STUDY THE EFFECTS OF IRRIGATION REGIMES OF STRAWBERRIES ON THE YIELD UNDER DRIP IRRIGATION

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Introduction

The geographical location of our country predetermines a tendency towards warming and drought. This requires research into the response of agricultural crops to water scarcity, optimization of the parameters of irrigation regimes, and the search for resources for the efficient use of irrigated water.

The shortage of water for irrigation of agricultural crops necessitates a reduction in irrigation regulations or a complete dropout of irrigation to eliminate the deficit.

In Bulgaria there are extremely favorable conditions for the cultivation of different berry crops, incl. of strawberries that are of great economic importance, mainly due to its high productivity and production efficiency. They are characterized by poor dryness, with growth and fruiting largely dependent on the presence of sufficient moisture in the soil during the growing season. Therefore, the optimization of the water regime in the soil is of the utmost importance for the management of the processes of yield formation and the achievement of sustainable results and production of high quality from this crop. The application so far of the surface drip irrigation of this culture shows the expedience and the economic benefit of applying this way to the conditions in our country. This method fully meets the requirements for sustainable agriculture and organic production of fruit, incl. provides high yields, reduces undesirable side effects [2].

Studies carried out so far on irrigation of strawberries show that this culture responds very well to microwaving both in terms of production size and in terms of quality [3]. Studies in Bulgaria and abroad in this regard show that a prudent regulation of soil moisture during flowering and ripening can increase yields from 20% to 50% [5], while pollutant water savings are from 20 to 40% [4].

Favorable climatic conditions for efficient strawberries are available throughout the country up to 1200-1300 m above sea level [1].

The aim of the study is to study the parameters of the irrigation regime of strawberries at optimal and insufficient water supply in drip irrigation

Material and method

The surveys for the establishment of the pollack regime of "Polka" strawberry strains in surface drip irrigation were carried out during the period 2015 - 2016 in the experimental field of the Pushkarov Institute - Chelopechene, Sofia.

The following options were tested:

Precipitate humidity - 85% of WHP (water holding capacity)

- 100% realization of the water application rate (variant 1);
- 80% realization of the water application rate (variant 2);
- 60% realization of the water application rate (variant 3).

Irrigation norms are calculated using the formula:

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

Where: m is the size of water application rate in mm;

α – soil density in gr / cm3;

H – depth of the active soil layer in m (in test H = 0.5 m);

δт - of WHC - marginal Polish moisture in% relative to absolute dry weight of soil;

δт - presumptive soil moisture in% relative to the absolute dry weight of the soil;

K – the irrigation rate reduction factor taking into account the area occupied by the plants in 1 dka. In the experiment K = 0.52.5, ie. 52.5% of the area is irrigated.

Drop irrigation does not apply the entire irrigation rate as with other watering methods. A reduction is required at the expense of the unwatered area. For this purpose, the Ferckman, Grazoli [6] formula was used, taking into account the planting scheme. After calculating the irrigation rate for option 1, the norms of the other options are also set against its size.

Result and discussion

Phenological development.

The growing season of strawberries is divided into two sub-periods during which soil humidity is required for plant growth. The first sub-period of irrigation (spring) is the formation and growth of new leaves and blooms, fruiting. The second sub-period of irrigation is after harvesting the fruit, which creates normal conditions for the development of the crop. During this period, new leaves and runners are formed and fruit buds are planted, leaves are not dried.

The start of the vegetation of strawberries (2015) began in the third ten-day period of March, beginning of the buttoning is the second decade of April, and the beginning of the flowering began in the third ten-day period of April. After the massive blooms, which ended in the third ten-day period of May, strawberry harvesting began. The first harvest was made on 7 June and the last one was 30.06 (Table 1). The second period of irrigation is after harvesting the fruit. It started on July 1st and ended on 16 October.

The start of vegetation for strawberries in 2016 began in the second ten-day period of March, with the beginning of buttonisation being the third ten-day period of April and the beginning of the flowering in the first ten days of May. After the mass flowering, which ended in the second ten-day period of May, strawberry harvesting began. The first harvest was made on June 2 and the last on June 14 (tab.1). The second period of straining of strawberries begins after fruit harvesting ends from July to October.

Table 1:*Phenological development of strawberries*

year	Start of vegetation	Start of buttonization	Blooming			fruit development		
			start	mass	end	start	Mass	end
2015	20,03	14,04	24,04	07,05	23,05	2,06	07,06	30,06
2016	14,03	22,04	20,04	02,05	18,05	28,05	02,06	22,06

Tracking the rainfall and temperature regimes, especially during the summer months of July and August, showed that rainfall in the country is far from sufficient to satisfy the plants' soil moisture needs, and the ten-day temperatures over the entire growing season considerably exceeded the relevant norms. In practice, this confirms the thesis that drought in the country is not an episodic phenomenon, but climatological normality.

Table 2: *Rainfall during raspberry vegetation period*

Periods	Total rainfall, mm		
	2015	2016	Precipitation provision %
м. IV - IX	321	234	62,4
average multi-annual	293	120	92,2
м. V -VI	167	137	-
average multi-annual	152	54	-

In the years of study, the provision of rainfall in the 60-year series characterized 2015 as dry with a guarantee of 62.4% and 2016 as very dry with a provision of 92.2% for the period April-September / . The fallen rainfall during the vegetation of the crops is unevenly distributed, which necessitated the realization of watering. The months of April, May and June during the different ten-days periods are dry, with daily rainfall ranging from 1.0 to 26.0 mm. During this period, the most active phase of the culture development and the soil moisture in the active soil layer is below the required for biological growth (Table 2).

Table 4: Monthly sums of average daily air temperatures in ^oC

years	Monthly sums						Total for the period april-september		
	April	May	June	July	August	September	Total for the period IV – IX	Deviation from the average for the period 1957-2016 г.	
								total	%
2015	257,8	509,3	533,8	734,0	683,8	559,5	3278,2	+ 193,86	6,28
2016	412	431,8	621,3	672	645,3	514,7	3297,1	+ 212,76	6,90
Average for 1957-2016 г.							3085,15		

With regard to air temperature, the years under review are characterized as very warm with provision of 7.72% (2016g) and 12.75% (2015). The temperature values for the period April-September tend to increase compared to the average for the 60-year series with deviations of + 6,90% (2016) and + 6,28% (2015), (Table 3).

Table 5.1: *Irrigation regime for drip irrigation for the region of Sofia First irrigation period (April - June)*

variant	2015			2016			Average for the period 2015-2016 г.		
	Irrigations, number	water application rate m^3/da	Irrigation rate m^3/da	Irrigations, number	water application rate m^3/da	Irrigation rate m^3/da	Irrigations, number	water application rate m^3/da	Irrigation rate m^3/da
With 100% water application rate	7	17,8	124,6	8	17,7	141,6	8	17,7	133,2
with 80% water application rate	7	14,2	99,7	8	14,2	113,6	8	14,2	106,6
with 60% water application rate	7	10,7	74,7	8	10,6	84,8	8	10,7	80,7

Table 5.2: *irrigation regime for drip irrigation for the Sofia region Second irrigation period (July-October)*

variant	2015			2016			Average for the period 2014-2016 г.		
	Irrigations, number	water application rate m^3/da	Irrigation rate m^3/da	Irrigations, number	water application rate m^3/da	Irrigation rate m^3/da	Irrigations, number	water application rate m^3/da	Irrigation rate m^3/da
With 100% water application rate	11	16,9	185,9	12	17,7	212,0	11	17,3	199,0
with 80% water application rate	11	13,5	148,7	12	14,0	168,0	11	13,6	158,0
with 60% water application rate	11	10,1	115,0	12	11,0	134,0	11	10,4	124,0

Irrigation and irrigation regulations

The size and timing of watering irrigation of crops depends on the amount and distribution of rainfall during the growing season. They depend on the water-physical properties of the soil, the needs of water culture and the dynamics of meteorological factors. The realized number of irrigations as well as the watering and irrigation norms in the two experimental years do not differ significantly due to the almost uniform weather conditions in the field experiments. Years of field experiments on the amount of precipitation during the

growing season of culture (April to September) are characterized as dry.

The lunar period for the active vegetation of strawberries in the Sofia region covers the time from the second ten days of April, when the development of the culture begins - formation and growth of new leaves and blooms, formation and ripening of the fruit till the end of the harvest period - 30 June. The greatest number of irrigations were realized in the phases of flowering and fruiting of the crop. The second subperiod of watering for strawberries in the Sofia area came after July 1 and ended September 24. This period is one of the driest periods of the development of the culture and a higher number of waterings have been realized.

The results from the triennial experimental years show that during the first period of irrigation of the strawberry on average for the three years the number of the pollinators was 8 with the average water application rate - 17,2 mm and the irrigation rate - 133,0 mm, and during the second period of irrigation - 11 pcs. waterings with average irrigation rate - 17.3 mm and irrigation rate - 199 mm. The total irrigation rate for the two irrigation periods is 332 mm. (Table 5)

The irrigated regimes in the outdoor strawberries, in the case of surface drip irrigation, have had a significant impact on the formation of yields.

The data from Table 6 show that the highest yields in the soil-meteorological conditions for the Sofia field, on average, for two years were obtained with the variant, irrigated with 100% implementation of the irrigation norm. The yield is 1060 kg / dka, followed by the 20% reduction in the irrigation rate of 781 kg / dka. The lowest yields were obtained with the 40% reduction of the norm - 665 kg / dka. Lowering the irrigation rate by 20% resulted in a 28% reduction in yields compared to the 100% irrigation-irrigated option. This irrigation regime can be used in the event of a water shortage. The decrease of the irrigation rate by 40% resulted in a more drastic reduction of the yield - 38%, which is due to the very dry and hot year of the field experimentation (Table 6).

Table 6: *Yields strawberry variety "Polka" by years and average for the period*

variant	2015		2016		average 2015 – 2016	
	yield kg/dka	differences ±	yield kg/dka	differences ±	yield kg/dka	differences ±
1. 100%	970	St	1150	St	1060	St
2. 80%	757	-219	805	-345	781	-279
3. 60%	628	-341	701	-449	665	-395

CONCLUSIONS

On the basis of the field experiments we can draw the following conclusions:

1. For the period of active vegetation of the crop (April-June), 8 irrigations with with an average water application rate of 17.7 mm and a total irrigation rate for the period -133.0 mm were needed and respectively realized and for the autumn period (July September) - 11 irrigations with average water application rate- 17.3 mm and irrigation rate -199.0 mm. The total irrigation rate for the two irrigation periods is 332 mm

2. The realized irrigation regimes in individual years have had an impact on the yields obtained, with the highest yields being obtained for the variants irrigated with a 100% water application rate. The yield is 1060 kg / dka, followed by the 20% reduction in the water application rate of 781 kg / dka. In the event of a water shortage, it is recommended to apply irrigation regime with up to 20% reduction of the water application rate.

3. The analysis of meteorological factors shows that the rainfall in the country is insufficient to satisfy the requirements of the plants from soil moisture and the ten-day temperature values over the whole vegetation period considerably exceed the respective norms, which requires the use of drip irrigation for successful fruit production in the case of water shortages and relatively high temperatures, as well as the application of water-saving irrigation technologies.

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