S
Control	36.033	Control	-	34.766	Control	-
$N_{100}P_{50}K_0$	40.033	4.300	*	39.866	5.100	*
$N_{100}P_{50}K_{50}$	38.966	2.933	-	40.433	5.666	*
$N_{150}P_{50}K_{50}$	37.200	1.166	-	39.800	5.033	*
$N_{100}/P_0/K_0$	41.066	5.033	*	38.066	3.300	-
LSD 5%	3.797			4.542		
LSD 1%	5.232			7.891		
LSD 0,1%	7.193			18.182		

CONCLUSIONS

The research carried out in the Urzicuța area, in the south of Dolj County, Romania, analyzed the influence of using both the conventional system and the minimum tillage system on the chemical minimum tillage system on the chemical and physical properties of the Cernozem soil.

The Chernozem on which the experiment was done has good chemical properties with a neutral to slightly basic pH reaction, a medium content of Humus, a low supply of Nitrogen and low to medium supply in Phosphorus and Potassium.

The analyses performed showed a low content of Zinc, Copper, Iron and Manganese in all experimental variants.

In the minimum tillage system, compared to the conventional system, a higher content of total Nitrogen and Phosphorus was recorded in most variants where mineral fertilizers were applied. The influence of soil practices on the bulk density, total porosity and the degree of compaction for the depth interval of 0-20 cm did not show changes in the application of the conventional system or the minimum tillage system. The differences between the variants are insignificant in the case of the two applied systems.

Changes in physical parameters were recorded at the depth interval of 20-40 cm, especially when taking into consideration the total porosity and the degree of compaction of the soil.

Applying the minimum tillage system practices showed that there are no significant changes in terms of bulk density, total porosity and degree of compaction, but the Chernozem on which the research was performed, has a high content of nitrogen, phosphorus and potassium compared to the conventional system variants.

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