PHYSIOLOGICAL PERFORMANCE OF COMMON BEAN SEEDS PRODUCED IN RIO GRANDE DO SUL - BRAZIL

Thainá Fogliatto Moreira[1], Eveline Ferreira Soares[1], Stela Maris Kulczinsky[2], Daniela da Silva[3], Bruna Cariolato Moreira[4], Rodrigo Couto Santos[5]

[1] Alunas de doutorado, Programa de Pós-graduação em Fitotecnia, Universidade Federal do Rio Grande do Sul (UFRGS); thainafogliatto@gmail.com
[2] Docente do curso de Agronomia, Universidade Federal de Santa Maria (UFSM)
[3] Aluna de doutorado, Programa de Pós-graduação em Agronomia, Universidade de Passo Fundo (UPF)
[4] Bióloga, Universidade Federal de Santa Maria (UFSM)
[5]Docente do curso de Engenharia Agrícola, Universidade Federal da Grande Dourados (UFGD)

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ABSTRACT

In Brazil, the common bean is cultivated in both small and large rural properties and under different production systems, representing great social and economic importance. For its cultivation, it is essential to use seeds of good physiological quality. However, this has become a challenge due to the fact that the vast majority of farmers save their own production and use it to implement their crops in the next harvest. The objective of this work was to evaluate the physiological quality of seeds of common bean cultivars IPR Urutau, IAC Veloz, IPR Tuiuiu, IPR Uiapuru, and BRS Esteio, produced in Rio Grande do Sul. The experimental design used for the physiological tests was completely randomized, with eight replications per cultivar. Data were submitted for analysis of variance, and means, when significant, were compared using the Scott-Knott test ($p < 0.05$) for error probability. All bean cultivars analyzed are within the minimum standard for commercialization required by the Brazilian Ministry of Agriculture. Seedlings with greater development and greater mass production result from more vigorous cultivars. Of the cultivars observed, Veloz stands out, as it presents the highest germination, favoring its physiological performance superior to the other cultivars.

KEYWORDS: Germination; *Phaseolus vulgaris*; Physiological potential.

DESEMPENHO FISIOLÓGICO DE SEMENTES DE FEIJÃO COMUM PRODUZIDAS NO RIO GRANDE DO SUL – BRASIL

RESUMO

No Brasil, o feijoeiro é cultivado tanto em pequenas quanto em grandes propriedades rurais e sob diferentes sistemas produtivos, representando grande importância social e econômica. Para o seu cultivo é essencial o uso de sementes de boa qualidade fisiológica. Porém, isso tem se tornado um desafio pelo fato de a grande maioria dos agricultores salvarem sua própria produção e utilizarem para a

implantação de suas lavouras na safra seguinte. O objetivo desse trabalho foi avaliar a qualidade fisiológica de sementes das cultivares de feijão comum IPR Urutau, IAC Veloz, IPR Tuiuiu, IPR Uiapuru e BRS Esteio, produzidas no Rio Grande do Sul. O delineamento experimental utilizado para os testes fisiológicos foi inteiramente casualizado com oito repetições por cultivar. Os dados foram submetidos à análise de variância e as médias quando significativas foram comparadas pelo teste de Scott-Knott ($p < 0,05$) de probabilidade de erro. Todas as cultivares de feijão analisadas estão dentro do padrão mínimo para comercialização exigido pelo Ministério da Agricultura do Brasil. Plântulas com maior desenvolvimento e maior produção de massa são resultantes de cultivares mais vigorosas. Das cultivares observadas, destaca-se a Veloz, por apresentar a maior germinação, favorecendo seu desempenho fisiológico superior às demais cultivares.
PALAVRAS-CHAVE: Germinação; *Phaseolus vulgaris*; Potencial fisiológico.

INTRODUCTION

The bean (*Phaseolus vulgaris L*.) is an important crop in Brazil due to its notoriety in the Brazilian diet, and the grain is a source of proteins, carbohydrates and iron. Its production is verified in subsistence crops, with emphasis on small producers, as well as highly mechanized crops (QUINTEIRO; BALDINI, 2018).

A good part of bean crops is carried out using non-certified seeds because most farmers save their production for later implantation of the crop in the new season (ABRASEM, 2020). Given this, the physiological quality of these grains is not assured and may have low germination and vigor, as well as a high rate of contamination by pathogens, factors that affect the emergence of seedlings and generate losses in productivity (KRZYZANOWSKI *et al.,* 2018).

According Kryzanowski *et al.* (2022), the use of good quality seeds is essential to obtain good crop productivity, as is the case with a common bean. Its quality is represented by the action of the genetic, physiological, physical and sanitary components that are related to the cultivars (OLIVEIRA *et al.,* 2019).

It is understood that physiological quality is the capacity of the seed to perform its vital functions through the germination process, vigor and longevity under favorable edaphoclimatic conditions (TEJO *et al.,* 2021). The physiological quality can be validated by germination and vigor indices (VAZQUEZ; SÁ, 2015). Recent studies using different common bean cultivars reveal that they differ in terms of their physiological quality (SANTOS *et al*., 2019; ARAÚJO NETO *et al*., 2020). Therefore, it is necessary that bean cultivars have good physiological quality, otherwise, they will not manifest their maximum productive potential. Therefore, this study aimed to evaluate the physiological performance of common bean cultivar seeds produced in Rio Grande do Sul.

MATERIAL AND METHODS

The seeds used in the study were purchased from farmers in the cities of Cruz Alta (RS), Pejuçara (RS) and Seberi (RS). The cultivars used were IPR Urutau, IAC Veloz, IPR Tuiuiu, IPR Uiapuru and BRS Esteio, all of the common black-type beans.

Physiological analyses were conducted at the Laboratory of Phytopathology and Seed Production and Technology of the Department of Agronomic and Environmental Sciences at the Federal University of Santa Maria, Campus of Frederico Westphalen/RS.

The physiological quality of the seeds was evaluated with the germination

tests described by (BRASIL, 2009) and the vigor tests proposed by (KRZYZANOWSKI *et al.,* 2018), which considered physiological and resistance tests.

Physiological tests

The germination test used 400 seeds per treatment divided into four replicates of 50 each. The tests were installed following the recommendations of the “Regra de Análise de Sementes” (RAS) (BRASIL, 2009). These were distributed on the substrate composed of three layers of paper (Germitest), moistened with distilled water at 2.5 times its weight. After making the rolls, they were placed in a Biochemical Oxygen Demand (BOD) type germinator at a constant temperature of 25 (±2) ºC, with relative humidity between 80-85% and a photoperiod of 12 hours. The counts occurred on the fifth and ninth days, totaling, in the final count, the percentage of normal, abnormal and dead seedlings (BRASIL, 2009). Together with the germination test, the first germination count was performed, resulting in the percentage of normal seedlings on the fifth day after the installation of the test (BRASIL, 2009).

For the length of the shoot and primary root of the seedling, eight replicates were used with 50 seeds per treatment, in which ten normal seedlings were randomly removed for each treatment. The length of the shoot was obtained by measuring the distance between the insertion of the basal portion of the primary root to the apex of the shoot, while the length of the radicle was defined by measuring the distance between the apical and basal part of the primary root with the aid of a digital caliper and expressed in millimeters.

According to Campuzano-Duque and Blair (2022), regarding the green and dry mass seedlings, both determinations must be made with ten samples, each using a precision scale (grams). Thus, after weighing the seedlings, they were placed in paper bags and kept in an oven at 65 ºC until they reached constant weight, and the dry mass value was computed.

The seedling emergence test in the field was carried out in flower pots where four replications were sown with 25 seeds per cultivar, which were later kept in a greenhouse at a temperature of 23 ºC and humidity of 80% for ten days. The results were expressed as a percentage of normal seedlings. The standard for counting was determined when the emerged seedling had expanded primary leaflets. The end of the trial occurred when there was stabilization of seedling emergence. The evaluations were carried out ten days after sowing and the result was expressed as a percentage of normal seedlings emerged.

The evaluation of the Speed of Emergence Index was carried out in conjunction with the seedling emergence test in the field. From the beginning of emergence, the number of emerged seedlings was counted following Equation 1 proposed by Maguire (1962).

$$ESI = (G1/N1)+ (G2/N2)+ ... + (Gn/Nn) \quad (1)$$

Wherein:
ESI = Emergency Speed Index;
G = number of normal seedlings computed in the counts;
N = number of days from sowing to the 1st, 2nd, and nth evaluation.

The height of the aerial part of the seedling was performed on the tenth day, along with the emergence test, measuring only the aerial part of the seedling with the aid of a ruler. Ten plants were measured for each replication (SALES *et al.,* 2021).

Resistance test

The accelerated aging test was carried out using *Gerbox* boxes that contained a stainless-steel screen inside where the seeds were uniformly distributed. Inside the box, 40 ml of water was added. The boxes were closed and kept in BOD incubator chambers at 41 ºC for 72 h (SANTOS *et al.,* 2004). After this period, the germination test was performed, as previously described. The evaluation took place on the fifth day, and the number of normal seedlings was determined (BRASIL, 2009).

The data obtained in each test were subjected to analysis of variance, and when a significant difference was observed, the Scott-Knott means comparison test ($p < 0.05$) was performed using the SISVAR ® software (FERREIRA, 2011).

RESULTS AND DISCUSSIONS

Physiological Quality

Common bean cultivars showed significant differences in terms of physiological quality. The germination results obtained through the percentage of normal seedlings (PN) revealed a significant difference between the cultivars (Table 1), indicating that all had germination greater than 80%. Among them, the Veloz cultivar stands out for presenting the highest germination rate of normal plants (90.25%) and Tuiuiu for the lowest germination (83.75%), but it does not differ significantly from the other cultivars. All cultivars analyzed are within the minimum standard required by the Ministry of Agriculture for commercialization, which is above 80% (BRASIL, 2013).

TABLE 1- Percentage of germination at the first count (PC) and accelerated aging (EA) of seeds of different cultivars of common bean (*Phaseolus vulgaris*).

Cultivars	Germination (%)			PC (%)	EA (%)
	PN	PAN	SM		
Esteio	85.75 b	7.50 b	6.75 a	82.50 b	66.00 a
Tuiuiu	83.75 b	11.25 a	5.75 a	71.50 b	64.50 a
Uirapuru	85.00 b	7.00 b	8.00 a	82.50 b	53.00 b
Urutau	85.00 b	8.00 b	7.00 a	81.00 b	56.00 b
Veloz	90.25 a	5.00 b	4.50 a	89.25 a	70.50 a
CV(%)	5.2	41.7	47.32	6.68	19.47

*Means followed by the same letter in the column, do not differ from each other by the Scott-Knott test ($p < 0.05$). PN= Normal Seedlings; PAN= Abnormal Seedlings; SM= Dead Seeds; PC= First Count; EA= Accelerated Aging. CV (%)= Coefficient of Variation.

Suzana *et al.* (2017) found similar results when evaluating 21 lots of common bean seeds, verifying that most of those used in the Middle-Upper Uruguay region of Rio Grande do Sul presented ideal germination, above 80% as recommended by the Ministério da Agricultura (Brazilian Ministry of Agriculture).

Santos *et al.* (2019) evaluated the physiological quality of two seed lots of the ANfc 9 and IPR Tangará bean cultivars from the Paraná state, whether they were

commercial or saved, and found that for the germination variable, there was a difference between the lots, the commercial ones from lots 1 and 3 had germination percentages between 97 and 96.5%, while batches 2 and 4 were 79% and 47%.

Araújo Neto *et al.* (2020) evaluated 15 lots of the black-type beans seeds produced by family farmers and by the Agricultural Research Company of Minas Gerais (EPAMIG) and found that lots black-type 10, black-type 12 and black-type 15 had germination percentages lower than 80 %, that is, outside the standards acceptable by current legislation.

Regarding the variable abnormal seedlings (PAN), it was verified that there was a difference between the cultivars, with Tuiuiu standing out for the highest percentage (11.25%), followed by Urutau with 8%, however, it did not differ from the Uirapuru cultivars, Esteio and Veloz. Notably, a seedling abnormality is a measure inversely proportional to seed vigor and whose characteristic determines the potential loss of its germination capacity (PINHEIRO *et al.,* 2019).

As for the variable dead seeds (SM), expressed in percentage, there was no significant difference between cultivars, with values ranging from 4.50% to 8%. Thus, the Veloz cultivar had the highest physiological potential, mainly because it had the highest value of normal plants (90.25%), followed by the lowest values of abnormal seedlings (5%) and dead seeds (4.50%).

When examining the vigor of bean seeds through the first count (PC) germination test (Table 1), it was found that the Veloz cultivar was the most vigorous, with 89.25% germinating five days after the test was implemented, differing significantly from the other cultivars. The Tuiuiu cultivar had the lowest vigor (71.50%) and, consequently, the lowest germination and the highest number of abnormal seedlings.

Chagas *et al.* (2018), when evaluating the physiological quality of cowpea seeds, found that the Paulista genotype had the lowest germination (84.5%) and consequently the highest percentage of abnormal seedlings (15%) and dead (0.50%). Studying the physiological quality of cowpea creole seeds, Dantas *et al.* (2023) found that although most samples had a high percentage of radicle emission, this did not translate into a high percentage of vigorous seedlings since most samples had abnormal seedlings.

The physiological quality of seeds is related to their ability to perform their vital functions, the effects on their quality are highly relevant and are usually translated by a decrease in the percentage of germination, an increase in abnormal seedlings and a reduction in vigor (OLIVEIRA *et al.,* 2019).

As for the vigor defined by the accelerated aging test (EA), there was a significant difference between the cultivars, with the cultivars Veloz, Esteio and Tuiuiu included in the group of the most vigorous, with average values of 70.50%, 66.00% and 64.50% germination, respectively. The group of less vigorous cultivars was represented by Uirapuru (53.00%) and Urutau (56.00%), according to Table 1.

It is understood that seed vigor is the sum of all its properties, which are associated with the various aspects of its performance or its batch, especially during germination and seedling emergence. Those that show good performance are classified as vigorous, and those with low performance are called low vigor (NAKAO *et al.,* 2018).

When analyzing seedling performance through the variables shoot length (CPA) and root length (CPR) of seedlings, it was observed that there was no significant difference (Table 2). However, the evaluated bean cultivars differed

significantly in terms of the weight of green and dry seedlings (Table 2), observing that the Uirapuru cultivar obtained the highest averages for green mass (1.051 g) and dry mass (0.218 g). Seedlings with the lowest averages were observed in the Esteio cultivar with 0.744 g (MVP) and 0.113 g (MSP), not differing significantly from the others.

TABLE 2- Seedling shoot length (CPA), root length (CPR), green seedling mass (MVP) and dry seedling mass (MSP) of different bean cultivars (*Phaseolus vulgaris*)

Cultivars	Seedling Length (mm)		Seedling Mass (g)	
	CPA	CPR	MVP	MSP
Esteio	8.531 a	11.331 a	0.744 c	0.113 c
Tuiuiu	8.506 a	11.600 a	0.889 b	0.179 b
Uirapuru	9.393 a	11.287 a	1.051 a	0.218 a
Urutau	7.281 a	11.181 a	0.898 b	0.192 b
Veloz	8.556 a	11.293 a	0.837 b	0.161 b
CV (%)	17.19	10.41	11.03	15.79

* Means followed by the same letter in the column, do not differ according to the Scott-Knott test ($p < 0.05$). CV(%)= Coefficient of Variation.

There was a significant difference between the physiological potential of the seeds of the common bean cultivars only in the EV and IVE vigor tests (Table 3). The AP, MVAP and MSAP vigor tests did not show differences in quality between them. The cultivar Tuiuiu showed a higher percentage of emergence (77.00%), not significantly different from the cultivars Urutau (68.00%), Veloz (75.00%) and Uirapuru (74.00%). As for the IVE, the highest values were also found for the Tuiuiu cultivar (28.78%), not differing significantly from the Veloz cultivar (25.68%). Seeds with a lower physiological potential were observed in the Esteio cultivar, with an EV of 47% and an IVE of 11.50, below the other cultivars analyzed.

TABLE 3- Greenhouse emergence values (EV), emergence speed index (IVE), seedling height (AP), seedling height green mass (MVAP) and seedling height dry mass (MSAP) at ten days from seeds of bean cultivars (*Phaseolus vulgaris*).

Cultivares	EV (%)	IVE	AP (mm)	MVAP (g)	MSAP (g)
Esteio	47.00 b	11.50 c	8.97 a	5.85 a	1.09 a*
Urutau	68.00 a	21.22 b	8.31 a	6.43 a	1.18 a
Veloz	75.00 a	25.68 a	8.03 a	5.70 a	1.23 a
Uiapuru	74.00 a	21.17 b	8.43 a	6.75 a	1.24 a
Tuiuiu	77.00 a	28.78 a	8.78 a	6.31 a	1.12 a
CV (%)	14.93	12.39	7.47	18.31	13.91

* Means followed by the same letter in the column, do not differ according to the Scott-Knott test ($p < 0.05$). CV(%)= Coefficient of Variation.

The emergence test allows for evaluating the ability of the seeds to develop normal and uniform seedlings under uncontrolled field conditions, which is essential

for the selection of the best lots. Higher emergence speeds, a high percentage of emergence, and their uniformity indicate seeds with high vigor (PÚBLIO JUNIOR *et al.*, 2019). These factors influence dry matter accumulation and affect crop yield (SZARESKI *et al.,* 2018).

CONCLUSÃO

The common bean cultivars analyzed in this study are within the minimum standard required by the Brazilian Ministry of Agriculture for commercialization. It was verified that the more vigorous seeds had greater seedling development and mass production. The Veloz cultivar showed the highest germination, contributing to its superior physiological performance compared to the other cultivars.

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