EROSION INFLUENCE ON YIELD AND WATER EFFICIENCY IN MAIZE CROP FROM NORTH WESTERN ROMANIA

Osvat Marius*

*University of Oradea, Faculty of Environmental Protection, Oradea, Romania

Abstract
The paper is based on research realized in leakage control plots located on a land with a slope of 10% at Agricultural Research and Development Station Oradea. It is worth mentioning that both 2012 and 2013 were years with fewer rainfalls than multiannual average of rainfall registered during the vegetation period of maize. In 2012, sowing maize from top to valley in comparison with sowing on level curves direction determined a decreasing of yield about 150 kg/ha. Also, in the variant cultivate from top to valley the yield difference registered at base and the top of the slope is higher than the yield registered at the variant sowing on the level curves direction (2460 kg/ha vs 1700 kg/ha). In 2013 yield loss due to seeding from top to valley was 195 kg / ha, and the difference between yield registered at the base and top of the slope was higher in the variant with maize sowing of top to valley compared to variant sown on the level curves direction (2410 kg / ha vs. 1950 kg / ha). Sowing maize on the level curves direction assuring better water use efficiency and obtaining a higher yield quantity at 1 m³ of water used.

Keywords: erosion, curve, yield, maize, water use efficiency

INTRODUCTION

In the North-Western part of Romania are summarized Satu Mare, Bihor and Salaj counties (Domuta C., 2005). There are important surfaces with slope soils that erosion occurs, with its serious consequences both for the present and especially for the future (Domuta C., 2006; Neamţu T., 1996, etc).

Research on erosion of slopes soils were mainly carried out at the Agricultural Research Development Station Oradea. The first researches were conducted at Cordau in 1972 by Colibas I; results obtained were completed by Gheorghe Ciobanu. În 1982-1984 Colibas I., Colibas Maria and Mihuţ I. have done researches at Hidiselul de Sus. In 1983 were made Pocola standard perimeter on 1500 ha and remember researchers conducted researches regarding to crop rotation and fertilization of terraced lands, soil losses and slopes hydrology. During 1986-1990 researches were coordinated by Domuta C., which in 1986 placed an experience with 17x2 variants of organic fertilizers (manure, green manure and straw), mineral and organo-mineral fertilizers. During 1990 - 1994 Domuta C., in Beiuş, elaborated a research field with crop rotation and fertilization and in the control plots with leakage the researches concerned at crop system. During 1999-2013 Domuta C. continued the researches from Beiuş in Oradea on a land with a

slope of 10%; the researches being funded through projects Relansin , CEEX and CNCSIS.

Nistor D. and Nistor Doina effectuated research regarding the agrotechincs of land with slope in standard perimeter Zalau, and Cordos I. coordinated the research carried out in standard perimeter Socond, SatuMare county.

MATERIAL AND METHOD

The research was conducted at the Agricultural Research and Development Station Oradea in the leakage control plots located on a land with a slope of 10%. In the leakage control plots were studied following variants:

V1 - black fallow
V2 - maize seeded from top to valley
V3 - maize seeded on the level curves direction
V4 - wheat
V5 – clover

The yield of the maize from the base and the top of the hill has been determined in four repetitions in each position, and the limit differences were determined through analysis of variance (Domuta C., 2006).

Water use efficiency (EVA) was determined using the following formula:

$$EVA = \frac{Yield}{\Sigma\,(e + t)};$$

in which:

EVA = water used efficiency, kg/m^3
$\Sigma\,(e + t)$ = plants water consumption; m^3/ha

Water consumption of the plants was determined by soil water balance method using the following formula:

$$Ri + P = \Sigma\,(e + t) + Rf;$$

in which:

Ri – initial water reserve, m^3/ha;(at maize sowing time)
P – rainfall during the maize vegetation period, m^3/ha;
$\Sigma\,(e + t)$ = plants water consumption; m^3/ha;
Rf – final water reserve, m^3/ha (at harvesting of maize);

The depth used for soil water balance was 0-150cm. Initial water reserve and final water reserve was calculated with formula:

Ri(Rf) = Ux BD x H

In which:

U = soil moisture, %

BD = bulk density, g/m^3

H = depth, cm

RESULTS AND DISCUSION

Influence of erosion and direction of sowing on the yield of maize

Research shows a bigger difference between the yields obtained at the top of the hill compared to the base of the hill under condition of maize cultivated from top to valley, compared to maize sown on the level curves direction, 2460 kg / ha (67%) compared to 1700 kg / ha (39%). In both variants of maize the differences between yields obtained on the base of the hill versus top of the hill were very significant statistically (table 1 and 2)

Table 1

Influence of the position on the hill on maize yield in the variant sown from top to valley and on the level curves direction in the conditions from Oradea, 2012

Sowing variant	Position on hill	Yield		Difference		Statistically signification
		kg/ha	%	kg/ha	%	
From top to valley	Top	3790	100	-	-	Mt
	Base	6250	167	2460	67	***
		$LSD_{5\%}$	**360**			
		$LSD_{1\%}$	**680**			
		$LSD_{0,1\%}$	**1240**			
On the level curves direction	Top	4320	100	-	-	Mt
	Base	6020	139	1700	30	***
		$LSD_{5\%}$	**310**			
		$LSD_{1\%}$	**590**			
		$LSD_{0,1\%}$	**950**			

Table 2

Influence of sowing direction on maize yield in the conditions from Oradea, 2012

Sowing variant	Yield		Difference		Statistically signification
	kg/ha	%	kg/ha	%	
On the level curves direction	5170	100	-	-	Mt
From top to valley	5020	97	-150	-3	-

$LSD_{5\%}$ **210**

$LSD_{1\%}$ **390**

$LSD_{0,1\%}$ **640**

In 2013 in maize sown from top to valley, the difference between the yields obtained at the base and top of the slope (2410 kg / ha) is higher than the difference obtained in the variant with maize sown on the level curves direction (1950 kg / ha) (table 3).

103

Table 3

Influence of the position on the hill on maize yield sown from top to valley and on the level curves direction in the conditions from Oradea, 2013

Sowing variant	Position on versant	Yield		Difference		Statistically signification
		kg/ha	%	kg/ha	%	
From top to valley	Top	4010	100	-	-	Mt
	Base	6420	160	2410	60	***
			LSD$_{5\%}$	**160**		
			LSD$_{1\%}$	**390**		
			LSD$_{0,1\%}$	**680**		
On the level curves direction	Top	4420	100	-	-	Mt
	Base	6370	144	1950	44	***
			LSD$_{5\%}$	**210**		
			LSD$_{1\%}$	**430**		
			LSD$_{0,1\%}$	**790**		

In average, the maize cultivated from top to valley registered a statistically significant loss of yield compared with maize sown on the level curves direction , its value is 195 kg / ha (table 4).

Table 4

Influence of sowing direction on maize yield in the conditions from Oradea, 2013

Sowing variant	Yield		Difference		Statistically signification
	kg/ha	%	kg/ha	%	
On the level curves direction	5395	100	-	-	Mt
From top to valley	5200	96	-195	-4	0

LSD $_{5\%}$ 170
LSD$_{1\%}$ 330
LSD$_{0,1\%}$ 610

Influence of erosion and direction of sowing on water use efficiency by maize crop

Table 5

Soil water balance (0-150 cm) in maize sown from top to valley and on level curves direction at the top and base of the hill, Oradea 2012

Position	Interval		Days number	Initial reserve	Rainfall	Total in soil	Final reserve	Total water consumption
	From	To						
Maize sown from top to valley								
Top	1.04.	20.09.	173	4620	2881	7501	3570	3931
Base	1.04.	20.09.	173	4870	2881	7751	3630	4121
Maize sown on the level curves direction								
Top	1.04.	20.09.	173	4730	2881	7611	3620	3991
Base	1.04.	20.09.	173	4860	2881	7741	3710	4031

In 2012, soil water reserve determined due to sowing maize had lower values at the top of the slope compared to the base of slope, both variants of sowing from hill to valley and variant with sowing on curves level direction.

Also at the top of the slope, the water reserve had a lower value in the variant from the top to the valley than variant with sowing on level curves direction. The values of maize water consumption at the base and the top of the hill were similar in both variants regarding on seed direction (table 5).

For 1 m^3 of water used in the top of the hill was obtained 0,964 kg maize gain in variant sown from the top to the valley and 1.517 kg in the variant sown on the level curves direction. Between water efficiency determined at the base and the top of the hill there is a big difference in variant sown from top to the valley, compared to variant sown on the level curves direction, 57% vs. 38% (table 6).

Table 6

Influence of the position on the hill on the water use efficiency (EVA) in maize crop sown from top to valley and on level curves direction, Oradea 2012

Position	EVA		Difference
	Kg/m³	%	%
Maize sown from top to valley			
Top	0,964	100	-
Base	1,517	157	57
Maize sown on the level curves direction			
Top	1,082	100	-
Base	1,493	138	38

In maize sowing on the curves level direction for 1 m^3 water used was obtained with 3% more production compared to variant sown from top to valley (1,288kg / m^3 to 1,255 kg / m^3) (table 7).

Table 7

Influence of seed direction on water use efficiency (EVA) in maize crop, Oradea 2012

Seed direction	EVA		Difference
	Kg/m³	%	%
From top to valley	1,255	100	-
On level curves direction	1,288	103	+3

In 2013, soil water reserve determined at maize sowing period had lower values at the top of the slope compared to the base of slope, both variants of sowing from top to valley and variant with sowing on level curves direction. Also at the top of the hill, the water reserve had a lower value in the variant from the top to the valley than variant with sowing on level curves direction. The values of maize water consumption at the base and the top of the hill were similar in both variants regarding on seed direction (table 8).

Table 8

Soil water balance (0-150 cm) in maize sown from top to valley and on level curves direction at the top and base of the hill, Oradea 2013

Position	Interval		Days number	Initial reserve	Rainfall	Total in soil	Final reserve	Total water consumption
	From	To						
Maize sown from top to valley								
Top	1.04.	15.09.	172	4510	2707	7217	3620	3597
Base	1.04.	15.09.	172	4820	2707	7527	3740	3787
Maize sown on the level curves direction								
Top	1.04.	15.09.	172	4670	2707	7377	3680	3697
Base	1.04.	15.09.	172	4730	2707	7437	3710	3727

For 1 m^3 of water used in the top of the hill was obtained 1, 12 kg maize gain in variant sown from the top to the valley. Between water efficiency determined at the base and the top of the hill there is a big difference in variant sown from top to the valley, compared to variant sown on the level curves direction, 53% to 42% (table 9).

Table 9

Influence of the position on the hill on the water use efficiency (EVA) in maize crop sown from top to valley and on level curves direction, Oradea 2013

Position	EVA		Difference
	Kg/m³	%	%
Maize sown from top to valley			
Top	1,12	100	-
Base	1,70	153	53
Maize sown on the level curves direction			
Top	1,20	100	-
Base	1,71	142	42

In maize sown on the curves level direction at 1 m^3 water used was obtained more mainly production compared to variant with maize sown from top to valley (table 10).

Table 10

Influence of seed direction on water use efficiency (EVA) in maize crop, Oradea 2013

Seed direction	EVA		Difference
	Kg/m³	%	%
From top to valley	1,41	100	-
On level curves direction	1,46	104	4

CONCLUSIONS

Maize is one of the crop that assure a bad protection against erosion. Seeding on the direction from top to valley intensify the erosion

phenomenon and the research in the leakage control plots located on a land with a slope of 10% at Agricultural Research and Development Station Oradea aimed the studying the influence of seed direction on maize yield and water efficiency.

It is worth mentioning that both 2012 and 2013 were years with fewer rainfalls than multiannual average of rainfall registered during the vegetation period of maize.

In 2012, sowing maize from hills to valley direction in comparison with sowing on the level curves determined a decreasing of yield about 150 kg/ha. Also, in the variant cultivate from top to valley the yield difference registered at base and the top of the hill is higher than the yield registered in the variant sowing on the level curves direction (2460 kg/ha vs 1700 kg/ha).

In 2013 yield loss due to seeding the direction top to the valley was 195 kg / ha, and the difference between yield registered at the base and top of the hill was higher in the variant with maize sowing from top to valley compared to variant sown on the level curves direction (2410 kg / ha vs. 1950 kg / ha).

Sowing maize on the direction of curves level assuring a better water use efficiency and obtaining a higher main yield quantity at 1 m^3 of water used.

The research highlights the necessity for maize cultivation on the level curves direction, thereby avoiding significant damage caused by erosion, and emphasizing the differences between yields obtained at the base of the hill versus top of the hill.

REFERENCES

1. Borza Ioana Maria, 2007 - Valorificarea apei de către cultura porumbului din Câmpia Crişurilor. Editura Universităţii Oradea, p.195-208
2. Borza Ioana, 2010 - Plants population influence on water use efficiency in maize from Crişurilor Plain, Research Journal of Agricultural Science Timisoara Vol. 42 (1) 1-688, ISSN: 2066-1843 p. 14-21
3. Botzan M., 1972 – Bilanţul apei în solurile irigate. Editura Agro-Silvică, Bucureşti
4. Brejea R., 2009, Tehnologii de protecţie sau refacere a solurilor. Editura Universităţii din Oradea
5. Brejea R., 2010 – Ştiinţa solului. Editura Universiţtii din Oradea

6. Brejea R., 2011 - Practicum de Pedologie. Editura Universitatii din Oradea

7. Brejea R., Domuţa C., Şandor M., Borza I., Domuţa Cr., 2012 - Researches regarding the soil and yield losses on the erosined soils from Bihor Analele Universităţii din Oradea. Fascicula: Protecţia Mediului Vol XIX ANUL 17 Editura Universităţii din Oradea

8. Domuţa C., Man T.E., Sabau N.C., Brejea R., 2002 - Research concerning the influence of water deficit in the soil on plant water consumption, yield and water use efficiency in main crops during 1976-2000, in The Crişurilor Plain conditions. – International Conference on Drought Mitigation and Prevention of Land Desertification, Bled, Slovenia, April 21-25

9. Domuţa C., 2005 - Irigarea culturilor, Editura Universităţii din Oradea, ISBN 973-613-778.

10. Domuţa C., 2006 - Agrotehnica diferenţiată, Editura Universităţii din Oradea, ISBN (10) 973-759-193-3, ISBN(13) 978-973-759-193-7

11. Domuţa C. (coord.), si colab., 2008 - Asolamentele in sistemele de agricultura Ed. Universitaţii din Oradea

12. Domuţa C., 2012 – Agrotehnica. Ed. Universităţii din Oradea

13. Domuţa Cr., 2011 - Subasigurarea cu apă a porumbului, soiei şi sfeclei de zahar din Câmpia Crişurilor. Editura Universităţii din Oradea

14. Grumeza N. şi colab., 1989- Prognoza şi programarea aplicării udărilor în sistemele de irigaţii. Editura Ceres, Bucureşti.

15. Grumeza N., Kleps Cr., 2005 – Amenajările de irigaţii din România. Editura Ceres Bucureşti.

16. Jude E., 2012 – Ecologie generala. Editura Universităţii din Oradea, ISBN – 978-606-10-899-5

17. Kleps Cr., 2000 - Transferul tehnologic al rezultatelor din domeniul îmbunătăţirilor funciare. Bul. AGIR nr. 3.

18. Man T. E. şi colab., 2007 – Hidroamelioraţii. Editura Aprilia Print, Timişoara.

19. Mureşan A. şi colab., 1992 – Irigaţii, desecări şi combaterea eroziunii solului. Editura didactică şi pedagogică Bucureşti.

20. Neamţu T., 1996 – Ecologie, eroziune şi agrotehnică antierozională. Ed. Ceres Bucureşti

21. Şandor Maria, 2007 – Combaterea excesului de umiditate în Câmpia Crişurilor. Editura Universităţii din Oradea.