

WEATHER CHARACTERISTICS OF 2009 WITH ASPECT OF SPRING FIELD CROPS GROWING IN PANNONIAN REGION OF CROATIA

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ABSTRACT - Weather characteristics of 2009 with aspect of field crops growing in Pannonian region of Croatia

Aim of this study was appreciation of the 2009 growing season with aspect of spring crops growing in Pannonian region of Croatia and its comparison with favourable 2005 and unfavourable 2007. With that regard, precipitation and air-temperature regime impacts were focused. Total six weather bureaus were used as source of weather data as follows: Osijek, Gradište (near to Zupanja) and Slavonski Brod situating in Eastern Croatia; Bjelovar, Sisak and Zagreb-Maksimir situating in Central Croatia. Precipitation in the April-September period of 2009 was 306 mm (mean of six tested localities of the region) or 31 % lower in comparison with long-term mean (LTM) 1961-1990 (442 mm) but at same time air-temp. was for 2.4 °C higher (19.5 °C and 17.1 °C, respectively). However, weather characteristics in July and August have especially effects on spring crops growing. In general, water deficit in combination with higher air-temp. have detrimental effects. Precipitations in July+August of 2009 (means of three representing localities) were 81 mm (LTM = 140 mm) and 152 mm (LTM = 166 mm), for Eastern Croatia and Central Croatia, respectively. At the same time mean air-temp. were 23.0 °C (LTM = 20.5 °C) and 22.5 °C (LTM = 20.0 °C), respectively. These data are indicator of less favorable weather conditions in 2009 for spring crops growing. Comparison of weather characteristics in two recent growing seasons is a typical example degree of their favorability. Under favourable weather conditions of the 2005 growing season, precipitation in July + August (means of six tested localities of the region) were 328 mm or more than 2 fold more in comparison with LTM (154 mm). At the same time, air-temp. was 20.4 °C (LTM: 20.2 °C). However, analogical data for the unfavourable 2007 were 95 mm or 38 % lower than LTM and it is accompanied with the higher air temp. (22.7 °C) for even 2.5 °C. As result of these differences of weather characteristics are maize yields 4.87 t/ha in 2007 or about 30% lower than in 2005 (means of six counties covering tested weather bureaus centers).

Key words: air-temperatures, precipitation, spring crop yields, Croatia

SAŽETAK: Karakteristike vremenskih prilika 2009. g sa stajališta uzgoja proljetnih usjeva u Panonskoj regiji Hrvatske

Cilj ovoga rada je procjena vegetacije 2009. g s aspekta uzgoja proljetnih kultura u Panonskoj regiji Hrvatske i usporedba s povoljnom 2005. i nepovoljnom 2007. g. U tom pogledu je analiziran utjecaj oborinskog i temperaturnog režima. Ukupno šest meteoroloških postaja je korišteno kao meteoroloških podataka (oborine i srednje temperature zraka): Osijek, Gradište (kod Županje) i Slavonski Brod (subregija Istočna Hrvatska), Bjelovar, Sisak i Zagreb-Maksimir (subregija Središnja Hrvatska). U razdoblju travanj-rujan 2009. palo je prosječno 306 mm kiše (prosjeck za šest lokaliteta) ili 31% manje od višegodišnjeg prosjeka (VGP) 1961-90 (442 mm), a istovremeno su temperature zraka bile za 2,4 °C više (19.5 °C, odnosno 17.1 °C). Međutim, vremenske prilike u dva ljetna mjeseca (srpanj i kolovoz) imaju osobito utjecaj na uzgoj proljetnih usjeva. Općenito, suša u kombinaciji s visokim temperaturama zraka imaju štetan utjecaj. U srpnju i kolovozu 2009. palo je 81 mm kiše u Istočnoj Hrvatskoj, odnosno 152 mm u Središnjoj Hrvatskoj (prosjeci po tri lokaliteta), a temperature zraka iznosile su 23.0 °C (VGP = 20.5 °C), odnosno 22.5 °C (VGP = 20.0 °C). Ovi podaci ukazuju na manje povoljne uvjete za uzgoj proljetnih kultura u 2009. godini. Usporedba vremenskih prilika u dvije vegetacije mogu poslužiti kao tipični primjeri stupnja njihove pogodnosti. U povoljnim uvjetima 2005. g oborine u srpnju i kolovozu iznosile su 328 mm (prosjeck za šest lokaliteta regije) ili preko 2 puta iznad VGP a temperature zraka bile su 20.4 °C u rangu VGP (20.2 °C). Međutim, analogna usporedba za nepovoljnu 2007. je 95 mm ili 38 % manje od VGP i 22,7 °C ili za 2,5 °C veća od VGP.

Kao rezultat ovih razlika vremenskih prilika su i prinosi kukuruza 4,87 t/ha ili oko 30% niži nego u 2005. godini (prosjeci za šest županija koje pokrivaju šest meteoroloških postaja).

Ključne riječi: temperature zraka, oborine, prinos proljetnih usjeva, Hrvatska

INTRODUCTION

Weather characteristics are important factor of field crops yield under agroecological conditions of Croatia. They are main reason for considerable varying of yields of individual crops among years for short period. For example, in decade- period 1998-2007 maize yield variation in Croatia (State Bureau for Statistics, 2008) was in range from 3.86 t/ha (2007) to 6.92 t/ha (2005) and they are mainly resulted by weather characteristics (KOVACEVIC ET AL., 2009; SOSTARIC AND JOSIPOVIC, 2006). Aim of this study was appreciation of the 2009 growing season with aspect of spring crops growing and its comparison with favourable 2005 and unfavourable 2007. With that regard, precipitation and air-temperature regime impacts were focused.

MATERIAL AND METHODS

Source of the data

For this study, the data from State Hydrometeorological Institute (precipitation and air-temperature) and State Institute for Statistics (statistical yearbooks: maize yield) were used. Total six weather bureaus were used as source of weather data as follows: Osijek, Gradište (near to Zupanja) and Slavonski Brod representing Eastern Croatia, Bjelovar, Sisak and Zagreb-Maksimir representing Central Croatia. Rain factor (RFm) was calculated monthly as quotient of precipitation (mm) and mean air-temperatures (°C) according GRACANIN (1950).

Description of the area

Pannonian region of Croatia is mainly lowland area of the country and occupies close to 60% of the state territory. It was divided in Central Croatia and Eastern Croatia regions and both are main field crops growing area. However, the eastern part of the region is more important with aspect of field crop growing because of more favourable agroecological, especially soil, conditions.

RESULTS AND DISCUSSION

Water storages in soil at beginning of the spring crops 2009 growing season were mainly in level of long-term means (LTM: 1961-1990) based on criterion precipitation quantities for three-month period (January-March: precipitation 150 mm and 154 mm, for 2009 and LTM, respectively). Precipitation in the April-September period of 2009 was 306 mm (mean of six tested localities of the region) or 31 % lower in comparison with LTM (442 mm) but at same time air-temperatures was for 2.4 °C higher (19.5 °C and 17.1 °C, respectively). However, weather characteristics in two summer months (July + August) have especially effects on spring crops growing. In general, water deficit in combination with higher air-temperatures have detrimental effects. Precipitations in July+August of 2009 (means of three representing localities) were 81 mm (LTM = 140 mm) and 152 mm (LTM = 166 mm), for Eastern Croatia and Central Croatia, respectively. At the same time mean air-temperatures were 23.0 °C (LTM = 20.5 °C) and 22.5 °C (LTM = 20.0 °C), respectively (Tables 1 and 2). These data are indicating less favorable weather conditions for spring crops growing.

Table 1. Precipitation and air-temperatures in Pannonian region of Croatia in 2009

Locality	Monthly precipitation (mm) and mean air-temperature (°C) for the 2009 growing season												Σ mm	X °C
	April		May		June		July		August		September			
	mm	°C	mm	°C	mm	°C	mm	°C	mm	°C	mm	°C		
EASTERN CROATIA SUBREGION (the eastern part of Pannonian region)														
Osijek	19	14.6	39	18.3	63	19.2	14	23.2	61	22.9	10	19.1	206	20.0
Zupanja	19	14.8	38	18.9	77	19.5	43	23.4	37	23.2	2	19.7	244	19.9
Slav. Brod	13	14.2	44	18.1	104	19.3	61	22.6	29	22.3	29	18.7	280	19.2
x	17	14.5	40	18.4	81	19.3	39	23.1	42	22.8	14	19.2	233	19.6
Precipitation in the January-March period: 132 mm (mean of three localities)														
CENTRAL CROATIA SUBREGION (the western part of Pannonian region)														
Bjelovar	33	14.9	50	18.1	102	19.2	50	22.4	21	22.6	37	18.5	293	19.3
Sisak	31	14.8	44	18.7	153	19.7	171	22.5	37	22.4	30	18.0	466	19.4
Zagreb	52	14.5	49	18.4	68	19.8	96	22.3	79	22.6	22	18.9	366	19.4
x	39	14.7	48	18.4	108	19.6	106	22.4	46	22.5	30	18.5	374	19.4
Precipitation in the January-March period: 167 mm (mean of three localities)														
MEANS OF BOTH SUBREGIONS														
	28	14.6	44	18.4	95	19.5	73	22.8	44	22.7	22	18.9	306	19.5

Table 2. Precipitation and air-temperatures in Pannonian region: long-term means (1961-1990)

Locality	Monthly precipitation (mm) and mean air-temperature (°C): means 1961-1990												Σ mm	X °C
	April		May		June		July		August		September			
	mm	°C	mm	°C	mm	°C	mm	°C	mm	°C	mm	°C		
EASTERN CROATIA SUBREGION														
Osijek	54	11.3	59	16.5	88	19.5	65	21.1	59	20.3	45	16.6	370	17.6
Zupanja	Data not-available (45 km air-distance from Osijek toward south)													
Slav. Brod	58	10.9	73	15.9	86	19.0	83	20.7	73	19.8	62	16.1	435	17.1
x	56	11.1	66	16.2	87	19.3	74	20.9	66	20.1	54	16.4	403	17.3
Precipitation in the January-March period: 138 mm (mean of two localities)														
CENTRAL CROATIA SUBREGION														
Bjelovar	63	10.8	79	15.6	96	18.7	78	20.4	82	19.5	65	15.8	463	16.8
Sisak	73	11.1	82	15.8	91	19.1	77	20.8	85	19.8	76	16.0	484	17.1
Zagreb	64	10.6	79	15.3	100	18.5	83	20.1	95	19.3	79	15.8	500	16.6
x	67	10.8	80	15.6	96	18.8	79	20.4	87	19.5	73	15.9	482	16.8
Precipitation in the January-March period: 169 mm (mean of three localities)														
MEANS OF BOTH SUBREGIONS														
	62	11.0	73	15.9	92	19.1	77	20.7	77	19.8	64	16.2	442	17.1

Comparison of weather characteristics in two recent growing seasons (2005 as favorable and 2007 as unfavorable) are typical example of weather impacts on spring crops yield in example of maize as the first-ranked field crop of the region: under less favorable weather conditions of 2007 maize yields were 4.87 t/ha or about 30% lower than under

favorable conditions of 2005 (Table 3). Under favourable weather conditions of the 2005 growing season, precipitation in two summer months (July + August: means of six tested localities of the region) were 328 mm or more than 2 fold more in comparison with LTM. At the same time, air-temperature was close to LTM. However, analogical data for the unfavourable the 2007 growing season were 95 mm or 38 % lower than LTM and it is accompanied with the higher air temperature for even 2.5 °C (Tables 1 and 2). In general, drought and hot stresses are more detrimental factor for the spring crops yield under conditions of Eastern Croatia subregion (KOVACEVIC ET AL., 2009) and the data for 2007 are in accordance with this observation.

Table 3. Precipitation and air-temperatures in Pannonian region for two growing seasons

Maize yield t/ha**	Precipitation (mm) and mean air-temperature (°C) *														Σ mm	X °C
	April		May		June		July		August		September		mm	°C		
	mm	°C	mm	°C	mm	°C	mm	°C	mm	°C	mm	°C				
	THE FAVORABLE GROWING SEASON (2005)															
	a) Eastern Croatia (the eastern part of Pannonian region) sub-region															
7.51	62	11.7	46	17.0	94	19.5	160	21.6	209	19.4	71	17.1	642	17.7		
	b) Central Croatia (the western part of Pannonian region) sub-region															
6.86	64	11.7	74	16.6	61	19.9	121	21.5	166	19.0	71	16.9	557	17.6		
	Means in level of both sub-regions (a + b)															
7.19	63	11.7	60	16.8	78	19.7	140	21.6	188	19.2	71	17.0	600	17.7		
	THE UNFAVORABLE GROWING SEASON (2007)															
	a) Eastern Croatia (the eastern part of Pannonian region) sub-region															
4.95	5	13.5	85	18.2	61	22.4	31	23.6	45	22.4	90	14.5	317	19.1		
	b) Central Croatia (the western part of Pannonian region) sub-region															
4.79	5	13.8	72	18.2	67	22.4	42	23.2	72	21.5	144	14.6	402	18.9		
	MEANS OF BOTH SUBREGIONS															
4.87	5	13.7	78	18.2	64	22.4	36	23.4	59	21.9	117	14.6	359	19.0		

* means of three Weather Bureaus: a = Osijek + Zupanja + Slavonski Brod; b = Bjelovar + Sisak + Zagreb

** means of three Counties: a = Osijek-Baranya + Vukovar-Syrmium + Brod-Posavina; b = Bjelovar-Bilogora + Sisak-Moslavina + Zagreb

Table 4. Rain factor (RFm) values according GRACANIN (1950)

Pannonian subregion	Rain factor (RFm = precipitation / air-temperature) - GRACANIN (1950)								
	2005			2007			2009		
	June	July	Aug.	June	July	Aug.	June	July	Aug.
a) Eastern Croatia	4.8sa	7.4h	10.1h	2.7a	1.3pa	2.0a	4.2sa	1.7a	1.8a
b) Central Croatia	3.1a	5.6sh	8.7h	3.0a	1.8pa	3.3a	5.5sh	4.7sa	2.0a

Legend: a = arid, h = humid, sa = semiarid, sh = semihumid, pa = perarid, ph = perhumid

According Gracanin's Rain factor (RFm) weather in July and August of 2009 had characteristics of semiarid/arid climate in Eastern Croatia subregion and status in Central Croatia subregion was slightly more favourable (semihumid/semiarid/arid). Also, in the same time perarid /arid conditions were main characteristics of unfavourable the 2007 and semiarid/humid conditions characterized favourable the 2005 growing season (Table 4).

Similar effects of weather characteristics on maize yields were found by our earlier studies and they are in accordance by experiences from USA Corn Belt (THOMPSON, 1986; SHAW 1988). KOVACEVIC ET AL., (1994) showed yields of maize in Croatia for the 1960-1989 period. Precipitation in 4-month (May-August) period for tested period were 214 mm (Osijek) and 249 mm (Podr. Slatina). Grain yields variation among the year were from

3.14 t/ha to 8.43 t/ha (former municipality Vukovar – now part of Vukovar-Syrmium County: mean yield 6.00 t/ha) and from 2.94 t/ha to 5.81 t/ha (former municipality Podr. Slatina– now part of Virovitica-Podravina County: mean yield 4.13 t/ha). Degree of soil fertility between Vukovar and Slatina areas (JANEKOVIC, 1971) is main reason for maize yield differences.

In general, the lower yields of maize were in connection with the lower precipitation, especially in area of former Vukovar municipality. For example (KOVACEVIC ET AL., 1994), yield variation among years for the 1960-1989 period in Vukovar municipality was in the range from 3.14 t/ha (1961: precipitation in Vukovar during July+August 37 mm) to 8.43 t/ha (1984: precipitation 134 mm). At the same time, in Podr. Slatina municipality, maize yields for the focused years were 2.94 t/ha (1961: precipitation in Podr. Slatina during July+August 95 mm) and 5.22 t/ha (1984: precipitation 132 mm). JOSIPOVIC ET AL. (2005) reported variation of maize yields in Brod-Posavina County for the period 1981-2003. With that respect, precipitation in May-August period (Slavonski Brod Weather Bureau) had considerable influences on maize yields in formerly Slav. Brod municipality (1981-1990: range from 2.91 to 5.84 t/ha, precipitation 175 mm and 335 mm, respectively) and Brod-Posavina County (1996-2003: range from 3.98 to 6.42 t/ha, precipitation 219 mm and 334 mm, respectively).

JUG ET AL. (2007) tested impacts of soil tillage practices on maize yields under conditions of Baranya (stationary field trial on chernosem in the 19991-2001 period). Under normal weather conditions of the 1999 growing season (precipitation in July+August 125 mm) maize yielded 9.55 t/ha (no-tillage system) to 10.53 t/ha (conventional soil tillage). However, under drought stress of 2000 (only 48 mm) by no-tillage practice yield was drastically reduced (0.76 t/ha and 7.81 t/ha, respectively).

However, sunflower yielded considerably lower under wet year conditions. LIOVIC ET AL., (2006) reported data of sunflower yields and weather characteristics of individual growing season from 1981 to 2003 in Eastern Croatia. Under wet conditions of the 1982, 1999 and 2001 growing seasons (mean precipitation in Nasice for June-August = 349 mm) yield of sunflower were less than 2 t/ha (mean 1.76 t/ha), while under normal and dry conditions they were above 2.0 t/ha.

CONCLUSIONS

Based on precipitation and air-temperature regimes, the 2009 growing season is characterized as less favorable for majority spring crops growing. With that respect, water shortage in combination with high air-temperatures, especially in August, are main responsible factor. Under these conditions, only sunflower is more tolerant, while for maize and soybean are relative more susceptible crops.

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