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RESEARCH ARTICLE

Herbicides doses in the defoliation of common bean to anticipate mechanized harvesting

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Abstract: Background: The use of desiccant herbicides can allow the anticipation of common bean harvesting by providing a reduction in the humidity of plants and grains.

Objective: Determine the effect of doses of desiccant herbicides on the moisture content of the plants (stems, leaves and grains), in the 100 grains mass, grain yield and physiological quality of the seeds of two contrasting common bean cultivars.

Methods: The experimental design for each cultivar (BRS FC 104, super early cycle, 60 days from sowing to harvesting and BRS Estilo, normal cycle, 90 days from sowing to harvesting) as in randomized blocks in the factorial scheme 4 x 3 x 4, with four replications. Treatments consisted of four herbicides (ammonium glufosinate (200 g L^{-1} of active ingredient, ai), glyphosate (480 g L^{-1} of acid equivalent), diquat (200 g L^{-1} of ai) and paraquat (200 g L^{-1} of ai), with three doses (200 g L^{-1}, 400 g L^{-1} and 600 g L^{-1} of ai per ha for ammonium glufosinate, diquat and paraquat, and 480 g L^{-1}, 960 g L^{-1} and 1,440 g L^{-1} of ae per ha for glyphosate) with evaluations of the variables at 0, 3, 5 and 7 days after application of the herbicide.

Results: All desiccants used provided faster drying of the botanical structures allowing faster harvesting in relation to control plants. The dosage of 200 g L^{-1} of the ai ha^1 in the cultivar BRS FC 104 and 1,440 g L^{-1} of ae per ha for glyphosate and 600 g L^{-1} of ai per ha for the others dessicants in the cultivar BRS Estilo were those that provided best plant drying. The use of desiccants in plants of common bean did not affect crop grain yield. The dosage of 600 g L^{-1} of ai per ha of the ammonium glufosinate desiccant provided a reduction in vigor and normal seedlings and an increase in abnormal seedlings in the cultivar BRS FC 104.

Conclusion: All desiccant herbicides used allowed anticipation of common bean harvesting.

Keywords: *Phaseolus vulgaris*; Desiccants; Ammonium Glufosinate; Glyphosate; Diquat; Paraquat

1. Introduction

Common bean (*Phaseolus vulgaris* L.) is the main source of vegetable protein for direct consumption by the low-income population (Ganascini et al., 2019). The cultivation of common beans in Brazil is carried out in three harvesting period; the first is called "summer harvesting", the second "off-season harvesting" and the third "winter harvesting". In the growing season 2018/2019 the common bean planted area in Brazil was about three million hectares, distributed over the three harvesting periods, which was 944,000 ha in the summer harvesting, 1.5 million ha in the off-season harvesting and 578,000 ha in the winter harvesting (Conab, 2020).

Among the stages of crop development, harvesting time is one of the most important since, if it is not done properly, it can cause losses, mechanical damage and cause the browning of the grains, which interfere in grain quality and in the commercial value (Souza et al., 2004). The best time for harvesting common bean seeds is just after physiological maturity, a time when the seeds have high vigor, germination and maximum accumulation of dry matter (Coelho et al., 2012; Lamego et al., 2013; Santos et al., 2005). However, at this stage, the seeds have a high moisture content (above 40%) and the plant is still with green and moist leaves and stems. With these characteristics, mechanized harvesting is impaired, as it can cause mechanical damage to seeds (Coelho et al., 2007) and poor performance of harvesting machines (Silva et al., 2017). Assis et al. (2019) reported that harvesting common beans with humidity above 18% causes damage to the grains by smashed.

Thus, to avoid losses in the common bean harvesting, the farmer has to wait for the plants to dry and reduce the moisture content of the grains (Muasya et al., 2002). Therefore, the seeds remain in the field for longer than the physiological maturation phase, and are exposed to environmental variations in temperature and humidity, which can negatively affect soil quality (Lacerda et al., 2005), as the loss and gain of seed water decreases its germination potential and vigor (Lamego et al., 2013).

Studies related to pre-harvest desiccation for seed production have been carried out mainly in crops such as rice (He et al., 2015), common beans (Coelho et al., 2012; McNaughton et al., 2015; Tavares et al., 2016; Zagonel et al., 2002) and soybean (Guimarães et al., 2012; Kappes et al., 2009, 2012; Silva and Rosa, 2016). This application of pre-harvest desiccant herbicides minimizes the deterioration and loss

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of grain quality of crops by standardizing the maturation and dehydration of plants and seeds and, therefore, enabling faster harvesting and reducing the exposure of seeds to weather conditions and attack by pests and diseases (Assis et al., 2019; Kappes et al., 2009; Lacerda et al., 2003; Pelúzio et al., 2008). The use of desiccant can provide anticipation of the harvest by up to seven days without causing reductions in the crop grain yield (Daltro et al., 2010; Kappes et al., 2009). However, some important aspects must be considered in a seed production system when desiccants are used, such as: mode of action and rate of the desiccant, environmental conditions, phenological stage of the crop at the time of desiccant application and influence on the germination and vigor of seeds (Lacerda et al., 2005).

However, there are still few studies to determine the best rate of herbicides used in the bean crop in order to anticipate the harvesting, avoid losses in productivity and preserve the physiological quality of the seeds. Besides, some farmers are using glyphosate to make this dessication without recommendation. The objective of this work was to determine the effect of doses of desiccant herbicides on the moisture content of the plants (stems, leaves and grains), in the mass of 100 grains, grain yield and physiological quality of the seeds of two common bean cultivars.

2. Material and methods

The experiments were conducted in the winter season of the years 2018 and 2019 at Capivara Farm, located in the municipality of Santo Antônio de Goiás, GO, at 16º28'00 "S and 49º17'00" W, and 823 m altitude. The region's climate is tropical savannah, and is considered Aw type according to the Köppen classification. There are two well-defined seasons, usually dry from May to September (autumn/ winter) and rainy from October to April (spring / summer), the average annual rainfall is between 1,500 to 1,700 mm. The average annual temperature is 22.7 °C, varying annually from 14.2 °C to 34.8 °C.

The experimental areas were cultivated for five growing season under no-tillage systems, with corn/ soybeans grown in the summer and common beans in the winter. The soil in the experimental areas was classified as an Oxisol. Before deployment of the experiments, in June 2018 and 2019 as well, soil was sampled at a depth of 0-0.20 m and then, chemical analyzes in this soil were carried out to characterize the experimental area (Table 1). Chemical analyzes were performed according to the methodology proposed by Donagema et al. (2011).

Table 1 - Chemical attributes of the soil in the experimental areas, in the 0-0.20 m layer, before applying the treatments. Santo Antônio de Goiás, growing seasons 2018 and 2019.

	pH	Ca	Mg	P	K	SOM[1]
Year	in H_2O	--------mmol$_c$ dm^{-3}------		------mg kg^{-1}------		g kg^{-1}
2018	5.4	26.0	10.1	12.4	92	34.3
2019	6.0	15.1	12.7	13.0	171	32.7

[1]Soil organic matter.

Two experiments were conducted, one in 2018, with the cultivar BRS FC 104 (super early life cycle, around 60 days), and another in 2019, with the cultivar BRS Estilo (normal life cycle, around 90 days). In both experiments, a randomized block design was used in the factorial scheme with four replications. In 2018, the treatments consisted of a combination of three desiccants (ammonium glufosinate (200 g L^{-1} of active ingredient, ai) (Finale®), diquat (200 g L^{-1} of ai), (Reglone®) and paraquat (Gramoxone®) (200 g L^{-1} of ai), with three doses (200, 400 and 600 L ha^{-1} of the active ingredient) and four times for determining the variables (0, 3, 5 and 7 days after application of the herbicide). In 2019, the factors were the same, however, the glyphosate desiccant (480 g L^{-1} of acid equivalent) (Glyphosate®) was added using the levels of 480, 960 and 1,440 g L^{-1} of the acid equivalent per ha. Additionally, in each experiment the control treatment was used, in which the common bean plants were not dried with herbicides. The spraying of herbicides was carried out using a manual sprayer with a pressure supplied by a CO_2 pressured source and a type of conical nozzle (TX-VS2). Climatic conditions and at the time to apply the herbicides environmental conditions were with high temperatures (> 30 °C) and low humidity (less than 30%).

The sowing of common bean cultivars BRS FC 104 and BRS Estilo was carried out by a no-till seeder with five planting rows, spaced 0.45 m apart and regulated to distribute 10 viable seeds per meter. The machine was equipped with a furrower and was always operated in the same direction, at a speed of 4 km h^{-1}. The experiments were installed in the first half of June, in both years. Fertilization was carried out in accordance with the soil analysis and with the recommendations of Sousa and Lobato (2004), with 320 kg ha^{-1} of the formulated 5-30-15 (N-P_2O_5-K_2O), which was placed in the sowing furrow). The topdressing fertilization was carried out with 60 kg ha^{-1} of nitrogen as urea. The central pivot sprinkler irrigation system was used, and water management was performed according to the crop needs (Silveira and Stone, 2001). The sanity management of the crop was carried out according to the needs to keep the plants free of insects, diseases and weeds (Vieira et al., 2006). Therefore, when necessary, it was applied the recommended product to control insects, diseases and weeds.

In the experiments, the drying rate of the botanical structures of the plants (stems + leaf, pods + grains, whole plant) was determined; mass of 100 grains; the germinate index of the seeds and the grain yield. Effect of plant desiccation was carried out on samples of five plants in each plot, taken immediately before the desiccant application and at three, five and seven days after application. The analyzed plants were harvested close to the soil and then separated into two fractions, stems with leaves and pods with grains. Each fraction of the plant was weighed to obtain the wet weight and, later, it was placed in the greenhouse at a temperature of 65 °C, where it remained until the constant mass. The water content of the plant fractions was determined (equation 1).

$$WC = \frac{(M1 - M2).100}{M1}$$, where:

WC = water content in plants (%)
M1 = wet mass of plant botanical structures (g)
M2 = dry mass of plant botanical structures (g)

Also on the seventh day after desiccation, plants were harvested, in 2 m from the central row, from each plot to determine the mass of 100 grains, the germinate index of the seeds and the grain yield of the bean. The mass of 100 grains and productivity were expressed in grams and kg ha^{-1}, respectively, after the water content was corrected to 130 g kg^{-1}. The germinate index of the seeds was evaluated at 30 days after common bean harvesting.

The data obtained were submitted to analysis of variance and when detected significance, the averages were compared by the Tukey test at $p < 0.01$. In addition, Dunnett's test was performed to compare each treatment with the control treatment. In the quantitative factor (days after applying desiccant) we performed a regression analyses.

3. Results and discussion

In the cultivar BRS FC 104 there was isolated effect of the days after the application of the desiccant for the moisture content in the variables stem + leaf, pods + grains, and in the whole plant, and there was no effect on the mass of 100 grains (Table 2). Thus, after the application of the desiccant, the plant start to lose water and the moisture content decreased day after day in all botanic structure. Comparing the moisture content of botanical structures with the control treatment (without the application of desiccant), it appears values was significantly lower in the plants where desiccant was applied than in the control plants (Figure 1). According to several authors, the application of desiccant herbicides during physiological maturation can provide several benefits that favor faster harvesting, such as reducing the deterioration and loss of grain quality of crops by standardizing the maturation and dehydration of plants and seeds, reducing the exposure of seeds to the weather and attack of pests and diseases (Assis et al., 2019; Kappes et al., 2009; Lacerda et al., 2003; Pelúzio et al., 2008). According to Silva et al. (2017), the ideal time for harvesting common beans is when the grains have a moisture content between 18 and 24%. It was observed that at seven days after dessicant application, the moisture content of grains and pods was 21.4%, that is, suitable for harvesting, whereas in the control treatment plants, these values were at 37.1%. The use of desiccant applied during physiological maturation can provide an advance of the harvest by up to seven days (Daltro et al., 2010; Kappes et al., 2009).

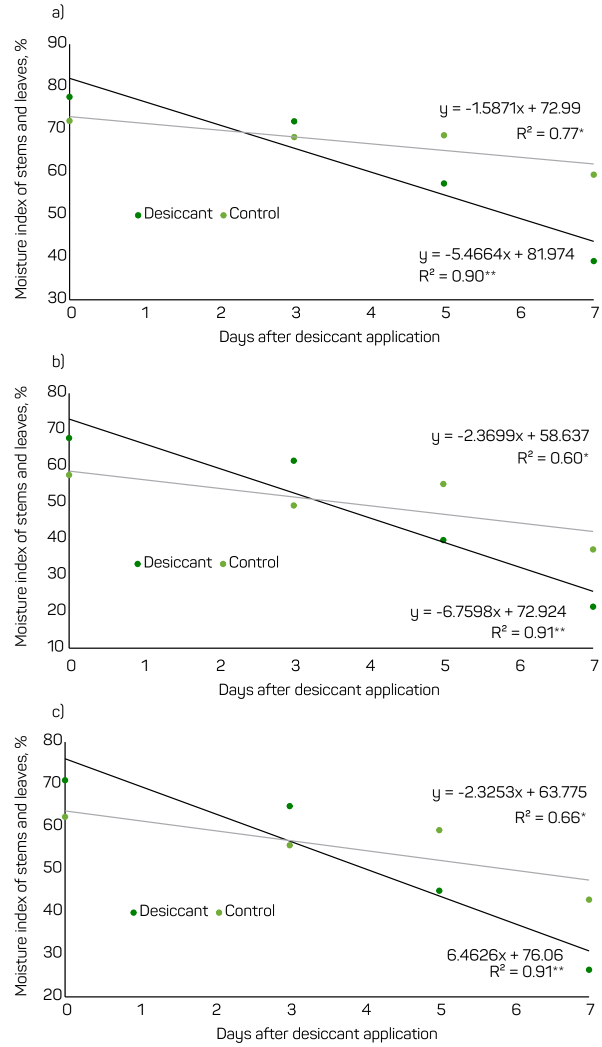

Figure 1 - Moisture content of botanical structures of common bean cultivar BRS FC 104, leaves and stems (A), grains and pods (B) and whole plant (C) depending on the days after the desiccant application.

In the cultivar BRS FC104, the desiccation of plants for mechanized harvest was not affected by the herbicide type (Table 2). Thus, the three desiccants were equally efficient as they provided a reduction in the moisture content of the plant's botanical structures. These three desiccants act on photochemical reactions, with diquat and paraquat acting on photosystem I (Zagonel et al., 2002) and ammonium glufosinate acts on the enzyme glutamine, which acts on the synthesis of the nitrogen assimilation pathway (Brunharo et al., 2014). The cultivar BRS FC104 has a type II growth habit, being erect and with an average height of 18 cm (Melo et al., 2017). Thus, the exposure of plants to sunlight may have contributed to the faster drying of the common bean plants as observed in this experiment. Similar results of fast drying of the common bean plants due dessicant application were also observed by Silva et al. (2017).

Table 2 - Moisture content of plant botanic structure (%) and mass of 100 grains (g) of common bean, cultivar BRS FC 104, as affected by the type of the desiccant used in the pre-harvest, the application dose and the number of days after desiccation.

Factors	Stem and Leaves	Pods and grains	Whole plant	M100
Desiccant	----Moisture index %----			grams
Ammonium glufosinate	61.2	46.5	51.0	27.3 a
Paraquat	64.2	47.3	53.6	28.7 b
Diquat	59.1	49.0	50.9	27.4 a
Factors	**F probability ($p < 0.05$)**			
Desiccant (De)	ns	ns	ns	*
Dose (Ds)	ns	ns	ns	ns
DADA	*	*	*	ns
De x Ds	*	*	*	ns
De x DADA	ns	ns	ns	ns
Ds x DADA	ns	ns	ns	ns
De x Ds x DADA	ns	ns	ns	ns
CV	14.3	20.2	17.2	8.1

Means followed by the same letter in the column, do not differ by Tukey's test ($p < 0.05$). ns - not significant. * significant at $p < 0.05$. DADA - Days after desiccant application.

There was an interaction between the desiccant doses and the moisture content in the botanical structures (Table 2). Thus, in most evaluations, the moisture content of botanical structures was similar among the desiccants for the different doses (Table 3). Therefore, from the point of view of the farmers, the best would be to use of the lowest doses that contribute to reducing the cost of production. However, the dosage of 200 g L^{-1} ha^{-1} of the active ingredient is slightly less than the manufacturer's recommendation; this can be explained because the common bean was harvested in September, a time with high temperatures and low relative humidity that favors more rapid drying of material in the field.

Table 3 - Moisture content of common bean botanic structure (%), cultivar BRS FC 104, influenced by the interaction between the desiccant used in the pre-harvest and the application rate.

Desiccant	Dose (L ha^{-1}).		
	1	2	3
	Stem + Leaves		
Ammonium glufosinate	64.8 aA	61.4 aAB	57.4 aB
Paraquat	64.6 aA	64.4 aA	63.4 aA
Diquat	62.2aA	53.5 bB	61.8 aA
	Pods + Grains		
Ammonium glufosinate	48.3 aA	48.7 aA	42.7 bA
Paraquat	50.3 aA	50.0 aA	46.7 abA
Diquat	45.7 aA	44.4 aA	51.7 aA
	Whole plant		
Ammonium glufosinate	53.5 aA	52.2 aA	47.3 bA
Paraquat	54.9 aA	54.3 aA	51.6 abA
Diquat	50.7 aAB	47.1 aB	55.0 aA

Means followed by the same letter, lower case in the column or upper case in the row, do not differ by Tukey's test ($p < 0.05$).

In the BRS Estilo cultivar, there was interaction between desiccant type and days after its application (Table 4). Thus, it appears that all botanical structures studied (leaves and stems, grains and pods, and the whole plant), as observed in the cultivar BRS FC104, the moisture content was higher in the control treatment compared to the desiccants used (Figure 2). These results reinforce the report of other authors who showed that the application of desiccant accelerates the drying of the plants and favors the anticipation of the harvest (Daltro et al., 2010; Kappes et al., 2012; Silva et al., 2017).

There was an effect of the doses of applied desiccants on the reduction of the water content of the leaves and stems, pods and grains, and the whole plant, and the maximum performance was achieved with the dose of 1,440 g L^{-1} of acid equivalent per ha and 600 g L^{-1} of active ingredient for the other dessicants (Table 4). The cultivar BRS Estilo has a normal cycle (cycle around 90 days from sowing to harvesting) and biomass production far superior to the cultivar BRS FC 104 (super early cycle, around 60 days from sowing to harvesting), with an average height of 40 cm (Melo et al., 2009). This may explain why in the dose of 200 g L^{-1} of active ingredient for the desiccants, the cultivar BRS FC 104 was completely dry and in the cultivar BRS Estilo, higher doses had to be applied.

Table 4 - Moisture content of plant botanic structure (%) and mass of 100 grains (g) of common bean, cultivar BRS Estilo, as affected by the type of the desiccant used in the pre-harvest, the application dose and the number of days after desiccation.

Factors	Stem and Leaves	Pods and grains	Whole plant	M100
Desiccant	----Moisture index %----			grams
Ammonium glufosinate	54.8	40.3	44.4	24.0
Paraquat	62.4	46.3	52.2	24.0
Diquat	61.9	47.6	52.2	23.9
Glyphosate	61.3	48.8	52.6	23.9
Dose (g ae/ai L^{-1} ha^{-1})				
200 for other dessicants and 480 for glyphosate	61.9 b	49.2 c	53.1 b	23.9
400 for other dessicants and 960 for glyphosate	60.9 b	45.9 b	50.5 b	23.9
600 for other dessicants and 1,440 for glyphosate	57.6 a	42.3 a	46.7 a	24.0
Factors	**F probability ($p < 0.05$)**			
Desiccant (De)	*	*	*	ns
Dose (Ds)	*	*	*	ns
DADA	*	*	*	ns
De x Ds	ns	ns	ns	ns
De x DADA	*	*	*	ns
Ds x DADA	ns	ns	ns	ns
De x Ds x DADA	ns	ns	ns	ns
CV	11.5	16.7	13.5	5.2

Means followed by the same letter in the column, do not differ by Tukey's test ($p < 0.05$). ns - not significant. * significant at $p < 0.05$. DADA - Days after desiccant application. CV Coefficient of variation.

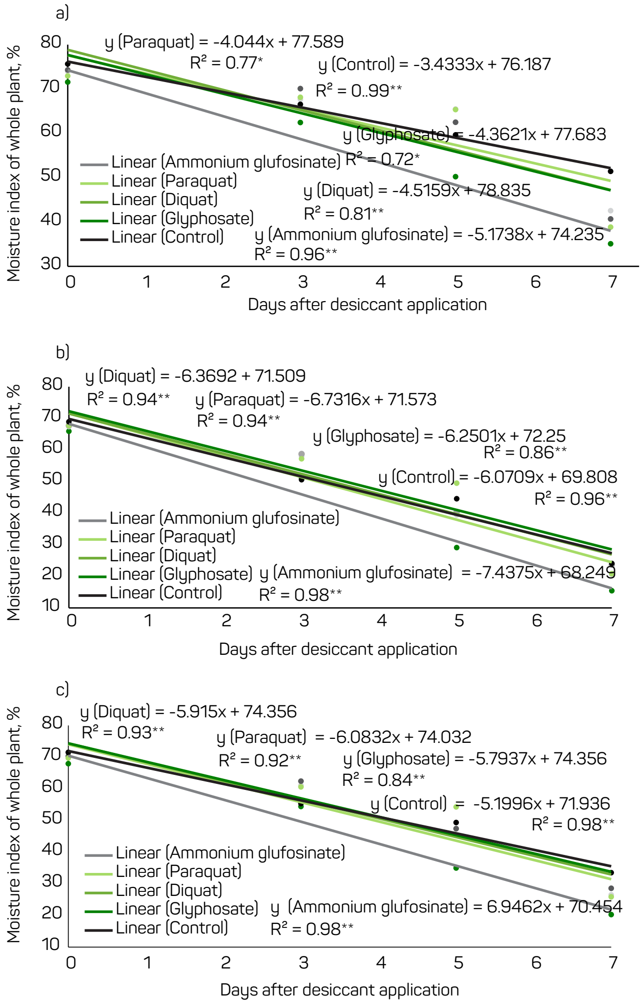

Figure 2 - Moisture content of botanical structures of common bean cultivar BRS Estilo, leaves and stems (A), grains and pods (B) and whole plant (C) depending on the desiccant used and the days after the desiccant application.

However, regardless of the dose and desiccant used, it appears that the harvest of common beans, meeting the recommendation for moisture content in the grains between 18 and 22% (Silva et al., 2017), could be done at 7 days after physiological maturation/application of the desiccant. On the other hand, in treatments without the application of the desiccant, the harvest could be made 11 days after the physiological maturation, that is, only four days in relation to the treatments with the application of the desiccant. This is due to the environmental conditions of high temperatures and low humidity, in which the harvest was made in September and allowed the plants to dry quickly. For example, Silva et al. (2017) reported that the application of diquat provided the anticipation of the harvest in 29 days and the ammonium glufosinate, 22 days, when the harvest was made in Vargem Grande do Sul, SP in July, when the temperatures are much lower and the relative humidity of the air above the values found in September in the municipality of Santo Antônio de Goiás, GO. Given this result, the question comes, would it be necessary to carry out this desiccation to accelerate the harvest in a period when there is no rain in the Central Brazil region, and therefore, theoretically, there would be no rush to carry out the harvest, because the plants would not suffer from the weather. However, several authors warn that the application of desiccants is not only used to anticipate the harvest, but also to standardize the drying of the plants and improve the quality of the grain, since the common bean maturation is not uniform (Assis et al., 2019; Kappes et al., 2009; Lacerda et al., 2003; Pelúzio et al., 2008; Silva et al., 2017).

In the cultivar BRS 104, the mass of 100 bean grains showed a higher value in the desiccation of the plants with paraquat in relation to the one carried out with ammonium glufosinate or diquat (Table 2). However, this parameter was not affected either by the doses of the herbicide applied, nor by the date of harvest of the grains in relation to the application of the treatments. In the BRS Estilo cultivar, the mass of 100 grains was also not significantly influenced by the active ingredients of the desiccants or by the applied doses (Table 4). However, it was found that, when applying the desiccation treatments, the grains had less mass, which increased and stabilized in the three days of desiccation.

Both in the cultivar BRS 104 (Table 5) and BRS Estilo (Table 7) grain yield was not affected by the active ingredient of the desiccant or by the applied doses. This result is important, as it shows that this technology can be used to anticipate the harvest and standardize the drying of the plants without running the risk of reducing crop productivity.

Table 5 - Grain yield, seed vigor, normal and abnormal common bean seeds of cultivar BRS FC 104 as affected by the desiccant used in the pre-harvest and the applied rate.

Factors	Grain yield (kg ha^{-1})	Vigor (%)	Normal (%)	Abnormal (%)
Desiccant				
Ammonium glufosinate	2,567	90.4	91.5	6.6
Paraquat	2,606	94.3	95.7	2.6
Diquat	2,333	93.8	94.6	3.5
Control	2,479	95.8	96.5	1.75
Dose (g ai L^{-1} ha^{-1})				
200	2,685	93.8	94.7	3.1
400	2,505	92.7	94.0	3.9
600	2,317	91.9	93.1	5.7
Factors	F probability ($p < 0.05$)			
Desiccant (DE)	ns	ns	ns	*
Dose (Ds)	ns	ns	ns	ns
DE x Ds	ns	*	*	*
CV	21.5	5.0	4.5	73.5

ns (no significative) and * (significative). CV Coefficient of variation. Means followed by + do not differ to control treatment by the Dunnett test.

However, it was found that for the cultivar BRS FC 104 there was a significant interaction between the type of desiccant and the application dose for the parameters vigor of seeds, normal and abnormal seedlings (Table 6). Thus, at the dosage of 600 g L^{-1} of the active ingredient per ha of the desiccant ammonium glufosinate, in relation to the herbicides paraquat and diquat, provided a reduction in the vigor values of seeds and normal seedlings and increased the value of abnormal common bean seedlings. Lacerda et al. (2003, 2005) observed that the germination of seeds from plants dried with ammonium glufosinate was lower, when compared with the drying done with paraquat, diquat and their mixtures. Guimarães et al. (2012) add that the application of ammonium glufosinate provided a higher percentage of abnormal seedlings, when compared to paraquat used at the same time. According to the authors, although it is also a contact herbicide, it is easier translocated into the plant than paraquat and diquat and can cause greater damage to the seed, compromising its physiological quality. However, these problems of reduced vigor and normal seedlings and increased abnormal seedlings, were only found at the dose of 600 g L^{-1} of the active ingredient per ha and only in the cultivar BRS FC 104.

In conclusion, the use of dessicants reduced the period of harvesting in four days in both cultivars (BRS FC 104 and BRS Estilo). Paraquat, diquat and ammonium glufosinate with the rate of 200 g L^{-1} of ai per ha in the super early life cycle cultivar BRS FC 104 and 1,440 g L^{-1} of ae per ha for glyphosate and 600 g L^{-1} of ai per ha for the others dessicants in the normal life cycle cultivar BRS Estilo were the best dose used. The use of desiccants in common bean plants cultivars BRS FC 104 and BRS Estilo did not affect the grain yield of the crop. The dosage of 600 g L^{-1} ha^{-1} of the ammonium glufosinate desiccant provided a reduction in vigor and normal seedlings and an increase in abnormal seedlings in the cultivar BRS FC 104.

Table 6 - Seed vigor, normal and abnormal seedlings influenced by the interaction between the type of desiccant used in the pre-harvest of common bean cultivar BRS FC 104 and the dose used in desiccation.

Desiccant	Dose (g ai L^{-1} ha^{-1})		
	200	400	600
	Seed vigor (%)		
Ammonium glufosinate	95.0 aA	91.8 aAB	84.5 bB
Paraquat	93.5 aA	93.8 aA	95.5 aA
Diquat	93.0 aA	92.8 aA	95.8 aA
	Normal seedlings (%)		
Ammonium glufosinate	96.3 aA	92.3 aAB	86.0 bB
Paraquat	95.0 aA	95.3 aA	96.8 aA
Diquat	92.8 aA	94.5 aA	96.5 aA
	Abnormal seedlings (%)		
Ammonium glufosinate	2.3 aB	5.3 aB	12.3 aA
Paraquat	2.8 aA	2.5 aA	2.5 bA
Diquat	4.3 aA	4.0 aA	2.3 bA

Means followed by the same letter, lower case in the column or upper case in the row, do not differ by Tukey's test ($p < 0.05$).

Table 7 - Grain yield, seed vigor, normal and abnormal common bean seeds of cultivar BRS Estilo as affected by the desiccant used in the pre-harvest and the applied rate.

Factors	Grain yield (kg ha^{-1}	Vigor (%)	Normal (%)	Abnormal (%)
Desiccant				
Ammonium glufosinate	3,420	91.4	93.9	1.7
Paraquae	3,459	86.4	89.5	6.8
Diquat	3,551	89.2	90.9	4.9
Glyphosate	3,657	89.3	92.3	6.2
Contol	3,566	88.5	93.5	3.0
Dose (g ae/ai L^{-1} ha^{-1})				
200 for other des-sicants and 480 for glyphosate	3,550	87.4	89.9	5.3
400 for other des-sicants and 960 for glyphosate	3,552	89.6	91.9	4.9
600 for other des-sicants and 1,440 for glyphosate	3,464	90.3	93.1	4.4
Factors	**F probability ($p < 0.05$)**			
Dessicant (DE)	ns	ns	ns	ns
Dose (Ds)	ns	ns	ns	ns
DE x Ds	ns	ns	ns	ns
CV	13.2	11.2	9.8	174,2

ns (no significative) and * (significative). CV Coefficient of variation. Means followed by + do not differ to control treatment by the Dunnett test.

Author' contributions

JGS: performed the trial and contributed in the writing of the manuscript. ASN: made statistical analyses and write the manuscript. PHLS: contributed in the conducting of the trial.

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