English Version

Effect of edaphoclimatic changes in South-Central region of the state of Tocantins on grain yield of soybean cultivars

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Abstract

The objective was to evaluate the influence of different times and seeding rates on soybean (*Glycine max* (L.) Merrill.) grain yield in the Central-Southern region of the state of Tocantins. Four trials were installed in the agricultural year 2008/09. The experimental design was randomized blocks 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), and two sowing dates in each of the two municipalities. The first sowing date in Gurupi was December 3 and the second December 18, 2008. In Palmas, the first season was on 31 November and the second on 16 December 2008. The variables evaluated were plant height and insertion of first pod, a hundred seed weight and grain yield. It can be observed that with the delay of sowing date it reduces the grain yield, but the increase of density of planting is dependent on the cultivar and the evaluated characteristics are dependent on the season and the municipality of planting. Palmas offers to the cultivars the highest mean grain yield and to Gurupi the best development of soybean plant.

Key words: *Glycine max*; climate changes; soil fertility

Introduction

The soy bean crop in Brazil has major importance on food production, due to the increasing demand on the inside and foreign market of protein and high quality oil. Soy bean represents, as well, important source of raw material on industry and animal food, and it has wide adaptation to Brazilian conditions (VIDOR e DALL'AGNOL, 2002). Those are the reasons that provided multiple utilizations and the formation of an industrial complex destined to its processing, making it one of the most important "commodities" to generate a favorable balance of trade (SHIGIHARA e HAMAWAKI, 2005).

On the last decade, due to the release of genotypes adapted to the conditions of low latitude by breeding programs, soy presented a significant increase on the cultivated area, on Midwest and North regions. In Brazil Central, it has become the best option of cultivation, and it is responsible for the opening of the cerrado region (ARANTES, 1993; EMBRAPA, 2002).

The sowing date determines the exposition of soy to the limiting climatic changes; therefore sowing in inadequate dates can affect the height, the cycle and the productivity of the plants and increase the crop loss. The best date to sow depends on the cultivar and on the place, what shows the necessity of development of experimental work in different production areas aiming to indicate to the producers the most appropriated time to cultivate soybean and cultivars suited for this region (ODA et al., 2009).

The utilization of recommended cultivars is a practice that provides an increase in the crop production with low additional costs and higher economic return, which makes it important for the socio-cultural improve of the local producer.

The interaction genotypes x environment, i.e., the variation of cultivars behavior through the places and time of sowing makes the cultivar recommendation difficult by the breeder, since a given variety may present high yields in one location over other variety and the opposite occurs in other location, year or planting season.

In this context, the introduction and evaluation experiments of cultivars will provide actual data *in loco* on the cultivar recommendation adapted to the

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edaphoclimatic conditions of the South Central region of Tocantins. These experiments will supply producers with information about the behavior of cultivars from other regions, and may thus indicate them the superior ones, creating the possibility of their use on the institution breeding program.

Based on the hypothesis that to each soybean cultivar there is an indication of an ideal time to sowing, as well as there is among the cultivars one that excels the other, either on the time or the location, the work aimed to evaluate the effects of edaphoclimatic variations on the South Central region of the state of Tocantins on the productivity of soybean cultivars.

Materials and Methods

The experiments were installed on the Experimental Station on the Federal University of Tocantins – Gurupi University Campus, in Gurupi (300 m of altitude, 11° 43' S and 49° 04' W), and in Palmas-TO (280 m of altitude, 12° 45' S and 49° 14 W).

The experiments were: AMB1: Gurupi–TO (DEC/03/08); AMB2: Gurupi–TO (DEC/18/08); AMB3: Palmas–TO (NOV/31/08); AMB4: Palmas–TO (DEC/15/08). Each experiment was constituted of 21 cultivars, sent by public and private seed producers.

The chemical characteristics of the soil, sampled to a depth of 0-20 cm, in the municipality of Gurupi – TO was: 0,0 of Al^{3+} ($mmol_c\ dm^{-3}$); 2,1 of Ca^{2+} ($mmol_c\ dm^{-3}$); 0,6 of Mg^{2+} ($mmol_c\ dm^{-3}$); 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: 0,0 of Al^{3+}($mmol_c\ dm^{-3}$); 2,3 dof Ca^{2+} ($mmol_c\ dm^{-3}$); 1,2 of Mg^{2+} ($mmol_c\ dm^{-3}$); 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 was randomized blocks, with the plot constituted by four rows of five meters, spaced by 0.4 meters. On the harvest, it was despised 0.5 meters of the end of each central row. The useful area of the plot was 3.6 m^2.

The fertilizer utilized was 400 kg ha^{-1} of 05-25-15 fertilizer. It was performed as well fertilization in the covering with Potassium chloride 90 kg ha^{-1}. In the moment of plantation, it was effected the inoculation of the seed with strains of *Bradyrhizobium japonicum*, aiming to obtain a good nodulation on the roots of the plant, guaranteeing the nitrogen supply to the crop.

It was performed the control of the broadleaf weeds with herbicide 15 days after the culture germination and narrow leaves herbs 30 days after the culture germination. In each 15 days it was sprayed fungicide and insecticide.

The density of seeding was calculated aiming to obtain 14 plants per meter. In the plots which presented a higher number than the expected, it was performed a thinning 15 days after the emergence.

The plants from each experimental plot were harvested one week after they presented 95% of dry pods, i.e., R8 range of Fehr et al. (1971) stage. After the harvesting, the plants were threshed and seeds weighted, after being dried (12% of humidity) and cleaned, to determine the grain yields.

Based on the useful area of the plot, it was obtained the following agronomic characteristics of the plants:

a) Number of days to flowering (DF) – number of days, counted from the emergence until an open flower on the main stem occurs on 50% of the plants of the spot;

b) Number of days to the maturation (DM) – number of days, counted from the emergence, until the plants present 95% of mature pods;

c) Height of the first pod insertion (AV) – distance, in cm, measured from the soil surface to the first pod, obtained on the maturation period, in 10 plants of the useful area.

d) Plant height (AP) – distance, in cm, measured from the soil surface to the end of the main stem, on maturation period, in 10 plants of the useful area.

e) Grain production (PG) – weight obtained, in grams per spot, and transformed to kg ha^{-1}, after the grain drying until approximately 12% of humidity.

After the obtaining of data, it was performed an analysis of variance in each characteristic. Subsequently, it was analyzed the individual variance, and then a joint analysis of the experiments that showed homogeneity on the variance. On the significant interactions were performed the decomposition, with the joint of averages made by Scott and Knott test at 5% probability.

Results and Discussion

In all the characteristics there was a significant effect (p≤0.01) of the interaction between cultivars and environments (periods and location of sowing), which indicates that the effects of the environment and cultivars are not enough to explain all the variations found. In these cases, It was made a decomposition. The isolated factors were also significant in the characteristics (p≤0.01). The Coefficient of Variation in all characteristics was low, ranging from 1.36 to 12.34% (Table 1). According to Scapim (1995), coefficients of variation below 20% represent medium to high experimental precision.

In the first environment (AMB1), the cultivar M8766RR obtained the highest AP average (90.7 cm), with no difference (p>0.05) from the cultivar CM-017 (85.6 cm) and cultivar M8527RR (84.5 cm). Regarding to the environment of sowing, the height of the cultivar M8766RR was the same as the AP observed on AMB2, and it was only different (p≤0.05) to the environment of Palmas (AMB 3 and 4).The cultivars grouped with higher AP averages were P98Y70 (71.2 cm), M8766RR (75.6 cm), M-SOY 9056 (72.5 cm), M-SOY 8360 (75.4 cm), FTS-ESPERANÇA RR (74.8 cm), FTS-4188 (79.8 cm), CM-017 (78.8 cm) e CM-149 (71.3), which are superior to the other cultivars. However, the lower plain heights obtained on this experiment present mechanic harvest patterns (Table 2). According to Barros et al. (2003), the ideal height of the soybean plant on mechanical harvest, under the conditions of cerrado, is higher then 50 cm.

The sowing provided on December 3rd (AMB – 74.3 cm) and December 18th (AMB2 – 70.4 cm), both in Gurupi, were appropriated to the plan development, since the measure of the heights obtained on these environments was relatively higher then those obtained on other environments (Palmas 1 and Palmas 2) (Table 2).

In AMB1, the cultivars which were noteworthy with the highest height of insertion of the first pod (AIV) were CM-015 (20.3 cm), M9144RR (20.1 cm), M-SOY 9056 (19.3 cm), CM-149 (19.3 cm) M8766RR (19.1 cm), M8360RR (18.8 cm) and M8867RR (18.5 cm), with a difference (p≤0,05) from the inferior averages. In AMB2, the cultivar M8766RR (32 cm) presented the best AIV average, and maintained constant AIV when cultivated in other environments (AMB1, AMB3 and AMB4). On AMB3 and AMB4 the cultivars P 98Y91, CM-017 and CM-102 maintained good AIV averages (16.7 and 20 cm), (16.3 and 17.8) and (17 and 17.1 cm), respectively. The cultivars that showed higher AIV averages, independent of the environments, were M8766RR (22.4 cm), P98R91 (21.4 cm), FTS-4188 (21.3 cm), CM-017 (20.4 cm), MSOY 9056 (19.1 cm) e M8360RR (18.9 cm) (Table 3). The second environment provided the highest AIV values, independent on the cultivars, ranging from 20.1 to 32.0 cm, which showed to be more able to plant development, both in AP and AIV.

The cultivars P98Y70, M8766RR, M9144RR, ENGOPA-314, P98R91, MSOY 9988, MSOY 8867, M9056RR, M8360RR, FTS-ESP, FTS-4188, CM-017, CM-102 e M-SOY 9350 presented

Table 1. Summary of the analysis of joint variance, in randomized blocks, of 21 commercial soybean cultivars characteristics on experiments in Gurupi and Palmas-TO municipalities on 2008/2009 crops.

FV	GL	Mean square				
		AP	AIV	NDF	NDM	PROD
BLOCK/AMB	8	60.3	2.2	1.0	2.9	89044
CULTIVARS (C)	20	60.3**	37.5**	44.7**	95.0**	1680365**
ENVIRONMENT (A)	3	2475.8**	1047.2**	90.5**	9509.9**	72357352**
C x A	60	105.8**	18.8**	33.2**	58.1**	513378**
RESIDUE	160	32.2	3.1	0.5	2.9	118653
Average		68.6	17.2	45.5	116.9	2790
CV (%)		8.3	10.2	1.5	1.5	12.3

*** significant by test of F at 1% probability. AP: Plant height; AIV: height of insertion of the first pod; NDF: number of days to flowering; NDM: number of days to maturation; PROD: grain productivity (kg ha $^{-1}$).*

Table 2. Plant height average of soybean cultivars on experiments conducted on different places and sowing periods in Gurupi and Palmas-TO municipalities on 2008/09 crop

CULTIVARS	PLANT HEIGHT(cm)														
	AMB1			AMB2			AMB3			AMB4			AVERAGE		
P98Y70	77.2	b	A	81.1	a	A	65.5	b	B	55.8	b	C	71.2	A	
M8766RR	90.7	a	A	84.8	a	A	68.2	b	B	54.7	b	C	75.6	A	
M9144RR	86.5	a	A	67.6	b	B	62.4	b	B	53.3	b	C	69.2	B	
ENGOPA-314	66.8	c	A	68.3	b	A	66.6	b	A	60.5	a	A	65.1	B	
P98R91	64.2	c	A	65.6	b	A	69.0	b	A	64.1	a	A	66.6	B	
P98Y51	52.0	d	B	60.8	b	A	63.2	b	A	54.7	b	B	57.8	B	
MSOY -9988	76.3	b	A	70.6	b	A	72.6	a	A	57.3	b	B	67.0	B	
P99R01	64.5	c	A	62.7	b	A	70.2	b	A	54.8	b	B	62.3	B	
M8867RR	73.3	b	A	67.2	b	A	65.3	b	A	51.2	b	B	65.2	B	
M9056RR	79.0	b	A	77.5	a	A	78.8	a	A	58.2	b	B	72.5	A	
M8527RR	84.5	a	A	63.9	b	B	68.0	b	B	50.9	b	C	66.9	B	
M8360RR	78.9	b	A	68.6	b	B	80.8	a	A	67.4	a	B	75.4	A	
FTS-ESPERANÇA RR	72.3	b	B	75.6	a	A	74.7	a	A	60.8	a	B	74.8	A	
FTS-4188	88.3	a	A	75.9	a	B	78.8	a	B	62.4	a	C	79.8	A	
CM-015	68.6	c	A	71.8	b	A	66.1	b	A	65.7	a	A	68.7	B	
CM-017	85.6	a	A	75.5	a	A	79.1	a	A	75.3	a	A	78.8	A	
CM-136	59.1	d	A	61.3	b	A	67.0	b	A	52.8	b	B	58.5	B	
CM-149	78.4	b	A	74.3	a	A	72.0	a	A	62.8	a	B	71.3	A	
CM-102	62.4	c	A	66.1	b	A	62.9	b	A	67.0	a	A	63.9	B	
A-7002	75.3	b	A	68.4	b	A	68.2	b	A	62.9	a	A	67.9	B	
M-SOY 9350	76.8	b	A	71.5	b	A	67.6	b	B	60.0	a	B	68.1	B	
AVERAGE	74.3		A	70.4		A	69.9		A	59.6		B	68.9		

Average followed by the same lowercase letters on columns and uppercase on the lines constitute a group statistically homogeny, by Scott and Knott test, at 5% of probability. AMB1: Gurupi – TO (Sowing on Dec/03/08); AMB2: Gurupi – TO (Sowing on Dec/ 18/08); AMB3: Palmas – TO (Sowing on Nov/31/08); AMB4: Palmas – TO (Sowing on Dec/15/08).

average of flowering days (NDF) ranging from 47 and 48 days, in the first environment (sowing on 12/03/08, in Gurupi), with a difference ($p \leq 0,05$) from the other cultivars with earlier flowering. In the second environment, by contrast, the cultivars M9144RR (46 days), M-SOY 9988 RR (46 days), M-SOY 8867 RR (46 days), FTS-ESPERANÇA RR (46), FTS-4188 (47 days) and M-SOY 9350 (47 days) were later. In general, there was a decrease on the number of days over the flowering on planting periods. The later cultivars, independent of the environment, were the cultivars ENGOPA-314 (48 days), M-SOY 9988 (48 days), M-SOY 8867 (48 days), M-SOY 9056 (48 days), FTS-ESP (48 days), FTS-4188 (49 days), CM-015 (48 days) and MSOY 9350 (49 days) (Table 4).

The cultivars which show later cycles, on AMB1, were P98Y70 (122 days), M-SOY 9144 (124 days), EMGOPA 314 (124 days), M-SOY 8867 (125 days) and M-SOY 9350 (123 days). The cultivar M-SOY 9056, on AMB4, was the one which obtained the later cycle among the cultivars and the environment. The second sowing period in Palmas, independent on the cultivar, provided greater soybean plant cycles. The average number of days to maturation (NDM), on AMB4, ranged from 126 to 136 days. The cultivars CM-015 (112 days), CM-136 (113 days) e CM-102 (113 days), independent on the environment, were the earlier ones (Table 5).

In the first environment (12/03/08), the cultivars which presented greater average of grain productivity were ENGOPA 314 (3389 kg ha^{-1}), P98R91 (3548 kg ha^{-1}), M-SOY 9988 (3665 kg ha^{-1}), M-SOY 8527 (3847 kg ha^{-1}) and M-SOY 9350 (3569 kg ha^{-1}). In the second environment the cultivar M-SOY 9144 obtained the higher PROD average

Table 3. Height of insertion of the first pod of soybean cultivars on experiments conducted on different sowing locations and periods in Gurupi and Palmas-TO municipalities, on 2008/09 crop.

CULTIVARS	HEIGHT OF INSERTION OF THE FIRST POD (CM)														
	AMB1			AMB2			AMB3			AMB4			AVERAGE		
P98Y70	14.7	b	B	26.3	b	A	13.1	b	B	14.1	b	B	18.5	B	
M8766RR	19.1	a	B	32.0	a	A	15.0	a	C	17.0	a	C	22.4	A	
M9144 RR	20.1	a	A	22.0	c	A	15.8	a	B	14.8	b	B	19.7	A	
ENGOPA 314	11.4	c	B	18.9	d	A	12.2	b	B	10.3	d	B	15.0	B	
P98R91	13.2	c	D	29.0	b	A	16.7	a	C	20.0	a	B	21.4	A	
P98Y51	10.5	c	B	23.7	c	A	12.7	b	B	13.2	c	B	16.0	B	
MSOY -9988	17.1	a	A	18.6	d	A	16.3	a	A	13.5	c	B	18.3	B	
99R01	11.1	c	C	20.9	d	A	15.4	a	B	15.2	b	B	16.8	B	
M8867RR	18.5	a	A	20.2	d	A	14.2	b	B	9.6	d	C	16.7	B	
MSOY -9056	19.3	a	A	20.1	d	A	17.0	a	B	14.3	b	B	19.1	A	
MSOY -8527	15.5	b	B	22.1	c	A	15.4	a	B	12.2	c	C	18.1	B	
M8360RR	18.8	a	B	23.0	c	A	14.3	b	C	15.1	b	C	18.9	A	
FTS-ESPERANÇA RR	15.6	b	B	24.3	c	A	13.4	b	B	13.1	c	B	18.2	B	
FTS-4188	18.4	a	B	27.9	b	A	19.1	a	B	13.4	c	C	21.3	A	
CM-015	20.3	a	B	23.7	c	A	12.1	b	C	14.7	b	C	19.3	A	
CM-017	15.6	b	B	28.1	b	A	16.3	a	B	17.8	a	B	20.4	A	
CM-136	16.1	b	B	22.0	c	A	14.6	b	B	14.9	b	B	17.6	B	
CM-149	19.3	a	A	20.4	d	A	13.3	b	B	15.6	b	B	18.7	B	
CM-102	15.2	b	B	22.5	c	A	17.0	a	B	17.1	a	B	18.6	B	
A-7002	16.3	b	B	20.1	d	A	11.6	b	C	15.4	b	B	15.6	B	
MSOY -9350	17.7	a	B	21.2	d	A	11.7	b	D	15.5	b	C	17.5	B	
AVERAGE	16.4		B	23.2		A	14.6			14.6		B	18.5		

Average followed by the same lowercase letters on columns and uppercase on the lines constitute a group statistically homogeny, by Scott and Knott test, at 5% of probability. AMB1: Gurupi – TO (Sowing on Dec/03/08); AMB2: Gurupi – TO (Sowing on Dec/ 18/08); AMB3: Palmas – TO (Sowing on Nov/31/08); AMB4: Palmas – TO (Sowing on Dec/15/08).

(2375 kg ha^{-1}); however, it did not differ from the ones which obtained PROD averages above 1813 kg ha^{-1}. The first sowing period in Palmas (AMB3), independent on the cultivar, provided the highest PROD averages (4223 kg ha^{-1}). In this environment (AMB3) it was obtained by cultivar P98R91 the highest average of grain production (5050 kg ha^{-1}), however, it did not differ from the cultivars which obtained averages above 4521 kg ha^{-1}.

The highest averages on grain production, independent on the environment, were obtained by cultivars A-7002 (3048 kg ha^{-1}), M-SOY 8527 (3028 kg ha^{-1}), FTS-4188 (3102 kg ha^{-1}), M-SOY 9350 (2911 kg ha^{-1}), M-SOY 9988 (2663 kg ha^{-1}), P98Y51 (2722 kg ha^{-1}), P98R91 (2784 kg ha^{-1}), Engopa 314 (2938 kg ha^{-1}), M-SOY 9144 (2981 kg ha^{-1}), M8766RR (2858 kg ha^{-1}) and P98Y70 (2657 kg ha^{-1}). The first sowing periods, independent on the location, are the most indicated to the soybean harvest on the South Center region of the state of Tocantins.

Similar results were observed by Barros et al. (2003), who also found in their experiments that the ideal sowing period under the conditions of the South of the state of Tocantins is around the end of November or the beginning of December. Others sowing dates provide a decrease on the productivity, which makes them unviable.

The best plant development was observed in Gurupi. The height of the soybean plant in Gurupi was on average 16.93% higher than the one observed in Palmas and the height of insertion of the first pod

Table 4. Average of soybean cultivar flowering on the experiments conducted on different sowing locations and periods in Gurupi and Palmas – TO municipalities on 2008/09 crop

CULTIVARS	FLOWERING (DAYS)																	
	AMB1			AMB2			AMB3			AMB4			AVERAGE					
P98Y70	48	a	A	45	b	B	46	g	B	46	b	B	47	b				
M8766RR	48	a	A	45	b	B	33	i	C	45	c	B	44	c				
M-SOY 9144	47	a	A	46	a	B	32	i	C	46	b	B	44	c				
ENGOPA-314	48	a	B	44	c	C	58	a	A	44	c	C	48	a				
P98R91	48	a	A	44	c	D	47	f	B	45	c	C	46	b				
P98Y51	45	b	B	43	c	C	48	e	A	44	c	C	46	c				
M-SOY 9988	48	a	B	46	a	C	50	d	A	46	a	C	48	a				
P99R01	41	c	B	44	c	A	45	h	A	45	c	A	45	c				
M-SOY 8867	48	a	B	46	a	C	51	c	A	44	c	D	48	a				
M-SOY 9056	47	a	B	44	c	C	54	b	A	44	c	C	48	a				
M-SOY 8527	41	c	B	44	c	A	45	h	A	44	c	A	45	c				
M-SOY 8360	48	a	A	44	c	C	47	f	B	44	c	C	47	b				
FTS-ESPERANÇA RR	47	a	B	46	a	C	50	d	A	47	a	B	48	a				
FTS-4188	48	a	B	47	a	C	54	b	A	44	c	D	49	a				
CM-015	46	b	B	44	c	D	54	b	A	45	c	C	48	a				
CM-017	48	a	A	45	b	B	45	g	B	45	c	B	47	b				
CM-136	40	c	B	44	c	A	45	h	A	45	c	A	44	c				
CM-149	46	b	A	45	b	B	46	g	A	44	c	B	46	b				
CM-102	47	a	A	45	b	B	47	f	A	45	b	B	46	b				
A-7002	41	c	C	44	c	B	45	h	A	43	c	B	44	c				
M-SOY 9350	48	a	B	47	a	C	52	c	A	47	a	C	49	a				
AVERAGE	46		B	44		C	47		B	45		C	46					

Average followed by the same lowercase letters on columns and uppercase on the lines constitute a group statistically homogeny, by Scott and Knott test, at 5% of probability. AMB1: Gurupi – TO (Sowing on Dec/03/08); AMB2: Gurupi – TO (Sowing on Dec/18/08); AMB3: Palmas – TO (Sowing on Nov/31/08); AMB4: Palmas – TO (Sowing on Dec/15/08).

was on average 29.41% higher in Gurupi. Although, it had no influence on the components of grain productivity, i.e., even if Gurupi had the greater soybean plant development, Palmas provided higher grain yield, since the yield observed in Palmas were on average 11.61% higher than the observed in Gurupi.

The greater soybean plant development, in Gurupi relating it to Palmas, may be due to the best rainfall distribution, with shorter intervals without precipitation occurring in Gurupi (Figures 1 and 2). The warmer temperatures and the higher relative humidity observed in Gurupi also influenced the better development of the soybean plant. According to Taiz and Zeiger (2004), plants absorb and lose water constantly. To photosynthesize, plants need to remove carbon dioxide from the atmosphere, however, in doing so, they expose themselves to water loss and threat of dehydration. Most of the water lost by the plant evaporates from the leaf.

The same authors report that in a sunny day, hot and dry, a leaf renews up to 100% of its water in only one hour.

In Palmas, probably due to climatic conditions, there was higher water absorption by soybean roots and consequently higher absorption of nutrients. Thus, even if it is not the most favorable environment to plant development, due to climatic characteristics, the soil fertility allied to the minimum of water on the soil solution and the induction of bigger evapotranspiration, provided the cultivars, independent on the sowing period in Palmas, greater nutrient availability affecting directly the productivity. The soil fertility condition in Palmas was superior to the one in Gurupi (P, 56% superior and

Table 5. Average of soybean cultivar maturation on the experiments conducted on different sowing locations and periods in Gurupi and Palmas – TO municipalities on 2008/09 crop

CULTIVARS	MATURATION (DAYS)														
	AMB1			AMB2			AMB3			AMB4			AVERAGE		
P98Y70	122	a	B	104	a	D	116	b	C	132	a	A	116	a	
M8766RR	114	d	B	103	b	C	91	d	D	128	c	A	108	d	
M-SOY 9144	124	a	A	106	a	B	91	d	C	126	c	A	110	d	
ENGOPA 314	124	a	B	103	b	D	119	a	C	133	a	A	116	a	
P98R91	121	b	B	103	a	D	118	a	C	134	a	A	116	a	
P98Y51	119	b	B	103	b	C	117	b	B	128	c	A	114	b	
M-SOY 9988	118	c	B	102	b	C	116	b	B	133	a	A	115	b	
P99R01	120	b	B	104	a	C	118	a	B	134	a	A	116	a	
M-SOY 8867	125	a	B	103	b	D	118	a	C	133	a	A	117	a	
M-SOY 9056	120	b	B	105	a	C	118	a	B	136	a	A	117	a	
M-SOY 8527	117	c	B	102	b	C	118	a	B	130	b	A	114	b	
M-SOY 8360	117	c	B	103	b	C	114	c	B	130	b	A	114	b	
FTS-ESPERANÇA RR	119	b	B	105	a	D	116	b	C	133	a	A	115	a	
FTS-4188	116	c	B	105	a	C	118	a	B	134	a	A	116	a	
CM-015	111	e	B	100	b	C	112	c	B	135	a	A	112	c	
CM-017	114	d	B	100	b	C	116	b	B	135	a	A	114	b	
CM-136	115	c	B	101	b	C	113	c	B	132	a	A	113	c	
CM-149	114	d	B	101	b	C	115	b	B	135	a	A	114	b	
CM-102	111	e	C	101	b	D	116	b	B	133	a	A	113	c	
A-7002	119	b	B	102	b	C	119	a	B	135	a	A	116	a	
M-SOY 9350	123	a	B	105	A	C	121	a	B	134	a	A	117	a	
AVERAGE	118		B	103		D	114		C	133		A	114		

Average followed by the same lowercase letters on columns and uppercase on the lines constitute a group statistically homogeny, by Scott and Knott test, at 5% of probability. AMB1: Gurupi – TO (Sowing on Dec/03/08); AMB2: Gurupi – TO (Sowing on Dec/18/08); AMB3: Palmas – TO (Sowing on Nov/31/08); AMB4: Palmas – TO (Sowing on Dec/15/08).

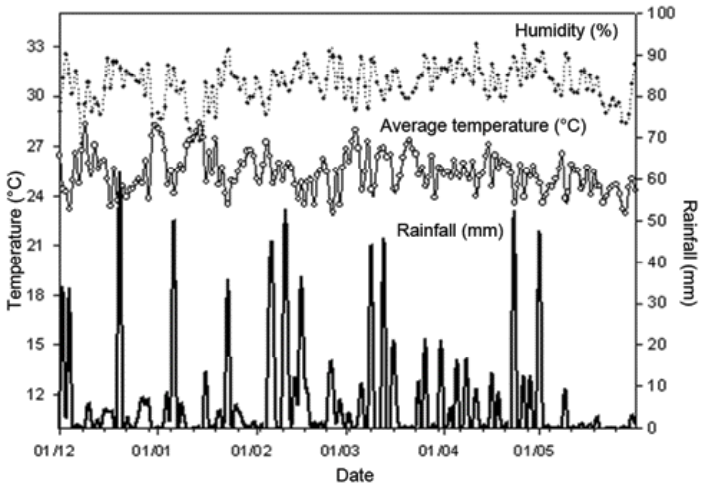

Figure 1. Daily humidity evaporation, average air temperature and rainfall from November 2008 to May 2009, UFT, Gurupi (TO) – (SOURCE: Gurupi Climate Station – TO).

Table 6. Average of productivity of soybean cultivar grains on the experiments conducted on different sowing locations and periods in Gurupi and Palmas – TO municipalities on 2008/09 crop

CULTIVARS	GRAIN PRODUCTIVITY (kg ha^{-1})														
	AMB1			AMB2			AMB3			AMB4			AVERAGE		
P98Y70	2965	b	B	2259	a	C	3892	B	A	2475	b	C	2657	a	
M8766RR	2911	b	B	1813	a	C	4750	a	A	2742	b	B	2858	a	
M-SOY 9144	2579	c	C	2375	a	C	4850	a	A	3333	a	B	2981	a	
ENGOPA 314	3389	a	B	1862	a	D	4983	a	A	2600	b	C	2938	a	
P98R91	3548	a	B	1714	b	C	5050	a	A	1942	c	C	2784	a	
P98Y51	2937	b	B	1436	b	D	4954	a	A	2350	b	C	2722	a	
M-SOY 9988	3665	a	A	1956	a	B	3713	B	A	2300	b	B	2663	a	
P99R01	2613	c	B	1639	b	C	4192	B	A	2333	b	B	2552	b	
M-SOY 8867	3151	b	B	2351	a	C	3758	B	A	1808	c	C	2493	b	
M-SOY 9056	3281	b	B	1684	b	C	3996	B	A	1717	c	C	2513	b	
M-SOY 8527	3847	a	B	1870	a	D	4758	a	A	2467	b	C	3028	a	
M-SOY 8360	3145	b	B	1533	b	C	4008	B	A	1867	c	C	2521	b	
FTS-ESPERANÇA RR	2135	d	B	1892	a	B	4975	a	A	1988	c	B	2515	b	
FTS-4188	3100	b	B	2258	a	C	4942	a	A	2542	b	C	3102	a	
CM-015	2425	c	B	1554	b	C	3950	B	A	2158	c	B	2294	b	
CM-017	2725	c	B	1135	c	D	3317	c	A	1954	c	C	2158	b	
CM-136	1622	d	B	661	c	C	3933	B	A	1783	c	B	1859	b	
CM-149	2462	c	B	1620	b	C	3225	c	A	1958	c	C	2204	b	
CM-102	2415	c	A	1369	b	B	2850	c	A	1792	c	B	2117	b	
A-7002	3184	b	B	2240	a	C	4521	a	A	2442	b	C	3048	a	
M-SOY 9350	3569	a	A	1556	b	C	4058	B	A	2679	b	B	2911	a	
AVERAGE	2937		B	1751		C	4223		A	2249		C	2615		

Average followed by the same lowercase letters on columns and uppercase on the lines constitute a group statistically homogeny, by Scott and Knott test, at 5% of probability. AMB1: Gurupi – TO (Sowing on Dec/03/08); AMB2: Gurupi – TO (Sowing on Dec/18/08); AMB3: Palmas – TO (Sowing on Nov/31/08); AMB4: Palmas – TO (Sowing on Dec/15/08).

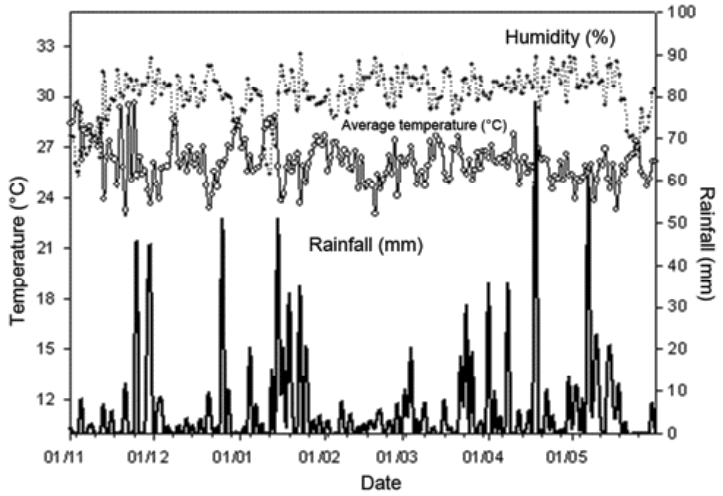

Figure 2. Daily humidity variation, average air temperature and rainfall from November 2008 to May 2009, UFT, Palmas (TO) – (SOURCE: Palmas Climate Station)

K concentration was 60 times higher) and provided the highest averages on grain production.

In accordance with Araújo et al. (2005), high levels of phosphorus (270 kg ha^{-1}) provide higher productivity of soybean grains, as well as more encouragement to nodulation, namely, higher probability of nitrogen fixation and higher response to P, since N response is directly proportional to phosphorus fertilization (NOVAIS e SMYTH 1999). Thus, climate conditions provide the cultivars best plant development and soil fertility condition increased grain productivity, when there is a minimum of water on the soil solution. Another important point is that in edaphoclimatic extreme conditions there is the possibility of selecting cultivars more adapted front these factors, and my be thus used in breeding programs.

According to Guimarães et al. (2008) the height of the plant is a major characteristic on the determination of the cultivar introduced to a region, since it is related to the grain yield, control of weeds and loss during mechanical harvest. The variation on the plant height may be influenced by the sowing period, spacing of plants between and within the ranks, water supply, temperature, soil fertility and other general conditions of the environment. However, the AP and the AIV observed in this environment were on average above 60 and 12 cm, and, according to Barros et al. (2003), it is acceptable to have the mechanized harvesting.

Conclusions

As there is a delay on the sowing there is a decrease on the number of days to flowering and soy maturation.

The sowing period influences the height of insertion of the first pod.

The cultivars M8527RR, A-7002, FTS-4188, M-SOY 9350, P98Y70, M8766RR, M9144RR, ENGOPA 314, P98R91, P98Y51 and M-SOY 9988 RR are indicated to the soybean harvest on the South Center of the state of Tocantins.

The soybean cultivars M8527RR, ENGOPA 314, M-SOY 9350 and M-SOY 9988 RR are indicated to the sowing on the first period on the South region of the state of Tocantins.

The soybean cultivars P98Y70, M8766RR, M-SOY 9144, ENGOPA 314, M-SOY 9988, M-SOY 8867, M-SOY 8527, FTS-ESP, FTS-4188 and A-7002 are indicated to sowing on the second period on the South region of the state of Tocantins.

The soybean cultivars M8766RR, M-SOY 9144, ENGOPA 314, P98R91, P98Y51, M-SOY 8527, FTS-ESP, FTS-4188 and A-7002 are indicated to sowing on the first period on the Center region of the state of Tocantins

The soybean cultivar M9144RR is the most indicated to sowing on the second fortnight of December, on the South Center region of the state of Tocantins.

The soybean sowing period which provides the cultivars the highest grain productivity average in Gurupi – TO is December 3rd.

The soybean sowing period which provides the cultivars the highest grain productivity average in Palmas – TO is November 31st.

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