IMPACT OF WATERING REGIMES ON APPLE YIELDS UNDER VARIOUS METEOROLOGICAL CONDITIONS AND MICRO IRRIGATION.

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SUMMARY: *Analysis of meteorological factors shows that the temperature sums during the vegetation of the main crops grow but are relatively stable, ie. they are not a limiting factor for their normal growth and development. Rainfall, however, in terms of quantity and distribution changes in a considerably wider range over ten days periods, months and years. The instability of this meteorological factor predetermines irrigation as a major event of the agro-technical complex, which is decisive for the achievement of high and sustainable yields.*

Increasing water deficit requires the use of water-saving irrigation technologies in the practice of irrigated agriculture and the conduct of research to optimize irrigation regimes in order to increase the efficiency of irrigation water used. One of the ways to achieve this goal is irrigation with reduced irrigation norms while preserving the number of waterings. The advantage of these reduced irrigation regimes is the saving of water at acceptable yield losses. Their application is warranted when there is a possibility of accurate dosing of irrigation water and the irrigations are of low cost.

In order to establish the irrigation regime of apples in drip irrigation, field experiments were carried out on the Chelopechene-Sofia experimental field. Irrigation is carried out with a drop in pre-watering humidity to 85% of WHC and variants irrigated by a reduction of irrigation rate with 20% and 40% compared to the variant irrigated at 100% WHC and non-irrigated variant.

The conducted irrigated regimes during the years have had an impact on the yields obtained, with the highest results being obtained for the irrigated variants with 100% irrigation rate and the lowest for the non-irrigated variants. The largest increase in yield was obtained in 2004 (characterized as dry), which is with 55% (apples) more than non-irrigated variants, and the smallest increase of 25% (apples) was obtained during the humid 2005.

INTRODUCTION

To determine the impact of drought on crop yields, yields are compared in irrigated and non-irrigated conditions. Thus, the impact of meteorological indicators on the development of crops during their vegetation period, according to the biological and physiological requirements during their individual development phases, is taken into account.

The optimal irrigation and irrigation norms mentioned in the literature are moving widely (Dochev, 1983) due to the dependence of these parameters on soil-climatic conditions, age, applied cultivation technology (Keeler, J., D. Karmelli, 1974). (Lazarov et al., 1982). (Kirilov, K., 1994) offer the best prerequisites for the application of the so- called broken irrigation regime by reducing the size of irrigation rates.

The advantage of these reduced irrigation regimes is the saving of water at acceptable yield losses. Their application is warranted when there is a possibility of accurate dosing of irrigation water and the irrigations are of low cost.

From the world's and our local science, it has been found that from applied techniques and technologies for irrigation of apples most suitable for their biological requirements with maximum efficiency of irrigation water is drip irrigation (Drupka, W., 1979). This mode of irrigation ensures that you get biologically optimized yields with high quality fruits and significant water savings. (Dochev, 1983), (Kuiesza, W., 1973)

The aim of the paper is to determine the influence of irrigation regimes on the yields of drip-irrigation grown apples in years with different weather conditions.

Material and method

In order to determine the influence of the irrigation regimes on the yields of dropped apples, studies of the experimental field of "Pushkarov" Institute - Chelopechene - Sofia (2001-2005) were carried out.

The following options were tested:

1. Non-irrigated option
2. Watering with irrigation rate 100% M;
3. Watering with irrigation rate of 80% M;
4. Watering irrigation rate 60% M.

Irrigation was carried out by surface drip irrigation with drippers KP - 4.6, perforated pipes between 0.60 m. The soil is leached chromic forest, slightly sandy loam in the ore layer formed on the base of an old delluvial cone of sediment materials. It is poorly stocked with nitrogen, on average with phosphorus and well stocked with potassium. On average, for the layer 0 - 60 cm, the soil has the following water-physical properties: WHC = 22.1%, wilting point humidity - 12.3% on absolute dry soil weight with WHC - 1.47 g / cm3. For the soil layer 0 - 100 cm, the same indicators have values: WHC - 21.8%, wilting point humidity - 12.3% and bulk density - 1.50 cm3. The soil is suitable for growing apples.

RESULTS

Meteorological conditions of the experiments

Regarding the amount and the distribution of rainfall during the April-September vegetation period, the conditions during the individual years are characterized by variety and appearance 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. The July-August period for two of the years 2001 and 2004 is very dry, for two - 2002 and 2005 - humid and for one - 2003 - with average conditions (Table 1 and Fig. 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 the years 2002, 2003 and 2005, the 10-day sums significantly exceeded the average multi-annual.

Table 1. *Rainfall over apple vegetation period (2001-2005)*

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	-	-	-		

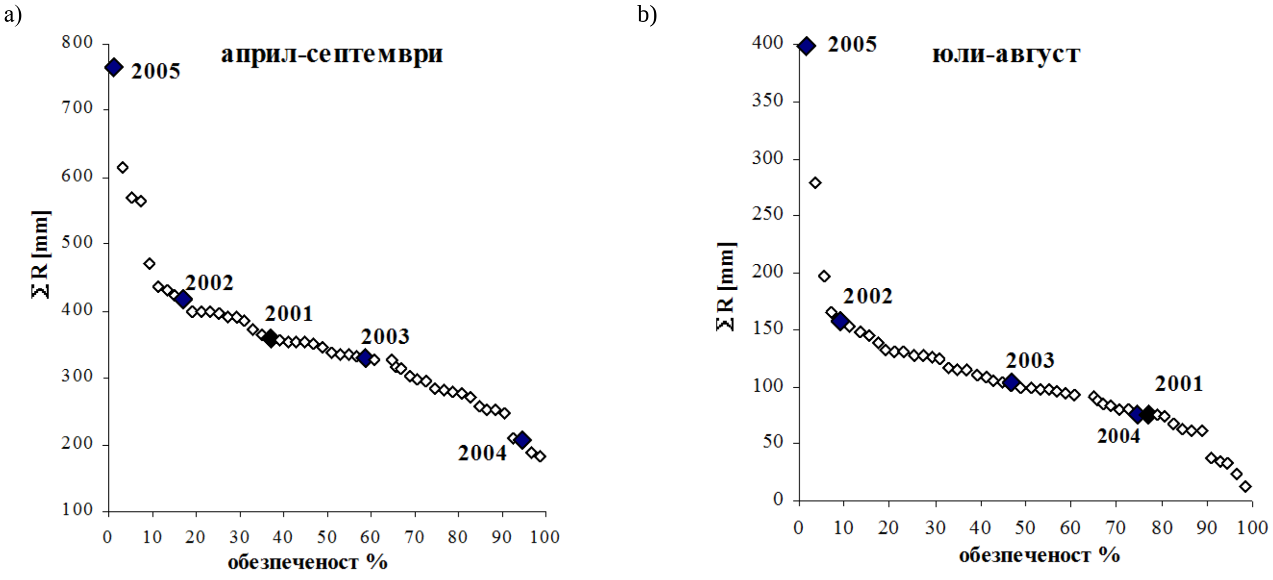

Fig. 1 *Coverage curves for the fifty-year series (1956-2005) for the periods: (a) April to September; b) July-August*

Air temperature and deficiency of water vapor saturation in the air affect the life cycle rates of the plant, including on the intensity of photosynthesis. The temperature sums for both the April-September and the July-August vegetation periods 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 period 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 temperatures over the whole growing season of 2003, 2004 and 2005 significantly exceeded the relevant norms.

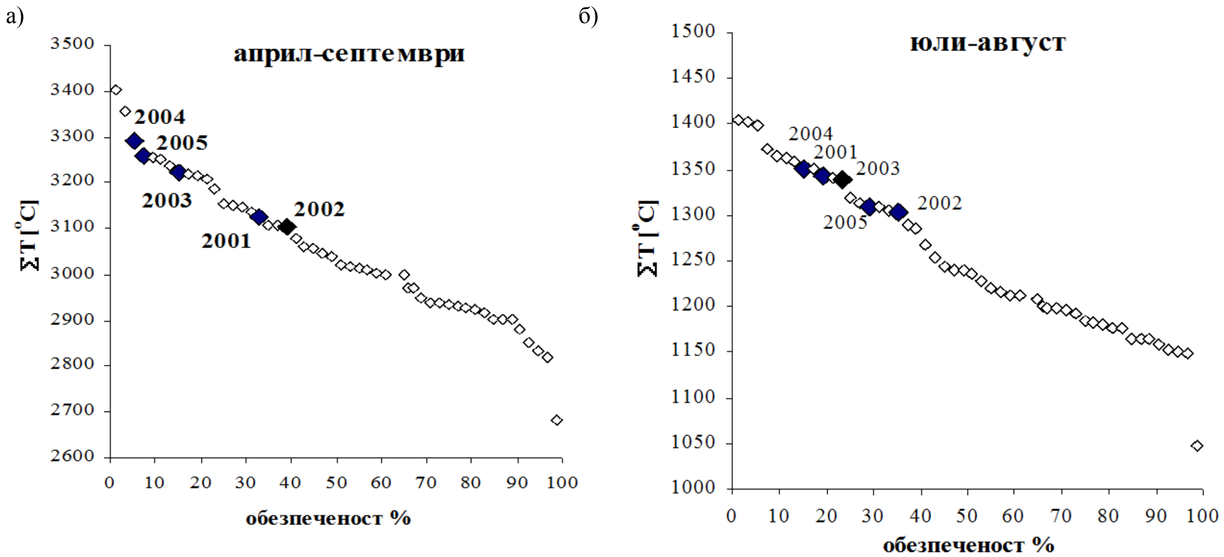

Fig. 2. *Coverage of the temperature sums for the fifty-year series (1956-2005) for the periods: a) April-September; b) July-August*

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

The results of the five-year study show that the number of irrigations and the irrigation rate is determined by the weather conditions (precipitation) in individual years, with the number of irrigations for apples varies from 14 to 20.

The results obtained for the apple harvest during the various humid years 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 55% (apples) more than the non-irrigated option, and the smallest increase of 25% (apples) was obtained during the humid 2005.

The irrigated regimes during the years also affected the yields obtained. Highest yields were obtained in the variants irrigated with 100% irrigation rate of 2087 kg / dca (apples) and the lowest in non-irrigated variants 1266 kg / dca (apples). Lowering the irrigation rate by 20 and 40% resulted in a 7% and 14% reduction in apple yields (Table 2, Fig. 3 and Fig. 4).

Of the tested irrigation regimes, most suitable biologically is the irrigation regime with the implementation of a 100% irrigation rate, which is recommended with a good water supply. In the case of a occurring water deficit, apply irrigation regime with a 20% reduction of the irrigation rate, where satisfactory yields are obtained.

Table 2. *Yields of apples in drip irrigation conditions in the region of Sofia*

Years	**2001**		**2002**		**2003**		**2004**		**2005**	
Variant	Yield kg/dka	Relative yield,%	Yield kg/dka	Relative yield %	Yield kg/dka	Relative yield, %	Yield kg/dka	Relative yield, %	Yield kg/dka	Relative yield, %
No irrigation	1567	100	704	100	1135	100	855	100	2070	100
100%M	2122	135	1769	251	1945	156	1866	218	2737	132
80% M	2053	131	1603	228	1828	143	1681	196	2592	125
60% M	2004	128	1421	202	1712	135	1459	170	2444	118

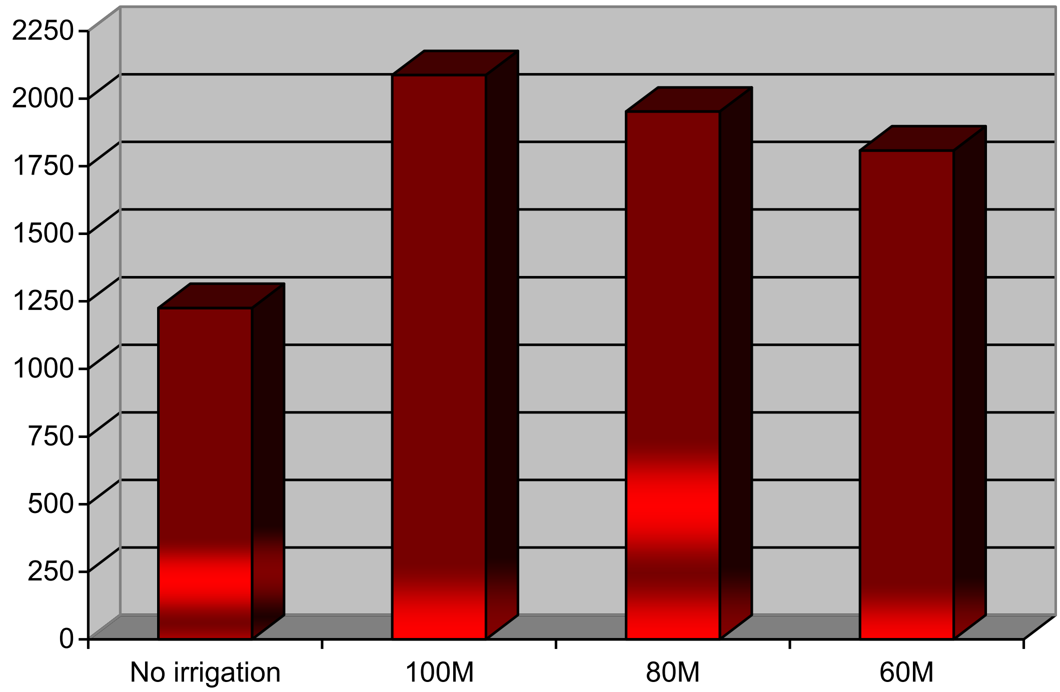

Table 3. *Yields of apples in drip irrigation conditions average for the period 2001-2005.*

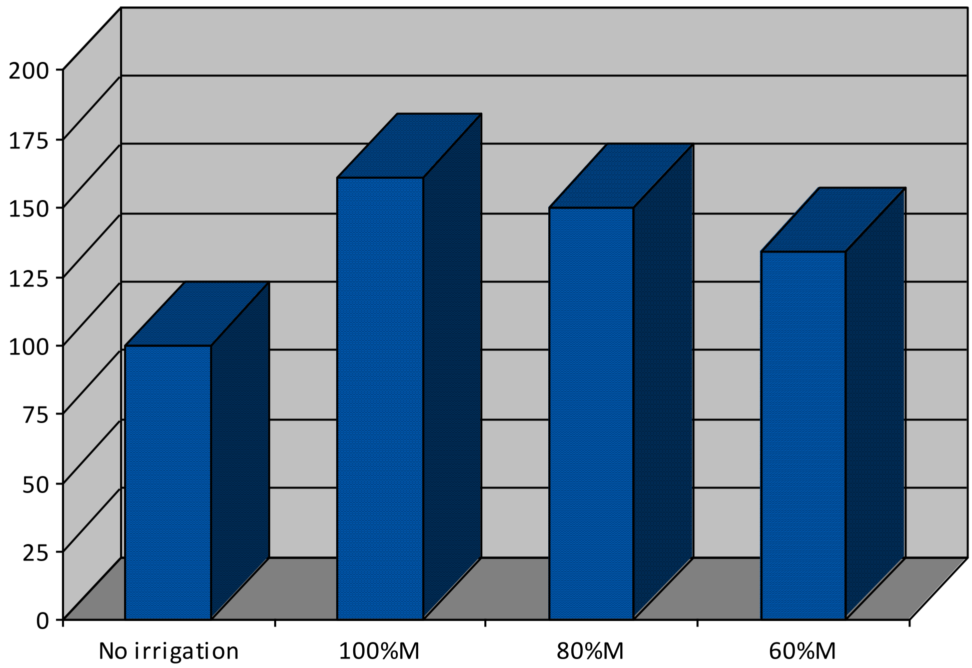

Fig.4. *Relative yields of apples in drip irrigation conditions and different irrigation rates, compared to the non-irrigated option, average for the period 2001-2005*

CONCLUSIONS

1. The analysis of meteorological factors shows that the rainfall in the country is insufficient to satisfy the plants' requirements of soil moisture and the ten-day temperature values over the whole vegetation period exceed the respective norms. This requires optimization of the irrigation regime and the use of water-saving technologies for irrigation in the production of apples.

2. The highest increase in apple yields with irrigation was obtained during the dry years, which is 55% more than the non-irrigated option, and the smallest increase by 25% - during the humid 2005. The reduction of the irrigation rate by 20 and 40 % has led to a reduction in apple yields of 7% to 14%.

3. From the tested irrigation regimes biologically the most suitable is the irrigation regime with the implementation of a 100% irrigation rate, which is recommended under conditions of good water supply. In case of water deficit, the application of irrigation regime with a 20% reduction of the irrigation rate gives acceptable results.

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