RESEARCH RESULTS REGARDING WATER CONSUMPTION OF PEPPER CROP IN FIELD CONDITIONS

Hoble Adela, M. Dirja, E. Luca, Luca Cristina Laura, T. Salagean
University of Agricultural Sciences and Veterinary Medicine, Faculty of Horticulture, 3-5 Manastur St., 400372, Cluj-Napoca, Romania; adelahoble@yahoo.com

Abstract. To calculate water consumption by direct method took into account the amount of water coming into the system, following the rules of watering, values were established irrigation scheme-specific variants. Direct method for determining soil water consumption is the soil water balance method, whose principle is to establish the "inputs" of water (all sources of supply of soil) is equal to "output" of water (all soil water consumption). The concept of soil water balance implies the balance between the amount of water penetrated into the soil and is lost and quantitative expression of the hydrological regime.

Keywords: water exploitation coefficient, water exploitation efficiency

INTRODUCTION

Along with the light and temperature, water plays an important ecological role as determining the distribution of vegetation in the world. Thus in regions with excess water hydrophilic plants grow in the suitable humidity, mesophilic plants and in areas with low humidity, plants grow xerofile (Jacob, 2001; Gâdea, 2003). Physiological phenomena of growth are the most sensitive to lack of water, the process stops at a degree of hydration is not sufficient for the development of other physiological processes, as photosynthesis and respiration (Gâdea, 2003). Plant water sources are liquid precipitation, snow, dew and fog, humidity and soil water reserve (Grumeza et al., 1988). In general continental climate, recorded a maximum rainfall in late spring, early summer, when vegetation is explosive after it stalled, possibly until fall, when in some areas there is a second maximum rainfall, which is presented by Luca et al. (2003), which is characteristic for our country. Method feature is draining surface watering vegetables by furrows or strips (Popescu, 1975) but had exceptional results and how drip irrigation, sprinkler irrigation two ahead. INDRICĂ and Horgoş (2007) specify that the pepper crop field most common method is through drip irrigation on the surface, but it is used the spray. Also Popescu (1975) noted that water requirement for establishing appropriate production plan proposed irrigation scheme can be dimensioned by the soil water balance method, taking into account three types of hydrological regimes encountered on land irrigation: hydrological regime uninfluenced by groundwater (closed loop) influenced by groundwater hydrologic regime (open circuit) and hydrological regime of irrigation combined with drainage, fluid system containing any quantity of water received and disposed of soil and soil water reserves from beginning and end of the period.

MATERIAL AND METHOD

In making observations were chosen five kinds of peppers approved for production in Romania: Green sweet pepper - OPAL, long green pepper - FEHER, long red pepper,

red sweet pepper - CALIFORNIA WONDER, bell pepper – SPLENDID (HOBLE et al., 2011).

In the three experimental years were followed productions made under irrigation in five varieties of peppers grown in field irrigation system was applied to two active humidity interval of 50% IUA and 80% IUA, which is considered a factor determinative technology in achieving objectives.

To determine water consumption in pepper crop in field for the experimental years 2009, 2010 and during the growing season of 2011, the direct method was used, the soil water balance method and indirect methods, such as Thornthwaite method (monthly weightings, denoted by "k" for months vegetation period are: in k = 1.29, k = 1.31 in June, July k = 1.32, k = 1.22 in August and in September k = 1.04. empirical coefficient, denoted with, following calculation has a value of 0.94) Hargreaves and Samani method as the original equation (1985) and modified by Trajkovic (2007) (for the area to which it belongs experimental field having the following values: Ra = 16.0 in May, for June Ra = 17.2, Ra = 16.6 for July, the month August Ra = 15 = 4.5, for September Ra = 11, 5), these two interactions based on climatic factors.

To obtain soil water consumption related field pepper crop was estimated initial reserves of water, rainfall intensity greater than 8 mm and the amount of water added to the soil by irrigation regime applied for each month of vegetation period, they amounted to "inputs" of water in the soil, minus the final soil water reserve for each month during the growing season.

Water consumption calculation formula was based on soil water balance in a closed circuit, the groundwater at depths greater than 31 meters, with no intake system.

Soil water balance is given by (LUCA et al., 2008):

$$Ri+P+M=ETR_{opt}+Rf, \text{ from which resulted:}$$

$$ETR_{opt}=Ri+P+M-Rf$$

RESULTS AND DISCUSSION

Watering rules calculated values for the two variants, depending on the onset splashing are presented in Table 1. By applying watering according to the experience (50% and 80% of IUA) resulted watering schemes for each year from 2009-2011 (Table 2). By applying watering according to the experience (50% and 80% of IUA) resulted watering schemes for each year from 2009-2011 (Table 2). Irrigation norm applied in 2009 is of 3261.77 m3/ha at 50% of the IUA, respectively 2134.98 m3/ha at 80% of the IUA, irrigation norm for 2010 was of 2075.67 m3/ha for the 50% of the IUA, and 1423.32 m3/ha at 80% of the IUA, in 2011 received a standard irrigation of 3558.30 m3/ha at 50% IUA, respectively 2253.59 m3/ha for the 80% IUA. In Table 3 and 4 are summarized the values obtained for water during the growing season by indirect methods.

Table 1

The irrigation rates calculated for surface irrigation (m^3/ha)

Variant	H (m)	DA (g/cm^3)	CC (%)	CO (%)	P_{min} (%)	m (m^3/ha)
a_1 - 50 % IUA	0,3	1,28	31,59	17,55	24,57	296
a_2 - 80 % IUA	0,3	1,28	31,59	17,55	28,78	119

Note: h-watering depth; DA-apparent density; CC-field capacity; CO-wilting coefficient; P_{min}-minimum level of watering; m-watering norm.

Table 2

Watering schedule to cultivated peppers in field for experimental years 2009-2011

Variant	Month	Mai / May			June			July			August			September		
	Year	′09	′10	′11	′09	′10	′11	′09	′10	′11	′09	′10	′11	′09	′10	′11
a_1 - 50 % IUA		1	1	1	2	1	3	3	2	2	3	1	3	2	2	3
a_2 - 80 % IUA		1	1	1	2	2	5	5	3	3	5	2	5	4	4	5
Total vegetation period																
Total	waterings a_1	11	7	12												
	waterings a_2	17	12	19												

Note: ′09 – experimental year 2009; ′10 – experimental year 2010; ′11 – experimental year 2011

Table 3

Potential evapotranspiration estimated by Thornthwaite method for vegetation period of years 2009-2011

Month	May	June	July	August	Sept.
Temperatura medie lunară (2009) (^oC)	15,60	18,40	20,50	19,90	16,50
ETP m3/ha /luna	1054,93	1241,92	1385,21	1245,02	889,94
Temperatura medie lunară (2010) (^oC)	15,10	18,40	20,10	20,10	13,80
ETP m3/ha /luna	1022,97	1241,92	1359,79	1256,78	752,34
Temperatura medie lunară (2011) (^oC)	14,70	18,80	20,00	19,90	-
ETP m3/ha /luna	997,36	1267,28	1353,43	1245,02	-

Table 4

Potential evapotranspiration estimated by Hargreaves-Samani, modifyed by Trajkovic method for vegetation period of years 2009-2011

Year	Month / Index	May	June	July	August	September
2009	T_{max} (^oC)	25,1	25,9	27,7	27,7	25
	T_{min} (^oC)	5,5	8,8	11,1	12	3,2
	T_{med} (^oC)	15,3	17,35	19,4	19,85	14,1
	ETP lunară (m^3/ha)	1333,38	1390,25	1448,99	1251,07	935,06
2010	T_{max} (^oC)	21,5	24,9	26,9	27,5	21,1
	T_{min} (^oC)	9,6	13,4	14,7	14,3	8,8
	T_{med} (^oC)	15,55	19,15	20,8	20,9	14,95
	ETP lunară (m^3/ha)	1087,27	1235,17	1319,47	1194,79	753,144
2011	T_{max} (^oC)	23	26,6	26,5	27,6	-
	T_{min} (^oC)	7,6	12,1	14	13,1	-
	T_{med} (^oC)	15,3	19,35	20,25	20,35	-
	ETP lunară (m^3/ha)	1203,77	1370,11	1314,14	1225,66	-

Note: T_{max} – maximum temperature; T_{min} – minimum temperature; T_{med} – medium temperature; ETP – potential evapotranspiration.

Table 5 summarizes water recovery coefficient values obtained for each specific variant variety of irrigation regime in 2009-2011. Table 6 summarizes water recovery efficiency values obtained for each specific variant variety of irrigation regime in 2009-2011.

Table 5

Water valorization coefficient (m^3/ha) of pepper crop in years 2009-2011

Year	*Watering regime*	*Total water consumption* (m^3/ha)	*Variety*	*Yield averrage* (kg/ha)	*Water valorization coefficient* (m^3/kg)
2009	50% IUA	4678,57	c_1	33212	0,141
		4678,57	c_2	42207	0,111
		4678,57	c_3	30490	0,153
		4678,57	c_4	37582	0,124
		4678,57	c_5	32632	0,143
	80% IUA	3729,69	c_1	34962	0,107
		3729,69	c_2	43950	0,085
		3729,69	c_3	31978	0,117
		3729,69	c_4	39042	0,096
		3729,69	c_5	33345	0,112
2010	50% IUA	4874,42	c_1	32573	0,150
		4874,42	c_2	37293	0,131
		4874,42	c_3	26643	0,183
		4874,42	c_4	35302	0,138
		4874,42	c_5	28278	0,172
	80% IUA	4222,07	c_1	34758	0,121
		4222,07	c_2	38480	0,110
		4222,07	c_3	28815	0,147
		4222,07	c_4	36713	0,115
		4222,07	c_5	30517	0,138
2011	50% IUA	3940,99	c_1	33818	0,117
		3940,99	c_2	40642	0,097
		3940,99	c_3	30375	0,130
		3940,99	c_4	36443	0,108
		3940,99	c_5	30968	0,127
	80% IUA	2932,81	c_1	36407	0,081
		2932,81	c_2	44548	0,066
		2932,81	c_3	33502	0,088
		2932,81	c_4	40133	0,073
		2932,81	c_5	33628	0,087

Note: c_1 – green sweet pepper – OPAL; c_2 – long green pepper – FEHER; c_3 – long red pepper; c_4 – red sweet pepper – CALIFORNIA WONDER; c_5 –bell pepper-SPLENDID.

Table 6

Water efficiency valorization (kg/m^3) of pepper crop in years 2009-2011

Year	*Watering regime*	*Variety*	*Yield averrage* (kg/ha)	*Total water consumption* (m^3/ha)	*Waterefficiency valorization* (kg/m^3)
2009	50% IUA	c_1	33212	4678,57	7,10
		c_2	42207	4678,57	9,02
		c_3	30490	4678,57	6,52
		c_4	37582	4678,57	8,03
		c_5	32632	4678,57	6,97
	80% IUA	c_1	34962	3729,69	9,37
		c_2	43950	3729,69	11,78
		c_3	31978	3729,69	8,57
		c_4	39042	3729,69	10,47
		c_5	33345	3729,69	8,94
2010	50% IUA	c_1	32573	4874,42	6,68
		c_2	37293	4874,42	7,65
		c_3	26643	4874,42	5,47
		c_4	35302	4874,42	7,24
		c_5	28278	4874,42	5,80
	80% IUA	c_1	34758	4222,07	8,23
		c_2	38480	4222,07	9,11
		c_3	28815	4222,07	6,82
		c_4	36713	4222,07	8,70
		c_5	30517	4222,07	7,23
2011	50% IUA	c_1	33818	3940,99	8,58
		c_2	40642	3940,99	10,31
		c_3	30375	3940,99	7,71
		c_4	36443	3940,99	9,25
		c_5	30968	3940,99	7,86
	80% IUA	c_1	36407	2932,81	12,41
		c_2	44548	2932,81	15,19
		c_3	33502	2932,81	11,42
		c_4	40133	2932,81	13,68
		c_5	33628	2932,81	11,47

Note: c_1 – green sweet pepper – OPAL; c_2 – long green pepper – FEHER; c_3 – long red pepper (capia); c_4 – red sweet pepper – CALIFORNIA WONDER; c_5 –bell pepper – SPLENDID.

CONCLUSIONS

Established irrigation regime for growing peppers in the field had two minimum levels of active interval of 50% of the IUA and 80% of IUA. Watering to maintain the minimum level of 50% of IUA was 296 m3/ha water was applied 10 waterings, averaged over three years, and the minimum level of 80% of IUA were administered on average 16 waterings, in quantities of 118 m3/ha water.

Quantities of specific water management regime depended on irrigation and rainfall, taking into account the quantities of precipitation greater than 8 mm, depending and they laid out a range of watering regime 50% of IUA to be 9 days, and 80% of irrigation regime IUA to 6 days.

In the experimental year 2010, because the amount of rainfall during the growing season was about 534 mm, compared to the years 2009 (rainfall amount of 326 mm) and 2011 (329 mm), the number was the watering rules lower for both irrigation schemes, 50% of IUA with 7 total watering managing irrigation norm of 2075 m3/ha water, and 80% of the 12 watering IUA with a irrigation norm of 1423.32 m3 / ha.

Averaged over the three years to obtain an average of 899 m3/ha water for irrigation regime at the minimum level of 50% of the IUA, and that 705 m3/ha in irrigation regime at the minimum level of 80% of the IUA.

Reference evapotranspiration values determined by indirect method Thornthwaite far exceeds actual evapotranspiration values in field pepper crop, with an average of 1750 m3/ha. Water consumption determined by the indirect method Hargreaves - Samani, the modified equation is closer to the actual values, calculating an average of 1137 m3/ha water. For versions watered with irrigation regime at minimum level of 50% of the IUA, production was lower by a factor of valuation of water increased by approximately 30% than the other variant, resulting in field grown peppers that had a poor "management" of water in the watering variants with a larger amount of water and low frequency.

Comparing the indices obtained by calculation that the average water recovery efficiency of 7.6 kg/m3 pepper characteristic culture for alternative irrigation regime at the minimum level of 50% of the IUA is lower than recovery efficiency obtained for water irrigation system design with the minimum level IUA 80% of its value averaging 10.22 m3/kg in the three experimental years.

The highest values of the index efficiency of water recovery has been long green pepper variety FEHER value of 10.51 m3/kg, and the lowest long red peppers (CAPI) with value of 7.75 m3/kg. Green bell pepper varieties OPAL and red pepper CALIFORNIA WONDER is found similarities between efficiency values.

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