

## YIELD COMPONENTS OF DIFFERENT HYBRIDS OF MAIZE (*Zea mays* L.) CULTIVATED IN SOUTH ROMANIA UNDER DROUGHT CONDITIONS

Viorel ION<sup>1</sup>, Georgeta DICU<sup>2</sup>, Daniel STATE<sup>2</sup>, Gina FÎNTÎNERU<sup>1</sup>, Lenuța Iuliana EPURE<sup>1</sup>,  
Adrian Gheorghe BĂȘA<sup>1</sup>, Maria TOADER<sup>1</sup>

<sup>1</sup>University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Mărăști Blvd,  
District 1, 011464, Bucharest, Romania

<sup>2</sup>SC Procera Agrochemicals Romania SRL, 47 Muncii Street, 915200, Fundulea, Călărași, Romania

Corresponding author email: viorelion@agro-bucuresti.ro

### Abstract

*Maize (Zea mays L.) is the most important crop in Romania as harvested area. The grain yield is determined by the yield components, these been the elements which participate to the yield formation. These components have to be known by farmers, as well as the farmers have to understand the plant responses to drought. Thus, the farmers will have the possibility for a correct choice of hybrids and to take appropriate decisions as a premise to obtain the best yield for the specific soil and climatic conditions.*

*The aim of the paper was to present the results obtained at an assortment of maize hybrids regarding yield components and grain yield under the soil and climatic conditions from South Romania in the drought year 2012. Ten hybrids created in Romania were studied, respectively: Cera 270, Cera 290, Cera 370, Cera 390, Cera 6, Cera 420, Cera 2504, Cera 4505, Bărăgan 48, and Cera 10. The hybrids were studied in four different locations in South Romania, respectively: Fundulea – Călărași County; Vâlcelele – Călărași County; Vișani – Brăila County; Poșta Călnău – Buzău County.*

*Some of the studied maize hybrids (CERA 10, CERA 390, CERA 270, CERA 2504, CERA 420, CERA 290) showed to have the potential to produce good grain yield (more than 4 tons/ha) under water stress. The grain yield obtained in 2012 in South Romania at the studied hybrids of maize was between 24.1 and 53.4% from the yield obtained in favourable climatic conditions. It is interesting to notice that at the studied hybrids of maize the weight components of yield are much more affected by drought than the numerical component of yield.*

**Key words:** maize, hybrids, yield, yield components, drought.

### INTRODUCTION

Maize (*Zea mays* L.) is the most important crop in Romania as harvested area. In the last decade, the annual harvested area with maize was between 2 and 3.2 million hectares, while the average grain yield of maize was between 1.6 and 4.5 tons per hectare.

As harvested area of grain maize, Romania ranges the first place in European Union, while as total grain production ranges the second place, after France. Romania has a real potential for developing the maize crop by increasing first of all the yield. Achieving this aim need to overcome one of the main constraints which is the drought especially in South Romania, the most important Romanian growing area for maize.

Drought stress is a major constraint factor affecting crop production in arid and semiarid climates (Beheshti and Behboodi, 2010; Haldrup, 2012).

In maize, reductions in grain yield caused by drought ranged from 10 to 76% depending on the severity and the stage of its occurrence (Bolaños et al., 1993, cited by Khodarahmpour and Hamidi, 2012).

The effect of water deficit is depending on genotype (hybrid) ability to tolerate water stress. Under limiting water conditions, the correct choice of varieties (hybrids) are among the most important possibilities to efficiently use the available water.

Understanding plant responses to drought is of great importance and also a fundamental part of making the crops tolerant to stress (Reddy et al., 2004; Zhao et al., 2008, cited by Khayatnezhad et al., 2011).

The yield increasing is continuously achieved by developing new hybrids with high grain yield and better tolerance to biotic and abiotic stress factors. That is why the farmers have to often change the cultivated maize hybrids with

new created ones as a basic condition to get better yields.

The newly hybrids of maize have to be studied in different cultivation conditions for identifying the most suitable hybrids for each cultivation area. Thus, the farmers will have the possibility for a correct choice of hybrids based on knowledge regarding their yielding capacity on the specific soil and climatic conditions.

The yielding capacity of plants is determined by the yield components, which are the components that are participating to the yield formation. These components have to be known by farmers in view to take the appropriate decisions for obtaining the best values for them under the specific growing conditions as a premise to obtain the best yield for the given conditions.

The aim of the paper was to present the results regarding yield components and grain yield obtained at an assortment of Romanian maize hybrids studied under soil and climatic conditions from South Romania.

The study was realised under field conditions in the year 2012, which was characterised as a drought year.

## MATERIALS AND METHODS

Researches were performed in the years 2012 on an assortment of ten hybrids of maize created in Romania, respectively: Cera 270 (FAO group 270), Cera 290 (FAO group 290), Cera 370 (FAO group 370), Cera 390 (FAO group 390), Cera 6 (FAO group 390), Cera 420 (FAO group 420), Cera 2504 (FAO group 440), Cera 4505 (FAO group 450), Bărăgan 48 (FAO group 480), and Cera 10 (FAO group 540).

The hybrids were studied in four different locations in South Romania, respectively:

- Fundulea – Călărași County, which is characterised by: average altitude of 68 m; cambic chernozem soil; medium to heavy texture; pH between 6.4 and 6.8; humus content between 2.8 and 3.2%; nitrogen content of 0.17-0.18%; phosphorus content of 10-25 ppm; potassium content of 135-170 ppm; average temperature of 10.4°C; sum of precipitation of about 550 mm.
- Vâlcelele – Călărași County, which is characterised by: altitude between 40 and 45 m; chernozem soil; clay-loam texture; pH between 7.2 and 7.8; humus content

between 2.2 and 2.8; phosphorus content of 36 ppm; potassium content of 180 ppm; average temperature of 11.2°C; sum of precipitation of about 514 mm.

- Vișani – Brăila County, which is characterised by: average altitude of 43 m; cambic chernozem soil; loamy texture; soil reaction is slightly acid in the soil above layer, but slightly alkaline between 30 and 64 cm depth; humus content of 3.03% in Am layer, and 2.12% in AC layer; nitrogen content of 0.157%; phosphorus content of 15-23 ppm; potassium content of 129-163 ppm; average temperature of 11°C; sum of precipitation of about 460 mm.
- Poșta Călnău – Buzău County, which is characterised by: average altitude of 151 m; cambic chernozem soil; pH between 6.00 and 6.78; humus content between 1.20 and 2.74%; low nitrogen content; small to medium phosphorus content; medium potassium content; average temperature of 11.8°C; sum of precipitation of about 410 mm.

The year 2012 can be characterized as been a warm and dry year in early spring, summer and autumn. With the exception of February, when temperatures were below the multiannual average, in all other months till November temperatures were higher than multiannual averages, especially in April and August (monthly average temperature higher with 3.1°C than multiannual average value), and in July (monthly average temperature higher with 4.7°C than multiannual average value).

March and April registered a rainfall deficit, but crops used water reserves accumulated in the soil during winter and developed well in early growing stages. May month was very wet with rain rate of 160 mm, which means more than double compared to the normal value. After May month with excess of rainfall, one followed a dry period which has been extended until autumn, period that culminated in July with only 2 mm precipitation (about 70 mm deficit). The lack of water (Figure 1) has affected good plant growth and development, and as a result the yield components and grain yield.

The crop technology was the usual one for cultivating grain maize in South Romania.

To the studied hybrids of maize, determinations were performed in view to establish the yield components and the grain yield, respectively: plant population (number of plants per hectare), ear length (cm), number of rows per ear, number of kernels per ear, number of kernels per row, ear weight, kernel weight per ear, kernel rate per ear, weight of thousand seeds, grain yield at 14% humidity (kg per hectare).



Figure 1. Effect of drought in 2012 in South Romania

In each location and for each hybrid, two plants in four replications (in total eight plants) were analysed for establishing the yield components. The analysed plants were representative (average plants) for the plant population in the crop. The ears were detailed analysed in laboratory.

The obtained data were statistically processed by analyses of variance (Anova-single factor).

## RESULTS AND DISCUSSIONS

Under the drought conditions of 2012, the ear length at the studied hybrids of maize varied between 10.8 and 17.7 cm (Table 1). The highest average value for all the four areas in which the hybrids were studied was obtained for CERA 270 hybrid (16.4 cm), while the smallest average value was obtained for CERA 4505 (13.1 cm). Among the four areas where the hybrids were studied, the highest values (15.9 cm in average for the studied hybrids) were obtained in Vişani area from Brăila County, and the smallest values (13.6 cm in average for the studied hybrids) were obtained in Poşta Călnău area from Buzău County.

In average for all the studied hybrids and locations the ear length under the 2012 climatic conditions registered 14.8 cm.

Table 1. Average ear length (cm) at the studied hybrids of maize, in different locations from South Romania and in 2012 climatic conditions

Maize hybrid	Locations				Average (hybrid)
	Fundulea	Vâlcelele	Vişani	Poşta Călnău	
CERA 270	17.4*	14.4	16.9	17.0	16.4
CERA 290	15.6	16.8	14.8	12.7	15.0
CERA 370	13.5	13.4	17.0	13.6	14.4
CERA 390	14.5	15.7	16.5	13.6	15.1
CERA 6	13.5	17.4	17.7	13.6	15.6
CERA 420	17.0	14.8	15.1	12.8	14.9
CERA 2504	15.4	16.0	15.9	15.0	15.6
CERA 4505	13.1	12.4	12.4 <sup>oo</sup>	14.4	13.1
Bărăgan 48	12.0 <sup>o</sup>	13.3	15.3	12.8	13.4
CERA 10	15.4	13.9	17.4	10.8	14.4
Average (control)	14.7	14.8	15.9	13.6	14.8
LSD 5%	2.5	3.9	2.6	4.2	2.0
LSD 1%	3.3	5.3	3.5	5.6	2.8
LSD 0.1%	4.4	7.0	4.6	7.4	3.7

The average number of rows per ear at the studied hybrids of maize varied between 11.0 and 17.5 (Table 2). The highest average value for all the four areas in which the hybrids were studied was obtained for CERA 2504 hybrid (15.6 rows per ear), while the smallest average value was obtained for CERA 290 (13.0 rows per ear). Among the areas where the hybrids were studied, the highest average value was obtained in Fundulea area from Călăraşi County (15.2 rows per ear), while the smallest value was obtained in Vâlcelele area from Călăraşi County (13.3 rows per ear).

In average for all the studied hybrids and locations, the number of rows per ear under the 2012 climatic conditions was of 14.

The average number of kernels per ear at the studied hybrids varied between 215.9 and 518.5 (Table 3). The highest average value for all the four areas in which the hybrids were studied was obtained for CERA 10 hybrid (378.1 kernels per ear), while the smallest average value was obtained for CERA 370 (257.0 kernels per ear). Among the areas where the hybrids were studied, the highest average value was obtained in Fundulea area from Călăraşi County (385.3 kernels per ear), while the smallest value was obtained in Poşta Călnău area from Buzău County (297.5 kernels per ear).

The highest number of kernels per ear obtained in Fundulea area is the result of the high values of rows per ear and ear length.

In average for all the studied hybrids and locations the number of kernels per ear under the 2012 climatic conditions was of 332.2.

Table 2. Average number of rows per ear at the studied hybrids of maize, in different locations from South Romania and in 2012 climatic conditions

Maize hybrid	Locations				Average (hybrid)
	Fundulea	Vâlcelele	Vişani	Poşta Călnău	
CERA 270	15.8	12.8	12.3	15.6	14.1
CERA 290	13.5	13.3	12.8	12.3	13.0
CERA 370	15.5	13.5	13.5	13.0	13.9
CERA 390	13.0	13.3	12.5	14.3	13.3
CERA 6	17.5	13.8	13.0	13.3	14.4
CERA 420	16.5	12.3	14.0	12.5	13.8
CERA 2504	17.3	14.8	15.3	14.8	15.6
CERA 4505	14.3	13.5	12.5	13.3	13.4
Bărăgan 48	12.5 <sup>o</sup>	11.0	16.5**	13.8	13.5
CERA 10	16.5	14.8	14.3	13.5	14.8
Average (control)	15.2	13.3	13.7	13.6	14.0
LSD 5%	2.4	3.2	2.0	2.4	1.8
LSD 1%	3.2	4.4	2.7	3.2	2.4
LSD 0.1%	4.3	5.8	3.6	4.2	3.2

Table 3. Average number of kernels per ear at the studied hybrids of maize, in different locations from South Romania and in 2012 climatic conditions

Maize hybrid	Locations				Average (hybrid)
	Fundulea	Vâlcelele	Vişani	Poşta Călnău	
CERA 270	474.4	207.8	304.6	326.3	328.3
CERA 290	406.3	371.6	330.6	288.8	349.3
CERA 370	305.6	229.1	272.0	221.4	257.0
CERA 390	334.0	409.4	375.6	373.3	373.1
CERA 6	387.9	397.8	346.3	238.9	342.7
CERA 420	518.5	322.9	342.3	266.0	362.4
CERA 2504	421.5	308.8	378.1	346.3	363.7
CERA 4505	333.6	241.5	215.9 <sup>o</sup>	339.4	282.6
Bărăgan 48	237.0	244.9	370.0	286.1	284.5
CERA 10	434.3	371.6	418.6	288.0	378.1
Average (control)	385.3	310.5	335.4	297.5	332.2
LSD 5%	156.3	140.6	107.7	150.0	83.7
LSD 1%	210.8	189.5	145.2	202.2	112.8
LSD 0.1%	279.7	251.6	192.7	268.3	149.8

The average number of kernels per row at the studied hybrids varied between 16.5 and 31.3 (Table 4). The highest average value for all the four areas in which the hybrids were studied was obtained for CERA 390 hybrid (28.2 kernels per row), while the smallest average value was obtained for CERA 370 (18.4 kernels per row). Among the areas where the hybrids were studied, the highest average value

was obtained in Fundulea area from Călăraşi County (24.9 kernels per row), while the smallest value was obtained in Poşta Călnău area from Buzău County (21.3 kernels per row).

In average for all the studied hybrids and locations the number of kernels per row under the 2012 climatic conditions was of 23.4.

Table 4. Average number of kernels per row at the studied hybrids of maize, in different locations from South Romania and in 2012 climatic conditions

Maize hybrid	Locations				Average (hybrid)
	Fundulea	Vâlcelele	Vişani	Poşta Călnău	
CERA 270	30.2	15.5	24.8	19.5	22.5
CERA 290	30.5	28.2	26.4	21.7	26.7
CERA 370	19.0	17.2	20.6	16.9	18.4
CERA 390	25.5	31.3	30.0	25.9	28.2
CERA 6	21.7	28.8	27.2	17.7	23.9
CERA 420	31.0	24.7	23.7	20.0	24.9
CERA 2504	23.9	20.7	24.7	23.9	23.3
CERA 4505	23.4	17.1	16.5	25.7	20.7
Bărăgan 48	18.0	19.4	22.3	20.2	20.0
CERA 10	25.8	24.8	29.3	21.1	25.3
Average (control)	24.9	22.8	24.6	21.3	23.4
LSD 5%	9.2	9.7	6.6	11.0	5.1
LSD 1%	12.4	13.0	8.8	14.8	6.8
LSD 0.1%	16.5	17.3	11.7	19.6	9.1

The average ear weight at the studied hybrids varied between 28.9 and 116.6 g (Table 5). The highest average value for all the four areas in which the hybrids were studied was obtained for CERA 390 hybrid (78.1 g), while the smallest average value was obtained for CERA 4505 (47.3 g). Among the areas where the hybrids were studied, the highest average value was obtained in Fundulea area from Călăraşi County (81.3 g), and the smallest value was obtained in Poşta Călnău area from Buzău County (59.4 g).

In average for all the studied hybrids and locations the ear weight under the 2012 climatic conditions was of 67.7 g.

The average kernel weight per ear registered a comparable situation with those of the average ear weight at the studied hybrids. Thus, the average kernel weight per ear varied between 22.9 and 95.0 g (Table 6). The highest average value of the kernel weight for all the four areas in which the hybrids were studied was obtained for CERA 10 hybrid (63.9 g), while the smallest average value was obtained for CERA 4505 (39.2 g). Among the areas where the

hybrids were studied, the highest average value was obtained in Fundulea area from Călărași County (67.5 g), while the smallest value was obtained in Poșta Călnău area from Buzău County (47.7 g).

In average for all the studied hybrids and locations the kernel weight per ear under the 2012 climatic conditions was of 54.7 g.

Table 5. Average ear weight (g) at the studied hybrids of maize, in different locations from South Romania and in 2012 climatic conditions

Maize hybrid	Locations				Average (hybrid)
	Fundulea	Vâlcelele	Vișani	Poșta Călnău	
CERA 270	116.6*	47.3	63.9	77.6	76.4
CERA 290	86.9	72.9	68.3	68.6	74.2
CERA 370	82.2	45.5	59.0	47.5	58.6
CERA 390	75.6	77.8	90.8*	68.0	78.1
CERA 6	61.2	75.6	68.0	41.8	61.7
CERA 420	97.3	76.4	76.1	61.6	77.9
CERA 2504	86.4	54.6	83.7	76.9	75.4
CERA 4505	60.7	49.5	28.9 <sup>ooo</sup>	50.0	47.3 <sup>o</sup>
Bărăgan 48	48.9 <sup>o</sup>	45.5	55.5	57.0	51.7
CERA 10	97.5	70.4	89.4*	44.8	75.5
Average (control)	81.3	61.6	68.4	59.4	67.7
LSD 5%	27.1	31.5	20.2	33.8	19.0
LSD 1%	36.6	42.5	27.3	45.5	25.6
LSD 0.1%	48.5	56.4	36.2	60.4	34.0

Table 6. Average kernel weight per ear (g) at the studied hybrids of maize, in different locations from South Romania and in 2012 climatic conditions

Maize hybrid	Locations				Average (hybrid)
	Fundulea	Vâlcelele	Vișani	Poșta Călnău	
CERA 270	95.0*	35.9	50.5	62.0	60.9
CERA 290	70.1	56.9	54.5	56.0	59.4
CERA 370	67.7	35.6	45.2	37.1	46.4
CERA 390	65.7	61.4	72.2*	55.2	63.6
CERA 6	51.9	58.0	49.9	30.2	47.5
CERA 420	75.6	64.4	58.9	49.7	62.2
CERA 2504	73.5	43.3	67.6	59.3	60.9
CERA 4505	51.7	41.2	22.9 <sup>ooo</sup>	40.8	39.2
Bărăgan 48	40.5 <sup>o</sup>	36.2	45.8	49.1	42.9
CERA 10	83.0	58.1	77.3**	37.2	63.9
Average (control)	67.5	49.1	54.5	47.7	54.7
LSD 5%	24.2	23.8	16.3	27.5	15.7
LSD 1%	32.6	32.1	22.0	37.1	21.1
LSD 0.1%	43.2	42.5	29.2	49.2	28.1

The average kernel rate per ear at the studied hybrids varied between 64.5% and 87.0% (Table 7). The highest average value for all the four areas in which the hybrids were studied was obtained for CERA 10 hybrid (84.1%), while the smallest average value was obtained for CERA 6 (74.7%). Among the areas where the hybrids were studied, the highest average

value was obtained in Fundulea area from Călărași County (82.5%), while the smallest value was obtained in Poșta Călnău area from Buzău County (78.4%).

In average for all the studied hybrids and locations the kernel rate per ear under the 2012 climatic conditions was of 80.0%.

Table 6. Average kernel rate per ear (%) at the studied hybrids of maize, in different locations from South Romania and in 2012 climatic conditions

Maize hybrid	Locations				Average (hybrid)
	Fundulea	Vâlcelele	Vișani	Poșta Călnău	
CERA 270	81.4	75.7	79.0	79.3	78.9
CERA 290	80.7	77.9	80.7	80.5	80.0
CERA 370	80.2	78.6	76.3	77.4	78.1
CERA 390	87.0	79.1	78.2	77.2	80.4
CERA 6	84.3	76.4	73.4	64.5 <sup>ooo</sup>	74.7 <sup>o</sup>
CERA 420	75.1 <sup>oo</sup>	83.6*	78.3	77.9	78.7
CERA 2504	84.5	76.9	80.8	76.8	79.8
CERA 4505	85.5	83.6*	74.7	81.4	81.3
Bărăgan 48	82.0	84.6**	82.5	86.2*	83.8
CERA 10	84.5	82.3	86.6	82.9	84.1
Average (control)	82.5	79.9	79.1	78.4	80.0
LSD 5%	5.4	3.9	8.1	7.8	5.0
LSD 1%	7.3	5.3	10.9	10.5	6.7
LSD 0.1%	9.7	7.0	14.5	13.9	9.0

The average weight of thousand seeds at the studied hybrids varied between 110.6 and 223.7 g (Table 8). The highest average value for all the four areas in which the hybrids were studied was obtained for CERA 270 hybrid (183.5 g), while the smallest average value was obtained for CERA 6 hybrid (133.9 g). CERA 6 hybrid which registered the smallest average value of weight of thousand seeds has the smallest kernel rate per ear. Among the areas where the hybrids were studied, the highest average value was obtained in Fundulea area from Călărași County (177.3 g), while the smallest value was obtained in Poșta Călnău area from Buzău County (160.4 g).

In average for all the studied hybrids and locations the weight of thousand seeds under the 2012 climatic conditions was of 165.6 g.

The average plant population at the studied hybrids was in normal limits for maize cultivation in South Romania under rainfall conditions (no-irrigation), this varying between 62.5 thousand plants per hectare in Vâlcelele area from Călărași County and 66.0 thousand plants per hectare in Fundulea area from Călărași County (Table 9).

Table 8. Average weight of thousand seeds (g) of the studied maize hybrids of maize, in different locations from South Romania and in 2012 climatic conditions

Maize hybrid	Locations				Average (hybrid)
	Fundulea	Vâlcelele	Vişani	Poşta Călnău	
CERA 270	200.1*	172.9	166.5	194.5	183.5
CERA 290	173.3	152.3	164.8	194.1	171.1
CERA 370	223.7***	152.8	166.8	166.2	177.4
CERA 390	196.6	149.3	192.8*	149.8	172.1
CERA 6	134.2 <sup>000</sup>	145.7	145.2	110.6 <sup>00</sup>	133.9
CERA 420	146.0 <sup>00</sup>	198.7	172.9	191.6	177.3
CERA 2504	175.5	142.2	179.9	171.3	167.2
CERA 4505	155.9	183.9	116.7 <sup>000</sup>	119.5 <sup>0</sup>	144.0
Bărăgan 48	172.3	172.1	127.1 <sup>00</sup>	172.4	161.0
CERA 10	195.6	158.3	183.8	133.8	167.9
Average (control)	177.3	162.8	161.7	160.4	165.6
LSD 5%	21.6	38.8	24.7	36.8	32.4
LSD 1%	29.1	52.3	33.3	49.6	43.6
LSD 0.1%	38.6	69.4	44.1	65.8	57.9

Table 9. Average plant population of the studied hybrids of maize, in different locations from South Romania and in 2012 climatic conditions

Maize hybrid	Plant population (no of plants per hectare) in different locations			
	Fundulea	Vâlcelele	Vişani	Poşta Călnău
CERA 270	66,783	62,491	62,432	67,353
CERA 290	60,925	65,803	67,794	63,294
CERA 370	68,567	53,528	66,471	57,133
CERA 390	64,581	62,893	65,321	61,221
CERA 6	67,076	63,843	61,732	53,923
CERA 420	64,616	60,645	57,850	62,447
CERA 2504	64,458	68,960	63,580	66,599
CERA 4505	69,224	61,255	60,040	67,129
Bărăgan 48	66,059	61,346	69,099	62,258
CERA 10	68,194	64,961	59,606	66,646
Average	66,048	62,573	63,393	62,800

The average grain yield at the studied hybrids varied between 1,453 and 6,958 kg per hectare (Table 10). The highest average value for all the four areas in which the hybrids were studied was obtained for CERA 10 hybrid (4,445 kg per hectare), while the smallest average value was obtained for CERA 4505 (2,754 kg per hectare). Among the areas where the hybrids were studied, the highest average value was obtained in Fundulea area from Călăraşi County (4,776 kg per hectare), while the smallest value was obtained in Poşta Călnău area from Buzău County (3,241 kg per hectare). In average for all the studied hybrids and locations the grain yield under the 2012 climatic conditions was of 3,756 kg per hectare. The specific climatic conditions from South Romania in the year 2012, characterised as a drought year, affected significantly the values

of the yield components and the grain yield compared to the normal values, respectively values obtained in favourable climatic conditions (Table 11, Table 12). The most affected hybrids, with grain yields less than 30% from normal values, were CERA 4505, CERA 370, and Bărăgan 48, while the less affected hybrid, with grain yields higher than 50% from normal values, was CERA 270 (Table 12). Middle affected hybrids, with grain yields between 30 and 50% from normal values, were the following: CERA 2504, CERA 290, CERA 390, CERA 10, CERA 420, and CERA 6.

Table 10. Average grain yield at 14% humidity (kg per hectare) of the studied hybrids of maize, in different locations from South Romania and in 2012 climatic conditions

Maize hybrid	Locations				Average (hybrid)
	Fundulea	Vâlcelele	Vişani	Poşta Călnău	
CERA 270	6,958*	2,232	3,358	4,524	4,268
CERA 290	4,662	4,050	3,959	3,572	4,061
CERA 370	4,592	1,941	3,217	2,233	2,996
CERA 390	4,589	4,076	5,069*	3,653	4,347
CERA 6	3,869	3,985	3,266	1,713	3,208
CERA 420	5,271	4,161	3,583	3,375	4,098
CERA 2504	4,953	3,133	4,639	4,295	4,255
CERA 4505	3,882	2,676	1,452 <sup>000</sup>	3,004	2,754
Bărăgan 48	2,876 <sup>0</sup>	2,840	3,406	3,396	3,130
CERA 10	6,111	4,095	4,929*	2,643	4,445
Average (control)	4,776	3,319	3,688	3,241	3,756
LSD 5%	1,803	1,466	1,151	1,884	1,188
LSD 1%	2,431	1,976	1,552	2,540	1,601
LSD 0.1%	3,226	2,623	2,060	3,371	2,125

The grain yield as average value at the studied hybrids in all the four areas from South Romania was of 37.8% from the normal value (Figure 2).

Among the yield components, the kernel rate per ear is almost not affected by drought (98.9% in 2012 of normal value). Less affected by drought are the number of rows per ear (82.5% in 2012 of normal value) and the ear length (69% in 2012 of normal value). Middle affected by drought are the weight of thousand seeds (57.1% in 2012 of normal value), number of kernels per row (55.1% in 2012 of normal value), and number of kernels per ear (46.1% in 2012 of normal value). The most affected by drought are the ear weight (24.3 in 2012 of normal value) and the kernel weight per ear (24.1 in 2012 of normal value) (Figure 2).

Table 11. Normal\* values of the yield components and yield at the studied hybrids of maize

Maize hybrid	Ear length (cm)	Number of rows per ear	Number of kernels per ear	Number of kernels per row	Ear weight (g)	Kernel weight per ear (g)	Kernel rate per ear (%)	Weight of thousand seeds (g)	Grain yield at 14% humidity (kg per hectare)
CERA 270	20	14-16	650	43	220	180	81	270	7,000-9,000
CERA 290	20	16	720	45	250	200	80	280	8,000-11,000
CERA 370	22	18	700	40	320	256	80	290	8,800-13,100
CERA 390	20	18	680	40	300	250	82	310	8,500-11,900
CERA 6	22	14-16	680	45	235	185	78	275	7,500-11,000
CERA 420	22	16	720	45	310	250	80	320	7,900-12,300
CERA 2504	22	16	750	48	265	215	80	290	8,200-11,300
CERA 4505	24	20	920	46	350	295	84	260	8,300-14,600
Bărăgan 48	24	16	760	48	330	270	82	310	9,000-13,200
CERA 10	20	22	710	32	300	250	82	300	7,800-14,000

\*Values obtained in favourable climatic conditions.

Table 12. Average values of the yield components and yield at the studied hybrids of maize in 2012, in South Romania

Maize hybrid	Ear length (cm)		Number of rows per ear		Number of kernels per ear		Number of kernels per row		Ear weight (g)		Kernel weight per ear (g)		Kernel rate per ear (%)		Weight of thousand seeds (g)		Grain yield at 14% humidity (kg/ha)	
	cm	%-n	Nr.	%-n	Nr.	%-n	Nr.	%-n	g	%-n	g	%-n	%	%-n	g	%-n	kg/ha	%-n
CERA 270	16.4	82.0	14.1	94.0	328.3	50.5	22.5	52.3	76.4	34.7	60.9	33.8	78.9	97.4	183.5	68.0	4,268	53.4
CERA 290	15.0	75.0	13.0	81.3	349.3	48.5	26.7	59.3	74.2	29.7	59.4	29.7	80.0	100.0	171.1	61.1	4,061	42.7
CERA 370	14.4	65.5	13.9	77.2	257.0	36.7	18.4	46.0	58.6	18.3	46.4	18.1	78.1	97.6	177.4	61.2	2,996	27.4
CERA 390	15.1	75.5	13.3	73.9	373.1	54.9	28.2	70.5	78.1	26.0	63.6	25.4	80.4	98.0	172.1	55.5	4,347	42.6
CERA 6	15.6	70.9	14.4	96.0	342.7	50.4	23.9	53.1	61.7	26.3	47.5	25.7	74.7	95.8	133.9	48.7	3,208	34.7
CERA 420	14.9	67.7	13.8	86.3	362.4	50.3	24.9	55.3	77.9	25.1	62.2	24.9	78.7	98.4	177.3	55.4	4,098	40.6
CERA 2504	15.6	70.9	15.6	97.5	363.7	48.5	23.3	48.5	75.4	28.5	60.9	28.3	79.8	99.8	167.2	57.7	4,255	43.6
CERA 4505	13.1	54.6	13.4	67.0	282.6	30.7	20.7	45.0	47.3	13.5	39.2	13.3	81.3	96.8	144.0	55.4	2,754	24.1
Bărăgan 48	13.4	55.8	13.5	84.4	284.5	37.4	20.0	41.7	51.7	15.7	42.9	15.9	83.8	102.2	161.0	51.9	3,130	28.2
CERA 10	14.4	72.0	14.8	67.3	378.1	53.3	25.3	79.1	75.5	25.2	63.9	25.6	84.1	102.6	167.9	56.0	4,445	40.8

%-n = percent of values obtained in 2012 from the normal values (from the values obtained in favourable climatic conditions).

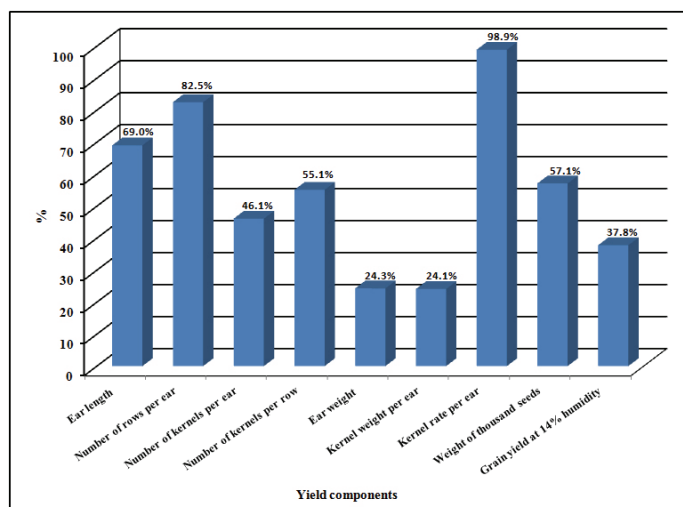


Figure 2. Yield components at the studied hybrids of maize as average percent of values obtained in 2012 from the normal values (values obtained in favourable climatic conditions)

## CONCLUSIONS

The drought from the year 2012 affected significantly the values of the yield components and the grain yield at the studied hybrids of maize compared to the normal values.

The grain yield obtained in 2012 in South Romania at the studied hybrids of maize was between 24.1 and 53.4% from the yield obtained in favourable climatic conditions.

Some of the studied maize hybrids (CERA 10, CERA 390, CERA 270, CERA 2504, CERA 420, CERA 290) showed to have the potential to produce good grain yield (more than 4 tons/ha) under water stress.

Among the studied hybrids, the most affected by drought (with grain yields less than 30% from yield obtained in favourable climatic conditions) were CERA 4505, CERA 370, and Bărăgan 48, while the less affected by drought (with grain yields higher than 50% from yield obtained in favourable climatic conditions) was CERA 270.

The yield components at the studied hybrids of maize were affected by the drought conditions from the year 2012 as follows:

- not affected by drought: kernel rate per ear (98.9% of normal value);
- less affected by drought: the number of rows per ear (82.5% of normal value) and the ear length (69% of normal value);
- middle affected by drought: the weight of thousand seeds (57.1% of normal value), number of kernels per row (55.1% of normal value), and number of kernels per ear (46.1% of normal value);
- most affected by drought: the ear weight (24.3% of normal value) and the kernel weight per ear (24.1% of normal value).

The weight components of yield are much more affected by drought than the numerical component of yield.

Among the four areas from South Romania in which the hybrids of maize were studied in the climatic conditions of the year 2012, Fundulea area from Călărași County was the most favourable for maize while Poșta Călnău area from Buzău County was the less favourable.

## ACKNOWLEDGEMENTS

The researches carried out for the elaboration of the present paper were financed by Romanian Program “Partnerships for Priority Domains”, project PN-II-PT-PCCA-2011-3.2-1778 “OPTimization of BIOMass and Approach to Water conservation” (OPTIBIOMA-W), Contract no. 45/2012.

The experiments in the field were performed with the support from SC Procera Agrochemicals Romania SRL.

## REFERENCES

- Beheshti A.R., B. Behboodi fard, 2010. Dry matter accumulation and remobilization in grain sorghum genotypes (*Sorghum bicolor* L. Moench) under drought stress. Australian Journal of Crop Science 4 (3), p.185-189.
- Haldrup Ch., 2012. Water management – Larger yield and lower costs. Scientific Papers. Series A. Agronomy, Vol. LV, p. 154-157.
- Khayatnezhad M., M. Hasanuzzaman, R. Gholamin, 2011. Assessment of yield and yield components and drought tolerance at end-of season drought condition on corn hybrids (*Zea mays* L.). AJCS 5 (12), p. 1493-1500.
- Khodarahmpour Z., J. Hamidi, 2012. Study of yield and yield components of corn (*Zea mays* L.) inbred lines to drought stress. African Journal of Biotechnology Vol. 11 (13), p. 3099-3105.