THE INFLUENCE OF CONSERVATION TILLAGE SYSTEMS ON PRODUCTIVITY ELEMENTS IN THE MAIZE CROP ON THE MOLDAVIAN PLAIN

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Abstract

The experiment was carried out between 2005 – 2008 at Ezareni – The Experimental Farm of the Agricultural University of Iasi, in the East side of Romania (47°07' N latitude, 27°30'E longitude), on a cambic chernozem (SRTS-2003), or haplic chernozems (WRB-SR, 1998), with a clay-loamy texture, 6.8 pH, 2.7% humus content and a medium level of fertilization. The experimental area has an annual average temperature of 9.4°C and precipitation of 587 mm. The experiment was a "split plot" design with three replicates. Plots covered an area of 60 m^2 with a rotation of soybean - winter wheat - maize. The maize mean yield values showed significant differences in plots plowed at 20 cm and very significant results in the disc harrow treatment when compared to the control treatment. These findings confirm that increasing tillage depth result in higher yields. In disc harrow plots, the mean yield over three years was 4532 kg/ha while the conventional tillage variant (plowed at 20 cm) yield recorded 5528 kg/ha. The highest yield of 6482 kg/ha was recorded in the control treatment (plowed at 30 cm). The conservation variants, chisel and paraplow, resulted in intermediate yields between disc harrow and the control treatment, the differences being statistically nonsignificant.

Key words: conservative tillage, maize, yield.

The world total of cultivated land is estimated to have increased by 466 % from 1700 to 1980: during this time, a net area of more then 12 x 106 km^2 of land was brought into cultivation (Mayer, W. and Turner, B.L., 1992).

Research on the yields obtained in different tillage systems are contradictory. While some have found that no-till and reduced tillage provide higher yield compared with the conventional tillage (Francis GS. et al., 1987, Hodgson DR., et al., 1989 Lal R.et al. , 1989, Aslam M.et al., 1999) others contradict the previous assertion (O'Sullivan MF. and Ball BC., 1982, Beyaert RP., 2002, Dam RF. et al., 2005).

Climate change is becoming one of the main factors directly or indirectly affecting the productivity of agricultural crops, the efficiency and stability of agriculture and related industries. Reality of climate changes requires a careful revision of traditional soil and plant management technologies. In addition, a new approach and propagation of sustainable soil management technologies implementation in practical farming becomes very important. Soil is a dynamic resource that supports plants. It has biological, chemical, and physical properties, some of which change in response to how the soil is managed. A wide range of different factors indicate a soil that functions effectively today and will continue to do that in the future. Creating soils with favorable characteristics can be accomplished by utilizing management practices that optimize the processes found in native soils (Feiza V. et al., 2008).

The major driving force behind agricultural expansion has been unprecedented population growth in the past several decades. According to the United Nations Department of Economic and Social Affairs, world population currently stands at 6 billion persons and is growing at a rate of 1.33 percent per year (U.N.D.E.S.A.). The best estimate of long-range population increase projects a stabilization of growth rate at replacement level around 2050 with a maximum population of 10 billion by 2150-2200.

If the medium population growth scenario is realized, the demand for major cereals will increase at a rate of about 1.2 percent per annum for wheat and rice and 1.5 percent for maize (FAO 1992, Rosegrant, M.W et. al., 1998). The projected demand for cereal production in the next 30 years stands at 43% for rice, 44% for wheat and 56% for maize above current production levels (Cassman, K.G., 1999).

The necessary increase in food production must be based on agricultural intensification of cropland already under cultivation. The new land that can be brought under cultivation exists either in ecologically sensitive ecoregions (e.g., tropical rainforest) or on agriculturally marginal soils (e.g., too steep, too shallow, too dry or too cold). Therefore, the strategy is to enhance soil productivity per unit area, time and energy-based input from existing croplands.

MATERIAL AND METHOD

The experiment was carried out between 2005 – 2008 at Ezareni – The Experimental Farm of the Agricultural University of Iasi, in the East side of Romania (47°07' N latitude, 27°30'E longitude), on a cambic chernozem (SRTS-2003, or haplic chernozems WRB-SR, 1998), with a clay-loamy texture, 6.8 pH, 2.7% humus content and a medium level of fertilization. The experimental area has an annual average temperature of 9.4°C and precipitations of 587 mm. The experiment was a "split plot" design with three replicates. Plots covered an area of 60 m^2 with a rotation of soybean - winter wheat – maize, with the current experiment in maize *(Zea Mays)*.

The experimental soil tillage systems were as follows: V_1 – disc harrow , V_2 – paraplow, V_3 – chisel plow + rotary harrow, V_4 – plough at 20 cm and V_5 – plough at 30 cm (control).

To determinate the Thousand Grain Weight (TGW) and Hectolitric Weight (HW) the technical standards SR 6123/1999 and SR 6123-2/1999 were used. The maize yield is expressed as average between the yield of the unfertilized plots and the plots fertilized with $N_{80}P_{80}$.

The ANOVA procedure was used to evaluate the significance for the split plot design in three replicates. Treatment means were separated by the least significance difference (LSD) test and all significant differences were reported at 5%, 1% and 0.1% levels.

RESULTS AND DISCUSSIONS

The purpose of this study was to evaluate the influence of conventional and minimum tillage systems on maize yield and productivity elements in the pedoclimatic conditions of the Moldavian Plain. One of the main objectives for the soil tillage system was to create an optimal physicochemical state of the soil and to preserve this state over the whole vegetation period.

Significant differences were observed in plots plowed at 20 cm and very significant in the disc harrow treatment compared to the control treatment during 2005-2008. These results support the fact that in maize, increasing tillage depth results in higher yields. In the disc harrow plots, the mean yield over three years was 4532 kg / ha while the conventional tillage variant (plowed at 20 cm), yielded 5528 kg/ha. The highest yield of 6482 kg / ha (15.5% corrected moisture) was recorded in the control treatment (plowed at 30 cm). The conservation variants, chisel and paraplow, yielded intermediate yields between the disc harrow and the control treatment, without statistical signification *(tab. 1)*. The yield of the chisel treatment represents 93% from the control, (plough at 30 cm).

Experiments on the determination of yield are difficult to compare because of differences in each experimental period (2005-2008), soil types and different climatic regime. Kapusta G. et al. (1996), after 20 years of experiments with maize grown under no-till, reduced tillage system and conventional, on silty clay soil in the southern state of Illinois – USA did not obtain significant differences between the three different tillage systems.

In a research in Quebec – Canada, Dam R.F. et al. (2005) obtained after 11 years minimum differences in maize yield between conventional system, reduced system tillage (only disc harrow) and no-till (7.4 t/ha in conventional, 7.3 t/ha in disc harrow variant, 7.2 t/ha in no-till).

As shown in *table 2*, on unfertilized maize (N_0P_0), the mean values of 1000 grain weight (TGW) ranged between 273 g for the disc harrow treatment (conservative tillage system) to a maximum of 298 g for the control (plowed at 30 cm).

It should be noted that for the $N_{80}P_{80}$ fertilized variants, the lowest mean value during 2005-2008 was recorded also in disc harrow (299.67 g) with the maximum occurring (342 g) in the control treatment. The conservation tillage treatment with chisel plow and fertilized recorded the closest values to the control treatment, 328 g only 4 % lower, the difference being statistically nonsignificant. Small significant differences, close to the control treatment, were recorded in the paraplow - fertilized plot.

Variants plowed at 20 cm and disc harrow showed very significant negative differences. All five unfertilized tillage treatments showed significant differences in comparison with the control treatment (plough at 30 cm on $N_{80}P_{80}$). Analyzing separately each year, it was easily observed that in 2006/2007 the values of TGW are the smallest from the entire period resultig from a drought.

Hectolitric weight furnishes information about the average density and the shape of the kernels.

The mean values for hectolitric weight (*table 3*) after three years of experiments varied between 63.3 and 68.3 kg in unfertilized variants, and 67.7 to 75.3 kg in fertilized variants.

Table 1

Mean values of tillage systems on maize yield (2005/2008)

Tillage system	Yield		Differences to the control variant (kg/ha)	Statistical significations
	kg/ha	Comparison with control variant (%)		
Disc harrow	4531.8	69.91	-1950.7	ooo
Paraplow	5817.7	89.74	-664.8	
Chisel + rotary harrow	6032.2	93.05	-450.3	
Plough 20 cm	5528.3	85.28	-954.2	o
Plough 30 cm	6482.5	100.00	0	control

LSD 5% = 829.3 kg LSD 1% = 1206.3 kg LSD 0.1% = 1809.4 kg

Table 2

The influence of "tillage systems x nutrient level" on Thousand Grain Weight (TGW) on maize (2005/2008)

Treatments	Year	2005/ 2006	2006/ 2007	2007/ 2008	Average		Statistical significations
					Kg/hl	%	
Disc harrow	$N_{80}P_{80}$	320	260	319	299.67	87.62	**ooo**
	N_0P_0	282	252	285	273.00	79.82	**ooo**
Paraplow	$N_{80}P_{80}$	343	283	349	325.00	95.03	**o**
	N_0P_0	292	266	293	283.67	82.94	**ooo**
Chisel + rotary harrow	$N_{80}P_{80}$	347	288	349	328.00	95.91	
	N_0P_0	297	266	297	286.67	83.82	**ooo**
Plough 20 cm	$N_{80}P_{80}$	329	274	330	311.00	90.94	**oo**
	N_0P_0	285	261	288	278.00	81.29	**ooo**
Plough 30 cm	**$N_{80}P_{80}$ (M)**	**354**	**314**	**358**	**342.00**	**100.00**	**control**
	N_0P_0	302	287	307	298.67	87.33	**ooo**

LSD 5% = 1.1 LSD 1% = 1.5 LSD 0.1 % = 2.1

Table 3

The influence of "tillage systems x nutrient level" on Hectolitric Weight (HW) on maize (2005/2008)

Treatments	Year	2005/ 2006	2006/ 2007	2007/ 2008	Average		Statistical significations
					Kg/hl	%	
Disc harrow	$N_{80}P_{80}$	69	64	70	67.7	89.82	**ooo**
	N_0P_0	64	61	65	63.3	84.07	**ooo**
Paraplow	$N_{80}P_{80}$	72	70	73	71.7	95.13	**ooo**
	N_0P_0	67	64	67	66.0	87.61	**ooo**
Chisel + rotary harrow	$N_{80}P_{80}$	74	70	75	73.0	96.90	**ooo**
	N_0P_0	67	64	68	66.3	88.05	**ooo**
Plough 20 cm	$N_{80}P_{80}$	72	69	72	71.0	94.25	**ooo**
	N_0P_0	65	63	66	64.7	85.84	**ooo**
Plough 30 cm	**$N_{80}P_{80}$ (M)**	**76**	**72**	**78**	**75.3**	**100.00**	**control**
	N_0P_0	69	66	70	68.3	90.71	**ooo**

LSD 5% = 1.1 LSD 1% = 1.5 LSD 0.1 % = 2.1

The analysis of this indicator shows that the control treatment (plowed at 30 cm + $N_{80}P_{80}$), is clearly superior to the other treatments.

CONCLUSIONS

Phosphorous and nitrogen applications in splits up to silking time significantly improved the vegetative and reproductive growth of maize, resulting in increase grain yield, the 1000 grain weight and hectolitric weight.

Tillage systems significantly affected the maize yield. In the conditions of Moldavian plain, the highest yield was recorded in the control treatment, plough at 30 cm and fertilized, followed by conservation tillage – chisel.

When we have to choose a proper tillage system, not only the immediate arguments should be considered like the highest yield, but also the long term view in order to ensure productivity and profitability and to be environmentally friendly and to conserve soil and water resources.

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