IMPACT OF IRRIGATION REGIMES IN DRIP IRRIGATION OF RASPBERRIES ON THE YIELDS

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SUMMARY : *Berry cultures - strawberries, raspberries, blackberries, blackcurrants, etc. are of great economic importance due to growing demand and high productivity. In general, they are susceptible to droughts and are so demanding for soil moisture, and their growth and yield depend to a large extent on the presence of sufficient soil moisture.*
In order to establish the irrigation regime of raspberriesin drip irrigation conditions, field experiments were conducted on the experimental field Chelopechene-Sofia. Irrigation was carried out with a pre-irrigation humidity less than 85% of WHC and variants watered with irrigation rate reduction of 20%, 40% compared to the variant irrigated at 100% of WHC and non-irrigated variant.
Realized irrigation regimes in individual years have had an impact on the yields obtained, with the highest yields being obtained for the irrigated variants with 100% irrigation rate and the lowest in non-irrigated variants. The highest increase in yield was obtained in 2004 (dry), which is with 67% more compared to non-irrigated variants, and the smallest increase of 33% was obtained in the humid 2005.
The analysis of meteorological factors shows that the rainfall in the country is insufficient to satisfy the requirements of plants of soil moisture, and the temperature sums over ten-days periods over the whole vegetation period considerably exceed the respective norms. This requires the use of drip irrigation for the successful production of raspberries under conditions of water deficiency and relatively high temperatures.
KEY WORDS*: RASPBERRIES, IRRIGATION REGIME, DRIP IRRIGATION, RAINFALL, TEMPERATURES, DROUGHT, YIELDS.*

INTRODUCTION

Increasing water deficit requires the use of irrigation technologies in the practice of irrigation agriculture, as well as research to optimize irrigation regimes for agricultural crops to achieve water saving and achieving economically viable yields.

In determining the impact of drought on crop yields, the most significant of the meteorological indicators are the sum of rainfall and the sum of the temperatures during the different periods of the crop development or for the whole vegetation period. The yields obtained in irrigated and non-irrigated conditions reflect their impact on the development of crops during their vegetation period, depending on the biological and physiological requirements during their individual developmental phenophases.

In this case, information on yields obtained from multi-year field experiments in optimum irrigation and in water deficit conditions is extremely important. These and other results are needed to adapt crop cultivation technology to drought conditions.

The studies carried out so far on raspberries irrigation, show that for the yields to grow it is very important water be provided before the ripening of the fruits and during the whole harvest period (Kuiesza, W., 1973). According to the same authors, droughts have the greatest negative impact on yield two weeks before fruit harvesting and during ripening. Through maintaining a limited water deficit in the soil, the yield of raspberries increased by over 9.6% and in dry years by 27.6% compared to non-irrigated variants. (Mackenrron, 1982).

One single study has been carried out in our country on raspberry irrigation, resulting in determining some parameters of the irrigation regime in drip irrigation (Ivanov, Al., 1998), and for the double bearing(everbearing) varieties of raspberries entering the country massively, research is almost lacking.

It has been established from our global practice that drip irrigation (Drupka, W., 1979, Kireva, R., V. Petrova, 2014) is the most suitable for their biological requirements. This mode of irrigation ensures that you get biologically optimized yields with high quality fruits and significant water savings. (Kuiesza, W., 1973)

The aim of the study is to determine the influence of irrigation regimes on the yield of raspberries grown in drip irrigation in years with different provision of meteorological factors.

Material and method

In order to establish the effect of irrigation regimes on raspberries yields, tests were conducted at the experimental field of the Pushkarov Institute in Chelopechene- Sofia (2001-2005).

The following irrigation options have been researched:

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

Irrigation was performed by surface dropping with droppers KP-4.6, perforated tubing between 0.60 m. The soil is leptosol, slightly sandy loam in the plowing layer, formed on the base of an old diluvial cone made of sediment materials. It is poorly stocked with nitrogen, average stocked with phosphorus and well stocked with potassium. On average, for the layer 0-60 cm, the soil has the following water-physical properties: a water holding capacity/WHC/ - 22.1%, a humidity till wilting 12.3% by weight of absolutely dry soil, bulk dencity at WHC 1,47 g /cm3. For the soil layer 0 - 100 cm, the same indicators have the following values: WHC - 21.8%, humidity till wilting - 12.3% and bulk density - 1.50 cm3. The soil is suitable for growing raspberry plantations.

Results

Meteorological conditions of the experiments

Regarding the amount and distribution of rainfall during the April-September vegetation period, the conditions during the individual years are characterized by variety and manifestation of extremes. According to the provision of rainfall, defined in the 1956-2005 series (Table 1 and Figure 1a), three of the years - 2001, 2002 and 2005 are humid, one - 2003 - average and one - 2004 - very dry (Table 1, fig. 1). A humid spring was observed in 2001 and 2003, and a humid autumn in 2002. Summer droughts lasting more than ten days were observed throughout all the years of the surveyed period. Their manifestation is mainly in June (2002, 2003, 2004 and 2005), and only in two years (2001 and 2002) - in July. For some ten days periods in 2002, 2003 and 2005, ten-day amounts significantly exceeded the average.

Table 1: *Rainfall during raspberries vegetation period (2001– 2005 years.)*

Periods	Total rainfall, mm					Rainfall factor security, (%)				
Year	2001	2002	2003	2004	2005	2001	2002	2003	2004	2005
м. IV – IX	358	418	329	258	765	37,1	17,3	59	94,6	1,4
Average multi-annual	365	365	365	365	365	-	-	-	-	-
м. VII – VIII	75	158	104	73	400	76,8	9,3	47	74,8	1,4
Average multi-annual	110	110	110	110	110	-	-	-		

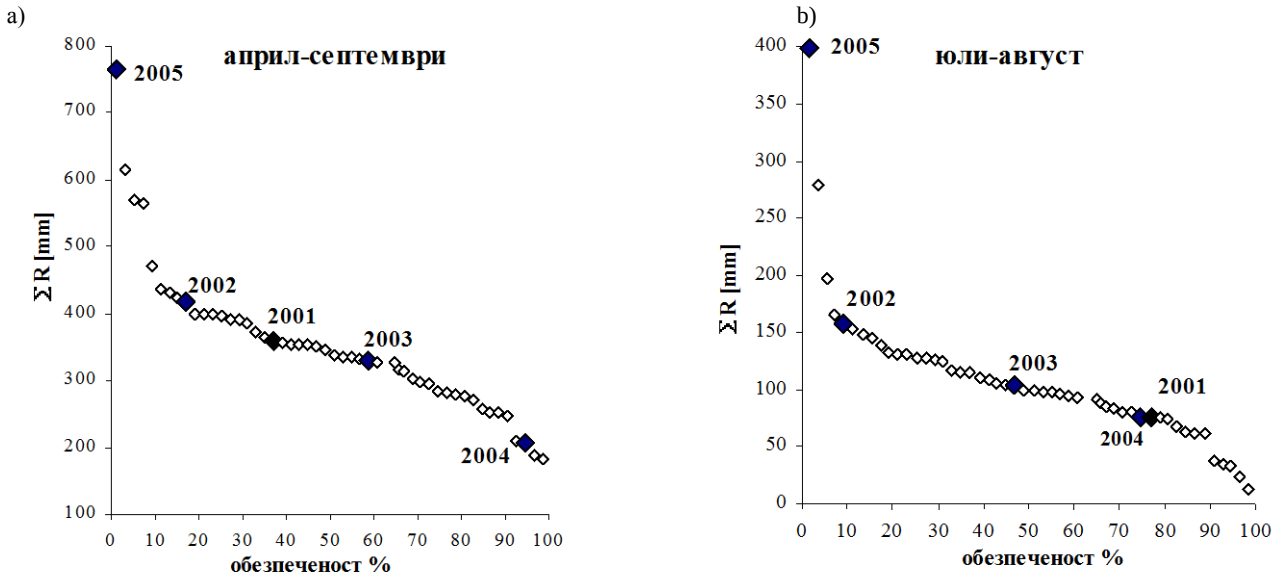

Fig. 1 Coverage curves for the fifty-year series (1956-2005) for the periods: (a) April to September; b) July-August

The temperature and deficiency of saturation of air with water vapor influence the speed of the life processes of the plant, incl. on the intensity of photosynthesis. The temperature sums, both for the April-September and the July-August vegetative period, show that without exception the years are warm (Figure 2). In 2002 conditions were close to the average. The same shows the dynamics of ten-day temperatures compared to the average of the 1901-2005 averages. The smallest deviations are observed in 2001. The values for August and September 2002 are below the norms for these months. The ten-day period temperature sums for the whole growing season of 2003, 2004 and 2005 significantly exceeded the relevant norms.

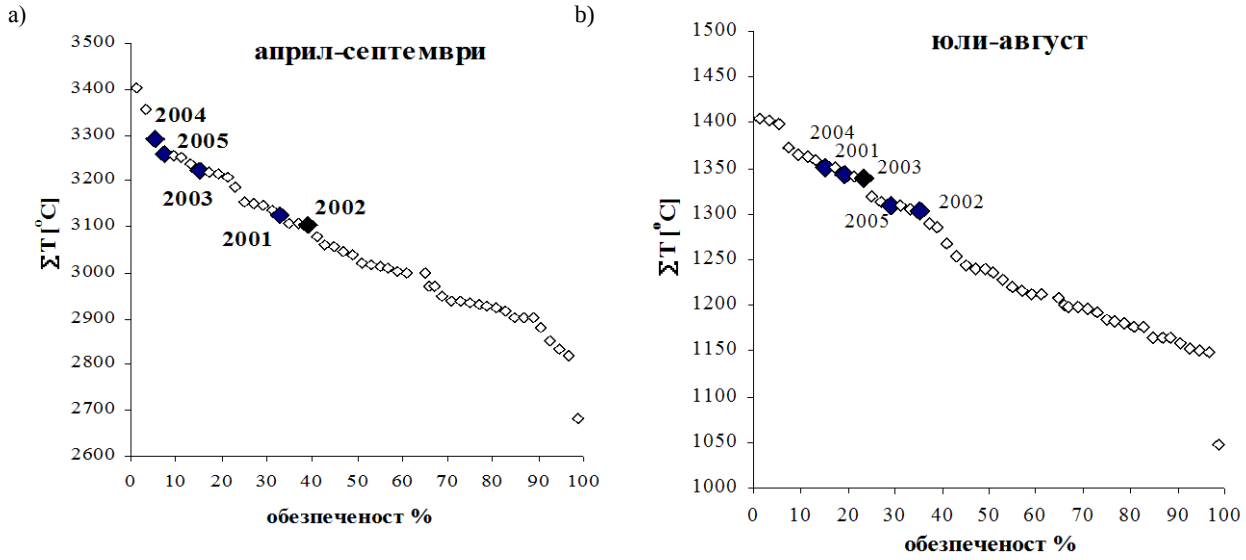

Fig. 2. *Coverage of the temperature sums for the fifty-year series (1956-2005) for the periods: a) April-September; b) July-August*

The need for irrigation to maintain optimum soil moisture in the 0-60 cm layer is mainly due to the amount and distribution of rainfall during the vegetation period of the crop. The irrigations are realized with a soil moisture drop in the layer 0-60 cm below 85% of the WHC.

The results from the five-year long studies show that irrigation norms depend on the meteorological conditions (rainfall) over the different years and the number of irrigations varies from 8 to 22.

The results obtained for the raspberry harvest during the different years from humidity point, show the influence of the irrigation regimes on its size. The greatest increase in yields was obtained during dry years (the July-August period for two years - 2001 and 2004 is very dry). The increase in yields is 67% more than the non-irrigated option, and the 33% increase was obtained during the humid 2005.

The irrigated regimes during the years also affected the yields obtained. The highest yields were obtained in the variants irrigated with 100% irrigation rate - 929 kg / dca (raspberries) and the lowest in non-irrigated variants 406 kg / dca (raspberries). The reduction of the irrigation rate by 20 and 40% has led to a reduction in raspberry yields of 8% and 17%, respectively (Table 3).

Of the tested irrigation regimes in biological terms, the irrigation regime is most suitable with the implementation of a 100% irrigation norm, which is recommended under conditions of good water supply. In the case of a water deficit occurring, apply irrigation regime with a 20% reduction of the irrigation rate, which produces satisfactory yields in both cultures.

Table 3 :*Yield of raspberries using drip-irrigation in the area of Sofia – Chelopechene district*

Years	2001		2002		2003		2004		2005		Average 2001-2005г.	
Variant	Yeild kg/dka	Relative yield%	Yeild kg/dka	Relative yield%	Yeild kg/dka	Relative yield%	Yeild kg/dka	Relative yield%	Yeild kg/dka	Relative yield%	Yeild kg/dka	Relative yield%
Non irrigation	248	100	424	100	350	100	331	100	672	100	406	100
100% M	871	351	822	194	955	272	1000	302	991	147	929	228
80% M	769	306	794	187	885	252	936	283	914	136	860	211
60% M	689	277	788	186	798	228	794	239	828	120	779	191

Conclusions

1.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 for the whole vegetation period considerably exceed the respective norms, which necessitates the optimization of the irrigation regime and the use of water-saving irrigation technology for the successful production of raspberries under conditions of water deficit and relatively high temperatures.

2. The largest increase in raspberry yields was obtained during the dry years, which is 67% more than the non-irrigated option, and the smallest increase of 33% was obtained during the humid 2005.

3. Reduction of the irrigation rate by 20 and 40% results in a reduction in the yield of raspberries from 8% to 14%

4. From the tested irrigation regimes, from biological perspective, the irrigation regime most suitable is with the implementation of a 100% irrigation norm, which is recommended under conditions of good water supply. In the case of a water deficit occurring, apply an irrigation regime with a 20% reduction of the irrigation rate, which yields satisfactory yields for both crops.

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