Revista Brasileira de Ciências Agrárias
ISSN (on line) 1981-0997
v.15, n.4, e8677, 2020
Recife, PE, UFRPE. www.agraria.pro.br
DOI:10.5039/agraria.v15i4a8677
Protocol 8677 - 04/06/2020 • Approved in 02/07/2020

Does the sowing period change the grain technological quality of cowpea cultivars?

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ABSTRACT: The aim of the present study was to evaluate whether the sowing period changes the grain technological quality of cowpea cultivars and to indicate which of these have the highest technological quality when grown in the Center-South region of Brazil. The experiment was conducted in a randomized block design, with a 6 x 3 factorial arrangement, using six cowpea cultivars (BRS Itaim, BRS Guariba, BRS Potengi, BRS Cauamé, BRS Novaera and BRS Tumucumaque) and three sowing seasons, with four replicates. The evaluations held referred to the grain size and hydration, cooking time and crude protein content through sulfuric acid digestion. There was an interaction between cowpea cultivars and sowing dates for all analyzed variables. The sowing season alters the grain technological quality of cowpea when under the conditions of the Center-South region of Brazil, with the genotype-season effect dependent. Sowing dates in December and January generated lower technological quality of the cowpea beans. The BRS Tumucumaque cultivar possesses the best grain technological characteristics, having the largest grains with the highest crude protein content, as well as the shortest cooking time.

Key words: genotypes; protein; cooking time; *Vigna unguiculata* (L.) Walp

A época de semeadura altera a qualidade tecnológica dos grãos de cultivares de feijão-caupi?

RESUMO: O objetivo do presente trabalho foi avaliar se a época de semeadura altera a qualidade tecnológica dos grãos de cultivares de feijão-caupi e indicar quais cultivares apresentam maior qualidade tecnológica em cultivo na região Centro-Sul do Brasil. O experimento foi realizado em delineamento de blocos casualizados, com arranjo fatorial 6 x 3, sendo utilizadas seis cultivares de feijão-caupi (BRS Itaim, BRS Guariba, BRS Potengi, BRS Cauamé, BRS Novaera e BRS Tumucumaque) e três épocas de semeadura, com quatro repetições. As avaliações foram referentes ao tamanho e hidratação dos grãos, tempo de cozimento e teor de proteína bruta através de digestão ácida sulfúrica. Observou-se interação entre cultivares de feijão-caupi e épocas de semeadura para todas as variáveis analisadas. A época de semeadura altera a qualidade tecnológica dos grãos de feijão-caupi nas condições da região Centro-Sul do Brasil, sendo o efeito genótipo dependente. As épocas de semeadura de dezembro e janeiro geram menor qualidade tecnológica dos grãos do feijão-caupi. A cultivar BRS Tumucumaque apresenta as melhores características tecnológicas dos grãos, possuindo os grãos mais graúdos e com maior teor de proteína bruta, além do menor tempo de cozimento.

Palavras-chave: genótipos; proteína; tempo de cozimento; *Vigna unguiculata* (L.) Walp

Introduction

Cowpea, *Vigna unguiculata* (L.) Walp represents an important source of proteins, calories, vitamins and minerals for the basic diet of the population of several countries, especially in the developing ones (Publio Júnior et al., 2017; Gondwe et al., 2019). Its grains constitute one of the main components of the Brazilian diet, mainly in the North and Northeast regions, where the production is concentrated with more than 70% of national value (Conab, 2020). In the Center-South of Brazil, the production represents 25.8% of the national value, with an annual cultivated area of 159 thousand ha (Conab, 2020).

Overall, the cowpea has a very competitive production cost in relation to other crops, which contributes to the growing interest of producers from different regions of Brazil (Castro Júnior et al., 2015; Costa et al., 2019). Hence, the crop has been expanding to the Center-South of Brazil, as an off-season alternative, in succession to the crops of soybeans, maize and rice (Costa et al., 2019), attaining a high yield and satisfactory economic return (Almeida et al., 2017; António et al., 2019).

One of the reasons for expanding the cowpea-cultivated area to the Center-South was the development of new cultivars with the erect size and uniform maturation traits, which favor the mechanized harvesting (Freire Filho, 2011; Publio Júnior et al., 2017). Furthermore, it is worth emphasizing that besides the increasing interest of producers in cultivating this species, there has been a greater demand from the Center-South population, mainly for preparing typical dishes, especially in the state of Minas Gerais.

According to Freitas et al. (2013), breeding programs have strived to expand their trial network so that new cowpea cultivars are available to producers in different regions of the country. It is essential that these new cultivars present, in addition to high grain yield, a high technological quality, thus ensuring an equally higher sale price and acceptance by the consumer market (Freire Filho, 2011).

Concerning the crops consumed directly by the population, such as the cowpea, it is worth mentioning that evaluating the grain technological quality of different cultivars is as important as evaluating the productive potential of each genotype. Thus, during the launching process, registering and/or protecting a new cowpea cultivar, some parameters of technological grain quality must be met. For that matter, evaluations of characteristics such as grain size, color, cooking time, the percentage of whole grains after cooking, protein content, grain brightness, and resistance of the cultivar to biotic and abiotic factors (Carbonell et al., 2010) are essential for launching and indicating already existing cultivars. Therefore, studies on the technological quality of the grains from cowpea cultivars are paramount to indicate the best genotypes for the Center-South region of Brazil.

Among the abiotic factors that can reduce the bean grain technological quality, high temperatures and precipitation during the harvesting period can be mentioned (Perina et al., 2014). These factors can cause a greater amount of hard-shelled grains, longer cooking time, and stains on the grain tegument as well as diseases, thus reducing the grain quality, its acceptance by the consumer market and the product price (Carbonell et al., 2010). Therefore, sowing at appropriate times is essential so that the crop harvest does not coincide with high temperatures and precipitation, especially in regions where the crop is little cultivated (Perina et al., 2014).

The objective of this study was to evaluate whether the sowing time changes the grain technological quality of cowpea cultivars and to indicate which of these has the highest technological quality under the edaphoclimatic conditions of the Center-South region of Brazil.

Materials and Methods

The experiment was conducted in Uberaba, Minas Gerais (19°39’19” S and 47° 57127” W), in an altitude of 795 m, average annual rainfall of 1,600 mm and average temperature of 22.6 °C. The climate, according to Koppen climatic classification, is the Cwa type (subtropical dry winter - temperatures below 18 °C; and hot summer - temperatures above 22 °C) (Alvares et al., 2013). The experimental area soil is classified as “Latossolo Vermelho” (Oxisol) with a sandy loam texture (Embrapa, 2013). The soil had the following chemical attributes in its arable layer: (0.00-0.20 m): 6.3 pH (H_2O); 24.4 mg dm^{-3} of P; 89.4 mg dm^{-3} of K; 1.9 cmolc dm^{-3} of Ca; 0.7 cmolc dm^{-3} of Mg; 1.9 cmolc dm^{-3} of H^+ Al; 59.8% base saturation and 10.0 g kg^{-1} of organic matter.

Figure 1 illustrates the climatic data referring to the maximum and minimum air temperatures and rainfall, collected daily during the conduction of the experiment for the three sowing times.

The mean maximum temperatures for the sowing periods of 14/12/2012, 14/01/2013 and 14/02/2013 were 28.7, 28.1 and 27.8 °C, respectively, while the mean minimum temperatures were 19.7, 19.4 and 17.4 °C, also respectively. In turn, the accumulated precipitation for the sowing dates of 14/12/2012, 14/01/2013 and 14/02/2013 were 738, 676 and 414 mm.

The experiment was set up in a randomized block design, under a 6 x 3 factorial design, consisting of six cowpea cultivars (BRS Itaim, BRS Guariba, BRS Potengi, BRS Cauamé, BRS Novaera and BRS Tumucumaque) and three sowing seasons (14/12/2012, 14/01/2013 and 14/02/2013), with four replicates. Four planting lines composed each plot, each five meters long, with the two central lines considered as the useful area, having 0.5 m from the ends of each line disregarded. Embrapa Mid-North supplied the seeds of the cultivars used in the present study.

The chosen sowing dates were according to the climatic and cultivation characteristics from most of the Center-South region of Brazil. The dates from December to February include the rainy season of the climatic types Cwa and Aw, most common in this region and suitable for obtaining high cowpea yields. Moreover, this same period encompasses

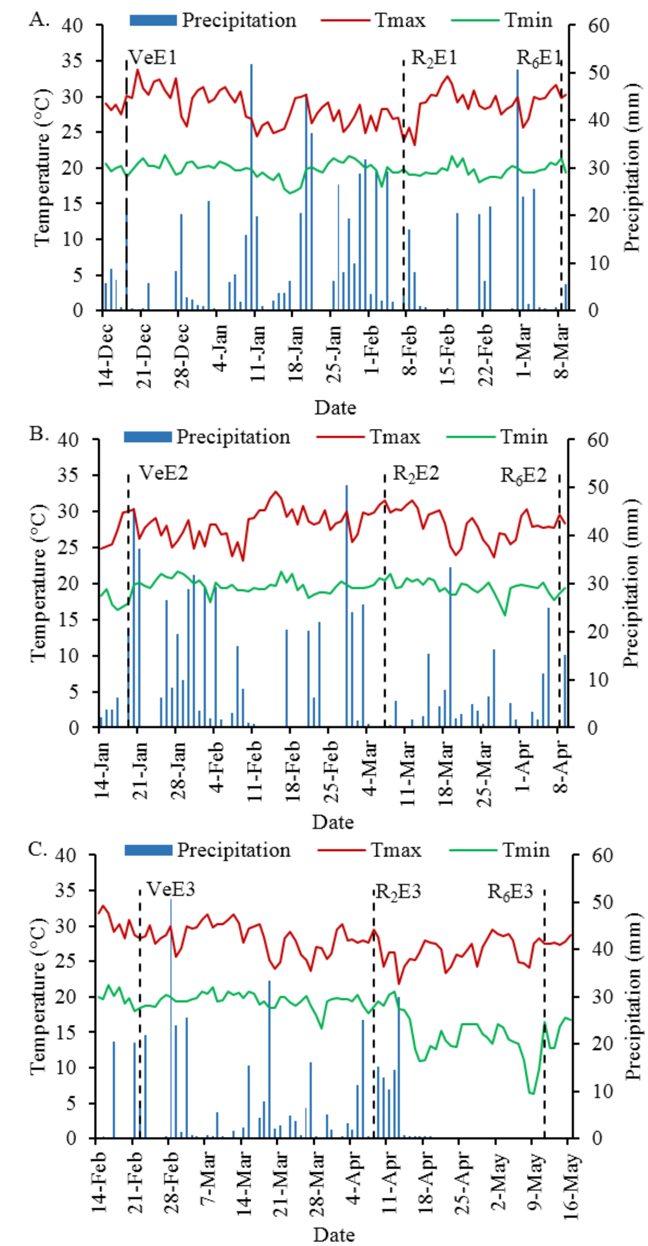

Figure 1. Mean data for every five days of precipitation, maximum and minimum temperature recorded in the experimental area from December 2012 to May 2013 in Uberaba (MG). V_e (emergency); R_2 (full bloom); R_6 (physiological maturation); E1 (A.) Sowing on 14/12/2012; E2 (B.) Sowing on 14/01/2013; and E3 (C.) Sowing on 14/02/2013.

possible areas for renewal of sugarcane fields and succession of cowpea with other grain crops, such as soybeans and maize, thus generating high applicability of the found results.

The sowing was manual in order to maintain a distribution of eight plants per meter, using a 0.40-m-spacing between rows and having an average population of 200 thousand plants per hectare (Cardoso et al., 2005).

Base fertilization was performed in the sowing furrow with 20 kg ha^{-1} P_2O_5 and 20 kg ha^{-1} K_2O, in the form of simple superphosphate and potassium chloride, respectively. The topdressing fertilization occurred 25 days after emergence of seedlings, by using 20 kg ha^{-1} of nitrogen (N) in urea form (Cardoso et al., 2005). Weed control was by manual weeding at 15 and 30 days after seedling emergence.

Harvested grains were classified by size, passing through circular sieves of 16 mm and 15 mm under agitation, for one minute. The grain mass retained in each sieve was weighed and divided by the total mass, thus calculating the percentage of grains retained in sieves 16 and 15. The other technological evaluations were performed on grains retained in sieve 15 of each plot.

The grain crude protein content (g kg^{-1}) was calculated by using the equation CPC = total N x 6.25 (AOAC, 1995), in which N represents the total N content in the grains, obtained by sulfuric acid digestion (Bataglia et al., 1983).

The cooking time was determined with the aid of an adapted Mattson cooker, consisting of 25 vertical plungers, weighing 90 g at its extremities, ending in a 1/16" tip. This tip rests on the bean grains during the cooking, and when these are cooked, it perforates the grain, thus moving the plunger. The sample cooking time was obtained when 50% + 1 of the plungers, that is, 13 in total, were moved. In order to perform this evaluation, the grains were previously hydrated in distilled water for a period of 12 hours. During the test, water temperature was maintained at 96 °C. More information on the cooking time methodology and the description of Mattson cooker can be found in Ribeiro et al. (2007).

Concerning the hydration capacity of the grains, 50 grams from each sample previously weighed were placed in plastic cups with a volume of 300 mL. After that, these samples received 200 mL of distilled water. During a period of 18 hours, there were readings of the water volume not absorbed by the grains of each sample every two hours. For this, each sample was poured over a sieve into a graduated cylinder, with accuracy of 2.5 mL, to determine the water volume not absorbed by the grains. Following this procedure, the grains and the same water were placed in a plastic cup for the next reading. At the end of 18 hours, the beans were completely drained and placed on absorbent paper for 10 min and then weighed.

Regarding the determination of the maximum hydration time, second-degree regressions were plotted for each sample between the water volume absorbed by the grains and the analysis time. The hydration ratio of the grains was obtained by the relation between the final mass of hydrated grains and their initial mass (50 grams). At the end of the test, the percentage of hard-shelled grains was determined, calculated as the ratio between the mass of unhydrated grains in relation to the total hydrated grains mass of each cultivar, after 18 hours.

Data were subjected to analysis of variance (Test F) and, when significant at 5% probability, means were compared emplying the Tukey test at 5% probability with the Sisvar software (Ferreira, 2011).

Results and Discussion

The yield of the sieves with 15 and 16 mm, the percentage of hard-shelled grains, the grain cooking time and the

Table 1. Mean square and coefficient of variation (CV) regarding the yields of the 16 (RP16) and 15 mm (RP15) sieves, percentage of hard-shelled grains (HSG), cooking time (CT), grain hydration ratio (HR) of the cowpea cultivars sown under different sowing times.

Treatments	RP16	RP15	HSG	CT	HR
Cultivars (C)	4084.9**	1.231**	91.8**	12.6**	0.12**
Sowing times (E)	2074.9**	65.8**	35.1**	239.6**	0.14**
Interaction C x E	375.0**	89.0**	35.1**	6.3**	0.03**
CV (%)	15.2	15.8	84.4	11.5	2.21
General mean	57.1	23.4	1.1	9.0	2.17

** Significant at 1% of probability by the F test.

hydration ratio were all influenced by the interaction between cowpea cultivars versus the sowing times (Table 1).

The cultivars BRS Itaim and BRS Novaera demonstrated higher percentages of grains retained in sieve 16 during the sowing on 14/12/2012 and 14/02/2013, with values ranging from 73.3 to 90.5%, respectively (Table 2). It is worth emphaiszing that on 14/02/2012, the BRS Tumucumaque and BRS Potengi cultivars also had the highest values of grains retained in the sieve 16. During the sowing on 14/12/2012, as well as on 14/02/2013 there was a higher percentage of grains retained in sieve 16 for all cultivars. BRS Guariba and BRS Cauamé had the highest percentage of grains in sieve 15 for the three sowing dates (Table 2). We also observed that the BRS Novaera cultivar demonstrated less grain retention in the sieve 15 when sown on 14/12/2012 and 14/02/2013.

The BRS Guariba and BRS Cauamé cultivars were the only ones that did not had the highest sieve 16 yield in any of the sowings. The other cultivars demonstrated a higher sieve yield 16 (mean letter "a") in at least one of the three sowings. Therefore, they are genotypes with smaller grains and which may have less acceptability by the consumer market from the Center-South region.

The grain size criterion has been adopted in the commercialization of grains; however, there is no reference in the literature concerning the methodology for this characteristic in cowpea cultivars. This demonstrates the importance of scientific studies aimed at defining the grain classification methodology that best meets the demands of the various cowpea consumption markets regarding the grain size.

In the present study we observed that, within each sowing, the cultivars with the highest sieve 16 yield, letter a in the mean test, had approximately 70% of the grains retained in that sieve (Table 2). According to Carbonell et al. (2010), higher common bean cultivars present at least 70% of the grains retained in the oblong sieve 12. Hence, there is a similarity between the values of the most consumed bean species in Brazil, although in shape and distinct sizes. Thus, the value of 70% of grains retained in the 16 mm circular sieve could be an initial parameter for determining promising cultivars for the consumer market in different regions of Brazil, requiring further studies with more cultivars to validate this reference value.

When analyzing the percentage of hard-shelled grains, only the BRS Cauamé cultivar presented such grains after 18 hours of hydration. However, during the sowing on 14/02/2013, this phenomenon was more expressive, having 15% of hard-shelled grains (Table 2). For Jombo et al. (2017) and Farinelli & Lemos (2010), the incidence these grains after the hydration period of common bean grains is directly related

Table 2. Unfolding of the interaction of cowpea cultivars and sowing period for the yields of sieve no. 16 and sieve no. 15.

Cultivars	Sieve no. 16 yield			Sieve no. 15 yield		
	(% of grains retained)					
	Sowing time					
	14/Dec	14/Jan	14/Feb	14/Dec	14/Jan	14/Feb
BRS Itaim	84.8 abA	49.6 bB	73.3 aA	10.2 dB	20.0 bcA	15.5 bcAB
BRS Guariba	50.7 dA	37.7 bcA	41.7 bA	33.3 abB	29.9 aB	40.2 aA
BRS Tumucumaque	71.3 bcA	72.1 aA	74.6 aA	23.4 cA	16.4 cB	20.1 bcAB
BRS Novaera	90.5 aA	45.7 bB	76.0 aA	4.8 eB	14.1 cA	13.3 cA
BRS Potengi	61.7 cdAB	49.9 bB	69.0 aA	25.6 bcA	25.3 abA	22.4 bA
BRS Cauamé	27.1 eA	24.9 cA	27.9 cA	37.2 aA	29.3 aB	40.5 aA
	Hard-shelled grains (%)					
	Sowing time					
	14/Dec	14/Jan	14/Feb			
BRS Itaim	0.0 bA	0.0 aA	0.0 bA			
BRS Guariba	0.0 bA	0.0 aA	0.0 bA			
BRS Tumucumaque	0.0 bA	0.0 aA	0.0 bA			
BRS Novaera	0.0 bA	0.0 aA	0.0 bA			
BRS Potengi	0.0 bA	0.0 aA	0.0 bA			
BRS Cauamé	4.1 aB	1.2 aC	15.0 aA			

Means followed by the same lowercase letter in the column and uppercase in the row, do not differ by Tukey test at 5% probability.

to situations of water stress and high temperatures during the period preceding the grain harvest season, being also a factor affected by the genotype. This is verified for the BRS Caumé cultivar, which was the only one that had hard-shelled grains in all sowing periods.

As for the cooking time of the grains, during the sowing carried on 14/01/2013 and 14/02/2013, the cowpea cultivars did not differ statistically from each other, requiring from 6 to 9 min for cooking (Table 3). During the sowing on 14/12/2012, the BRS Guariba cultivar demonstrated a longer cooking time (17 min). This result corroborates with that found by Pereira et al. (2014), who analyzing the cooking time among cowpea cultivars, found a greater value for the BRS Guariba cultivar. When analyzing the sowing period, we noticed that during the sowing on 14/12/2012, the cowpea cultivar grains needed more time for their cooking (from 11 to 17 min) (Table 3).

The grain cooking time has become an important factor for acceptance by the consumer of a given cultivar (Oliveira et al., 2013). In Brazil, some cowpea cultivars developed by the breeding program of Embrapa Mid-North have shown cooking times ranging from 13 min (BRS Tumucumaque) to 23 min (BRS Potengi), with an average of 18 min (Freire Filho, 2011). Ávila et al. (2015) observed a mean cooking time of cowpea of approximately 10 min while Pereira et al. (2014) found values between 2 and 6 min. In the latter, the values are close to those of the present study and confirm the variability in the cooking time of cowpea, either as a function of the cultivar, sowing time and environmental conditions.

In common beans, high rain levels cause changes in the grain physiological quality, thus modifying the integument integrity and water absorption (Farinelli & Lemos, 2010; Jombo et al., 2017). Such conditions may also have been responsible prolonging the cooking time of different cowpea cultivar grains, since a greater rainfall precipitation occurred in the experiment region during the cycle of the cultivars sown on 12/14/2012 (Figure 1A).

As for the hydration capacity, the grains of the BRS Tumucumaque cultivar demonstrated a higher hydration ratio (2.22 - 2.47) during the three sowing periods, when compared to the others (Table 3). In the sowing on 14/02/2013, the grains of the cowpea cultivars had a higher hydration ratio (1.95 - 2.47). Kaptso et al. (2008) found a similar result when analyzing two cowpea genotypes, verifying a hydration ratio between 2.25 and 2.45.

The BRS Cauamé cultivar presented a lower hydration ratio during the sowing on 14/12/2012 and 14/02/2013 (Table 3). Campos et al. (2010) evaluated the hydration ratio after 20 hours of soaking in five cowpea cultivars and their results ranged from 1.96 (BRS Novaera) to 2.42 (BRS Manzagão). Yet, for Rodrigues et al. (2005), the increase or reduction of the hydration capacity is directly related to climatic conditions during the crop cycle, which interfere in both the physiological quality as well as integrity of the bean grains. This was evidenced in the cultivar BRS Cauamé sown on 14/02/2013 (Table 2), in which the highest percentage of hard-shelled grains culminated in a period of greater water restriction (Figure 1C).

The crude protein content of cowpea beans is one of the factors that contribute to their high consumption in certain regions and countries (Gondwe et al., 2019), also an important parameter that can indicate cultivars with greater nutritional value. This nutritional characteristic was not altered by the interaction between cultivars and sowing times, with the effect of factors occurring in an isolated manner (Table 4). The cultivars BRS Guariba, BRS Tumucumaque and BRS Cauamé all demonstrated mean crude protein levels higher than

Table 4. Mean square and coefficient of variation (CV) for the crude protein content from cowpea cultivars sown at different periods.

Treatments	Crude protein content ($g\ kg^{-1}$)
Cultivar (C)	
BRS Itaim	222 c
BRS Guariba	244 a
BRS Tumucumaque	240 ab
BRS Novaera	227 bc
BRS Potengi	225 bc
BRS Cauamé	233 abc
Sowing time (E)	
14/Dec	228 b
14/Jan	253 a
14/Feb	215 c
C	890.20**
E	8.850.41**
Interaction C x E	251.84^{ns}
CV (%)	5.32
General Mean	232

Means followed by the same lower case letter in the column do not differ by Tukey test at 5% probability. ** significant at 5% and ns – not significant by the F test.

Table 3. Unfolding of the interaction between cowpea cultivars and sowing period for cooking time and hydration ratio.

Cultivars	Cooking time (min)			Hydration relation ---------		
	Sowing period					
	14/Dec	14/Jan	14/Feb	14/Dec	14/Jan	14/Feb
BRS Itaim	11bcA	8 aB	7 aB	2.12 bB	2.05 dC	2.25 cA
BRS Guariba	17 aA	9 aB	7 aC	2.05 cdC	2.15 bcB	2.29 bA
BRS Tumucumaque	13 bA	8 aB	6 aB	2.22 aC	2.35 aB	2.47 aA
BRS Novaera	11 bcA	9 aB	7 aC	2.10 bcB	2.10 cdB	2.25 bcA
BRS Potengi	12 bcA	8 aB	7 aB	2.10 bcC	2.17 bB	2.30 bcA
BRS Cauamé	11 cA	7 aB	6 aB	2.00 dB	2.17 bA	1.95 dB

Means followed by the same lowercase letter in the column and uppercase in the row, in each analysis, do not differ by Tukey test at 5% probability.

the other analyzed cultivars, thus indicating genotypes with greater nutritional value, especially for the less fortunate part of the population and with limited access to other protein sources.

During the sowing held on 14/01/2013, cowpea cultivars demonstrated higher crude protein levels (253 g kg^{-1}), which may have been influenced by numerous factors, from intrinsic characteristics of the cultivar to the influence of climatic factors (Pereira et al., 2014). According to Freire Filho (2011), under the conditions of the Northeast, BRS Cauamé and BRS Tumucumaque cultivars had crude protein levels of 239 and 235 g kg^{-1}, respectively, values similar to those in the present study. Hamid et al. (2016) found a mean protein content of 220 g kg^{-1} for cowpea cultivars. Thereby, cowpea has a higher protein content than common beans, where the mean is 200 g kg^{-1} (Farinelli & Lemos, 2010), making it a nutritional advantage for the cowpea.

Although there was a difference in the time required for maximum grain hydration, no significant interaction between cowpea cultivar factors and sowing dates for this characteristic were found. However, we observed the effect of the factor cultivar in isolation. Regardless of the sowing period, the time required for maximum hydration ranged from 12:24 to 14:22 for the BRS Tumucumaque cultivar and from 12:37 to 14:51 for the BRS Cauamé cultivar (Table 5).

The grain hydration process is one of the factors present in the characterization of the grain physiological quality, contributing to the extraction of some constituent of interest in the cooking, in the reduction or elimination of anti-nutritional factors existing in the grains and, consequently, in the digestibility improvement (Bhokre & Joshi, 2009). Cavariani et al. (2009) emphasized that the process in question may be affected by the integument permeability, due to variations in its thickness and composition, in addition to being affected by the cultivar and cultivation location. Campos et al. (2010) verified that the BRS Guariba and BRS Novaera cultivars, grown in Boa Vista-RR, presented times for maximum hydration of 11:48 and 11:42 hours, respectively, these values similar to those found in the present study.

Besides changing the technological quality, the sowing period also interferes with the agronomic performance of the cowpea. Evaluating the sowing period effect on this said performance, Almeida et al. (2017) verified that sowing at the beginning of the summer (December) and mid-summer (January) reduces yield in relation to sowing at the end of the same season (February) for most cultivars. According to the authors, this occurs due to the higher incidence of fungal diseases in the rainiest seasons (December and January), affecting the yield of the cultivars. Still, the authors point out that even though it is a season with low rainfall at the end of the cycle, sowing in February under the studied conditions generates greater cowpea yield, since there is an adequate water supply until the flowering at this time, and this fact is associated with the crop tolerance to water deficit. These results were similar to those found in the present study, in which the best grain technological characteristics of cowpea cultivars were with sowing in February. Thus, high rainfall amounts throughout the cycle, beyond impairing the agronomic performance of cowpea, also reduces the technological quality of its grains.

Table 5. Time for maximum grain hydration (TMH) of cowpea cultivars sown at different times.

Times	Regression equation	R^2	TMH
BRS Itaim			
14/12/2012	$y = -0.00009x^2 + 0.126x + 15.42$	0.76**	11:40
14/01/2013	$y = -0.00007x^2 + 0.108x + 13.69$	0.77**	12:51
14/02/2013	$y = -0.00009x^2 + 0.126x + 18.33$	0.70**	11:38
Mean	-	-	12:03
BRS Guariba			
14/12/2012	$y = -0.00007x^2 + 0.104x + 11.96$	0.82**	12:23
14/01/2013	$y = -0.00008x^2 + 0.119x + 14.97$	0.77**	12:24
14/02/2013	$y = -0.00008x^2 + 0.128x + 18.16$	0.73**	13:19
Mean	-	-	12:46
BRS Tumucumaque			
14/12/2012	$y = -0.00008x^2 + 0.130x + 11.69$	0.88**	13:32
14/01/2013	$y = -0.00009x^2 + 0.134x + 14.03$	0.83**	12:24
14/02/2013	$y = -0.00008x^2 + 0.138x + 16.62$	0.82**	14:22
Mean	-	-	13:38
BRS Novaera			
14/12/2012	$y = -0.00007x^2 + 0.111x + 15.40$	0.73**	13:12
14/01/2013	$y = -0.00008x^2 + 0.116x + 16.15$	0.72**	12:04
14/02/2013	$y = -0.00009x^2 + 0.130x + 20.49$	0.65**	12:02
Mean	-	-	12:38
BRS Potengi			
14/12/2012	$y = -0.00008x^2 + 0.116x + 14.24$	0.78**	12:04
14/01/2013	$y = -0.00008x^2 + 0.124x + 14.13$	0.81**	12:52
14/02/2013	$y = -0.00009x^2 + 0.135x + 17.78$	0.75**	12:30
Mean	-	-	12:46
BRS Cauamé			
14/12/2012	$y = -0.00006x^2 + 0.107x + 6.124$	0.95**	14:51
14/01/2013	$y = -0.00008x^2 + 0.133x + 7.065$	0.95**	13:51
14/02/2013	$y = -0.00007x^2 + 0.106x + 6.826$	0.92**	12:37
Mean	-	-	13:59

Amount of water absorbed (mL). R^2 = coefficient of determination; ** significant at 1% probability by the test t.

Conclusions

The sowing season alters the technological quality of cowpea grains under the conditions of the Brazilian Center-South region, with this effect dependent on the genotype.

Sowing in periods with precipitation during the whole crop cycle, such as in December and January, reduces the grain technological quality, but not the protein content. To that end, sowing in the rainiest seasons requires a greater attention when choosing the cultivar, as the difference between their productive potential and quality is greater under this condition than during sowing periods that have less precipitation at the crop cycle end (February).

Since cowpea is a crop with high tolerance to water deficit, cultivation in rainy seasons until the flowering, such as February under the studied conditions, contributes to obtaining high yields and grain quality for the Center-South region of Brazil.

Among the cultivars, BRS Tumucumaque stands out because, besides having a larger grain size, shorter cooking time and not having hard-shelled grains, it has the highest protein content among the studied genotypes, thus indicating its high nutritional value.

Acknowledgements

We would like to thank Embrapa Mid-North for supplying the seeds of the cultivars used in this study.

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