The Influence of Tillage and Irrigation on the Maize Production

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ABSTRACT

The main objective of this project is to elaborate a non-conventional tillage system for various agro-pedoclimatic areas of Romania, characterized by the reduction of drought effects and production stability, the reduction of technological inputs and increase of economic efficiency, the efficient capitalization of limited water resources, soil preservation and environmental protection. By comparison with the traditional tillage system for maize, namely plowing, the experiment is statistically backed, with the significance very significantly negative. If we relate to the vibromix tillage, the productions are statistically backed and are very significant in the version cultivated in conditions of 100% irrigation and 50% irrigation. The research has been carried out at the Valul lui Traian Station for Agricultural Research and Development. The experiments were placed according to the method of subdivided plots, in three repetitions on the field, with tillage systems adapted to the local conditions and consisted of the following versions: the level of water supply (three graduations), deep loosening of the soil (two graduations), basic tillage (three graduations). Maize reacted very well to tillage. Taking into account the high cost of irrigation in Dobrudja, these results support the farmers by offering solutions for the need to reduce production costs without diminishing production.

The analysis of the yield obtained in maize as an effect of tillage shows that the chisel plow works are statistically very significant. Maize reacts well to vibromix tillage when the field is chisel plowed or not and/or irrigated-not irrigated, resulting in productions that are quantitatively close to those obtained by plowing, but with a capitalization rate higher than in this version.

The research results showed us that a chisel plow work done every three or four years and irrigation with only 50% of the AHI can result in productions close to the ones obtained by irrigation with 100% of the AHI.

Keywords: *irrigation, maize, production, tillage*

INTRODUCTION

The promotion of conservation agriculture system in versions adapted to the soil conditions with mid-heavy texture (30-42% clay in the arable horizon) and to the requirements of the main crops in the south of Romania which should provide competitive productions, both quantitatively and qualitatively, with reduced costs and high profit, taking into account soil improvement and

environmental protection (Cociu A. and Cismas G.D., 2011)..

The elaboration of a nonconventional soil tillage system adapted to various agro-pedoclimatic areas of Romania targets the following:

- the possibility to use soil loosening methods without overturning the furrow, by working with the chisel or paraplow, with superior

economic results, especially in cereals, and important beneficial effects on the evolution of soils;

- reduced soil tillage, including any system where modifications of the conventional technology are applied, with the purpose of reducing the degree of soil mobilization, the number of crossings over the field and of expenses;
- sowing on untilled field;
- to restore the soil content in organic matter by incorporating vegetal remains and by the cultivation by rotation of plants that restore soil fertility;
- preservation of soil water by protecting the soil with various types of mulch, preventing thus water loss by evaporation at ground level.

To obtain more information and recommendations regarding the stability of high production that is also economically efficient, in the major crops, in normal or critical natural conditions, based on the integrated and highly efficient use of natural resources and inputs, in compliance with the EU norms of soil conservation and environmental protection.

MATERIALS AND METHODS

The soil in the location perimeter of the experimental lot is vermic chernozem, formed on loess deposits, with medium texture, namely loamy to loamy-earthen, with a clay content between 28 and 32%, distributed homogenously in the soil profile. The soil is light and very light (the degree of subsidence being under 0%), emphasizing a high risk for degradation by excessive loosening on short-term and a high risk for secondary depth compaction on long-term. The soil permeability to water is high (the numeric values of the hydraulic conductivity being over 20-30 mm.h⁻¹). In the area, groundwater is usually deeper than 10 m. Consequently, the natural drainage is good and the risk of excess humidity (at the surface or at depth) is highly reduced.

The structural hydrostability of the soil is reduced, the content of water-stable structural macroaggregates is under 4-8%, emphasizing thus a high risk of soil degradation by destructuration, especially in the intensely irrigated areas, and particularly at the surface.

The soil supply with nutritive elements is moderate. Thus, in the first 10 and 20 cm, respectively, the humus content was between 3.59

and 3.02%; the content of mobile phosphorus was between 60 and 40 mg.kg⁻¹, total nitrogen was between 0.23 and 0.20%, and potassium was between 180 and 170 mg.kg⁻¹.

The soil reaction was poor to moderately alkaline, the pH (determined in water) being 8.00-8.02.

At the same time, the project has important positive economical effects resulted from the larger surfaced tilled at one crossing. By the basic work of the soil with the chisel, the average fuel consumption is reduced by 40-50% per ha, the work time is reduced by approx. 8-% per ha, and the expenses with spare parts, maintenance and amortization of technical equipment by approx. 20-40%.

The experiments were placed according to the method of subdivided plots, in three repetitions on the field, with tillage systems adapted to the local conditions, oriented towards the protection of the agrophysical state of the soil, towards water conservation and economical optimization of the agricultural management and consisted of the following versions:

A. The level of water supply

- A1 – full-time irrigation (1m) on 0-90 cm;
- A2 – half-time irrigation (1/2m) on 0-90 cm;
- A3 – not irrigated.

B. Deep loosening of the soil

- B1 – by chisel plow (work executed at the beginning of the experiments);
- B2 – no chisel plow work.

C. Basic tillage

- C1 – plowing with moldboard plow 20 – 22 cm;
- C2 – plowing with chisel plow 18-20 cm;
- C3 – tillage with disk plow 13 – 15 cm;

The plants cultivated every year by rotation were: maize, soy and wheat.

Fertilization and other specific works for plant protection during the vegetation period, and pest and disease control were applied uniformly for all versions.

In the irrigated plots, one to three waterings were applied uniformly, according to the plant requirements, but also to the technical and economical possibilities.

Observations were accomplished of the evolution of the vegetative phenophases.

The average yield per ha was determined and the productivity elements were analyzed.

Soil samples were collected in order to establish soil humidity.

Also, soil samples were collected in order to establish the effect of tillage on certain physical and chemical soil indicators.

RESULTS AND DISCUSSION

The purpose of tillage is to create the best conditions for the sowing and germination of seeds, as well as for the springing, growth and development of plants. By comparison with the traditional tillage system for maize, namely plowing, the experiment is statistically backed, with the significance very significantly negative. However, the productions are very high (Tab.1).

Maize reacted very well to tillage (Tab. 1). In the experimental versions, high productions on average were obtain for three years and they were between 8231 kg/ha in the irrigated 50%/no chisel plow/chisel work version and 12432 kg/ha in the irrigated/chisel plow/plowing version, the latter also representing the maximum production per experiment.

With 50% of the active humidity interval (AHI) we can obtain productions similar to the ones obtained in the version without chisel plow and irrigated with norms of 100% of the AHI (Tab.1).

If we relate to the vibromix tillage, the productions are statistically backed and are very significant in the version cultivated in conditions of 100% irrigation and 50% irrigation/plowing (Tab.2)

In the versions with irrigation 100% and chisel plow work, the productions were over 11000 kg/ha in all the three types of tillage, while in the plowed version, the production was 12432 kg/ha.

In the versions with irrigation 100%/no chisel plow work and irrigation 50%/chisel plow work, the productions were over 10000 kg/ha. This leads to the conclusion that with chisel plow work, done once every three or four years, and irrigation with only 50% of the AHI, we can obtain productions close to those accomplished by irrigation with 100% of the AHI. Taking into account the high cost of irrigation in Dobrudja, these results support the farmers by offering

Tab. 1. The maize production obtained as an effect of tillage and various water supply regimen, Valul lui Traian, 2008-2010

NR	VARIANTA			PRODUCTIA		DIFERENTA		SEMNF.	
	Irigat	Scarif./Nscr.	Lucr.sol	Kg/ha	%	KG/HA			
1	100%	Scarif.	A	12432	100	Mt.	3720	Mt.	***
2	100%	Scarif.	C	11093	89	-1339	2381	000	***
3	100%	Scarif.	VB	11625	93	-807	2913	000	***
4	100%	Nescarf.	A	11215	90	-1217	2503	000	***
5	100%	Nescarf.	C	10324	83	-2108	1612	000	***
6	100%	Nescarf.	VB	10725	86	-1707	2013	000	***
7	50%	Scarif.	A	10953	88	-1479	2241	000	***
8	50%	Scarif.	C	10246	82	-2186	1534	000	***
9	50%	Scarif.	VB	10875	87	-1557	2163	000	***
10	50%	Nescarf.	A	9073	72	-3359	361	000	
11	50%	Nescarf.	C	8231	66	-4201	-481	000	
12	50%	Nescarf.	VB	9654	77	-2778	942	000	
13	0%	Scarif.	A	10700	86	-1732	1988	000	***
14	0%	Scarif.	C	10233	82	-2199	1521	000	***
15	0%	Scarif.	VB	9741	78	-2691	1029	000	***
16	0%	Nescarf.	A	8712	70	-3720	Mt	000	
17	0%	Nescarf.	C	9462	76	-2970	750	000	
18	0%	Nescarf.	VB	9301	74	-3131	589	000	

DL 5% 980 kg/ha

solutions for the need to reduce production costs without diminishing production.

Tillage accomplished on a field with irrigation 50%/no chisel plow work provided large productions, somewhere between 8231 kg/ha in the chisel version and 9654 kg/ha in the vibromix version. It is important to observe the latter version, where the production was 581 kg higher than the plowed version.

In conditions of no irrigation and chisel plow work at the beginning of the experiment, the highest production was in the plowed version, namely 10700 kg/ha. In the maize sown after chisel plow and chisel work, the production was 10233 kg/ha, 467 kg/ha less than in the indicated version.

The analysis of the yield obtained in maize as an effect of tillage (Tab.3) shows that the chisel plow works are statistically very significant, with 11361 kg/ha in the plowed version, 10747 kg/ha

in the vibromix version, and 10524 kg/ha in the chisel version (Tab.3). It is interesting and worth remembering that when the chisel plow was not used, the highest production was in the vibromix version, 9893 kg/ha.

In regards to the maize reaction to tillage and irrigation, it can be observed in Tab. 4 that the production is between 11823 kg/ha (irrigated 100%/plowing) and 9238 kg/ha (irrigated 50%/chisel). We also observe a very good form for maize in the vibromix/irrigated 100% and irrigated 50% versions, the production being 11175 kg/ha and 10264 kg/ha, respectively, 467kg/ha and 1026 kg/ha more, compared to the chisel version.

CONCLUSION

The analysis of the results obtained leads to the following conclusions:

Maize reacts well to vibromix tillage when the field is chisel plowed or not and/or irrigated-

Tab. 2. Maize production under the influence of tillage and of various water supply levels, Valul lui Traian, 2008-2010

NR	Varianta		Productia		dif.	Semnificatia
	Irigat	Lucr.sol	Kg/ha	%	Kg/ha	
1	100%	A	11823	100	Mt	
2	100%	C	10708	90	-1115	000
3	100%	VB	11175	94	-648	000
4	50%	A	10013	100	Mt	
5	50%	C	9238	92	-775	000
6	50%	VB	10264	102	+251	***
7	0%	A	9706	100	Mt	
8	0%	C	9847	101	+141	***
9	0%	VB	9521	98	-185	000

DL 5% 51,81

Tab. 3. Maize production under the influence of tillage and chisel plow work permanence, Valul lui Traian, 2008-2010

Nr.	Varianta	Productia		Diferenta		Semnif.
	Scarif./Nscr.	Lucr.sol	Kg/ha	%	Kg/ha	
1	Scarif.	A	11361	117	1700	***
2	Scarif.	C	10524	108	863	***
3	Scarif.	VB	10747	111	1086	***
4	Nescarf.	A	9661	100	Mt	
5	Nescarf.	C	9339	96	-322	000
6	Nescarf.	VB	9893	102	232	***

DL 5% 5,64 DL 1% 7,67 DL 0,1% 10,27

not irrigated, resulting in productions that are quantitatively close to those obtained by plowing, but with a capitalization rate higher than in this version.

In conditions of water supply at 50% of the AHI and no irrigation, with or without chisel plow work, the profit is similar in all tillage versions, so we can recommend the other two tillage systems as alternative to plowing in order to protect the physical parameters of the soil.

The research results showed us that a chisel plow work done every three or four years and irrigation with only 50% of the AHI can result in productions close the ones obtained by irrigation with 100% of the AHI.

Given the high costs of irrigation in Dobrudja, these results support the farmers by offering solutions to the need to reduce production costs without diminishing the production.

It was remarked from the analysis of the results that if the chisel plow is not used, the highest yield was obtained in the vibromix version, namely 9893 kg/ha, 232 kg/ha more compared to the plowed version and 554 kg/ha more compared to the chisel version.

We must emphasize the fact that by tillage at water consumption reduced at half compared to the versions irrigated with 100% of the AHI (between 363.8 mm/ha/year and 366.8 mm/ha/year), after irrigation 50% and chisel plow work, the following productions were obtained: 10953 in the plowed version, 10875 kg/ha in the vibromix version and 10246 kg/ha in the chisel version, which recommends these versions before those with water supply at 100% of the AHI.

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