RESEARCHES REGARDING THE USE OF THE PAN EVAPORATION METHOD IN IRRIGATION SCHEDULING OF SUNFLOWER FROM CRISURILOR PLAIN

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Abstract

The paper is based on the research results obtained during 1976 – 2010, in Oradea, in a long term trial. The method uses the daily soil water balance on watering depth (0-75 cm) and monthly crop coefficients, „Kc". Crop coefficients were determined as reports between the optimum water consumption (on 0-150 cm) and pan evaporation. For realizing the optimum water consumption, soil moisture was determined ten to ten days. Irrigation, was applied when the soil water reserve on 0-75 cm depth, decreased bellow easily available water content. The crop coefficient „Kc" have the specifical values for every month: 0,9 in Aprilie, 1,08 in May, 1,40 in June, 1,28 in July and 0,9 in August.

There are the differences of - 4.5 % and 7.8 % between the soil water reserve determined by direct method (soil samples) and the soil water reserve calculated by soil water balance method using the pan evaporation values and the crop coefficient "K_c". These small diferences recomand the irrigation scheduling in sunflower based on pan evaporation use and on soil water balance.

Key words: pan evaporation, crop coefficient, irrigation scheduling, sunfloewer

INTRODUCTION

Correct establishing of the irrigation moment use is very important for plants growth, and finally for yield quantity and quality (Botzan, 1966, Apetroaiei, 1977, Grumeza et all,1989, Domuţa, 2003, 2005, 2009, Domuţa. et all, 2004). In the same time, a correct irrigation scheduling prevents the negative ecological consequences (Domuta, 1995, 2005). The irrigation scheduling methods the most use on the world are based on the link between plants water consumption and reference evapotranspiration (ET_0) (Smith, 1992). Reference evapotranspiration can be calculated by very large diversity of method based on the one on more climate elements or can be measured by evaporimeters or by lysimeter. Doorembos and Pruitt, 1992, studied 4 from the most known and use method for reference evapotranspiration establishing and placed the pan evaporation method on the second position with the differences in comparison with optimum water consumption of the plants ± 15%; Penman modified was situated on the first position with differences of ± 10%, ration method and Blaney Criddle methods had differences of ± 20% and ± 25%.

MATERIAL AND METHOD

Researches was carried out in Agricultural Research and Development Station Oradea, during 1976-2010 in a long term trial.

The climate area is moderate wet one, multiannual average temperature (1931-2010) is of 10.2^{o}C and multiannual rainfall are of 615.5 mm; the average on the warm period (April- September) for air temperature is of 17.2^{o}C and for rainfall is of 368.9 mm.

Research field is placed on preluvosoil with law acid reaction, median content of the nitrogen, phosphorus and potassium. Soil profile includes B_t horizon with colloid clay of 41,2%; Bulk density is median –big, (1.44 g/cm^3-1.64 g/cm^3); wilting point (WP) and field capacity (FC) have the median values. Easily available water content (Wea) was established using the formula: Wea = WP + 2/3 (FC-WP) (Brejea, 2010):

Soil moisture was determined by gravimetric method till 1985 and by gravimetric method on 0-50 cm and by neuthron method (apparatus made in Romania) on 50-150 cm after that. This scheme of neutron method use insures the precision demanded by the large area of impact for these research data (Domuta C., 2003, 2005, 2009).

Sunflower water consumption (∑(e+t) was established by soil water balance method using the formula: Ri + P+ ∑ m = Rf + ∑(e+t); Wich: Ri = initial soil water reserve; P = rainafall; ∑m = irrigation rate; Rf = final soil water reserve (Brejea R., 2009)

Depth balance used was 0-150 cm. Ten to ten days the soil moisture was determined and soil water reserve was maintained between easily available water content and field capacity on 0-75 cm depth. Annual irrigation rate use was 218.0 mm/ha, variation interval 30.0 mm/ha - 402.0 mm/ha.

Research field has on irrigation equipment which permitted an exactly measure and uniforme distribution of the irrigation water. The quality of the irrigation water was very good.

Sunflower was studied together with other significant crops for this area: wheat, maize, sugarbeet, potato, soybean, bean alfalfa, for silo. Large structure of the crops from research field assured a very good crops rotation. Foreruner plant for sunflower was wheat and all the crop technology was optimum one.

8'o clock pan evaporation was determined every day in 3 evaporimeter placed in the station for irrigation scheduling near the research field for water consumption determination.

Crop coefficient "K_C" was determined dividing the monthly water consumption of the irrigated sunflower to average of the pan evaporation.

RESULTS AND DISCUSSION

Sunflower daily water consumption

Daily water consumption values in unirrigated conditions are smaller than in irrigated conditions. Irrigation determined the increase of the water consumption values with 30% in May and June, 55% in July and 98% in August.

The maximum value of the daily water consumption was registered in July in irrigated conditions and in June in unirrigated conditions (table 1).

Table 1

Daily water consumption in unirrigated and irrigated sunflower, Oradea, western Romania, 1976 – 2010

Specification	April		May		June		July		August	
	mm/ ha	%	mm/ ha	%	mm/ ha	%	mm/ ha	%	mm/ ha	%
Unirrigated										
Average	1.85	100	2.72	100	4.09	100	3.85	100	1.94	100
Variation interval	0.5-2.4	-	1.4-4.3	-	1.9-6.5	-	0.6-5.0	-	0.3-3.6	-
Irrigated										
Average	1.92	105	3.82	130	5.31	130	5.97	155	3.85	198
Variation Interval	1.0-3.5	-	1.9-4.5	-	3.6-6.8	-	3.2-7.9	-	2.9-5.9	-
Diff. irrig.-unirrig.	1.3	5	1.1	30	1.22	30	2.12	55	1.91	98

The values of the pan evaporation increased to July when the maximum value 4.66 mm/day was registered. The biggest value of the variation interval, 10,0 mm/day, was registered in August and the smallest 1.1 mm/day, was registered in April (table 2).

Table 2

Daily pan evaporation (mm), Oradea, Western Romania 1976 –2010

Specification	**IV**	**V**	**VI**	**VII**	**VIII**
Average	2.13	3.53	3.79	4.66	4.24
Variation interval	1.1-5.7	1.6-9.2	1.2-9.2	2.0-9.8	1.8-10.0

Correlation daily pan evaporation – daily sunflower water consumption

Correlation between daily evaporation and daily water consumption of the unirrigated varriant has the next expression: $y = 1.2484e^{0.2139x}$. (Fig.1) In irrigated sunflower the expression of the correlation is: $y = 0.8444e^{0.4165x}$. (Fig. 2)

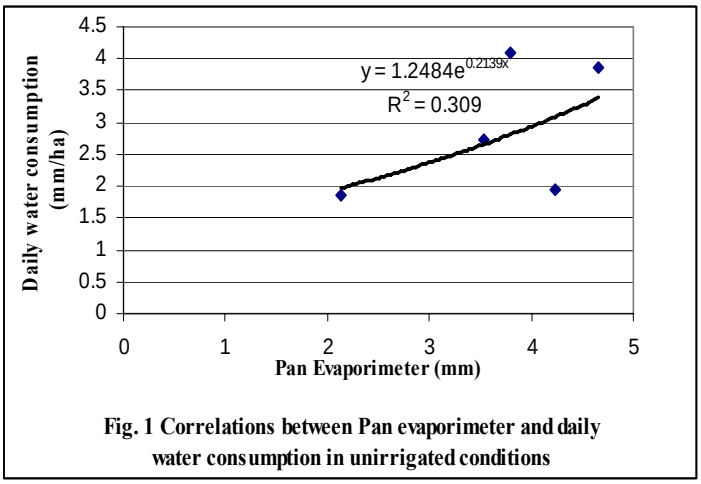

Fig. 1 Correlations between Pan evaporimeter and daily water consumption in unirrigated conditions

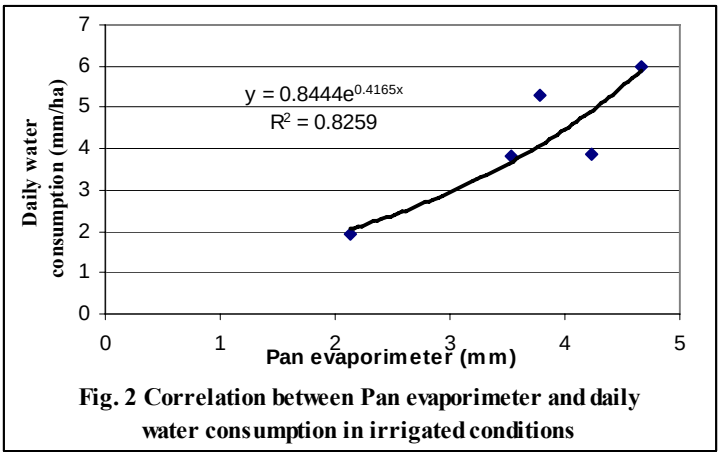

Fig. 2 Correlation between Pan evaporimeter and daily water consumption in irrigated conditions

Crop coefficient "K_c" in sunflower

Crop coefficients will be used in the transformation of the daily pan evaporation in the sunflower water consumption.

The maximum value of the K_c is for June 1,40, July has a value of 1,28, May 1,08 and April and August have of 0,90 (table 3).

Table 3

Crop coefficient "K_c" in sunflower , Western Romania, 1976 -2010

April	May	June	July	August
0.90	1.08	1.40	1.28	0.90

Irrigation scheduling based on pan evaporation.

The method is based on the soil water balance on watering depth. A fixed watering depth is used in Romania. The notes book of balance for every month of the crop vegetation period is used; an example is presented in the table 4.

Table 4

Note book of balance

Month ……..Crop……., Plot……; Field capacity… mm/ha; Wilting point..Easily available water content ….mm/ha

Day	Water reserve	Rainfall	Watering	Total water into the soil	Pan evaporation	Kc	Daily water consumption	Watering datum
1								
2								
.								
31								

In sowing sunflower day the soil samples are prelevated on the watering depth (0-75 cm) and soil moisture is determined; the value of the soil water reserve for 0-75 cm depth is calculated and in the note book for this month balance is written. If the rainfall was registered in the first day of the balance their value will introduce in the note book. If the soil water reserve has the value below easily available water content the irrigation rate is need and their value will be written in the note book, too and total water into the soil will be calculated. Pan evaporation registered in this day will be multiplied with k_c of the month and the results is the sunflower water consumption; deducting this value from total water into the soil, the value of the soil water reserve for the end of the sunflower sowing day was obtained. The balance continues for all the days of the sunflower irrigation season using the irrigation when the soil water reserve will decrease to the level of the easily available water content.

The soil water reserve values determined using the pan evaporation are very close to the values determined by the soil samples in the 11 determination moments, the differences were between – 4.5% and 7.8% (table 5.)

Table 5

Differences between soil water reserve (mm/ha) determined by pan evaporation and direct determination of the soil water reserve, in sunflower, Oradea, Western Romania, 2009

Determination day	Water reserve based on soil samples	Water reserve based on pan evaporation data	Differences	
			mm/ha	%
1. 10.05.	242.0	233.4	-8.6	-4.5
2. 20.05	251.0	250.5	-0.5	-0.2
3. 31.05.	249.0	264.8	15.8	6.4
4. 11.06.	229.0	222.5	-0.65	-2.9
5. 21.06.	251.0	255.9	4.9	1.9
6. 1.07 .	219.7	215.8	-0.39	-1.8
7. 19.07.	211.6	224.7	13.1	6.2
8. 30.07.	188.0	202.6	14.6	7.8
9. 10.08.	205.0	217.6	12.6	6.1
10. 20.08.	178.6	198.4	13.3	1.2
11. 1.09.	219.6	232.3	13.3	1.2
Average	222.2	228.9	6.7	3.0

CONCLUSIONS

The researches carried out during 1976-2010 in Agricultural Research and Development Station Oradea determined the following conclusions:

- Irrigation scheduling of the sunflower based by Pan evaporation method uses the soil water balance on 0-75 depth of the soil for every day of the irrigation season. Daily pan evaporation is measured every day an dis used for transformation in optimum water consumption of the sunflower using the crop coefficient "k_c"
- Crop coefficients "K_c" have specifical values for every month and dividing the optimum water consumption of the sunflower to pan evaporation were obtained. Optimum water consumption was obtained maintaining the soil water reserve on 0-75 cm between easily available water content and field capacity. The average for period 1976 –2010 of the crop coefficient K_c are: 0.9 in April, 1.08 in May, 1.40 in June, 1.28 in July and 0.9 in August.

There are the differences of - 4.5 % and 7.8 % between the soil water reserve determined by direct method (soil samples) and the soil water reserve calculated by soil water balance method using the pan evaporation values and the crop coefficient "K_c". These small diferences recomand the irrigation scheduling in sunflower based on pan evaporation use and on soil water balance.

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