Study of the influence of irrigation norms on the productivity of raspberry plantations

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Summary: *To establish the effect of irrigation of raspberries grown in soil and meteorological conditions in the area of the village of Chelopechene - Sofia, studies were conducted in drip irrigation of plantations with remontant variety "Lyulin", testing different regimes - from full satisfaction of daily needs of the culture from water to irrigation with reduced by 20% and 40% irrigation rates. A variant under non-irrigated conditions has also been tested.*

When determining the effect of irrigation of raspberries by changing the yield compared to the non-irrigated variant, it was found that in the variant with 100% irrigation rate (optimal) the increase in raspberry yield reaches 59%, and in variants irrigated with reduced irrigation rates, the size yields increased by 54% and 47% respectively. It has been proven that the optimization of the moisture in the active soil layer contributes to a significant increase and stabilization of yields, which for the experimental conditions are from 835 to 1074 kg / dka and the additional yield varies from 404 to 627, kg / dka or from 47 up to 59% on average for the study period.

The established productivity of the irrigation water is the highest in the variants with 40% reduction of the optimal norm and changes during the years of the experiment from 13.0 kg.ha-1.mm-1 to 24.0 kg.ha-1 .mm-1. It is the lowest in the variants irrigated with 100% realization of the irrigation norm.

Introduction

A number of studies have been conducted on the limiting factor - water for the implementation of optimal irrigation regime in our country. Their main goal is to establish the effectiveness of the application of different irrigation regimes for irrigation in case of insufficient water supply. The effect of irrigation in most cases is determined on the basis of the obtained additional yield from irrigation and the productivity of irrigation water (Eneva, 1993; Muhova, R., 2005, Kirkova J.2003.)

Studies conducted so far in the irrigation of raspberries show that to increase yields it is very important to water before the fruit ripens and during the entire period of harvest (Kuiesza, W., 1973, Oosten, A., 1976). According to the same authors, the greatest negative impact of drought has on the yield two weeks before harvest and during ripening. While maintaining a limited water deficit in the soil, the yield increases by more than 9.6%, and in dry years by more than 27.6% compared to non-irrigated variants (Mackenrron, 1982).

The aim of the present study is to establish the effect of irrigation of raspberries grown under conditions of optimal irrigation and water deficit for Sofia region.

In irrigated agriculture, water shortages can occur not only due to physical shortage of water, but also due to its unavailability due to high cost, energy and organizational problems, limited capacity of the sewerage network during the dry and hot summer months, emergencies and etc.

Material and method

The field studies were conducted in the experimental field of ISSAPP "N. Pushkarov" - Sofia. The following irrigation variants have been tested:

1. option 1 - without irrigation;
2. option 2 - irrigation with 100% irrigation rate;
3. option 3 - irrigation with 80% irrigation rate;
4. option 4 - irrigation with 60% irrigation rate;

The amount of irrigation rate was calculated according to the methodology proposed by (Frecman and Garzoli, 1980).

To monitor the dynamics of soil moisture, soil samples were taken with option 2 (100% irrigation rate) at a depth of 0–60 cm every 10 cm, which were processed by the weight-thermostatic method. .

The installation is made with irrigation wings double-walled pipelines for drip irrigation type "Agrodrip" with a diameter of 20 mm and a hole for water supply every 30 cm.

During the experiment, the developed technology for the creation of the raspberry plantation was used, as well as the agricultural techniques for its cultivation by the Experimental Station for Berry Crops - Kostinborod. Irrigation was performed through a drip installation type "Drozbach".

Results and discussions

The productivity of each agricultural crop depends on a complex of factors, the main ones being: the type of crop, its varietal characteristics, the applied agrotechnics, the number of realized irrigations, the way in which they are submitted and last but not least the meteorological conditions.

Table 1. *Rainfall during raspberry vegetation period (1999–2001)*

Periods	Total rainfall,mm			Rainfall factor security, %		
	1999	2000	2001	1999	2000	2001
m. IV - IX	398	182	358	19,2	98,6	33,1
average multi-annual	365	363	362	-	-	-
m. VII - VIII	152	28	75	7,3	96,6	70,8
average multi-annual	108	107	117	-	-	-

The amount of precipitation during the vegetation period of the crop (398 mm) for 1999 is 33 mm higher than the average long-term values, and for the period July - August by 44 mm and characterizes the year as wet (19.2%), and the July-August period is moderately dry. In 2001, which is characterized as moderately humid (33.1%), the amount of precipitation in April - September is almost the same as that of the average long-term series - 358 mm, and in July - August it is 75 mm)

Extremely dry with the provision of precipitation and temperatures - 98.6% and 3.4% is the year 2000, where the amount of precipitation for the period April - September is 182 mm, which is 50% less than the average long-term values.

The months of July and August are particularly dry this year, with the amount of precipitation being 28 mm, much lower than the average long-term values for the same period of 107 mm. These rains were extremely insufficient for the development of raspberries, which predetermined the implementation of a large number of waterings.

The results obtained from the three-year research show that the number of irrigations and the amount of irrigation norms are

determined by the meteorological conditions (precipitation) in the individual years. The number of irrigations varies from 12 to 17, and the size of the irrigation rate from 216 to 450 m3 / dka, with the largest number of irrigations being realized in a very dry year (2000), where the number of irrigations reaches 25 and the size of irrigation norm 450 m^3 / dka

When determining the effect of irrigation of raspberries by changing the yield compared to the non-irrigated variant, it was found that in the variant with 100% irrigation rate (optimal) the increase in raspberry yield reaches 60%, and in variants irrigated with reduced irrigation rates, the size yields increased by 54% and 46% respectively. (Table 2) compared to the non-irrigated variant on average for the research period.

The obtained results for the yield of raspberries during the different years in terms of humidity show the influence of drip irrigation on its size. The largest increase in the yield of raspberries was obtained in the dry year 2000, which is about three times higher than in the non-irrigated variant, and the smallest increase by 247 kg / dka was obtained in the wet year 1999.

When comparing the yields obtained in the irrigation variants with the yield obtained with optimal irrigation, it was found that with the reduction of the irrigation rate by 20% the yield decreases by 11%, and with the greater reduction of the irrigation norm (by 40%) the yield decreases with 23%. On average for the research period, the highest productivity of irrigation water amounting to 4.1 kg of raspberries per 1 m^3 of water was obtained in the variant in which 60% of the irrigation norm is realized. (Table 2)

Table 2. *Efficiency and productivity of irrigation water on raspberry average for the period (1999-2001)*

variant	M	Y	+Y	compared to variant 1 in %	compared to variant 2 in %	P
non irrigated	-	447	100	100	42	-
100% M	324	1074	627	240	100	3,3
80%M	259	963	516	215	89	3,7
60%M	195	835	388	186	77	4,3

Designations in the table: M - irrigation rate, m^3dka, Y - total yield, kg / dka; + Y-Extra. Yield kg / dka; P - productivity of 1m^3 of water.

Another important indicator characterizing the efficiency of irrigation is the productivity of the irrigation norm, showing the additional yield for 1mm of the irrigation norm and with a unit of measurement kg.ha-1.mm-1. The data by variants for all experimental years and on average for the experimental period are presented in Table 3.

Table 3. *Productivity of the irrigation norm, additional yield by variants and years*

variants	1999			2000			2001			average		
	+Y	M	PR	+Y	M	PR	+Y	M	PR	+Y	M	PR
100%M	2470	216	11,4	10090	450	22,4	6230	306	20,3	6263	324	19,3
80%M	1830	173	12,7	8410	360	23,4	5210	245	21,2	5160	259	19,8
60%M	1700	139	13,0	5990	250	24,0	4410	197	22,3	4033	195	20,7

Designations in the table: + Y - additional yield, kg / ha; M - irrigation rate, mm; PR - productivity of the irrigation rate kg.ha^{-1}.mm^{-1}

The effect of irrigation is expressed through the additional yield and productivity of the irrigation rate, as the data by years are presented in (Table 3). It has been proved that in the conditions of regulated water deficit the yield does not change in proportion to the change in the size of the irrigation norm. Therefore, the productivity of the lower irrigation rate is often higher. For the experimental conditions the values vary from 11.4 to 24.0 kg.ha^{-1}.mm^{-1}, with the highest values being reached in the dry year 2000.

The obtained results for the productivity of irrigation norm show (Table 3) that it is the highest in the variants irrigated with 40% reduction of the optimal norm and varies from 13.0 kg.ha^{-1}.mm^{-1} to 24.0 kg.ha^{-1}.mm^{-1}. It is the lowest in the variants irrigated with 100% realization of the irrigation norm. The constant water deficit during the vegetation of the crop leads to yield losses that are not proportional to the percentage reduction of the irrigation rate. In all cases, the reduction in yield is less than the reduction in the irrigation rate. On average for the period of the research with correction of the irrigation norm by 20%, the yield decreases by 11%, and with 40% reduction of the irrigation norm the yield decreases by 23%. In all cases, the reduction in yield is less than the reduction in the irrigation rate

Conclusions

The optimization of the moisture in the active soil layer contributes to a significant increase and stabilization of the yields, which for the experimental conditions are from 835 to 1074 kg / dka and the additional yield varies from 404 to 627, kg / dka or from 47 to 50% on average. for the study period.

Reduced irrigation rates during the growing season of raspberries lead to yield losses that do not correspond to the percentage reduction of irrigation water. At 20% correction of the irrigation rate the yield decreases by 11% compared to the optimal variant, and at 40% reduction of the irrigation rate the losses of raspberry yields reach 22%.

The productivity of the irrigation water is the highest in the variants irrigated with a 40% reduction of the optimal norm and varies from 13.0 kg.ha^{-1}.mm^{-1} to 24.0 kg.ha^{-1}.mm^{-1} . It is the lowest in the variants irrigated with 100% realization of the irrigation norm, as the highest values are during the year with the least precipitation - 2000.

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