CLIMATIC CHANGES AND THEIR POSSIBLE IMPACT ON WATER CONSUMPTION, IN MAIN CROPS OF ROMANIA

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Abstract: *The aim of the studies and researches - By the performed researches, the calculation of moisture deficit and irrigation water supply was performed, based on both climatic scenarios and determination of water consumption in irrigated crops, due to predicted climatic changes, in Romania. Stage of the research - Theoretical and practical researches in Romania regarding the plant water consumption were performed at NARDI Fundulea. Materials and methods - To achieve the proposed objectives, the paper presents a schedule for a mathematical modulation, with 12 variants „4 x 3", in five reps, where reps represented the values obtained under five pedoclimatic areas in Romania. Factor A – tested crop, with the following graduations: A1- sunflower, A2- maize, A3- sugar beet, A4- soybean; Factor B – climatic scenario, with the following graduations: - B1-Tn – current average temperatures, B2-Tn+2oC – increasing, with 2°C, of the current average temperatures, B3-Tn+5oC – increasing, with 5°C, of the current average temperatures. The necessity of irrigation in a certain area was established depending on moisture deficit estimated as difference between water consumption and supply sources for soil and plant. The ETRO value was highly precisely estimated, using Thornthwaite method, and to register all the modifications of irrigation regime elements, the water soil balances for all crops under study were achieved. Novelty degree - The paper, try to underline the negative impact of global warming, by using methods of water consumption indirect determination. Stage of achievements - Following the researches on world plane, measures to use modern irrigation techniques, limited water supplies, crop breeding for drought resistance as well as new species were taken. Limits of the research - To achieve the researches, indirect methods to determine the water consumption were used. Practical Implications of the research - The proposals are very important for irrigated farming, because it is important to produce a lots and cheap, for food security. Paper originality - The paper presents high level of originality, no similar papers were performed till present, in Romania. Importance of the paper - The paper highlights the possible increases, in the future, of the water consumption, in main crops, under the context of water and energy limited resources.*

Key words : *limited water supplying; watering rate; irrigation norm; water consumption*

INTRODUCTION

The main consequences of global warming are increasing of ocean level as well as the modification of extreme meteorological events (drought, heat, floods, strong winds) which will have as major effects, the disappearance of some plant and animal species, risks in human health and demographical changes. The crop productivity presents fluctuations from one year to another, being significantly influenced by variability of climatic conditions and especially by extreme climatic events. The global warming is a phenomenon unanimously accepted by the international scientific community, being already emphasized by the data analysis during long time. The extreme temperatures recently registered, such as heat of 2003 and especially 2007, were related to increasing of extreme phenomena frequency during last decades, as a consequence of climatic changes. In Romania, on about 14.7 millions ha, of which 9.4 millions arable land (64% of total arable land), the soils are affected, in low or high degree, by frequent droughts, during long time and consecutive years (>7 millions ha of agricultural land – 48%) or moisture excess in rainy years (>6 millions ha).

MATERIALS AND METHODS

To achieve the objectives of this paper, three possible climatic scenarios were established, such as:

1. Tn - current average temperatures
2. Tn+2°C - increasing of current average temperatures with 2°C
3. Tn+5°C - increasing of current average temperatures with 5°C

The ETRO value was estimated by Thornthwaite method, based on correlation between water consumption of a crop and air average temperature.

So, depending on values of the normal average temperatures, the values of monthly average ones were achieved, in the case of increasing with 2^0C respectively 5°C.

Based on these values, the annual thermic indices for the three scenarios (Tn; Tn+2°C and Tn+5°C), in five pedo-climatic areas under study (Dobrudja, Tecuci Plain, South of Moldavia, Mostiştea Plain and Burnaz Plain), were calculated.

To calculate the soil water balances, the values of initial reserves, of minimum ceiling and of watering rates specific for the five areas under study were used. The average values, on 20 years at least, of areas under study with 80% calculation supply were used too.

After the calculation of soil water balance for all crops, in all locations and for all climatic scenarios, 60 variants synthesized in a tri-factorial model with 60 variants, 5 x 4 x 3 type, in one rep. By combining results obtained from tri-factorial mathematical model, with 60 variants, in one rep, resulted the sub-variant 2, with 12 variants, 4 x 3 type, in five reps (Dobrudja, Tecuci Plain, South of Moldavia, Mostiştea Plain and Burnaz Plain are considered as reps).

RESULTS AND DISCUSSION

The influence of average temperature increasing and of cultivated genotype on main parameters of hydric balance is presented in tables 1-6. At all studied parameters, the highest values were achieved in sugar beet, while the lowest ones in sunflower; maize and soybean occupy an intermediary position, but with almost identical values in both crops.

It is important to underline the percentage increasing almost identical in all crops vs. current climatic conditions, such as: daily average evapo-transpiration will increase with about 10%, in the case of temperature increasing with 2°C and with about 30% in the case of temperature increasing over 5°C 9table1);

Table 1

Data synthesis regarding the influence of average temperatures increasing and species on daily average evapo-transpiration

VARIANT		DAILY ETRO		Vs. check variants	
		m^3/ha	rel. %	m^3/ha	Signif.
sunflower	t_n	30	100	Mt	
	t_n + 2 °C	33	110.07	3	***
	t_n + 5 °C	38	128.19	8	***
maize	t_n	34	100	Mt	
	t_n + 2 °C	37	110.71	4	***
	t_n + 5 °C	44	129.76	10	***
Sugar beet	t_n	36	100	Mt	
	t_n + 2 °C	39	108.94	3	***
	t_n + 5 °C	46	129.05	10	***
Soybean	t_n	34	100	Mt	
	t_n + 2 °C	37	108.88	3	***
	t_n + 5 °C	43	128.40	10	***

LSD 5%=0.56 LSD 1%=0.75 LSD 0,1%=0.99

Total evapo-transpiration will has a possible increasing with the same values (table2);

The hydric deficit may increase with more than 11%, at t_n+2^oC and with 32 - 36% at t_n+5^oC (table 3);

Regarding the average irrigation water supply, it will increase with about 10 % at t_n+2^oC and with 35- 43% at t_n+5^oC (table 4);

As compared to current situation, the average watering number will increase with one, at t_n+2^oC and with two, at t_n+5^oC (sunflower, maize and soybean), while in sugar beet, three waterings will be necessary (table 5);

The average irrigation rate will increase with values of 820-1780 m^3/ha in sunflower and maize, with 620-1920 m^3/ha (sugar beet) and with 820-1950 m3/ha (soybean); all differences are very significant (table 6).

Table 2

Data synthesis regarding the influence of average temperatures increasing and species on total average evapo-transpiration

VARIANT		TOTAL ETRO		Vs. check variants	
		m^3/ha	rel. %	m^3/ha	Signif.
sunflower	t_n	4734	100	Mt	
	t_n + 2 °C	5213	110.12	479	***
	t_n + 5 °C	6093	128.72	1359	***
maize	t_n	5511	100	Mt	
	t_n + 2 °C	6053	109.85	543	***
	t_n + 5 °C	7110	129.02	1599	***
Sugar beet	t_n	6485	100	Mt	
	t_n + 2 °C	7132	109.98	647	***
	t_n + 5 °C	8352	128.79	1867	***
Soybean	t_n	5554	100	Mt	
	t_n + 2 °C	6099	109.81	545	***
	t_n + 5 °C	7162	128.95	1608	***

LSD 5%=84.11 LSD1%=112.97 LSD 0,1%=149.26

Table 3

Data synthesis regarding the influence of average temperatures increasing on hydric average deficit

VARIANT		Hydric deficit		Vs. check variants	
		m^3/ha	rel. %	m^3/ha	Signif.
sunflower	t_n	4198	100	Mt	
	t_n + 2 °C	4677	111.41	479	***
	t_n + 5 °C	5557	132.38	1359	***
maize	t_n	4939	100	Mt	
	t_n + 2 °C	5482	110.99	543	***
	t_n + 5 °C	6538	132.38	1599	***
Sugar beet	t_n	5831	100	Mt	
	t_n + 2 °C	6478	111.10	647	***
	t_n + 5 °C	7697	132.02	1867	***
Soybean	t_n	4962	100	Mt	
	t_n + 2 °C	5687	114.62	725	***
	t_n + 5 °C	6784	136.72	1822	***

LSD 5%=191.45 LSD1%=257.14 LSD 0,1%=339.72

Table 4

Data synthesis regarding the influence of average temperatures increasing and species on water average need

VARIANT		Water need		Vs. check variants	
		m^3/ha	rel. %	m^3/ha	Signif.
sunflower	t_n	3753	100	Mt	
	t_n + 2 °C	4134	110.68	399	
	t_n + 5 °C	5026	134.57	1291	***
maize	t_n	4114	100	Mt	
	t_n + 2 °C	4980	121.06	866	***
	t_n + 5 °C	5775	140.38	1661	***
Sugar beet	t_n	5294	100	Mt	
	t_n + 2 °C	5910	111.64	616	**
	t_n + 5 °C	7122	134.53	1828	***
Soybean	t_n	4166	100	Mt	
	t_n + 2 °C	5186	124.49	1020	***
	t_n + 5 °C	5979	143.54	1814	***

LSD 5%=448.65 LSD 1%=602.60 LSD 0,1%=796.14

Table 5

Data synthesis regarding the influence of average temperature increasing and species on average watering number

VARIANT		No of waterings		Vs. check variants	
		m^3/ha	rel. %	m^3/ha	Signif.
sunflower	t_n	4	100	Mt	
	t_n + 2 °C	5	125.00	1	***
	t_n + 5 °C	6	155.00	2	***
maize	t_n	5	100	Mt	
	t_n + 2 °C	6	120.00	1	***
	t_n + 5 °C	7	144.00	2	***
Sugar beet	t_n	6	100	Mt	
	t_n + 2 °C	7	112.90	1	***
	t_n + 5 °C	9	138.71	3	***
Soybean	t_n	5	100	Mt	
	t_n + 2 °C	6	120.00	1	***
	t_n + 5 °C	7	148.00	2	***

LSD 5%=0.39 LSD1%= 0.52 LSD 0,1%=0.69

Table 6

Data synthesis regarding the influence of average temperature increasing and species on average irrigation rate

VARIANT		Average irrigation rate		Vs. check variants	
		m^3/ha	rel. %	m^3/ha	Signif.
sunflower	t_n	3190	100	Mt	
	t_n + 2 °C	4010	125.71	820	***
	t_n + 5 °C	4970	155.80	1780	***
maize	t_n	4010	100	Mt	
	t_n + 2 °C	4830	120.45	820	***
	t_n + 5 °C	5790	144.39	1780	***
Sugar beet	t_n	5000	100	Mt	
	t_n + 2 °C	5650	113.00	650	***
	t_n + 5 °C	6920	138.40	1920	***
Soybean	t_n	4010	100	Mt	
	t_n + 2 °C	4830	120.45	820	***
	t_n + 5 °C	5960	148.63	1950	***

LSD 5%= 256.46 LSD 1%=344.46 LSD 0,1%=455.09

CONCLUSIONS AND RECOMMENDATIONS

Due to climatic changes, the aridization process will intensify, atmospheric and pedological drought will be prolonged.

The association between atmospheric and pedological drought will has obviously harmful effects for crops, leading to diminution or even crop compromising. By atmospheric drought, it means periods of time over 10 days during vegetation with rainfall below 5 mm, high temperatures, warm winds and low air relative humidity (20-30%).

The crop water need will increase with 35-40 % in the case of temperature increasing with $5^{o}C$, with catastrophic effects regarding the human food security.

Due to increasing of water need and watering number, the agriculture will become un-efficient, that lead to serious social problems.

Having in view the importance of climatic changes, the European Union has decided that, it is important to implement measures for diminution of global warming below $2^{0}C$.

The climatic changes represent a phenomenon which could be diminished or even stopped, if all countries will take measures for reduction of gas emissions.

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