



# RICE DROUGHT PHENOTYPING FOR MODELING

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**Embrapa**  
Arroz e Feijão

Ministério da  
Agricultura, Pecuária  
e Abastecimento

**BRASIL**  
UM PAÍS DE TODOS  
GOVERNO FEDERAL

## INTRODUCTION

**Drought occurs generally in major rice producing regions of Brazil, which occasionally causes severe crop losses. To cope with this problem, it is desirable to develop drought resistant rice cultivars.**

**Knowledge of physiological variability of drought resistance and modeling the rice to find out the effect of the main physiological parameter on rice adaptation to drought can increase breeding efficiency on developing such cultivars.**

**Two experiments were conducted at Embrapa Rice & Beans Research Center, Santo Antônio de Goiás-Goiás, Central parte of Brazil, where rainy season is from October to April. Three experiments, with and without drought stress, were conducted during the dry season, at AGENCIARURAL Experimental Station, Porangatu-Goiás.**

**Experimental plots:** Nine rows of 6m long and 0.35m inter-row at Santo Antônio and 0.4m at Porangatu.

**Plant density:** 20 plants per meter linear

**Fertilization:** 16 kg ha<sup>-1</sup> N, 120 kg ha<sup>-1</sup> P<sub>2</sub>O<sub>5</sub>, 64 kg ha<sup>-1</sup> K<sub>2</sub>O and 5 kg ha<sup>-1</sup> Zn.

**Topdressing:** 20 and 30 kg N ha<sup>-1</sup>, 40 and 55 days after sowing, respectively, at Santo Antônio, and 30 kg N ha<sup>-1</sup>, at pre-heading, at Porangatu.

**Weeds control:** 1 kg ha<sup>-1</sup> of oxadiazon.

## Genotypes:

**BRS Soberana,  
BRS Curinga,  
Primavera,  
Guarani, and  
CNA 9019.**

These genotypes present different plant type growth  
> modern - with erects leaves and  
> traditional - with droopy leaves.  
They also present different response to drought stress.

All of these are japonica type,  
having similar growth cycle,  
except BRS Curinga -longer

## WATER MANAGMENT

In well-irrigated treatment, the soil water potential was maintained higher than  $-0.025$  MPa, at 15 cm depth (Stone et al., 1988) during the plant growth, while in drought stress treatment, natural weather conditions were maintained. However, under severe drought stress (dry season Porangatu 2006, 2007) the experiments were well irrigated until 30 days after emergence and then a moderate drought stress was applied, with the application of 50% of water applied to well irrigated plants up to harvest (soil water potential about  $-0.07$  MPa).

Exp overview- planting  
date: 05/12/2006

Irrigation system



## SETS OF DATA COLLECTED:

### Phenology characterization based on four plants (weekly)

- . N° Green and dead leaves (MS),
- . N° ligulated green leaves (MS),
- . Expanding leaves fraction (MS),
- . Length and width of last ligulated leaf (MS),
- . Height - from soil to tip of panicle (MS),
- . Total number of tillers per plant,
- . Total number of green leaves (MS + tiller)

## Growth analysis based in one meter (20, 50, and 75 DAP and at physiological maturity)

- . **Tiller number**
- . **Blade area**
- . **Blade dry weight**
- . **Plant dry weight**

**NOTE: At the physiological maturity 100 grain weight, tiller fertility, spikelets sterility and yield were also determined.**

## **Physicals and chemicals properties of the soil.**

**Bulk density, % silt, % clay, % sand, water saturation, field capacity, permanent wilting point, C, N, P, K, Al, Ca, Mg, Zn, Cu, Fe, Mn, and CEC at 0-20, 20-40, 40-60 and 60-80 cm soil depths, respectively.**

**Soil moisture was determined weekly interval using just one replication of all genotypes on well irrigated and with drought stress.**



**Planting date: 01/11/2006**



**Planting date: 02/16/2006**



**Planting date: 01/11/2006**

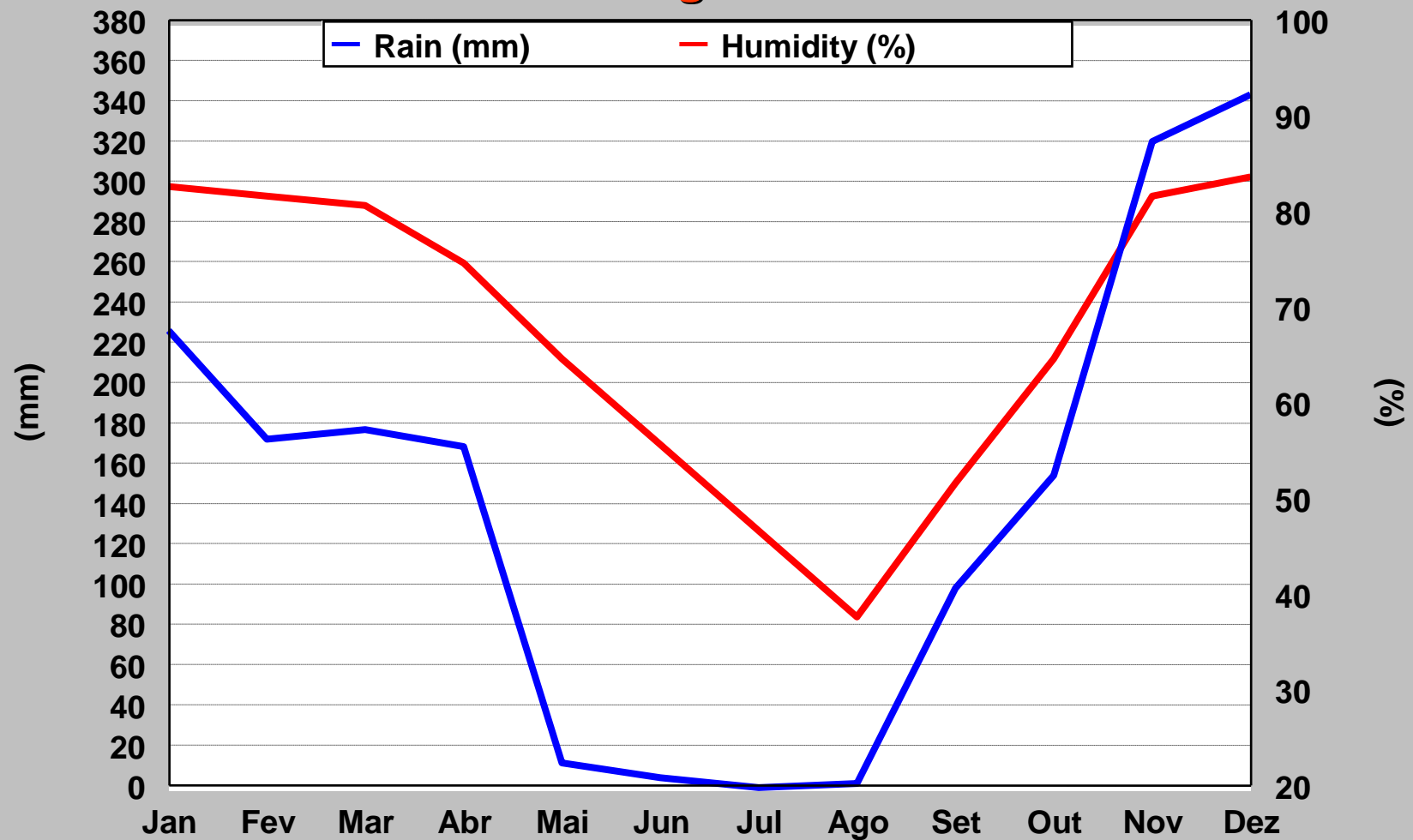


**Planting date: 05/12/2006**



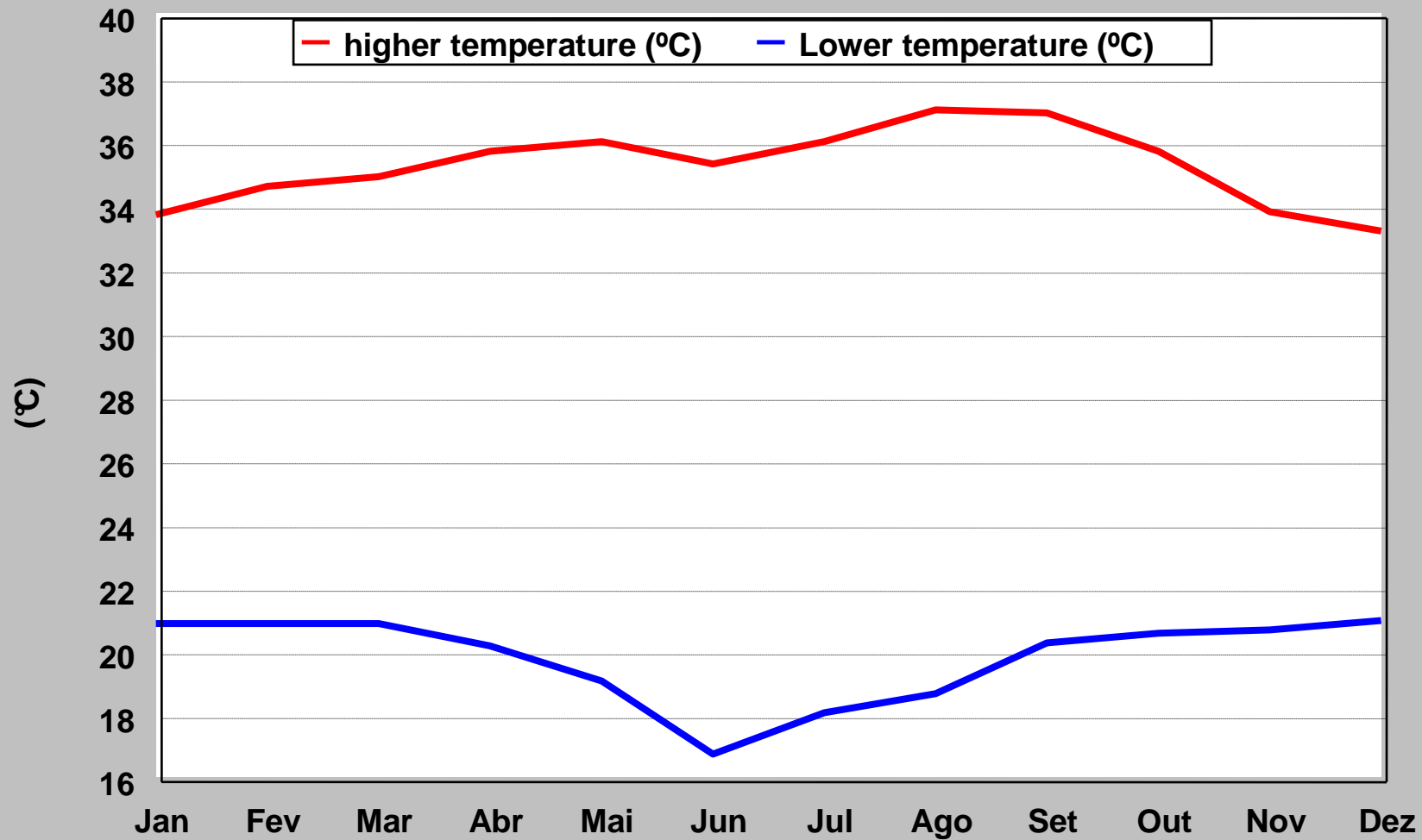
**Planting date: 06/11/2006**

## Rain distribution and humidity Porangatu-GO



## Higher and lower temperature

### Goiânia - GO



## pH and levels of Al, macro and micronutrients, Porangatu, GO

Depth (cm)	pH	Al	Ca (cmol dm <sup>-3</sup> )	Mg	P (mg dm <sup>-3</sup> )	K
0-20	5.5	0.1	1.6	0.5	2.9	59
20-40	5.2	0.1	0.5	0.2	0.6	32
40-60	5.3	0.0	0.4	0.2	0.4	22
60-80	5.3	0.0	0.3	0.2	0.3	14

Depth (cm)	Cu	Zn (mg dm <sup>-3</sup> )	Fe	Mn	Organic matter (g dm <sup>-3</sup> )
0-20	0.8	0.8	46	31	19
20-40	0.6	0.2	33	10	11
40-60	0.5	0.1	25	8	8
60-80	0.4	0.1	24	7	5

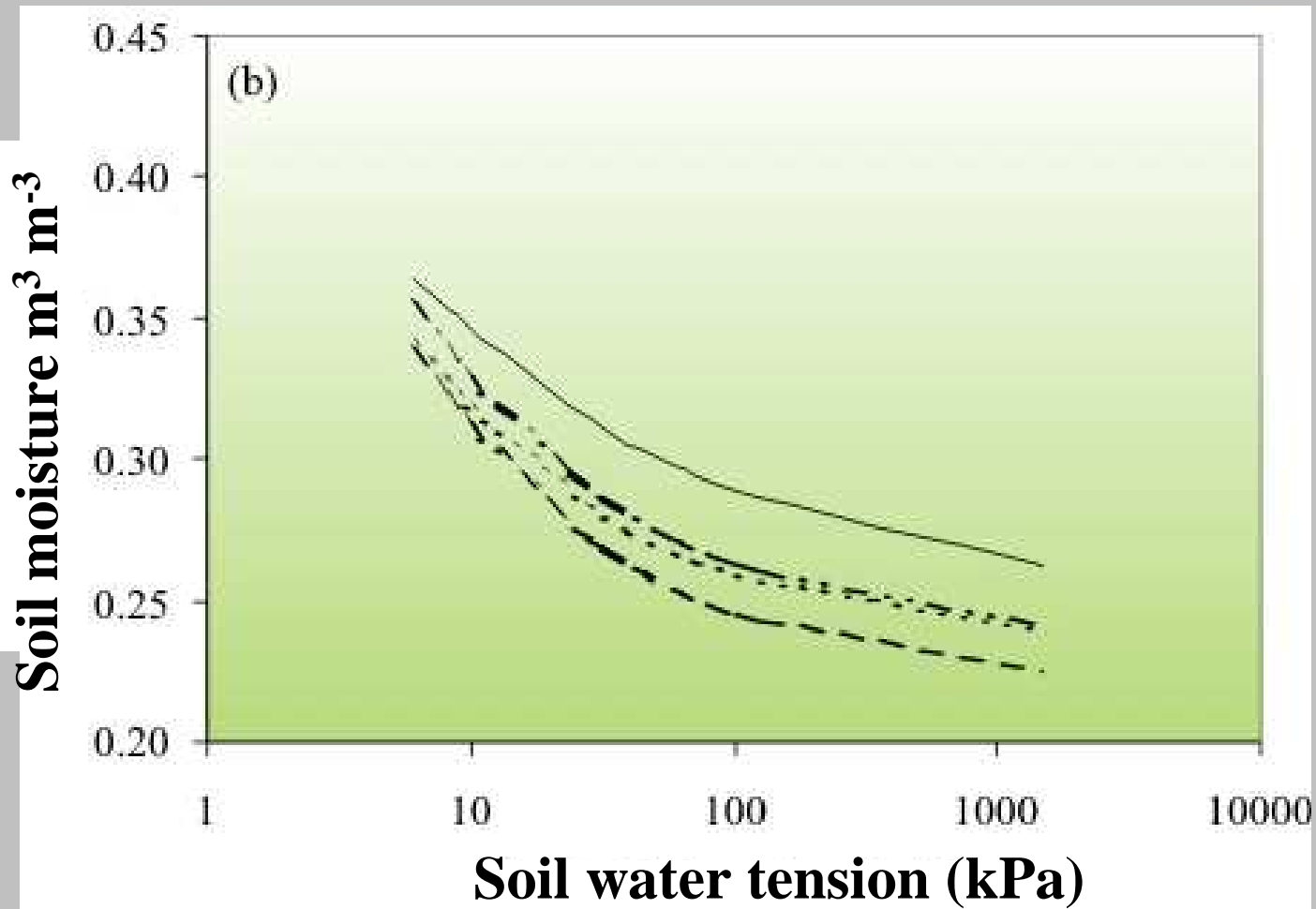
## Soil texture, Porangatu, GO.

Depth (cm)	Texture (g kg <sup>-1</sup> )			Textural Classification
	Clay	Silt	Sand	
0-20	429	80	491	Sandy clay
20-40	449	80	471	Sandy clay
40-60	489	80	431	Sandy clay
60-80	549	60	391	Clay

## Soil physics characteristics

Depth (cm)	Soil bulk density (Mg m <sup>-3</sup> )	Porosity (m <sup>3</sup> m <sup>-3</sup> )			Aggregates diameter > 2 mm (%)
		Macro	Micro	Total	
0-20	1.48	0.09	0.35	0.44	31.3
20-40	1.50	0.10	0.34	0.44	43.7
40-60	1.31	0.17	0.34	0.51	63.1
60-80	1.30	0.15	0.36	0.51	64.4

<b>Depth (cm)</b>	<b>Available water capacity (mm)</b>
<b>0-20</b>	<b>16.6</b>
<b>20-40</b>	<b>15.8</b>
<b>40-60</b>	<b>17.2</b>
<b>60-80</b>	<b>17.4</b>



Soil water adsorption curves, Porangatu, GO.

Phenotyping Site of Sto. Antônio-GO, 2006 - First planting date - 01/11/2006  
**Wet season.**

Source of variation	DF	Yield	Dry matter	Spikelet sterility	Tiller Fertility	Grain/ panicles	Plant high	Panicles/ m2
Hidr treatment (A)	1	52925.60 <sup>ns</sup>	49843.60 <sup>ns</sup>	0.60 <sup>ns</sup>	30.57 <sup>ns</sup>	1156.70 <sup>ns</sup>	14.88 <sup>ns</sup>	384.40 <sup>ns</sup>
Error (a)	6	1981993.83	270011.47	122.64	7.29	218.38	201.52	561.98
Genotypes (G)	4	9961110.4**	1396307.8**	2068.1**	48.2**	9811.1**	100.7**	4483.35**
A x G	4	192701.13 <sup>ns</sup>	318264.54 <sup>ns</sup>	6.43 <sup>ns</sup>	13.11 <sup>ns</sup>	411.66 <sup>ns</sup>	13.59 <sup>ns</sup>	391.6 <sup>ns</sup>
Error	24	628995.01	372371.24	44.18	12.43	202.72	31.96	814.32
<b>CV (%)</b>		<b>23.90</b>	<b>16.54</b>	<b>24.11</b>	<b>3.64</b>	<b>9.46</b>	<b>5.79</b>	<b>15.22</b>

ns - F not significant at 5%; \*\* - F significant at 1%.

Phenotyping Site of Sto. Antônio-GO, 2006 - First planting date - 01/11/2006  
**Wet season.**

GENOTYPES	Yield Kg ha <sup>-1</sup>	Dry matter Kg ha <sup>-1</sup>	Spikelet sterility -%	Grain/ Panicles -n°	Tiller Fertility - %	Panicles/ m2 - n°	Plant high (cm)
BRS Curinga	4319A	4407A	16.09C	138.3C	97.29A	220.8A	92.3A
BRS Primavera	2291B	3551AB	48.22A	184.8A	95.67A	161,0D	97.6A
BRS Soberana	2002B	3369B	36.23B	144.9B	99.26A	178.3C	99.8A
CNAS 9019	3607A	3680AB	29.65B	183.4A	98.99A	202,0B	97.0A
Guarani	4370A	3442B	7.66C	100.8D	93.37A	175.8C	101.8A

ns - F not significant at 5%; \*\* - F significant at 1%.

Phenotyping Site of Pornagatu-GO, 2006 - First planting date - 05/12/2006  
**Dry season.**

Source of variation	DF	Yield	Dry matter	100 grain	Spikelet sterility	Tiller fertility	Grains/ panicle	Plant high	Panicles/ m2
Hidr treatment (A)	1	21490094.0**	26580411.2**	0.09*	1064.5**	10.01 <sup>NS</sup>	914.89 <sup>NS</sup>	51.53 <sup>NS</sup>	18232.90 <sup>NS</sup>
Error (a)	6	583315.69	1070736.59	0.01	31.42	182.34	258.04	612.48	4458.05
Genotypes (G)	4	6576102.8**	2594549.5**	2.55**	871.78**	467.71**	7826.48**	500.59 <sup>NS</sup>	10526.4**
A x G	4	556332.84 <sup>NS</sup>	351956.29 <sup>NS</sup>	0.01 <sup>NS</sup>	221.95**	29.38 <sup>NS</sup>	860.59**	787.85 <sup>NS</sup>	1406.15 <sup>NS</sup>
Error	24	354098.63	482446.68	0.02	36.50	129.10	180.55	522.73	1373.93
CV (%)		18.43	18.96	4.87	24.14	12.95	11.70	22.38	14.70

ns - F not significant at 5%; \*\* - F significant at 1%.

Phenotyping Site of Pornagatu-GO, 2006 - First planting date - 05/12/2006  
**Dry season.**

GENOTYPES	YIELD	DRY MATTER	100 GRAIN	SPIKELETS STERILITY	GRAIN/PANICLE	TILLER FERTILITY	PANICLE S/M2	PLANT HIGHT
	KG HA <sup>-1</sup>	KG HA <sup>-1</sup>	G	%	Nº	%	Nº	CM
Without drought stress								
BRS CURINGA	4561 AB	4865 AB	2.29 B	21.85 AB	134.0 B	97.18 A	344 A	98.2 A
BRS PRIMAVERA	5595 A	5206 A	2.22 B	27.18 A	177.0 A	93.99 A	235 B	114.3 A
BRS SOBERANA	2657 C	3670 B	2.44 B	23.93 A	101.0 CD	80.77 A	291 AB	93.1 A
CNAS 9019	3280 C	4396 AB	2.33 B	15.43 AB	111.0 BC	84.89 A	278 AB	97.5 A
GUARANI	3719 BC	4252 AB	3.57 A	10.98 B	75.1 D	79.29 A	221 B	102.0 A
<b>MEAN</b>	<b>3962</b>	<b>4478</b>	<b>2.57</b>	<b>19.87</b>	<b>119.6</b>	<b>87.22</b>	<b>273</b>	<b>101.0</b>
With drought stress								
BRS CURINGA	2958 A	2991 AB	2.22 B	28.21 B	97.0 BC	96.74 A	257 A	90.3 A
BRS PRIMAVERA	3274 A	3218 A	2.17 B	35.87 B	150.0 A	92.07 A	208 A	104.9 A
BRS SOBERANA	1485 B	1743 B	2.23 B	51.46 A	106.0 BC	79.39 A	252 A	130.3 A
CNAS 9019	2293 AB	3099 AB	2.28 B	25.46 B	118.0 B	92.40 A	234 A	96.7 A
GUARANI	2472 AB	3186 AB	3.49 A	9.94 C	79.0 C	80.52 A	204 A	94.3 A
<b>MEAN</b>	<b>2496</b>	<b>2847</b>	<b>2.48</b>	<b>30.19</b>	<b>110.0</b>	<b>88.22</b>	<b>231</b>	<b>103.3</b>
CV (%)	18.43	18.96	4.87	24.14	11.70	12.95	14,70	22.38
Drought effect (%)	-37.00	-36.41	-3.56	51.90	-8.04	1.15	-15.61	2.24

Phenotyping Site of Pornagatu-GO, 2006 - Second planting date - 06/11/2006.  
**Dry season.**

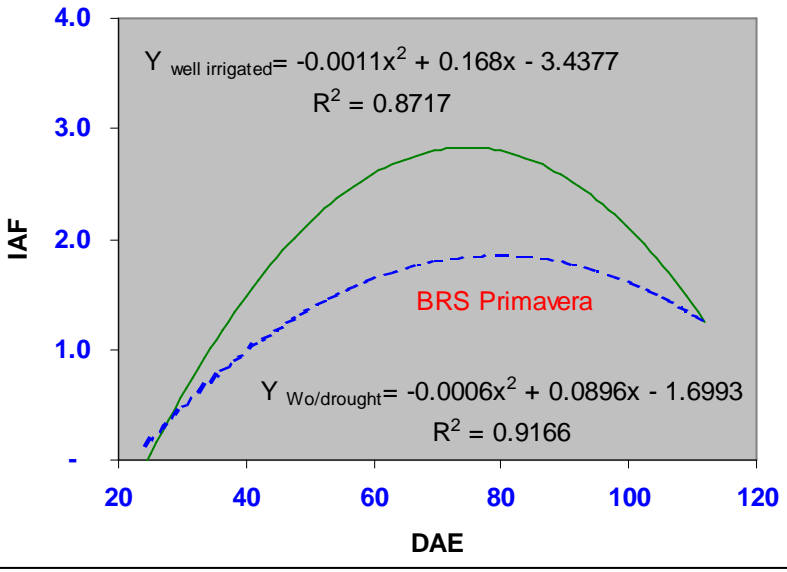
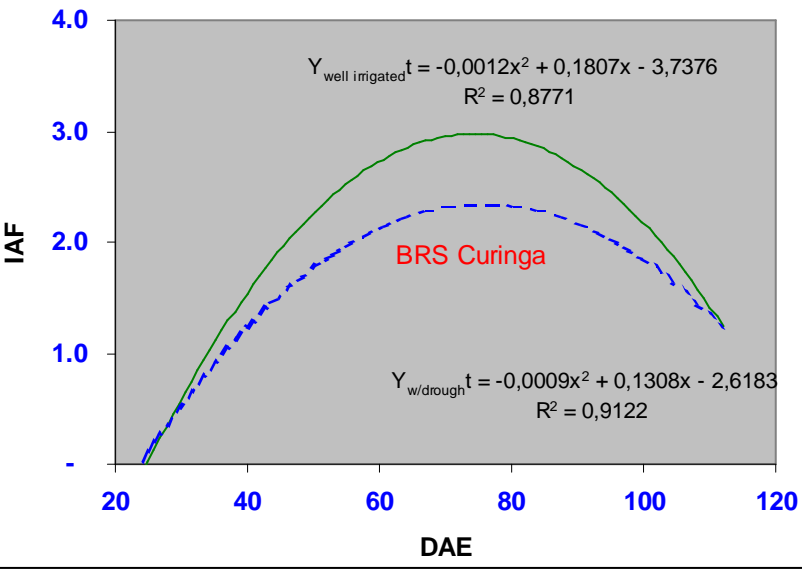
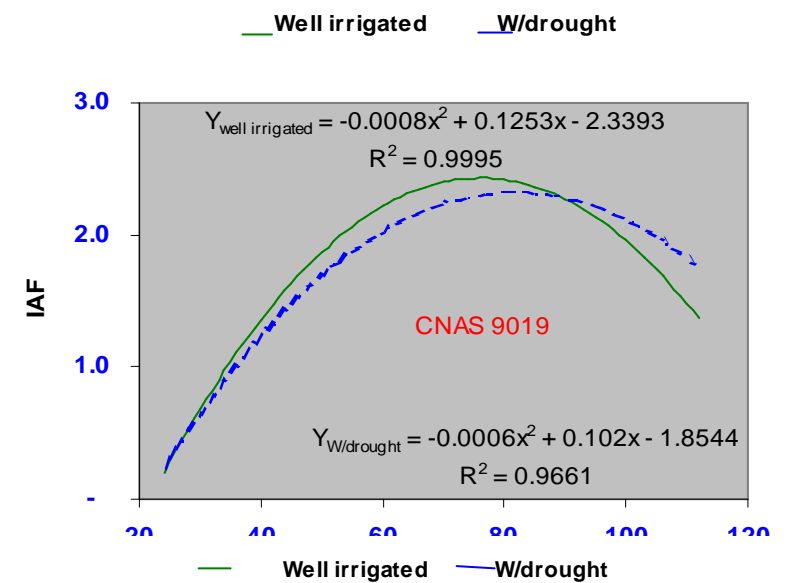
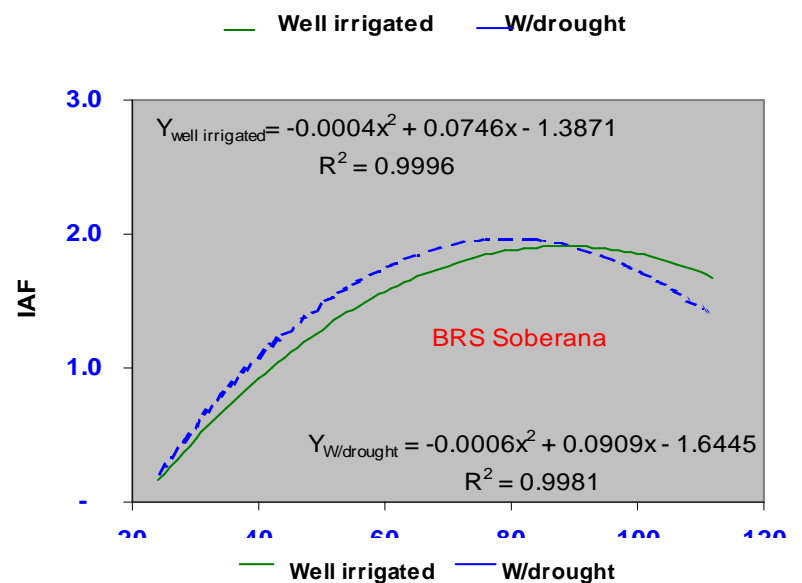
Source of variation	DF	Yield	Dry matter	100 grain	Spikelet sterility	Tiller fertility	Grains/panicle	Plant high	Panicles/m <sup>2</sup>
Hidr treatment (A)	1	32851562.5**	27692288.1**	0.536**	3971.053**	16.848 <sup>NS</sup>	143.262 <sup>NS</sup>	982.08**	8236.9**
Error (a)	6	278301.233	310962.717	0.016	286.943	15.847	480.684	24.542	331.517
Genotypes (G)	4	202213.15 <sup>NS</sup>	236216.65 <sup>NS</sup>	0.374 <sup>NS</sup>	140.118 <sup>NS</sup>	13.922 <sup>NS</sup>	322.593 <sup>NS</sup>	42.376 <sup>NS</sup>	656.025 <sup>NS</sup>
A x G	4	373582.5 <sup>NS</sup>	318163.1 <sup>NS</sup>	0.085 <sup>NS</sup>	107.436 <sup>NS</sup>	36.319 <sup>NS</sup>	1791.414 <sup>NS</sup>	88.35*	1950.025 <sup>NS</sup>
Error	24	615223.608	980473.175	0.213	321.227	33.626	981.274	33.262	3380.392
CV (%)		28.31	33.81	17.74	55.49	6.36	30.80	5.81	24.07

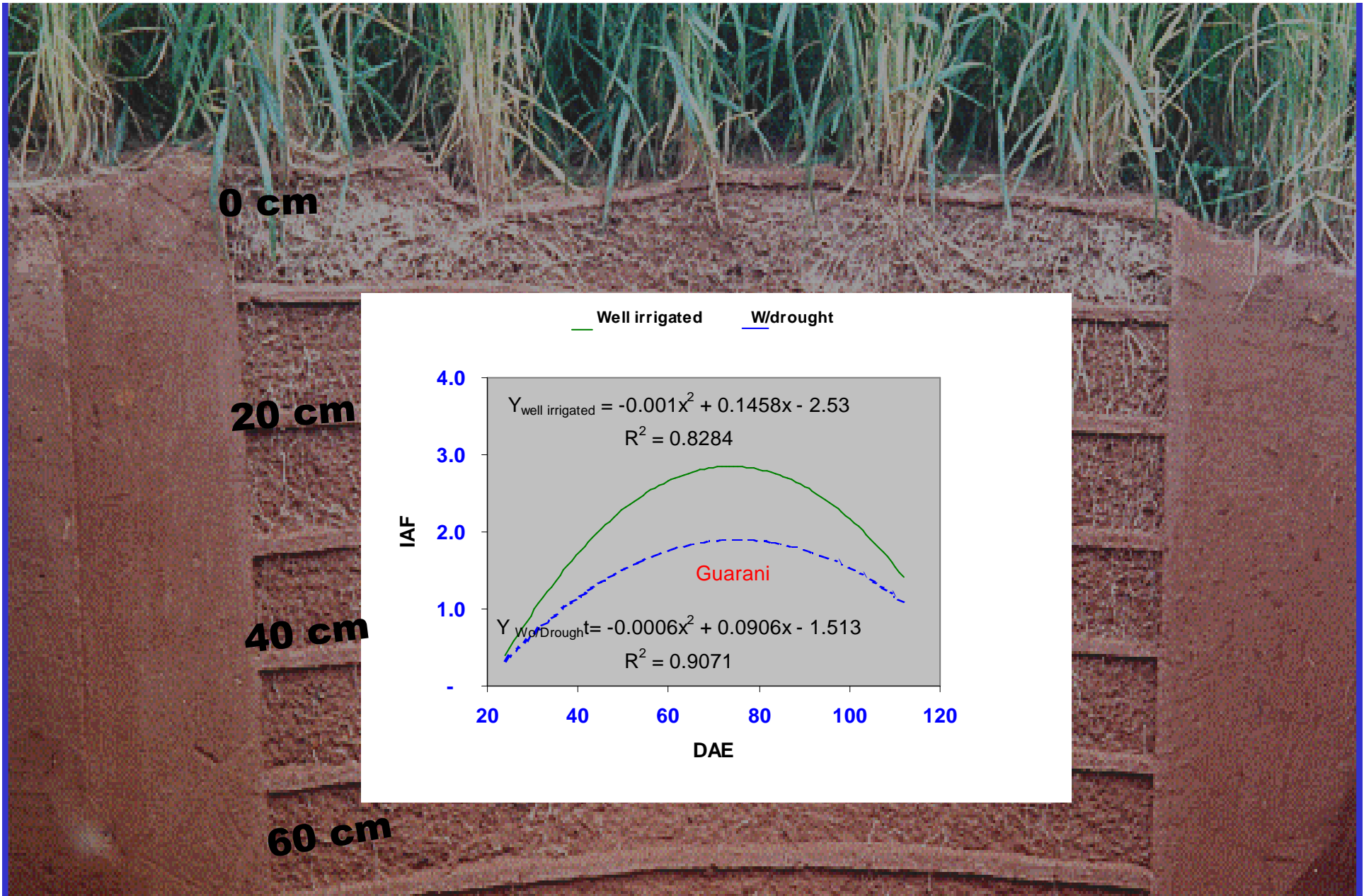
ns - F not significant at 5%; \*\* - F significant at 1%.

Phenotyping Site of Pornagatu-GO, 2006 - Second planting date - 06/11/2006.

**Dry season.**

GENOTYPES	YIELD	DRY MATTER	100 GRAIN	SPIKELETS STERILITY	GRAIN/PANICLE	TILLER FERTILITY	PANICLE S/M2	PLANT HEIGHT
	KG HA <sup>-1</sup>	KG HA <sup>-1</sup>	G	%	Nº	%	Nº	CM
Without drought stress								
BRS CURINGA	3537 A	3567 A	2.51 A	22.92 A	88.0 A	91.24 A	247 A	102.1 A
BRS PRIMAVERA	3847 A	3697 A	2.81 A	14.74 A	94.0 A	89.75 A	223 A	100.7 A
BRS SOBERANA	3478 A	3817 A	2.74 A	32.40 A	110.8 A	88.72 A	220 A	106.6 A
CNAS 9019	4142 A	4313 A	2.45 A	24.77 A	125.6 A	90.90 A	220 A	110.9 A
GUARANI	3380 A	3409 A	3.09 A	16.84 A	80.7 A	92.17 A	227 A	100.8 A
<b>MEAN</b>	<b>3677</b>	<b>3761</b>	<b>2.72</b>	<b>22.33</b>	<b>57.3</b>	<b>90.56</b>	<b>227</b>	<b>104.2</b>
With drought stress								
BRS CURINGA	1676 A	1899 A	2.54 A	42.94 A	117.6 A	89.01 A	238 A	99.1 A
BRS PRIMAVERA	1968 A	2268 A	2.27 A	38.09 A	107.2 A	94.37 A	246 A	96.0 A
BRS SOBERANA	2184 A	2116 A	2.52 A	39.79 A	82.0 A	92.89 A	288 A	89.3 A
CNAS 9019	1686 A	2022 A	2.29 A	47.53 A	98.4 A	95.21 A	272 A	94.3 A
GUARANI	1808 A	2177 A	2.81 A	42.95 A	11.3 A	87.82 A	236 A	92.9 A
<b>MEAN</b>	<b>1864</b>	<b>2096</b>	<b>2.48</b>	<b>42.26</b>	<b>42.8</b>	<b>91.86</b>	<b>256</b>	<b>94.3</b>
CV (%)	28.31	33.81	17.74	55.49	30.80	6.36	24.07	5.81
Drought effect (%)	-49.29	-44.25	-8.53	89.22	-25.21	1.44	12.63	-9.50







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THANKS

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