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Full Length Research Paper

Agronomic performance, production components and agricultural productivity of maize (*Zea mays* L.) cultivars

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The rain fed crop is highly dependent on environmental conditions, and study aims to evaluate the agronomic performance, yield components and agricultural productivity of six maize cultivars in the region of the coastal tablelands of Alagoas State, Brazil. The experimental design was randomized complete block, with five replications and six treatments. Six maize cultivars, three varieties (Jaboatão, Batité and AL Bandeirante) and three hybrids (AG 7098, AG 7088 and AG 8677) were evaluated from June 8 to October 14, 2015. The experimental area of 2000 m^2 (0.2 ha) was divided into six cultivation rows of seven meters linear portions; spaced 0.8 m between rows and 0.25 m between plants, totaling 50.000 plants ha^{-1}. During the experiment, the following were evaluated: plant height, leaf area index (LAI), culm diameter and at the end of the experiment, the production components, agricultural productivity, water balance and the grains water content were determined. The highest grain yield was obtained by hybrid AG 8677 (4.2 t ha^{-1}) followed by the AG 7098 (3.6 t ha^{-1}), with an average of 3.0 t ha^{-1} for all cultivars. Variety AL Bandeirante achieved a productivity similar to that of hybrid AG 7088. The lowest productivities were verified by varieties Jaboatão (2.0 t ha^{-1}) and Batité (2.2 t ha^{-1}). However, these yields were statistically similar to that of variety AL Bandeirante. The maximum water excess during cultivation of maize was 504 mm. An increased productivity was shown by hybrid AG 8677, and the smallest of the range was the variety Jaboatão. The average productivity of the hybrids was 50% higher than that of the varieties.

Key words: Water balance, grain yield, water deficit.

INTRODUCTION

Maize (*Zea mays* L.) is consider as an important stable crop for agriculture and for the world economy; it is the most productive grain crop throughout the world with production corresponding to 38.1% of all grains, followed by wheat with 29.1% and rice with 20.8% (Conab, 2016). Maize has been used worldwide for food, feed and production of biofuel among other uses. Although Brazilian agronomic technologies have evolved, productivity is still considered very low in some regions, especially in Alagoas, State, Brazil.

The average maize yield in Brazil is 5.3 with 2.0 t ha^{-1} in Northeastern and 1.0 t ha^{-1} in Alagoas (Conab, 2016). However, the agricultural potential of maize is much above this and among the factors responsible for the low productivity, is the lack of tolerant cultivars moisture variations of soil (water excess and deficit), caused by poor distribution of rainfall in the region of the coastal tablelands of Alagoas State, Brazil.

Globally, 15% of arable land is irrigated and currently accounts for 42% of all crop production; 7100 km^3 of water are consumed annually to produce food (Sumberg, 2012; Rockstrom et al., 2012).

In the forest region of Alagoas State, Brazil, the annual rainfall varies between 1.500 and 2.000 mm, despite being considered superior to the water requirements of maize, there is also water shortage due to poor distribution of rainfall in time, resulting in the occurrence of dry spells (Souza et al., 2004). Depending on the intensity and the phenological stage of the crop, the water deficit reduces the growth rate and yield of agricultural crops, especially in the critical period (pre-flowering to early grain filling). When soils have a small water storage capacity, it may not be possible to overcome impacts of the variability of rainfall as referred for maize (Popova et al., 2014).

This sensitivity can be observed in the physiological processes related to the formation of the zygote and early grain filling due to high perspiration, which occurs due to the higher leaf area index (Bergamaschi et al., 2004). Therefore, there is a need for resistant cultivars for adverse environmental conditions, preferably in rainfed crops, which reduces the risks caused by poor distribution of rainfall.

High soil water deficits resulted in severe decreases in yield and net income, however, in regions where water scarcity exists, irrigation managers and farmers should adopt the deficit irrigation approach to achieve economically sustainable crop production (Karasu et al., 2015).

Potential yield is relevant to benchmark crops where irrigation, the amount and distribution of rainfall, or a combination of irrigation and rainfall ensure that water deficits do not constrain yield (Sadras et al., 2014).

Due to yield instability of main crops associated with drought, the use of technologies such as irrigation and precision agriculture (PA) has been recently adopted in large scale (Vian et al., 2016).

The advantages of the use of irrigation in agriculture are associated directly to the correct management in order to increase productivity and reduce production costs (Pereira et al., 2015).

The effect of the deficit and/or excess of water on the growth and yield of maize depend on the development stage, the cultivar, duration and intensity of these factors (Machado, 2016). Therefore, the water balance has been used as a tool to determine the periods in which the plant is subjected to adverse water conditions. Another tool used to know the plant development standards is the analysis of crop growth, which differs at its various stages of plant development. Therefore, determining the growth rate for maize cultivation is of fundamental importance to adjust the critical stage of crop to periods of better water distribution.

Whereas the rainfed crop is highly dependent on environmental conditions, this study aims to evaluate the agronomic performance, yield components and agricultural productivity of six maize cultivars in the region of the coastal tablelands of Alagoas State, Brazil.

MATERIALS AND METHODS

The present study was conducted at the Agricultural Sciences Center of the Federal University of Alagoas, Rio Largo - AL, (09°28.02 "S, 35° 49 43" W; 127m), region of the coastal tablelands of Alagoas State, Brazil. The soil of the area is classified as cohesive argisolic Yellow Latosol texture medium/clayey, flat topography with slopes less than 2% (Carvalho, 2003). The authors evaluated six maize cultivars, three varieties (Jaboatão, Batité and AL Bandeirante) and three hybrids (AG 7098, AG 7088 and AG 8677), from June 8 to October 14, 2015.

The experimental design was randomized complete block, with five replications and six treatments. The experimental area was 2000 m^2 (0.2 ha) divided into six cultivation rows, seven meters linear portions; spaced 0.8 m between rows and 0.25 m between plants, totaling 50.000 plants ha^{-1}.

Soil preparation was done by a disc plows and two graders, both 25 cm depth. The depth of fertilization was determined based on chemical analysis of soil (Table 1), and to obtain a productivity of 10 t ha^{-1} grain. To this was applied 217 kg N ha^{-1}, 96 kg P_2O_5 ha^{-1} and 188 kg K_2O ha^{-1} (Coelho, 2008), which was used as source of urea, superphosphate and chloride potassium, respectively.

During the experiment, the following were evaluated: plant height, leaf area index (LAI), culm diameter and at the end of the experiment, the production components, agricultural productivity, water balance and the grains water content were determined.

The canopy height was measured from the root collar to the highest point of the plant (vegetative canopy) in 10 plants in each plot marked. The LAI was calculated by Equation 1 (Watson, 1947; Marafon, 2012):

$$LAI = \frac{LA \text{ x } NP}{10.000} \tag{1}$$

Where: LA- is the leaf area (m^2); NP- is the number of plants per hectare which is 10000 to one hectare area in m^2.

Leaf area was calculated every two weeks by ten plants in each plot sampling, using Equation 2 (Hermann and Câmara, 1999):

$$LA = L \text{ x } W \text{ x } 0.75\text{x } (N+2) \tag{2}$$

Where: L- is the length of the leaf "+3" (m); W- is the width of the leaf "+3" (m); 0.75 is a shape coefficient. This coefficient was determined by areas by Martins (2002) integration method, correction of shape maize leaves; N is the number of

Table 1. Chemical characteristics of the soil of the experimental area.

Layer[1]	pH	P	K	Ca	Mg	Al	V	M	OM
m	in H_20	mg dm^{-3}	-----------	$cmol_c$ dm^{-3}	----------		---------------	% ---------------	
0.0-0.2	5.80	47.00	0.11	4.00	1.40	0.05	47.70	1.20	2.24

[1]OM = Organic matter; V = base saturation; m = aluminum saturation.

photosynthetically active leaves.

For the determination of diameter of culm, measurements were made at a time corresponding to 1/3 from the base with graduated calipers. For the determination of the production and agricultural productivity, four core lines of five meters long (16 m^2) in each plot were harvested. All the ears of maize with at least a grain formed were then counted. Of total maize harvested in each plot, were randomly selected fifteen ears for the determination of the following components: length, diameter, number of grains per line, lines per spike, grains per spike, mass of grains per spike and cobs.

The length of spike was measured with a tape and the diameter with calibre. The number of grains per line and lines per spike were obtained by counting the grains in each line and the number of lines, and the number of grains of cob from the multiplication of both. The mass of grains per spike, the 1.000 grains and spike were determined by weighing the grain and mass of cob. Then the rest of the material was threshed and weighed to determine the agricultural productivity. All variables related to mass of grain were adjusted to 13% water content (Brazil, 2009).

The water balance was carried out daily until the stage of physiological maturity of maize, considering that soil has a 40 mm water storage capacity. Thus, it was possible to monitor the water availability in the soil in ten days scale by Thornthwaite and Mather (1955) method, according to Pereira et al. (2002). Meteorological data were provided by the agrometeorology and solar radiation laboratory (ASRAL), which maintains a weather station next to the experimental area. The data were submitted to analysis of variance by F test and means were compared by Tukey test at 5% probability.

RESULTS AND DISCUSSION

Pluvial precipitation during the conduct of research was 831.3 mm, considered superior to the water requirements of maize. However, there was similarity in the distribution of rainfall during the crop cycle. In general, there was excess water until the ninetieth day after planting (DAP), and a small deficit in some growth stages (Figure 1). For Bergamaschi et al. (2006), the water need by the maize varies between 200-400 mm, and distributed during cultivation.

In the water balance of the maize cultivation, it is observed that there was excess respectively and water deficit of 503 and 111 mm, for cultivars AL Bandeirante and AG 8677 (Figure 1A and B), both reached physiological maturity with 112 DAP. A water deficit of 5 mm occurred between the 1st and 2nd ten-day period, another 13 mm between the 4th and 8th ten-day period and a third of 93 mm between the 9th ten-day periods to physiological maturity. During cultivation, in the variety Jaboatão, there was an excess of 506 and 145 mm water deficit (Figure 1B). The largest deficit during the cultivation of the variety Jaboatão was 128 mm, and took place between the 9th and 13th ten-day period, while the lowest occurred during the 1st and 2 nd ten-day period (4 mm) and between 4th and 8th ten-day period (13 mm). Among the three varieties studied, it was found that during cultivation, Batité was the lowest excess (500 mm) and higher hydric deficit (151 mm). This deficit was distributed at three different times: 5 mm between the 1st and 2nd ten-day period, 13 mm between the 4th and 8 th ten-day period and the largest deficit (133 mm) between the 9th and 13th ten-day period (Figure 1C).

The knowledge of the process that constitute the soil water balance equation or simply the soil water balance components in field cropping is important, for instance, to correctly detect water deficits periods during the crops cycle, to indicate the need for irrigation and to present nutrient losses by leaching (Moreira, 2012).

During the cultivation, the hybrid AG 7098 was the largest excess (504 mm) and the lowest water deficit (101 mm). There was a deficit of 4 mm between the 1st and 2nd ten-day period, 13 mm between the 4th and 8th ten-day period and 84 mm between the 9th and 12th ten-day period (Figure 1E). Regarding the hybrid AG 7088, there was an excess of water deficit and 501 and 145 mm, respectively. The distribution of the deficit was also very similar to the other cultivars. Between the 1st and 2nd ten-day period, the deficit was 5 mm, between the 4th and 8th ten-day period was 13 mm and between 9th and 12th ten-day period water deficit was 127 mm.

Although, planting have occurred on the same date, the physiological maturity occurred at different times, which was influenced by heat accumulation and efficiency in water use among cultivars. So, there were differences regarding water distribution throughout the crop. As shown in Figure 1, the largest deficit water was 13 mm, not interfering with the development of crop because it mostly occurred outside the critical period of the crop (Figure 1).

Souza et al. (2015) reported that in the stages of flowering and seed filling and most radiation interception, the ETc reached daily average values equal to 5.3 mm day^{-1}, characterizing the period of highest water demand of corn. On the other hand, the excess water occurring between the stages of emergency and grain doughy (Figure 1) may have leached the available nutrients in the soil solution; which reduces crop growth and physiological processes associated with formation of the zygote in maize plants.

The varietal characteristics and environmental factors determine the vegetative growth of crops. During the plant

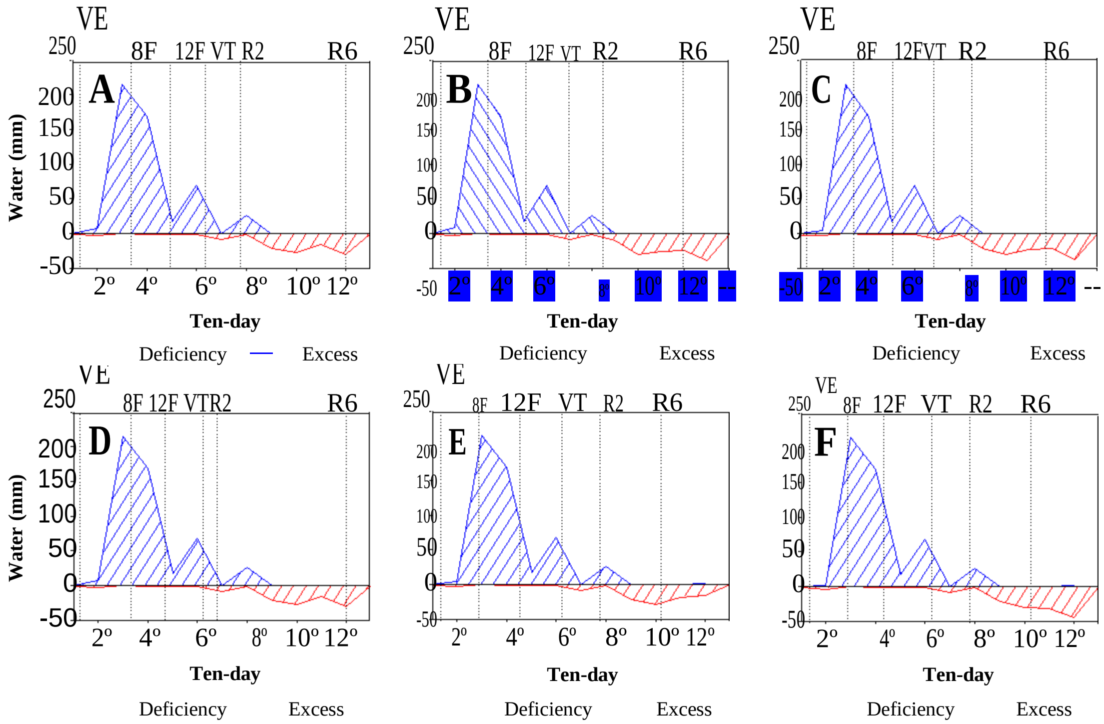

Figure 1. Deficit and excess water six maize cultivars: AL Bandeirante (A), Jaboatão (B), Batité (C), AG8677 (D), AG7098 (E) and AG7088 (F), in the region Rio Largo – Alagoas State, Brazil, in rainfed crop, from June 8 to October 14, 2015.

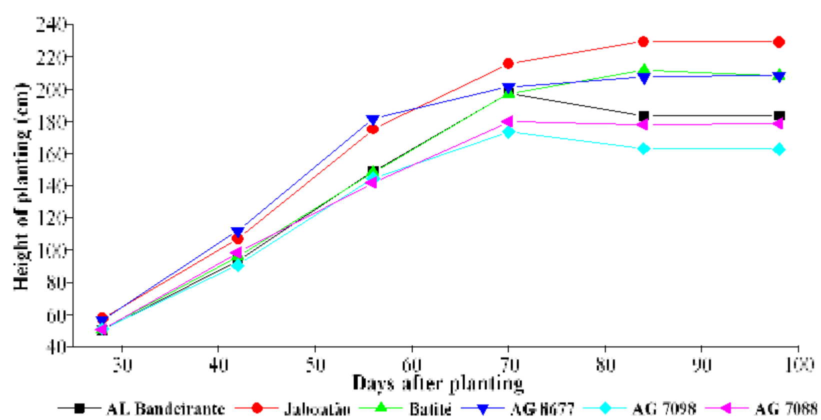

Figure 2. Height of the canopy of six maize cultivars, depending on the DAP, in the region Rio Largo, Alagoas State, Brazil, in rainfed crop, from June 8 to October 14, 2015.

height maize cycle characterized by presenting two growth stages (Figure 2). In the first phase growth, it was approximately linear and occurred between emergency and the start of flowering (at tasseling stage); and in the second phase, there was occurrence of stability in plant height in the period between the stages of flowering and grain doughy/hard (Figure 2). 70 and 98 DAP to Jaboatão variety had the highest and the hybrid AG 7098 the lowest. After the first growth phase (70 DAP), this height was 215.5 cm and the second stage (98 DAP) to 229.2 cm Jaboatão, while the hybrid AG 7098 obtained height of 173.2 cm to 70 DAP and 162.5 cm to 98 DAP. The average growth rate of the variety Jaboatão was 3.0 cm day^{-1} in the first growth phase and 0.5 cm day^{-1} in the second phase; while, the hybrid AG 7098 grew to 2.5 cm^{-1} in the first stage and 0.2 cm^{-1} in the second stage.

The average daily growth rate of varieties during the first phase was 2.9 and 0.1 cm in the second. The hybrids had

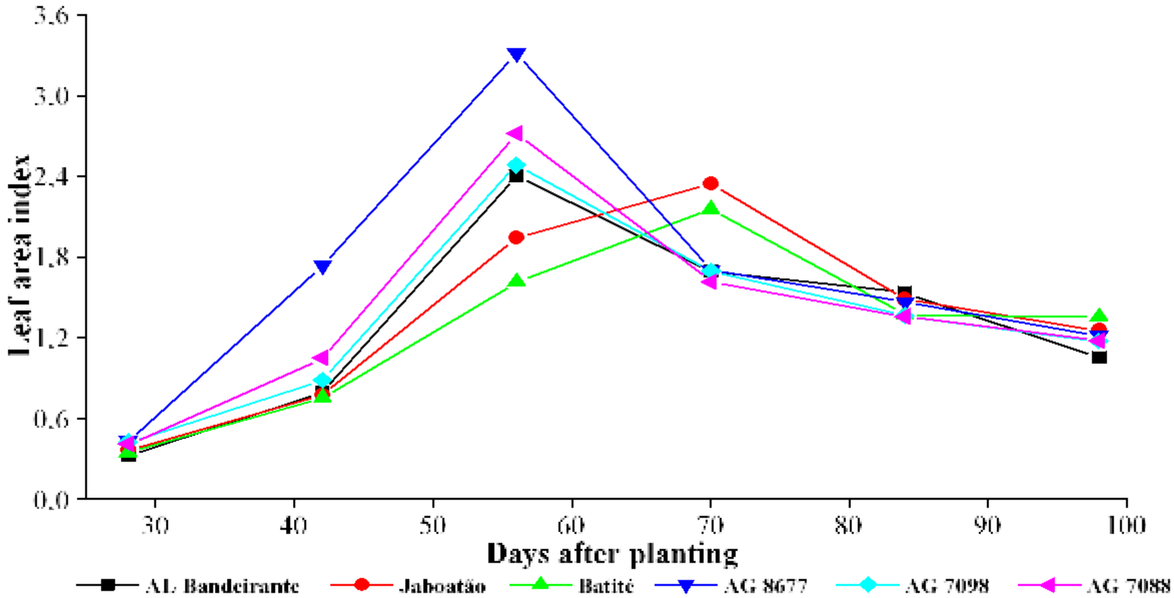

Figure 3. Leaf area index (LAI) of six maize cultivars, depending on the DAP in the region Rio Largo – Alagoas State, Brazil, in rainfed crop, from June 8 to October 14, 2015.

an average growth of 2.6 cm day^{-1} on the first stage and 0.06 cm day^{-1} on the second growth phase. The results showed that under the same environmental conditions, varieties were more efficient as compared to the growth rate. The reduction in the growth rate of the culture from 70 DAP, where the second growth stage took place because the photoassimilates are directed to spikes production and accumulation of starch in the grains.

The results of this study corroborate those obtained by Alvarez et al. (2006), who found that the height of the maize at 100 DAP was 197.3 cm; 193.7 and 203.5 cm for Pioneer 30F35 cultivars, and 2B7070 2B688, respectively. Gilo et al. (2011) observed similar results, working with six maize cultivars in the region of Aquidauana, MS State, Brazil, where daily growth rate of 2.6 cm and an average height of 183.8 cm was observed at 70 DAP.

The leaf area index (LAI) is responsible for interception of solar radiation in agriculture, and represents the leaf area of the plants on the ground coverage area. The results demonstrate that the cultivars were divided into two groups with the same behavior, and three stages of development throughout the growing cycle (Figure 3). Silva et al. (2015) verified that the AG30A91 genotype had a higher leaf area index, reflecting higher estimates of potential productivity.

The first group formed by the cultivars AG 8677, AG 7088, AG 7098 and AL Bandeirante showed a maximum LAI 2.7 at 56 DAP. At this point, the AG 8677 cultivar presented IAF 3.3 and variety AL Bandeirante 2.4; followed by a reduction of 48.5% for AG 8677 cultivar and 71.0% for the variety AL Bandeirante between 56 and 70 DAP (IAF second stage). In the third phase of development, which took place between 70 and 98 DAP, the IAF belonging to the first group of cultivars reduced by an average of 38.2% for the second phase, where aLAI average of 1.2 was found.

The second group also showed similar behavior with the first, but at different times. The maximum LAI was 70 DAP with values ranging from 2.3 for the variety Jaboatão to 2.16 for Batité, checking the end of the first phase of development, which ended after 70 DAP. The second stage of development occurred between 70 and 84 DAP, with an average reduction on the order of 36.2 and 8.4% in the third stage of development occurred between 84 and 98 DAP (Figure 3). At 98 DAP variety, Batité showed higher LAI (1.2), while the lowest AL Bandeirante (1.1).

The maximum LAI occurred at 56 DAP averaged 2.8 for hybrid and 2.0 for the varieties, while the minimum obtained at 98 DAP was 1.2 for both cultivars. Regarding the LAI hybrids, they were higher by 0.8 varieties, encouraging greater uptake of solar radiation by the canopy of plants.

After the maximum LAI, with the assessments carried out at 56 and 70 DAP, this index began to decrease (Figure 3) having commenced stability at different times; 70 DAP for cultivars AG 8677, AG 7098, AG 7088 and AL Bandeirante and 84 DAP for Jaboatão and Batité varieties. The reduction in LAI is a function of leaf senescence, physiological process that occurs in the maize crop at the end of the vegetative phase, at tasseling stage. At this time, there is a reduction of crop growth (Figure 2) and the leaf emission, since the produced assimilates is directed to the formation of spikes. This same behavior regarding the LAI was also verified by

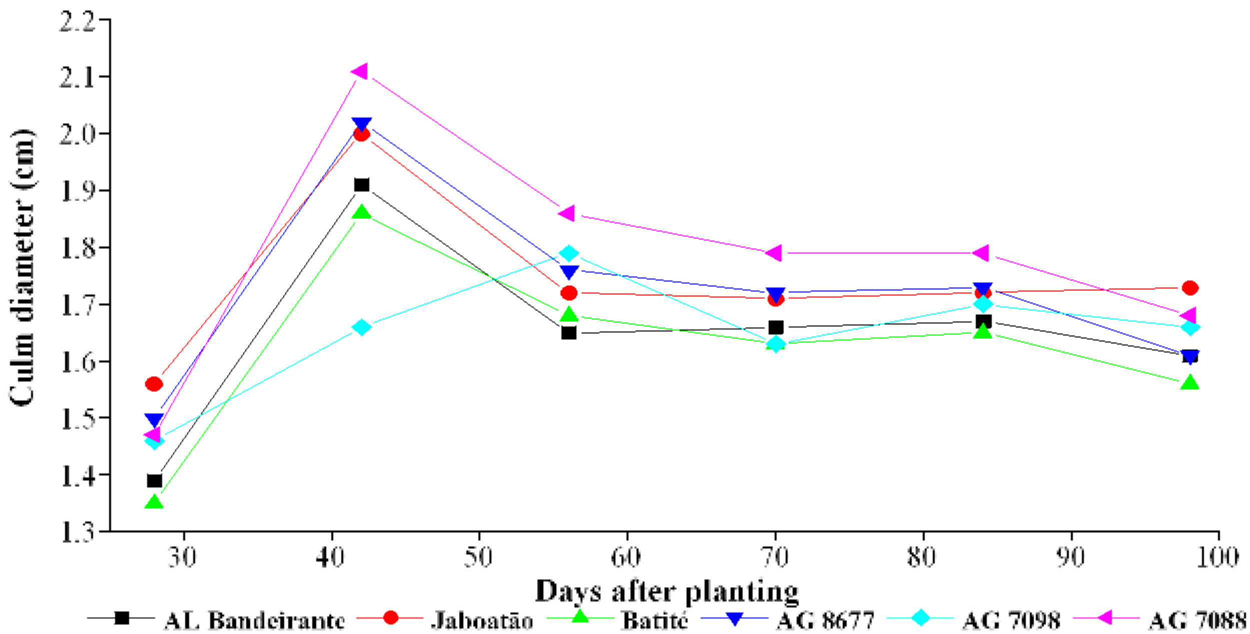

Figure 4. Behavior of diameter of culm of six maize cultivars, depending on the DAP in the region Rio Largo – Alagoas State, Brazil, in rainfed crop, from June 8 to October 14, 2015.

Mergener (2007) in the region of Campos Novos – SC State, Brazil, and Veloso et al. (2009) in the region of Piracicaba – SP State, Brazil.

In this study, there was variation in LAI of cultivars in all evaluation times, which shows that this index is also strongly influenced by genetic characteristics of cultivars. Although, below ideal, the greater IAF until the beginning of flowering (56 DAP) was verified by hybrid AG 8677.

The maximum diameter of culm occurred at 42 DAP for most cultivars, averaging 1.9 cm, except the hybrid AG 7098, which had a different behavior than the other. For this hybrid, the maximum diameter (1.8 cm) occurred at 56 DAP, the second largest diameter at this time of evaluation. However, after 42 DAP, the larger diameter (2.1 cm) was observed in the hybrid AG 7088 and the lowest (1.7 cm), the AG 7098, then there was a reduction in the diameter of the culm in the last evaluation (Figure 4).

At 98 DAP, mean diameter was 1.6 cm, and the maximum and minimum values observed were 1.7 cm for variety Jaboatão and 1.5 cm for Batité. Both hybrid varieties presented as a maximum diameter of 1.9 cm and 1.6 min at 42 and 98 DAP, respectively. The hybrid AG 7088 showed the largest diameter of culm in four evaluation times, lower than the hybrid AG 8677 to 28 DAP and variety Jaboatão to 98 DAP (Figure 4). This same behavior was also observed by Gilo et al. (2011), where the authors observed a maximum diameter of 1.9 cm at 45 min and 100 DAP to 1.5 cm.

Among the variables studied in growth analysis, the diameter of culm is less varied, since this variable depends on the genetic characteristics of the plant, population density, used spacing, the leaf area and environmental conditions throughout the crop cultivation.

The maize cultivars had no significant effect by the F test at 1% probability for the length of ear (LE), mass of cob and the beans water content (Table 2). On the other hand, it is observed that there were significant differences among cultivars for other production components. Cultivar AG 7088 showed a higher number of rows per ear of maize (17), followed by cultivar AG 7098 (15.6). The AG 8677 cultivars and AL Bandeirante were similar and lower than the AG 7088 and AG 7098. The cultivars Jaboatão and Batité varieties were similar and lower than others (Table 2).

The average results obtained in this study approached those obtained by Meira et al. (2009) and Nascimento et al. (2011), who found 15 and 13.6 rows of grains per ear of maize, respectively. They also reported that the number of rows of grains per ear of maize is highly dependent on the genetic characteristics of cultivars.

The larger numbers of grains per row were obtained by AG 7088 and AG 8677 cultivars, both were similar (Table 2). Cultivars AL Bandeirante, Batité and AG 7098 also had no significant effect on the row for grains number, and thus both were similar to cultivars with higher values (AG 7088 and AG 8677) and to cultivar Jaboatão that presented fewer numbers of grains per row (19). The number of grains per row is directly related to the thickness of grain and the length maize ear. The results obtained in this study were lower than the average observed by Meira et al. (2009), who reported that the

Table 2. Analysis of variance of yield components of six rainfed maize cultivars in the region Rio Largo – Alagoas State, Brazil, in rainfed crop, from June 8 to October 14, 2015.

Cultivars[1]	LE	NRE	NGR	Mass of cob	Water content
				------- g ------	------ % -----
Jaboatão	11.68^{a}	10.28^{a}	19.02^{a}	18.78^{a}	18.59^{a}
AL Bandeirante	11.58^{a}	14.18^{b}	23.32^{ab}	19.00^{a}	13.33^{a}
Batité	11.98^{a}	10.96^{a}	21.14^{ab}	16.09^{a}	14.73^{a}
AG 7088	10.68^{a}	17.00^{d}	23.89^{b}	17.71^{a}	17.07^{a}
AG 7098	11.99^{a}	15.58^{c}	23.59^{ab}	19.40^{a}	14.57^{a}
AG 8677	12.20^{a}	14.16^{b}	25.60^{b}	23.09^{a}	22.11^{a}
Means	11.83	13.69	22.76	19.01	16.73
CV%	8.74	2.83	6.90	12.89	7.07

[1]Means followed by the same letter in the column do not differ by Tukey test at 5% probability. LE: length of ear, NRE: number of rows per ear and NGR: number of grains per row.

Table 3. Analysis of variance of yield components and agricultural productivity of six rainfed maize cultivars in the region Rio Largo – Alagoas State, Brazil, in rainfed crop, from June 8 to October 14, 2015.

Cultivars[1]	DS	NGE	MGE	M1.000G	Productivity
	--- cm --		------------ g -----------		---- t ha^{-1} ----
Jaboatão	4.10^{b}	198.65^{a}	68.10^{ab}	355.26^{c}	2.08^{a}
AL Bandeirante	4.15^{b}	330.29^{b}	79.34^{ab}	260.47^{ab}	2.97^{ab}
Batité	3.66^{a}	232.00^{a}	60.60^{a}	279.37^{ab}	2.21^{a}
AG 7088	4.26^{bc}	406.91^{c}	91.04^{bc}	230.28^{a}	3.63^{bc}
AG 7098	4.32^{bc}	367.74^{bc}	89.77^{bc}	258.71^{ab}	3.11^{b}
AG 8677	4.51^{c}	360.94^{bc}	113.17^{c}	297.73b	4.20^{c}
Means	4.17	316.09	83.67	280.31	3.04
CV%	3.10	10.59	4.29	9.54	4.97

[1]Means followed by the same letter in the column do not differ by Tukey test at 5% probability. DE: Diameter of ear, NGE: number of grains per ear, MGE: mass of grains per ear; M1.000G: mass of 1.000 grains.

average length of ear was 18.4 cm.

Table 3 shows that there was a significant effect on the components of production and agricultural productivity. The largest diameter was obtained by the hybrid AG 8677, which did not differ statistically from the AG 7088 and AG 7098 hybrids, which were similar. The Jaboatão and AL Bandeirante varieties were similar and higher than the Batité variety that showed the smallest diameter of spike (3.7 cm). These results are close to those obtained by Born et al. (2011) in Botucatu – SP State, Brazil.

The hybrid AG 7088 had the highest number of grains per ear (406.91 grains), but did not differ from hybrid AG 7098 and AG 8677, which were similar and did not differ from variety of AL Bandeirante. The Jaboatão and Batité varieties did not differ statistically, but were lower than the range of AL Bandeirante (Table 3). On average, cultivars had 316.0 grains per ear of maize. These results were 40% lower than the results obtained by Gonçalves Junior et al. (2008).

The largest mass of grains per ear was observed in the hybrid AG 8677 (113.17 g), however, this did not differ statistically from the hybrid AG 7088 and AG 7098; both were similar (Table 3). The Jaboatão and AL Bandeirante varieties also did not differ among themselves, and were similar to the AG 7088 and AG hybrid 7098. The lower mass of grains per ear was observed in the range Batité (60g), similar to the mass of varieties Jaboatão and AL Bandeirante. Even under irrigation, corn yield showed high spatial variability (Vian et al., 2016).

The largest mass of 1000 grains was obtained by the variety Jaboatão (355.2 g). Varieties AL Bandeirante, Batité and hybrid AG 7098 were not statistically different from each other, but were similar to the AG 8677 and AG

7088 hybrids with a mass of 1000 grains 297.7 and 230.3 g, respectively (Table 3). The average mass of 1,000 grains obtained in this study was higher than the results found by Nascimento et al. (2011) and lower than that obtained by Meira et al. (2009).

The largest grain yield was obtained with the hybrid AG 8677 (4.2 t ha^{-1}) followed by the AG 7098 (3.6 t ha^{-1}), with an average of 3.0 t ha^{-1} for all cultivars. Variety AL Bandeirante achieved productivity similar to hybrid AG 7088. The lower productivities were verified by Jaboatão varieties (2.0 t ha^{-1}) and Batité (2.2 t ha^{-1}); however, these yields were statistically similar to variety AL Bandeirante. France et al. (2011) reported agricultural income in the order of 3, 6 and 9 t ha^{-1} using different doses of nitrogen (N) when the leaves ranged from 1.3, 2.2 to 2.6% (N), respectively. However, the agricultural productivity of the maize crop is directly related to several factors, among them are: the genetic potential of the cultivar, the water and nutrient availability, weather conditions, etc.

In this study, the water surplus of approximately 504 mm occurred between planting and on ninety days (90 DAP), may have resulted in a reduction in agricultural productivity due to the reduction of oxygen near the root system of the plants due to flooding of the experimental area, and consequently the leaching of nutrients from the soil solution. Taking into account the agricultural productivity, hybrid maize is more tolerant to water as compared to other varieties studied.

Conclusion

The maximum water excess during cultivation of maize was 504 mm. The mass of ear is influenced by the number of grains per row and the number of rows per ear of maize. The largest mass of 1,000 grains was obtained by variety Jaboatão and maximum grains per ear by hybrid AG 7088. There was increased productivity in the hybrid AG 8677, and the smallest in Jaboatão.

The average productivity of hybrid was 50% higher than the varieties. The agricultural yield of maize crop is directly related to LAI.

Conflict of interest

The authors did not declare any conflict of interest.

ACKNOWLEDGEMENTS

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