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Physiological quality of cowpea seeds under different water regimes

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Abstract

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Cowpea is one of the most cultivated legumes in the world and plays an important role in Brazilian agricultural production. In this sense, the objective of the present study was to evaluate the physiological quality of cowpea seeds from plants subjected to different water regimes. The experimental design used was in randomized blocks, with four replications. The treatments were arranged in an experimental arrangement of subdivided plots involving five levels of water replacement in the soil, via evapotranspirometric demand (120; 100; 80; 60, and 40% of ETo) in the plots and four cultivars of cowpea (*BRS Rouxinol, BRS Novaera, BRS Tumucumaque* and *BRS Itaim*) in the subplots. The harvest was carried out 90 days after planting. Water content, mass of 1000 seeds, germination, first germination count, germination speed index, root protrusion, seedling length, and fresh and dry mass of seedlings were determined. Under the conditions in which the work was carried out, all levels of water replacement favor the physiological quality of the seeds of the studied cultivars. Seeds of *BRS Novaera* and *BRS Itaim* cultivars showed better physiological potential. Smaller amounts of water are recommended for the production of quality seeds.

Keywords: Vigna unguiculata; germination; vigor; water management

Introduction

Cowpea (*Vigna unguiculata* (L.) Walp.) is among the most consumed legumes in the world, with Brazil being the third largest producer, reaching 2,9 million tons in the 2021/2022 harvest season (CONAB, 2021). It is predominantly cultivated under rainfed conditions by family farmers in the North and Northeast regions (Souza et al., 2020), and extensively in the Brazilian Semiarid (Soares et al., 2021), owing to its resilience to adverse climatic conditions (Melo et al., 2022). Cowpea, rich in proteins and low-cost, exhibits excellent productivity for family agriculture.

Cowpea cultivars possess unique genetic, physiological, and morphological characteristics. Therefore, they respond differently to local climatic conditions, which means that if planted at the same time, they may be subjected to different temperature and air humidity conditions at harvest time (Ramos et al., 2014). Furthermore, the final seed production is highly influenced by agronomic practices applied in the field, to maintain genetic purity and seed quality (Casler and Vogel, 2020).

Water is one of the primary limiting factors for cowpea development. Its excess or deficiency can disrupt biotic and abiotic factors, altering the growth and development of the crop, particularly in arid and semiarid areas, where water scarcity represents a serious limitation to socioeconomic development, necessitating the use of irrigation to enable agricultural production (Francisco et al., 2022).

When water stress occurs during the early stages of seed development, it can have negative effects on photosynthetic activity, limiting assimilate production for seed development, resulting in reduced seed physiological quality (Koch et al., 2017).

Given the above, the objective of this study was to evaluate the physiological quality of cowpea seeds from plants, subjected to different water regimes.

Material and Methods

The trial was conducted at the Experimental Farm and Seed Analysis Laboratory of the State University of Montes Claros – UNIMONTES, Janaúba-MG Campus. The region's climate, according to the Köppen classification, is of the AW type, characterized by a rainy summer and a dry winter (Alvares et al., 2013). The seeds were obtained from Embrapa Meio Norte, Teresina, PI.

The experimental design used was a randomized complete block design with four replications. The treatments were arranged in split plots involving five levels of soil water replenishment, via evapotranspiration demand (120; 100; 80; 60 and 40% of ETo) in the plots, and four cowpea cultivars (*BRS Rouxinol, BRS Novaera, BRS Tumucumaque*, and *BRS Itaim*) in the subplots.

Soil preparation was carried out conventionally, consisting of plowing and two harrowing operations. Planting fertilization was performed according to the results of soil analysis from the experimental area and based on recommendations for cowpea cultivation (Melo et al., 2005).

A medium-textured Eutrophic Red Latosol was used, classified according to SiBCS (Embrapa, 2018), with the following soil analysis results: pH = 5,9; P = 4,7 mg dm^{-3}; K = 168 mg dm^{-3}; Ca = 3,7 cmolc dm^{-3}; Mg = 0,5 cmolc dm^{-3}; Al = 0 cmolc dm^{-3}; H+Al = 1,5 cmolc dm^{-3}; SB = 4,8 cmolc dm^{-3}; t = 4,8 cmolc dm^{-3}; T = 6,3 cmolc dm^{-3}; m = 0%; V = 76%; clay content = 35%; silt content = 5%; sand content = 60%; organic matter = 1,6 dag kg^{-1}.

After sowing, daily irrigations were carried out for one hour until the primary leaves opened. After this period, a preset irrigation schedule of every two days was implemented. Once the plants reached four true leaves, the treatments with five levels of water replenishment were initiated, according to evapotranspiration demand by the Penman-Monteith-FAO method (Allen et al., 2006), using data collected from the local meteorological station. A semi-automated drip irrigation system was used, consisting of a control head composed of a filtering mechanism (150 mesh disk filter), volumetric doser, pressure regulator valve, dedicated 6-station controller, electric valve control system, Mixrite® fertilizer injector, and gate valve.

Harvesting was done manually 90 days after planting, when the seeds reached physiological maturity, corresponding to stage R5, where plants had yellow leaves and dry pods (Campos et al., 2000). The harvested pods were placed in sealed plastic bags, identified according to the treatment, and sent to the seed laboratory, where manual threshing was performed to remove the seeds, separating them from inert material and broken seeds.

The thousand seed weight was determined from the pure seed portion, where eight replicates of 100 seeds were randomly selected for each cultivar (Brazil, 2013).

Initially, seed moisture content was determined using the oven method at 105 ± 3°C for 24 hours, using four replicates of 50 seeds, with results expressed as a percentage (Brazil, 2013).

For the germination test, seeds were sown in germitest® paper rolls, moistened with distilled water at a volume equivalent to 2,5 times the weight of the dry paper. The rolls were kept in a germinator previously set at a constant temperature of 25°C, and evaluations of normal seedlings were made on the fifth and eighth days after test setup, with results expressed as a percentage. Normal seedlings were considered those presenting complete, developed, proportional, and healthy essential structures (Brazil, 2013).

Root protrusion was evaluated 48 hours after test setup, which consisted of determining the number of seeds that emitted a radicle with a minimum length of 2 mm, with results expressed as a percentage (Pereira et al., 2012).

The first germination count was performed together with the germination test, which involved counting the number of normal seedlings, emerged on the fifth day after sowing, with results expressed as a percentage (Brazil, 2013).

The germination speed index (GSI) was performed together with the germination test, counting the number of normal seedlings emerged daily until the end of the test. With the obtained data, the GSI was calculated according to the formula proposed by (Maguire, 1962).

Seedling length was measured on the eighth day after sowing, using ten normal seedlings (primary root and hypocotyl) from each replicate, with the aid of a millimeter ruler, and results were expressed in centimeters per seedling.

The determination of fresh and dry seedling weight was performed using the previously measured normal seedlings, which were weighed on a balance with a precision of 0,001 g to obtain fresh weight. Subsequently, the seedlings were placed in paper bags and taken to an air-circulating oven at 65°C until reaching constant weight, for 72 hours. After this period, the samples were weighed again to obtain the dry weight, and results were expressed in g per seedling.

The data were subjected to analysis of variance using the F-test. For significant interaction among cultivars, means were compared by Turkey's test at 5% probability; for interaction between factors and the isolated water replenishment levels factor, an analysis was done through polynomial regression, using the SISVAR statistical software (Ferreira, 2019).

Results and Discussion

The moisture content of the cultivars ranged from 8.8 to 9.1%, values considered ideal for orthodox seeds, such as cowpea, which are capable of tolerating drying at low moisture levels. This fact is important for greater reliability of the results obtained in the other tests performed because, according to Steiner et al. (2011), similar moisture contents are essential so that germination and vigor tests are not affected by differences in metabolic activity, wetting speed, and seed deterioration intensity.

Moisture has a direct effect on seed quality and longevity. Therefore, monitoring seed moisture in production systems is of great importance, because moisture stimulates embryo metabolic activity, reducing seed quality and vigor, directly affecting germination power (Pereira et al., 2022). Seeds with moisture content of 8.8 and 9.1%, as observed in the present study, decrease pest and fungal attacks, ensuring that seeds maintain quality during storage (Carvalho and Nakagawa, 2012).

The interaction between the factors, water replenishment levels, and cultivars, was significant ($P < 0,05$) for the variables first germination count, germination speed index, and root protrusion (Table 1). For the isolated analysis of the factors, there was a significant effect ($P < 0,05$) of water replenishment levels only for germination. The cultivar variation significantly influenced the thousand seed weight, seedling length, fresh and dry seedling weight.

Analyzing the seed germination variable, it is observed that there was an effect of water replenishment levels only for the cultivar *BRS Itaim*, showing a quadratic behavior (Figure 1). The highest rates were obtained when seeds were produced under the application of the lowest irrigation depth (40% of ETo), making it possible to achieve 87% germination under these conditions. These results indicate that even when produced under a stress situation, characterized by lower soil water availability, plants stood out in producing seeds of the *BRS Itaim* cultivar with a higher germination percentage. However, from this point, there were decreases in values, reaching 73% germination under conditions of 100% of ETo, representing a reduction of 10.96% compared to 40% soil moisture. Subsequently, there were increases in germination values, ending with 79% under 120% ETo conditions.

França et al. (2020) observed a variation of 61 to 100% in the germination percentage of snap bean seed cultivars from different harvests and water replenishments.

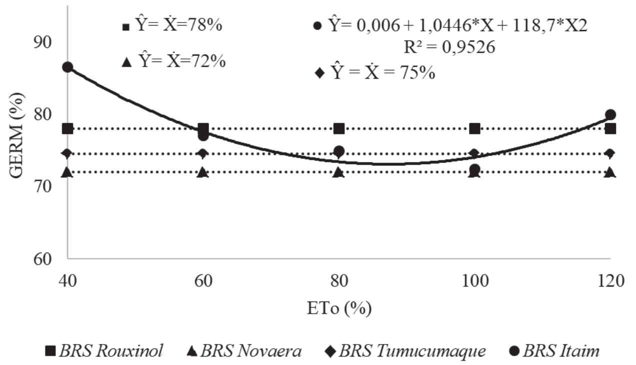

Fig. 1. Germination (GERM) of cowpea cultivar seeds, *BRS Itaim*, produced under different levels of soil water replenishment
Source: Authors' own elaboration

Table 1. Summary of the analysis of variance for the variables germination (GERM), first germination count (FGC), germination speed index (GSI), root protrusion (RP), seedling length (SL), fresh mass (FM), dry mass (DM) and mass of 1000 seeds (M1000) of cowpea cultivars (C), produced under different levels of water replenishment (N)

SV	DF	GERM (%)	FGC (%)	GSI –	RP (%)	SL (cm)	FM (g)	DM (g)	M1000 (g)
Water replen. levels (N)	4	460.83*	323.95 ^{ns}	29.53 ^{ns}	309.50 ^{ns}	7.60 ^{ns}	44.23 ^{ns}	2.02 ^{ns}	0.89 ^{ns}
Block (B)	3	134.05 ^{ns}	471.80 ^{ns}	0.95 ^{ns}	197.20 ^{ns}	1.10 ^{ns}	24.62 ^{ns}	1.39 ^{ns}	1.02 ^{ns}
Error 1	12	72.93	249.72	15.45	66.53	6.33	26.36	0.87	0.93
Cultivars (C)	3	202.18 ^{ns}	93.40 ^{ns}	42.17*	196.37 ^{ns}	60.92*	610.32*	12.46*	82.11*
N x C	12	71.56 ^{ns}	146.15*	23.93*	152.53*	4.13 ^{ns}	54.22 ^{ns}	1.36 ^{ns}	1.87 ^{ns}
Error 2	45	98.39	76.67	10.64	74.31	4.14	30.66	0.96	2.32
CV (N)	–	11.36	26.10	14.18	24.16	19.88	18.91	17.83	5.12
CV (C)	–	13.20	14.46	11.77	14.86	16.08	20.39	18.68	8.09

SV = Sources of Variation; CV = Coefficient of Variation; DF = Degrees of Freedom; *Significant by F test at 5%; ns = not significant.
Source: Authors' own elaboration

The reduction in germination values of seeds produced under conditions of higher soil moisture levels may be related to hypoxia, a condition of oxygen deficiency. In an anaerobic environment, metabolism shifts from respiration to fermentation, resulting in the malfunction of various enzymes, which can lead to cell collapse (Ogawa et al., 2016).

The germination of the cultivars (*BRS Rouxinol*, *BRS Novaera*, and *BRS Tumucumaque*) was not influenced by the irrigation levels applied to the plants during seed production. These cultivars showed average values of 78%, 72%, and 75%, respectively (Figure 1), indicating that it is possible to use lower amounts of water in the soil and still achieve good physiological seed quality.

It is important to highlight that the germination percentage obtained under the water conditions of 40% of ETo (87%) exceeds the standard for the commercialization of cowpea seeds, surpassing the minimum percentage required by the Ministry of Agriculture, Livestock, and Supply for basic seeds of 70% and for certified seeds of the first and second generation, S1 and S2 seeds, of 80%, according to Normative Instruction n No 45 (Brazil, 2013). For seeds from other cultivars, the values obtained only met the requirements for the commercialization of basic seeds. Therefore, Pereira et al. (2022) emphasize that producers, who use irrigation systems in their crops, may save costs with management, while maintaining seed quality standards according to the legislation.

According to Marcos Filho (2015), water is one of the factors that most compromises seed germination, as it is responsible for reactivating metabolism and other steps, involved in the germination process. Under natural conditions, the ability of seeds from some species to germinate under conditions of low water availability confers ecological advantages to them (Carvalho and Nakagawa, 2012).

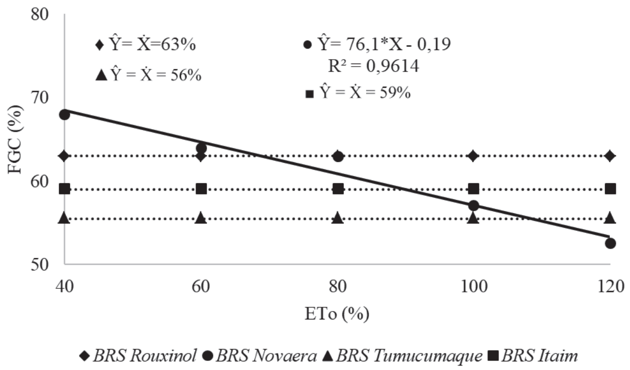

Fig. 2. First germination count (FGC) of cowpea cultivar seeds, *BRS Novaera*, produced under different levels of soil water replenishment

Source: Authors' own elaboration

For the first germination count, which allows inference about the speed of seed germination, there was an effect of water replenishment levels only for the *BRS Novaera* cultivar, showing a decreasing linear behavior (Figure 2). The estimated value of the first germination count was 68% at 40% of ETo, decreasing linearly as the water availability increased until reaching 53% at 120% of ETo, representing a decline of 37.5%, reinforcing the influence of adequate water availability on the speed of seed germination of the *BRS Novaera* cultivar. In line with the results obtained, França et al. (2020) observed an increase in seed vigor of snap beans, assessed by the first germination count test, when they were subjected to depths of 25% to 125%.

The first germination count is based on the principle that samples with higher percentages of normal seedlings are the most vigorous, as they exhibit faster germination rates. Thus, it can be used as a vigor test.

One possible explanation for the reduction in the first germination count at higher water levels, is that excess moisture may have caused damage to the seeds from cultivated plants, due to rapid imbibition, resulting in inadequate soil aeration, reduced potassium absorption, and nitrification. All these factors tend to favor a reduction in vigor, as the establishment of a seedling stand in the field is directly proportional to the speed of emergence and growth of their parts (Wendt et al., 2017).

Oliveira et al. (2017) emphasize that vigor and germination are essential stages to avoid losses, and are crucial for the establishment of bean crops, as rapid and uniform seedling fixation in the field is a fundamental prerequisite for achieving adequate stand establishment, ensuring productivity, and product quality (Marcos Filho, 2015).

Analyzing the breakdown of cultivars within each water replenishment level for the variable of first germination count, a significant difference was observed only at the 40% water replenishment level, where the cultivars *BRS Rouxinol* and *BRS Novaera* were statistically superior to the cultivar *BRS Tumucumaque*, which, in turn, did not differ from the cultivar *BRS Itaim* (Table 2).

These results suggest that these cowpea cultivars may have adopted strategies, such as physiological and biochemical adaptation mechanisms, to increase their tolerance to low soil water levels, in agreement with the findings of Silva et al. (2018). Dutra et al. (2015) also found that the highest physiological rates of the *'BRS Guariba'* and *'BRS Marataoã'* cultivars were found with 40% of ETo, highlighting what may characterize greater tolerance to water deficit.

Some studies demonstrate that vigor is always more affected than germination when subjected to low water levels,

Table 2. First germination count (%) of seeds of cowpea cultivars, produced under different levels of soil water replacement

Cultivars	Water Replenishment Levels (%)				
	40	60	80	100	120
BRS Rouxinol	67.50 a	64.50 a	53.00 a	60.00 a	61.50 a
BRS Novaera	68.00 a	64.50 a	59.00 a	57.00 a	52.50 a
BRS Tumucumaque	48.50 b	68.50 a	55.00 a	52.00 a	66.00 a
BRS Itaim	57.00 ab	74.00 a	59.00 a	53.00 a	55.50 a
CV (%)		14.46			

Means, followed by the same letter in the column do not differ significantly according to Tukey's test at 5% probability.
Source: Authors' own elaboration

as seen in corn (Machado et al., 2020) and soybean (Carvalho et al., 2016) seeds. According to Marcos Filho (2015), the behavior of seeds is based on genotype, so there are cultivars that produce seeds with better physiological performance within the same species.

The interaction between water replenishment levels and cultivars influenced the IVG, with a significant effect only for the *BRS Tumucumaque* cultivar (Figure 3). The highest indices (31.52) were observed with a water availability of 40%, decreasing to the level of 83.40% of ETo, where it was possible to obtain IVG of 25.50 under these conditions, representing a decline of 16.25%. According to Gonçalves et al. (2017), differences in irrigation levels are certainly associated with the cultivar, the time of conducting the experiment, the local climatic conditions, as well as the method used to estimate ETo.

No cultivar breakdown within each water replenishment level for GSI, significant differences were observed at the 60 and 120% water replenishment levels (Table 3). At 60% of ETo, the GSI values of the *BRS Tumucumaque* cultivar were higher compared to the *BRS Rouxinol* cultivar, which, in turn, did not show statistical differences from the *BRS Novaera* and *BRS Itaim* cultivars. Meanwhile, at 120% of ETo, the *BRS Novaera* and *BRS Tumucumaque* cultivars exhibited statistically higher indices compared to the BRS Itaim cultivar, which, however, did not differ from the BRS Rouxinol cultivar. Higher GSI values indicate that the seeds from a particular sample exhibited a faster initial development, thus indicating greater vigor.

For the production system, seeds are the primary input, and their physiological quality is the factor responsible for the initial development in the field, ensuring crop guarantee and high productivity (Rodrigues et al., 2018). Thus, it is important to highlight that for most of the studied cultivars, the levels of soil water replenishment did not influence the IVG, indicating that even under conditions of lower soil water availability, the produced seeds germinated more rapidly and uniformly, expressing greater vigor.

Root protrusion was significantly influenced by the levels of soil water replenishment only for the *BRS Novaera* and *BRS Tumucumaque* cultivars, whose results were fitted to quadratic regression equations (Figure 4).

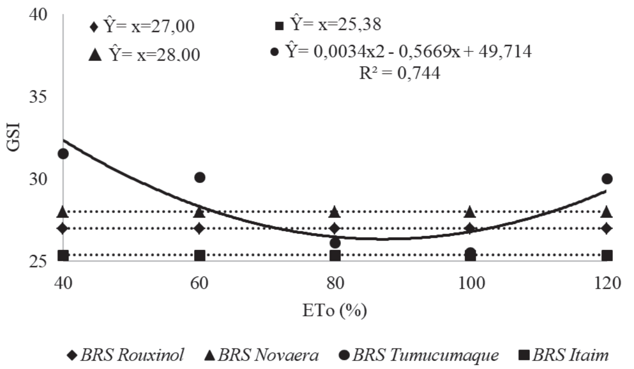

Fig. 3. Germination Speed Index (GSI) of cowpea cultivar seeds, *BRS Tumucumaque*, produced under different levels of soil water replenishment
Source: Authors' own elaboration

Table 3. Germination Speed Index (GSI) of cowpea cultivar seeds under different levels of soil water replenishment

Cultivars	Water Replenishment Levels (%)				
	40	60	80	100	120
BRS Rouxinol	28.68 a	23.46 b	30.24 a	25.31 a	27.81 ab
BRS Novaera	27.66 a	29.51 ab	25.99 a	27.88 a	32.09 a
BRS Tumucumaque	31.52 a	30.12 a	26.11 a	25.50 a	30.54 a
BRS Itaim	26.93 a	24.26 ab	28.24 a	25.38 a	25.07 b
CV (%)		11.77			

Means, followed by the same letter in the column do not differ significantly according to Tukey's test at 5% probability.
Source: Authors' own elaboration

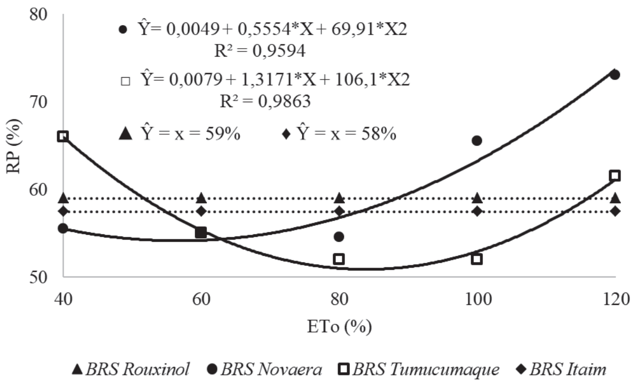

Fig. 4. Root protrusion (RP) of cowpea cultivar seeds, *BRS Novaera* and *BRS Tumucumaque*, produced under different levels of soil water replenishment
Source: Authors' own elaboration

For the cultivar *BRS Novaera*, it is possible to observe that at 40% of the ETo, the estimated value of root protrusion was 65%, decreasing from this point onwards and reaching 54.10% under the water replenishment condition of 57.52% of the ETo, showing a decline of 18.70%. Subsequently, there was an increase in values as the water replenishment levels increased, ending with 73% of protrusion at 120% of the ETo, providing the highest estimated values of root protrusion. For the cultivar *BRS Tumucumaque*, the highest percentages of root protrusion (66%) were observed at the water replenishment level of 40% of the ETo, decreasing as the water availability increased up to 83.36% of the ETo, reaching 51.20% of protrusion, representing a decline of 37%. From this point onwards, there was an increase in values as the water availability increased, reaching 62% with 120% of the ETo.

Water provides metabolic reactions that mobilize the energy reserves contained in the cotyledons, making carbohydrates available to the cells, thus promoting embryo development and consequently plant development. Thus, seeds with rapid radicle growth can be classified as potentially more vigorous, as they provide higher growth rates in the initial stages of development (Dutra et al., 2007). When evaluating the effect of different soybean cultivars, Carvalho et al. (2016) found that cultivars with greater tolerance to water stress developed a more extensive root system.

Seeds have reserves in the cotyledons, which under ideal environmental conditions are metabolized, forming the radicles and later the hypocotyl (Araújo et al., 2018). When there are restrictions on water availability for plants during the seed production phase, seed vigor may decrease if the occurrence happens during the storage of reserves or close to seed maturation (Aumonde et al., 2019). Excess water can cause problems due to restrictions on aeration and possible damage during imbibition, as it reduces the development of meristematic tissues and exposes the seeds to adverse environmental conditions for a longer period, resulting in a reduction in the development and establishment of the bean's root system (Marcos Filho, 2015).

Studying the breakdown of cultivars within the water replenishment levels for root protrusion, there was a significant difference between cultivars only at the 120% water replenishment level, where the *BRS Novaera* cultivar showed superior results compared to the other cultivars, differing from the BRS Itaim cultivar, which, in turn, did not show significant differences from the *BRS Rouxinol* and *BRS Tumucumaque* cultivars (Table 4).

As previously reported, it is observed that, similarly to the other variables, the results showed that for most cultivars, the levels of water replenishment did not influence root protrusion, allowing for the use of lesser amounts of water and obtaining high-quality seed production.

These results are likely related to the fact, that the effect of different levels of water replenishment during the vegetative development of cowpea, combined with genetic factors, allowed for the accumulation of reserves, which were later transported to the seeds for embryo and reserve organ formation and growth (Carvalho and Nakagawa, 2012).

For the variables such as thousand seed weight, seedling length, fresh seedling weight, and dry seedling weight,

Table 4. Root protrusion (%) of cowpea cultivar seeds, produced under different levels of soil water replenishment

Cultivars	Water Replenishment Levels (%)				
40	40	60	80	100	120
BRS Rouxinol	59.00 a	44.50 a	62.50 a	60.00 a	57.50 ab
BRS Novaera	55.00 a	55.00 a	54.50 a	65.50 a	73.00 a
BRS Tumucumaque	66.00 a	55.00 a	50.50 a	52.00 a	61.50 ab
BRS Itaim	63.00 a	49.00 a	61.50 a	57.50 a	56.50 b
CV (%)		14.08			

Means, followed by the same letter in the column do not differ significantly according to Tukey's test at 5% probability.
Source: Authors' own elaboration

Table 5. Thousand seed weight (M1000), seedling length (SL), fresh mass weight (FM), and dry mass weight (DM) of cowpea cultivars produced under different levels of soil water replenishment

Cultivars	M1000 (g)	SL (cm)	FM (g planta^{-1})	DM (g planta^{-1})
BRS Rouxinol	169.60 b	12.08 b	23.68 b	4.74 b
BRS Novaera	201.50 a	11.74 b	25.60 b	5.22 b
BRS Tumucumaque	172.20 b	11.56 b	24.00 b	4.65 b
BRS Itaim	209.30 a	15.26 a	35.34 a	6.37 a
CV (%)	8.90	16.08	20.39	18.68

Means, followed by the same letter in the column do not differ significantly according to Tukey's test at 5% probability.
Source: Authors' own elaboration

isolated effects were observed only for the cultivar factor (Table 5). It is observed that seeds from the *BRS Itaim* cultivar presented higher means in all variables, with the *BRS Novaera* cultivar not differing from *BRS Itaim* in thousand seed weight, showing higher values compared to the other cultivars.

According to Vieira (2013), seeds from genotypes with higher fresh weight have greater efficiency in their cellular metabolism, as they can convert their reserves into energy for optimal seedling growth. Additionally, evaluating seedling length and dry matter are important for vigor assessment, as they represent greater uniformity in seedling emergence.

Thousand seed weight is of high importance as it is used for seeding density calculation, and to estimate seed physiological quality, maturity, and health (Barros et al., 2021). Therefore, having a higher thousand seed weight is an interesting characteristic for the *BRS Novaera* and *BRS Itaim* cultivars, as it is related to seed vigor. As stated by Carvalho and Nakagawa (2012), larger seeds contain well-developed embryos and larger reserves, making them potentially more vigorous.

Choosing the appropriate genotype is considered essential for determining tolerance to water stress and adverse conditions in the field. According to Grzybowski et al. (2019), in the absence of soil moisture, when the genotype exhibits certain tolerance to water deficit, the effect of seed vigor is significant in crop establishment, as the interaction between genotype and environment affects the efficiency of carbon production and distribution in the plant for its full growth (Koch et al., 2017).

Conclusions

The physiological quality of seeds can be understood as the set of characteristics or attributes that determine the quality of seeds with action, determined by the levels of water replacement of the evaluated cultivars. Thus, we can observe that water replacement during the planting condition of the evaluated cowpea cultivars (*BRS Rouxinol, BRS Novaera, BRS Tumucumaque*, and *BRS Itaim*), is a key factor for the success of seed production. Among the analyzed cultivars, *BRS Novaera* and *BRS Itaim* cultivars showed better physiological potential.

This ability to adjust the functional characteristics of cowpea seeds to water conditions is essential for seed physiological quality, and lesser amounts of water should be used for the production of quality seeds.

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Declaration of interest's statement

The authors declare no conflict of interest.

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