OPTIMIZATION OF WATER CONSUMPTION FOR THE IRRIGATION OF THE TOMATO FIELD IN GREENHOUSES ON THE TERRITORY OF BALENI VILLAGE, DAMBOVITA COUNTY

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Abstract
The topic of this work is of actuality for vegetable growers in Dambovita County and beyond, given the problem of using freshwater resources with its biological and economic implications. The research aimed at the establishment of the irrigation regime in cold greenhouses and solariums for private producers in Baleni village, Dambovita county and not only as a basic element for watering schedule in order to obtain reliable production of quality and higher quantity only in the context of maintaining the water balance of soil at constant parameters.
Experiments were conducted within the Baleni village area in Dambovita county on a group of solariums with a total developed area of 2500 square meters. We analyzed quantitative and qualitative issues for two types of table tomatoes according to the irrigation regimes applied for a period of three years.
The varieties of table tomato were Jadelo and Tangra which were applied with irrigation watering regimes with a recurrence of 3 and 6 days, for 3 watering rules corresponding to values of 50% ETM, 100% and 150% ETM ETM.
For any addition to the watering rate it corresponded a significant increase in production of tomatoes by increasing the number of tomatoes per plant and the weight gain of each tomato, especially to reduce the number of low quality tomatoes.
Corresponding to values of 50, 100, 150% of ETM, there was an annual average production of 61, 82 and 91 tons / ha, with a total of 17, 21 and 22 tomatoes per plants with an average weight of 92, 100 and 105g / fruit.
The research paper shows that in terms of restrictions on the consumer, ie the amount of irrigation water for values corresponding to 50% of ETM, specific to agricultural drought, there can be a considerable tomato production of 61 tons / ha for solariums.

Keywords: evapotranspiration, cultural coefficient, watering rate , irrigation rate, average productivity

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1.INTRODUCTION

The water problem in the world is a vital one that requires efficient use of water consumption of all the utilities, especially for irrigation which is the largest consumer of freshwater. Water as a basic component in the growth and development of plants influences the growth and development of plants but also the quantity and quality of agricultural crops.

The usage of water must take into consideration the environmental protection, limiting water loss being an imperative for horticulturists and others, which means that the efficient use of irrigation water requires its administration according to water requirements for horticultural crops (Lee, IBet.al, 2006).

It is already known that a large part of the tomato acreage in the protected environments on the county level is the table tomatoes. For such cultures of tomatoes, the irrigation has a dual role: to obtain high productions in irrigated conditions, ie obtaining high weight vegetables or to obtain higher quality products than the conditions without irrigation.

The method of irrigation is by drip irrigation, the implementation of the watering norms was done according to the water requirements of

plants taking into account the specific economic considerations and the principles of correct management of water resources (Feng et Chengbin.'s., 2008).
Irrigation intervals and amounts of irrigation water can be adjusted manually or automatically through the use of computers that take certain signals generated by sensors of soil moisture or tensiometers. There is a need to establish objective criteria for determining the amount of water and every watering norm for each irrigation period (Davidov, D., 2010).
This paper started from the premise that there is a need for counseling farmers on the importance of the irrigation of the tomato cultures in protected areas without heating, the need to fulfill the water balance on the surface that needs to be cultivated with table tomatoes, and that the research results can be quickly applied by them.
So the purpose of the research was to cover the lack of experimental information on the role of tomato crop irrigation in protected areas for the farmers in Baleni village and others.

Equipment and method

This research work was conducted during 2010 - 2013, in Baleni, Dambovita, the protected areas were made of circular metal structure covered with transparent polyethylene on a total area of 2500 square meters (Allen, RG, et. al., 1991).
The pedological study shows that the soil is mostly reddish stagnated preluvosoil, poorly gleying-stagnated, developed on noncarbonated clay loam deluvial material. The land equipped with greenhouses is mostly plains, the horizontal surface has an unevenness of 5 to10 cm, the parental material has a medium content in exchangeable bases, the groundwater is found at a depth of 10m. Physico-chemical analyzes are presented in Table 1.
The following works were made in each greenhouse(Yu, I.H et.al., 2008):
- A plot with two varieties of tomatoes without irrigation;
- A plot with the two varieties of tomato that were applied by watering norms from 3 to 6 days;
- An elementary plot with two types of tomatoes which have had irrigations for 50%, 100% and 150% ETM.

Evapotranspiration for the reference crop was estimated using the relationship:

$$ETM = Eta \times Kpan \times Kc$$

Eta was estimated using BAC Class atmidometer positioned inside the solarium and also with the help of the Penman-Monteith's formula (Kasperski-Wolowicz et. Al., 2006) and Hpan has a value of 0.80 considering the humidity inside the solarium and especially the lack of wind, and during the culture cycle the following cultural coefficients were taken (Dağdelen N.et.al., 2008): Kc = 0.65 from emergence to bloom, kc = 0.85 from bloom to the first harvest, Kc = 1.1 throughout the harvest period.
Each elementary plot had 50 plants spaced at 30 cm, on 5 parallel rows with a distance between them of 55 cm and 3 m long.
The tomato culture in the greenhouses began on the following dates: 07/03/2010 for the first year of observation, 10.03.2011 for the second year and 20.03.2012 for the year 2012. Throughout the research the tomato culture has benefited from the work of fertilization and plant required.
Water supply for irrigation of plots was made with a HDPE plant irrigation system with supply nozzles which have a distance of 30 cm between them and measuring the flow of water necessary to ensure the watering rules was done using a flow meter disposed upstream of each plot (Liu Xiumei et al, 2010).
Harvesting tomatoes was done differently depending on their calibrated sizes, thus: large tomatoes with a size greater than 87 mm, average tomatoes with a thickness of 56-87 mm and small tomatoes with an average thickness of less than 56 mm.
On the basis of the state experiences the experimental protocol on application irrigation schedule as shown in Table 2.

On the basis of experiences there was an experimental protocol regarding the schedule of irrigations as shown in Table 2.

Tabelul 1. Analize fizice si chimice

Nr. Reprezentative profile	horizon	Sample depth /cm	pH	CaCO3	Humus	Azoth parameters	P2O5 mobil ppm	K2O mobil ppm	Geometric analyses					SB	SH	V%	Al,me/100g	NO3 ppm
									N coarse	N fine	Dust I	Dust II	Loam					
172	Ao	0-26	5,38	-	1,92	1,31	16,4	126	12,2	23,0	22,3	11,6	30,9	12,5	5,8	68,3	0,4	0,7
-	Bt1w2	50	5,80	-	1,04	0,81	9,2	63	12,4	23,0	20,7	11,7	32,9	14,2	4,0	78,0	-	0,2
-	Bt2w2	65	5,91	-	-	-	-	-	13,6	20,4	17,5	10,9	37,6	17,5	4,3	80,3	-	0,1
-	Bt3w3	95	5,89	-	-	-	-	-	13,0	22,3	15,9	10,4	38,4	17,4	4,7	78,7	-	-
-	B/Cw3	120	5,86	-	-	-	-	-	13,5	21,0	15,7	9,3	40,5	17,6	4,2	80,7	-	-

Tabel 2. Irrigation volumes and number of interventions during irrigation from 2010-2013

Year	Irrigation rate [m^3/ha]	Interventions with irrigation every 3 days			Interventions with irrigation every 6 days		
		50% E.T.M	100% E.T.M	150% E.T.M	50% E.T.M	100% E.T.M	150% E.T.M
2010	Irrigation supply rate [m^3/ha]	100	100	100	100	100	100
	Number of experimental watering [m^3/ha]	34	34	34	17	17	17
	Experimental irrigation rate [m^3/ha]	1321	2642	3963	1321	2642	2963
2011	Irrigation supply rate [m^3/ha]	500	500	500	500	500	500
	Number of experimental watering [m3/ha]	34	34	34	17	17	17
	Experimental irrigation rate [m3/ha]	1410	2820	4230	1410	2820	4230
2012	Irrigation supply rate [m3/ha]	210	210	210	210	210	210
	Number of experimental watering [m3/ha]	32	32	32	16	16	16
	Experimental irrigation rate [m3/ha]	1800	3600	5400	1800	3600	5400

For the 2 varieties of tomatoes in the first 2 years there were imposed 17 rules for watering for their application at an interval of 6 days and 34 watering rules for their application in 3 days. Stagional volume of water for the first two years was 1200-1300 M3\/ha for a value of 50% ETM, 2400-2600 M3\/ha for a value of 100% ETM and 3600-3900 M3\/ha for a 150% ETM. 16 irrigations were applied in the 3rd year with a return period of 6 days and 32 irrigations every 3 days and the volume of stagional water was of 1800, 3600, and 5400 M3\/ha for 50%, 100% and 150% ETM.

3. RESULTS AND DISCUSSION

In general it was based on representing the data obtained through three years of research regarding the tomato culture, but the climate data was kept in mind for the next 3 year period. For example in the first year of 2010 we achieved the best tomato productions up against the previous years, namely about 117.3 t /. For the next 2 years of research, productions were lower, given the lower seasonal temperatures compared to 2010 (Bertram, L., 1992).

The average production of tomatoes in these 3 years shows a significant growth of productivity, especially an improvement on the weight of tomatoes by applying differential irrigation, as shown in Figure 1.

The average production of tomatoes for the 3 years of observation, corresponding to the three rules of watering, has been of 91,4 to\/ha for 150% ETM, 82,5 to\/ha for 100% ETM and 60.7 t\/ha for 50% ETM, as in Figure 2.

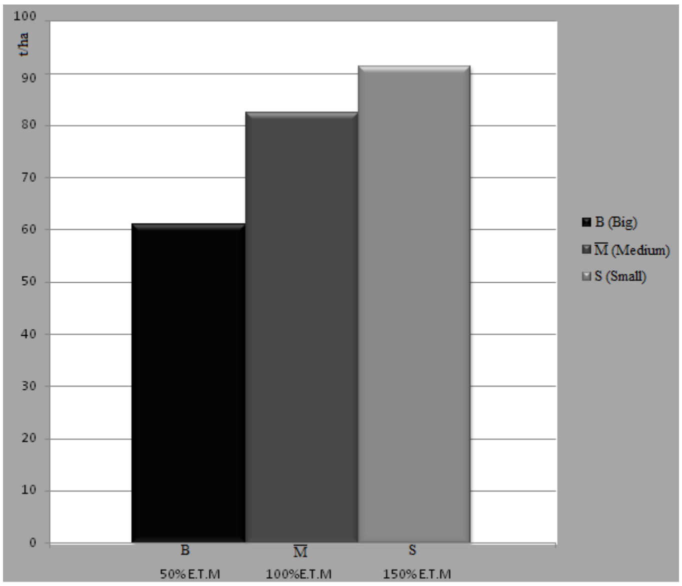

Fig. 2. Triennial average production of tomatoes depending on the ETM

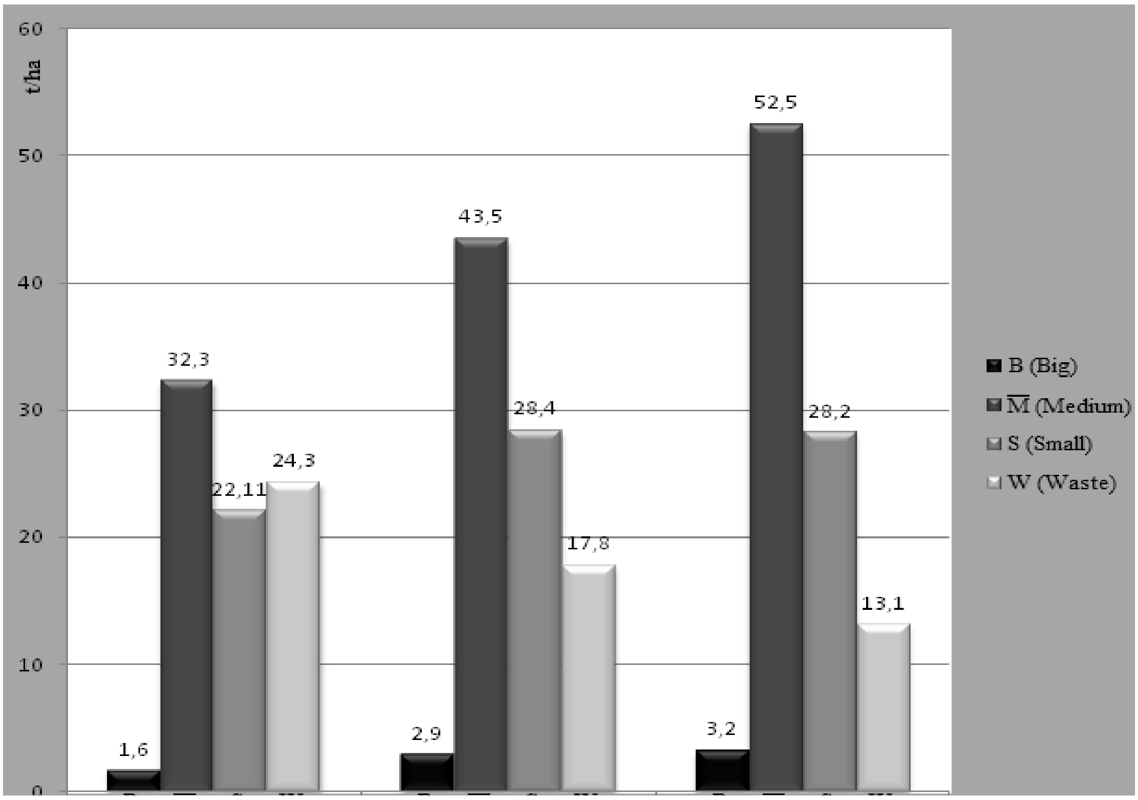

Fig.1 Triennial average tomato production depending on the sizes of tomatoes

It was a production of 35 t\/ha for the quantity of irrigation water at the level of 50% of ETM, a production of 50.5 t\/ha for 100% ETM and up to 60.3 millions t\/ha for 150% ETM. Quantity of rotten tomatoes is inversely proportional to the amount of irrigation water, i.e. at large volumes of irrigation water, the quantity of rotten tomatoes is small, meaning 10.6 t\/ha for walues of 150% ETM, 14.2 t\/ha for values of 100% ETM and 10\/ha for values of 50% ETM.
In conclusion it can be said that the irrigation volumes corresponding to the values of 150% of ETM obtain productions of high quality tomatoes , with a proper commercial distribution of fruits obtained, i.e. the quantity of rotten tomatoes is 42% for 50% ETM, 27% for 100% ETM and 20% for 150% ETM, as in Figure 3.

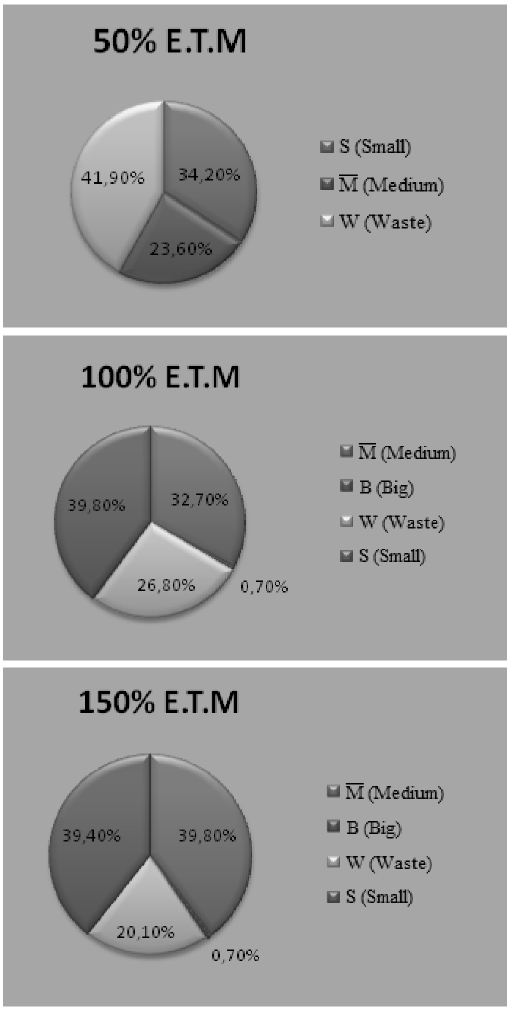

Fig. 3. Triennial percentage of average production of tomatoes and quality classes according to the ETM

The ranges of supply with irrigation water to 3 and 6 days did not differ in any significant manner the commercial tomato productions compared to rotten tomato production, instead it can be observed a tendency of producing large amounts of rotten tomatoes for extended irrigation intervals and productions of large or medium tomatoes for short irrigation intervals.
For the two tomato crops were obtained significant differentiated productions, statistically, for example, the culture of Tangra has produced an average of 71,5 t\/ha of commercial tomato while the culture of Jadelo has produced a quantity of 84,8 t\/ha, as show in the figure. nr. 4.

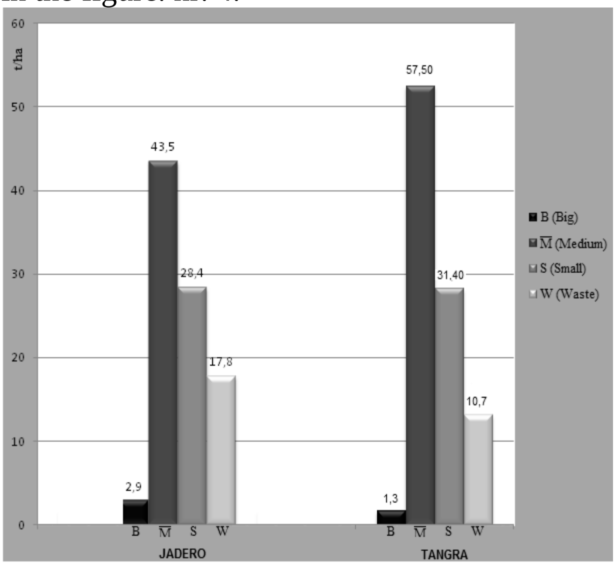

Fig 4. Triennial average production of tomatoes for the variety of Jadelo and Tangra depending on size of fruit

These results show the fact that the two tomato crops that have received large amounts of irrigation water, have resulted in getting some big tomatoes productions, of very good quality and that both varieties of tomatoes behave about the same as compared to the amount of water provided through irrigation.
From the analyses conducted, it results that between irrigation water volumes that were operated and irrigation intervals there is a significant relationship, i.e. the average and small weighs are a result of smaller irrigation norms for longer periods, while higher average weights are characteristic of large quantities of irrigation water administrated for short periods.
So we can say that the solution must be found for the administration of large irrigation

volumes to corresponding values of 150% ETM, which will be administered at short time intervals (Frenz, f., et al., 1983).

CONCLUSIONS

The results of the experiences highlight, as a method of applying, that the hydric balance is valid for solariums, taking into account the climatic differences of the 3-year study.

In case of applying irrigation rules corresponding to 150% ETM, it shows that the number of large weight fruit is high, thus resulting in a higher production for commercial tomatoes and a minimal amount of waste.

The linearity of the results obtained on the three years of observation, show that similar climatic conditions can reach high values of tomato production and especially in terms of high quality, depending on the volume of irrigation calculated in relation to the water consumption based on the universal formula for balance, but with well-established culture coefficients that are specific to each tomato crop, multiply by a factor of 1.5.

Established crop coefficients for Baleni village, which can be applied for irrigation water requirements are:

- Kc = 0.6 – specific coefficient to the planting period;
- Kc = 0.9 - specific coefficient to the period from planting to flowering;
- Kc = 1.35 - specific coefficient until getting the first harvest;
- Kc = 1.8 - specific coefficient for the entire production period after the first harvest

These cultural values of the coefficients confront the values of the coefficients obtained that are experiencing the same climatic conditions in the field. Higher values of the coefficients obtained in greenhouses as against values from field crops are the consequence of plant size in the greenhouse but especially due to the greenhouse effect generated by the polyethylene sheet.

It is found that the scientific establishment of cultural coefficients corresponding to each crop in part under certain climatic conditions may apply irrigation rules which can determine a number of superior high-quality fruit, ie obtaining high productions of tomato with low cost prices, given the rational use of irrigation water.

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