IRRIGATION REGIME FOR LONG-FRUIT CUCUMBERS GROWN UNDER GREENHOUSE CONDITIONS

Assoc. Prof. PhD R. Kireva, Prof. PhD M. Mihov
Institute of Soil Science, Agricultural Technology and Plant Protection "Nikola Pushkarov", Sofia, Bulgaria
Email: R.Kireva@abv.bg ; M.Mihov@abv.bg

SUMMARY: *The deficit of the irrigation water requires irrigation technologies of more efficient water use .For cucumbers the most suitable is the drip irrigation. For establish the appropriate irrigation schedule of cucumbers under the soil and climate conditions in the village of Chelopechene, near Sofia city, research was conducted with drip irrigation adopting varying irrigation schedules - from fully meeting the daily crops water requirements cucumbers to reduced depths with 20% and 40%. Have been established irrigation schedule, irrigation water productivity and yields of in plastic unheated greenhouses of the Sofia plant.*

KEY WORDS*: IRRIGATION, YIELD, IRRIGATION SCHEDULING, DRIP IRRIGATION, PLASTIC UNHEATED GREENHOUSE, LONG-FRUIT CUCUMBERS*

Introduction

Climate change due to global warming has a significant impact on water resources, including groundwater and surface water (Ziad A. M. and S. A. Jamous, 2010). Drought periods vary in duration and time of manifestation.

Climate change in agriculture as a result of climate change necessitates the use of appropriate systems and technologies for growing and irrigating crops in accordance with soil, climate, environmental and economic conditions. Under the new conditions of agricultural development, water is a limiting factor and becomes extremely important from an environmental and economic point of view. It is also a decisive factor in achieving the maximum productive capacity of crops in the optimal provision of plants with water.

Reducing crop water consumption can be achieved by: optimizing the parameters of the applied irrigation regime, irrigating crops with reduced irrigation rates and applying water-saving irrigation technologies such as drip irrigation.

In this aspect, it is unrivaled in greenhouse vegetable production. This technology fully meets the requirements for sustainable agriculture and environmentally friendly fruit production, ensures high yields and quality of production, reduces unwanted side effects. (Branson, R.L., 1981)

It has been proven that vegetable crops respond very well to drip irrigation, both in terms of quantity and quality of production, and in terms of irrigation water productivity.

One of the most common - the cucumber is demanding on soil and air humidity. This is due to its relatively poorly developed root system and to the arrangement of its leaf apparatus with a poorly developed cuticle (Shaban, H, et al, 2014)

For their normal development and fruiting, soil moisture is required to be above 80% of the WHC (Murtazov et al., 1975), with the best results in the use of plant water obtained by drip irrigation, and the increase in yields reaches from 15% to 18% against rain and gravity irrigation (Clark, 1979)

Concerning the cultivation of vegetables in the Sofia region, the following more important conclusions can be drawn regarding the natural conditions:

- the area is suitable for growing vegetables, as the temperature conditions meet their requirements. The duration of the period with steady retention of average daytime air temperatures above 10C is 180 - 200 days. The temperature sum for this period is 33 - 35C. This temperature sum is sufficient for the development of basic vegetable curls. (Hershkovich and Stefanov, 1982).

- to obtain earlier production in the area, it is necessary to use plastic greenhouses to prevent late spring and early autumn frosts. (Mihov et al., 1981)

Research on irrigation regimes of vegetable crops, incl. and long-fruit cucumbers grown in cultivation facilities continue to be relevant, given the objective changes that occur in agriculture.

The purpose of the forthcoming research is to establish the optimal values ??of irrigation parameters of long-fruited cucumbers irrigated by drip - irrigation and irrigation norms, inter-irrigation periods and number of irrigations.

●MATERIAL AND METHODS

In order to determine the drip regime in terms of the amount of water supplied, the irrigation period, the amount of irrigation rate, and the influence of irrigation regimes on the yields of long-fruit cucumbers.The Gergana variety was chosen for the experiment because of its wide distribution, high quality, taste and quantity indicators. The experiment was carried out in unheated plastic greenhouses of the type "Polymerstroy" in an experimental field in the village of Chelopechene - Sofia, as follows:

1st variant - irrigation with 120% of the irrigation rate determined in the optimal variant (120% m);

2nd variant - irrigation with full irrigation rate (100% m) - optimal irrigation (control);

3rd variant - irrigation with 80% of the irrigation rate, determined in the optimal variant (80% m);

4th variant - irrigation with 60% of the irrigation rate, determined in the optimal variant (60% m);

The irrigation in the optimal variant (variant 2) is applied when the soil humidity drops to 85% of the WF in the layer 0 - 0,5 m, and the amount of irrigation rate is calculated for wetting up to the WF of the entire active soil layer (0 - 60 cm).

Irrigation rates are calculated by the formula:

$$m = [10.H\alpha.(\delta_T om\ ППВ - \delta_T\ пр.вл.)].K.K_1$$

where: m is the magnitude of the irrigation rate in mm;

α is the bulk density of soil in gr / cm3;

H is the depth of the active soil layer in m (in the experiment H = 0.5 m);

δт of WFD - field moisture limit in% relative to the absolutely dry soil weight;

δm BC - over-humidity of the soil in% relative to the absolutely dry weight of the soil;

K - the rate of reduction of the irrigation rate, taking into account the area occupied by plants in 1 dka. In the experiment, K = 0.525, i.e. 52.5% of the area is irrigated.

Drip irrigation does not convey the size of the entire irrigation rate, as with other irrigation methods. Reduction is made at the expense of the non-irrigated area. The Ferckman formula, Grazoli [6] was used for this purpose, taking into account the planting scheme. After calculating the irrigation rate for variant 2, the norms of the other variants are determined by its size.

The irrigation was done with an Agrodrip drip irrigation installation. The pipelines of this type of irrigation systems are polyethylene, consisting of two pipes inserted into each other with a long screw channel formed for the movement of water with an outside diameter of 20 mm, the openings for supplying water through 30 cm, the water quantity of one opening. is 2.4 l / h at a working pressure of 0.1 MPa.

Soil moisture dynamics is monitored by sampling soils that have been processed by the thermostatic weight method in the 100% version of the irrigation rate. 100% irrigation rate is the rate calculated on the basis of water - the physical properties of the soil and its mechanical composition, the biology of the crop, the soil WHC, the over-humidity.

The experiment was performed by block method in four repetitions on leached cinnamon forest soil, characterized by the following water-physical properties: PPV - 20,2 relative to the absolute weight of the soil, bulk density at WHC 1,54 g / cm3 and humidity 10.38%, by weight of absolutely dry soil.

Results and discussion

Studies on irrigation standards, taking into account the water-physical characteristics of the soil type, make it possible to determine the extent to which the biological needs of the crop are fully met without significant loss of water.

The results obtained from the experimental years are unidirectional, since the experiment is performed under controlled conditions and the experimental years have similar meteorological conditions. In terms of air temperature, the years during which the experiment was taken are characterized as warm.

The presented results of the replanted irrigation and irrigation norms show that to maintain soil moisture in the range between 85-100% of the WHC in long-fruit cucumbers, they were realized with 21 irrigations average over the study period. Under the conditions of the Sofia Field, they were implemented from the beginning of April to the end of July. The inter-irrigation periods during the different phases of the culture's development are different. At the beginning of the growing season, the needs of the plants for humidity are small, there is little and the tension of meteorological factors and irrigation are carried out in 7 - 10 days. During this period, the plants had a small leaf area and lacked fruiting organs and fruits. The root system is poorly developed. With increasing leaf area and the formation of fruiting organs and fruits, the needs of plants for soil moisture increase. During this period the tension of the meteorological factors in both the open air and the greenhouse increased. Waterings are made every 3-4 days.

In Option 2, where the calculated irrigation rate is submitted, it is found that the over-humidity is maintained on average 85-90% of the WHC.

Maximum irrigation rates in individual years during the period of maximum water consumption can be submitted in 3-4 days and meet the needs of the plants. Under 1.5 atmospheres, they are realized within 2 - 3 hours.

Irrigation rates by year varied from 11.6 to 22.1 mm for the individual variants, and irrigation rates from 230 to 450 mm averaged over the study period (Table 1). The main part of the water consumption of greenhouse vegetables is evapotranspiration, which is not significantly different from irrigation norms, since it is formed almost entirely from them.

Table 1: *Number of irrigations, watering's and irrigation norms in variants*

Variants	Number of irrigations					Irrigation norm, mm					W.norm mm
	2001	2002	2003	2004	Average	2001	2002	2003	2004	Average	Average
1.120% M	21	19	22	20	21	22,1	21,9	22,0	21,7	22,0	449
2.100% M	21	19	22	20	21	18,4	18,2	18,4	18,6	18,3	374
3. 80% M	21	19	22	20	21	14,7	14,5	14,8	14,4	14,6	300
4. 60% M	21	19	22	20	21	11,8	11,6	11,9	10,8	11,5	230

The yields that are obtained from vegetables in cultivation facilities of the type of unheated greenhouses depend to some extent on the weather conditions of the particular year (temperatures) and the factors tested. In the present development, the test factor is the size of the irrigation rate.

The irrigation regimes implemented influenced the formation of yields of long-fruit cucumbers. The highest yields in the soil and meteorological conditions for the Sofia, field average over the study period were obtained in the variant irrigated with 120% realization of the irrigation rate. Its yield is 8391 kg / dka, followed by the variant with 100% irrigation rate - 8010 kg / dka. The lowest yields were obtained with the variant with 40% reduction of the norm - 6055 kg / dka. A 20% increase in the irrigation rate led to a slight increase in yields by 5%, which is economically unreasonable compared to the cost of the water supplied. In the face of water scarcity and costly irrigation water, the information collected proves that the increase in irrigation rates of the studied crop grown in a plastic greenhouse is not justified.

A 20% reduction in the irrigation rate resulted in an 8% decrease in yields compared to the 100% irrigation option. This irrigation mode can be used in case of water shortage

Table 2: *Yield of the long-skirted on variants end years*

Variants	2001	2002	2003	2004	2001 - 2004	
	Yeild, kg/dka	Yeild, kg/dka	Yeild, kg/dka	Yeild, kg/dka	Yeild, kg/dka	Relative, yield %
120% M	8728	8189	8597	8051	8391	105
100%M	8320	7836	7938	7946	8010	St
80% M	7780	7327	7351	7184	7411	92
60%M	6520	5662	6204	5834	6055	75

2001 – 2004 г $GD_{5\%}$ =1790 kg/dka; $GD_{1\%}$ =2510 kg/dka; $GD_{0,1\%}$ =3548 kg/dka;

Experiments conducted under greenhouse conditions with long-fruit cucumbers show that cost-effective irrigation yields for irrigation water are obtained while maintaining soil moisture within 85-90% of WHC, which best meets the biological needs of the crop and its water-physical properties. The 20% increase in the irrigation rate led to a slight increase in yields from 2% to 5%, which is economically unreasonable compared to the cost of the water supplied. In the face of water scarcity and costly irrigation water, the information collected proves that the increase in irrigation rates of the studied crop grown in a plastic greenhouse is not justified.

Conclusions:

1.To maintain soil moisture in the range of 85 - 90% of WHC when growing long-fruit cucumbers in plastic unheated greenhouses, 21 irrigation irrigation rates of 18.3 mm and irrigation rate of 374 mm are required.

2. For the study period, the highest yield of long-fruit cucumbers was obtained at 120% irrigation rate - 8391 kg / dka and the lowest at 40% reduction in irrigation rate - 6055 kg / dka.

3.The increase of the irrigation rate by 20% resulted in a slight increase in yields from 2% to 5%, by 5%, which does not compensate for the consumption of water. In the face of water scarcity and expensive irrigation water, it was proved that the increase in the irrigation norms of the studied crop grown in a plastic greenhouse was not justified.

3.The results of the experiment give us reason to recommend that irrigation of long-fruit cucumbers under greenhouse conditions should be carried out with an irrigation rate of 18 mm or a total of 374 m3 / dka irrigation rate. In case of water shortage, apply a irrigation regime with a 20% reduction in the irrigation rate, in which a satisfactory yield of 7411 kg / dka is obtained.

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