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RESEARCH ON THE INFLUENCE OF TECHNOLOGICAL SYSTEMS ON MAIZE CULTIVATION IN THE SOUTH OF DOLJ COUNTY, ROMANIA

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Abstract

Conservation agriculture implies practices that are applied in such a way as to cause minimum damage to the environment. Conservation practices, the most important aspect of conservation agriculture, are widely supported worldwide, and it is considered that they take care of soil health, plant growth and the environment. The growing concern for food security through improved soil management techniques requires the identification of a sustainable, environmentally friendly and ecological system that would also ensure a high yield for the cultivated plants. Research reports have identified more benefits of conservation practices, than of conventional practices, in terms of crop yields. Moreover, while no less than 25% of greenhouse gas emmissions released into the atmosphere are attributed to agriculture, research in relation to the processes of climate change mitigation and adaptation found that the zero tillage (ZT) practice is the most environmentally friendly among different processing techniques. Therefore, conservation practices involving zero tillage and minimal tillage, which have the potential to break up the compact surface area of the soil with reduced soil disturbance, provide a better soil environment and a crop yield with minimum impact on the environment. In this context, in 2019, an experiment was performed in order to analyze the influence of cultivation practices on maize yield in Urzicuta locality, Dolj County, in the Sourthern Oltenia Region of Romania. In this experiment, two tillage systems were applied, with A representing the applied soil practices (a1-conventional tillage and a2 - minimum tillage), each with control and fertilized variants, as following - b1-control, b2-$N_{100}P_{50}K_0$, b3-$N_{100}P_{50}K_{50}$, b4-$N_{150}P_{50}K_{50}$ and b5-$N_{100}P_0K_0$. While following the development of maize in both systems and for each variant, this paper aims to identify the best system that would ensure an increased yield for the cultivation of maize in the specified region.

Key words: *minimum tillage, sustainability, fertilisation, soil resources.*

INTRODUCTION

The decrease in the soil's fertility, which has repercussions on the health and on the quality of agricultural yields, 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, 2012; 2015; Marin, 2012; 2015).

When choosing which technological systems should be applied, one must take into account the properties of the soil and its degree of supply in nutrients. The experiments that were conducted have shown that soils respond differently to the application of different technological systems and the soil's properties that can influence these responses are: soil humus content, soil texture, soil structure, the calcium carbonate content, the degree of nutrient supply, etc. An important factor is also given by the application of fertilizers that contain nitrogen, phosphorus and potassium.

Soil conservation practices are considered among the most important components of conservation agriculture. Therefore, by applying minimum tillage systems, the water available for plants in the soil is better preserved and water losses are reduced (Kopek, 2015; Simon, 2018).

Other than that, research conducted with different technological systems has shown that by applying minimum tillage systems the degree of weeding in maize crops is 116% higher than in the case of applying conventional systems (Chițoi, 2018).

Regardless, the yields obtained at minimum tillage and without tillage depend on the soil's characteristics and on the characteristics of each plant (Rusu, 2015).

MATERIALS AND METHODS

In order to follow the influence of technological systems and the influence of fertilization applyed on the maize crops, in 2019, an experimental field was arranged in the southern part of Dolj County, on Chernozem soils (Figure 1).

The representative soil in the research area is a typical Chernozem with a loamy texture, having a neutral reaction of 7.12-7.40, humus of 3.30%, total nitrogen of 0.135%, P_{AL} 15 mg/kg, K_{AL} 90 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 - Urzicuța locality, Dolj County

Table 1. Characterization of the main chemical properties of the soil

System technological	pH	H %	N total %	P_{AL} mg/kg	K_{AL} mg/kg
Conventional	7.12	3.40	0.135	15	94
Minimum tillage	7.51	3.32	0.107	30	92

The preparation of the land for the plots cultivated in the minimum tillage system was carried out with a disc at a depth of 25 cm in autumn, on the 20th of September, 2018. When the germinative bed was prepared, one disc passing took place, while in the conventional system the plowing was made at 25 cm depth with discs.

The cultivated maize hybrid was PR 9911, a semi-late hybrid, from the FAO 410 group. It is characterized by an excellent production capacity, and offers the future plant an extremelly developed root system. For the experiment described in this paper around 65,000 germinating plants/ha were sown in an irrigated system with the precursor plant being also maize.

This experiment included conventional practices and minimum tillage practices (part A) with the following variants: 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-$N_{100}P_0K_0$. Each variant had three repetitions and for the statistical data processing the variation analysis was used.

RESULTS AND DISCUSSIONS

In order to measure the influence of technological systems and fertilization on the maize crop, the following analyzes were made for 10 plants from each repetition and variant: plant height, plant weight, root system weight (Table 2), leaf weight and the maize production was calculated in tonnes/ha.

In Table 1 the highest weight of the root system was recorded in the b4 variant with $N_{150}P_{50}K_{50}$ kg/ha. It can be seen, in this variant, that the application of complex fertilizers containing nitrogen, phosphorus and potassium have contributed to a better distribution of the root system of the plants in the soil.

In the b5 variant, where only 100 kg of nitrogen were applied, the root system weight was close to the b1-unfertilized variant. Nevertheless, the differences are significant in all variants, when compared to the control variant.

Table 2. The influence of fertilization on the root system weight of maize

Variants	Production, g/10 plants	%	g/plant	%	Significance
b1-Control	243.66	100	Mt	-	-
b2-$N_{100}P_{50}K_0$	321.66	132.01	78	32.01	***
b3-$N_{100}P_{50}K_{50}$	440.66	238.73	197	138.73	***
b4-$N_{150}P_{50}K_{50}$	549.50	538.38	305.83	438.38	***
b5-$N_{100}P_0K_0$	263.16	581.47	19.5	481.47	***
LSD 5%=4.42 g/plants LSD 1%=6.10 g/plants LSD 0.1%=8.38 g/plants					

The tillage practices highlighted a higher distribution of the root system in the variants in the conventional system, given by a better soil processing and a better aeration of the soil, than in the case of the minimum tillage system.

In the case of both the conventional system and the minimum tillage system, the differences obtained, in comparision to the control variant, are significant.

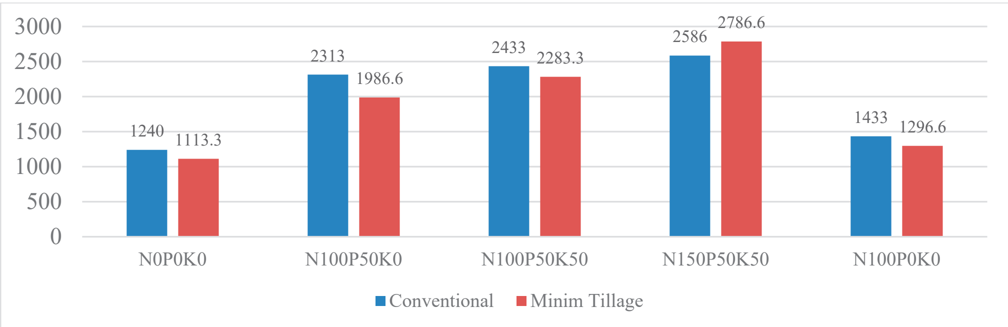

Figure 2. The weight of the maize stalk in conventional and minimum tillage systems (g)

In Figure 2 we can see a tendency to increase the corn stalk, a higher weight for the conventional system compared to the minimum tillage for the variant to which nitrogen 150, phosphorus 50 and potassium 50 were applied.
The values obtained were higher than in the conventional system. In the minimum tillage system, the weight values of the root system are lower than in the conventional system, which indicates the fact that, by applying the minimum tillage system practices, a more accentuated compaction is registered, which can influence the distribution of the root system.

Table 2. The influence of tillage practices on the root system weight of maize

Variants	a1-Conventional			a2-Minimum tillage		
	g/plant	Difference	Significance	g/plant	Difference	Significance
b1-Control	251.66	-		235.66	-	-
b2-$N_{100}P_{50}K_0$	322.66	71	***	320.66	85	***
b3-$N_{100}P_{50}K_{50}$	443.33	191.6	***	438	202.33	***
b4-$N_{150}P_{50}K_{50}$	551.66	300	***	547.33	311.66	***
b5-$N_{100}P_0K_0$	273.66	22	***	252.66	17	*
LSD 5%=6.262797 LSD 1%=8.628812 LSD 0.1%=11.86143				LSD 5%=10.20789 LSD 1%=20.30318 LSD 0.1%=55.93887		

The weight of the maize leaves at harvest increased with the application of different doses of nitrogen, phosphorus and potassium in both systems, but in the case of the conventional system, a higher quantity of leaves was produced, when compared to the minimum tillage system.

The highest amount of leaves was obtained in variant b4 of 626.6 g in the conventional system and 596.6 in the minimum tillage system. In variant b5, where the 100 kg of nitrogen were applied, did not lead to the increase of leaf weight, compared to the respective control value, of 395 g in the conventional variant and 291.6 g in the minimum tillage system (Figure 3).

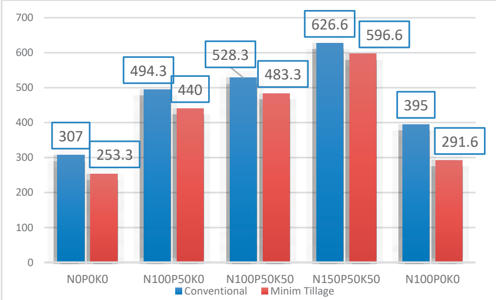

Figure 3. Weight of maize leafs in conventional and minimum tillage system (g)

Table 3. The influence of fertilizers on the height of maize plants

Variants	Height	Difference	Height	Difference	Significance
	cm	%	cm	%	
b1-Control	184.16	100	Mt	-	-
b2-$N_{100}P_{50}K_0$	271.83	147.60	87.66	47.60	***
b3-$N_{100}P_{50}K_{50}$	307.08	166.74	122.91	66.74	***
b4-$N_{150}P_{50}K_{50}$	316.00	171.58	131,83	71.58	***
b5-$N_{100}P_0K_0$	214.25	116.33	30.08	16.33	***
LSD 5%=3.184271 LSD 1%=4.387253 LSD 0.1%=6.030853					

At harvest, the average height of the plants ranged from 184 cm, in the control variant, to 316 cm in the b4 variant, with $N_{150}P_{50}K_{50}$. It can be seen how only applying a dose of 100 kg of nitrogen can only lead to an increase of height of up to 214.25 cm. On the other hand, under irrigation conditions, the application of complex fertilizers with nitrogen, phosphorus and potassium greatly influences the development of maize plants (Table 3).

The height of the plants did not show significant differences regardless of the technological system applied, however, in both the conventional and the minimum tillage system, the highest height of maize plants was recorded by applying variant b4 - $N_{150}P_{50}K_{50}$, that led to having results with a height of 321.66 cm and 310.66 cm respectively, as shown in Table 4.

Table 4. The influence of tillage practices on the height of maize plants

Variants	a1-Conventional			a2-Minimum tillage		
	cm	Difference	Significance	cm	Difference	Significance
b1-Control	187.5	Mt	-	180.83	Mt	-
b2-$N_{100}P_{50}K_0$	274.33	86.83	***	269.33	88.5	***
b3-$N_{100}P_{50}K_{50}$	311.66	124.16	***	302.5	121.66	***
b4-$N_{150}P_{50}K_{50}$	321.33	133.83	***	310.66	129.83	***
b5-$N_{100}P_0K_0$	217.83	30.33	***	210.66	29.83	***
LSD 5%=4.50324 LSD 1%=6.204513 LSD 0.1%=8.528914				LSD 5%=7.429184 LSD 1%=14.83235 LSD 0.1%=41.03982		

The maize production in the experimental field, varied, in 2019, from 6.22 tonnes/ha in the control variant, to 14.13 tonnes/ha in the b4 variant, in which $N_{150}P_{50}K_{50}$ was applied. This dosage is recommended for the maize hybrid used in the experimental field, in the conditions of the Chernozem soils from the southern part of Oltenia, Romania and in accordance with the soil's degree of supply in nutrients (Table 5).

Although there are many claims related to the good potassium supply of Chernozems, the undertaken experiments and the results obtained for maize crops, under irrigation conditions, highlighted the importance of using complex mineral fertilizers (Table 5).

Table 5. The influence of fertilizers on maize yield

Variants	a1-Conventional		a2-Minimum tillage		Significance
	Yield, t/ha	%	Yield, t/ha	%	
b1-Control	6.22	100	Mt	-	-
b2-$N_{100}P_{50}K_0$	11.86	190.43	5.63	90.43	***
b3-$N_{100}P_{50}K_{50}$	12.69	388.13	6.46	288.13	***
b4-$N_{150}P_{50}K_{50}$	14.13	880.88	7.90	780.88	***
b5-$N_{100}P_0K_0$	8.01	1133.64	1.78	1033.64	***
LSD 5%=0.515511 LSD 1%=0.710265 LSD 0.1%=0.976352					

Regarding the influence of the two technological systems applied on maize production, it can be shown that, in both the conventional and minimum tillage system, the production increased significantly when compared to the control variant. In the b4 variant, where $N_{150}P_{50}K_{50}$ was applied, the production was of 13.9 t/ha in the conventional system and of 14.30 t/ha in the minimum tillage system. For all other variants and doses applied, maize yields were lower in the minimum tillage system, compared to the conventional system, as shown in Table 6.

Table 6. The influence of tillage practices and fertilizers on maize yield

Variants	**a1-Conventional**			**a2-Minimum tillage**		
	t/ha	Difference	Significance	t/ha	Difference	Significance
b1-Control	6.28	Mt	-	6.175	Mt	-
b2-$N_{100}P_{50}K_0$	12.28	6.00	***	11.44	5.26	***
b3-$N_{100}P_{50}K_{50}$	12.89	6.60	***	12.50	6.32	***
b4-$N_{150}P_{50}K_{50}$	13.97	7.69	***	14.30	8.12	***
b5-$N_{100}P_0K_0$	8.66	2.38	***	7.366	1.19	*
LSD 5%=0.729042 LSD 1%=1.00466 LSD 0.1%=1.38077				LSD 5%=1.04416 LSD 1%=1.981983 LSD 0.1%=5.165623		

CONCLUSIONS

The experiments carried out in 2019 in the ecopedological conditions found in the South of Dolj County, that tried to verify the influence of the conventional system and the minimum tillage system might have on maize production and characteristics, allowed to fundamentate the choice, in terms of which would be the best technological system and the best doses of fertilizers to be applied for maize cultivation.

The application of the conventional system, that ensures a better aeration of the soil, led to significant differences when compared to the minimum tillage system, especially regarding the distribution of the root system of the obtained biomass and regarding the height of the plants.

The highest maize production of 14.30 t/ha was obtained by applying the minimum tillage system and the b4 variant, with a dose of $N_{150}P_{50}K_{50}$, as compared to a production of 13.97 t/ha in the conventional system.

Therefore, taking into consideration the pedoclimatic conditions, the properties and the clay texture of the Chernozem from the Southern Oltenia, Romania, it is concluded that the minimum tillage system can be applied for maize cultivation in irrigated system.

Based on this research, the optimum doses of fertilizers that would obtain the highest maize production, were 150 kg/ha nitrogen, 50 kg/ha phosphorus and 50 kg/ha potassium.

Given the low potassium supply of Chernozems in the area of research, it is necessary to apply complex fertilizers that also contain potassium.

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