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DRIP IRRIGATION AND PRODUCTIVITY OF WATER AT GROWING STRAWBERRIES IN AN OPEN AREAS

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Abstract: *Research of drip irrigation was conducted in order to establish the right irrigation scheduling of strawberry grown in soil and weather conditions of the Sofia region in the period 2011-2013. The various watering modes were tested from full satisfaction of the daily water needs of culture to irrigation reduced by 20% and 40% of the irrigation norms.*

Strawberry irrigation scheduling was established for the field around Sofia capital - number irrigations, irrigations depths, irrigation rate and yields. The highest yields were obtained at 100% irrigation rate - 1518 kg/dka. The reduced irrigation depths with 20% resulted in rather small drop in yields by 25%. This irrigation scheduling can be applied in conditions of water deficit.

Key words: Irrigation, yield, irrigation scheduling, drip irrigation, strawberry.

1.INTRODUCTION:

Micro-irrigation of strawberry plants is more extensively used in view of possibilities to efficiently control the processes in the irrigation system and in the plant irrigated. This method meets in full the requirements for sustainable agriculture and ecological fruit production, as well as it provides high yields, and reduces the unwanted side effects (Kireva, Petkov, [3]; Petrova, [6]; Moteva et al, [4]). Applying this method of irrigation in strawberry cultivation which is of essential economic importance mainly because of its high productivity and production efficiency, requires to establish in detail the parameters of irrigation regime under the particular conditions in the Republic of Bulgaria.

The studies for strawberry irrigation performed up to now show that this culture reacts very well to micro irrigation both with respect to the production volume and with respect to the quality. (Taparauskiene, Miseckaite, [7]). The research in Bulgaria and abroad show that a reasonable regulation of soil moisture during blossoming and ripening may increase the yield from 20% to 50% (Ivanov, [2]) and has a signification influence on total yield, berry weight, and leaf area. The results of strawberry research obtained in foreign countries, show the positive effect of irrigation (Taparauskiene, Miseckaite, [7]) and saving of irrigation water may reach from 20 up to 40 % (Cetin, et. al. [1], Kireva, Petkov, [3]; Petkov, et. al. [5], Petrova, [6]). There are favourable climate conditions for efficient strawberry cultivation across Bulgaria up to 1200-1300 m altitude (Ivanov, [2]).

The purpose of this research is to establish the main parameters of irrigation regime, the productivity of irrigation water for strawberries cultivated at drip irrigation on open areas.

2. MATERIALS AND METHODS:

The studies to establish the irrigation regime of strawberries "Polka" variety at drip irrigation were performed at practice ground in experiment field at the Institute of Soil Science, Agritechnologies and Plant Protection "N. Pushkarov" - Chelopechene (42°73' 23" N, 23° 47' 32" E and 550 m. altitude) around the Sofia capital during period 2011-2013.

The following variants were tested:

Pre irrigation moisture - 85% of limit field moisture capacity LFMC

1. 100% realized rate of water application
2. 80% realized rate of water application
3. 60% realized rate of water application

The experiment was performed by block method in four replications. The irrigation was performed using drip-irrigating system with following parameters: the distance between the drippers is 0,30m with flowing out water amount of 2,1 l/h allocated in each row. The plants are planted in two-row band with distance between bands - 0,90 m, between rows 0,35 m and

inside the row - 0,20 m, path width - 0,70 m. The size of practice ground for each variant in one replication is 28,8 m^2, and the harvested area is 115,2 m^2.

During the experimental period, the studies were performed in the following lines:

Values of rate of water application and irrigation rate

The irrigated standards are calculated according to the formula:

$$m = [10H.\alpha.(\delta\tau \text{ LFMC} - \delta\tau \text{ pr. m.})].K$$

where,

m –rate of water application in mm;

α – soil volume density in gr/cm^3;

H – depth of active soil layer in m (in this experiment H = 0,50 m);

δτ LFMC /limit field moisture capacity/ – limit field moisture capacity in % with respect to the absolutely dry weight of soil;

δτ pr. m /pre irrigation moisture/ – preirrigation moisture of soil in % with respect to the absolutely dry weight of soil;

K – coefficient of rate of water application reduction taking into account the area cropped with plants in 1 dka; In our experiment, K = 0,525, i.e., 52,5% of the area is irrigated.

For the drip irrigation the amount of total rate of water application is not given as for the other methods. So reduction is required at the expense of the not irrigated area. For this purpose, the formula of Zivkov, [8] is used taking into account the scheme of planting. After calculating the rate of water application for variant 1 with respect to its size, the standards for the other variants were established.

In order to track the soil moisture dynamics, soil samples were taken from variant 1 in every three days at depth to 0,50 m, at every 0,10 m in 3 replications; these samples were processed according to the usual gravimetric thermostatic method.

The soil is cinnamon forest leached soil, slightly sandy-clayish in its upper layer formed on the base of old talus cone made of alluvial materials. The soil is poorly supplied with nitrogen, moderately – with phosphorus, and better supplied – with potassium. At the average for the layer of 0 – 0,60 m the soil has the following water physical properties: LFMC = 22,1%, withering moisture content – 12,3% with respect to the absolutely dry weight of soil, bulk weight at LFMC – 1,47 g/cm^3. For the soil layer of 0 – 100 cm, the same indicators have the following values: LFMC – 21,8%, withering moisture content – 12,3% and bulk weight – 1,50 m^3. The soil is suitable for cultivation of strawberry plants.

3. RESULTS AND DISCUSSIONS:

The studies on the rates of water application corresponding to the water physical features of soil, the soil type and the meteorological conditions in the individual years enable establishing such volume of watering, at which the biological needs of plants will be completely met without allowing big water losses.

Table -1: Rainfall during the vegetation period at strawberries (2011 – 2013)

Periods	Total rainfall (mm)/		
	2011	2012	2013
Month from IV till IX	244	245	260
Average multi-annual	365	291	345
Month from V till VI	73	114	218
Average multi-annual	156	124	117

During the three experimental years, the availability of precipitation amounts in 50-year sequence characterize the vegetation period of culture growth (April – September) as very dry for the three experimental years. The least rainfall was in 2011 (244mm) and 2012 (245mm), and in 2013 (260mm) (Table 1). The precipitations fallen during the culture vegetation were irregularly distributed so irrigation was performed during all three experimental years.

The volume and periods of watering depend on the amount and distribution of rainfall during the culture vegetation period. The irrigations also depend on the soil water-physical properties, the needs of culture in water and the dynamics of meteorological factors. The number of irrigations performed and the size of watering and rate of water application during the three experimental years do not differ essentially due to the almost equivalent meteorological conditions during the field experiments performance. The years during which the field experiments were carried out with respect to the amount of precipitations in the vegetation period of culture growth (April – September) are characterized as very dry, and the temperature sum for the same period characterized the years as very warm. The precipitations are one of the limiting factors for yield obtaining. Because of their irregularity during the vegetation period we were forced to apply irrigation as a mandatory measure in order to create optimal conditions for the crops growth. It is seen from the analysis of meteorological conditions that during the studied years the summer drought occurred that is typical for our climate conditions. The drought is usual in June, July and August. This affects the

evapotranspiration of raspberries, its productivity and the need of watering (Petrova, [6]).

The results obtained in the three-year studies show that the number of irrigations and the size of rates of water application are determined by the meteorological conditions (precipitations) in the individual years. The number of irrigations varies from 7 to 9, and the rate of water application is from a 120 to 153 m^3/dka. The rates of water application are implemented in the period from the beginning of April until the end of June, and the biggest number of irrigations is in the periods of blossoming and fruit bearing. At the average, in the period of studies (Table 2) during the vegetation of strawberries 8 irrigations were supplied with an average rate of water application of 17m^3/dka and irrigation rate of 138m^3/dka. The specific conditions provided for the plant growth lead to formation of different yields

The irrigation regimes implemented during the strawberry cultivation in open air irrigated by surface drip irrigation affected the yield formation.

The data in Table 3 show that the highest yields under the soil and meteorological conditions of Sofia valley at average for the period of studies are obtained for the variant irrigated by 100% of rate of water application. The yield in this variant is 1518 kg/dka followed by the variant with 20% reduction of rate of water application - 1142 kg/dka. The lowest yields are obtained for the variant with 40% reduction of rate of water application – 935 kg/dka. The reduction of rate of water application by 20% resulted in decrease of yields by 25% compared to the variant irrigated with 100% of rate of water application. This irrigation regime may be used when there is water deficiency. The reduction of rate of water application by 40% resulted in more drastic decrease of yield– 40%, due to the very dry and hot years in carrying out the field experiments.

Table -2: Number irrigations, irrigations rate and irrigation depth of strawberry

Variant	2011			2012		
	Num-ber Irrig-ation	Irrigati on rate mm	Irrigati on depth mm	Num-ber irriga-tion	Irrigati on rate mm	Irriga-tion depth mm
100%M	9	17	153	7	17	120
80%M	9	14	126	7	13	90
60%M	9	10	90	7	10	70

2013			Average for period 2011-2013r.		
Number irriga-tions	Irrigati on rate mm	Irrigatio n depth mm	Number irrigatio ns	Irrigation rate mm	Irrigatio n depth mm
8	18	144	8	17,3	138
8	14	112	8	13,6	109
8	10	80	8	10	80

Table -3: Strawberry yield per years.

Variants	2011		2012	
	Yeild, kg/da	Yeild, %	Yeild, kg/da	Yeild, %
100% M	1600	100	1554	100
80% M	1188	25	1220	23
60% M	953	40	1020	36

2013		Average for the period 2011-2013	
Yeild, kg/da	Yeild, %	Yeild, kg/da	Yeild, %
1400	100	1518	100
1019	28	1142	25
833	40	935	39

The irrigation regime studied affected the productivity of irrigating water. The highest productivity is for the variants irrigated with lower rate of water application. The analysis of results obtained show that for every cubic meter of irrigation water at average for the period of studies, the quantity of strawberries varies from 10,4 to 11,7 kg (Table 4), and the highest values have been obtained during the dry years – up to 14,6 kg per every cubic meter of water. The highest productivity of irrigating water is obtained for the variant, for which 60% of rate of water application has been performed, and amounts from 10.4 to 14,6 kg per every cubic meter of water.

The results obtained for the productivity of irrigating water show that by increasing the water availability of plants, the productivity of irrigating water is reduced which is most clearly expressed for the variants watered by 100% of rate of water application.

Table -4: The irrigation water productivity of strawberries per years.

Variants	Productivity 1 m^3 water kg/dka			
	2011г	2012	2013	Average
100% M	10,4	13,0	9,7	11,0
80% M	9,4	13,5	9,0	10,4
60% M	10,5	14,6	10,4	11,7

4. CONCLUSIONS

The analysis of results obtained from the field experiments shows:

● During the period of crop active vegetation (from April till June) 8 watering, irrigations were performed by average irrigation norm of 18,0 mm and the total irrigation norm for the period was 140,0 mm.

● In biological respect, the most suitable regime of the tested irrigation regimes is the when for which 100 % rate of water application is performed and it is recommended under the conditions of good water availability.

● Reduction of the rates of water application does not result in drastic decrease of yields and this may be recommended under the conditions when temporary water deficiency is occurring.

● The highest yields in average for the period under study have been obtained for the variant irrigated with 100% of rate of water application. The yield in this regime is 1518 kg/dka, followed by the variant with 20% reduction of rate of water application - 1142 kg/dka. In case water deficiency has occurred the irrigation regime should be applied with 20% reduction of rate of water application.

● The productivity of irrigating water for drip irrigation of strawberries increases with the reduction of rate of water application. The highest productivity values are obtained for irrigation with 60% of the optimal rate of water application.

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