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RESEARCH PAPER

Competition with spreading dayflower (*Commelina diffusa* L.) can affect the agronomic characteristics and mineral content of common bean grains

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Abstract

L.S.G. Oliveira, L.P. Dalvi, S.C. Altoé, L.J.F.N. Rocha, and F.L. Oliveira. 2017. Competition with spreading dayflower (*Commelina diffusa* L.) can affect the agronomic characteristics and mineral content of common bean grains. Cien. Inv. Agr. 44(2): 121-126. The objective of this study was to evaluate the effects of the presence of *Commelina diffusa* weeds on the agronomic characteristics and mineral content of bean grains (*Phaseolus vulgaris* L.). The experiments were conducted using a completely randomized design with five replications in a greenhouse. The treatments consisted of two bean cultivars (BRS Ametista and BRS Estilo) grown in the presence and absence of the weeds. The weeds affected the agronomic and mineral characteristics of the varieties; caused a decrease in the number of leaves; reduced the chlorophyll content in the leaves; and reduced the nitrogen, phosphorus and iron contents in the grains. Competition with spreading dayflower did not cause significant effects on the stem diameter or the levels of potassium, calcium, and magnesium in the grains. The BRS Estilo variety was less affected by weed competition than BRS Ametista and showed higher values for the number of leaves, chlorophyll content, and accumulation of manganese and iron in the grains.

Keywords: Food security, mineral characteristics, *Phaseolus vulgaris* L, weeds.

Introduction

The common bean (*Phaseolus vulgaris* L.) is one of the most important crops for food security in Brazil. The crop is grown in most parts of the country in different environmental conditions across different planting dates and production systems (Scholten *et al.*, 2011). The plant is very sensitive to environmental variations, so the productivity and grain quality may differ in various situations (Teixeira *et al.*, 2009).

To obtain the maximum yield, it is necessary to control all limiting factors, including weed competition, that can impact the nutrient availability

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(Cury *et al*., 2013). Knowing the interference levels of a weed community in a crop system is important for determining the influence of the weeds on the growth, development and productivity of common beans (Bressanin *et al*., 2013).

The low ability of beans to compete with weeds exposes the crop to intense competition with these invasive plants, which leads to average losses of approximately 25% of the grain yield (Vidal *et al*., 2010). The spreading dayflower (*Commelina* sp.) is one of the most important groups of weed species that can damage beans. *Commelina diffusa* is typically an annual herb, though it may be perennial in the tropics. The species spreads diffusely, creeps along the ground, branches heavily, roots at the nodes and achieves stem lengths up to 1 m. This species spreads easily and has a high ability to survive in adverse conditions with a high reproductive efficiency (Cury *et al*., 2012).

The common bean has low soil cover and presents a low competitive capacity, which reduces the yield potential of the cultivars. When this crop grows under high weed competition, the grain yield can be significantly reduced (Vidal *et al*., 2010). It is important to understand the competition caused by weeds, since high weed populations present during early development or reproductive stages can increase production costs (Cury *et al*., 2012). Therefore, determining the level of spreading dayflower competition with various bean varieties is important for understanding the yield losses. In this context, the objectives of this study are to evaluate two bean varieties in the presence and absence of spreading dayflower and to assess the growth characteristics, yields and mineral accumulations of the grains.

Materials and methods

The experiments were conducted in a greenhouse at the Center of Agricultural Sciences – Federal University of Espirito Santo, in Alegre – ES (Brazil). The greenhouse trials were conducted in May 2014 in a 2×2 factorial experiment. The first factor was the presence or absence of spreading dayflower competition, and the second factor was the type of bean cultivar: 'BRS Ametista' or 'BRS Estilo.' The experiments were developed in a completely randomized design with five replications, totaling 20 experimental units.

The soil was collected from the university farm at the Center of Agricultural Sciences – Federal University of Espírito Santo, located in Rive Village, Alegre – ES. The soil was classified as yellow oxisol with a clay loam texture (Embrapa, 2006). The results of the chemical and physical analyses of the soil were as follows: pH (H_2O), 5.4; P (mg dm^{-3}), 10; K (mg dm^{-3}), 83; S (cmol dm^{-3}), 6; Ca (cmol dm^{-3}), 1.5; Mg (cmol dm^{-3}), 0.4; Al (cmol dm^{-3}), 0.3; base saturation (%), 46.8; B (mg dm^{-3}), 0 and 21; Cu (mg dm^{-3}), 2.0; Fe (mg dm^{-3}), 61; Mn (mg dm^{-3}), 47; Zn (mg dm^{-3}), 2.9; and 1.4 kg organic matter dag^{-1}. The textural components were 7.4% sand, 0.4% silt and 2.2% clay.

In a previously conducted germination test, the bean seeds obtained more than 90% germination when using the Rules for Seed Analysis – RAS methodology (Brazil, 2009).

The spreading dayflower was planted in pots (8 L) using stem sections with three nodes and four sections per pot. The bean plant seeds were planted simultaneously in the pots. Ten days after planting, the beans were thinned to one plant per pot.

The parameters evaluated were the stem diameter (SD – 50, DAE - days after emergence), measured with a digital caliper; the number of leaves (NL – 65 DAE); and the number of pods per bean plant (NP – 65 DAE). The leaf chlorophyll content (LC) was determined 30 d after emergence using a Clorofilog portable model CFL 1030 – Falker®. The grain yield per plant (GYP) was obtained by weighing all grains from each plant. The average grain weight (GW) was determined by dividing the total grain biomass by the number of grains per plant. For the evaluation of the grain mineral characteristics, including N, P, K, Ca, Mg, Mn, Fe and Zn, the grains were collected separately, packed in paper bags and dried in an oven for 72 h at 60 °C. The grains were ground into a fine powder, and the characteristics were analyzed following the methodology described by Malavolta *et al.* (1997).

Analysis of variance was performed using R Statistical Software 3.1.1 (R Development Core Team, 2014). If significant, the treatments were compared using an F-test (p=0.05), and when the factors interacted, the means were separated using a Tukey test (p≤0.05).

Results and discussion

The presence of spreading dayflower did not affect the stem diameters of the bean plants, and the bean plants did not impact the stem diameters of the weeds (Table 1). This result demonstrates that competition between this weed and common beans does not affect the growth of either plant in terms of the stem diameter.

In fertile soil and during windy agricultural years, the stem diameter is extremely important to the crop development because this morphological characteristic is linked to the yield and has a close relationship to the plant lodging. Manabe *et al.* (2015) observed different effects on the bean stem diameter, which were initially negatively affected by interference with *Brachiaria plantaginea* weeds, but differences were not observed between the treatments 60 d after emergence.

The BRS Estilo variety had higher results for the leaf number and chlorophyll content than BRS Ametista. The presence of spreading dayflower resulted in significant reductions in the number of leaves and bean chlorophyll content. These reductions occurred due to the competition between the bean plants and weeds for the same resources, including soil nutrients such as nitrogen and phosphorus (Table 3). The reductions were also due to the competition for moisture in the pots, which led to reductions in the chlorophyll content and number of leaves. Previous studies of weed interference in a chickpea crop (*Cicer arietinum* L.) showed that the chlorophyll concentration was affected throughout development, and this reduction was more evident 30 d after emergence (Amaral *et al.*, 2015).

The spreading dayflower competition negatively affected all grain yield parameters of the beans (Table 2). The pod number, total grain production and average grain weight were all lower under spreading dayflower competition. Furthermore, the weed has a longer cycle than the annual crops. Oliveira *et al.* (2010) conducted an experiment with cowpea varieties and showed that weed

Table 1. The effects of spreading dayflower competition and different common bean varieties on the stem diameter (SD) collected at 50 DAE (days after emergence), number of leaves (NL–65 DAE), and leaf chlorophyll content (LC–30 DAE) in common bean plants.

	SD (mm)	NL	LC
Varieties			
BRS Ametista	3.90	12.40b	35.41b
BRS Estilo	4.09	14.30a	39.32a
Spreading dayflower			
Weed-free	4.19	15.20a	39.42a
Weed competition	3.81	11.50b	35.31b
CV%	11.28	12.25	8.17

Means within a column followed by the same letter do not differ significantly according to an F-test at a 5% significance level. C.V.=coefficient of variation.

interference reduced the number of pods in the crop. For common beans, the number of pods per plant is the component that is most correlated with the grain yield (Santos *et al*., 2003).

The grain mineral characteristics of both varieties were not affected during the weed-free treatment (Table 3). However, the presence of spreading dayflower negatively affected the nitrogen and phosphorus contents in the common bean grains. The reduction in nitrogen and phosphorus in the bean grains was related to the competition between the crops for nutrients during the flowering period. During this period, the processes of cell division and growth and the intensive metabolic and hormonal activities resulted in greater nutritional requirements from the plants (Taiz & Zeiger, 2013).

The reduction in the nitrogen content may have been responsible for the decrease in the chlorophyll content as described above, since the chlorophyll content correlates with the concentration of N in plant and crop yields (Silveira *et al.,* 2003). The manganese content was significantly higher in BRS Estilo than in BRS Ametista (Table 4). The presence of spreading dayflower influenced the zinc and manganese accumulation in the bean grains. Zinc has basic functions in plants that are related to the metabolism of carbohydrates, proteins and phosphates. Zn is related to protein synthesis and energy production; is a component of numerous enzymes, such as dehydrogenases, proteinases, peptidases and phosphohydrolases; and is an important part of the photosynthesis process (Taiz & Zeiger, 2013). Cichy *et al.* (2005) showed that the bean zinc content is influenced by the pH and zinc concentration in the soil.

The iron content was influenced by the weed competition in both cultivars, which was different from effects of magnesium and zinc, as shown in Table 5. Both varieties in the presence and absence of spreading dayflower showed the same results.

Table 2. The effects of the spreading dayflower competition and different common bean varieties on the number of pods per plant (NPP), grain yield per plant (GYP) and grain weight (GW).

	NPP	GYP (g)	GW (g)
Varieties			
BRS Ametista	7.80	11.01	0.31
BRS Estilo	8.70	10.93	0.30
Spreading dayflower			
Weed-free	9.50a	13.15a	0.32a
Weed competition	7.00b	8.80b	0.28b
CV%	20.99	9.73	11.04

Means within a column followed by the same letter do not differ significantly according to an F-test at a 5% significance level. C.V.=coefficient of variation.

Table 3. The effects of spreading dayflower competition and different common bean varieties on the contents of nitrogen (N), phosphorus (P), potassium (K), calcium (Ca) and magnesium (Mg) in the bean grains.

	N	P	K	Ca	Mg
Varieties					
BRS Ametista	1.66	3.12	17.18	1.66	1.96
BRS Estilo	1.55	2.94	16.61	1.79	2.07
Spreading dayflower					
Weed-free	1.71a	3.48a	16.62	1.65	2.04
Weed competition	1.49b	2.57b	17.17	1.80	1.99
CV%	12.75	15.13	19.07	26,15	17.42

Means within a column followed by the same letter do not differ significantly according to an F-test at a 5% significance level. C.V.=coefficient of variation.

Table 4. The effects of spreading dayflower competition and different common bean varieties on the zinc (Zn) and manganese (Mn) content in the bean grains.

	Zn	Mn
Varieties		
BRS Ametista	24.98	13.60b
BRS Estilo	25.29	21.99a
Spreading Dayflower		
Weed-free	25.48	17.83
Weed competition	24.79	17.76
CV%	9.48	7.67

Means within a column followed by the same letter do not differ significantly according to an F-test at a 5% significance level. C.V.=coefficient of variation.

Table 5. The effects of spreading dayflower competition on the iron (Fe) content in the bean grains.

	Fe	
Spreading Dayflower	BRS Ametista	BRS Estilo
No weed	44.59 aB	55.14 aA
Competition	46.31 aA	42.57 bA
CV%	11.39	

Means followed by the same lowercase letters in a column and capital letters on the lines do not differ significantly according to a Tukey test ($p \leq 0.05$). C.V.=coefficient of variation.

However, in the absence of spreading dayflower, BRS Estilo accumulated more iron than BRS Ametista. For BRS Ametista, differences in the iron accumulation were not observed. The iron and manganese are partially mobile nutrients and may be transferred from the leaves to the grains.

The spreading dayflower competition with the beans negatively affected the number of leaves, leaf chlorophyll content, number of pods, grain yield production, average grain weight and contents of nitrogen, phosphorus and iron in the bean grains. The bean competition reduced the number of leaves and leaf chlorophyll content in the spreading dayflower. The BRS Estilo variety was less affected by the weed competition than BRS Ametista, and showed higher values for the number of leaves, chlorophyll content, and manganese and iron accumulation in the grains. The ability to remove nutrients from the soil and the amount of nutrients allocated in the grains varied because of the different the grain varieties and the weed competition.

Resumen

L.S.G. Oliveira, L.P. Dalvi, S.C. Altoé, L.J.F.N. Rocha, y F.L. Oliveira. 2017. La competencia de la maleza (*Commelina diffusa* L.) puede afectar las características agronómicas y el contenido mineral de los granos de frijol. Cien. Inv. Agr. 44(2): 121-126. El objetivo de este estudio fue evaluar los efectos de la competencia de malezas por *Commelina diffusa* sobre las características agronómicas y el contenido mineral de granos de frijol (*Phaseolus vulgaris* L.). El experimento se realizó en un diseño completamente al azar con cinco repeticiones, en un invernadero. Los tratamientos consistieron en dos cultivares de frijol (BRS Ametista y BRS Estilo) cultivados en presencia y ausencia de la maleza. El sistema de malezas afectó las características agronómicas y minerales de las variedades, provocando una disminución en el número de hojas, reduciendo el contenido de clorofila en las hojas y reduciendo el contenido de nitrógeno, fósforo y hierro en los granos. La competencia con el girasol extendido no tuvo efecto significativo en el diámetro del tallo, ni en los niveles de potasio, calcio y magnesio en los granos. La variedad BRS Estilo fue menos afectada por la competencia de malezas, mostrando mayores valores de número de hojas, contenido de clorofila, acumulación de manganeso y hierro en los granos en comparación con BRS Ametista.

Palabras clave: Características minerales, *Phaseolus vulgaris* L., plantas de malezas, seguridad alimentaria.

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