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UTILIZATION OF EROSION CONTROL TECHNOLOGIES FOR CONSERVATION OF AGRICULTURAL LAND ON SLOPES FROM WATER EROSION AND DROUGHT

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ABSTRACT:
The present development proves that utilization of erosion control technologies which incorporate the soil conservation methods of breaking with dead-furrowing and furrowing with breaking and dead-furrowing at growing corn on slopes results in decreasing the surface run-off at heavy rainfall transforming it into in-soil run-off which increases the soil water supply and is conducive to reducing the drought in the agricultural land on slopes.
KEY WORDS:
soil erosion, erosion control, water erosion, drought.

1. INTRODUCTION

Agricultural land deterioration resulting from drought and soil erosion is reality in our country and has been determined by our scientific community [2; 6].

The recurrent and prolonged drought which is being observed in Bulgaria according to Alexandrov B. (2002), Slavov N. (2002) and Slavov N et al (2002) results in enduring decrease in the productive moisture supply within the layer of the agricultural crop root below the optimum rates and decrease in the soil fertility. On the other hand, a denudation process such as water erosion intensifies and results in great soil loss as a consequence of the irrational activities of the man. These two processes which are not visibly inter-related have too much in common and it is mainly that the rainfall transformed into surface water run-off is irreparably lost which increases the water deficit in the soil. This results in decrease in the soil fertility in arid areas as is the case with our country.

So far the research and the utilized techniques for water erosion control have been focused mainly on diminishing the soil loss and bringing under control the water surface run-off rather than on its rational utilization.

The present research aims at specifying to what extent the effect of the transformation of the surface water run-off into in-soil one through some erosion control techniques is conducive to improving the soil water supply.

2. MATERIALS AND METHODS

The research was carried out within the period of 2003 -2006 in the experimental field at the Experimental Station on Erosion Control, Ruse in the neighbourhood of Indiyska Coliba, in the area of the village of Trastenik, the district of Rousse, non-irrigated field with calcareous chernozem of medium erosion and average gradient of 5° (8.7%).

Two following field tests, carried out in the block method, in two versions, with four repetitions were set and completed for the purpose of this research:
a_1 – corn, grown with traditional tillage applied in the direction of the slope;
a_2 – corn, grown with erosion control tillage applied transversely to the slope.

Different tillage and growing techniques were carried out on the observed agricultural crop within the test period for the two versions. With a_1 version they included all conventional technological operations known for growing corn, in the direction of the slope. With a_2 version the conventional tillage applied transversely to the slope was accompanied by the erosion control methods of breaking and dead-furrowing (carried out at primary tillage simultaneously to sowing the crop and the first hoeing) and furrowing with breaking and dead-furrowing (carried out simultaneously to the technological operation of earthing-up).

Field management and erosion tests were carried out in accordance with the established methods during the test period. The field management tests comprised soil tests and biometrical observations while the erosion tests were performed via the stationery method. The amount of surface water run-off and washed out soil after each rainfall were determined during the test period via draining sites created for each version.

3. RESULTS AND DISCUSSIONS

The results for the soil moisture, the soil moisture balance and the amount of the surface water run-off for the two versions which were obtained from the soil tests during the test period are to be reviewed with regard to the set purpose of determining to what extent the diminishing amount of surface water run-off resulting from the applied soil conservation technique is rationally utilized for improving the soil moisture supply.

Data in Table 1 shows that soil moisture within the 0-150 cm layer, for the three-year test and within the three research periods (before sowing, at maximum growth of the crops and after harvest) is higher for a_2 version, for which erosion control technique incorporating the soil conservation methods of breaking with dead-furrowing (at different stages of the agricultural production process) and furrowing with breaking and dead-furrowing (simultaneously with the technological operation of earthing-up) were applied.

A soil moisture balance has been performed with regard to determining the amount of the real evapotranspiration. Water balance of soil characterizes the moisture gain and drain in it. Data in Table 2 is obtained after calculations and it shows that the actual annual evapotranspiration of the version grown with erosion control technique is higher than that of the version grown with conventional technique applied in the direction of the slope.

The amount of surface water run-off after each heavy rainfall was calculated during the test period via draining sites created for each version. The obtained results, shown in Table 3 indicate that the values of the surface water run-off are from 3.0 to 6.5 times lower with a_2 version compared to those from a_1 version grown with conventional tillage technique in direction of the slope.

Table 1. Soil moisture content in % within the 0-150 cm layer at a test with corn, 2004 – 2006

Period	2004		2005		2006	
	Versions		Versions		Versions	
	a_1	a_2	a_1	a_2	a_1	a_2
Before sowing	17,55	20,87	19,01	19,01	21,67	22,98
At maximum growth	14,94	16,23	14,36	16,25	13,32	15,63
After harvest	12,39	14,30	17,42	19,17	10,61	11,92

Table 2. Soil moisture balance at a test with corn of h=150 mm, 2004 – 2006

Indices	2004		2005		2006	
	Versions		Versions		Versions	
	a_1	a_2	a_1	a_2	a_1	a_2
Initial soil water supply W_o (mm)	329,06	381,92	376,40	377,19	412,81	423,98
Final soil water supply W_{kp} (mm)	241,61	257,40	363,21	379,57	227,58	221,71
Difference between the amount of the total rainfall and the total surface water run-off and the water in the hard run-off $N - \sum Q$ (mm)	82,10	133,30	263,80	368,00	113,90	140,10
Evapotranspiration E_{tp} (mm)	169,55	257,82	276,99	365,62	299,13	342,37

Table 3. Total amount surface water run-off at a test with corn, 2004–2006

Date	Rainfall, mm	Surface water run-off – m^3/ha		Erosion control effect, times
		Version		
		a_1	a_2	
19.06.2004	14,0	121,6	37,7	3,2
22.06.2004	12,0	110,1	37,0	3,0
23.07.2004	8,0	73,8	16,7	4,4
Total annual	34,0	305,5	91,4	3,3
Average annual	11,3	101,8	30,5	3,3
07.06.2005	20,0	184,6	45,9	4,0
04.07.2005.	66,0	201,2	54,9	3,7
11.07.2005	27,0	195,4	46,5	4,2
13.08.2005	13,0	96,3	16,3	5,9
01.09.2005	17,0	69,5	-	-
25.09.2005	38,4	91,1	14,0	6,5
Total annual	181,4	838,1	177,6	4,7
Average annual	30,2	139,7	29,6	4,7
01.07.2006	20,0	105,4	27,2	3,9
06.08.2006	19,0	98,5	24,6	4,0
Total annual	39,0	203,9	51,8	3,9
Average annual	19,5	101,9	25,9	3,9

All of the above results indicate that applying erosion control techniques at growing corn on slopes has a favorable effect on the significant decrease of the surface water run-off turning it into in-soil one and thus utilizing it for the needs of the agricultural crops.

This technology together with the erosion control methods incorporated in it increases the soil water permeability, thus creating conditions for intensive absorption of the surface water from heavy rainfall and for increase in the soil water supply (over 650 m^3/ha) during the vegetation period of the crops. The above confirms the statement of Hristov A. (1982), expressed at the end of the previous century, that the erosion control methods and techniques are reliable means for water erosion control in the modern agriculture as well as for soil water conservation, for better utilization of the vegetation rainfall and for diminishing the harmful effect of drought and drying up on the agricultural land on slopes in Bulgaria [6].

4. CONCLUSION

1. Utilization of the erosion control technology incorporating the soil conservation methods of breaking with dead-furrowing and furrowing with breaking and dead-furrowing at growing corn on slopes results in decreasing the surface water run-off 3.0

to 6.5 times, transforming it into in-soil run-off which increases the soil water supply with up to above 650 m^3/ha during the vegetation period of the plants.
2. Making use of the surface water run-off at applying erosion control techniques contributes to diminishing drought in the agricultural land on slopes in Bulgaria.

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