IRRIGATION REGIME AND WATER CONSUMPTION FOR LETTUCE CULTIVATED IN PROTECTED AREAS

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Abstract. *The research purpose of this paper, was to determine water consumption and the watering scheme for lettuce, cultivated in a protected area, while aiming to attain early crops of high quality, at low specific costs. Every producer should be able to estimate the amount of necessary water, use it rationally, exploit correctly irrigated fields and crop watering techniques in order to meet yield and harvest quality goals at the lowest production costs.*

Keywords: water consumption, irrigation regime, lettuce, protected area

INTRODUCTION

When crop requirements towards water cannot be assured through natural means as precipitations, in a protected system, watering gains a great importance. Watering scheme implies prevention of the soil humidity deficit for a certain crop and for certain soil conditions, by estimating the first watering, as to be an efficient one, or the date of the last watering, as to avoid the negative effects of humidity stress (RITCHI et al., 1990).

The decision to water crops should be taken while considering all the aspects that refer to soil, water, plant, climatic factors and the equipment used to obtain maximum yielding of the crop, as: soil capacity to retain water, quality of the irrigation water, volume of the applied water and watering frequency (CARRIJO et al., 1999).

Generally, vegetables have higher water consumption, when comparing them to other crop plants and a strong negative response in production quality and quantity, when not properly irrigated. Water use efficiency can be attained only when knowing the needs for water of the irrigated crop, the watering moment, the quantity of water required at a certain irrigation moment (watering rate) and throughout the whole vegetation period (watering scheme).

MATERIAL AND METHOD

Experiments regarding water consumption and watering schemes studies for lettuce, were carried out between years 2004 and 2006, at The University of Agricultural Sciences and Veterinary Medicine, Cluj-Napoca, inside the greenhouses belonging to Vegetable Growth discipline. Researches were conducted in two experimental cycles (spring and autumn) in each year, within trials that added in two factors, one of them having two and the other one three graduations.

Experimental factors and their graduations were:

Factor A: watering method, with following graduations:

a_1- drip watering

a_2- micro-sprinkler watering

Factor B: watering moment, with following graduations:

b_1- at 60% from the active humidity interval

b_2- at 70% from the active humidity interval

b_3- at 80% from the active humidity interval

Establishing main hydrophysical parameters, characterizing the soil from the agrochemical point of view and framing the experimental plots according to a texture category, was done following the methods of the ICPA system.

To determine water consumption of the lettuce cultivated in protected area, a direct method, soil water balance method was used. In order to determine water consumption through direct method, soil water reserve was accurately established at the beginning and at the end of the vegetation period, using the gravimetric method.

RESULTS AND DISCUSSION

After applying the irrigation according to the experiment plan (at 60%, 70% and 80% from the I.U.A) using the mentioned methods (drip irrigation and micro-sprinklers irrigation) the irrigation scheme resulted for the 2 crop cycles (in the spring and the autumn), in each year for the 2004-2006 period (table 1).

Table 1

The number of watering, applied in the three years of experience

Variant	2004		2005		2006	
	Spring	*Autumn*	*Spring*	*Autumn*	*Spring*	*Autumn*
V1-P-60 % IUA	10	9	10	8	11	9
V2-P-70 % IUA	18	16	19	14	18	15
V3-P-80 % IUA	31	28	35	24	33	26
V4-M-60 % IUA	6	5	7	5	6	5
V5-M-70 % IUA	10	8	10	7	10	8
V6-M-80 % IUA	16	14	17	12	17	13

After watering according to the irrigation scheme, at three different moments, it can be observed, that, wetting numbers grew while the humidity level of the soil arose, in correspondence with the watering moment established and where water was supplied through drip irrigation, the wetting number was twice as big as the one reached due to micro-sprinklers irrigation. The number of wettings was smaller for micro-sprinklers irrigation, as water rates were almost double in compassion to drip irrigation ones. In fall, the wetting number was reduced, but still the variants wetted through drip were more frequently wetted.

Irrigation rates applied to lettuce crops, during the three experimental years (table 2), varied dependent on the watering method and the level of humidity maintained in soil.

Table 2

The irrigation norms (m^3/ha) on vegetation period (Cluj-Napoca, 2004-2006)

Variant	2004		2005		2006	
	Spring	*Autumn*	*Spring*	*Autumn*	*Spring*	*Autumn*
V1-P-60 % IUA	1080	972	1080	864	1188	972
V2-P-70 % IUA	1458	1296	1539	1134	1458	1215
V3-P-80 % IUA	1674	1512	1890	1296	1782	1404
V4-M-60 % IUA	1614	1345	1883	1345	1614	1345
V5-M-70 % IUA	2020	1616	2020	1414	2020	1616
V6-M-80 % IUA	2160	1890	2295	1620	2295	1755

In each year, water rates were bigger for micro-sprinklers variants and lower for drip variants. Where the amount of water is concerned, the wetting moment had a significant role, because variants frequently wetted had bigger water rates than the ones wetted through the same method, but not at the same frequency.

The water rate of 80% from the active humidity interval distinguishes itself from the rest, through maximal values, both for drip irrigation (between 1674 and 1890 mc/ha) and micro sprinklers irrigation (between 2160 and 2295 mc/ha), applied in spring cycle.

Water rates applied in autumn crops, are lower, with maximal values in 2004 autumn: 1512 mc/ha through drip irrigation and 1890 mc/ha through micro-sprinklers irrigation.

During vegetation period, lettuce water consumption oscillated in accordance to the development state of the crop, water rates and watering methods, recording low values at the beginning and at the end of the vegetation period and maximal values at the middle of the vegetation period, which corresponds with the period of heads development.

The influence of climatic conditions brings differences between the average water consumption of the two crop cycles. In each of the three experimental years, water consumption recorded in spring is bigger than the one recorded in autumn.

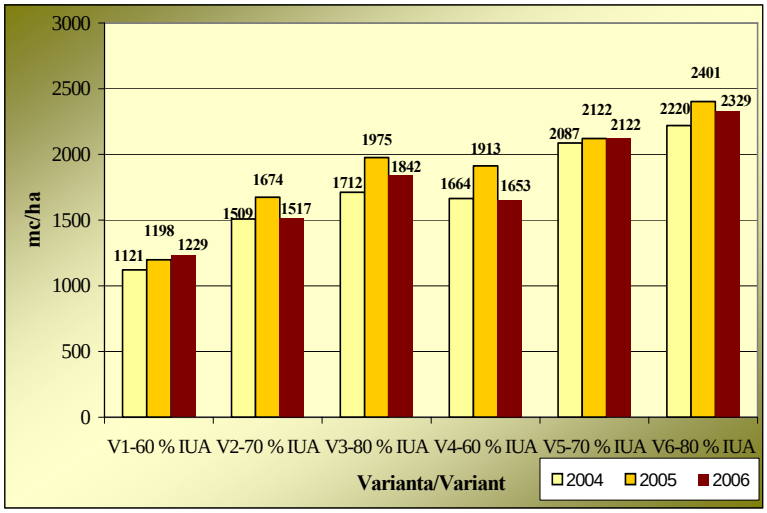

Fig. 1. Lettuce water consumption in spring culture, for the period of 2004-2006

Where the total water consumption is concerned, during spring crops (figure 1), the highest values were recorded in 2005: between 1198 m^3/ha and 1975 m^3/ha for drip irrigation and 1913 m^3/ha and 2401 m^3/ha for micro-sprinklers irrigation, respectively.

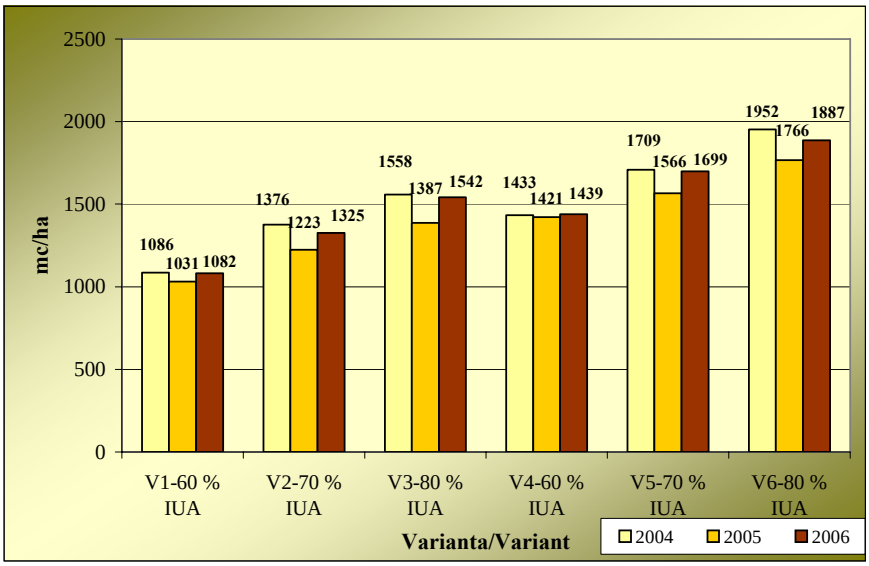

Fig. 2. Lettuce water consumption in autumn culture, for the period of 2004-2006

In the second crop cycle, in autumn (figure 2), lettuce total water consumption recorded maximal values in 2004, at an 80% water rate from the active humidity interval, with 1558 m^3/ha at drip irrigation and 1952 m^3/ha at micro-sprinklers irrigation.

Irrigation norm and the way it was applied influenced the growth of the lettuce plants and the dynamic of the heads development with consequences upon the yield level and quality.

A correlation between yield and water consumption was made based on the values of total lettuce yield and total water consumption during vegetation in 2004-2006. The two coefficients, correlation (r) and determination (R^2), were separately calculated for the applied irrigation methods (drip and micro-sprinkler), due to the significant differences obtained between them when concerning yield and water consumption.

In the first crop cycle, during spring time (figure 3), a strong correlation can be observed between lettuce yields and total water consumption, the correlation coefficient being noticeably significant with a value of r= 0.94, when irrigation occurs through drips, and very significant with a value of r= 0.97, when irrigation occurs through micro-sprinklers. Yields were determined by water consumption up to 89% at salad irrigated through drips (R^2= 0.89), and up to 93% at lettuce watered through micro-sprinklers (R^2= 0.93).

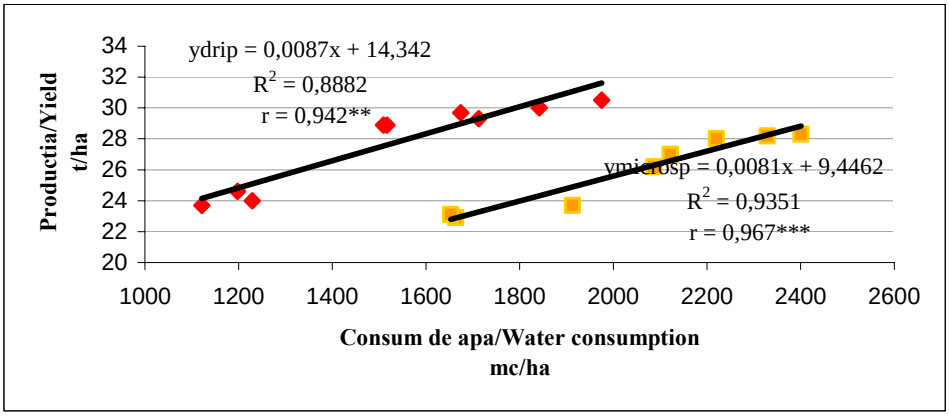

Fig. 3. Correlation between lettuce production and total water consumption (spring cycle)

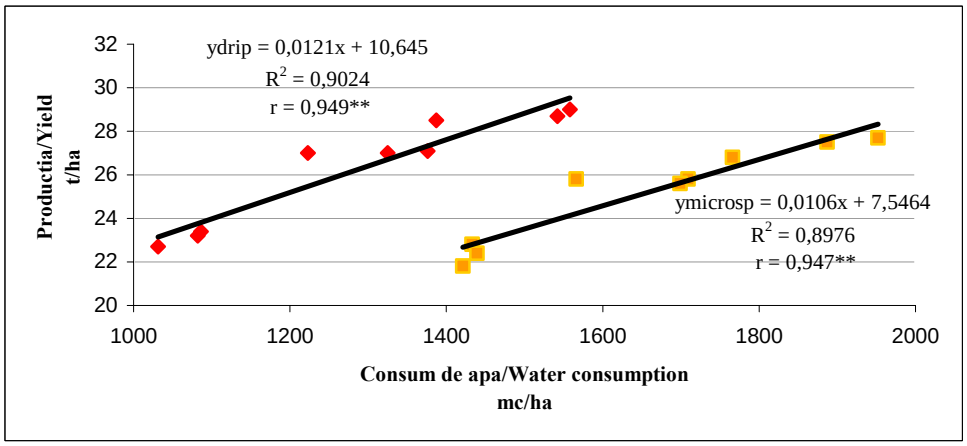

Fig. 4. Correlation between lettuce production and total water consumption (autumn cycle)

Between the analyzed parameters of the autumn crop (figure 4), the correlation is lineal, noticeably significant and the value of the correlation coefficient is r= 0.95, both for the lettuce watered through drips and the one watered through micro-sprinklers, this indicating yields close dependence on the water consumption of the crop. Lettuce yield of the autumn was 90% determined by water consumption for both of the methods.

CONCLUSIONS

Water use efficiency was higher in case of drip irrigation in comparison to micro-sprinkler irrigation. The results obtained show the usefulness of drip irrigation in vegetable growing which considerably decreased water consumption and maintained proper moisture conditions for lettuce growth and yielding.

Reducing irrigation had resulted in significant decrease of marketable yield. This was accompanied by a decrease in the crop water use, as a consequence of inadequate soil moisture in the rooting zone.

From a qualitative point of view, in what lettuce heads are concerned, drip irrigation is recommended, because it assures control upon the quantity of applied water, as well as quality yield, due to the fact that not the entire surface is moistened, the water reaches the soil directly, in the root area, and the leaves remain dry, which reduces the percent of rotten wasted plants. This method is also recommended when higher yield are desired, no matter the costs.

From an economical point of view, micro-sprinklers irrigation is recommended. Though the yields are lower using this method, they are enough to determine a higher gain.

In the mater of proper wetting moment, it is recommended a water rate of 80% from the active humidity interval, in which case yields are noticeable higher than in the case of 60% or 70% rates from the active humidity interval.

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