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Effect of the sowing season and densities in grain yield in soybean, in the South-center region of Tocatins State

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Abstract

The objective was to evaluate the influence of different times and seeding rates on seed yield of soybean (*Glycine max* (L.) Merrill.) in south-central region of Tocantins state. Four experiments were installed in the agricultural year 2008/09. The experimental design was a randomized block design with three replications and 36 treatments. The treatments were arranged in a factorial 3 x 3 x 2 x 2, consisting of three cultivars (M-SOY 9144 RR, M-SOY 8867 RR and P98Y70), three seeding rates (6, 10 and 14 plants per meter), two sowing dates in each of the two municipalities. The first sowing date in Gurupi was December 3 and the second on December 18, 2008. In Palmas, the first time was on November 31 and the second on December 16 2008. The variables measured were plant height and insertion of first pod, hundred seed weight and seed yield. It may be noted that with the delay of sowing date the grain yield decreases, but the increase of seeding rate depends on the cultivar and the variables are dependent on the season and the municipality of planting. The results of Palmas provided the cultivars the highest average yield and the city of Gurupi the best development of soybean plant.

Key words: Glycine max; climate changes; soil fertility

Introduction

Brazil is the second soybean grain world producer. In the crop 2007/2008 it achieved a yield of 60 million tones, in an area of 21.3 million hectares, which corresponds to a productivity of 2816 kg ha^{-1} (CONAB, 2008). From this production, 23.7 million tones were exported, adding in the Brazilian financial account approximately 11 billion dollars (SECEX, 2009).

In the last decade, due to the development of genotypes adapted to the conditions of low latitude, by the genetic improvement programs soybean presented a significant increase in the cultivated area in the South-West and North regions. In the region called Brazil Central, it became the best option of cultivation, and is the responsible of the opening of the region of cerrados (ARANTES, 1993; EMBRAPA, 2002).

In the state of Tocantins, the soybean represents the first culture in terms of participation in the gross amount of the production. The state has advantage in the soybean cultivation in relation to other states, as favorable edaphoclimatic conditions, abundance of water resources and privileged geographic location (PELUZIO et, al 2006).

When consulting the historic of culture yield it is possible to visualize fluctuations motivated mainly by meteorological elements as anomalies in rainfall. Thus, research works related to methods of management have been studied and used with the aim to reduce the impacts of climate adversities over the agricultural productivity and availability of food

Received on: 20 apr. 2010. Accepted for publication on: 21 jul. 2010.

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(QUEIROZ, 1998).

The seeding period is defined by a set of environmental factors which react among themselves and interact with the plant, providing ranges in the yield and affecting other agricultural characteristics (PEIXOTO et al., 2000). Since the environmental factors present uneven behavior year after year, regionalized experiments with each genotype are necessary to quantify the response of this genotype to these different environmental interactions (PELUZIO et al., 2008).

The population density is another manipulable characteristic in the management which affects directly in the final yield of the culture. According to GAUDÊNCIO et al. (1990), soybean tolerates wide range in the plant population, changing more its morphology than the grain yield.

Considering this, this work aimed to evaluate the influence of different periods and seeding densities in the soybean (*Glycine max* (L.) Merrill.) grain productivity in the South-Center region of Tocantins state.

Material and methods

Four experiments were installed in the agricultural year 2008/2009, in experimental fields in the Universidade Federal de Tocantins (Federal University of Tocantins), being two in Gurupi (280 m of altitude, 11°43'S and 49°04'W) and two in Palmas (300 m of altitude, 10°41' S and 47°03'W). Seeding was performed: Period 1: Gurupi–TO (12/03/08); Period 2: Gurupi–TO (12/18/08); Period 1: Palmas-TO Palmas–TO (11/31/08); Period 2: Palmas–TO (12/15/08). Each experiment represents one planting period.

The chemical characteristics of the soil, sampled at the depth of 0-20 cm, in the municipality of Gurupi–TO were: 0.0 of Al^{+++} ($mmol_c\ dm^{-3}$); 2.1 of Ca^{++} ($mmol_C\ dm^{-3}$); 0.6 of Mg^{++}($mmol_C\ dm^{-3}$); 0.0 of K^+(mg dm^{-3})[1]; 3.7 of P (mg dm^{-3}) and 5.9 of pH (H_2O) and in the municipality of Palmas-TO, they were: 0.0 of Al^{+++}($mmol_c\ dm^{-3}$); 2.3 of Ca^{++}($mmol_C\ dm^{-3}$); 1.2 of Mg^{++}($mmol_C\ dm^{-3}$); 60.0 of K^+ (mg dm^{-3})[1]; 8.4 of P (mg dm^{-3}) and 6.0 of pH (H_2O).

The experimental design used was randomized blocks, with three replications and 36 treatments. The treatments were disposed in a factorial scheme 3 x 3 x 2 x 2, constituted by three cultivars (M-SOY 9144 RR, M-SOY 8867 RR e P98Y70), three seeding densities (6, 10 and 14 plants per linear meter), two seeding periods in two municipalities.

The experimental plot was composed by four lines with 5.0 m of length, with spacing between lines with 0.4. In the harvest, it was despised the two lateral lines and 0.5 m of the extremities of the two central lines.

The fertilization performed was of 400 kg ha^{-1} of fertilizer 05-25-15. It was performed also the cover fertilization with Potassium Chloride 90 kg ha^{-1}. In the moment of the seeding it was performed the inoculation of seeds with *Bradyrhizobium japonicum* strains, with the aim at obtaining a good root nodulation of plants, guaranteeing the supply of nitrogen to the culture.

It was performed the control of weed of wide leaves with herbicide 15 days after the culture germination; and herbs with narrow leaves 30 days after the culture germination. Each 15 days it was performed spraying of fungicide and insecticide.

The plants of each experimental parcel were harvested one week after they presented 95% of the mature pod, i.e., in the stage R_8 of the FEHR et al. (1971) scale. After the harvest, the plants were trilled, and the seeds dried at the Sun (obtaining of 12% of humidity), dry and weighted, to determine the grain production.

Based on the useful area of the parcel, the following agronomical characteristics of the plants were evaluated: number of days to flowering, number of days for maturation, height of insertion of the first legume, plant height, number of pods per plant, number of seeds per pod, weight of 100 seeds, grain yield and degree of lodging.

After obtaining the data, it was performed the analysis of individual variance, and later the joint analysis of the experiments which presented homogeneity of variance. After that, the means were compared by the Tukey test at 5% and 1% of probability.

Results and discussion

Experiments in Gurupi - TO

The analyses were separated by place (Gurupi and Palmas). There was a significant effect in the plant height between cultivars and seeding periods, indicating that the effects of the cultivars and seeding periods do not explain all the ranges found, being performed, in this case, decomposition. The same occurred in the interactions cultivars x periods x seeding periods. The seeding period provided significant effect in all the characteristics. Regarding the cultivars, there was no significant effect regarding the PROD. By contrast, concerning the plant density there was a significant effect ($p \leq 0,01$) in plant height (PH) and first pod insertion (FPI).

The coefficients of variation were satisfactory, being: 7.96% (PH), 15.45% (FPI), 9.48% (WHS) e 14.35% (PROD). PIMENTEL-GOMES (1985) classified them as low, when inferior to 10%; medium, when from 10% to 20%, high, when from 20% to 30% and very high, when superior to 30%. Thus, this coefficients of variation may be classified as from medium to high experimental accuracy.

The highest plant height was obtained by the cultivar M-SOY 9144 RR in the first seeding period (86.1 cm), being significantly different from the average of PH obtained in the second seeding period and by cultivar P98Y70 (73.5 cm) in the first seeding period (Table 1), independent on the cultivar. For the cultivars, independent on the seeding period, there was no significant difference.

Regarding the interactions between cultivars and plant densities, the highest average of PH was obtained by the cultivar M-SOY 8766 RR with 14 plants per linear meter (87.7 cm), being different from the average of PH obtained with 6 plants (74.9 cm) and also different from the average of PH obtained by the cultivar M-SOY 9144 RR (77.8 cm). The density of 14 plants per linear meter, independent on the cultivars, provided the lowest average of PH (81.6 cm), being different from the average of PH provided by the density of six plants (70.6 cm). Plant height is an important characteristic of the crop science, highly influenced by cultivar and by the plant population, in a way that larger populations stimulate the growth of the plants and the elevation of the height of first pod insertion (PELUZIO, 2007).

The highest average of height of first pod insertion (FPI) was obtained by the cultivar M-SOY 8766 RR in the second period of seeding (27.4 cm), being different between cultivars and seeding periods (Table 2). As for cultivars, independent

Table 1. Average of plant height (cm) of soybean cultivars in different seeding periods and plant densities in Gurupi – TO in the 2008/09 crop.

Cultivars	Period 1 12/03/08	Period 2 12/18/08	Averages	Plant density (m^{-1})		
				6	10	14
P98Y70	73.5 bA	74.4 aA	74.0 b	68.2 aB	74.6 bAB	79.2 abA
M-SOY 8766 RR	83.9 aA	80.2 aA	82.1 a	74.9 aB	83.5 aAb	87.7 aA
M-SOY 9144 RR	86.1 aA	62.7 bB	74.4 b	68.8 aB	76.5 abAB	77.8 bA
Averages	81.2 A	72.4 B	76.8	70.6 B	78.2 A	81.6 A

Averages followed by the same lowercase letters in the line and lowercase in the column do not differ by Tukey test at 5% probability. Period 1: 12/03/08; Period 2: 12/18/08

Table 2. Average of first pod intertion (cm) of soybean cultivars in different seeding periods and plant densities in Gurupi – TO in the 2008/09 crop.

Cultivars	Period 1 12/03	Period 2 12/18	Averages	Plant Dens. (m^{-1})	Period 1	Period 2	Averages
P98Y70	15.9 bB	19.9 bA	17.9 b	6	18.9 aA	18.7 bA	18.8 b
M-SOY 8766 RR	20.7 aB	27.4 aA	24.1 a	10	18.3 aB	21.5 bA	19.9 ab
M-SOY 9144 RR	18.9 abA	18.7 bA	18.8 b	14	18.3 aB	25.9 aA	22.1 a
Averages	18.5 B	22.0 A	20.3		18.5 B	22.0 A	20.3

Averages followed by the same lowercase letters in the line and lowercase in the column do not differ by Tukey test at 5% probability. Period 1: 12/03/08; Period 2: 12/18/08

on the seeding period, cultivar M-SOY 8766 RR was the one that obtained the highest average of FPI, differing significantly from the other cultivars. Regarding to the seeding periods, independent on the cultivar, the one which provided the best averages of FPI was the second period of seeding.

Concerning the weight of 100 seeds (WHS), independent on the seeding periods, the cultivar P98Y70 obtained the highest average of WHS (17.3 g), being only significantly different from the cultivar M-SOY 8766 RR (13.5 g). The first seeding period, independent on the cultivars, provided the highest averages of WHS (17.0 g), differing significantly from the average of WHS provided by the second seeding period (Table 3).

The highest average of grain productivity was obtained by the cultivar P98Y70 in the first seeding period (3288 kg ha^{-1}), differing from the average obtained by the other cultivars (Table 4). In the second seeding period (2061 kg ha^{-1}) the cultivar M-SOY 9144 RR obtained the highest PROD average (2466 kg ha^{-1}), differing from the cultivar M-SOY 8766 RR (2002 kg ha^{-1}). The first seeding period provided the highest PROD averages (3167 kg ha^{-1}), independent on the cultivar, differing from the average provided from the second seeding period (2176 kg ha^{-1}).

Experiments in Palmas – TO

In all the characteristics there was significant effect of the interaction between cultivars and density of soybean plants and seeding period and density. In the interaction cultivar and seeding period, it was verified significant effect in plant height (PH), height of first pod insertion (FPI) and weight of a hundred seeds (WHS), indicating that the effect of the cultivars, period and density of the soybean plants do not explain all the ranges found, being performed, in this case, the developments. Regarding to the FPI there was significant difference between the cultivars, seeding periods and plant densities. There was a significant effect between cultivars and seeding periods related to PH and WHS. Concerning the grain productivity (PROD) there was significant effect only between seeding period and density of soybean plants. The Coefficients of variation were low in all the characteristics, being 7.8% (PH), 9.2% (FPI), 5.6% (WHS) and 7.2% (PROD). According to SCAPIM (1995), these coefficients of variation lower than 10% represent great experimental accuracy.

The first seeding period provided to the cultivars highest plant heights, in which P98Y70 presented the highest PH (75.7 cm), differing ($p \leq 0.05$) from the M-SOY 9144 RR (66.1 cm). In the

Table 3. Average of weight of a hundred seeds (g) of soybean cultivars in different seeding periods and plant densities in Gurupi – TO in the 2008/09 crop.

Cultivars	Period 1 03/12	Period 2 18/12	Averages
P98Y70	18.9	15.7	17.3 a
M-SOY 8766 RR	13.9	13.0	13.5 b
M-SOY 9144 RR	18.3	16.2	17.2 a
Averages	17.0 A	14.9 B	16.0

Averages followed by the same lowercase letters in the line and lowercase in the column do not differ by Tukey test at 5% probability. Period 1: 12/03/08; Period 2: 12/18/08

Table 4. Average of grain productivity (kg ha^{-1}) of soybean cultivars in different seeding periods and plant densities in Gurupi – TO in the 2008/09 crop.

Cultivars	Period 1 03/12	Period 2 18/12	Average
P98Y70	3288 aA	2061 abB	2674
M-SOY 8766 RR	3283 aA	2002 bB	2642
M-SOY 9144 RR	2929 aA	2466 aB	2698
Médias	3167 A	2176 B	2671

Averages followed by the same lowercase letters in the line and lowercase in the column do not differ by Tukey test at 5% probability. Period 1: 12/03/08; Period 2: 12/18/08

second period the cultivar P98Y70 obtained alone the highest PH average (65.1 cm); with this, independent on the seeding period, cultivar P98Y70 obtained the highest average of PH (70.4 cm) (Table 6). Among the cultivars, it was not observed averages of plant height inferior to 50 cm, which favors the practice of mechanized harvest. PH is a characteristic influenced by population density of plants, considering that the increase in the competition provides increase in the PH and FPI.

Regarding to the interaction between plant density and cultivars, P98Y70 obtained the highest PH average (74.2 cm) in the density of 6 plants per linear meter, differing significantly from the one obtained with the density of 14 plants and between cultivars in the density of 6 plants. In the density of 10 plants, the PH obtained by cultivar P98Y70 differed significantly only from cultivar M-SOY 9144 RR. On the other hand, in the density of 14 plants there was no significant difference between cultivars (Table 6).

The density of 10 plants per linear meter provided to the cultivars, in the first seeding period, highest PH (74.8 cm), differing significantly only in the density of 6 plants (67.8 cm). In all plant densities it was observed highest PH in the seeding period. This suggests that not only the plant densities provided highest PH, but also the edaphoclimatic conditions appropriated to the plant development are of major importance. In the second seeding period there was no significant difference of PH provided by different plant densities.

The cultivars M-SOY 8766 RR (17 cm) and M-SOY 9144 RR (16.1 cm), independent on the seeding period, were superior to cultivar 98Y70 (14 cm). The same behavior between cultivars is observed in the second seeding period. The first seeding period, independent on the cultivar, provided to the cultivars the highest averages of FPI (15.7 cm) and independent on the seeding periods, cultivars M-SOY 9144 RR and M-SOY 8766 RR obtained FPI averages superior to cultivar P98Y70 (Table 6).

Regarding the interaction between plant densities and cultivars, M-SOY 9144 RR obtained the highest average of FPI (16.8 cm) in the density of 10 plants per linear meter, differing significantly from the one obtained with the density of 6 plants and between the cultivar in the density of 10 plants. In the density of 14 plants, the FPI obtained by cultivars M-SOY 9144 RR and M-SOY 8766 RR were different ($p \leq 0.05$) from the one obtained by

Table 6. Average of plant height (cm) of soybean cultivars in different seeding periods and plant densities in Palmas – To, in the 2008/09 crop.

Cultivars	Period 1	Period 2	Averages	Plant density per linear meter						
	Nov 31	Dec 15		6	10	14	Period	6	10	14
M-SOY 8766 RR	70.7 abA	50.7 bB	60.7 b	55.7 bB	64.8 abA	61.5 aAB	1	67.8 aB	74.8 aA	69.9 aAB
98Y70	75.7 aA	65.1 aB	70.4 a	74.2 aA	71.5 aAB	65.5 aB	Nov 31			
M-SOY 9144 RR	66.1 bA	54.3 bB	60.2 b	59.8 bA	58.2 bA	62.7 aA	2	58.7 bA	54.9 bA	56.6 bA
Averages	70.8 A	56.7 B	63.8	63.2	64.8	63.2	Dec 15			

Averages followed by the same lowercase letters in the line and lowercase in the column do not differ by Tukey test at 5% probability. Period 1: nov/31/08; Period 2: dec/15/08

Table 7. Average height of first pod insertion (cm) of soybean cultivars in different seeding periods and plant densities in Gurupi – To, in the crop 2008/09.

Cultivars	Period 1	Period 2	Averages	Plant density per linear meter						
	Nov 31	Dec 15		6	10	14	Period	6	10	14
P98Y70	14.0 bA	9.9 bB	11.9 b	12.7 aA	11.3 bA	11.8 bA	1	13.8 aB	17.3 aA	16.0 aA
M-SOY 8766 RR	17.0 aA	13.8 aB	15.4 a	13.3 aB	16.7 aA	16.0 aA	Nov 31			
M-SOY 9144 RR	16.1 aA	15.2 aA	15.7 a	14.3 aB	16.8 aA	16.0 aAB	2	13.1 aA	12.6 bA	13.2 bA
Averages	15.7 A	13.0 B		13.4 B	14.9 A	14.6 A	Dec 15			

Averages followed by the same lowercase letters in the line and lowercase in the column do not differ by Tukey test at 5% probability. Period 1: nov/31/08; Period 2: dec/15/08

the cultivar. On the other side, independent on the cultivar, the densities of 10 and 14 plants provided to cultivars different FPI averages ($p>0.05$) from the averages obtained with the density of 6 plants (Table 6).

The density of 10 plants per linear meter provided to cultivars, in the first seeding period, highest FPI (17.3 cm), being different only from the density of 6 plants (13.8 cm). In all the plant densities it was observed highest FPI in the first seeding period. This confirms the importance of studies of seeding periods and plant densities. In the modern productive system, values of first pod insertion inferior to 12 cm (YOKOMIZO, 1999) may result in losses in the harvest, and, consequently, reduce the gain of the producers. This demonstrates that the use of the cultivar P98Y70, in late seeding, may provide harvest losses.

The highest average of weight of 100 seeds was obtained by the cultivar M-SOY 9144 RR (20.3 g) in the fist seeding period, being different from the one obtained in the second period and also by cultivar M-SOY 8766 RR (15.7 g) in the first period (Table 8). The first seeding period, independent on the cultivar, provided to the cultivars the highest averages of WHS(18.7 g) and independent on the seeding period the average of WHS of the cultivars M-SOY 9144 RR (18.8 g) and P98Y70 (18.2 g) were different from the WHS average of the cultivar M-SOY 8766 RR (14.8 g).

When analyzing the interaction between densities and cultivars, the highest average of WHS was obtained by the cultivar M-SOY 9144 RR in the density of 14 plants (19.3 g), being different from the WHS averages obtained by the other cultivars, in this density. The WHS of the cultivars P98Y70 and M-SOY 9144 RR were different from those obtained by the cultivar M-SOY 8766 RR in the density of 6 and 10 plants. However, there was no significant difference of WHS between plant densities.

The density of 10 plants per linear meter provided to the cultivars, in the first seeding period, higher WHS (19.0 g), being different from the average obtained in the second seeding period (15.0 g). There was significant difference between plant densities only in the second seeding period. The densities of 6 (16.2 g) and 14 plants (16.1 g) provided the best WHS averages, differing from the WHS average obtained in the density of 10 plants (15.0 g), in the second seeding period.

Regarding to the soybean grain productivity (PROD), there was no significant difference between cultivars, in the same seeding period. The highest PROD average obtained by the cultivar M-SOY 9144 RR (3908 kg ha^{-1}), in the first seeding period, differing significantly from the one obtained in the second seeding period (2344 kg ha^{-1}). The same behavior was observed by the other cultivars, i. e., the first period also provided the highest PROD averages (Table 9). The first seeding period, independent on the cultivar, provided the highest PROD averages (38.07 kg ha^{-1}).

The density of 6 plants provided the highest PROD averages (3980 kg ha^{-1}), in the first seeding period, differing significantly from the PROD average obtained in the density of 10 plants, in the same period (3534 kg ha^{-1}). Besides that, it differed from the PROD average observed in the second seeding period, in the density of 6 plants (1887 kg ha^{-1}). Regarding to the productivity averages, independent on the seeding period, the plant densities did not provide significant difference.

Table 8. Average weight of 100 seeds (g) of soybean cultivars in different seeding periods in Palmas – To, in the crop 2008/09.

Cultivards	Period 1	Period 2	Averages	Plant density per linear meter						
	Nov 31	Dec 15		6	10	14	Period	6	10	14
P98Y70	20.1 aA	16.2 aB	18.2 a	19.0 aA	17.8 aA	17.7 bA	1	18.3 aA	19.0 aA	18.8 aA
M-SOY 8766 RR	15.7 bA	13.9 bB	14.8 b	14.5 bA	14.5 bA	15.3 cA	Nov 31			
M-SOY 9144 RR	20.3 aA	17.2 aB	18.8 a	18.3 aA	18.7 aA	19.3 aA	2	16.2 aA	15.0 bB	16.1
Averages	18.7 A	15.8 B		17.28	17.0	17.4	Dec 15			abA

Averages followed by the same lowercase letters in the line and lowercase in the column do not differ by Tukey test at 5% probability. Period 1: nov/31/08; Period 2: dec/15/08

Table 9. Average grain productivity (kg ha^{-1}) of soybean cultivars in different seeding periods and plant densities in Palmas – TO, in the crop 2008/09.

Cultivars	Period 1 Nov 31	Period 2 Dec 15	Averages
P98Y70	3769 aA	2156 aB	2962
M-SOY 8766 RR	3744 aA	2211 aB	2978
M-SOY 9144 RR	3908 aA	2344 aB	3126
Averages	3807 A	2237 B	3022

Periods	Plant densities		
	6	10	14
1 Nov 31	3980 aA	3534 aB	3907 aA
2 Dec 15	1887 bB	2360 bA	2464 bA

Averages followed by the same lowercase letters in the line and lowercase in the column do not differ by Tukey test at 5% probability. Period 1: nov/31/08; Period 2: dec/15/08

The seeding periods performed in Palmas provided to the cultivars the highest differences among each other in almost all the characteristics, with the exception of FPI. This implies that, the success of selection of cultivars in Palmas is more favorable than in Gurupu. However, the best plant development was observed in Gurupi. The plant height in Gurupi was in average 16.93% higher that the one observed in Palmas and the first pod insertion was in average 29.41% higher in Gurupi. Although, it did not influence the compounds of grain productivity, i.e., even as Gurupi have provided further soybean plant development, Palmas provided highest average of weight of a hundred seeds and grain productivity, since the WHS and PROD observed in Palmas were, in average, 7.35 and 11.61% superior to those observed in Gurupi, respectively.

The best soybean plant development, in Gurupi comparing to Palmas, may be due to better rainfall distribution, occurring less intervals without rainfall in Gurupi (Figures 1 and 2). The milder temperature observed in Gurupi also influenced in the better development of the soybean plant, besides the highest relative humidity observed in this municipality. According to TAIZ and ZEIGER (2004), plants absorb and loose water constantly. In order to photosynthesize, plants need to remove carbon dioxide from the atmosphere, but, in doing so, they become exposed to water loss and threat of dehydration, in which most part of the water lost by the plant is evaporated from the leaf. The same authors report that in a sunny day, hot and dry, a leaf

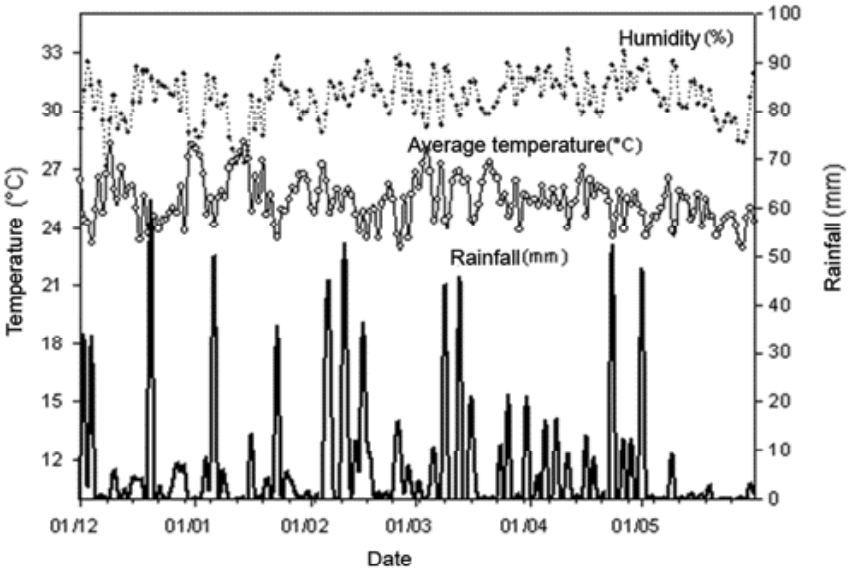

Figure 1. Daily variation of humidity, average temperation and rainfall from november 2008 to may 2009, UFT, Gurupi (TO) – (Source: Climatologic Station from Gurupi – TO).

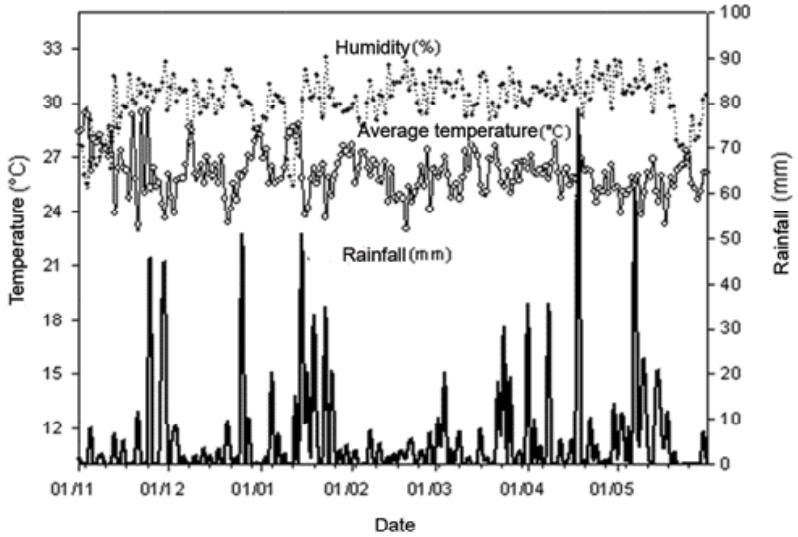

Figure 2. Daily variation of humidity, average temperation and rainfall from november 2008 to may 2009, UFT, Palmas (TO) – (Source: Climatologic Station from Palmas – TO).

will renew until 100% of its water in just an hour.

In Palmas, probably due to climate conditions, there was highest water absorption by soybean plant roots and consequently more absorption of nutrients. With this, even if it is not the most favorable environment for the development of the plant, regarding to climate conditions, the soil fertility allied to a minimum of water in the soil solution and the induction of higher evapotranspiration, provided to cultivars, independent on the densities and seeding periods in Palmas, higher availability of nutrients affecting directly the productivity. The condition of soil fertility in Palmas was superior to Gurupi (P, 56% superior and the concentration of K 60 times higher) and provided not only the highest WHS averages but also the grain productivity averages. With this in mind, we may conclude that the climate conditions provide the cultivars better plant development and the conditions of soil fertility higher WHS and grain productivity, when there is a minimum of water in the soil solution. Another important point is that in extreme edaphoclimatic conditions there is the possibility of selection of cultivars more adapted to these factors, which may be thus used in breeding programs. Therefore, cultivar M-SOY 9144 RR was one of the most productive in the second seeding period in Gurupi, differing from the cultivar M-SOY 8766 RR.

According to GUIMARÃES et al. (2008), plant height is a fundamental characteristic in the determination of the cultivar to be introduced in a region, since it is related to grain yield, control of weeds and losses during the mechanical harvest. The ranges in plant height may be influenced by seeding period, plant spacing between and within rows, water supply, temperature, soil fertility and other general conditions of the environment. However, the PH and FPI observed in the present environment were in average above 60 and 12 cm, being, according to BARROS et al. (2003), acceptable the mechanical harvest.

Conclusions

The soybean cultivars P98Y70, M-SOY 8766 RR and M-SOY 9144 RR have the same behavior, regarding to grain productivity, in the South-Center region of the state of Tocantins;

The first soybean seeding period, independent on the place, is the most indicated for the South-Center of the state of Tocantins;

The densities of 6 and 14 plants per linear meter are the most indicated to obtain the highest soybean grain production in the South-Center region of the state of Tocantins.

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