

INFLUENCE OF SOIL TILLAGE UPON THE YIELD OF SEVERAL SEMI-LATE MAIZE HYBRIDS GROWN AT MOARA DOMNEASCĂ – ILFOV

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Abstract

The concept of sustainable agriculture system includes numerous types of tillage, but in all cases the chosen variant takes into account the following: the climatic and edaphic conditions, the ecological particularities and the characteristics of the crop, and the technical level, so that crop production could be close to or even exceed the results achieved in the traditional system.

The technological tillage systems have developed significantly over the past decades, in concept and the extension of conservative tillage methods, both worldwide and in Romania. Given the complex mechanization based on a variety of machinery and agricultural machinery, modern agriculture creates numerous possibilities for reducing interventions on the soil, thus increasing the profitability of agricultural production (Guș Petru, Rusu Teodor, 2008).

This paper presents the results of the research carried out on the reddish preluvosoil of the Teaching Farm belonging to USAMV Bucharest and located at Moara Domnească, Ilfov County, in 2014.

The biological material consisted in semi-late maize hybrids and the Romanian hybrid OLT – (FAO 400) as control. The experimental variants were: plough 20 cm (control), chisel 20 cm, chisel 40 cm, disk 10 cm, disk/plough 20 cm, disk/chisel 40 cm.

In all tillage variants (Both traditional and minimal), the hybrid P0216 was the most productive, with the highest yield of 7595.3 kg/ha.

Key words: *Zea mays* L., yield, soil tillage, bulk density.

INTRODUCTION

Soil is the most important natural resource of mankind. The existence and development of human society depend vitally on soil quantity and quality, and by its production capacity.

The soil tillage system can change the morphological, physical, chemical and biological features of the soil (Canarache A., 1978, 1986, Nedeff V., 1995, Pintilie C. and collab., 1979, Dick R.P., 1992, Dexter A.R., 2004, Munkholm L.J. and collab., 2005).

In time, the long-term use of the conventional soil tillage system can alter soil fertility, increasing evaporation; at the same time, the surface soil layers turn into dust, thus becoming susceptible to wind and water erosion (Lal, R., A.A. Mahboubi and Faussey, N.R., 1994).

Maize (*Zea mays* L.) is grown on large areas of the Romanian Plain as it is one of the most important crop plants. Traditional soil tillage is the most used in this area. To reduce soil degradation and to increase water retention of the area, it is recommended to use conservation

tillage and to maintain the plant waste (Picu, 2005). Over the past few years, the No-tillage and Minimum tillage systems have become popular among the soil conservation measures taken in Romania. The implementation of these two systems are perceived as effective on soil compaction, i.e. provide higher resistance to penetration, compared with the traditional system, which results in better soil moisture and temperature (Moraru P. I., Rusu T., 2013).

The research carried out on the reddish preluvosoil of Moara Domnească, Ilfov, showed that soil structure and other soil features are favourably influenced by the minimum tillage system (Marin D.I. and collab., 2005).

MATERIALS AND METHODS

Research was performed on reddish preluvosoil, at the experimental field of the Teaching Farm located at Moara Domnească, Ilfov.

The test included the following factors:

Factor A – the soil tillage system, with the following variants: a₁-plough at 20 cm in depth (control), a₂-chisel 20 cm, a₃-chisel 40 cm, a₄-disk 10 cm, a₅-disk/plough 20 cm, a₆-disk/chisel 40 cm, disk/chisel 40 cm and disk/ararat 20 cm in the previous crop (winter wheat).

Factor B – maize hybrids: Olt (FAO 400), P0216 (FAO 510), Sumbra (FAO 500).

Basic tillage was carried out in the last decade of September.

Sowing was performed in the second decade of April by using the sower SPC 6.

For weed control, we applied herbicides (Dual Gold at a rate of 1.4 l/ha (s-metholachlorine 960 g/l) - preemergent and Dicopur Top 1.0 l/ha (344 g/l acid 2.4 D + 120 g/l dicamba) + Titus 25DF, 50g/ha (25% rimsulfuron methyl) - postemergent).

Two mechanical hoeings were also carried out. N₁₂₀P₆₀K₆₀ kg s.a./ha fertilization was also performed, using the NPK 15:15:15 complex fertilizer and urea.

During the experiment we performed observations and measurements that included: the seedling emergence date, height growth rate, leaf formation rate, fruition rate, biomass accumulation rate, numer of grains per cob, TGW, HM. We also measured the weeding level depending on the soil tillage type.

The influence of tillage on the features of the reddish preluvosoil was emphasized by measurements performed after the soil tillage, before crop start and after harvest.

We measured bulk density (B.D.) of the soil by using the method of cylinders with a constant volume of 100 cm³; the results were interpreted after N. Stângă, 1978.

- very light < 0.94 g/cm³;
- light 0.95-1.07 g/cm³;
- unhardened 1.08-1.20 g/cm³;
- slightly hardened 1.21-1.34 g/cm³;
- moderately hardened 1.35-1.47 g/cm³;
- very hardened > 1.48 g/cm³.

Harvesting was performed between 15-20 September.

Climate conditions were a highly influential factor on crop production and soil features. We used the data recorded by the Găneasa Weather Station to determine the climate conditions.

From the climatic viewpoint, 2014 was characterized by annual average temperatures and rainfalls above the standards for the

respective area (Table 1). During the maize growth period (April-August), the average temperature was 19.9°C, i.e. 1.7°C over the standard, while the sum of rainfalls was 381.2 mm, i.e. 65.5 mm over the multiannual average values; however, the values were lower in July and August.

Table 1. Climatic conditions of Moara Domneasca, Ilfov County (2013-2014)

Nr. crt.	Month	Average temperature (°C)		Average monthly rainfalls (mm)	
		2013-2014	Normal	2013-2014	Normal
1	Oct.	14.0	11.0	81.7	35.8
2	Nov.	8.3	5.3	17.6	40.6
3	Dec.	-0.2	0.4	1.2	36.7
4	Jan.	-0.5	-3.0	33.2	30.0
5	Feb.	1.2	-0.9	7.6	32.1
6	Mar.	8.9	4.4	37.3	31.6
7	Apr.	13.4	11.2	116.0	48.1
8	May	19.3	16.5	88.0	67.7
9	Jun.	19.9	20.2	113.0	86.3
10	Jul.	22.8	22.1	38.0	63.1
11	Aug.	24.1	21.1	26.2	50.5
<i>Average/Sum Apr-Aug</i>		<i>19.9</i>	<i>18.2</i>	<i>381.2</i>	<i>315.7</i>
<i>Average/Sum</i>		<i>11.9</i>	<i>9.8</i>	<i>559.8</i>	<i>522.5</i>

RESULTS AND DISCUSSIONS

Influence of soil tillage on bulk density - B.D. (g/cm³)

Research carried out in the 2013-2014 agricultural year showed that B.D. varied in spring for 0-10 cm in depth, depending on the soil tillage type, between 0.95-1.10 g/cm³. The values were classified according to N. Stângă, 1978, as follows: light (variant plough 20 cm), unhardened (variant disk 10 cm) (Table 2). At 10-20 cm in depth, the values of B.D. varied between 1.11 g/cm³ in the plough 20 cm and disk/plough 20 cm variants, unhardened soil, and 1.46 g/cm³ (variant disk 10 cm), moderately hardened soil. For the 20-30 cm interval, the lowest value was recorded in the variant chisel 40 cm (1.35 g/cm³) and the highest in the variant disk 10 cm (1.50 g/cm³). Bulk density for 30-40 cm varied between 1.44 g/cm³ in the variant chisel 40 cm and 1.56 g/cm³ in disk 10 cm, very hardened soil. For 0-40 cm in depth, depending on soil tillage, B.D. varied between 1.23 g/cm³ (the variant plough 20 cm) and 1.40 g/cm³ (the variant disk 10 cm).

Table 2. Influence of basic tillage on bulk density of reddish preluvo soil (g/cm³) in maize crop, Moara Domnească-IIfov, March 2014

Variant	Depth (cm)				Average (g/cm ³) 0-40
	0-10	10-20	20-30	30-40	
Plough 20	0.95	1.11	1.38	1.48	1.23
Chisel 20	1.05	1.25	1.45	1.48	1.30
Chisel 40	1.08	1.27	1.35	1.44	1.28
Disk 10	1.10	1.46	1.50	1.56	1.40
D/A20	0.97	1.13	1.40	1.49	1.24
D/C40	1.10	1.28	1.38	1.45	1.30

Influence of soil tillage on grain production in maize crop

The results regarding the influence of basic tillage on the maize grain production are presented in Table 3.

In the hybrid Olt, the highest production resulted from the variant of traditional tillage after disk (disk/plough 20 cm), i.e. 2% (135.4 kg/ha) higher than the control, plough 20 cm.

In the same hybrid, the lowest production was recorded by the disk variant (5960.8 kg/ha), i.e. 1014 kg/ha lower than the control, which was significantly negative. The production resulted from the hybrid P0216 varied between 7595.3 kg (traditional tillage after disk (the variant disk/plough 20 cm), i.e. 2% higher than the control, and 6246.0 kg/ha (the variant disk 10 cm), i.e. 84% of the control production.

In the hybrid Sumbra, the highest production was recorded by the variant alternating traditional tillage and disk/plough 20 cm (6959.3 kg/ha). The lowest production was recorded by the variant disk 10 cm

(5703.2 kg/ha), which was significantly negative, compared with the control.

The application of the minimum tillage system resulted in productions closer to the control in the variants chisel 40 cm and disk/chisel 40 cm (7149.5-7245.8 kg/ha).

Influence of the hybrid on grain production in different tillage variants

The comparative analysis of the maize hybrids (Table 4) shows that, compared with the hybrid Olt (the control), the hybrid P0216 recorded very significantly positive productions in all tillage variants. Thus, we recorded 6% production increase (484.7 kg/ha) in the variants plough 20 cm and disk/plough 20 cm (484.4 kg/ha). The hybrid Sumbra recorded lower grain productions than the hybrids Olt and P0216, with statistically assured differences in the variants chisel 40 cm (-182.6 kg), disk 10 cm (-257.6 kg) and disk/plough 20 cm (-151.6 kg/ha).

Table 3. Influence of basic soil tillage on grain production in a maize hybrid assortment, Moara Domnească - Ilfov, 2014

Hybrids/ Variant	OLT			P0216			SUMBRA			Average		
	2014 Kg/ha	%	Dif. Kg/ha	2014 Kg/ha	%	Dif. Kg/ha	2014 Kg/ha	%	Dif. Kg/ha	2014 Kg/ha	%	Dif. Kg/ha
A20	6975.5	100	Mt	7460.2	100	Mt	6888.5	100	Mt	7108.0	100	Mt
C20	6593.9	94	-381.6	6869.2	92	-591.0	6544.6	95	-343.9	6669.2	93.6	-438.8
C40	6868.5	98	-107.0	7149.5	96	-310.7	6685.9	97	-202.6	6901.3	97	-206.7
Disk	5960.8	85	-1014.7	6246.0	84	-1214.2	5703.2	83	-1185.3	5970.0	84	-1138.0
D/A20	7110.9	102	135.4	7595.3	102	135.1	6959.3	101	70.8	7221.8	101.6	113.7
D/C40	6845.6	98	-129.9	7245.8	97	-214.4	6776.0	98	-112.5	6955.8	97.6	-152.2

DL_{5%} = 320.5kg/ha

DL_{1%} = 429.4 kg/ha

DL_{0.1%} = 566.8 kg/ha

Table 4. Influence of hybrid on grain production in different soil tillage variants, Moara Domnească - Ilfov, 2014

Hybrids/ Variant	OLT (Control)			P0216			SUMBRA		
	Production 2014 Kg/ha	%	Dif. Kg/ha	Production 2014 Kg/ha	%	Dif. Kg/ha	Production 2014 Kg/ha	%	Dif. Kg/ha
A20	6975.5	100	Ct	7460.2	106	484.7	6888.5	98	-87
C20	6593.9	100	Ct	6869.2	104	275.3	6544.6	99	-49.3
C40	6868.5	100	Ct	7149.5	104	281.0	6685.9	97	-182.6
Disk	5960.8	100	Ct	6246.0	104	285.2	5703.2	95	-257.6
D/A20	7110.9	100	Ct	7595.3	106	484.4	6959.3	98	-151.6
D/C40	6845.6	100	Ct	7245.8	105	400.2	6776.0	99	-69.6

DL_{5%} = 124.8 Kg/ha

DL_{1%} = 177.5 Kg/ha

DL_{0.1%} = 257.0 Kg/ha

Influence of soil tillage on some production indicators – TGW, HM

Tables 5 and 6 present the values of productivity elements (TGW, HM) in the three maize hybrids, under the conditions of traditional and minimum tillage. In the hybrid

Olt, the thousand grain weight varied between 269.5 g (the variant disk 10 cm) and 280.2 g (the variant disk/plough 20 cm). In P0216, the thousand grain weight varied between 272.6-280.8 g in disk 10 cm and plough 20 cm – control, respectively.

Table 5. Influence of basic tillage on thousand grain weight (TGW) in a maize hybrid assortment, Moara Domnească – Ilfov, 2014

Hybrids/ Variant	OLT			P0216			SUMBRA		
	TGW (gr)			TGW (gr)			TGW (gr)		
	2014	%	Dif. (gr)	2014	%	Dif. (gr)	2014	%	Dif. (gr)
A20	278.1	100	Mt	280.8	100	Mt	277.0	100	Mt
C20	273.9	98	-4.2	274.1	97	-6.7	271.3	98	-5.7
C40	276.3	99	-1.8	277.0	98	-3.8	275.1	99	-1.9
Disk	269.5	97	-8.6	272.6	97	-8.2	269.0	97	-8.0
D/A20	280.2	101	2.1	279.7	99	-1.1	278.4	101	1.4
D/C40	276.8	99	-1.3	277.5	98	-3.3	275.2	99	-1.8

Table 6. Influence of basic tillage on hectolitre mass (HM) in a maize hybrid assortment, Moara Domnească – Ilfov, 2014

Hybrids/ Variant	OLT			P0216			SUMBRA		
	HM (kg/100 l)			HM (kg/100 l)			HM (kg/100 l)		
	2014	%	Dif. (kg/100 l)	2014	%	Dif. (kg/100 l)	2014	%	Dif. (kg/100 l)
A20	72.0	100	Mt	72.8	100	Mt	71.8	100	Mt
C20	69.1	96	-2.9	69.2	95	-3.6	68.9	96	-2.9
C40	70.9	98	-1.1	71.6	98	-1.2	70.5	98	-1.3
Disk	69.0	96	-3.0	69.6	95	-3.2	69.0	96	-2.8
D/A20	72.8	101	0.8	73.0	100	0.2	72.2	100	0.4
D/C40	71.6	99	-0.4	71.8	98	-1.0	71.9	100	0.1

In the hybrid Sumbra, the thousand grain weight varied between 269.0 g (the variant disk 10 cm) and 278.4 g (the variant disk/plough 20 cm). Compared with the control (the variant plough 20 cm), the hybrids Olt and Sumbra recorded a positive increase of TGW in the variant disk/plough 20 cm.

Regarding the hectolitre mass of the three hybrids, the lowest values were recorded by the variant disk 10 cm (69.0 kg/100 l in the hybrid Olt) and chisel 20 cm in the hybrids P0216 (69.2 kg/100 l) and Sumbra (68.9 kg/100 l). The highest values were recorded in the variant disk/plough 20 cm (72.8 kg/100 l in the hybrid Olt, 73.0 kg/100 l in the hybrid P0216 and 72.2 kg/100 l in the hybrid Sumbra).

CONCLUSIONS

Bulk density before the crop start showed that the soil tillage system resulted in valued varying between 0.95 g/cm³ (0-10 cm in depth, variant plough 20 cm) and 1.49 g/cm³ (30-40 cm in depth, the variant alternating traditional tillage and disk/plough 20 cm) in the conventional system, and 1.05 g/cm³ (0-10 cm in depth, variant chisel 20 cm) and 1.56 g/cm³ (30-40 cm in depth, variant disk 10 cm) in the non-conventional system.

The highest grain productions of the three maize hybrids were recorded in the variant alternating traditional tillage and disking (disk/plough 20 cm), with 2% increase in production (the hybrid Olt – 135.4 kg/ha, the hybrid P0216 – 135.1 kg/ha) and 1% increase in production (the hybrid Sumbra – 70.8 kg/ha) compared with the control.

In 2014, the hybrid P0216 recorded the highest production in all soil tillage variants, i.e. 7595 kg/ha in the variant alternating traditional tillage and disking (disk/plough 20 cm).

Annual chiselling at 40 cm in depth or the alternative disking/chiselling at 40 cm in depth recorded almost similar results as in the case of traditional tillage, as the production of the three maize hybrids represented 96-98% of the control production.

Minimum tillage on reddish preluvosoil can be an alternative to the traditional system (ploughing).

ACKNOWLEDGMENTS

This paper was written under the frame of the Partnership in priority domains – PN II, developed with the support of MEN-UEFISCDI, Project No. PN-II-PT-PCCA-2013-4-0015 contract 175/2014: Expert System for Risk Monitoring in Agriculture and Adaptation of Conservative Agricultural Tehnologies to Climate Change.

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