

ORIGINAL ARTICLE

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## WATER REQUIREMENTS OF THE MAIN FIELD CROPS IN TRANSYLVANIA (1964 – 2002)

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### ABSTRACT

This study represents a synthesis of the results of 39 years of researches (1964-2002) regarding the water requirements of the principal field crops.

**Key words:** water requirements, wheat, maize, potato, soybean, sugar beet

### REZUMAT

Acest studiu reprezintă o sinteză a rezultatelor din 39 de ani de cercetări (1964-2002) referitoare la regimul de irigare al principalelor culturi de câmp.

**Cuvinte cheie:** grâu, porumb, cartofi, sfeclă de zahăr

### **DETAILED ABSTRACT**

The researches of 39 years (1964-2002) were carried out on the experimental field of Irrigated Cultures of the temperate continental climate of Transylvania. The results of water requirements of some field crops (maize, sugar beet, potato, wheat, soybean, alfalfa, fooder maize, pumpkin) were determined with four methods: the method of water balance from the soil; the Thornthwaite method; the method of the BAC evaporimeter class A; the method of Piche evaporimeter. The water requirements determinate by indirect methods had similar values with those determinate by the method of the water balance of the soil, and this confirms that these methods also can be used in the forecast and in the warning of the watering, with the application of the correction coefficients calculated by the research team on the basis of data obtained in this study.

## INTRODUCTION

The arrangement and the exploitation of the irrigation systems of the crops requires the cognition of the plants' water requirements, the observing of the climatic conditions and the establishment of the water balance from the soil.

The consequence of the temperate-continental climate of Transylvania, characterized by 8-10<sup>0</sup> C the mean annual temperatures and 550-650 mm annual precipitation, having 3-4 drought periods, lasting for 20-25 days, is a deficiency in the hydrological balance. In this situation, the achievement of great and constant harvests becomes impossible without the utilization of irrigation.

The water necessity for irrigation is based upon the knowledge of the plant water requirements, which is obtained from data gathered on strings of 25-30 years of observations and determinations (Botzan M., 1972; Grumeza N., O. Mercuriev, C. Kleps, 1989).

This study represents a synthesis of the results of the research made over 39 years (1964-2002) regarding the water requirements of some field crops in Transylvania's conditions.

## MATERIAL AND METHODS

The researches were carried out on the experimental field of Irrigated Cultures on an alluvial-colluvial carbonated soil having a moderate alkaline pH and within the Meteorological Station from the University of Agricultural Sciences and Veterinary Medicine, Cluj-Napoca.

The water requirement has been determined on the ground of water balance from the soil, by bimonthly determinations of the moisture; following useful rains and irrigation, at the soil drying.

The region in which the researches regarding the water requirements at wheat, maize, soybean, potato, sugar beet, alfalfa, pumpkin and at successive cultures took place is characterized by an average multiannual regime of precipitation of 590 mm, and over the 39 years of experimentation of 565 mm.

In order to determine the water requirements, four methods were used:

1. The method of water balance from the soil;
2. The Thornthwaithe method (based on the value of the air temperature);
3. The method of the BAC evaporimeter class A;
4. The method of Piche evaporimeter.

## RESULTS AND DISCUSSIONS

On the ground of the data recorded after the method of the water balance from the soil, for 39 years, the daily, the monthly and the total water requirements have been calculated and also have been calculated the sources of superposition of the water (table 1 and 2). Also, the water requirements of the field cultures has been calculated with the three indirect methods as well as the coefficient of correction of the potential evapotranspiration for every method and culture in part, in relation to the method of the water balance from the soil (table 3 and 4).

The highest water requirements, on an average in the 39 years, has been recorded at the soybean (5624 m<sup>3</sup> water/ha) and at the alfalfa (5562 m<sup>3</sup> water/ha) followed by the sugar beet (5534 m<sup>3</sup> water/ha) and pumpkin (5270 m<sup>3</sup> water/ha), then the maize (5231 m<sup>3</sup> water/ha), potato (5230 m<sup>3</sup> water/ha) and autumnal wheat (4435 m<sup>3</sup> water/ha).

The successive cultures have recorded a total requirements of 2916 m<sup>3</sup> water/ha. The maximum water requirements have been achieved at all cultures in the month of June, July and August, having average values of 34-48 m<sup>3</sup>/ha/day. The sources of superposition of the water requirements in the region of Transylvania, on an average, are the following: precipitation: 70 %; irrigation: 20,7 % and the water reserve stored in the soil at the beginning of the vegetation period: 9,3 %. The water requirements determined by the indirect methods had similar values with those determined by the method of the water balance of the soil, and this confirms that these methods also can be used in the forecast and the warning of the watering. In order to generalize these methods it is necessary to adapt the obtained data with the help of the correction coefficients calculated by the research team on the basis of data obtained in the 39 years of observations and determinations.

Table 1. Water requirements – optimum ETP – in the main irrigated crops determined by water balance in the soil, Cluj-Napoca –Mean, 1964 – 2002

Crops	Months						Total m <sup>3</sup> /ha
	IV	V	VI	VII	VIII	IX	
Monthly requirements m <sup>3</sup> /ha/day							
Maize	14	26	34	39	36	22	-
Sugar beet	18	26	36	43	35	23	-
Potato	16	25	39	42	33	16	-
Wheat	23	37	37	33	15	-	-
Soybean	16	27	37	42	35	27	-
Alfalfa	21	27	37	48	27	22	-
Fodder maize	-	-	-	33	33	29	-
Pumpkin	-	32	39	41	37	23	-
Total monthly requirements m <sup>3</sup> /ha							
Maize	420	806	1020	1209	1116	660	5231
Sugar beet	540	806	1080	1333	1085	690	5534
Potato	480	775	1170	1302	1023	480	5230
Wheat	690	1147	1110	1023	465	-	4435
Soybean	480	837	1110	1302	1085	810	5624
Alfalfa	630	837	1110	1488	837	660	5562
Fodder maize	-	-	-	1023	1023	870	2916
Pumpkin	-	992	1170	1271	1147	690	5270

Table 2. Sources for covering water requirements (%), Mean 1964-2002

Crops	From the soil supply	From the rainfall	From irrigations
Maize	6,3	71,8	21,9
Sugar beet	12,5	67,7	19,8
Potato	17,6	65,9	16,5
Wheat	10,2	70,5	19,3
Soybean	9,7	77,2	13,1
Alfalfa	7,1	77,2	15,7
Fodder maize	-	64,5	35,5
Pumpkin	11,7	65,9	24,4
Mean	9,3	70,0	20,7

Table 3. Comparative data on water requirements (m<sup>3</sup> /ha) determined by indirect methods, Mean 1964-2002

Methods of determination	Months					
	IV	V	VI	VII	VIII	IX
Thornthwaite	15	26	37	39	32	23
Evaporimeter BAC clasa A	24	34	38	36	36	24
Evaporimeter Piche	32	35	35	37	36	29

Table 4. Correction coefficients of ETP calculated by indirect methods

Crops	Correction coefficients par months					
	IV	V	VI	VII	VIII	IX
Thornthwaite Method						
Maize	0,9	1,0	0,9	1,0	1,1	0,9
Sugar beet	1,2	1,0	1,0	1,1	1,1	1,0
Potato	1,0	1,0	1,1	1,0	1,0	0,7
Wheat	1,5	1,3	1,0	0,8	0,5	-
Soybean	1,0	1,0	1,0	1,0	1,1	1,2
Alfalfa	1,4	1,0	1,0	1,2	0,8	1,0
Fodder maize	-	-	-	0,8	1,0	1,2
Pumpkin	-	1,2	1,0	1,0	1,1	1,0
Evaporimeter BAC clasa A Method						
Maize	0,6	0,8	0,9	1,1	1,0	0,9
Sugar beet	0,8	0,8	0,9	1,2	1,0	1,0
Potato	0,7	0,7	1,0	1,2	0,9	0,7
Wheat	1,0	1,1	1,0	0,9	0,4	-
Soybean	0,7	0,8	1,0	1,2	1,0	1,1
Fodder maize	-	-	-	0,9	0,9	1,2
Pumpkin	-	0,9	1,0	1,1	1,0	1,0
Evaporimeter Piche Method						
Maize	0,4	0,7	1,0	1,0	1,0	0,8
Sugar beet	0,6	0,7	1,0	0,9	1,0	0,8
Potato	0,5	0,7	1,1	1,1	0,9	0,6
Wheat	0,7	1,0	1,0	0,9	0,5	-
Soybean	0,5	0,8	1,0	1,3	1,0	0,9
Alfalfa	0,7	0,8	1,0	1,3	0,8	0,8
Fodder maize	-	-	-	0,9	0,9	1,0
Pumpkin	-	0,9	1,1	1,1	1,0	0,8

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