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CULTIVARS SELECTION OF CARIOCA BEANS TYPE TO BE HARVESTED IN ARID FARMLANDS

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1 ABSTRACT

Brazil is a major bean (*Phaseolus vulgaris* L.) producer. Nevertheless, the unfavorable weather conditions (water deficit, mainly) cause the country’s average productivity to be far below its real potential. To avoid the drought effects, the use of tolerant cultivars is the most economical farming practice. This paper aims to evaluate the reactions and damages caused by water shortage in the production and growth components of five cultivars of Carioca beans and to select those with higher potential of being used in low rainfall conditions. The experiment was conducted at the IAPAR Experimental Station in Londrina, PR, during the 2011 water season, using the random delineation of blocks with split plots, so that the cultivars could be allocated in the sub-plot and in treatments with and without water deficit in the plots. The water deficit began in the pre-blooming stage and was kept for 20 days in the plots submitted to stress. Plants were collected for leaf area index and dry matter rate analyses 35, 47, 54 and 70 days after emergency. On the physiological maturity stage, the productivity characters were determined. The reduction index was calculated for each assessed variant. BRS Talismã proved to be drought-tolerant.

Keywords: *Phaseolus vulgaris* L., Water deficit, Drought tolerant.

OLIVEIRA NETO, S. S.; ZEFFA, D. M.; SARTORI, M. M. P.; MODA-CIRINO, V. SELEÇÃO DE CULTIVARES DE FEIJÃO DO GRUPO COMERCIAL CARIOCA PARA CULTIVO EM AMBIENTES COM DEFICIÊNCIA HÍDRICA

2 RESUMO

O Brasil é um grande produtor de feijão (*Phaseolus vulgaris* L.), no entanto, as condições climáticas desfavoráveis (déficit hídrico, principalmente) tornam a produtividade média do país bem abaixo do seu real potencial. Para evitar os efeitos da seca, as cultivares tolerantes

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são a prática agrícola mais econômica. Este trabalho visa avaliar as reações e os danos causados pela falta de água nos componentes de produção e crescimento de cinco cultivares de feijão carioca e selecionar aqueles com maior potencial de uso em condições de poucas chuvas. O experimento foi conduzido na Estação Experimental do IAPAR em Londrina-PR, na safra das águas de 2011, usando o delineamento de blocos ao acaso com parcelas subdivididas, de modo que as cultivares foram alocadas na sub-parcela e os tratamentos com e sem déficit de água, nas parcelas. O déficit hídrico começou no estágio pré-florescimento e foi mantido durante 20 dias nas parcelas submetidas ao estresse. Foram coletadas plantas para a análise de índice de área foliar e taxa de matéria seca aos 35, 47, 54 e 70 dias após a emergência. Na fase de maturação fisiológica foram determinados os caracteres de produtividade. O índice de redução foi calculado para cada variável avaliada. BRS Talismã mostrou ser tolerante à seca.

Palavras-chave: *Phaseolus vulgaris* L., Déficit hídrico, Tolerante à seca.

3 INTRODUCTION

The dry bean (*Phaseolus vulgaris* L.) is a leguminous plant grown mainly in less developed countries, in which Brazil is one of the biggest producers, taking on the worldwide second position, producing yearly 3,291.31 millions tons of grains in a cultivated area of 3,081.49 millions hectares and having an average yield of 1,068 kg.ha^{-1} (IBGE, 2018). Paraná State is the national leader on this leguminous plant production, accounting for 724.9 thousands tons or 21.9% from the total produced beans in the country, on which the total cultivated area is 452.1 thousands hectares and the productivity average of 1,603 kg.ha^{-1} (CONAB, 2018).

Among the unfavorable environmental factors the water deficit stands out from the rest by the world incidence range and by the productivity sharp drop. The water shortage, especially in arid and semi-arid regions makes about 60% of bean producer areas in the world are susceptible to water deficit occurrence in some of the farming stage (SINGH, 1995).

Beans crop is a lot vulnerable to severe water deficit, especially when compared to other leguminous plants (GUIMARÃES, 1996). The main components of the plant yield (grains amount and quality) are affected even when subjected to a short water scarcity period (ROSALES-SERNA et al., 2004).

The tolerance to drought may occur by means of some important mechanisms, such as: desiccation delay (capacity of keeping the tissue hydrated), tolerance to desiccation (capacity of performing physiological functions) and escape (capacity of completing the cycle before the beginning of water stress) (TAIZ; ZEIGER, 2013). Most of the tolerance mechanisms studied have the main function of protecting cell structure from the dehydration effects (VERSLUES et al., 2006).

Beans cultivars selection tolerant to drought is carried out by means of characters assessments connected with the yield, since it is the most important economically characteristic, besides the use of morphological and physiological variants associated to tolerance which permit the understanding of the lack of water effects in the plant (SINGH, 1995).

The genetic improvement to drought tolerance is the most applied technique to overcome the water deficit effects in the world (FRITSCHE-NETO; BORÉM, 2011; BASSETT, 2013). This way, the development of more adaptable cultivars to dry environment has become very important, mainly after the water crisis advance faced by some Brazilian states in the years 2014 and 2015, restricted the irrigation use by the farming sector.

In the face of abiotic stresses intensification, several research groups that work in the genetic improvement of common bean has implemented multidisciplinary programs for studies of abiotic stresses, aiming to identify drought tolerant genotypes (BLAIR et al., 2012). The genotypes SEA 5 and SEA 13 (SINGH; TERÁN; GUTIERREZ, 2001), IPR Uirapuru (MOLINA et. al., 2001), IAPAR 81 (MODA-CIRINO et al., 2001; AGUIAR et al., 2008), IAC Alvorada (CARBONELL et. al., 2008) are considered how drought tolerant.

Aiming at evaluating the reaction and the damages that the water stress causes in the production and growth components of Carioca beans plant, the current work aimed selecting varieties with potential of being used in places with low rainfall conditions and moderate water scarcity.

4 MATERIALS AND METHODS

The reaction to water deficit of five trade groups of Carioca beans cultivars (BRS Pioneiro, BRS Talismã, IPR Bem-te-vi, IPR Quero-quero and Iapar 81), were evaluated. Iapar 81 cultivar was considered as control, because it is classified as tolerant to water deficit (MODA-CIRINO et al., 2001; MOLINA et al., 2001).

The experiment was conducted at Experimental Agronomic Institute in Paraná (IAPAR), in Londrina-PR (23º 22’S, 51º 10’W and 585 m altitude), in the water season in 2011, in situations with and without water deficit. The experimental station has the following characteristics: annual climate average: 20.3ºC temperature, 69% relative humidity and 1,728 mm rainfall. The region climate classification is Cfa (subtropical climate). The region soil is classified as dystrophic Red Latosol, whose characteristics were described by Faria and Madramootoo (1996).

The trial design used was the blocks at random with split plots and it was repeated for three times. The cultivars composed the sub plot and the conditions with and without water deficit, the plot. The experiment was established in three seedbeds, having their side made of concrete and 100 m long, 5 m width and 1 m depth. The sub plot were composed by 5 meters line, spaced by 0.45 m, with sowing density of 20 seeds per linear meter, this one conducted within recommended period by agro climatic zoning for the region farming.

Basis fertilization was made according to soil chemical analyses. After the seedlings development, thinning was performed, leaving 12 plants per linear meter. Afterwards, in the V4 development stage (third opening of the tripartite leaves), it was carried out the nitrogen fertilization, using 200 $kg.ha^{-1}$ of ammonium sulphate. The occurrence of invasive species, pests and diseases were controlled with the use of chemical products registered for this farming. All the plots were wetted by spray irrigation till the beginning of the R5 development stage (pre-flowering) then irrigation was suspended for 20 days only for the plots submitted to water deficiency. After the water deficit period, all the plots started being wetted again. To avoid rain water supply to the plots submitted to water deficit, it was used portable shelters with a sliding pulley system on iron rails attached to the bed sides. The shelters were built in iron with their roofing and sides made of transparent polyethylene of 10 m long × 5 m width × 2.8 m height.

Sprinkler irrigation was carried out in order to maintain the plots without stress with the soil near the field capacity (216 mm) and the plots with water stress near the permanent wilting point (156 mm), the frequency of irrigation was performed every 2 days in order to maintain the soil moisture in the desired, the soil retention capacity was of 60 mm. During the stress period, it was performed soil moisture determination and then calculated the water storage in the 0 – 60 cm profile, according to works by Faria and Madramootoo (1996), for this, four moisture readings were taken in each plot (5 cm, 17.5 cm, 32.5 cm and 47.5 cm).

To evaluate the water deficit effect on the plant growth, during the farming cycle, it was determined the growth parameters: leaf area index (LAI) (Eq. 1a, 1b) and dry matter rate (DMR) (Eq. 2) which were obtained through the following expressions:

$$\text{LAI} = LA / GA \tag{1a}$$

$$LA = LN \times LAL \tag{1b}$$

Where:
LA - plant leaf area (*m*^{2});
GA - Ground area occupied by a plant = *0.04167 (m*^{2}*);*
LN – number of plant leaves;
LAL – leaf area of the collected leaf.

$$\text{DMR} = N \times W\,(g) \tag{2}$$

Where:
N – number of plants on an hectare;
W – a plant dry weight.

To determine LAI and DMR, 10 plants of each treatment (with and without water deficit) were selected by chance, of all genotypes, on 35, 47, 54 and 70 days after development (DAD). To estimate the LA it was made the area reading of one of the leaves in the middle third of each plant through a portable meter of a leaf area (model LI – 3000C Li–Cor, USA), on which the three leaflets were scanned, to measure the leaf area. To evaluate the DM, the selected plants were identified, packed in paper bags and dried in a forced aired oven, to 60 ± 2ºC temperature during 72 hours. After the drying, the samples were taken out and weighed.

During the physiological maturation phase (R9) it was sampled 10 plants, randomly, of the usable area of each sub plots and evaluated the following variants: NK– number of knots in the main stem; PL – plant length (length of main stem in cm); PP – number of string beans per plant; SP – number of seeds per string beans; SW – 100 seeds weight (g). Later, it was gathered the 2 main lines of each sub plot, discarding 0.5 m of each edge.

After the grains processing, it was determined the humidity and productivity of each plot where data were corrected to moisture standard of 13% and changed to kg.ha^{-1}, this way, originating the total yield of grains (TY).

To assess the water deficit effect in each of the evaluated characteristic, including to DMR and LAI, it was calculated the reduction rate (RR) (Eq. 3), by means of the following formula:

$$RR\,(\%) = [((NSV - WSV))/NSV] \times 100 \tag{3}$$

Where:
NSV – No water stress variant;
WSV – with water stress variant.

The LAI and DMR data were subjected to main components analysis using the Minitab 17 software (Minitab Inc) and the variants results of NK, PL, PP, SP, SW and TY submitted to analysis of homoscedasticity and variance, considering the treatment effects and genotypes as fixed.

The mathematical model used was Yijk = am + Pi + Bj + (PB)ij + Sk + (PS)ik + Eijk where Yijk = observed value in the i treatment, k genotype, j repetition; am = experiment general average; Pi = i-th treatment effect (i = 1 or 2); Sk = genotype k-th effect (k = 1, 2, 3, 4 or 5); Bj = block j-th effect (j = 1, 2 or 3); (PB)ij = random error a; (PS) ik = i-th interaction treatment effect with the genotype k-th; Eijk = random error b. The estimates of the genetic squared values (Eq. 4), genetic variation coefficient (VCg) (Eq.5), environmental variation coefficient (VCa (Eq.6) and VCb (Eq.7)) and B index (Eq.8) were performed using the following expressions:

$$\varphi g = (ASS - EASb) / rp \quad (4)$$

$$VCg = (\sqrt{\varphi g / m}) \times 100 \quad (5)$$

$$VCa = (\sqrt{EASa / m}) \times 100 \quad (6)$$

$$VCb = (\sqrt{EASb / m}) \times 10 \quad (7)$$

$$B = VCg / VCe \quad (8)$$

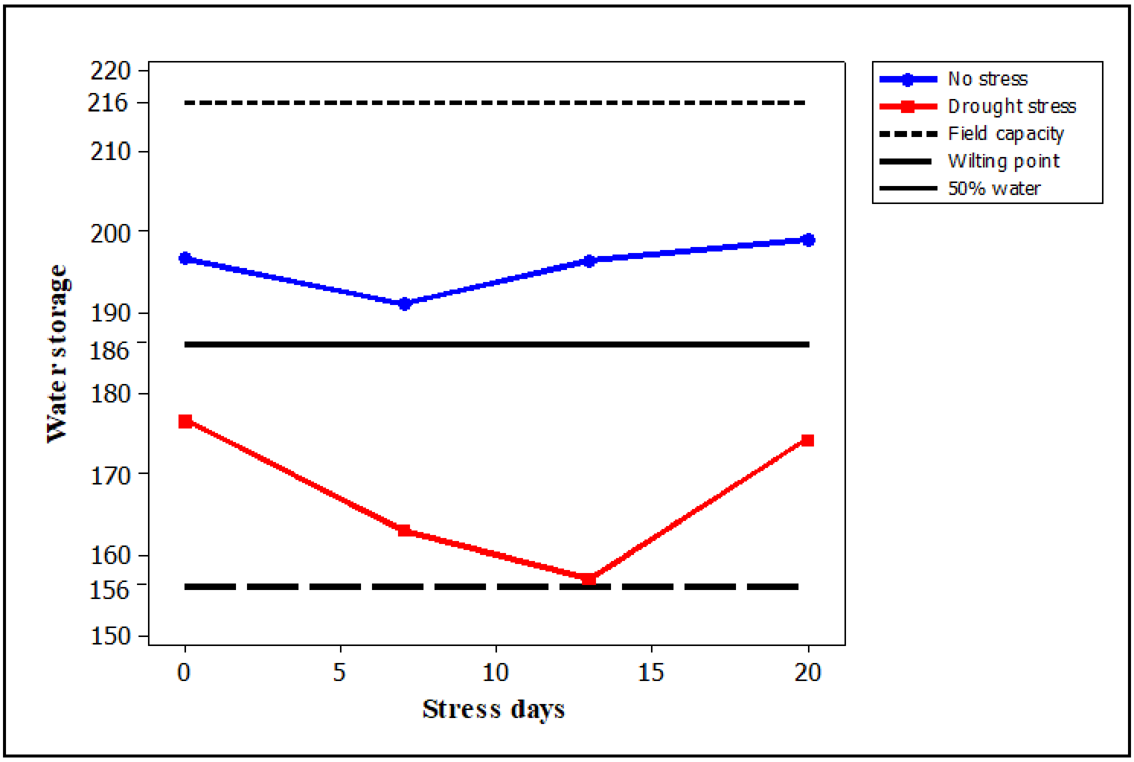
Where:
φg = genetic squared values;
ASS = average square of sub plots genotype;
EASb = error average square b;
r = repetitions numbers;
p = genotype numbers;
m = experiment general average.

The analyses of variance were performed using GENES program (CRUZ, 2006).

5 RESULTS AND DISCUSSION

The water storage in the soil is presented in Figure 1. In the plots without water stress the conditions of water storage were the best for plants development, since according to Aguiar et al. (2008), beans growth and production aren’t affected when the available water in the soil is kept above 50%. In the plots subjected to water stress, where the water storage was kept below 50% of the available water, there were evidences that escape and tolerance mechanisms were demanded, being this occurrence related by Jongdee et al. (2006), to more severe water deficiency.

Figure 1.Water accumulation in the soil profile (0-60 cm) in the plots with and without water deficit in Carioca bean genotype.



The multivariate analysis result for dry matter rate (DMR) and leaf area index (LAI) are presented in Table 1 and Figure 2. The main component 1 (PC1) represents 46.7% of information, the main component 2 (PC2) represents 25.4% and the main component 3 (PC3) represents 11.4%. In the PC1, PC2 and PC3 analysis it is obtained 83.4% of analyzed information.

Table 1. Main components of multivariate analysis for leaf area index (LAI) and dry matter rate (DMR) evaluated on 35, 47, 54 and 70 days after plants development in Carioca beans type cultivars, with and without water deficit.

VARIABLE	**PC1**	**PC2**	**PC3**
LAI 35	0.071	-0.470	-0.514
LAI 47	0.456	-0.051	-0.337
LAI 54	0.128	0.626	0.189
LAI 70	0.183	0.531	-0.354
DMR 35	0.417	0.024	0.230
DMR 47	0.480	0.076	-0.287
DMR 54	0.463	-0.162	0.187
DMR 70	0.344	-0.266	0.539
PROPORTION	0.467	0.254	0.114
CUMULATIVE	0.467	0.720	0.834

The highest values obtained indicate that this variant influences in a more significant way in the phenotypic results. In PC1, to LAI character, the highest factor load obtained was 0.456, that happened on the 47 days after the development (DAD), indicating that cultivars obtained a higher LAI on this period, decreasing with the advance on the water stress days. Similar results were observed by Ghanbari et al. (2013). For DMR, the highest value obtained was also on the 47 DAD (0.480), indicating that the plant went on producing photo-assimilated for a short period after the water stress beginning, decreasing on 54 and 70 DAD. This shows that with a higher number of days submitted to drought, the dry matter accumulation of the bean plant decreases. Similar results were obtained by Assefa et al. (2015) when evaluating 36 bean genotypes in water deficit conditions, it also showed the DMR reduction in the studied genotypes.

For PC2, the highest LAI observed was on the 54 DAD (0.626), decreasing on 70 DAD (0.531), on the other hand, for DMR, the highest value was observed on 47 DAD. For PC3, the highest LAI occurred on 54 DAD (0.189) and the highest DMR (0.539) on 70 DAD.

The results presented in Figure 2 show the distribution of bean cultivars in with and without water stress categories, according to the LAI and DMR variants analysis. In favorable field conditions, without water stress the IPR Quero-quero presented a close performance to IAPAR 81 comparing to LAI and DMR characters, for the first and second component (PC1 e PC2, respectively). When they were subjected to water deficit, its result was close to control in the analysis of the second component (PC2).

Analyzing the conditions with and without water stress altogether, it can be observed that BRS Talismã was classified in the same quadrant, giving evidences that even in water stress conditions, the LAI and DMR show they are pretty close. The IAPAR 81 control and IPR Quero-quero showed a similar performance in both evaluated conditions. The reduction index obtained for DMR and LAI were positive to the most of the evaluations performed during all the water deficit period, indicating that genotypes were vulnerable to water deficit and on this condition, it is reduced the leaf area and plants dry matter index significantly (Table 2).

Figure 2. Main components of multivariate analysis for LAI and DMR in Carioca beans type cultivars, with and without water deficit.

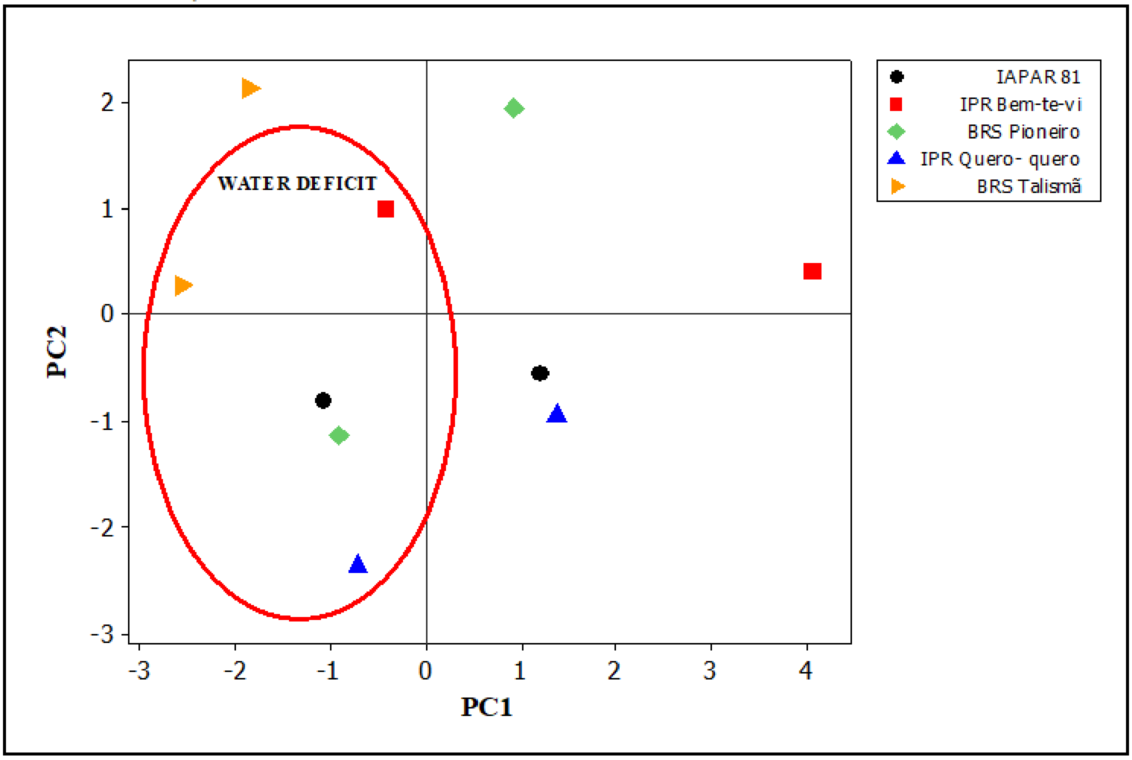


Table 2. Reduction index (%) for dry matter rate (DMR) and leaf area index (LAI) in Carioca beans type cultivars, with and without water deficit.

	35 DAD		47 DAD		54 DAD		70 DAD	
Genotypes	**DMR**	**LAI**	**DMR**	**LAI**	**DMR**	**LAI**	**DMR**	**LAI**
IAPAR 81	2.61	-0.12	48.32	34.13	42.10	-11.01	9.63	22.16
IPR Bem-te-vi	9.05	9.89	67.00	61.33	48.22	-3.34	31.52	10.43
BRS Pioneiro	10.72	0.62	58.60	25.79	-7.00	75.58	-1.00	34.25
IPR Quero-quero	5.89	7.69	65.76	48.39	16.10	45.92	-28.93	34.67
BRS Talismã	11.85	12.10	-41.72	-57.66	2.45	50.11	40.46	39.66

BRS Talismã presented an increase of DMR and LAI on 47 DAD, for this reason plants withstood better the conditions of water stress, on which they were submitted.

The same performance can be observed by IAPAR 81 control on 54 DAD, on which there was an increase of 11.01% on leaf area index and for IPR Quero-quero on 70 DAD, presenting a dry matter rate 28.96% higher than in the best conditions for farming.

The analysis of variance demonstrated significant effects for treatment in 5% to PL, PP, SP and TY e non-significant to NK and SW (Table 3). Significant treatment effects indicate that the variant answer is different considering the presence or the absence of water stress.

Genotypes differed statistically in 1% of probability just for PL and in 5% for PP, SP and SW. Significant cultivar effects indicate that there are differences between the materials for the evaluated characteristics and these differences happen due to genetic factors.

The interaction genotype × treatments was meaningful in 1% for PL, meaningful in 5% for PP and SW. The other characteristics didn't present meaningful effects. Effects of cultivar interaction by meaningful treatment indicate that the cultivars present different performance in the presence or absence of stress.

The highest estimative of genetic coefficient of variation (VC g%) was observed for TY (42.94) and the smallest for SW (4.62). High VCg indicates that there is a big contribution of genetic components in the characteristic variability.

The environmental coefficient of variation changed from 4.33 for SW (VCa) to 14.49 for VP (VCb).

B index, which relates VCg and VC b, provides an indication of genetic variability of a character without influence of its general average. There was a variation of 0.00 (NK) to 3.68 (TY). Values of B index above one (1) indicate that genotypes effects are very meaningful, presenting a big contribution on the total variance indicating a favorable situation to selection. This way, the PL and TY characters presented B index favorable to selection.

Table 3. Summary of analysis of variance and the estimative of genetic coefficient of variation (VCg), environmental coefficient of variation of error a (VCa), environmental coefficient of variation of error b (VCb) and B index (VCg / VCb), in Carioca beans type cultivars, with and without water deficit.

Variation sources	**FD**	**Average Square**					
		NK	**PL**	**PP**	**SP**	**SW**	**TY**
Blocks	2	0.23	10.97	0.90	0.49	2.83	595372
Water Deficit (D)	1	4.52^{ns}	933.09^{*}	539.41^{*}	2.51^{*}	0.45^{ns}	59334553^{*}
Error a	2	2.38	23.74	1.14	0.24	0.94	294068
Genotype (G)	4	0.05^{ns}	156.96^{**}	15.11^{*}	0.82^{*}	9.32^{*}	22402299^{ns}
Interaction D x G	4	0.35^{ns}	137.30^{**}	17.33^{*}	0.37^{ns}	10.63^{*}	4881333^{ns}
Error b	16	0.29	8.95	3.07	0.14	2.91	271641
VCg (%)		0	7.82	11.70	5.17	4.62	42.94
VCa (%)		12.84	7.67	8.84	7.58	4.33	12.12
VCb (%)		4.51	4.70	14.49	5.84	7.62	11.65
B (%)		0	1.66	0.81	0.88	0.61	3.68

^{ns}: non-significant; *, **: meaningful to 5% and to 1% of probability, respectively by test F; FD: freedom degree; NK: number of knots in the main stem; PL: plant lenght (cm); PP: number of string beans per plant; SP: number of seeds per string beans; SW: 100 seeds matter (g); TY: total yield of grains ($kg.ha^{-1}$); B: B index.

For all the evaluated variance, it was observed positive values for reduction index (RI) for the most cultivars, which prove that the water suppression occurred during the flowering phases and beginning of the string beans development caused physiological changes in the plants, provoking reduction, especially, in the number of string beans per plant and in the total yield (Table 4).

Table 4. Averages for evaluated characteristics and their respective index of perceptual reduction in Carioca beans type cultivars, with and without water deficit.

GENOTYPES	Number of Knots			Plants Lenght		
	NS	DS	RI	NS	DS	RI
	-- Number of knots·		%	-- Centimeters --		%
IAPAR 81	12.60	11.38	9.66	57.96	53.15	8.29
IPR Bem-te-vi	12.19	11.95	1.97	68.90	55.96	18.78
BRS Pioneiro	12.52	11.29	9.87	80.73	55.04	31.82
IPR Quero-Quero	12.19	11.90	2.35	64.05	63.43	0.96
BRS Talismã	12.62	11.72	7.13	73.95	62.24	15.84
	String Beans per Plant			**Seeds per String Beans**		
	NS	**DS**	**RI**	**NS**	**DS**	**RI**
	--N° String beans		**%**	**-- N° of seeds --**		**%**
IAPAR 81	12.76	7.24	43.26	6.38	5.81	8.93
IPR Bem-te-vi	18.95	7.86	58.52	6.91	5.77	16.51
BRS Pioneiro	19.95	7.00	64.91	7.29	6.29	13.72
IPR Quero-Quero	13.52	8.15	39.76	7.09	6.91	2.63
BRS Talismã	16.52	9.05	45.20	6.33	6.34	-0.05
	100 Seeds Matter			**Total Yield**		
	NS	**DS**	**RI**	**NS**	**DS**	**RI**
	------grams------		**%**	**------kg.ha^{-1}------**		**%**
IAPAR 81	19.25	21.58	-12.11	1537.43	909.33	40.85
IPR Bem-te-vi	21.20	23.06	-8.76	8023.87	3512.50	56.22
BRS Pioneiro	24.73	22.61	8.57	7133.20	2876.57	59.67
IPR Quero-Quero	22.22	22.79	-2.58	7781.57	4261.47	45.24
BRS Talismã	25.09	21.23	15.41	4918.07	3770.77	23.33

NS: no stress; DS: drought stress; RI: reduction index

When the plants were submitted to water deficiency, it was observed that the most affected production component was the number of string beans per plant, this is a result of the low percentage of flowers successfully pollinated and the abortion of eggs, causing the production of empty string beans (STONE; SILVEIRA, 2012), being IPR Quero-quero the least affected by stress for this characteristic. On the other hand, it was verified that the number of knots per plant and 100 seeds matter components were affected with less intensity, the last one presented negative results of reduction index for several cultivars (IAPAR 81, IPR Bem-te-vi and IPR Quero-quero), indicating that when they go through water stress, there was an increase in the seeds matter.

RI highest values occurred in the characteristics related to grains production components, as the number of string beans per plant, that varied from 39.76% for IPR Quero-quero, to 64.91% for BRS Pioneiro. High indexes of reduction to this variant may have happened because of the flowers abortion due to occurrence of water deficit in their reproductive stages (CUNHA et al., 2013). The flowers abortion didn’t permit the fruit formation, resulting in low quantity of string beans formed in the plants submitted to stress (FIEGENBAUM et al., 1991).

The total yield presented RI pretty varied, in which cultivar BRS Pioneiro was the most vulnerable to water deficit, presenting RI of 59.67% and cultivar BRS Talismã the least vulnerable (23.33%). Productivity reduction results of different cultivars under water deficit on this phase of bean cycle were also observed by other authors (AGUIAR et al., 2008; VALE et al., 2012; TEIXEIRA, 2015).

For the seeds per string beans characteristics, positive reduction indexes indicate that the string beans which were formed in the plants were stunted due to seed abortion caused by water deficit. Once phloem transport depend on cells turgor, the reduction of water potential in the phloem during the stress period may inhibit the sap movement to the seeds (LARCHER, 2004), causing this way a character reduction.

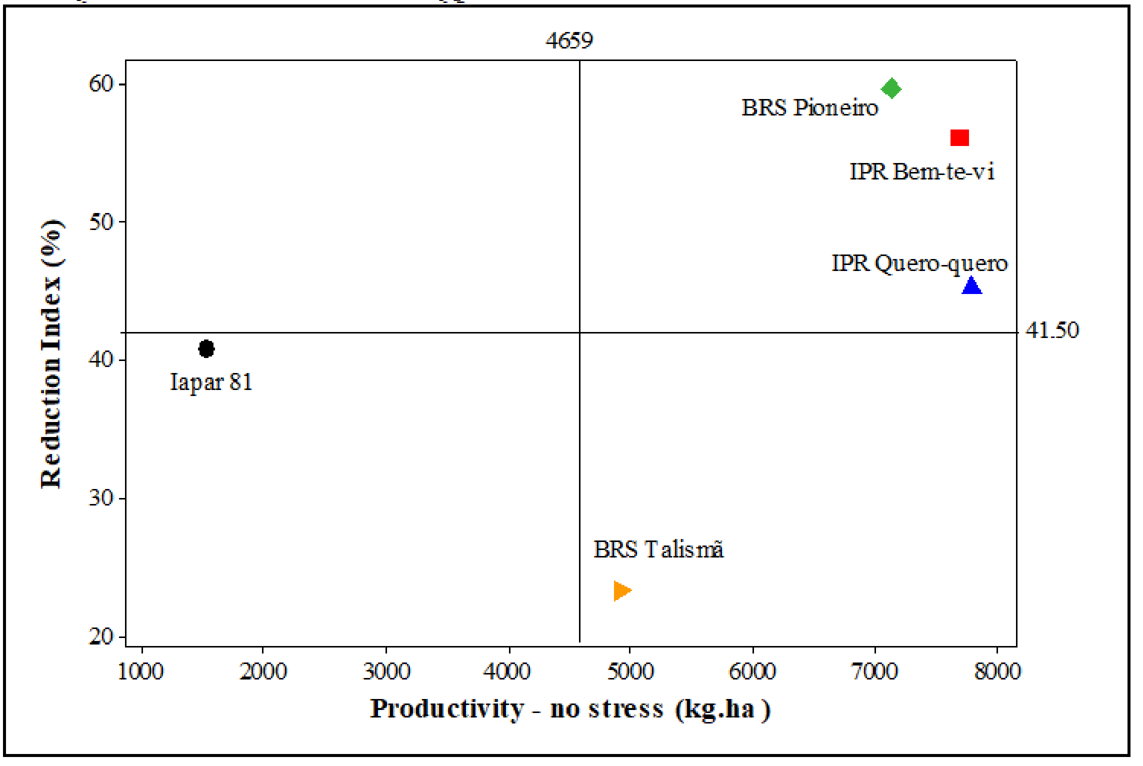
Figure 3 shows beans genotype development, in relation to total yield of grains without water deficit and RI% to the character TY. Thus, the materials were classified into four categories: 1- little tolerant to drought and with high productive potential; 2- little tolerant to drought and with low productive potential; 3- tolerant to drought with low productive potential and 4- tolerant to drought and with high productive potential.

Cultivars IPR Bem-te-vi, IPR Quero-quero and BRS Pioneiro were classified as little tolerant to drought, with high productive potential, though.

Cultivar IAPAR 81 presented low productive potential and tolerance to water stress, the results corroborate with Moda-Cirino et al. (2001), Molina et al. (2001) and Aguiar et al. (2008).

Cultivar BRS Talismã stood out as tolerant to drought and with high productivity (around 5,000 $kg.ha^{-1}$).

Figure 3. Relation between grains yield with no stress (TY) and reduction index for the grains yield of five Carioca beans types.



6 CONCLUSION

1. Genotypes present different responses concerning the duration of water suppression.
2. Cultivar BRS Talismã presents tolerance to drought and high potential of grains yield, which may be used for growing in farming areas with moderate water stress.

7 REFERENCES

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