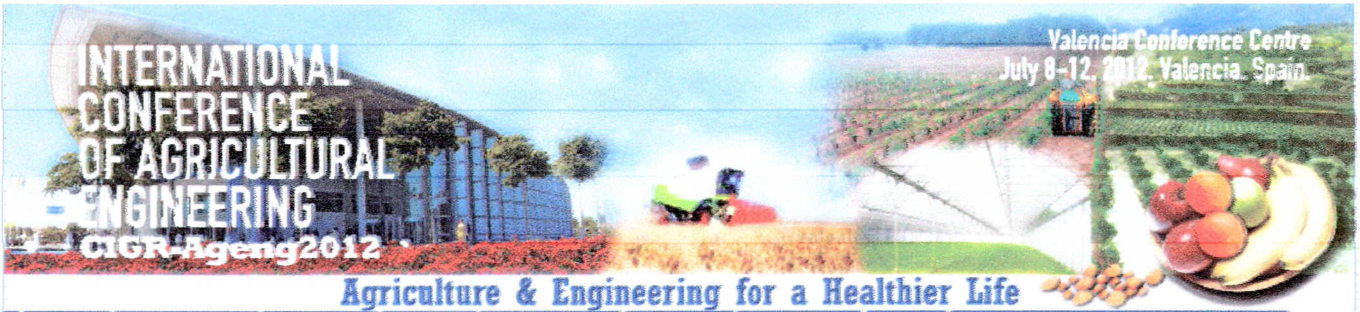

PRODUCTIVE PERFORMANCE OF MAIZE GENOTYPES UNDER WATER DEFICIT IN TERESINA, PIAUÍ STATE, BRAZIL

Abstract Nº: P1061

Authors: *Edson Bastos Alves; Milton Jose Cardoso; Ricardo Silva De Sousa;* **Aderson Soares De Andrade Júnior**; Valdenir Queiroz Ribeiro; Ramilos Rodrigues De Brito

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Introduction:

Maize has a great socio-economic importance in Brazil. However, there are many Brazilians regions that present irregular or low rainfall, reducing drastically the grain yield due to water deficit. Therefore, it is essential to develop studies focused on the evaluation and identification of drought tolerant maize genotypes.

Material and Methods:

Forty-two maize hybrids were evaluated in Teresina, Piauí State, northeastern Brazil, from September to December, 2010, under two irrigation water regimes: no water deficit (NWD) and water deficit (WD) during the reproductive phase, aiming identify genotypes tolerant to drought. The experimental design was randomized blocks with four replications. Irrigation was applied by conventional sprinkler system. Soil moisture content from 0.10 to 1.0 m was measured by Diviner 2000 probe. Grain yield and water use efficiency were evaluated.

Results/Conclusions:

During the crop cycle irrigation depth plus rainwater were 691.8mm and 490.6mm for NWD and WD, respectively, implying in maximum soil water depletions of 50% (NWD) and 80% (WD). The water use efficiency was 11.7 $kg.ha^{-1}.mm^{-1}$ and 4.6 $kg.ha^{-1}.mm^{-1}$ for NWD and WD, respectively. Under water deficit, the average grain yield was 2,274 $kg.ha^{-1}$, i.e. 72 % lower than no water deficit regime (8,074 $kg.ha^{-1}$). Moreover, 17 hybrids produced above the average, especially the hybrids ALFA 10 (4,770 $kg.ha^{-1}$), 30 A 37 (4,724 $kg.ha^{-1}$) and BX 1200 (4,577 $kg.ha^{-1}$).

Acknowledgements/References:

Productive performance of maize genotypes under water deficit in Teresina, Piauí State, Brazil

Edson A. Bastos[1], Milton J. Cardoso[1], Ricardo S. de Sousa[2], Aderson S. de Andrade Júnior[1], Valdenir Q. Ribeiro[1], Ramilos Rodrigues de Brito[3]

[1] *Embrapa Mid -North, Av. Duque de Caxias, 5650, Teresina, Piauí State, ZIP 64006-220, Brazil*
[2] *Post-Graduate Program in Agronomy, Federal University of Piaui (UFPI), Ininga Campus, Teresina, Piaui State, ZIP 64049-550, Brazil*
[3] *Post-Graduate Program in Agronomy, State University of São Paulo (UNESP), Botucatu, São Paulo State, ZIP 18610-307, Brazil*

**Corresponding author. E-mail: edson@cpamn.embrapa.br*

Abstract

Maize has a great socio-economic importance in Brazil. However, there are many Brazilians regions that present irregular or low rainfall, reducing drastically the grain yield due to water deficit. Therefore, it is essential to develop studies focused on the evaluation and identification of drought tolerant maize genotypes. Forty-two maize hybrids were evaluated in Teresina, Piauí State, northeastern Brazil, from September to December, 2010, under two irrigation water regimes: no water deficit (NWD) and water deficit (WD) during the reproductive phase, aiming identify genotypes tolerant to drought. The experimental design was randomized blocks with four replications. Irrigation was applied by conventional sprinkler system. Soil moisture content from 0.10 to 1.0 m was measured by Diviner 2000 probe. Grain yield and water use efficiency were evaluated. During the crop cycle irrigation depth plus rainwater were 692 mm and 491 mm for NWD and WD, respectively, implying in maximum soil water depletions of 26% (NWD) and 75% (WD). The water use efficiency was 11.7 $kg.ha^{-1}.mm^{-1}$ and 4.6 $kg.ha^{-1}.mm^{-1}$ for NWD and WD, respectively. Under water deficit, the average grain yield was 2,270 $kg.ha^{-1}$, i.e. 72 % lower than no water deficit regime (8,058 $kg.ha^{-1}$). Moreover, 18 hybrids produced above the average, especially the hybrids ALFA 10 (4,770 $kg.ha^{-1}$), 30 A 37 (4,724 $kg.ha^{-1}$) and BX 1200 (4,562 $kg.ha^{-1}$).

Key words: *Zea mays* L., water deficit, water use efficiency.

1. Introduction

The maize (*Zea mays* L.) is one of the three most widely cultivated crops in the world. In the Brazilian Northeast is one of the most planted grain crops but with low productivity. Among the factors that impact this productivity, there is the water deficit caused by the unevenness of the rainy season, where dry spells occur, often prolonged and at critical stages of growth and development of the crop.

It is noteworthy that water scarcity is a growing problem in many parts of the world. Predictions of climate change such as increased mean air temperature and decreased rainfall indicate that water is becoming even scarcer. However, agriculture is the main water user, about 70% (Frenken & Kiersch, 2011), suggesting that its efficiency is necessary to preserve this limited resource. For Zwart and Bastiaanssen (2004), increased water use efficiency can be achieved by different approaches; one of these being the use of genotype capable of producing acceptable yields under water stress.

Studies on drought tolerance involving maize can bring improvements in growth and yield of crop grains in regions with limited water resources (Li et al., 2009). In Brazil, few studies have been developed to identify maize genotypes tolerant to water stress (Silva et al., 2008, 2009, Teixeira et al., 2010, Cardoso et al., 2010; 2011a; 2011b; Brito et al., 2011, Bastos et al., 2008; 2011).

Cardoso et al. (2011b), in order to identify maize cultivars with drought and heat tolerance and more efficient water use observed mean values ranging from 1,157 $kg.ha^{-1}$ to 7,946 $kg.ha^{-1}$ for grain yield and 2.2 $kg.ha^{-1}.mm^{-1}$ at 14.9 $kg.ha^{-1}.mm^{-1}$ for water use efficiency under water deficit condition. There was average reduction in grains yield and water use efficiency by 53.6% and 38.6%, respectively.

For Durães et al. (2004), providing tolerant genotypes to abiotic stresses, especially drought, is an ongoing challenge for breeding programs, since water deficiency in soil is the major source of instability of the maize grains yield in tropical areas.

Thus, this study aimed at identifying maize cultivars with drought tolerance and more efficient to water use.

2. Material and Methods

Two experiments were conducted with maize, one under full-irrigation regime and the other under water stress condition in the experimental area of Embrapa Meio-Norte (05 ° 05 'S, 42 ° 48' W and 74.4 m) located in Teresina, Piauí, in the period from September to December 2010. According to Bastos and Andrade Júnior (2008), the annual relative humidity of Teresina is 72.6%, the average air temperature 28.2 ° C and 1336 mm annual rainfall.

The experimental area soil is Arenic Hapludult Distrophic (*Argissolo Amarelo Distrófico*, Brazilian Classification Scheme) sandy loam texture. The particle size analysis, considering the layer from 0 to 0.40 m, showed on average 76.45% sand, 10.45% silt and 13.10% clay. The value of field capacity, CC (10 kPa) considering the layer from 0 to 0.40 m was 21% and permanent wilting point, PMP (1500 kPa) of 9.0% volume basis.

The experimental design was randomized blocks with four replications, where the experimental plots consisted of a row of 4.0 m long 0.80 m spaced between each other and 0.20 m between-holes spaced. Treatments consisted of 42 maize hybrids coming from Embrapa Maize and Sorghum.

The area was irrigated through irrigation system with sprinkler nozzles 12 m x 12 m spaced and 1.6 $m^3.h^{-1}$ flow rate. The irrigation management was based on crop evapotranspiration (ETc) calculated using the crop coefficient (Kc) proposed by Andrade Junior. et al. (1998) and the reference evapotranspiration (ETo) estimated by the Penman-Monteith. Climatic data were obtained from a meteorological station of Embrapa Meio-Norte near the experimental area.

The water use efficiency (EUA) was determined by the ratio between the crops grain yield and the amount of water used to produce this yield. Monitoring the water content in soil was accomplished by means of a capacitance probe model Diviner 2000 ®, layered from 0.10 m to 0.70 m depth, from 17 days after sowing to the end the crop cycle. In the experiment under water deficit, the irrigation was interrupted between the pre-flowering and the first half of grain filling stage. During the water stress, the level of water depletion reached 75% of the total water content in the soil.

The data on grains yield (GY) ($kg.ha^{-1}$) and EUA ($kg.ha^{-1}.mm^{-1}$) were submitted to variance analysis, after verifying their homogeneity according to the methodologies of Pimentel-Gomes (1990) and Zimmermann (2004), being the treatments comparison made by the Scott-Knott test at 5% probability (Cruz, 2006).

3. Results and Discussion

The irrigation water applied plus rainfall totaled 692 mm and 491 mm for the experiments under full irrigation and under water deficit, respectively. Figure 1 A shows the occurrence of rainfall during the experimental period; however, since the soil has a sandy texture and the climate presents high solar radiation and reference evapotranspiration, it was possible to impose periods of water deficit in maize genotypes. This deficit is illustrated by Figure 1 B, which shows that the fraction of soil water depletion reached maximum values of 26% and 75%, respectively, for the full irrigation and water deficit experiments.

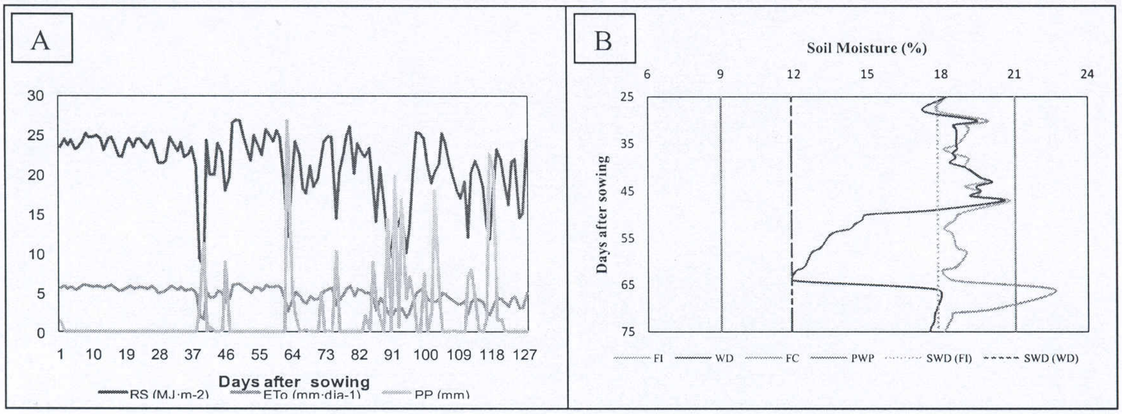

FIGURE 1. Solar radiation (RS), reference evapotranspiration (ETo) and precipitation (PP) values (1A); soil moisture (1B) of no water deficit (NWD) and water deficit (WD) experiments. FC: Field capacity; PWP: permanent wilting point; SWD (FI): Soil water depletion on full irrigation regime; SWD (WD): Soil water depletion on water deficit regime.

The water deficit was sufficient to cause significant differences in grains yield (GY) and water use efficiency (WUE) (Table 1). The GY mean values were 2,270.2 and 8,058.1 kg.ha-^{1} for water deficit and full irrigation regimes, respectively, implying 71.8% reduction on average. This reduction was greater than that (54.7%) obtained by Bastos et al. (2011) when studying 36 elite hybrids aiming at selecting maize genotypes tolerant to water stress and high temperatures based on the IAF and maize grain yield. The reductions in grain yields evidence the deleterious effect of water deficit, especially when it occurs in the reproductive phase of maize. According to Durães et al (2003), water deficit increases the interval between male and female flowering, reduces the pollen grain fertilizing and thus reduces the grains yield.

Under water deficit, 18 hybrids produced above the average (2,270.2 kg ha^{-1}). However, it is desirable that the selection of genotypes with drought tolerance takes into account the responsive capacity of these genotypes to irrigation. Therefore, the genotypes that simultaneously produced grains above average in both irrigation regimes were selected; highlighting the hybrids: ALFA 10, BX 1200, 30 A 91 Hx, BX 1290, 30 A 86 Hx, ALFA 905 , BRS 1031, 2 B 604Hx, SOMMA, CMS 1 D 219, DKB 350, ALFA 50 and YG.

The water deficit had significantly influence on the water use efficiency (WUE), whose values were 11.65 and 4.61 kg.ha^{-1}.mm^{-1} for the full and water deficit (WD) regimes, respectively. It was observed average reduction of 60.4% in the WUE of genotypes under WD condition compared to the full irrigation. These results were higher than those obtained by Cardoso et al. (2011a) when aimed at identifying maize cultivars with drought and heat tolerance with more efficient water use. According to Magalhães et al. (2009), the lines tolerant to water deficit have greater efficiency in water use compared with those sensitive. The best ratio of CO_2 absorption and H_2O consumption occurs when the stomata are partially closed, may be demonstrated at the beginning of water stress when the two diffusion processes are readily reduced, making the WUE reach higher values (Taiz & Zeiger , 2004; Tardieu, 2005).

TABLE 1. Grain yield (GY)[1] and water use efficiency (WUE) of 42 maize genotypes under full irrigation (FI) and water deficit regimes (WD). Teresina, Piauí State, 2010.

GENÓTIPO	GY ($kg \cdot ha^{-1}$)		Reduction	WUE ($kg \cdot ha^{-1} \cdot mm^{-1}$)	
	WD	FI	(%)	WD	FI
ALFA 10	4,770.6 a	8,671.8 c	44.99	9.73 a	12.53 c
30 A 37	4,723.8 a	6,884.4 e	31.39	9.63 a	9.95 e
BX 1200	4,561.9 a	8,649.3 c	47.26	9.30 a	12.51 c
30 A 91 Hx	3,985.9 b	11,087.8 a	64.05	8.12 b	16.03 a
BX 1290	3,855.6 b	9,728.5 b	60.37	7.86 b	14.06 b
30 A 86 Hx	3,819.9 b	9,710.3 b	60.66	7.79 b	14.04 b
ALFA 905	3,810.3 b	8,502.0 c	55.18	7.07 c	12.29 c
BRS 1031	3,747.4 b	8,516.3 c	55.99	7.64 b	12.31 c
2 B 604 Hx	3,723.2 b	10,318.5 b	63.91	7.59 b	14.92 b
SHS 7090	3,395.0 c	7,318.0 e	53.61	6.92 c	10.58 e
MAXIMUS	3,022.9 d	7,953.4 d	61.99	6.16 d	11.50 d
IMPACTO	2,766.7 e	7,610.9 d	63.65	5.64 d	11.00 d
SOMMA	2,641.1 e	8,797.7 c	69.98	5.38 e	12.72 c
CMS 1 D 219	2,411.0 f	8,982.9 c	73.16	4.91 e	12.99 c
ALFA 50	2,398.5 f	8,226.1 c	70.84	4.89 e	11.89 c
DKB 350 YG	2,331.0 f	8,086.5 d	71.17	4.75 e	11.69 d
2 B 707 Hx	2,320.3 f	7,235.6 e	67.93	4.73 e	10.46 e
DKB 390 YG	2,290.7 f	10,067.3 b	77.25	4.67 e	14.55 b
BRS 1010	2,211.1 g	6,250.9 f	64.63	4.51 e	9.04 f
GNZX 9505	2,102.3 g	7,469.4 e	71.85	4.29 f	10.80 e
30 A 70	2,061.5 g	7,227.5 e	71.48	4.20 f	10.45 e
DKB 185 YG	2,002.5 g	7,851.9 d	74.49	4.08 f	11.35 d
GNZX 8132	1,998.8 g	8,964.0 c	77.70	4.08 f	12.96 c
BX 1280	1,982.8 g	4,404.5 h	54.98	4.04 f	6.37 h
XB 6012	1,957.6 g	8,552.0 c	77.11	3.99 f	12.36 c
BRS 1035	1,948.5 g	8,276.6 c	76.46	3.97 f	11.97 c
STATUS	1,823.1 g	7,016.8 e	74.02	3.72 f	10.14 e
BM 709	1,607.6 h	7,761.2 d	79.28	3.28 g	11.22 d
OMEGA	1,568.7 h	7,206.9 e	78.23	3.20 g	10.42 e
DKB 330 YG	1,553.3 h	7,713.6 d	79.86	3.17 g	11.15 d
BMX 924	1,437.0 h	7,836.4 d	81.66	2.93 g	11.33 d
BM 810	1,358.3 i	5,111.9 g	73.43	2.77 h	7.39 g
DKB 399	1,336.4 i	7,300.2 e	81.69	2.72 h	10.56 e
DKB 175	1,189.3 i	7,360.2 e	83.84	2.43 h	10.64 e
2 B 587	1,170.3 i	8,589.4 c	86.38	2.38 h	12.42 c
DKB 177	890.8 j	8,162.5 d	89.09	1.82 i	11.80 d
DKB 315	884.1 j	7,392.9 e	88.04	1.80 i	10.69 e
SHX 7111	862.3 j	7,609.1 d	88.67	1.76 i	11.00 d
FORMULA	836.3 j	7,810.6 d	89.29	1.70 i	11.29 d
CMS 1 F 626	813.6 j	9,458.3 b	91.40	1.66 i	13.67 b
SHX 7222	590.7 j	7,864.5 d	92.49	1.21 i	11.37 d
30 A 77	587.6 j	8,903.2 c	93.40	1.20 i	12.87 c
Average	2,270.2	8,058.1	71.73	4.61	11.65
C. V. (%)	9.79	6.08	-	9.89	6.08
Test F	**	**	-	**	**

[1] Values with the same letter in column do not differ significantly by the Scott-Knott test ($P < 0.05$).

** Significant at 1% level by the test F

4. Conclusions

The ALFA 10, BX 1200, 30 A 91 Hx, BX 1290, 30 A 86 Hx, ALFA 905, BRS 1031, 2 B 604 Hx, SOMMA, CMS 1 D 219, ALFA 50 e DKB 350 YG hybrids present water deficit tolerance.

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