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INFLUENCE OF CROP SYSTEMS IN REDUCING OF DROUGHT EFFECT FOR MAIZE PLANTS

Nicolae IONESCU

Agricultural Research and Development Station Piteşti, Piteşti-Slatina Road, Km. 5, 117030, Piteşti, România, Phone: 0372753083, Fax: 0248206334, Email: nicolaeionescu50@gmail.com,

Corresponding author email: nicolaeionescu50@gmail.com

Abstract

Currently, new maize hybrids have had improved genetic traits. These characters are high production capacity and resistance to drought (Ali & Naidu, 1982). As the phenomena of increasing present drought affects maize plants (Dwyer & Steward, 1985; Lorens et al., 1987), so that grain yields that obtained are smaller (Undersander, 1987). Us, ordinary maize suffer from drought during maximum water consumption: July and August. Reducing the effects of drought can be done by different planting systems. The period under review was a dry year, a favorable year and a normal one. Of the three experimental factors (sowing date, density, new hybrids), the greatest influence was a time of sowing. The optimum time of sowing maize is held here from 10 April to 10 May. Early sowing favored obtain maximum yields of between 6.3 t.ha^{-1} in dry, 8.0 t.ha^{-1} in favorable and 5.9 t.ha^{-1} in a medium year.
Late sowing maize produced more less with 4.0 t.ha^{-1} dry year, 3.6 t.ha^{-1} in favorable and 2.3 t.ha^{-1} in normal conditions. Density had positive influence in favorable year, with 50 thousand plants.ha^{-1} and 30-50 thousand plants.ha^{-1} in the other two years. Cultivated hybrids with high production potential, demonstrated adaptability in these culture conditions. The new creations Iezer (F.125) Mostiştea, F.425 and F.475M along side Olt is recommended in the southern white luvisol.

Key words: *density, drought, grain yield, maize, sowing time.*

INTRODUCTION

During the growing season maize has different requirements for water (Hall et al., 1984). Total rains that fall in growth here amounts to 300-400 mm water. So if maize has blossomed to provide water, in July and August consumption is much higher. In these months the evapotranspiration potential (ETP) exceeds 70 mm and 50 mm rain fell. Under these conditions occurs drought. Drought is considered to be complex in maize (McPherson & Boyer, 1974; Pinter et al., 1979). Drought resistance, that definition is the ability of a plant/crop (maize us) to best use a limited resource of water (Morizet et al., 1990). New hybrids expressing different levels for drought resistance (Fabian & Gomoiu, 1982; Thakur & Rai, 1982; Martiniello & Lorenzoni, 1985). And hybrids of this material, specifically responded summer drought that occurs every year. In a very dry year, however, the negative effects in the formation of maize production were greatly amplified.

To reduce the effects of drought, can promote some culture systems. Practical goal is the best possible expression of genes optimized to avoid periods of drought. Some of these systems can promote early sowing. Thus, every year it aims to set the spring maize crop as early as possible. Sowing in an early period of time, is conditioned by several factors: achieving thermal factor, soil moisture, crop species staggering. For maize, sowing the good times may suffer some deviation, with great influence in the formation of grain production. Another necessary element is ensuring obtaining a successful chain is the density. While it was found that this crop density at emergence had a relatively low maximum yield formation. The explanation lies in the existence of production capacity offset the maize plant. Relatively low production from a maize plant may influence a higher yield per unit area, with a higher density. At the same time, by sowing maize hybrids us seeking and avoidance of summer droughts, both the sowing time and the density. Plants emerged as early showed a rapid increase until early summer. They proved to be more resistant to drought in July and August. If for some reason maize sowing is done late, in May, there are a number of negative phenomena: physiology unbalanced (Fabian & Gomoiu, 1982; Thakur & Rai, 1982), uneven growth (Ali & Naidu, 1982), effect of drought (Morizet et al., 1990).

The consequence is to reduce grain production. In order to observe the influence of the planting periods and densities of creating new hybrids, the experiments were conducted herein.

MATERIALS AND METHODS

Between 2012-2014 three-factorial experiments were established, such as the subdivided parcel, with factors:

- Factor A planting dates: first at the beginning of the sowing area, the second midterm, and the third at the end of sowing;
- Factor B seeding density: the graduation 30, 50 and 70 thousand plants.ha^{-1};
- Factor C hybrid: the first two were cultivated: Iezer (F.125), F.425 and Olt, and in the last year: Iezer (F.125), Mostiştea and F.475M.

Photo 1. Iezer (F. 125) hybrid

Variants area of 20 m^2 was in triplicate. Culture technology was recommended by the resort. Luvicsoil culture was in arable horizon following indices: pH=5.23, P_{AL}=17.7 mg.kg^{-1} d.w., Al^{3+}=37.2 mg.kg^{-1} d.w. and C_t=1.54%. During the growing season temperatures were recorded (minimum, average and maximum) and precipitation.

For every moment of sowing were calculated amounts of active degrees (Σtn>10^{0}C) and hydro-climatic indices ($I_{HC}=\frac{P\ mm}{ETP}100$, ETP - evapo-transpiration potenţial).

For the Albota maize is close to optimum climatic conditions and namely from sowing until the end of June (Figure 1).

In July and August, however, rainfall not cover consumption needs, so the phenomenon of drought. Compared to multi values in some years the phenomenon of drought can be attenuated or accentuated depending on the crop each year. Between investigated period 2012 was very dry, 2013 favorable and 2014 medium year. In these circumstances new hybrids of maize were differing in grain yields formation, with accents between times of sowing and densities.

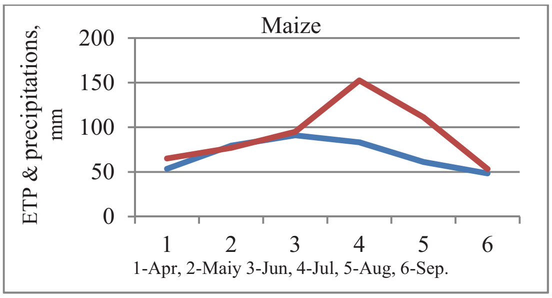

Figure 1. The ETP and precipitations evolution from maize vegetation, multiannual data

RESULTS AND DISCUSSIONS

Maize production depending on sowing dates, density, and hybrid expressed specificity in each crop year. It is caused by increasing variability of climatic conditions, from normal to close the obvious influence of drought. Thus, three different crop years were: 2012 arid, 2013 favorable and 2014 medium. To observe the influence of the three factors of the maize crop in these various conditions, the results will be presented for each crop year.

Maize under year 2012. For this period the maize was sown between April 5 and May 15. In the experiment, three sowing times were: April 12, May 3 and May 15. Climatic elements have evolved specific (Table 1). Thermal factor of plant vegetation has been fairly consistent: 1636 Σtn>10^{0}C first sown, between 1490^0 and 1402^0 to other sowing dates. Temperature excesses occurred in July, 8 days exceeded the maximum 35^{0}C and extreme media was 33.2^{0}C. Was very good rainfall in May and June, followed by lack of water in July (7 mm over the entire month). The climatic conditions this year have made it clear influence of drought. Hydro-climatic Index (I_{HC}) was between 69 and 65%, depending on the time of sowing.

Maize yields obtained fell from one time of sowing to another very evident (Table 2). Iezer hybrid (F.125) maximum yield was obtained at the first sowing time and density of 50,000 plants.ha^{-1}, with 4.657 t.ha^{-1}. In the second time production level dropped to an average of 2.314 t.ha^{-1}, while the third grains production was in medium 0.893 t.ha^{-1}. In this hybrid can say that in a typical year of drought, only by sowing at the earliest time could avoid large losses of production.

Table 1. Climatic evolution from maize vegetation, 2012, dry year

Sow times	Monthly values					$\Sigma tn>10^0$	I_{HC}* %
	Month	Tn^0C Min	Med	Max	P, mm		
I 12.04	Apr.	11	19	22	15	1636	69 %
	May	13	17	22	109		
	Jun.	17	22	28	110		
	Jul.	20	26	33	7		
	Aug.	17	24	32	53		
II 3.05	May	12	17	21	107	1490	65 %
	Jun.	17	22	28	110		
	Jul.	20	26	33	7		
	Aug.	17	24	32	53		
III 15.05	May	13	16	20	20	1402	65 %
	Jun.	17	22	28	110		
	Jul.	20	26	33	7		
	Aug.	17	24	32	53		

$*I_{HC} = \frac{P\ mm}{ETP} 100$; ETP- evapo-transpiration potential

F.425 hybrid produced most first time and density of 50,000 plants.ha^{-1}, with 4.823 t.ha^{-1} grain yield. Lowest production was obtained at 70,000 plants.ha^{-1} in the third sowing time (15 May), with 0.623 t.ha^{-1} grain. Olt hybrid produced under the same conditions comparable between 6.270 and 1.080 t.ha^{-1} respectively grain.

Table 2. Maize grain yields obtained by 2012, dry year conditions

Sowing times	Grain yields, t.ha^{-1} Dens. 30	50	70	Media
Hybrid F. 125, Iezer				
I*	4.623	4.657	3.767	4.349
II	2.550	2.433	1.960	2.314
III	1.000	1.007	0.673	0.893
Average	2.724	2.699	2.133	2.519
F. 425				
I	4.713	4.823	4.217	4.584
II	2.487	2.673	2.093	2.418
III	0.850	1.100	0.623	0.858
Average	2.683	2.865	2.311	2.620
Olt				
I	6.270	5.643	4.597	5.503
II	3.247	2.674	2.223	2.715
III	1.397	1.144	1.080	1.207
Average	3.638	3.154	2.633	3.142
	Time, A	Density, B	Hybrid, C	A.B.C
LSD 5%	0.924	0.488	0.226	5.226
LSD 1%	1.533	0.684	0.303	7.861
LSD 0.1%	2.867	0.967	0.398	12.748

*I-12.04, II-3.05, III-15.05.2012

Maize under 2013. The range created for sowing maize this year was between 10 April and 10 May. Data from the experiment were: 18.04, 24.04 and 08.05.2013. In terms of climate plants have received moderate temperatures close to requirements and with peak rainfall of 119 mm in June. $\Sigma tn>10^0C$ were between 1530^0C and 1473^0 the first two dates of sowing and 1355^0C last sowing (Table 3). Hydro-climatic indices ranged between 52-53%, although rain between 8 and 20 mm fell relatively uniform decadal intervals.

Table 3. Climatic evolution from maize vegetation, 2013, favorable year

Sow times	Monthly values					$\Sigma tn>10^0$	I_{HC}* %
	Month	Tn^0C Min	Med	Ma.	P, mm		
I 18.04	Apr.	10	21	24	0	1530	52 %
	May	13	19	25	52		
	Jun.	16	20	25	119		
	Jul.	16	21	27	35		
	Aug.	18	25	32	28		
II 24.04	May	12	19	29	52	1473	53 %
	Jun.	16	20	25	119		
	Jul.	16	21	27	35		
	Aug.	18	25	32	32		
III 8.05	May	12	18	24	36	1355	53 %
	Jun.	16	20	25	119		
	Jul.	16	21	27	35		
	Aug.	18	25	32	32		
	Sep.	11	19	22	0		

$*I_{HC} = \frac{P\ mm}{ETP} 100$; ETP- evapo-transpiration potential

Maize under 2014. This year maize sowing took place in two intervals: one early April 1-5, and second late from 20 to 31 May. Climatic conditions have induced this phenomenon, especially by the rains that have fallen in large amounts from April to July, continuously - Table 5. In the experiment first succeeded sown on April 4th and the following two points on 23 May and 29 May. At first sowing rains fallen negatively influenced plant east, after about 30 days. Under these conditions the density of emerged plants was lower by about 5-8%. Overall, plants sown of three times, with background excessively wet climate, and vegetation were extended until October (first decade).

Temperature have evolved close to normal, without excesses. $\Sigma tn>10^0C$ was different: the first sowing 1579^0, 1402^0 the second and 1339^0 for the third time. Hydro-climatic index was 116% for the first time and was between 95 and 100% in the over two times.

Table 4. Maize grain yields obtained from 2013, favorable year conditions

Sowing times	Grain yields, t.ha^{-1} Dens. 30	50	70	Media
Hybrid F. 125, Iezer				
I*	7.367	7.400	6.500	7.089
II	7.100	7.600	7.533	7. 411
III	4.768	4.400	4.367	4.512
Average	6.412	6.467	6.133	6.337
F. 425				
I	6.833	7.300	6.833	6.989
II	6.933	7.833	7.133	7.300
III	6.068	5.000	4.767	5.278
Average	6.611	6.711	6.244	6.522
Olt				
I	7.333	8.000	7.067	7.467
II	6.867	7.700	6.833	7.133
III	4.700	4.833	4.367	4.633
Average	6.300	6.844	6.089	6.411
	Time, A	Density, B	Hybrid, C	A.B.C
LSD 5%	0.283	0.303	0.117	0.563
LSD 1%	0.470	0.425	0.157	0.814
LSD 0.1%	0.877	0.600	0.206	1.217

*I-18.04; II-24.04; III-08.05.2013

Table 5. Climatic evolution from maize vegetation, 2014, normal year

Sow times	Montly values Month	Tn^{0}C Min	Med	Max	P, mm	Σtn> 10^0	I_{HC}* %
I 4. 04	April	11	14	18	180	1579	116 %
	May	12	17	22	158		
	Jun.	15	19	24	115		
	Jul.	18	23	28	138		
	Aug.	17	23	30	43		
	Sep.	12	17	23	88		
II 23. 05	May	15	18	26	0	1402	95 %
	Jun.	15	19	24	115		
	Jul.	18	23	28	138		
	Aug.	17	23	30	43		
	Sep.	12	17	23	88		
III 29. 05	Jun.	15	20	24	107	1339	100 %
	Jul.	18	23	28	138		
	Aug.	17	23	30	43		
	Sep.	12	17	23	88		
	Oct.	11	13	18	66		

$*I_{HC} = \frac{P\ mm}{ETP} 100$; ETP- evapo-transpiration potential

Maize production formed under these conditions was very good and namely the first two planting dates.

Their level often exceeded 5.000 t.ha^{-1} (Table 6). The highest yields in all three hybrids were obtained at densities of 30-50 thousand plants.ha^{-1}. The lowest yields were formed on the age of the third and the density of 70,000 plants.ha^{-1}.

Statistical analysis of grain production. Three years of maize crop showed a high variability. Hybrids sown at different times and in several densities expressed the normal and low limits. Variance analysis of experiments in the three years highlights the influences of factors studied (Table 7).

Table 6. Maize grain yields obtained from 2014, normal year condition

Sowing times	Grain yields, t.ha^{-1} Dens. 30	50	70	Media
Hybrid F. 125, Iezer				
I*	5.825	5.925	5.100	5.617
II	5.400	5.900	4.975	5.425
III	4.200	4.250	3.625	4.025
Average	5.142	5.358	4.567	5.022
Mostiştea				
I	5.350	5.600	4.550	5.167
II	5.750	5.650	4.925	5.442
III	4.100	3.900	3.800	3.933
Average	5.067	5.050	4.425	4.847
F. 475 M				
I	5.275	5.575	5.175	5.342
II	5.650	5.450	5.600	5.567
III	4.125	4.150	3.950	4.075
Average	5.017	5.058	4.908	4.994
	Time, A	Density, B	Hybrid, C	A.B.C
LSD 5%	0.188	0.149	0.127	0.410
LSD 1%	0.285	0.204	0.169	0.565
LSD 0.1%	0.459	0.278	0.220	0.782

*I-4.04; II-23.05; III-29.05.2014

Statistical calculation demonstrates that planting dates A-factor had the highest influence in all three years (very significant). In terms of density (B factor) in the first year were observed very obvious influences, and in the last two years have highlighted significant influence.

Hybrid (factor C) had evident influence in the first year and significant others two years. Of interactions, time of sowing (AxC), density (BxC) and hybrid (AxBxC) for 2013 year and sowing time (AxC) and density (BxC) with hybrid last year, had obvious influence.

CONCLUSIONS

In the white luvisol maize benefit of 420 mm rainfall for vegetation. Compared to these, ETP has a value of 550 mm, thus registering a deficit of 130 mm. Period with largest deficit is in July and August. In contrast, relative soil water reserve (whose regime is specific), and 10-20 mm rain falling during this period, could help mitigate the effect of drought.

Table 7. The analysis of Anova test, yield grains of maize

Variability cause	Sq. sum			LD	Variance, S^2			F test		
	2012	2013	2014		2012	2013	2014	2012	2013	2014
Rep.	1.62	0.35	0.181	2						
A Factor	199.50	105.92	48.265	2	99.75	52.96	24.13	66.6***	378***	223***
Error A	5.99	0.56	0.648	4	1.498	0.140	0.108			
Big parcels	*207.11*	*106.83*	*49.094*	*8*						
B Factor	7.59	3.65	5.694	2	3.795	1.820	2.847	5.50*	7.00*	29.1***
AxB	1.46	3.78	0.614	4	0.365	0.945	0.154	0.537	3.63	0.72
Error B	8.16	3.15	1.761	12	0.680	0.260	0.098			
Middle parcels	*17.21*	*10.58*	*8.069*	*18*						
C Factor	8.17	0.47	0.637	2	4.085	0.237	0.319	24.2***	5.27*	5.06*
AxC	1.67	4.07	0.864	4	0.418	1.018	0.216	2.47	22.6**	3.43*
BxC	0.97	4.87	1.678	4	0.243	1.218	0.420	1.43	27.1**	6.67*
AxBxC	3.45	2.67	1.059	8	0.432	0.334	0.132	2.55	7.42*	2.10
Error C	6.09	1.62	3.397	36	0.169	0.045	0.063			
Small parcels/plots	*19.48*	*16.38*	*7.635*	*54*						
Total experiment	*243.80*	*133.79*	*64.798*	*80*						

Climate of the three experimental years expressed a very dry first year (2012), a favorable year (2013) and third year medium favorable (2014).

Among the factors studied, sowing time had the greatest influence in the formation of maize new hybrids production. For the area, the time in which the terms are planting this plant ranges from 15-20 April and 15 May. Depending on the structure of plants from a farm, can sow maize between 15 and 25 April. New experimented hybrids produced maximum for early sowing, between 4.657 $t.ha^{-1}$ in dry year, 8.000 $t.ha^{-1}$ in favorable year and 5.925 $t.ha^{-1}$ in the medium year. Grain bigger losses occurred in the first year when hybrids were planted on May 3rd date. Summer drought of the three sowing period (15.05.2012) contributed to very low yields, between 0.623 and 1.397 $t.ha^{-1}$.

Densities studied, with relatively wide limits, had obvious influence on maize production in the first two years and very evident in the last year. In the favorable (2013) Iezer (F.125), F.425 and Olt produced more on 50,000 $plants.ha^{-1}$. In medium year (2014) Iezer hybrid formed the largest grain production to 50,000 $plants.ha^{-1}$ and Mostiştea and F.475M to 30,000 $plants.ha^{-1}$.

We cultivate hybrids were first noted very significant and meaningful in the first and significant third year. With high yield potential, all hybrids have fairly experienced the full spectrum of climate which benefited the studied period. The highest production was obtained with the hybrid Olt: 8.000 $t.ha^{-1}$ grains sown in April 18, 2013 year and 50,000 $plants.ha^{-1}$. Under the same conditions Iezer produced maximum 7.600 $t.ha^{-1}$ grains, and F.425 hybrid 7.833 $t.ha^{-1}$ grains.

Among the factors, both planting dates and density, with new hybrids showed significance. This acquires practical importance that farmers will resemble a new hybrid early period as possible and appropriate density.

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