IRRIGATION SCHEDULING IN DRIP IRRIGATED PEACH-TREE IN THE CONDITIONS FROM NORTHWESTERN ROMANIA

PROGNOZA IRIGAȚIEI LA CULTURA PIERSICULUI IRIGAT PRIN PICURARE ÎN CONDIȚIILE DIN NORD-VESTUL ROMÂNIEI

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Abstract. *The paper is based on the researches carried out in Oradea during 2007-2010. The purpose of this research was a comparative study of 4 determination reference evapotranspiration methods (measured with Pan and Piche evaporimeters or calculated with Thornthwaite and Penman-Monteith methods) with the optimum water consumption values of drip irrigated peach-tree. The results were calculated with variance analysis method and show statistically significant differences witch reflecting the need to determine the crop coefficients (Kc) for transformation the reference evapotranspiration values in the plant optimum water consumption. These coefficients will be used in the irrigation scheduling of drip irrigated peach-tree.*

Key words*: peach-tree, reference evapotranspiration, drip irrigation, irrigation scheduling, Pan evaporation.*

Rezumat. *Lucrarea se bazează pe cercetări efectuate la Oradea în perioada 2007-2010. Acestea au vizat studiul comparativ a 4 metode de determinare a evapotranspirației de referință (măsurate cu evaporimetrele Bac, respectiv Piche sau calculate prin metodele Thornthwaite, respectiv Penman-Monteith) comparativ cu valorile consumului optim de apă al piersicului irigat prin picurare. Calculul rezultatelor prin analiza variației arată diferențe foarte semnificative statistic ceea ce reflectă necesitatea determinării coeficienților (Kc) de transformare a evapotranspirației de referință în consum optim de apă. Aceşti coeficienți, urmează să fie folosiți în prognoza irigației la piersicul irigat prin picurare.*

Cuvinte cheie*: piersic, evapotranspirație de referință, picurare, prognoza irigației, evaporimetrul Bac*

INTRODUCTION

For the peach-tree crop, Oradea fruit growing area is even more important because before 1990, the Bihor County was in second place in the country regarding the peaches export. The drip irrigation of peach-tree crop from Oradea fruit growing area was studied by Violeta Şcheau (2005) in her PhD. thesis and represented the subject of other scientific papers (Domuța C. et al., 2007, Şcheau V. et al. 2006, 2009,). Irrigation scheduling has a great importance in the use of the

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irrigation systems the paper studied 4 of most recognized methods to optimize the timing of watering for drip irrigated peach-tree.

MATERIAL AND METHOD

The researches were carried out during 2007-2010 at the Research and Fruit-Growing Development Station Oradea in an orchard planted in 1996. The cultivar used was Superb of Autumn.

In depth 0-100 cm (deep watering peach-tree in this area, Grumeza N. et. all., 1989, Brejea R., 2010), the luvisol from research field has a colloidal clay content of 41,4%. On this depth the field capacity is 23.61% (3571 m^3/ha), and the wilting coefficient is 18.3% (2763 m^3/ha). Determining of the soil moisture ten to ten days on 0-100 cm depth the water reserve was maintained between easily available water content and field capacity.

In the four years studied were registered the following values of the annual rainfall: 556,1 mm in 2007, 332,0 in 2008, 420,0 mm in 2009 and 855,7 mm in 2010. In the peach-tree vegetation period were registered 283,1 mm in 2007, 304,4 mm in 2008, 241,5 mm in 2009 and 499,7 mm in 2010.

The peach-tree water consumption was obtained using the soil water balance method, (the depth of the water balance was of 0-150 cm) after the following formula:

$$Ri + Pv + \sum m = \sum(e+t) + Rf$$

were,

Ri = initial reserve (at the resumption of vegetation); Pv = rainfall during the growing season; $\sum m$ = irrigation rate; $\sum(e+t)$ = total water consumption; Rf = final reserve (at the fall leaves) (Domuța C., 1995, 2003, 2005).

Thorntwaite and Penman-Monteith values of the reference evapotranspiration were calculated using a known formula (Domuța C., 2009) and the Pan evaporation and Piche evaporation were determined every day at 8 o'clock.

The results were calculated using the analys of variance method.

RESULTS AND DISCUSSIONS

The differences between the water consumption of the drip irrigated peach-tree and the reference evapotranspiration (ET_o)

The difference between the total water consumption of the peach-tree and the reference evapotranspiration (ETo)

There are statistically assured differences between the water consumption of the peach-tree for the period IV-IX and the reference evapotranspiration determined using the four methods.

In dripp irrigated peach-tree, the differences between the total water consumption and the reference evapotranspiration determined using the four methods, are smaller and there are statistically assured in all the cases.

Using ET_o Thornthwaite was obtained a statistically significant difference of 295 m^3/ha (4.6%); using the Penman-Monteith and Pan evaporimeter methods were obtained significantly distinct differences of 778 m^3/ha (12.3%) and 892 m^3/ha (14.0%), by using the Piche evaporimeter was obtained a very significant difference of 3305 m^3/ha (52.1%) (table 1).

Table 1

The differences between optimum water consumption (ETR_{opt}) of the drip irrigated peach-tree and the reference evapotranspiration (ET_o) determined using different methods, Oradea 2007-2010

Crt. nr.	Variant	Value		Difference	
		m^3/ha	%	m^3/ha	%
1	ETR- drip irrigation	4823	100	-	-
2	ET_o Thornthwaite	6629	137,4	1806	37,4
3	ET_o Pan	7226	149,8	2403	49,8
4	ET_o Piche	9639	199,9	4816	99,9
5	ET_o Penman-Monteith	7112	147,5	2289	47,5

LSD 5% = 214; LSD 1% = 570; LSD 0,1% = 112

The differences between the daily water consumption of the drip irrigated peach-tree and the reference evapotranspiration (ETo)

In April, using the Penman-Monteith and Pan evaporimeter methods were not obtained statistically significant differences; the difference obtained using the Thornthwaite method is statistically significant distinct and other obtained using the Piche evaporimeter is very statistically significant. In May, the difference registered using the Thornhtwaite method was not statistically significant, the differences obtained using Penman-Monteith and Pan evaporimeter were statistically significant and the difference obtained using the Piche evaporimeter was highly statistically significant. In June, the difference registered using the Thornthwaite method was statistically significant and the differences obtained using the Piche evaporimeter were highly statistically significant. In July, using the Pan evaporimeter and Thornthwaite and Penman-Monteith methods were obtained statistically significant differences and with the Piche evaporimeter was obtained a very statistically significant difference. In August and September were registered the greatest differences, significantly distinct difference using the Thornthwaite method and very significant statistically differences using other methods. In September, with all the methods obtained very significant statistically differences in comparison with the real optimum water consumption of the drip irrigated peach-tree (table 2).

Table 2

The differences between the daily optimum water consumption (ETR_{opt}) of the drip irrigated peach-tree and the total reference evapotranspiration (ET_o), Oradea 2007-2010

Crt. nr.	Variant	IV	V	VI	VII	VIII	IX
		m^3/ha/ day	m^3/ha/ day	m^3/ha/ day	m^3/ha/ day	m^3/ha/ day	m^3/ha/ day
1	ETR – drip irrigation	26.1	37.2	42.2	48.9	37.2	15.4
2	ET_o Thornthwaite	19.1	38.2	44.5	46.8	42.7	25.4
3	ET_o Pan	26.0	41.4	46.3	48.0	47.6	27.0
4	ET_o Piche	36.4	52.1	62.2	64.9	64.5	35.2
5	ET_o Penman-Monteith	25.6	40.7	49.2	45.5	46.7	24.9
	LSD 5% =	4	6	4	4	7	6
	LSD 1% =	12	15	9	10	14	13
	LSD 0.1% =	25	27	19	21	23	22

The crop coefficients (K_c) for the transformation of the reference evapotranspiration in the optimum water consumption of the drip irrigated peach-tree

Showing the differences statistically assured between the peach-tree optimum water consumption and the reference evapotranspiration calculated with the four methods, the transformation in the optimum water consumption with the K_c coefficients is an extremely important and useful operation in design and operation of irrigation facilities.

The (K_C) coefficients for drip irrigation

The results presented in table 3 suggest that the K_c coefficient values are specific to every months and methods. In all the months of the vegetation period the (K_c) coefficient values are under unit values when is used the Piche evaporimeter method. At other three methods the values are subunit and overunit.

Table 3

The values of (K_c) coefficients for the transformation of the reference evapotranspiration in the optimum water consumption of the drip irrigated peach-tree, Oradea 2007-2010

Crt. nr.	Method	Month					
		IV	V	VI	VII	VIII	IX
2007							
1	Thornthwaite	0.93	0.75	0.94	1.04	0.98	0.83
2	Pan evaporimeter	0.69	0.62	0.78	0.94	0.64	0.83
3	Piche evaporimeter	0.52	0.47	0.56	0.61	0.49	0.67
4	Penman-Monteith	0.89	0.66	0.82	1.04	0.85	0.91
2008							
1	Thornthwaite	1.77	1.00	1.03	0.96	1.44	1.30
2	Pan evaporimeter	1.47	0.81	1.06	1.04	1.54	1.49
3	Piche evaporimeter	1.02	0.67	0.83	0.80	0.50	0.53
4	Penman-Monteith	1.49	0.95	1.05	1.07	0.73	0.95
2009							
1	Thornthwaite	1.57	1.17	1.24	0.77	0.73	0.49
2	Pan evaporimeter	1.13	1.59	1.40	0.78	0.94	0.46
3	Piche evaporimeter	0.84	1.10	1.00	0.64	0.61	0.35
4	Penman-Monteith	1.18	1.22	1.12	0.77	0.71	0.48
2010							
1	Thornthwaite	1.39	1.01	0.96	1.34	0.90	0.50
2	Pan evaporimeter	0.91	0.85	0.89	1.22	0.78	0.46
3	Piche evaporimeter	0.59	0.74	0.70	0.90	0.60	0.34
4	Penman-Monteith	0.69	0.91	0.83	1.34	0.73	0.43
Average 2007-2010							
1	Thornthwaite	1.42	0.98	1.04	1.03	1.01	0.78
2	Pan evaporimeter	1.05	0.97	1.03	1.00	0.98	0.81
3	Piche evaporimeter	0.74	0.75	0.77	0.74	0.55	0.47
4	Penman-Monteith	1.06	0.94	0.96	1.06	0.76	0.69

The irrigation scheduling of peach-tree using Pan evaporimeter

The irrigation scheduling is an extremly important operation and use of Pan evaporimeter suppose soil sampling only once, in spring, at the resumption of vegetation. In rest of days, water reserve is known from the monthly balance chart. This chart has mentioned at inputs the rainfall and the watering and at the outputs the Pan water consumption determined by the multiplying of daily evapotranspiration Pan (determined every day at 8 o'clock with the known methodology) with the (K_c) coefficient for that month. By making the balance is stand out the water reserve at the end of the day. If this reserve reached the easily available water content, the irrigation begins, bringing the water reserve at field capacity level. The balance depth is the culture watering depth, in our situation, 0-100 cm. The use of Pan evaporimeter method in the irrigation forecast has known advantages (Grumeza et al., 1989, Domuța C. et al., 2007) and his accuracy is very good, as shown in our research. In 2010, at the micro sprinker irrigated peach-tree crop, except the decade determinations of soil moisture, was calculated the water reserve also in balance monthly chart using the daily data of Pan evaporimeter and (K_c) coefficients for respectively month, established in 2007-2009 period.

Table 4

Differences between soil water reserve (m^3/ha) determined with Pan evaporimeter and water reserve determined by gravimetric method on 0-75 cm of the peach-tree, Oradea 2010

Crt. nr.	Determination data	Water reserve directly determined	Water reserve determined with Pan evaporimeter	Difference	
				m^3/ha	%
1	15.03	4284	4210	-74	-1.8
2	01.04	3956	3870	-86	-2.2
3	10.04	4391	4240	-151	-3.5
4	20.04	4137	4090	-47	-1.2
5	30.04	3699	3570	-129	-3.5
6	10.05	3593	3490	-103	-2.9
7	20.05	3246	3260	14	0.4
8	01.06	3624	3740	116	0.3
9	10.06	3684	3860	176	4.7
10	20.06	3171	3310	139	4.4
11	30.06	3608	3760	152	4.2
12	10.07	3503	3640	137	3.9
13	20.07	3398	3520	122	3.6
14	30.07	3669	3710	41	5.4
15	10.08	3518	3660	142	4.0
16	20.08	3593	3620	27	0.8
17	01.09	3442	3540	98	2.8
18	10.09	3570	3660	90	2.5
19	20.09	3620	3680	60	1.6
20	02.10	3642	3710	68	1.8
AVERAGE		**3667**	**3707**	**40**	**1.1**

The results presented in table 4 shows small differences between the water reserves directly obtained by gravimetric determination of soil moisture and water reserves indirectly determined using the Pan evaporimeter and (K_c) coefficients

for respectively month. The differences registered in 200 days of entire vegetation period of peach-tree crop are listed between -3.5% and 5.4%. This shows accuracy of method and considering the complexity of gravimetric determination of soil method is suggesting the great importance of using this method in the forecast irrigation by means of Pan evaporimeter at peach-tree crop.

CONCLUSIONS

1. In comparison with the total water consumption of drip irrigated peach-tree, the values of reference evapotranspiration calculated with Thorntwaite and Penman-Monteith methods or measured with Pan and Piche evaporimeter are statistically significant smaller.

2. Analysing statistically of the daily optimum water consumption in drip irrigated peach-tree in comparison with the reference evapotranspiration (ET_0) values determined with the four methods emphasized the statistically assured differences in every 6 month of the vegetation period of peach-tree. It shows the need of researches regarding the crop coefficient (K_C) for transformation of the reference evapotranspiration for every month of the vegetation period.

3. The research results obtained by parallel using of the Pan evaporimeter and gravimetric method for establishing the moment of watering application shows the differences between the two methods; the differences are between 3.5% and +5.4%, and sustain the opportunity of the Pan evaporimeter using in the irrigation scheduling of the peach-tree.

REFERENCES

1. Brejea R., 2010 – *Ştiința solului – îndrumător de lucrări practice*. Editura Universității din Oradea

2. Domuța C., 1995 – *Contribuții la stabilirea consumului de apă al principalelor culturi din Câmpia Crişurilor.* Teză de doctorat susținută la Academia de Ştiințe Agricole şi Silvice „Gheorghe Ionescu Şişeşti" Bucureşti

3. Domuța C., 2003 – *Oportunitatea irigațiilor în Câmpia Crişurilor*. Editura Universității din Oradea

4. Domuța C., 2005 - *Irigarea culturilor*. Editura Universității din Oradea

5. Domuta C., Scheau V. et al., 2007- *Comparison Between Peach-Tree Water Consumption And A Different Method Of Reference Evaporatranspiration (ETO) Calculation In The Conditions Of north Western Romania*, Scientifical Papers, seria B-L-Horticulture U.S.M.A.V.B., Ed. INVEL- Multimedia

6. Domuța C., 2009 – *Irigarea culturilor*. Editura Universității din Oradea

7. Domuța C (coord), 2009 – *Irigațiile în Câmpia Crişurilor 1967-2008.* Editura Universității din Oradea

8. Grumeza N. et al. 1989 – *Prognoza şi programarea aplicării udărilor în sistemele de irigații.* Editura Ceres Bucureşti

9. Şcheau Violeta, 2005 – *Influența irigării localizate asupra creşterii şi fructificării piersicului*. Teză de doctorat, USAMV Bucureşt

10. Scheau V., C. Domuta, Violeta Scheau, 2006 – *Irigarea localizată a piersicului*. Editura Universității din Oradea

11. Şcheau V. et al., 2009 - *Dwarf and Semi-Dwarf Peach Tree Cultivars Certified by the S.C.D.P. Oradea*. Natural Resources and Sustainable Development, Oradea pg. 118-122.