MAIZE IRRIGATION AT DIFFERENT WATER SUPPLYING LEVELS ON THE CLAY-ILLUVIAL CHERNOZEM FROM A.R.D.S. TELEORMAN

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ABSTRACT

The research performed at A.R.D.S. Teleorman, during 2000-2002, had as aim the determination of soil-water-plant-atmosphere interrelations, under optimum water supplying conditions (100%) and at different levels of induced hydric stress (dryland, irrigated 25%, 50%, 75% from optimum irrigation rate) in maize, with a view to reduce the irrigation water consumption on the clay-illuvial chernozem. Based on the obtained results, it has been ascertained that it is possible to achieve yields of 7,000-10,000 kg grain/ha by irrigation with limited water rates [50%, 75% respectively, from the optimum irrigation rate (50% active moisture interval)]. The pluviometric regime, non-uniformly distributed during the vegetation period, soil drought (induced hydric stress) associated with drought and heat rendered more difficult the pollination and grain formation. On an average, during the three years of experimentation, these conditions determined a sterility degree between 3.0 and 23.4% with smaller or greater negative influences on grain yield. The aspects regarding the irrigation impact on the physico-chemical features of clay-illuvial chernozem emphasized: the decrease of organic matter and chemicals content under variants with intense irrigation regime, a middle to great content of hydro-stable macro-aggregates (the smallest values were registered in the upper part of the ploughed layer at all experimental variants), a small to great content of structural micro-aggregates (especially under intense irrigated variants). According to the structural instability index, expressed as a ratio between dispersion and macro-hydro-stability, the clay-illuvial chernozem from A.R.D.S. Teleorman presents reduced vulnerability in the structural processes. According to the content of nutrients the soil belogs to the domain of middle to well supplied due to its intrinsic characteristics.

Key words: clay-illuvial, chernozem, irrigation, maize, water supplying levels

INTRODUCTION

The preservation and water use efficiency from irrigation and rainfall have a significant role in sustainable farming development in areas with hydric stress, contributing to the yield stability, water resources and soil fertility protection, decreasing of energy consumption and irrigation expenses (Picu, 1997).

Consequently, on world plane, the concerns of scientific research regarding the irrigation water use efficiency increased, having as aim the achievement of greater gains per the applied water unit (Dinar, 1993; Craciun et al., 1997; Zamfir and Zamfir, 1999).

The significant yield diminutions are determined by unfavourable environmental conditions. Among them, the hydric stress is a major limitative factor (Craciun and Craciun, 1993).

Often, there are substantial differences between plant water consumption, soil intrinsic properties as well as rainfall during the vegetation period, that significantly influence the obtained yields. The long-term observations emphasized that on the fields under irrigation, modifications of soil physico-chemical features occur. These modifications generally affect the soil fertility (Bora, 1991; Oprea et al., 1999).

The paper presents some results regarding the hydric stress effects on both maize grain yield and the physico-chemical features of the clay-illuvial chernozem.

MATERIAL AND METHODS

The researches were carried out during 2000-2002, at A.R.D.S. Teleorman, on a clay-illuvial chernozem and had in view the effect of sub-optimum irrigation rate on maize grain yield as well as on some soil features.

The experimental variants were: V_1 = dryland (control); V_2 = irrigated 25%; V_3 = irrigated 50%; V_4 = irrigated 75%; V_5 = irrigated 100%. The variants area was of 60 m^2 and the experiments were performed in randomized blocks and four irrigated repetitions [100%, 75%, 50%, 25% from the optimum irrigation rate (50% active moisture interval)] and non-irrigated one.

The irrigation method with installations adapted for experimental plots was utilized. The

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watering rates were precisely applied according to the readings performed on the glass rods of the water pool. The watering rates adequate to experimental variants were: V1 = 0 m3/ha; V2 = 175 m3/ha; V3 = 350 m3/ha; V4 = 525 m3/ha; V5 = 700 m3/ha. The waterings were applied when the soil moisture, on 0-80 cm depth, decreased to the minimum available water content.

The soil water deficit was determined by periodical samplings (ten to ten days determinations) and its dynamics was studied during the whole maize vegetation period. The water consumption was also determined by the soil hydric balance method.

In order to establish the irrigation influence on soil, soil samples (in plastic bags and metallic cylinders of 200 cm^3), have been taken in two observation stages: maize sowing and harvesting, on 0-20 cm depth for chemical analyses and on: 0-10 cm, 10-20 cm, 20-30 cm, 30-40 cm for physical analyses.

Fundulea 376 hybrid was used.

The technology applied during the three years of experimentation was optimum, adequate to soil and climate conditions.

RESULTS AND DISCUSSION

Maize grain yield

The three years of experimentation were totally different from the viewpoint of rainfall and applied watering number (Table 1).

Till now, the experimental results proved that the maize yield variation under irrigation is very small, which confirm that the hydric stress is a major factor of yield variation amplitude.

The year 2000 was characterized by a moisture deficit at germination as well as by an accentuate drought during the maximum maize consumption, period that coincides at A.R.D.S. Teleorman area, with the previous stage of tassel appearance followed by pollination, grain formation and filling (beginning of June – end of August). Under these conditions, the Fundulea 376 hybrid achieved a grain yield that varied between 464 kg/ha (non-irrigated variant) and 7,449 kg/ha (under optimum irrigation) (Table 2). As follows of soil water deficit, atmospheric drought and heat, the sterility degree largely ranged: 8.8% under 100% irrigation and 60.8% under dryland variant (control).

The year 2001 was characterized by a relatively normal rainfall regime, which determined the increasing of soil moisture level over the minimum available water content with 2-12% depending on the induced hydric stress level. Under these conditions, the drought occurred later (July) in comparison with the year 2000.

The climatic conditions of this year led to the achievement of some yields between 3,509 kg/ha (under dryland variant) and 12,444 kg/ha (under optimum irrigation). The variation limits of the sterility degree were of 0.1-5.3% depending on the induced hydric stress level.

Although the 2002 year exceeded the normal rainfall quantity, its repartition was very ununiform (i.e. May), fact that led to the obtainment of some yields between 6,895-12,055 kg/ha. The sterility degree had values between 0.1-4.1%, depending on the induced hydric stress level.

Table 1. Monthly repartition of rainfall (mm) during the maize vegetation period
A.R.D.S. Teleorman, 2000-2002

Experimental year	Month						Total IV-IX	No. of applied waterings
	IV	V	VI	VII	VIII	IX		
2000	27.4	8.5	32.3	15.8	2.5	77.2	163.7	5
2001	77.3	29.5	154.1	17.9	19.3	36.2	334.3	3
2002	44.5	26.8	114.4	94.2	123.0	32.4	435.3	3
Multiannual average	41.7	60.2	70.0	62.2	47.1	42.6	323.8	-
Experimental year	Rainfall registered during September 1st - March 31th							
	IX	X	XI	XII	I	II	III	Total IX-III
1999-2000	77.2	58.4	12.3	52.9	35.5	51.2	21.8	309.3
2000-2001	36.2	0.2	12.3	5.8	20.1	51.9	65.7	192.2
2001-2002	32.4	1.5	44.8	23.7	28.0	12.6	23.6	166.6
Multiannual	42.6	34.8	43.3	39.5	35.7	30.7	32.8	259.4

The maize grain yield considerably varied during the three years of experimentation under the rainfall influence as well as under induced hydric stress level, with values between 3,623 kg/ha (under dryland) and 10,649 kg/ha (under optimum irrigation – 100%). The yielding level increased proportionally to the applied irrigation rate, very significant gains being obtained under 100% irrigation conditions (7,026 kg grain/ha), 75% irrigation conditions (6,026 kg grain/ha), and 50% irrigation conditions (3,267 kg grain/ha) from the optimum irrigation rate (Table 2). In the droughtiest year, 2000 although the soil water deficit was diminished by waterings applied in critical stages, the yield level was very low, especially under dryland and 25% irrigation from the optimum irrigation rate, level determined by the very high sterility degree, too.

Table 2. Influence of maize irrigation at different hydric stress levels on grain yield
A.R.D.S. Teleorman, 2000-2002

Irrigation level*	Grain yield (kg/ha)						Sterility degree (%)			
	Experimental years									
	2000	2001	2002	average	%	diff. kg/ha	2000	2001	2002	average
Dryland (check)	464	3509	6895	3623	100	mt	60.8	5.3	4.1	23.4
Irrigated 25%	1761	5302	8233	5099	141	1476	26.4	1.2	1.1	9.6
Irrigated 50%	4044	7460	9167	6890	190	3267	13.4	1.2	0.8	7.7
Irrigated 75%	6882	10732	11333	9649	266	6026	10.7	0.3	0.1	3.7
Irrigated 100%	7449	12444	12055	10649	294	7026	8.8	0.1	0.1	3.0
LSD 5%	1295	1815	1340			1538				
LSD 1%	2095	2518	2039			2238				
LSD 0,1%	3115	3625	3150			3357				

* = Irrigated 100%, 75%, 50%, 25% from optimum irrigation rate

Maize water consumption

The total water consumption of plants [? (e+t)] is covered by rainfall (P), the difference between the two soil water reserves (Ri – Rf) and irrigation rate, in the case of variants irrigated at different hydric stress levels. The precipitation taken into consideration were those registered during the maize vegetation stage. The total water consumption for the five experimental variants studied and the sources of its coverage are given in table 3 and figure 1.

In 2000 year, a very droughty one [with only 8.5 mm, respectively 2.5 mm rainfall during May and July and with a total during the maize vegetation period of 163.7 mm (88.7 mm > 5 mm)], the variation of total water consumption of Fundulea 376 hybrid was almost of 50% depending on the water supplying level.

During this year, the total water consumption was covered by rainfall (19.1% - 31.7%), irrigation (38.5%-75.3%) and soil water reserve (5.6%-29.8%) under irrigated variants while under dryland conditions, the water consumption was covered by rainfall (45.5%) and soil water reserve (54.5%).

In 2001, normal year (with 334.3 mm of which 198.1 mm useful precipitation), the total water consumption registered values between 2,621 m^3/ha and 4,138 m^3/ha depending on the induced hydric stress level. This water consumption was covered by rainfall (47.9-65.5%), irrigation (17.3-50.7%), soil water reserve (1.4-17.2%) under irrigated variants while under non-irrigated conditions control variant, the water consumption was covered by rainfall (79.4%) and soil water reserve (20.6%).

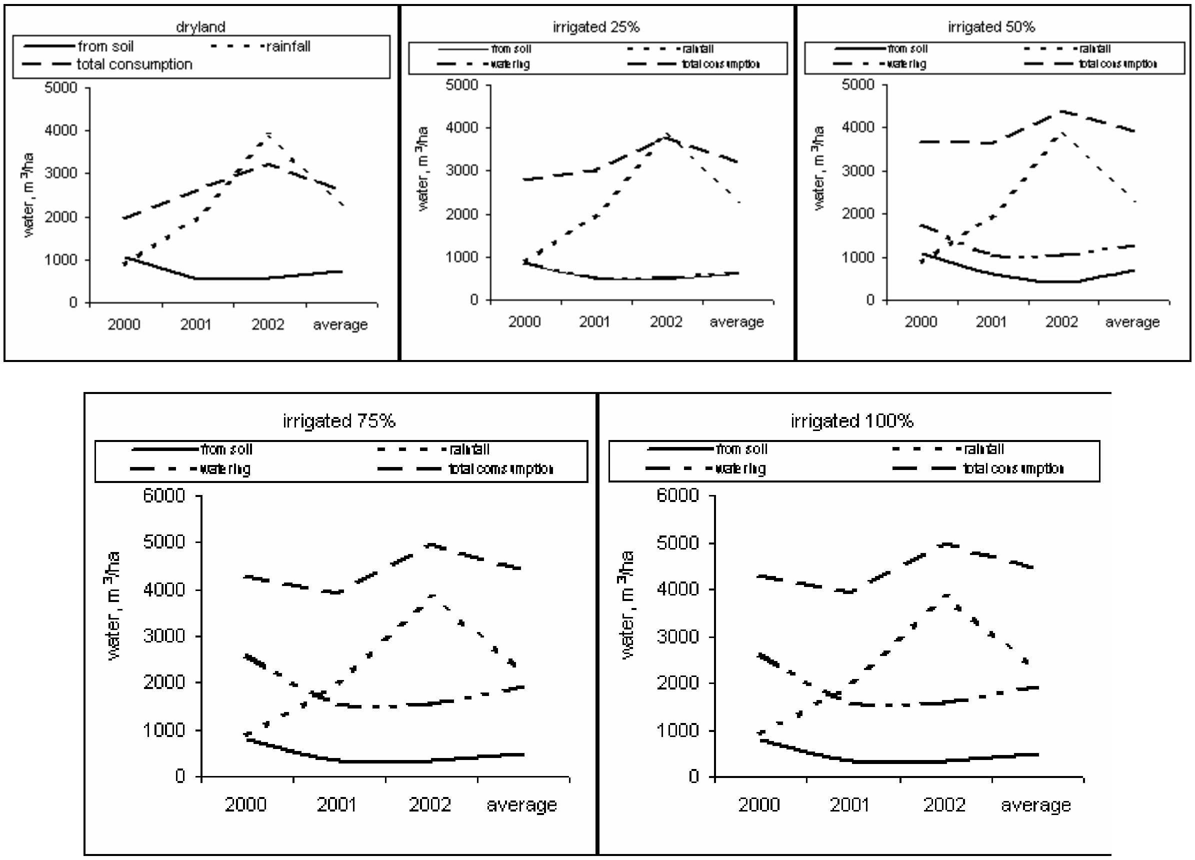

Figure 1. Evolution of water consumption and its covering sources for grain maize crop, A.R.D.S. Teleorman, 2000-2002

In 2002, wet year (over 400 mm rainfall during the vegetation period, of which 388.4 mm precipitation > 5 mm), the total values of water consumption registered variations that exceeded 10% depending on the water supplying level (induced hydric deficit) and ranged between 3,253 m^3/ha (dryland) and 5,546 m^3/ha (100% irrigated). These differences between the total consumption values are supported and explained by the insignificant differences regarding the water reserve registered on soil profile at harvesting.

The total values of water consumption during the whole experimentation period (2000-2002 average) were between 2,608 m^3/ha (dryland) and 4,778 m^3/ha (100% irrigated). Under irrigated variants this consumption was covered, on an average, by rainfall (41.7-70.3%), irrigation (10.5-49.9%) and soil water reserve (3.0-19.2%) while under non-irrigation - control variant - the consumption was covered by rainfall (72.1%) and soil water reserve (27.9%).

The analysis of relationship between the total water consumption and yields obtained in those five experimental variants, for maize, emphasized a very significant close link (Figure 2).

The water utilization efficiency (WUE), which is an usual parameter in agricultural research, expressing the rapport between yield and total water consumption, had values, on an average, between 13.89 kg grain/mm consumed water (dryland variant) and 22.29 kg grain/mm consumed water (100% irrigated variant) (Table 3).

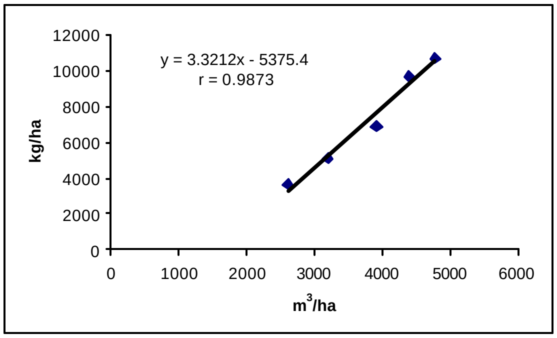

Figure 2. Water consumption - yield correlation at grain maize, A.R.D.S. Teleorman, 2000-2002

Table 3. Total water consumption and its covering sources of experimental plots from A.R.D.S. Teleorman during 2000-2002

Irrigation level	Experi-mental year	Soil water reserve			Pp > 5mm m^3/ha	? m m^3/ha	? (e+t) m^3/ha	WUE kg grain/mm consumed water
		Ri m^3/ha	Rf m^3/ha	Ri-Rf m^3/ha				
Dryland	2000	2,868	1,804	54.5% 1,064	45.5% 887	-	1,951	2.38
	2001	2,471	1,931	20.6% 540	79.4% 1,981	-	2,621	13.39
	2002	2,695	2,115	17.8% 580	82.2% 3,884	-	3,253	21.20
	average	2,678	1,950	27.9% 728	72.1% 2251	-	2,608	13.89
Irrigated 25%	2000	2,954	1,922	29.8% 832	31.7% 887	38.5% 875	2,794	6.30
	2001	2,519	2,000	17.2% 519	65.5% 1,981	17.3% 525	3,025	17.53
	2002	2,730	2,236	13.1% 494	73.0% 3,884	13.9% 525	3,781	21.77
	average	2,734	2,053	19.2% 615	70.3% 2251	10.5% 642	3,200	15.93
Irrigated 50%	2000	3,001	1,931	28.9% 1,070	23.9% 887	47.2% 1,750	3,707	1.09
	2001	2,609	2,001	16.7% 608	54.4% 1981	28.9% 1,050	3,639	20.50
	2002	2,861	2,453	9.3% 408	66.9% 3,884	23.8% 1,050	4,407	20.80
	average	2,824	2,128	17.7% 695	57.5% 2,251	24.8% 1,283	3,918	17.59
Irrigated 75%	2000	3,039	2,243	18.5% 796	20.6% 887	60.9% 2,625	4,308	15.97
	2001	2,651	2,297	9.1% 354	50.7% 1,981	40.2% 1,575	3,910	27.44
	2002	2,967	2,613	7.1% 354	61.3% 3,884	31.6% 1,575	4,984	22.74
	average	2,886	2,384	11.4% 501	51.1% 2,251	37.5% 1,925	4,401	21.92
Irrigated 100%	2000	3,038	2,776	5.6% 262	19.1% 887	75.3% 3,500	4,649	16.02
	2001	2,705	2,648	1.4% 57	47.9% 1,981	50.7% 2,100	4,138	30.07
	2002	3,007	2,900	1.9% 107	60.2% 3,884	37.9% 2,100	5,546	21.73
	average	2,917	2,775	3.0% 142	47.1% 2,251	49.9% 2,567	4,778	22.29

The content of chemical elements in maize plants

The results of analyses regarding the content of chemical elements of maize plants, on an average of the three experimentation years, for two testing stages: 6-7 leaves and heading-silky stage, are presented in table 4. It has been established that depending on the induced hydric deficit, the Nt, P, Na, K and Ca content decreases directly proportional with the irrigation level and observation stage (6-7 leaves towards heading - silky stage) while Mg content is lower in non-irrigated variants and 25% irrigated ones. At the rest of variants, the above mentioned content of chemical elements is relatively constant, but it decreases according as plants grow.

The heavy metal content also decreases depending on both induced hydric stress level and plant vegetation period.

Table 4. Effect of maize irrigation at different hydric stress levels on chemical elements content in plants, A.R.D.S. Teleorman, 2000-2002

Exp. var.	%						mg/kg						
	Nt	P	Na	K	Ca	Mg	Cu	Zn	Pb	Cd	Co	Ni	Mn
Six-seven leaves stage													
NI	3.89	0.40	0.02	3.23	0.59	0.43	8.13	19.4	13.8	0.500	4.65	5.0	89.6
I 25%	3.78	0.40	0.02	3.04	0.57	0.45	7.76	18.8	12.9	0.465	4.23	4.3	85.3
I 50%	3.66	0.39	0.02	2.84	0.55	0.46	7.38	18.2	11.9	0.430	3.80	3.5	80.9
I 75%	3.61	0.40	0.01	2.76	0.54	0.46	6.44	17.3	11.7	0.423	3.80	3.4	76.9
I 100%	3.56	0.40	0.01	2.67	0.52	0.46	5.50	16.3	11.5	0.415	3.80	3.3	72.8
Heading-silky stage													
NI	2.10	0.25	0.01	1.78	0.49	0.22	5.33	20.2	37.7	0.285	4.65	4.2	75.1
I 25%	1.86	0.23	0.01	1.58	0.46	0.25	5.32	21.1	26.7	0.275	4.40	3.5	73.0
I 50%	1.61	0.20	0.01	1.37	0.42	0.27	5.30	21.9	15.7	0.265	4.15	2.8	70.9
I 75%	1.54	0.21	0.01	1.23	0.40	0.27	5.15	18.4	15.6	0.250	4.10	2.3	69.9
I 100%	1.47	0.22	0.01	1.08	0.38	0.27	5.00	14.8	15.5	0.235	4.05	2.0	68.9

Note: NI = dryland;
I 25% = irrigated 25% from optimum irrigation rate;
I 50% = irrigated 50% from optimum irrigation rate;
I 75% = irrigated 75% from optimum irrigation rate;
I 100% = irrigated 100%, with optimum irrigation rate.

Modifications of physical and chemical properties in ploughed layer of the clay-illuvial chernozem

The soil physical state was appreciated by the structural hydro-stability, compaction degree, aeration potential conditions and permeability to water.

The results obtained in different testing stages (sowing, harvesting) are presented as average values of these three years of experimentation (Table 5).

At macro-structural level, on an average of the two testing stages, the soil presents middle to high hydro-stability, with a content of hydro-stable structural macro-elements between 15.13% g/g and 37.50% g/g. The smaller values were registered in the upper part of ploughed layer.

The structural micro-element content (dispersion) presents small to high values between 2.9% g/g and 6.3% g/g, that could lead to a small de-structural risk especially under irrigation (100%, 75%, 50% from the optimum irrigation rate). The highest values were registered especially at harvesting under irrigated variants as compared to non-irrigated one and in the most cases with significant differences.

The value scale for the structural instability index ranged between 0.11 and 0.35. Based on the estimation classes of this index, the clay-illuvial chernozem from Teleorman fitted in very small to small values limit, presenting a reduced vulnerability in the de-structural process. The highest values of structural instability index belong to variants with induced hydric deficit especially at harvesting, the differences between variants being significant.

The soil compaction degree was estimated by bulk density determination of soil samples. The obtained results show that on the whole the soil presents small (<1.30 g/cm^3) and middle (<1.40 g/cm^3) values of the bulk density, being in a favourable physical state for plant growth and development (Table 6). It has been established that an increasing of soil compaction degree takes place under irrigation in comparison with dryland conditions, especially on 10-20 cm depth (1.30-1.37 g/cm^3), at the base of surface tillages, sowing and crop management, as indirect effect of irriga-

Table 5. Effect of induced hydric deficit on structural hydro-stability of clay-illuvial chernozem
A.R.D.S. Teleorman, 2000-2002

Depth (cm)	Sowing					Harvesting				
	Irrigation level (induced hydric deficit)									
	NI	I 25%	I 50%	I 75%	I 100%	NI	I 25%	I 50%	I 75%	I 100%
	Macro-hydro-stability (AH, % g/g)									
0-10	19.63	20.88	21.25	23.13	17.00	17.88	17.38	15.13	20.38	16.13
10-20	29.88	29.25	34.88	29.25	31.13	21.13	37.50	30.13	29.13	32.00
20-30	34.75	33.63	31.88	37.13	31.25	30.50	33.38	29.13	26.25	28.63
30-40	33.63	19.75	24.00	30.75	21.50	34.63	23.13	26.75	22.51	19.13
	Micro-hydro-stability (D, % g/g)									
0-10	3.0	4.4	3.8	4.2	4.2	3.2	4.2	4.3	5.2	5.2
10-20	2.9	4.8	4.3	4.2	4.5	3.2	5.2	4.7	4.5	4.4
20-30	3.6	5.3	5.2	5.0	5.2	5.0	5.2	6.3	5.6	5.9
30-40	3.3	5.3	5.2	4.6	5.2	3.2	5.2	5.9	4.9	5.1
	Structural instability index (IS)									
0-10	0.18	0.25	0.24	0.19	0.28	0.20	0.28	0.32	0.26	0.34
10-20	0.15	0.25	0.14	0.16	0.17	0.18	0.18	0.19	0.18	0.16
20-30	0.11	0.19	0.18	0.14	0.18	0.19	0.18	0.23	0.24	0.23
30-40	0.11	0.25	0.29	0.18	0.29	0.11	0.25	0.27	0.25	0.35

Note: NI = dryland;
I 25% = irrigated 25% from optimum irrigation rate;
I 50% = irrigated 50% from optimum irrigation rate;
I 75% = irrigated 75% from optimum irrigation rate;
I 100% = irrigated 100%, with optimum irrigation rate.

tion, but at the same time as a consequence of structural hydro-stability decreasing, the soil becoming more vulnerable at compaction. As follows, the bulk density increase from small values to middle ones, does not seem to be, by now, a negative process, but it call the attention that the compaction increasing takes place rapidly under controlled conditions.

The values determined for resistance to penetration, on an average of the three years of experimentation, were between 19 and 41 kgf/cm^2 (Table 6).

The saturated hydraulic conductivity offers a quantitative image on water penetration and circulation processes on soil profile, depending on the granulometric composition, bulk density, structural stability, time of observations. In the present case, this parameter presents very high values (> 40.00 mm/h) on 0-10 cm depth at sowing, middle and high values, between 2.04 and 7.84 mm/h, 10.68 and 21.79 mm/h respectively, on 10-40 cm depth (Table 6). The smallest values are registered under irrigated variants at different induced hydric stress levels, at the end of vegetation (harvesting) and in depth on soil profile.

The total porosity presents middle values (49.3-50.8% v/v) and high ones, respectively (51.1-57.5% v/v), but smaller at control variant.

As regards the soil reaction, the results show significant modifications during both testing stages under all experimental variants. Thus, under dryland variant (average values of three experimental years), pH ranges between 5.90-5.93 (weakly acid) while under irrigated variants, (induced hydric deficit) pH ranges between 6.49 and 7.98 (weakly alkaline) (Table 7).

The humus content has values between 3.50 and 3.78%, so that, from this viewpoint, the soil is middle supplied. The smallest values were registered at harvesting (Table 7). The total nitrogen content and C/N ratio do not register significant modifications as a consequence of irrigation with different watering rates.

The phosphorus and potassium content is significantly modified depending on testing stage as well as induced hydric stress level, registering values between 45.5-93.5 ppm P, 20.1-25.3 ppm K respectively.

The nutrient content available to plants is a little higher under dryland as compared to irrigated variants, at different hydric stress levels due to export diminution by yield.

Table 6. Effect of induced hydric deficit on some physic
A.R.D.S. Teleorman, 2000

Depth (cm)	Sowing					Harv
	Irrigation level (induced h					
	NI	I 25%	I 50%	I 75%	I 100%	NI
Bulk density (g/cm^3)						
0-10	1.18	1.19	1.20	1.17	1.17	1.1
10-20	1.32	1.30	1.35	1.34	1.37	1.2
20-30	1.26	1.32	1.30	1.28	1.32	1.3
30-40	1.21	1.32	1.29	1.21	1.29	1.2
Resistance to penetration (kg						
0-10	22	21	26	19	22	27
10-20	34	33	35	28	26	37
20-30	35	41	35	34	29	38
30-40	35	41	40	27	35	35
Saturated hydraulic conductivit						
0-10	55.73	76.11	68.94	63.78	60.02	20.
10-20	13.03	5.65	16.81	21.79	20.56	17.
20-30	6.87	2.14	2.52	5.38	4.43	6.9
30-40	2.25	2.18	2.74	2.67	2.59	3.8
Total porosity (% v/v)						
0-10	56.2	55.8	55.4	56.5	56.7	57.
10-20	50.7	51.8	49.7	50.2	49.3	52.
20-30	53.2	50.8	51.6	52.4	51.1	51.
30-40	54.6	50.8	52.4	54.6	52.4	53.

Note: NI = dry land;
I 25% = irrigated 25% from optimum irrigation rate;
I 50% = irrigated 50% from optimum irrigation rate;
I 75% = irrigated 75% from optimum irrigation rate;
I 100% = irrigated 100% with optimum irrigation rate.

Table 7. Effect of induced hydric deficit on some chemic
A.R.D.S. Teleorman, 2000

Irrigation level	Sowing						
	pH (H_2O)	Humus %	Nt %	C/N	P-AL ppm	K-AL ppm	pH (H_2
NI	5.90	3.78	0.184	13.9	45.5	201	5.
I 25%	6.87	3.72	0.182	14.1	69.5	227	6.
I 50%	7.83	3.66	0.180	14.2	93.5	253	7.
I 75%	7.91	3.62	0.179	13.9	88.8	233	7.1
I 100%	7.98	3.57	0.179	13.5	84.0	213	7.

Note: NI = dryland;
I 25% = irrigated 25% from optimum irrigation rate;
I 50% = irrigated 50% from optimum irrigation rate;
I 75% = irrigated 75% from optimum irrigation rate;
I 100% = irrigated 100%, with optimum irrigation rate.

CONCLUSIONS

The grain maize yield was influenced by the evolution of climatic factors of the experimental years (especially of rainfall) as well as by induced hydric stress level. The grain yield increased directly proportional with the applied irrigation rate, the yield average gains being of 41-60%.

The un-uniform rainfall repartition, drought and heat conditions determined a relatively increased sterility degree, with negative consequences on grain yield.

The total water consumption of maize was covered by rainfall, irrigation and the difference of the two soil reserves, with differentiated participation of these sources (58.7% rainfall, 30.2% irrigation and only 11.1% soil reserve).

Regarding water utilization efficiency, economical yields are obtained by irrigation with limited water rates, 50% respectively 75% from optimum irrigation rate.

The physical and chemical features of the soil, makes the clay-illuvial chernozem from Teleorman as weakly vulnerable from structural viewpoint and as middle to well supplied one with nutrients due to its intrinsic features.

The effects of irrigation (different induced hydric stress level) on de-structural processes (weakly in this case) are due to soil-water impact, intensification of mechanic processes of compaction, moistening - drying, filling - contraction, warming - cooling and irrigation water quality.

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Table 1

Average yield of experiments with winter wheat cultivars, under irrigation and dry-land in six localities from the South of Romania (2002)

Locality	Average yield under:		Yield percentage diminution
	irrigation (kg/ha)	dry-land (kg/ha)	
Caracal	8560	5601	34.6
Marculesti	4716	3075	34.8
Teleorman	5963	3594	39.8
V. Traian	6941	3794	45.3
Fundulea	4858	1918	60.5
Simnic	(8560)	380	95.6

Table 2

Percentage diminution of some plant features under water stress conditions as compared to irrigation

Locality	Plant number	Plant height	Grain filling period	Spike number	Grain/ear	TKW	Test weight
Caracal	0	14,9	15,0	7,9	10,2	14,1	0,9
Teleorman	0	10,0	19,2	12,0	12,0	11,9	1,0
V.Traian	34,9	21,0	16,9	42,5	12,2	2,9	8,1

Fundulea	4,9	28,8	24,9	6,9	28,9	29,5	3,9
Simnic	27,6	61,7	30,0	65,0	64,5	53,1	10,7
Media	13,5	27,3	21,2	26,9	25,6	22,3	4,9

Table 3

Minimum, maximum and average yields registered at Fundulea in 2002 in international trials WWEERYT with genotypes grouped depending on the originating country

Source	Average yield of the tested genotypes (kg/ha)	Maximum yield of the tested genotypes (kg/ha)	Minimum yield of the tested genotypes (kg/ha)
Romania	2368	2953	2073
Russia	2327	2453	1980
Ukraina-Odessa	2224	3013	1287
Hungary	2181	2780	1320
Ukraina-Mironovka	2108	2753	1500
Moldova	1927	2560	1293
Bulgaria	1898	2873	1313
Turkey	1893	2420	1487
Azerbaidjan	1460	1553	1367
Kazahstan	1422	1833	853
LSD 5%	243	275	

Table 4

Correlations between yield under water stress conditions and different traits

Locality	Average	Correlation coefficients between yield under water stress conditions and:

	yield diminution because of water stress (%)	yield under irrigation	plant height under stress conditions	plant height under irrigation	heading time	spike/ m²	grain/ear	TKW
Caracal	34,6	**0,48**	0,29	-0,31	-0,12	0,20	0,11	-0,30
Teleorman	39,8	**0,80**	0,35	0,31	**-0,85**	**0,58**	-	-
Valu Traian	45,3	0,04	0,33	0,20	**-0,40**	**0,42**	**0,40**	0,22
Fundulea	60,5	0,00	**0,46**	-0,31	**-0,46**	**0,52**	0,30	-0,17
Simnic	95,6	-0,01	**0,41**	**-0,62**	-0,04	**0,40**	**0,50**	0,15

The bold characters are significant at the probability level of 0.05

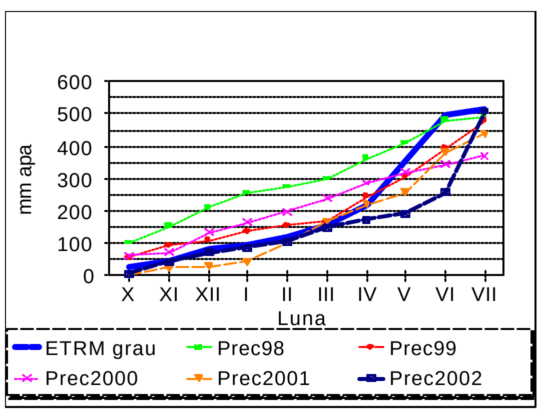

Figure 1. Average evapotranspiration and rainfall during 1999-2002 at Fundulea (mm water; month; wheat evapotranspiration; rainfall)

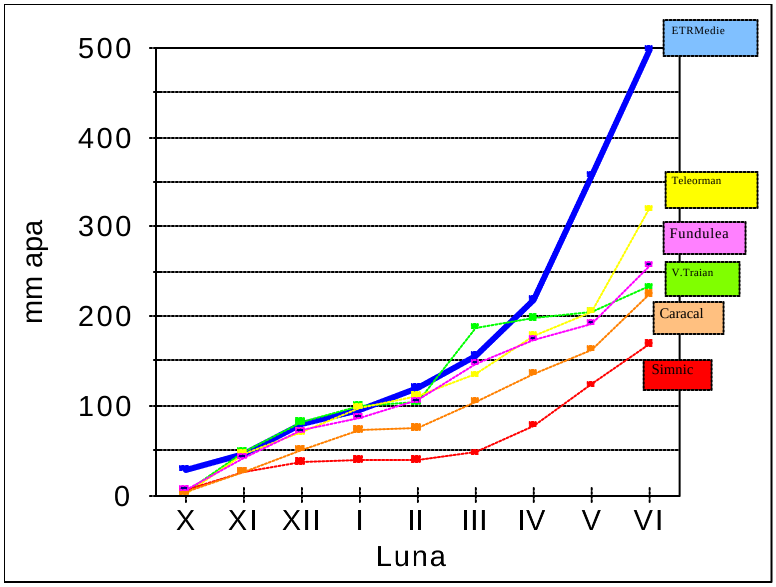

Figure 2. Average evapotranspiration and rainfall during the vegetation period in six locations of Southern of Romania in 2001-2002 year (mm water; month).

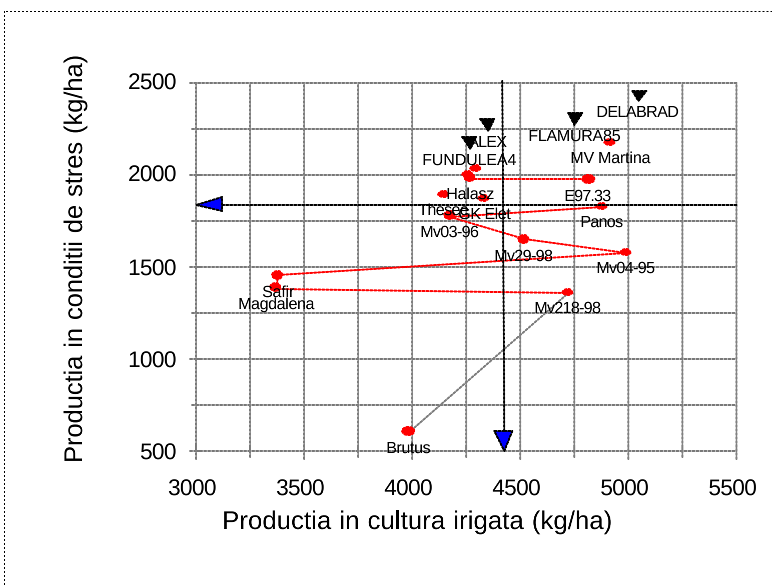

Figure 3. Yield obtained by some Romanian and foreign cultivars under irrigation and non-irrigation, in 2002 at Fundulea (arrows indicate the experiments average yield)(Yield under stress conditions; yield under irrigation).

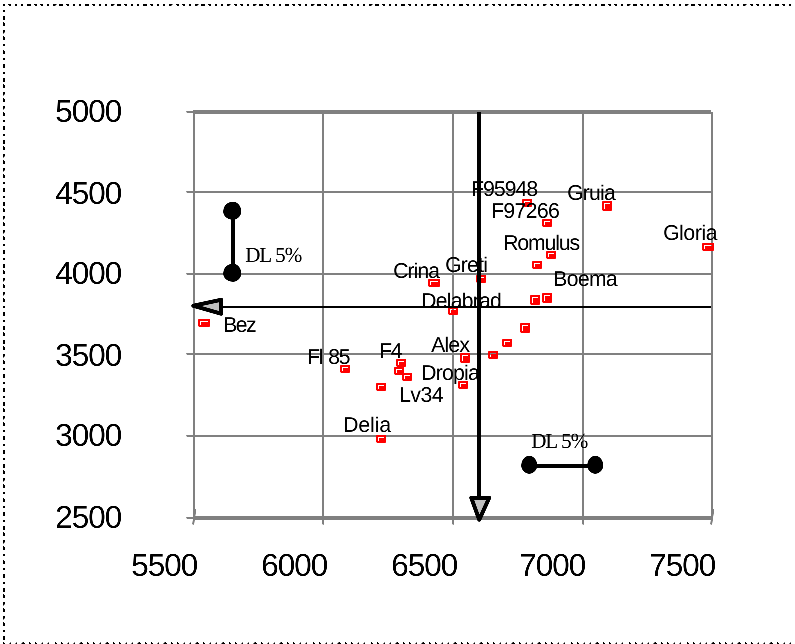

Figure 4. Average yields in four locations, obtained in 2002 by Romanian new lines and cultivars under irrigation and non-irrigation (arrows indicate experiments average yield)(Yield under non-irrigation; Yield under irrigation; LSD).