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COMMON BEAN SEED GERMINATION AND SEEDLING EMERGENCE UNDER INOCULATION WITH BIOSTIMULATORS

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ABSTRACT - Biostimulating microorganisms have protector effect against pathogenic agents, affect the stand formation, promote plant growth, and increase yield of agricultural crops. Thus, the objective of this work was to evaluate the seed germination and seedling emergence of different common bean cultivars as a function of treatments with *Bacillus subtilis* BV02 and *Trichoderma asperellum* BV10. Germination tests in paper rolls and sand were conducted in a completely randomized design, with a 2×4 factorial arrangement consisted of two cultivars, namely Campos Gerais (CG) and Estilo (ES), and four microorganism treatments, namely *B. subtilis* BV02 (*BS*), *T. asperellum* BV10 (*TA*), *B. subtilis* BV02 + *T. asperellum* BV10 (*BS+TA*), and Control. The variables analyzed were: germination speed index (GSI), emergence speed index (ESI), germination percentage, emergence percentage, root length, seedling height, and root and shoot fresh and dry weights. The CG cultivar had higher GSI, ESI, root length, seedling height, shoot fresh weight, root fresh weight, and shoot dry weight than the ES cultivar in the paper roll and sand tests. The common bean seed inoculation with *BS+TA* increased seedling height, shoot fresh weight, shoot dry weight, and root length in the ES cultivar. The CG cultivar had higher GSI, ESI, root length, root fresh weight, and root and shoot dry weights than the ES cultivar. The treatment of seeds with *BS+TA* is recommended to improve the performance of common bean seedlings of the ES cultivar.
Keywords: *Phaseolus vulgaris* L., *Bacillus subtilis* BV02, *Trichoderma asperellum* BV10.

INOCULAÇÃO COM BIOESTIMULADORES NA GERMINAÇÃO DE SEMENTES DE FEIJOEIRO E EMERGÊNCIA DE PLÂNTULAS

RESUMO - Os microrganismos bioestimuladores, além do efeito protetor contra agentes patogênicos, também influenciam na formação do estande, promovem crescimento e aumentam a produtividade de culturas agrícolas. Assim, o objetivo deste trabalho foi avaliar a germinação de sementes e emergência de plântulas de cultivares de feijoeiro em função do tratamento com *Bacillus subtilis* BV02 e *Trichoderma asperellum* BV10. Foram conduzidos ensaios experimentais em rolo de papel e em areia, instalados em delineamento inteiramente casualizado, fatorial 2 x 4, sendo o primeiro fator representado pelas cultivares (cv) Campos Gerais (CG) e Estilo (ES), e o segundo pelos microrganismos *B. subtilis* BV02, *T. asperellum* BV10, *T. asperellum* BV10 + *B. subtilis* BV02 e controle. As variáveis analisadas foram: índice de velocidade de germinação (IVG) e emergência (IVE), porcentagem de germinação (PG) e emergência (PE), comprimento de raiz (CR), altura de planta (ALP), massa fresca de parte aérea (MFPA), massa fresca da raiz (MFR), massa seca da parte aérea (MSPA) e massa seca de raiz (MSR). A cv CG possui maior IVG, IVE, CR, ALP, MFPA, MFR e MSPA que a cv ES, em ambos os testes. A inoculação de *B. subtilis* BV02 + *T. asperellum* BV10 promoveram incremento do ALP, MFPA, MSPA e CR na cv Estilo. A cv CG apresentou maior índice de germinação, emergência, CR, MFR, MSR e parte aérea que a cv ES. O tratamento de sementes com a associação *B. subtilis* BV02 + *T. asperellum* BV10 é indicado para melhorar o desempenho de plântulas de feijão cv ES.
Palavras-chave: *Phaseolus vulgaris* L., *Bacillus subtilis* BV02, *Trichoderma asperellum* BV10.

INTRODUCTION

Common bean (*Phaseolus vulgaris* L.) is one of the most produced crop species in Brazil and in the world; this plant is important as human food due to the high protein content in its grains (TOLEDO et al., 2009; BARBOSA and GONZAGA, 2012). The total common bean production in the 2019/2020 crop season in Brazil was 3.02 million Mg, over a planted area of 3.0 million hectares (CONAB, 2019).

Seeds are an important agricultural input that carries the genetic characteristics of the cultivar and is determinant for plant growth and grain yield (MARCOS FILHO, 2005). The seeds should have good genetic, physical, physiological, and plant protection qualities, which are factors that affect their capacity to originate high-vigor plants. The quality of the seeds affects the performance of vital functions, longevity, germination rate, vigor, and number of normal seedlings (TOLEDO et al., 2009).

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Emergence speed and plant growth determinations through fresh and dry weights, and seedling length evaluations are used to determine more vigorous seed lots, which will originate seedlings with higher development rates and weight gains by presenting higher capacity to use storage tissues reserves (KOLASINSKA et al., 2000; GONÇALVES et al., 2017).

The use of methods that promote a fast germination and canopy uniformity of common bean plants is essential for the good performance of the crop; the treatment of seeds with stimulants, fertilizers, and growth promoting microorganisms is one of the technics used for a good performance of crop canopy formation (MASTOURI et al., 2010; ALMEIDA; SARATTO, 2014; OLIVEIRA et al., 2017).

Growth promoting fungi and bacteria can colonize different plant organs, beneficially affecting them by stimulating seed germination and plant shoot and root growth and, consequently, the development of reproductive organs, increasing crop yield (PEDRO et al, 2012; OLIVEIRA et al., 2016; GUIMARÃES et al., 2018). Microorganisms of the genus *Bacillus* (bacteria) and *Trichoderma* (fungi) are among those that present growth promoting functions, and are used as biocontrol agents, mainly against soil pathogens (MASTOURI et al., 2010; HERMOSA et al., 2012; SANTOYO et al., 2012).

Considering the importance of common bean seed quality and the effect of seed treatments to reach good plant stand and yield, the objective of this work was to evaluate the seed germination and seedling emergence of different common bean cultivars as a function of treatments with *Bacillus subtilis* BV02 and *Trichoderma asperellum* BV10.

MATERIAL AND METHODS

The experiments were conducted at the Laboratory of Seeds of the Rio Verde University (UNIRV), in Rio Verde, GO, Brazil. Common bean (*Phaseolus vulgaris* L.) seeds of the cultivars Campos Gerais (CG) and Estilo (ES), provided by the company Sementes Caraíba (Rio Verde, GO) were used.

Germination tests in paper rolls and sand were conducted in a completely randomized design, with a 2×4 factorial arrangement consisted of two cultivars (CG and ES), and four microorganism treatments, namely *B. subtilis* BV02 at 2 mL of the commercial product Bio-Imune® per kilo of seeds (*BS*), *T. asperellum* BV10 1 mL of the commercial product Tricho-Turbo® per kilo of seeds (*TA*), *BS+TA*, and Control. The seeds were counted, placed in 100-gram containers, and treated by covering them using 600 mL of the solution per 100 kg of seeds (LUDWIG et al. 2011).

The germination test in paper rolls was carried out with four replications of 50 seeds for each treatment. The paper rolls were wetted with deionized water at the proportion of 2.5 times the dry paper weight and kept in a BOD chamber at 25°C and photoperiod of 12 h. The emergence test in sand was carried out with four replications of 25 seeds for each treatment. The treated seeds were sown in 2-cm depth furrows and irrigated according to the water need of the plants.

The germination and emergence percentages were measured by direct counting of seeds that exhibit essential structures; seeds with radicle length with at least 1 cm were counted as germinated for the paper roll test, and those with totally emerged cotyledons were counted as germinated for the sand test. The evaluations begun at the fifth and lasted up to the ninth day after the implementation of the test. The last evaluation of the germination and emergence tests was used to calculate the percentage of germinated seeds, and the daily data were used to calculated the germination speed and emergence indexes, using the equation described by Maguire (1962).

Seedlings of each replication were collected in the ninth day after the implementation of the tests; their shoots were separate from the roots, and their root length, seedling height, fresh shoot weight, and root fresh weight were evaluated. Root length and seedling height were measured using a ruler, and the results were expressed in centimeters. Shoot fresh weight and root fresh weight were determined using an electronic balance with precision of 0.01 g, and their dry weights were determined after drying the samples in a forced-air circulation oven at 65°C until constant weight.

The data were subjected to the Shapiro Wilk normality test and then to analysis of variance; significant means were compared by the Tukey's test at 5% probability, using the Sisvar program (FERREIRA, 2011).

RESULTS AND DISCUSSION

The analysis of the data showed that the GSI of the common bean cultivars evaluated was not affected by the seed treatments with the two microorganisms, reaching similar values to the control. The germination test in sand showed that the microorganisms applied, single or combined, had no effect on the germination, with no changes in ESI, for the CG cultivar; however, seeds of the ES cultivar treated with *BS+TA* resulted in a ESI 45% higher than that of non-treated seeds of the ES cultivar in the germination test in sand (Table 1).

The responses of the cultivars to the treatments within each microorganism used showed higher seed vigor for the CG cultivar when compared to the ES cultivar. The mean GSI for the CG cultivar was 6% higher than that of the ES cultivar. Thus, as in the germination test in paper rolls, seedlings of the CG cultivar were more vigorous in the emergence test in sand than those of the ES cultivar, with mean ESI 160% higher. The germination and emergence percentages were not affected by the seed inoculation with microorganisms in the paper roll test, except for the ES cultivar inoculated with *BS*, which presented lower germination than the other treatments, and lower emergence percentage when inoculated with TS when compared to the *BS+TA* (Table 2).

Similar to GSI and ESI, the highest germination and emergence percentages were found for the CG cultivar when compared to the ES cultivar, regardless of the microorganism treatments, in the paper roll test. The results indicate a lower natural vigor for seeds of the ES cultivar when compared to the CG cultivar, however, the treatment *BS+TA* increased the emergence percentage of seeds of the ES cultivar in the sand test, with similar results to that found for seeds of the CG cultivar under the *BS+TA* treatment.

TABLE 1 - Germination speed index (GSI) of common bean seeds of the cultivars Campos Gerais (CG) and Estilo (ES), treated with biostimulating agents, tested in paper rolls (GSI-PR) and in sand (GSI-S).

Biostimulating agents	IVG-PR		GSI-S	
	CG	ES	CG	ES
Control	15.02 Aa*	14.75 Aa	6.32 Aa	2.50 Bb
Trichoderma asperellum BV10 (Tricho-Turbo®)	15.10 Aa	14.69 Aa	7.11 Aa	2.23 Bb
Bacillus subtilis BV02 (Bio-Imune®)	15.03 Aa	14.18 Ab	5.76 Aa	2.89 Bb
Trichoderma asperellum BV10 + *Bacillus subtilis* BV02	15.36 Aa	14.43 Ab	4.67 Aa	4.85 Ab
CV(%)	2.70		29.11	

*Means followed by the same lowercase letter in the rows, or uppercase letters in the columns are not different by the Tukey’s test at 5% probability of error. CV = coefficient of variation.

TABLE 2 - Common bean seed germination tested in paper rolls and seedling emergence tested in sand for the cultivars Campos Gerais (CG) and Estilo (ES), treated with biostimulating agents.

Biostimulating agents	Germination (%)		Emergence (%)	
	CG	ES	CG	ES
Control	99.50 Aa*	95.00 Ab	92.00 Aa	56.00 ABb
Trichoderma asperellum BV10 (Tricho-Turbo®)	97.00 Aa	93.50 ABb	87.00 Aa	49.00 Bb
Bacillus subtilis BV02 (Bio-Imune®)	98.50 Aa	89.50 Bb	87.00 Aa	63.00 ABb
Trichoderma asperellum BV10 + *Bacillus subtilis* BV02	99.00 Aa	93.50 Ab	88.00 Aa	77.00 Aa
CV(%)	2.66		16.02	

*Means followed by the same lowercase letter in the rows, or uppercase letters in the columns are not different by the Tukey’s test at 5% probability of error. CV = coefficient of variation.

The microorganism treatments had no significant effect on the seedling height of the CG cultivar in both tests, paper rolls and sand. The treated seeds of the ES cultivar had 19% lower seedling height in the paper roll test, and the use of *BS+TA* increased seedling height in 19% when compared to non-treated seeds of this cultivar (Table 3).

TABLE 3 - Shoot height of common bean seedlings of the cultivars Campos Gerais (CG) and Estilo (ES), treated with biostimulating agents, tested in paper rolls (SH-PR) and in sand (SH-S).

Biostimulating agents	SH-PR (cm)		SH-S (cm)	
	CG	ES	CG	ES
Control	7.78 Aa*	7.73 ABa	7.03 Aa	5.61 Bb
Trichoderma asperellum BV10 (Tricho-Turbo®)	6.88 Ab	9.43 Aa	6.91 Aa	5.36 Bb
Bacillus subtilis BV02 (Bio-Imune®)	7.69 Aa	6.24 Bb	7.24 Aa	5.29 Bb
Trichoderma asperellum BV10 + *Bacillus subtilis* BV02	7.48 Aa	6.86 Ba	7.45 Aa	6.72 Aa
CV(%)	11.68		8.38	

*Means followed by the same lowercase letter in the rows, or uppercase letters in the columns are not different by the Tukey's test at 5% probability of error. CV = coefficient of variation.

The effect of the cultivars within the microorganism treatments in the paper roll test showed that the treatment of seeds with *TA* resulted in higher height for seedlings of the ES cultivar when compared to those of the CG cultivar. The seedlings of the ES cultivar were less vigorous in the sand test when compared to the CG cultivar, except when the seeds were inoculated with *BS+TA*, which showed 20% higher seedling height than the control plants, and similar seedling height to those of the CG cultivar.

The effect of the treatments on shoot fresh weight is shown in Table 4. None of the microorganism treatments resulted in higher shoot fresh weight in the paper roll test, for any of the cultivars, when compared to the controls. The analysis of cultivars within microorganisms showed that the treatments *BS* and *TA* resulted in higher accumulation of shoot fresh weight for the ES cultivar when compared to the CG cultivar, in the paper roll test.

The analysis of the cultivars within the microorganisms showed that the microorganisms affected the shoot fresh weight of the CG cultivar in the sand test. However, seeds of the ES cultivar treated with *BS* and *BS+TA* had 25% and 60% higher shoot fresh weight than the Control, respectively. The analysis of the microorganisms within the cultivars showed that seedlings of the ES cultivar were less vigorous than those of the CG cultivar, with similar results for the treatments *TA* and *BS*; however, the treatment *BS+TA* resulted in higher shoot fresh weight for the CG cultivar, denoting the better genetic characteristics of this cultivar.

TABLE 4 - Shoot fresh weight of common bean seedlings of the cultivars Campos Gerais (CG) and Estilo (ES), treated with biostimulating agents, tested in paper rolls (SFW-PR) and in sand (SFW-A).

Biostimulating agents	SFW-PR (g)		SFW-A (g)	
	CG	ES	CG	ES
Control	57.00 Aa*	58.27 Aa	30.38 Aa	15.09 Bb
Trichoderma asperellum BV10 (Tricho-Turbo®)	53.59 Ab	62.26 Aa	27.29 Aa	15.86 Bb
Bacillus subtilis BV02 (Bio-Imune®)	56.12 Ab	61.69 Aa	29.77 Aa	18.88 Bb
Trichoderma asperellum BV10 + *Bacillus subtilis* BV02	57.57 Aa	60.66 Aa	29.19 Aa	24.07 Aa
CV(%)	5.46		14.85	

*Means followed by the same lowercase letter in the rows, or uppercase letters in the columns are not different by the Tukey's test at 5% probability of error. CV = coefficient of variation.

The effect of the treatments on the shoot dry weight did not affect this parameter in the CG cultivar, in the paper roll and sand tests. The analysis of the cultivars within the microorganisms in the paper roll test showed that only the common bean seeds of cultivar ES treated with *BS+TA* had higher shoot dry weight than the CG cultivar; and seeds of the CG cultivar treated with *BS* had higher shoot dry weight than those of the ES cultivar (Table 5). The evaluation of microorganisms within the cultivars showed that seeds of the CG cultivar treated with *TA* and *BS* had higher shoot dry weight in the sand test than those of the ES cultivar; however, seeds of the ES cultivar treated with *BS+TA* resulted in seedling shoot dry weights similar to those of the CG cultivar treated with *BS+TA*.

TABLE 5 - Shoot dry weight of common bean seedlings of the cultivars Campos Gerais (CG) and Estilo (ES), treated with biostimulating agents, tested in paper rolls (SDW-PR) and in sand (SDW-S).

Biostimulating agents	SDW-PR (g)		SDW-S (g)	
	CG	ES	CG	ES
Control	9.36 Aa*	9.24 ABa	4.37 Aa	2.43 Bb
Trichoderma asperellum BV10 (Tricho-Turbo®)	9.49 Aa	9.62 Aa	4.00 Aa	2.68 ABb
Bacillus subtilis BV02 (Bio-Imune®)	9.35 Aa	8.10 Bb	4.07 Aa	3.21 ABb
Trichoderma asperellum BV10 + *Bacillus subtilis* BV02	8.92 Ab	10.38 Aa	4.09 Aa	3.53 Aa
CV(%)	6.35		12.96	

*Means followed by the same lowercase letter in the rows, or uppercase letters in the columns are not different by the Tukey's test at 5% probability of error. CV = coefficient of variation.

The root length of seedlings of the CG cultivar was not affected by the microorganisms used. The root length of seedlings from seeds treated with *TA* was 26% longer than that of the control, while those treated with *BS* resulted in root lengths 35% longer, with emphasis on the *BS+TA* treatment, which resulted in 85% longer root length for the ES cultivar. The analysis of the microorganisms within the cultivars showed that the root length of the cultivars was similar for the treatments with *TA* and *BS*; however, seedlings of the ES cultivar showed 37% longer root length than the control when using *BS+TA* (Table 6).

The root fresh weight of the CG cultivar was not affected, in the paper roll and sand tests. However, the treatment *BS* resulted in 43% higher root fresh weight for the seedlings of the ES cultivar in the paper roll test, when compared to the control. The analysis of the cultivars within microorganisms, in the paper roll test, showed that only the treatment with *BS* resulted in differences between cultivars; the ES cultivar had root fresh weight 37% higher than the CG cultivar (Table 7). The analysis of the cultivars within the microorganisms in the sand test, showed that seeds of the CG cultivar treated with *TA* had higher root fresh weight than those in the same treatment of the ES cultivar. However, seeds of the ES cultivar treated with *BS* and *BS+TA* resulted in no differences from the CG cultivar under the same treatments.

TABLE 6 - Root length of common bean seedlings of the cultivars Campos Gerais (CG) and Estilo (ES), treated with biostimulating agents, tested in paper rolls (RL-PR) and in sand (RL-S).

Biostimulating agents	RL-PR (cm)		RL-S (cm)	
	CG	ES	CG	ES
Control	11.99 Aa*	8.32 Cb	10.03^{ns}	8.50^{ns}
Trichoderma asperellum BV10 (Tricho-Turbo®)	12.08 Aa	10.73 Bb	9.35	8.05
Bacillus subtilis BV02 (Bio-Imune®)	11.82 Aa	11.37 Ba	10.50	10.35
Trichoderma asperellum BV10 + *Bacillus subtilis* BV02	11.23 Ab	15.46 Aa	8.85	9.60
CV(%)	7.52		14.43	

Means followed by the same lowercase letter in the rows, or uppercase letters in the columns are not different by the Tukey's test at 5% probability of error; ns = not significant. CV = coefficient of variation.

TABLE 7 - Root fresh weight of common bean seedlings of the cultivars Campos Gerais (CG) and Estilo (ES), treated with biostimulating agents, tested in paper rolls (RFW-PR) and in sand (RFW-S).

Biostimulating agents	RFW-PR (g)		RFW-S (g)	
	CG	ES	CG	ES
Control	11.93 Aa*	12.03 Ba	10.46 Aa	5.89 Ab
Trichoderma asperellum BV10 (Tricho-Turbo®)	11.36 Aa	13.07 Ba	10.44 Aa	6.95 Ab
Bacillus subtilis BV02 (Bio-Imune®)	12.41 Ab	17.30 Aa	11.23 Aa	8.27 Aa
Trichoderma asperellum BV10 + *Bacillus subtilis* BV02	13.47 Aa	10.40 Ba	10.01 Aa	11.01 Aa
CV(%)	16.76		24.93	

*Means followed by the same lowercase letter in the rows, or uppercase letters in the columns are not different by the Tukey's test at 5% probability of error. CV = coefficient of variation.

The analysis of root dry weight was not affected by the cultivars and microorganisms in the paper roll and sand tests (Table 8). Considering the results of GSI, ESI, germination percentage, emergence percentage, and shoot and root development found in the paper roll and sand tests, the CG cultivar showed superior genetics when compared to the ES cultivar. The genetic differences between common bean cultivars for gemination, root growth, initial shoot growth, and grain yield are well described in the study of Kappes et al. (2008).

TABLE 8 - Root dry weight of common bean seedlings of the cultivars Campos Gerais (CG) and Estilo (ES), treated with biostimulating agents, tested in paper rolls (RDW-PR) and in sand (RDW-S).

Biostimulating agents	RDW-PR (cm)		RDW-S (cm)	
	CG	ES	CG	ES
Control	1.22^{ns}	1.21^{ns}	0.92^{ns}	0.49^{ns}
Trichoderma asperellum BV10 (Tricho-Turbo®)	1.31	1.23	1.22	0.96
Bacillus subtilis BV02 (Bio-Imune®)	1.38	1.27	0.90	1.05
Trichoderma asperellum BV10 + *Bacillus subtilis* BV02	1.45	1.40	0.94	0.76
CV(%)	16.52		65.11	

*Means followed by the same lowercase letter in the rows, or uppercase letters in the columns are not different by the Tukey's test at 5% probability of error; ns = not significant. CV = coefficient of variation.

The absence of expressive differences between the microorganism treatments for the CG cultivar can be related to the high vigor showed in the tests of germination percentage and seedling development, and to the interaction between microorganisms and the specific genetic of the cultivar. The ESI, emergence percentage, plant height, shoot fresh weight, shoot dry weight, and root length of seedlings of the ES cultivar from seeds treated with *BS* and *BS+TA* were similar to those of the CG cultivar in the sand test. This indicates that the microorganism treatments can improve the agronomic potential of genetically less-competitive cultivars, mainly *BS+TA*. Abd-El-Khair et al. (2018) found that root length and fresh and dry weights of common bean plants of the cultivar Faba Giza were higher when the seeds were treated with *B. subtilis*, when compared to *Trichoderma harzianium*; however, they found no differences between these treatments for the cultivar Sakha. Oliveira et al. (2016) found increases in shoot and root fresh weights of common bean seedlings of the cultivar Estilo from seeds treated with *B. subtilis*. Sá et al. (2019) evaluated cowpea seeds inoculated with different strains of *B. subtilis* and a *Trichoderma* species and found increases in germination and radicle length when using the strain *B. subtilis* LCB 45.

The different response of the shoot and root fresh and dry weights, seedling height, and root length of the ES cultivar to the seed inoculation with *BS* and *BS+TA* can be due to the symbiotic interaction between the microorganisms and the common bean plants of this cultivar. The combination *BS+TA* promoted better effects than their application alone, under the tested conditions; although the *BS* had improved the responses. Chagas et al. (2017) also found that the treatment of maize and cowpea seeds with *B. subtilis* UFT-Bs10 alone and combined with *T. asperellum* UFT 201 increased the shoot and root dry weights of seedlings of these crops, confirming the results found in the present work for common bean seeds inoculated with *BS+TA*.

The increases in root length, and shoot and root fresh and dry weights found for the ES cultivar when using seed inoculation with *BS* and *BS+TA* can be due to the capacity of *Bacillus* spp. in produce analogous hormones, such as indole-3-acetic acid, and stimulate plants to increase hormone production. López-Bucio et al. (2007) reported that the inoculation of common bean and *Arabidopsis thaliana* seeds with *Bacillus megaterium* increase fresh and dry weights of both species, and these changes are related to the root architecture, including increases in number and lengths of lateral roots. Junges et al. (2017) found that the treatment of oilseed radish seeds with *B. subtilis*, or *B. subtilis* combined with *Trichoderma* spp. increase seedling root length, height, and fresh weight.

According to Chowdappa et al. (2013), the biostimulant effects of *Bacillus* spp. and *Trichoderma* spp. on tomato plant growth are due to increases in indole-3-acetic acid and gibberellic acid in the root system. The action of these hormones on the root can explain the results found in the present study regarding the significant effects found, mainly for the ES cultivar in the sand test, when the seeds were treated with *BS* and *BS+TA*. Thus, further studies for *Bacillus* strains or combinations between microorganisms for treatments of seeds of crop plants, such as common bean, are needed, as well as evaluations of biochemical and physiological changes that they cause to the seedlings.

CONCLUSIONS

The common bean seedlings of the cultivar Campos Gerais had higher germination speed index, emergence speed index, root length, and root and shoot fresh and dry weights than those of the cultivar Estilo.

The treatment of seeds with *B. subtilis* BV02 + *T. asperellum* BV10 is recommended to improve the performance of common bean seedlings of the cultivar Estilo.

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