RESEARCHES REGARDING THE USE OF THE PICHE EVAPORIMETER IN THE IRRIGATION SCHEDULING OF THE TOMATOES' SOLARIUM CROPS

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Abstract

The paper is based on the researches carried out during 2008-2010 in the solariums from Husasău de Criş, Bihor County. The direct link, statistically assured, between tomatoes' daily Piche evaporation and daily water consumption emphasized the opportunity of the Piche evaporimeter use in tomatoes' irrigation scheduling in solarium conditions. The use is based on the soil's water balance on 0-50 cm depth in the monthly chart using daily data of the Piche evaporation and the specific crop coefficient "Kc". In average of the studied period, the values of the crop coefficient were of: 0.75 in March, 0.51 in April, 0.66 in May, 0.76 in June, 0.90 in July, 0.62 in August and 0.64 in September.

Keywords: Piche evaporimeter, irrigation scheduling, solarium, tomatoes

INTRODUCTION

The Piche evaporimeter is used in the field crops' irrigation scheduling in France and Italy. Since 1969, this method is studied in some research fields from the potentially irrigated areas of Romania (Grumeza et all, 1989, Grumeza and Kleps, 2005, Domuţa, 1995, 2005, Domuţa et all, 2000). Our research evidenced the results obtained when using the Piche evaporimeter for tomatoes' irrigation scheduling in the solarium conditions.

MTERIALS AND METHODS

The research were carried out during 2008-2010 in the conditions of the solarium from Husasău de Tinca. The solarium area was of 200 m^2; three Piche evaporimeters were placed in the middle of the solarium. The levels of the water from Piche evaporimeter were noted down every day at 8 o'clock in the morning.

Regarding the temperatures outside the solarium, the lowest values were registered in March but the highest temperatures were registered in July (2008 and 2009) and in August (2010). (Table 1).

The optimum tomatoes' water consumption was obtained by maintaining the soil's water reserve on the watering depth (0-50 cm), between the easily available water content and the field capacity. This thing was possible by prelevating soil samples ten to ten days and determining its

soil moisture. The soil moisture was determined monthly, on 0-150 cm depth. Tomatoes' water consumption was determined using the soil water balance method, the depth considered was 0-150 cm.

Table 1

Average values of the air temperature inside and outside the solarium, Husasău de Tinca 2008-2010

Year	Place of determination	March	April	May	June	July	August	September
2008	Inside solarium	16.5	17.8	18.7	23.0	31.2	26.1	22.2
	Outside solarium	12.8	11.9	15.0	20.6	24.2	21.2	17.6
2009	Inside solarium	1.5	19.4	22.6	24.8	27.3	27.4	22.8
	Outside solarium	10.5	14.7	17.9	21.5	25.9	25.1	19.3
2010	Inside solarium	14.8	16.4	21.4	19.9	22.4	26.0	20.2
	Outside solarium	10.5	10.5	16.7	16.2	18.7	22.3	15.8
Average	Inside solarium	15.6	17.9	20.9	22.6	27.0	26.5	21.7
	Outside solarium	11.3	12.4	16.5	19.4	22.9	22.9	17.6

The Piche evaporimeter method is one of the indirect methods for irrigation scheduling. The indirect methods for irrigation scheduling are based on the crop coefficient (Kc) used and on the soil water balance on watering depth.

Crop coefficients (Kc) were calculated reporting the optimum water consumption to the reference evapotranspiration (ET_o), Piche evaporation in our case.

RESULTS AND DISCUSSION

Piche evaporation

The analysis of the monthly average of the Piche evaporation emphasizes a different situation in every year of the researched period.

In 2008, monthly values had a constant increase from March (3.91 mm/day) to July (7.64 mm/day); after that the values decreased. The biggest variation interval was registered in August. In 2009, the values of the Piche evaporation increased from March (3.55 mm/day) to June (6.76 mm/day), in July a smaller value (6.05 mm/day) was registered, in August the biggest value was determined (7.54 mm/day) and in September the smallest value (2.95 mm/day) was registered. The biggest variation interval of the daily Piche evaporation was registered in August. In 2010, the situation was

different, in May a first top of the monthly values was registered and in July, the second; the biggest variation interval was registered in September (table 2).

Table 2

Piche evaporation values (mm/day) in the solarium conditions, Husasău de Tinca 2008-2010

Year	Specification	March	April	May	June	July	August	September
2008	Average	3.91	5.67	5.96	6.33	7.64	5.62	3.10
	Variation interval	3.7-4.1	4.6-6.6	4.8-6.7	5.8-6.7	6.2-8.7	3.8-7.9	2.2-3.4
2009	Average	3.55	5.8	6.49	6.76	6.05	7.54	2.95
	Variation interval	3.1-4.0	4.0-6.9	5.9-7.4	6.1-7.5	5.7-6.4	5.5-8.4	2.0-4.9
2010	Average	3.83	5.06	5.62	5.40	6.44	6.36	3.6
	Variation interval	3.5-4.2	3.7-5.9	5.5-6.5	5.1-5.9	5.7-7.1	6.1-6.9	2.3-5.7
Average		3.76	5.51	6.02	6.16	6.71	6.51	3.22

The average of the studied period indicates values from 3.76 mm/day in March to 6.71 mm/day in July and a decrease of the Piche evaporation in August (6.51 mm/day) and in September, 3.22 mm/day.

Tomatoes' water consumption

In order to maintain the soil's water reserve on 0-50 cm depth between the easily available water content and the field capacity a specific irrigation regime was used every year: 464 mm/ha and 15 rates in 2008, 591 mm/ha and 19 rates in 2009, 479 mm/ha and 14 rates in 2010. The highest monthly irrigation rates were registered in July: 139 mm/ha in 2008, 164 mm/ha in 2009 and 125 mm/ha in 2010 (table 3).

Table 3.

Irrigation regime used in tomatoes to maintain the soil water reserve on 0-50cm between easily available water content and field capacity in the solarium conditions, Oradea 2008-2010

Year	March		April		May		June		July		August		September		Total	
	Σm	n	Σm	n	Σm	n	Σm	n	Σm	n	Σm	n	Σm	n	Σm	n
2008	30	1	35	1	82	3	97	3	139	4	102	3	-	-	484	15
2009	30	1	35	1	92	3	101	4	164	5	137	4	32	1	591	19
2010	30	1	31	1	70	3	92	3	125	4	110	2	30	1	479	14
Average	30	1	33.6	1	81	3	97	3	143	4	113	3	21	1	518	16

The total water consumption values were of 669 mm/ha in 2008, of 818 mm/ha in 2009 and of 640 mm/ha in 2010. The irrigation was the main source of the covering water consumption. From soil reserve tomatoes used 18.5 mm/ha, 27.6% from total water consumption. The biggest quantity of water used from soil reserve was registered in 2009, 227 mm/ha (27.7% from total water consumption). In 2010, the smallest water quantity, 161.0 mm/ha (25.1% from total water consumption) was registered (table 4).

Table 4.

Total water consumption [Σ(e+t)] and covering sources in the tomatoes crop from solarium, Husasău de Tinca 2008-2010

Year	Σ(e+t) mm	Covering sources of the water consumption			
		Soil water reserve		Irrigation	
		mm	%	mm	%
2008	669	185	27.6	484	72.4
2009	818	227	27.7	591	72.3
2010	640	161	25.1	479	74.9
Average	709	191	26.9	518	73.1

Specific values of the tomatoes' daily water consumption were registered. All the years the maximum value was registered in July: 5.94 mm/day/ha in 2008, 6.58 mm/day/ha in 2009 and 5.29 mm/day/ha in 2010 (table 5).

Table 5

Daily water consumption of the tomatoes in the condition from the solarium, Husasău de Tinca

Year	March	April	May	June	July	August	September
2008	2.92	2.92	3.97	4.47	5.94	3.77	1.6
2009	3.09	3.09	4.42	5.36	6.58	4.35	3.05
2010	2.38	2.38	3.47	4.26	5.29	3.94	1.28
Average	2.8	2.8	3.96	4.70	5.93	4.02	1.98

The correlation between the Piche evaporation and the daily water consumption of the tomatoes

There is a direct link between the daily Piche evaporation and the daily water consumption of the tomatoes. Mathematically, the expression of this link is $y = 0,3972x^2 - 3,0985x + 8,2299$ and the correlation coefficient is $R^2 = 0,8079$.

Crop coefficient Kc

The values of the crop coefficients Kc for transformation of the Piche evaporation in optimum water consumption have specific values for every month of the studied years. In every year, the biggest value was registered in July: 0.78 in 2008, 1.09 in 2009 and 0.82 in 2010 (table 6).

Table 6

Crop coefficient (Kc) for transformation of the Piche evapotranspiration in tomato optimum evapotranspiration in the solarium conditions, Husasău de Tinca 2008-2010

Year	March	April	May	June	July	August	September
2008	0.75	0.54	0.67	0.71	0.78	0.67	0.52
2009	0.87	0.53	0.68	0.79	1.09	0.58	1.03
2010	0.62	0.47	0.62	0.79	0.82	0.62	0.36
Average	0.75	0.51	0.66	0.76	0.90	0.62	0.64

Irrigation scheduling using the Piche evaporimeter

The use of the Piche evaporimeter in tomatoes' irrigation scheduling in the solarium conditions is based on the monthly chart regarding the soil water balance on the watering depth, 0-50 cm in our case. Soil water reserve must be determined only once in the tomatoes planting day. In the next days of the tomatoes vegetation period, the soil water reserve is obtained by using a calculation method. For example:

- tomatoes plating days: 27.03
- soil water reserve: 141 mm/ha
- Piche evaporation in 27.03 = 3.0 mm/day
- crop coefficient for March = 0.75
- optimum water consumption = 3.0 x 0.75 = 2.25

After the calculation, a soil water reserve is obtained at the end of the day 27.03. This example is presented in figure 1.

BALANCE CHART

Month: March

Crop: tomato; Watering depth=0-50 cm; Easily available water content= 138.6 mm/ha; Field capacity=176.4 mm/ha; Irrigation rate=37.8 mm/ha;

Day	Initial reserve	Irrigation	Total in the soil	Piche evaporimeter	Kc	Σ(e+t) for tomatoes	Final water reserve	Irrigation datum
27	141	-	141	3.8	0.75	2.85	138.15	28.03
28	138.15	37.8	175.95	4.2	0.75	3.15	172.8	-
29	172.8	-	172.8	4.6	0.75	3.0	169.8	-
30	169.8	-	-	-	-	-		-

Fig. 1. Balance chart

CONCLUSIONS

The paper is based on the researches carried out during 2008-2010 and the conclusions are:

- The Piche evaporimeter can be used in the solarium tomatoes crops' irrigation scheduling because the relation between the daily Piche evaporation and tomatoes' water consumption is statistically assured.
- Three evaporimeters placed in the middle of the solarium are recommended. The height of the evaporimeter's place is 1.7 m. Piche evaporation was determined every day at 8 o'clock and the specificall values were obtained.
- The Piche evaporimeter use in the irrigation scheduling of the tomatoes is based on the soil water balance of 0-50 cm depth and on the use of the specific crop coefficient Kc. In average of the period

1999-2001, the values of the crop coefficient are: 0.75 in March, 0.51 in April, 0.66 in May, 0.76 in June, 0.90 in July, 0.62 in August and 0.64 in September.

REFERENCES

1. Botzan M., 1966, Culturi irigate. Editura Agro-Silvică, Bucureşti
2. Cărbunar Mihai, Cornel Domuța, 2009, Elemente de tehnologie a tomatelor în solarii Editura Univesității din Oradea
3. Domuța C., 1995, Contribuții la stabilirea consumului de apă al principalelor culturi din Câmpia Crişurilor. Teza de doctorat. ASAS "Gheorghe Ionescu Şişeşti", Bucureşti
4. Domuța C., 2005, Practicum de irigarea culturilor şi agrotehnică, Editura Universității din Oradea
5. Domuța C., 2009**,** Irigarea culturilor, Editura Universității din Oradea
6. Domuța C. (coord), 2009, Irigațiile în Câmpia Crişurilor, Editura Universității din Oradea
7. Doorembos, J. and Pruitt, W.O. 1993. Crop water requirements. Irrigation and drainage paper FAO Rome.
8. Grumeza N., Merculiev O., Klepş Cr. şi colab., 1989, Prognoza şi programarea udărilor în sistemele de irigații. Editura Ceres, Bucureşti
9. Grumeza N., Klepş Cr. 2005, Irigațiile în România, Ed. Ceres Bucureşti