NEW ASPECTS REGARDING THE BEHAVIOUR OF MAIZE HYBRIDS UNDER DROUGHT AND HEAT CONDITIONS

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ABSTRACT

The behaviour of 22 Romanian maize hybrids was studied during 1999-2002 at the Agricultural Research and Development Station of Teleorman, under the conditions of three different types of drought. The experimental results show that the influence of drought on maize yield varied depending on the severity and the way of action of hydric and thermic stress, at different stages of plant growth and development. During the maize vegetation period, under dryland conditions compared to irrigation ones, drought led to yield diminution of about 28-35%. During tasselling, blooming, pollination and corn-grain formation, drought determined greater yield losses under dryland compared to irrigation, between 56-65%. Among the tested hybrids, Milcov, Fundulea 322, Partizan, Paltin, Fulger, Faur, Campion, Olt, Fundulea 376 and Rapsodia proved to have a good tolerance to drought and heat.

Key words: drought, heat, maize hybrids

INTRODUCTION

Under Burnas Plain conditions, the great frequency of drought and heat represents the main limiting factor of maize yield. In this area, both drought and heat occur as effect of insufficient soil moisture, air maximum temperature (>30°C), air minimum relative humidity (<35%) or cumulative action of these factors, during different maize vegetation stages (Mitu et al., 1994).

Other researches from the special literature (Cosmin et al., 1978; Ilicevici and Radu, 1986; Mitu et al., 1989) showed the complexity of drought and heat phenomena as well as the influence of these factors on maize growth and development.

During 1999-2002, under Burnas Plain conditions, different types of drought manifestation were registered, which led to the obtainment of new data regarding the behaviour of some maize hybrids.

MATERIAL AND METHODS

During 1999-2002, under dryland conditions, at A.R.D.S. Teleorman, the yields of 22 Romanian maize hybrids tested in competitive trials were used. The experiments were sown between 2[nd] May (2000) and 11[th] May (1999, 2001) and the physiological maturity was quoted between 15[th] August (1999, 2000, 2001) and 6[th] September (2002). In order to avoid the experiment compromising, in 2000 and 2002 years, waterings with reduced water norms were applied on 12[th] July (500 m^3/ha) and respectively 5[th] June (300 m^3/ha). The behaviour estimation of maize hybrids to drought and heat was made by comparing the yields obtained under both dryland and the irrigation conditions as well as by determination of sterile plant percentage.

The data processing and interpretation were performed by ANOVA, regressions and correlations (Saulescu and Saulescu, 1967; Sarca and Ciocazanu, 1993).

PEDOCLIMATIC AND VEGETATION CONDITIONS

The experiments were placed on a cambic/vertic chernozem, with high fertility, in a three years crop rotation (soybean - wheat - maize), on a background of 80 kg N + 80 kg P_2O_5/ha. In 1999, during the maize vegetation period (1[st] May - 31[st] August), 191.4 mm of rainfall was registered, with 19% less than the zonal normal quantity (237.6 mm), fact that suggests the droughty characteristic of this year for maize crop (Table 1).

The soil moisture reserve due to greater rainfall from the last two decades of May (22.8 and 20.7 mm) ensured favourable conditions for maize emergence and vegetative growth. The drought of 1999's summer was much attenuated by the more abundant rainfall from the third decade of June (33.3 mm) and the last two decades of July (45.4 mm), coinciding with maize flowering, silking, pol-

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lination and grain formation which led to the obtainment of high yields of 39.3 - 61.8 q/ha. In 2000 year, the rainfall during 1st May - 31st August represented only 25% from the multiannual zonal average (Table 1).

Table 1. Rainfalls and their distribution during the experimentation years
A.R.D.S. Teleorman, 1999-2002

Years / Months	IV	V	VI	VII	VIII	IX	Sum : 1.V–30.VI	Sum : 1.VII–31.VIII	Sum : 1.V–31.VIII.
1999	55.4	56.1	53.9	49.7	31.7	99.3	110.0 (85%)	81.4 (76%)	191.4 (81%)
2000	27.4	8.5	32.3	15.8	2.5	77.2	40.8 (31%)	18.3 (17%)	59.1 (25%)
2001	77.3	29.5	154.1	17.9	19.3	36.2	183.6 (141%)	37.2 (35%)	220.8 (93%)
2002	44.5	26.8	114.4	94.2	123.0	32.4	141.2 (109 %)	217.2 (201%)	358.4 (151%)
$\bar{x}$	51.2	30.2	88.7	44.4	44.1	61.3	118.9 (92%)	88.5 (82%)	207.4 (87%)
Normal quantity	41.9	59.4	70.4	61.4	46.4	42.8	129.8 (100%)	107.8 (100%)	237.6 (100%)

The very severe drought during the whole maize vegetation, negatively influenced the plant growth rhythm and had a harmful effect on fructification processes, leading to the obtainment of small yields of 8.6 - 31.9 q/ha.

In 2001 year, from the sowing to maize physiological maturity (1st May - 31st August), the cumulated rainfall was of 220.8 mm, insuf-ficient quantity for covering the maize water supply (Table 1). The rainfall distribution was ununiform during the maize vegetation period. Thus, June was rainier with 83.7 mm vs. the normal of area, while May, July and August were very droughty with deficits of 29.9, 43.5 and 27.1 mm. The more abundant rainfall from the second decade of June (110.9 mm) favourably influenced the maize vegetative development, because it coincided with the intense plant growth. The moisture deficits from July and August created unfavourable conditions during the reproductive organs appearance (flowering, silking) and grain formation, determining the obtainment of relatively small yields of 34.6 - 46.6 q/ha.

In 2002 year, the cumulated rainfall during 1st May - 31st August exceeded with 51% the normal of the zone (237.6 mm), suggesting favourable climatic conditions for maize crop (Table 1), but their distribution was ununiform during the maize vegetation period. Thus, June, July and August were rainier with 44.0, 32.8 and 76.6 mm vs. multiannual average, while May registered a moisture deficit of 32.6 mm. This moisture deficit from May and from the first decade of June negatively influenced the plants growth rhythm and their height. The more abundant rainfall from the last two decades of June and July as well as the rainfall from the first decade of August had a favourable influence on tasselling, flowering, silking, pollination and grain formation, leading to the obtainment of relatively great yields of 37.2 - 92.5 q/ha (Table 4).

Under thermic aspect, all experimentation years (1999-2002) have been characterized by hot summers, the average temperature of summer (VI-VIII) being with 1.4 - 2.8°C higher than the normal of the zone (Table 2). Sixty-one days in 1999, 63 days in 2000, 57 days in 2001 and 45 days in 2002, the air maximum temperatures during June - August (which coincided with the appearance of reproductive organs, pollination and maize grain filling) had values between 30 and 44°C, and the air minimum relative humidity decreased in some days till 15 - 30% (Table 3).

Analysing the climatic conditions of those four experimentation years, one can ascertain that they were very differentiated among them, by the manifestation of three distinct drought types. Thus, 1999 and 2000 years could be characterized as years with prolonged drought during the whole vegetation period, 2001 year as a droughty year in the second part of summer and 2002 year as a droughty year in the first part of maize vegetation period.

RESULTS AND DISCUSSION

The yields achieved by the maize hybrids, during the four years of experimentation, reflect the total rainfall quantity from the maize vegetation period (1st May - 31st August), being maximum in 2002, minimum in 2000 and intermediary in 1999 and 2001 (Table 4). In 301-400 FAO maturity group, on an average of the experimental cycle, Minerva and Milcov hybrids gave very significantly superior yields vs. control (Saturn), with 9.9 - 10.7 q/ha.

In 401-500 FAO maturity group, the greatest yields (52.2 - 52.7 q/ha) were obtained by Rapsodia, Paltin and Fulger hybrids, which exceeded the control (Fundulea 320) with significant yield gains vs. error and hybrids x years interaction.

Greater yields, between 44.5 and 49.5 q/ha were achieved by Fundulea 322, Danubiu, Granit, Olt and Partizan hybrids, too. Their yields gains, as compared with the standard hybrid (Fundulea 320) were very significant vs. experiment error.

In 501-600 FAO maturity group, Campion hybrid gave maximum yield of 54.7 q/ha, exceeding very significantly the control (Fundulea 376) with 14%. The yield difference (+6.8 q/ha) vs. control was very significant vs. hybrids x years interaction, too.

Table 2. Air average temperature (°C) during the maize vegetation period
A.R.D.S. Teleorman, 1999-2002

Years / Months	IV	V	VI	VII	VIII	IX	Average 1.VI.-31.VIII	Deviation vs. normal
1999	12.8	16.7	22.7	24.6	23.7	18.3	23.7	+ 1.9
2000	14.4	18.5	22.8	25.6	25.3	17.3	24.6	+ 2.8
2001	10.9	17.3	20.3	24.9	25.9	18.8	23.7	+ 1.9
2002	9.7	19.2	22.3	25.3	22.0	16.9	23.2	+ 1.4
$\overline{x}$	12.0	17.9	22.0	25.1	24.2	17.8	23.8	+ 2.0
Normal	11.6	16.9	20.5	22.5	22.3	18.0	21.8	-

Table 3. The frequency of heated days during the maize vegetation period
A.R.D.S. Teleorman, 1999-2002

Years	Months						Total June-August
	April	May	June	July	August	September	
No. of days with maximum air temperature > 30°C							
1999	-	1(32°C)	21(30-34°C)	23(30-36°C)	17(30-39°C)	5(30-35°C)	61
2000	-	8(30-31°C)	18(30-38°C)	22(30-44°C)	23(30-39°C)	4(30-32°C)	63
2001	-	4(30-31°C)	7(30-39°C)	25(30-37°C)	25(30-38°C)	9(30-33°C)	57
2002	-	5(30-31°C)	14(30-39°C)	23(30-38°C)	8(30-33°C)	-	45
No. of days with minimum air relative humidity < 30 %							
1999	4(27-30%)	8(20-30%)	10(20-30%)	6(20-30%)	8(20-30%)	12(15-30%)	24
2000	1(30%)	3(27-30%)	15(22-30%)	18(21-30%)	10(24-30%)	1(30%)	43
2001	4(27-30%)	5(20-30%)	10(25-30%)	8(23-30%)	16(22-30%)	12(22-30%)	34
2002	5(27-30%)	17(22-30%)	16(23-30%)	11(25-30%)	4(28-30%)	9(28-30%)	31

The linear regressions from hybrid and control yields, from each FAO maturity group, have been analysed, in order to estimate their behaviour, under the three drought types conditions manifested during the experimentation years (1999-2002).

In 301-400 FAO maturity group, Minerva and Milcov hybrids produced yields significantly superior vs. Saturn, both in 2000, year with extremely severe and long duration drought and in 1999, year with prolonged but moderate drought as well as in 2001 and 2002, years with partial drought manifested in different intervals of maize vegetation period (Figure 1). In comparison with the control (Saturn), Oituz hybrid gave a significantly superior yield in 2000, year with total drought, but it was inferior to control and Minerva and Milcov hybrids, in 1999, 2001 and 2002, years with partial or long-duration drought.

In 401-500 FAO maturity group, Olt hybrid gave yields significantly superior to control (Fundulea 320), during all experimentation years, showing a good adaptability to all kinds of drought (Figure 2).

Granit and Partizan hybrids gave yields similar to control (Fundulea 320) under excessive drought conditions (2000) and significantly superior to it under moderate drought conditions (1999, 2001 and 2002).

Paltin hybrid gave yields significantly superior to Fundulea 322, under all conditions during the experimentation years, manifesting a high ecological plasticity for the AR.D.S. Teleorman zone (Figure 3).

Danubiu, Rapsodia and Fulger hybrids had a behaviour similar to control (Fundulea 322)

Table 4. Yields obtained by the maize hybrids studied at A.R.D.S. Teleorman during 1999-2002

Hybrids	Years				Average yield		Diff.	Signif. vs:	
	1999	2000	2001	2002	q/ha	%	q/ha	error	interaction
FAO 301-400* : 45-55,000 pl./ha									
Saturn	41.3	8.6	36.2	54.7	35.2	100	Control	-	-
Minerva	55.6	14.2	46.6	64.0	45.1	128	+ 9.9	***	-
Milcov	55.3	22.3	39.2	66.7	45.9	130	+10.7	***	*
Oituz	40.9	16.7	34.6	37.2	32.4	92	– 2.8	0	-
	LSD 5%						2.6	10.1	
	LSD 1%						3.5	14.5	
	LSD 0.1%						4.6	21.3	
FAO 401-500* : 40-50,000 pl./ha									
Fundulea 320	44.6	20.7	35.1	59.6	40.0	100	Control	-	-
Fundulea 322	45.5	24.4	40.4	69.5	45.0	113	+ 5.0	***	-
Danubiu	46.5	28.4	39.6	83.6	49.5	124	+ 9.5	***	-
Granit	45.4	23.9	38.5	70.1	44.5	111	+ 4.5	***	-
Olt	44.0	31.9	42.2	73.4	47.9	120	+ 7.9	***	-
Opal	46.1	23.0	36.4	47.4	38.2	96	– 1.8	-	-
Pandur	43.1	24.9	35.6	46.2	37.4	94	– 2.6	°	-
Rapid	42.6	22.7	43.5	62.8	42.9	107	+ 2.9	*	-
Rapsodia	56.5	22.9	42.3	89.2	52.7	132	+12.7	***	*
Soim	50.6	30.5	45.4	40.1	41.6	104	+ 1.6	-	-
Vultur	48.5	15.9	42.5	63.4	42.6	107	+ 2.6	*	-
Partizan	46.1	24.7	36.7	82.7	47.5	119	+ 7.5	***	-
Paltin	61.8	28.3	46.0	73.8	52.5	131	+12.5	***	*
Fulger	54.4	25.8	45.3	83.1	52.2	131	+12.2	***	*
	LSD 5 %						2.5	11.2	
	LSD 1%						3.4	15.0	
	LSD 0.1%						4.4	19.7	
FAO 501-600* : 35-45,000 pl./ha									
Fundulea 376	50.4	27.2	36.6	77.4	47.9	100	Control	-	-
Octavian	49.2	21.1	39.4	80.6	47.6	99	– 0.3	-	-
Faur	51.7	23.9	39.8	79.5	48.7	102	+ 0.8	-	-
Campion	59.7	23.5	42.9	92.5	54.7	114	+ 6.8	***	*
	LSD 5 %						3.0	5.6	
	LSD 1 %						4.0	8.1	
	LSD 0.1%						5.2	11.9	

* The framing of hybrids in FAO maturity groups was done based on the cultivars (hybrids) official list from Romania for 2001, published in Info-Amsem, no. 2/2001.

in 2000, year with total unfavourable conditions for maize crop, but they proved to be productive in 1999, 2001 and 2002, years with moderate drought and heat. In 501-600 FAO maturity group, Octavian, Faur and Campion hybrids gave yields close to those of control (Fundulea 376) in 2000, the droughtiest year from the research period (Figure 4). These hybrids achieved yields significantly superior to Fundulea 376, only in 2002, the most favourable year for maize crop, which indicates a higher yielding potential.

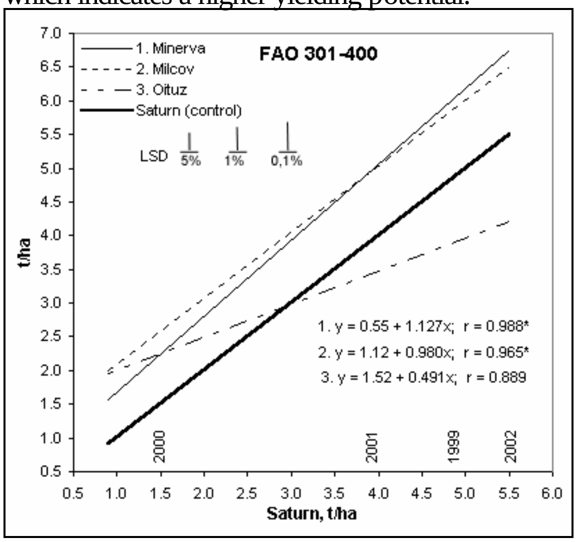

Figure 1. Linear regressions of grain yields of Minerva, Milcov, and Oituz hybrids compared to Saturn; A.R.D.S. Teleorman, 1999-2002

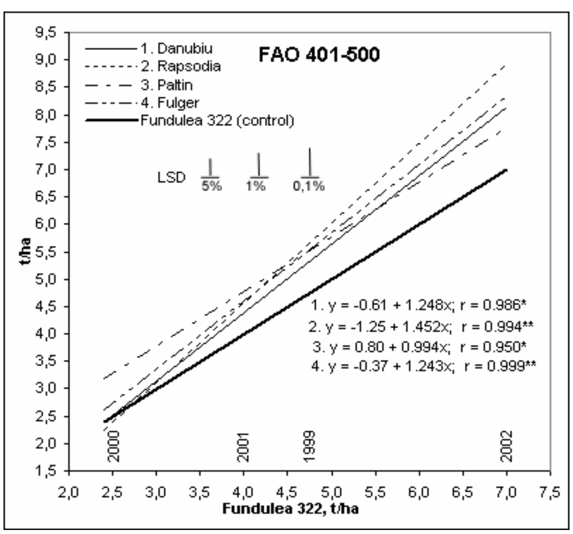

Figure 3. Linear regressions of grain yields of Danubiu, Rapsodia, Paltin and Fulger hybrids compared to Fundulea 322 A.R.D.S. Teleorman, 1999-2002

The significantly negative correlation (r = –0.803°°) between the frequency of sterile plants and yield (Figure 5) demonstrates that, in droughty years, the plant sterility represents the decisive factor of maize yield diminution.

The investigated hybrids had a different behaviour regarding the manifestation of this phenomenon. Thus, some of them: Milcov, Fundulea 322, Danubiu, Partizan, Paltin, Fulger, Fundulea 376, Faur and Campion presented a lower percent of sterile plants (5-9%) vs. average. The greatest number of sterile plants (14-20%) was registered in Saturn, Oituz, Pandur, Rapid and Vultur hybrids.

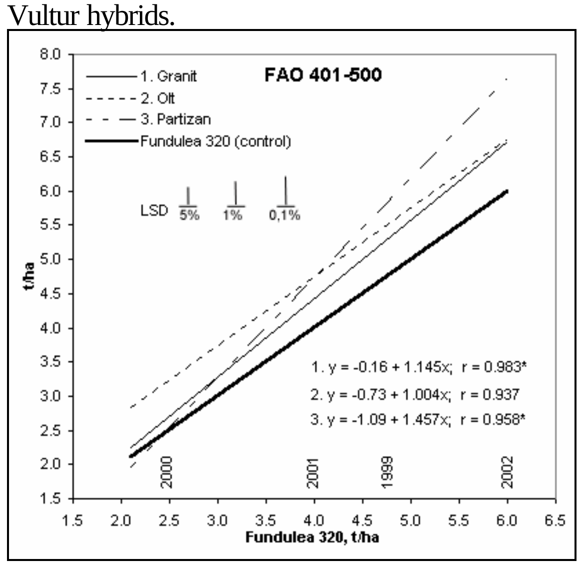

Figure 2. Linear regressions of grain yields of Granit, Olt and Partizan hybrids compared to Fundulea 320 A.R.D.S. Teleorman, 1999-2002

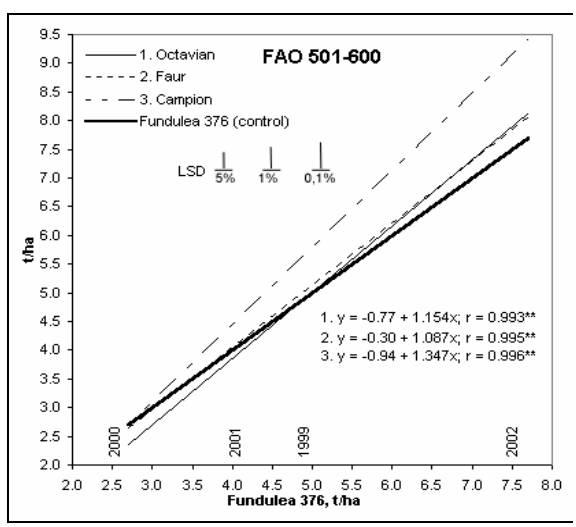

Figure 4. Linear regressions of grain yields of Octavian, Faur and Campion hybrids compared to Fundulea 376, A.R.D.S. Teleorman, 1999-2002

In order to establish the factors involved in the manifestation of this phenomenon, the correlations between some climatic elements and the number of sterile plants in the 22 maize hybrids tested at A.R.D.S. Teleorman, were calculated (Table 5).

The experimental data show that the rainfall during summer (1st May - 31st August) significantly diminished (r = –0.609°) the frequency of sterile plants.

Between maximum average air temperature during 1st June - 31st August and the sterile plant percentage, a significantly positive correlation (r = 0.699*) was established.

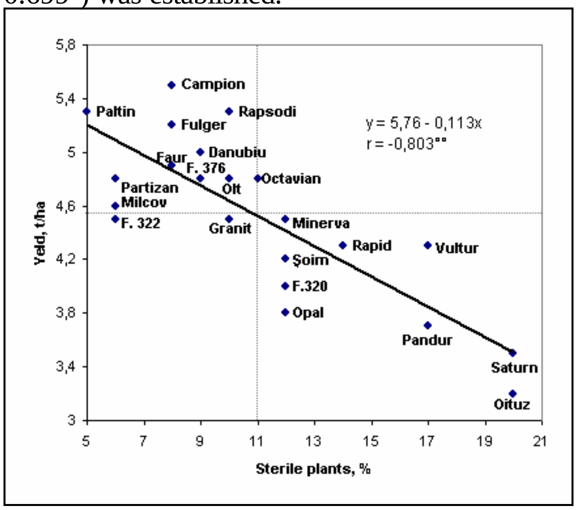

Figure 5. Correlation between sterile plant frequency and grain yield of maize hybrids tested at A.R.D.S. Teleorman during 1999-2002

A negative correlation, close enough (r = –0.623°), between minimum air relative humidity (average 1st June - 31st August) and the number of sterile plants, was determined.

Significantly positive correlations between the number of days with air absolute maximum temperatures (> 30°C) during 1st June - 31st August and the sterile plant percentage (r = 0.596*) as well as between the number of days with very low minimum air relative humidity (< 30%) for the same interval and the frequency of sterile plants (r = 0.839**), were established. These results emphasize that the more abundant rainfall and the higher air relative humidity, during 1st June - 31st August, determined the plant sterility diminution and maximum air temperatures and the frequency of days with heat during the same time, amplified the manifestation of this phenomenon.

The direct link between rainfall for a given period and maize yield is underlined by the correlation coefficients calculated for 1999-2002 years, under A.R.D.S. Teleorman conditions (Table 6). It is evident that the rainfall from May, June and July favourably but un significantly influenced the maize yield. A distinct influence had the rainfall from August and those during 1st May - 30th June and 1st July - 31st August, which were significantly positive correlated (r = 0.863**; r = 0.659*; and r = 0.753**) with grain yield.

The cumulated rainfalls during maize vegetative growth (1st May - 20th June), were not significantly correlated with yield.

Between the cumulated rainfalls during maize vegetative growth (21st June - 31st August) and yield, a distinctly significant positive correlation (r = 0.790**) was established.

A stronger positive correlation (r = 0.815**) was determined between the sum of rainfall during summer (1st June - 31st August) and maize yield.

During 1999-2002, at A.R.D.S. Teleorman, the highest correlation coefficient (r = 0.880**) was established between the sum of rainfalls during maize vegetative period (1st May - 31st August) and yield. Based on these results, one can ascertain that under in zones with high frequency of drought and heat from Burnas Plain, a favourable rainfall regime during this interval, ensures the obtainment of great and stable maize yields. The influence of rainfall quantity and distribution, during the vegetation, on maize yield, in 2001 and 2002, years with two different drought types, is presented in table 7.

In 2001, year with rainfalls prevalent distribution (81%) during the maize vegetative growth (1st May - 20th June) and only 19% during the flowering and grain formation (21st June - 31st August), the yield losses under dryland conditions vs. irrigation ranged between 56 and 65%, for hybrids belonging to the three maturity groups.

In 2002, year with rainfall supplementary distribution (76%) during pollination and grain filling (21st June - 31st August) and a deficient rainfall regime (24%) during plant intense growth (1st May - 20th June), the yield losses under dryland conditions vs. irrigation, for hybrids belonging to the three maturity groups, were less compared to 2001, with limits between 28 and 35%.

Based on this analysis, one can ascertain that in A.R.D.S. Teleorman zone, drought occurred in the second part of maize vegetation period (21st June - 31st August) determined the accentuated diminution of yield vs. drought occurred in the first part of vegetation (1st May - 20th June).

In 2001 and 2002 years, the maize irrigation with 1,200 and respectively 900 m^3 water/ha led to the obtainment of high yields (8,540 - 11, 440 kg/ha) and to an obvious increasing of water use efficiency (Table 8). Thus, in order to counteract the thermic and hydric stress effect on maize under Burnas Plain conditions,

Table 5. Correlations between some climatic elements and the number of sterile plants in maize hybrids tested at A .R.D.S. Teleorman during 1999-2002.

Climatic elements	Correlation coefficients (r)
Cumulated rain	
Maximum air t	
Minimum air r	
No. of days wi	
No. of days wi	

Table 6. Co

Factors
infall in May
infall in June
infall in July
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Table 7. Influence of rainfall quantity and distribution during the vegetation period on yield of maize hybrids tested at A.R.D.S. Teleorman during 1999-2002.

Years	Total rainfalls and their distribution			Grain yield, q/ha (average of maturity groups)			Yield losses vs. irrigation, %		
	1.V-31.VIII	1.V-20.VI	21.VI-31.VIII	FAO 301-400	FAO 401-500	FAO 501-600	FAO 301-400	FAO 401-500	FAO 501-600
2001	221 (100%)	179 (81%)	42 (19%)	40.1	40.3	39.7	56	62	65
	Irrigated = 1,200 m^3/ha			92.0*	106.8*	113.0*	-	-	-
2002	388 (100%)	93 (24%)	295 (76%)	56.0	69.3	82.5	35	32	28
	Irrigated = 900 m^3/ha			85.4*	101.0*	114.4*	-	-	-

*) Yields obtained in experiments performed by M.C. Zamfir

Table 8. Grain yield and water use efficiency of maize hybrids at A.R.D.S. Teleorman during 2001-2002

Years	Crop conditions	Total rainfall + irrigation during 1st May – 31st August (mm)		Grain yield, kg/ha (average of maturity groups)			Coefficient of water utilization (kg grains/mm water)		
				FAO 301-400	FAO 401-500	FAO 501-600	FAO 301-400	FAO 401-500	FAO 501-600
2001	Dry land	221	-	4,010	4,030	3,970	18.1	18.2	18.0
	Irrigated	-	341	9,200*	10,680*	11,300*	27.0	31.3	33.1
2002	Dry land	388	-	5,600	6,930	8,250	14.4	17.9	21.3
	Irrigated	-	478	8,540*	10,000*	11,440*	17.9	21.1	23.9

*) Yields obtained in experiments performed by M.C. Zamfir

beside the utilization of tole-rant to drought and heat hybrids, it is necessary to irrigate the maize crop.

CONCLUSIONS

During 1999-2002, at A.R.D.S. Teleorman, three types of drought and heat manifestation were registered during the maize vegetation stage:

– 1999 and 2000 – years with prolonged drought during the whole vegetation period (1st May - 31st August);

– 2001 – year with drought in the second part of summer (21st June - 31st August);

– 2002 – year with drought in the first part of maize vegetation period (1st May - 20th June).

In droughty years, the frequency of sterile plants was the decisive factor in maize yield diminution.

A favourable thermic and pluviometrical regime during 1st June - 31st August determined the plant sterility diminution and the high frequency of heat days increased the number of sterile plants.

The hybrids Milcov, Fundulea 322, Partizan, Paltin, Fulger, Faur, Campion, Olt, Fundulea 376 and Rapsodia had a good tolerance to drought and heat while Saturn, Oituz, Pandur, Rapid and Vultur proved to be sensitive to the manifestation of this phenomenon.

The strongest positive correlation was established between the rainfall quantity in maize vegetation period (1st May - 31st August) and yield.

The drought effects on maize yield were dependent on drought intensity and manifestation way during the different plant developmental stages.

Drought occurring in the maize vegetative growth (1st May - 20th June) determines yield losses under dryland conditions vs. irrigation, of 28-35%.

Drought occurring during maize tasselling, flowering, pollination and grain formation (21st June - 31st August) leads to higher yield losses, under dryland conditions vs. irrigation, of 56-65%.

In order to limit the yield losses, it is recommended the cultivation of two-three hybrids, with different precocities, having in view that the earlier hybrids (FAO 301-500 maturity group) give greater yields in years with drought in the second part of maize vegetation period (21st June - 31st August) while the semi-late hybrids (FAO 501-600 maturity group), in years with drought in the first part of maize vegetation period (1st May – 20th June).

REFERENCES

Cosmin, O., Fabian G., Gomoiu, E., 1978. Rezistenþa la secetã ºi arºiþã a porumbului. Probl.genet.teor.aplic., vol. X., nr. 3: 239-266.

Ilicevici, S., Radu, A., 1986. Efectul secetei asupra producþiei la porumb. Lucr. ºt., S.C.A. ªimnic, vol. VI : 11-25.

Mitu, D., Vlad, P., Cosmin, O., 1989. Reacþia unor hibrizi de porumb la secetã ºi arºiþã în condiþiile de la S.C.A. Teleorman. An. I.C.C.P.T. Fundulea, vol. LVII: 47-60.

Mitu, D., Vlad, P., Cosmin, O., Sarca, T., 1994. Comportarea unor noi hibrizi de porumb româneºti în condiþii de secetã ºi arºiþã. An.I.C.C.P.T. Fundulea, vol.LXI : 35 - 49.

Sarca, T., Ciocãzanu, I., 1993. Hibrizii de porumb (*Zea mays* L.) Fundulea 322, Fundulea 340, Rapid, Robust, Fundulea 410 ºi Temerar. An. I.C.C.P.T. Fundulea, vol. LX: 43-64.

Sãulescu, N.A., Sãulescu, N.N., 1967. Câmpul de experienþã. Edit. Agro-Silvicã, Bucureºti: 283-286; 311.

***, 2001. Lista oficialã a soiurilor (hibrizilor) de plante de culturã din România pentru anul 2001. Revista Info-Amsem, nr. 2/2001: 6-13.