DROUGHT INTENSITY IN VOJVODINA PROVINCE AND IMPACT ON FIELDS CROP PRODUCTION

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ABSTRACT: The lowlands in the northern parts of the Serbia and Montenegro, Province of Vojvodina, in which agricultural production is concentrated, have changeable, unstable and unforeseeable rainfalls and dry periods between June and August. Analysess of drought in Novi Sad, which represents (the Vojvodina Province) the average precipitation sum is 612 mm (270-931), and 348 mm (138-683) in the growing season.Depending on drought intensity, crop yields may be reduced to 50% in relation to the genetic yield potential. In extremely dry years, yield reductions in some crop species reach 90% in comparison with years with normal rainfall.

Key words: weather conditions, drought, precipitation, crop production, rainfed production, irrigation

INTRODUCTION

The northern part of territory of Serbia and Montenegro – Vojvodina Province are lowlands in which agricultural production is concentrated. These region have a moderately continental climate with warm summers, cold and dry winters, the precipitation unevenly distributed in space and time, and very often dry periods during June, July and August. These dry periods are also characterized by high air temperatures, hot and dry winds, increased plant water requirements. All these phenomena affect plant growth and considerably reduce yields of most crops. Depending on the time when they occur and their duration, droughts can cause serious damage and considerable yield losses.

In some years in Vojvodina Province, drought reaches catastrophic proportions for agricultural production. Years with sufficient precipitation and favorable distribution of rainfall are few: according to Vucic (1991), their percentage barely exceeds 5%. He mentioned 1976 as a favorable year, when high yields of spring crops were obtained, but such year did not recur from 1976 to 1990. Actually, in the period 1990-2001, were 1991,1999 and 2001, from the point of precipitation amount and distribution was favorable (Dragovic & Maksimovic, 2002).

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MATERIALS AND METHODS

Precipitation amounts and distribution per hydrological year for the Vojvodina Province were monitored in Novi Sad in the period 1923/1924 - 2002/2003 (80 years).

Drought impact on the yields of several field crops was analyzed in trials with and without irrigation established at the experiment field of Institute of Field and Vegetable Crops in Novi on the loamy chernozem soil. The trials had been conducted for a long period of time but our attention will be focused on the very dry years that occurred after 1990.

RESULTS AND DISCUSSION

Climatic conditions and drought intensity. The average precipitation sum per hydrological year is 612 mm, (270-931), the average precipitation during the growing season is 348 mm, (138-683) and the winter period 263 mm, (105-483). (Table 1).

Annual precipitation sums and distributions separately for hydrological years (a), growing seasons (b), winter periods (c) and July + August (d) show large variations in precipitation sum from one year to another (Figure 1).

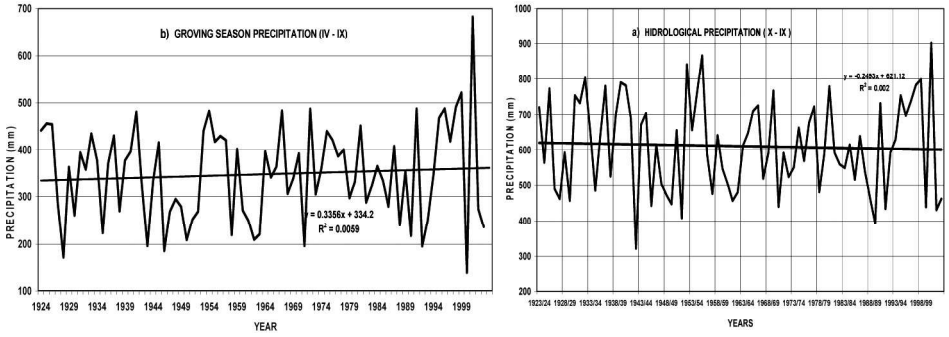
Table 1. Mean annual, seasonal and monthly sum of precipitation (mm) in Vojvodina Province (Novi Sad) in the period 1923/1924-2002/2003

Month	Average	Variation	Month	Average	Variation; mm-year
X	49	0 – 1961/1962 155 – 1932/1933	**IV**	50	3 – 1939 127 – 1933
XI	53	7 – 1986/1987 156 – 1952/1953	V	60	5 – 1948 185 – 1933
XII	50	3 – 1972/1973 150 – 1969/1970	VI	77	6 – 1938 233 – 2001
I	38	28 – 1928/1929 102 – 1987/1988	VII	60	2 – 1928 193 – 1991
II	36	2 – 1987/1988 113 – 1932/1933	VIII	56	1 – 1992 148 – 1972
III	39	0 – 1929/1930 119 – 1932/1933	IX	44	1 – 1947 162 – 2001
Winter period	263	105 – 1972/1973 438 – 1956/1957	Growing season	348	138 – 2000 683 – 2001
Mean annual sum: 612 mm, minimum 270 (2000/2001), maximum 931 (2001/2002)					

Precipitation for 10 hydrological years with lowest annual precipitation has the average annual precipitation 383 mm, with the maximum and minimum values of 456 and 322 mm, respectively. The respective figures for the growing season were 189, 274 and 138 mm, and for the winter period 193, 301 and 126 mm.

Severe droughts that occurred in the growing seasons like 2000, 2002, 2003, followed a series of several hydrological years with precipitation levels below average. Additionally, Spasova *et al.* (1997) reported that in Serbia and Montenegro in the period 1980-1996, 12 out of 16 years were recorded as dry.

Fig. 1. Distributon of precipitation in Province of Vojvodina (Novi Sad)



According to Stojsic & Shkoric (1997), drought occurs occasionally in a single year or in a series of years, causing severe damage to agricultural production. In some years (*e.g.*, 1928, 1951, 1990, 1992) drought was harmful not only to some crops but it turned the whole Pannonian Plain, or major parts of it, into an arid region.

Precipitation distribution during growing season is another important factor determining the occurrence of drought. In summer, precipitation typically occurs in the form of showers, which provide a small percentage of effective water to plants.

The evaluations of drought intensity according to mean annual or growing-season precipitation sums are not realistic indicators in contrast to the analysis according to precipitation sums in July and August in which period plant water requirements are highest. This was confirmed by the drought analysis for the Vojvodina Province made by Dragovic (1995).

Rainfall analysis for July and August for the period of 80 years (1924-2003) shows that 67 years or 83.7% and 69 years or 86.2% of the years had the monthly precipitation under 100 mm in July and August, respectively. That particular amount was chosen because most annual field crops as well as most perennial crops have their monthly water requirements in July and August over 100 mm. Dragovic (2000) considers these years as dry. There were 62.5% of extremely dry years with less than 50 mm respect to July and 50.0% with respect to August (Table 2).

Table 2. Percentage of dry years according to rainfall sum in Vojvodina Province (Novi Sad) for July and August (1924-2003)

Rank	July		August		Category
mm	No	%	No	%	
0-25	13	16.25	17	21.25	Extremely dry
26-50	29	36.25	23	28.75	Very dry
51-75	16	20.00	19	23.75	Dry
75-100	9	11.25	10	12.50	Moderately dry
	67	83.75	69	86.25	Total dry
101-125	6	7.50	9	11.25	Moderately rainy
>126	7	8.75	2	2.50	Rainy
Total	80	100	80	100	

The only way to estimate and categorize drought for agricultural purposes is to compare the sum of precipitation over a particular period against plant water requirements for the same period. The severity of drought, however, also depends on various other factors, such as air temperature, soil properties, cultural practices, cultivar susceptibility to drought, stage of plant development, *etc.*

Drought effect on crop production. The main reason for the low and unstable yields in Vojvodina province is the variation in the amount of precipitation during growing season, i.e., because of water deficit relative to plant water requirements. Analizing of the yields of field crops in the Vojvodina Province in the period 1965-2003, Bosnjak (2004) reported very low yields of the analyzed crops. The reductions exceeded 50% of the yields that can be obtained in irrigation (Table 3). Dragovic (1999) found that the average yields were much below the genetic yield potentials of these crops. Their genetic yield potentials were realized under 50%.

Table 3. Average and extreme yields and variation coefficient (Bosnjak, 2004)

Crop	Average yield (t ha-1)	Yield extremes (t ha-1)	Variation coefficient
Corn	5.08	2.26 - 7.11	21.57
Sugar beet	39.40	24.71 - 49.16	14.36
Soybean	1.86	0.92 - 7.25	27.55
Sunflower	1.96	1.39 - 2.63	16.64

Annual yield differences between irrigated and non-irrigated plots depended on crop grown and precipitation amount and distribution. Compared with irrigated crop production, drought impact on rainfed farming was expressed in a wide range, from few percents to 100% or more. In extremely dry years, the yields in non-irrigated plots in some crop species are 2-3 times less than those in irrigated plots. Numerous previous experiments have shown that drought in the Vojvodina Province causes large yield reductions. Dragovic & Maksimovic (1994) reported that the yield, on average for all crops, was reduced in dry years by 64% as compared with those obtained in irrigation.

The average yields in corn for the six years (1990, 1992, 1993, 2000, 2002 and 2003) were 14.6 t ha-1 in irrigation and 8.2 t ha-1 without irrigation. The increase due to irrigation was 6.4 t ha-1 or 78%. The highest yield in irrigation, 17.8 t ha-1, was obtained in 1990. Dobrenov *et al.* (1991) reported that in 1990 the irrigated hybrid NS-444 outyielded the non-irrigated control 4.29 times.

The average yield of irrigated sugarbeet for the six analyzed years was 90.1 t ha-1 and rainfed 56.0 t ha-1, *i.e.*, the effect of irrigation was 34.1 t ha-1 or 61%. The highest increase by irrigation, 131%, was obtained in the year 2000. Panic *et al.* (1992) report an average increase of 32.5% for irrigation trials conducted in the period 1986-1990. Yield performance of irrigated sugarbeet depends, in addition to weather conditions, on fertilization intensity and cultural practices applied (Maksimovic & Dragovic, 1997).

In soybean, similarly to other crops, drought impact and irrigation effectiveness are highest in extremely dry years. In a trial conducted at Rimski Sancevi in 1990, the irrigated soybean yielded 4.16 t ha-1, the non-irrigated one 0.95 t ha-1. The irrigation effectiveness in this year was 4.66 (Pejic, 1993). In 1992 and 1993, yields increases in irrigation were 84 and 82% respectively.

The sunflower is considered a drought-tolerant plant because of its well-developed root system and other characteristics. Maksimovic & Dragovic (2002) found in field trials that irrigation increased the yield of sunflower by 30% on average, but in dry years by 44%. The average yield in irrigation in some six years was 4.3, and 3.1 t ha-1 without irrigation, and impact of drought was 40%.

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