RESEARCH REGARDING THE USE OF THE PICHE EVAPORIMETER FOR IRRIGATION SCHEDULING IN CUCUMBER UNDER POLYETILENNE TUNNEL CONDITION

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Abstract

The paper based on the research carried out in Husasău de Tinca, North Western Romania, during 2007-2009.

Piche evaporimeter was installed in the middle of the polyetilenne tunnel and every morning the Piche evaporation was determined. The optimum water consumption was determined in two variants: 1) with mulch; 2) without mulch. . To maintain soil moisture under polyetilenne tunnel condition at depth 0-50 cm between easily available water content and field capacity was irrigated with 3430 m^3/ha in 2007, with 2890 m^3/ha in 2008 and 3340 m^3/ha in 2009.

Water consumption of cucumbers under polyetilenne tunnel condition was influenced by climatic conditions and crop system with mulch. In the year with the highest daily temperature average was registered highest water consumption, and in the variant without mulch total water consumption was higher than variant with mulch.

The crop coeficient „Kc" was determined like report between monthly water consumption of de cucumber and Piche evaporation from every month. The values of the crop coefficients were specifical sizes for every month and variant. The average value of the crop coefficients „Kc" for the variant with mulch were smaller than the crop coefficient values determined in the variant without mulch.

Key words: *irrigation scheduling, Piche evaporimeter, crop coefficient, mulch, cucumber, polyetilenne tunnel*

INTRODUCTION

Irrigation scheduling represents measures that ensure the correct timing of irrigation (Grumeza et al., 1989). Operation is very important for field crops and for the shelter because the correct time of watering application ensures optimum and uniform supply with water at crops, while irrigation made earlier than necessary, determine excess humidity for short periods of time, irrigation rate oversized and waste water and energy as well as negative consequences for the plant and soil. Delay of irrigation leads to installation hydric stress in soil and in the end to negative consequences on crop yields (Domuta, 2009,2012).

Irrigation scheduling methods used worldwide are based on direct and indirect determination of timing watering application.

Direct methods are based on the control of soil moisture using gravimetric methods, strain, electrometric, etc. From this category of methods, the strain gauge method is expanding, and this is facilitated by the construction of electronic sphygmomanometers easy to use and very accurate. Also in the category of direct methods of irrigation scheduling are joining the methods based on physiological indicators (growth of the fruit, the pressure cell, cellular juice concentration, the growth of the stem, etc.) but these methods are used more in research domain and their extension in production is a problem of the future.

Indirect methods are based on the link between plants water consumption (directly determined) and reference evapotranspiration (ET_0). The reference evapotranspiration can be calculated through a variety of methods using climatic elements or can be measured using evaporimeters or lysimeters (Grumeza et al., 1993).

Internationally are known about 100 types of evaporimeters , but Piche evaporimeter is widely used in irrigation scheduling in France and other countries. In Romania it is well known, researches regarding on using it are realized after 1966 in the network research fields for soil water balance conducted by Grumeza N., in the program: "Exploitation of irrigation and drainage facilities" from the Institute for Research Engineer, Irrigation and Drainage, Baneasa Girgiu. In field conditions Piché evaporimeters are realized in a weather shelter, but under polyetilenne tunnel condition renounced of this, placing the two evaporimeters on a stand with a height similar with weather shelter. The support with two evaporimeters was installed at the center of polyetilenne tunnel.

Determination of Piche evaporation was made every morning at 8 o'clock and noted in a register.

MATERIAL AND METHOD

The research was carried out in Husasau de Tinca in polyetilenne tunnel.

In conducting of soil moisture regime was considered the maintenance of water reserve at depth of 0-50 cm between easily available water content and field capacity (Domuta Cr., 2010).. Easily available water content was set at 2/3 (66%) of active moisture range. So was determined soil moisture from 10 to 10 days using the gravimetric method.

The three years studied were different regarding to air temperature. The highest average temperature for the period from June to September was registered in 2007, with the value of 20,6 ° C, followed by 2009 with

20,2 º C and 19,8 º C in 2008. In all this three years the average values for the period from June to September were higher than the multiannual average of the years 1931 - 2006, with a value of 19,3 º C (Table 1).

Table 1.

Average monthly temperature, Husasău de Tinca, 2007 – 2009

Year	Month				Average
	VI	VII	VIII	IX	VI - IX
2007	22.2	23.6	22.3	14.4	20.6
2008	21.0	20.9	22.0	15.4	19.8
2009	19.8	23.1	22.2	15.5	20.2
Multiannual average 1931 - 2006	19.3	20.8	20.9	16.2	19.3

RESULTS AND DISSCUSIONS

The optimum irrigation regime of cucumbers for maintaining of water reserve between easily available water content and field capacity on the depth of 0-50 cm was ensured by irrigation rate by 3430 m^3/ha in 2007, 2890 m^3/ha in 2008 and 3340 m^3/ha in 2009. Number of irrigation rate was 12 in 2007 and 2009 and 10 in 2008. The average value of irrigation rate on studied period was 3220 m^3/ha (Table 2).

Table 2

Irrigation regime used in cucumber for maintaining the water soil reserve at watering depth (0-50cm) between easily available water content and field capacity under polyetilenne tunnel conditions, Husasău de Tinca, 2007-2009

Year	Month								VI - IX	
	VI		VII		VIII		IX			
	Σm	n	Σm	n	Σm	n	Σm	n	Σm	n
2007	870	3	920	3	1010	4	630	2	3430	12
2008	650	2	600	2	850	3	790	3	2890	10
2009	500	2	950	3	1090	4	800	3	3340	12
Average	673	2	823	3	983	4	740	3	3220	12

Σm – irrigation rate (m^3 water/ha)
n – number of irrigations

Monthly irrigation rates used are directly correlated with air temperature. In June, the highest value of irrigation rate was used in 2007 (870 m^3/ha), in July 2009 (950 m^3/ha), August 2009 (1090 m^3/ha) and in September in year 2009 (800 m^3/ha).In average on the study period and in every year, the highest value of the irrigation rate and the largest number of irrigations were used in September.

With the indirect method were obtained values of reference evapotranspiration (ET_0), which is converted to water consumption using crop coefficients “Kc”.

The crop coefficients "Kc" are obtained by a specific methodology through the reporting of optimum daily water consumption at daily average reference evapotranspiration (Grumeza et al. 2005, Domuta et al., 2010).

Sampling of soil from 10 to 10 days and maintaining the water reserve between easily available water content and field capacity assured an optimum water regime of plants (Domuţa Cr., 2012).

At the beginning and the end of each month the soil samples were taken from a depth of 0-150 cm, thus ensuring the optimum conditions needed to calculate the optimum real consumption (ETR_{opt}) of the crops (Bei Mariana et al, 2010). Calculations of soil water balance are presented in tables 3, 4, 5.

In all three years studied the water reserve determined at establishment of cucumbers crop, both variant with or without mulch was below of field capacity (5611 m^3/ha). Final water reserve was above the wilting coefficient (2168 m^3/ha). Number of days of water balance period was 103 in 2007, 105 in 2008 and 99 in 2009.

Table 3

Soil water balance (m^3/ha) in cucumber without mulch and with mulch under polyetilenne tunnel conditions, Husasău de Tinca, 2007

Variant	Period		No. of days	Initial reserve	Irrigation rate	Total in soil	Final reserve	Total water consumption	Daily water consumption m^3/ha
	From	To							
Without mulch	19.06	01.07	11	4170	870	5040	4626	414	37.6
	01.07	01.08	31	4626	920	5546	3897	1649	53.2
	01.08	01.09	31	3897	1010	4907	3007	1900	61.3
	01.09	30.09	30	3007	630	3637	2500	1137	37.9
	19.06	30.09	103	4170	3430	7600	2500	5100	49.5
With mulch	19.06	01.07	11	4210	870	5080	4691	389	35.4
	01.07	01.08	31	4691	920	5611	4042	1569	50.6
	01.08	01.09	31	4042	1010	5052	3198	1854	59.8
	01.09	30.09	30	3198	630	3828	2700	1128	37.6
	19.06	30.09	103	4210	3430	7640	2700	4940	47.9

Table 4

Soil water balance(m^3/ha) in the cucumbers crop with or without mulch under polyetilenne tunnel conditions, Husasău de Tinca, 2008

Variant	Period		No.of days	Initial reserve	Watering	Total in soil	Final reserve	Total water consum.	Daily water consum. m^3/ha
	From	To							
Without mulch	17.06	01.07	13	4210	650	4860	4363	497	38.2
	01.07	01.08	31	4363	600	4963	3720	1243	40.1
	01.08	01.09	31	3720	850	4570	2970	1600	51.6
	01.09	30.09	30	2970	790	3760	2878	882	29.4
	17.06	30.09	105	4210	2890	7100	2878	4222	40.2
With mulch	17.06	01.07	13	4180	650	4830	4337	493	37.9
	01.07	01.08	31	4337	600	4937	3703	1234	39.8
	01.08	01.09	31	3703	850	4553	3025	1528	49.3
	01.09	30.09	30	3025	790	3815	2969	846	28.2
	17.06	30.09	105	4180	2890	7070	2969	4101	39.1

Table 5

Soil water balance(m^3/ha) in the cucumbers crop with or without mulch under polyetilenne tunnel conditions, Husasău de Tinca, 2009

Variant	Period		No.of days	Initial reserve	Watering	Total in soil	Final reserve	Total water consum.	Daily water consum. m^3/ha
	From	To							
Without mulch	24.06	31.07	38	3970	1450	5420	4010	1410	37.1
	01.08	31.08	31	4010	1090	5100	3370	1730	55.9
	01.09	30.09	30	3370	800	4170	2964	1206	40.2
	14.06	30.09	99	3970	3340	7310	2964	4346	43.9
With mulch	24.06	31.07	38	4010	1450	5460	4100	1360	35.8
	01.08	31.08	31	4100	1090	5190	3540	1650	53.2
	01.09	30.09	30	3540	800	4340	3140	1191	39.7
	14.06	30.09	99	4010	3340	7350	3140	4210	42.5

In this three experimental years were registered higher values of total water consumption without mulch compared with variant with mulch, the relative differences being of 3,2% in 2007, 2,9% in 2008 and 3,1% in 2009 .

In variant without mulch the cucumbers crop consumed a large quantity of water from soil reserves.

To cover total water consumption of cucumbers under polyetilenne tunnel the irrigation had the higher values, in variant without mulch being 67% in 2007 to 68% in 2008 and 77% in 2009. In variant with mulch the irrigation rate in total water consumption was higher, 69% in 2007, 70% in 2008 and 79% in 2009 (Table 6).

Table 6

Analysis of the mulch influence on total water consumption in cucumber under polyetilenne tunnel conditions, Husasău de Tinca , 2007 - 2009

Year	Variant	Total water consumption		Covering sources of water consumptions			
				Soil reserve		Irrigation	
		m^3/ha	%	m^3/ha	%	m^3/ha	%
2007	Without mulch	5100	100	1670	33	3430	67
	With mulch	4940	96,8	1510	31	3430	69
2008	Without mulch	4222	100	1332	32	2890	68
	With mulch	4101	97.1	1211	30	2890	70
2009	Without mulch	4346	100	1006	23.5	3340	77
	With mulch	4210	96,9	870	21	3340	79
Average	Without mulch	4556	100	1336	29	3220	71
	With mulch	4417	96.9	1197	27	3220	72
	Difference	-139	-3.1	-139	-2	-	+1

Determination of daily Piche evaporation was done every morning at 8 o'clock and dates are noted in a register. The daily values obtained during the study are presented in table 7.

Table 7

Daily Piche evaporation (mm) under polyetilenne tunnel conditions, Husasău de Tinca, 2007-2009

Average of the daily evaporation Piche (mm)											
June			July			August			September		
2007	2008	2009	2007	2008	2009	2007	2008	2009	2007	2008	2009
6.76	6.11	6.33	7.81	7.13	7.64	6.34	5.57	5.62	3.07	3.27	3.10

Another necessary element for irrigation scheduling using indirect methods is daily water consumption. As previously mentioned, it was determined by the soil water balance method based by soil moisture control. Decade determination of soil moisture at depth of 0-50 cm assured the maintaining of water reserve between easily available water content and field capacity ensuring optimum water supply of plants and obtaining of optimum values for water consumption of cucumbers with mulch and without mulch variant.

Daily average values are specific for each months of the vegetation period and in generally are lower in variant without mulch (Apahidean Al.S, şi colab., 2001).

Both variant with and without mulch, the highest average value of daily water consumption was registered in August (Table 8).

Table 8

Optimum water consumption in cucumber from the variant with and without mulch under polyetilenne tunnel conditions, Husasău de Tinca, 2007 - 2009

Year	Variant	Month							
		June		July		August		September	
		m^3/ha / day	%	m^3/ha /day	%	m^3/ha/ day	%	m^3/ha / day	%
2007	Without mulci	37.6	100	53.2	100	61.3	100	37.9	100
	With mulch	35.4	94.1	50.6	95.1	59.8	97.6	37.6	99.0
2008	Without mulci	38.2	100	40.1	100	51.6	100	29.4	100
	With mulch	37.9	99.2	39.8	99.3	49.3	95.5	28.2	95.9
2009	Without mulci	37.1	100	37.1	100	55.9	100	32.4	100
	With mulch	35.8	96.5	35.8	96.5	53.2	95.2	31.7	97.8
2007 - 2009	Without mulci	37.6	100	43.5	100	56.3	100	33.2	100
	With mulch	36.4	96.7	42.1	96.7	54.1	96.1	32.5	97.9
	Difference	-1.2	-3.3	-1.4	-3.3	-2.2	-3.9	-0.7	-2.1

Crop coefficient “Kc”, as it is known in the international literature, is determined as the ratio between daily water consumption of crop and daily reference evapotranspiration, daily Piche evaporation in this case.

From the data presented it is noted that the values of coefficient “Kc” are lower in all months of cucumbers growing stage, except the September 2007 and 2009 at cucumbers with mulch and the values registered at cucumbers with mulch are lower than values registered at cucumbers without mulch (Table 9).

Table 9.

The crop coefficients „Kc” for transformation of the Piche evaporation in optimum water consumption in cucumber with and without mulch in polyetilenne tunnel conditions, Husasău de Tinca, 2007-2009

Year	Variant	Month			
		June	July	August	September
2007	Without mulch	0,56	0,68	0,97	1,23
	With mulch	0,53	0,65	0,94	1,22
2008	Without mulch	0,62	0,56	0,93	0,89
	With mulch	0,61	0,55	0,89	0,86
2009	Without mulch	0,59	0,49	0,99	1,05
	With mulch	0,57	0,47	0,95	0,96
2007 - 2009	Without mulch	0,59	0,58	0,96	1,06
	With mulch	0,57	0,56	0,93	1,01

By multiplying the daily Piche evaporation in this day with coefficient “Kc” for that month, in the table above, were obtained daily water consumption in the day when were calculated . Subtracting this amount from the amount of the daily water reserve in the beginning of day was obtained the value of soil water reserve registered at the end of the day. If the water reserve is under easily available water content, then should irrigate.

Establishing this way the timing of irrigation, it is simple, and compared to theoretical calculations has the advantage that it using measures elements - Piche evaporation – under polyethylene tunnel conditions, gives extra rigor for irrigation of cucumbers crop and provides significant water savings . Regarding of gravimetric determination of soil moisture, using Piche evaporimeter in the timing of watering application has advantages does not require soil sampling, weighing and drying them (Brejea R., 2012).

For an accurate irrigation scheduling with Piche evaporimeter are necessary accurate data regarding on soil hydrophysics indices (field capacity, wilting coefficient, easily available water content) an accurate assessment of daily Piche evaporation, data regarding of “Kc” coefficients resulting from research performing. The method allows a high degree of

automatization, monthly data can be completed on the computer, can be achieved programs computer that provide automatic closure of irrigation system (Domuta C., 2012).

CONCLUSIONS

The research carried out in the polyetilenne tunnel from Husasău de Tinca, North Western part during 2007-2009 determined folowing conclusions:

To maintain soil moisture under polyetilenne tunnel conditions at depth 0-50 cm between easily available water content and field capacity were irrigated with 3430 m^3/ha in 2007, with 2890 m^3/ha in 2008 and 3340 m^3/ha in 2009.

Water consumption of cucumbers from polyetilenne tunnel was influenced by climatic conditions and crop system with mulch. In the year with the highest average of daily temperature was registered highest water consumption and in the variant without mulch total water consumption was higher than variant with mulch.

Irrigation scheduling based on use of Piche evaporimeter required daily Piche evaporation determinations, which had the highest value in July. To convert Piche evaporation in optimum daily water consumption of cucumbers were calculated coefficient "Kc" as ratio between optimum daily water consumption and Piche evaporation. The values of these coefficients are specific to each month of the growing stage. Average over the studied period in variant with mulch, the coefficient "Kc" values are lower than the values determined in the variant without mulch.

The results research sustain the possibility of the Piche evaporimeter for the irrigation scheduling in cucumber from polyetilenne tunnel both in the variant with mulch and in the variant without mulch. The method is based on the soil water balance on 0-50 cm depth and the use of the specifically crop coefficient “Kc” for transformation of the Piche evaporation in the optimum water consumption of the cucumber both in the variant with mulch and without mulch.

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