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Article

PRODUCTION AND NUTRIENT ACCUMULATION OF COMMON BEAN CULTIVARS UNDER COMPETITION WITH WEED

Produção e Acúmulo de Nutrientes de Cultivares de Feijoeiro sob Competição com Planta Daninha

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ABSTRACT - Improper management of weeds is one of the causes of low bean yield, as it is very susceptible to interference due to their slow initial growth. This study aimed to evaluate the influence of dayflower on grain yield and nutrient accumulation of bean cultivars. The experiment was carried out in a screened house, in 5 L pots, in a 2 x 4 factorial scheme. Factor 1 corresponded to the presence or absence of weeds, and factor 2 bean cultivars: BRS Pontal, BRS Agreste, BRS Ametista and BRS Estilo. The experiment was arranged in a completely randomized design with five replications. The coexistence of bean and weed was maintained throughout the crop cycle. Chlorophyll content, number of pods per plant, number of grains per plant, nutrients contents (N - nitrogen, P - phosphorus, K - potassium, Ca - calcium, Mg - magnesium, Mn - manganese, Fe - iron and Zn - zinc) in grains were evaluated. Competition with weeds negatively influenced chlorophyll content, number of pods, yield and N content in grains. The interaction was significant to P, Mg and Fe contents in grains, demonstrating that competition with weeds may impair allocation of these nutrients, resulting in grains of inferior nutritional quality. The cultivar BRS Agreste was more efficient to accumulate P and Mg in grains in competition with dayflower.

Keywords: absorption, *Commelina diffusa* L., grains, *Phaseolus vulgares* L.

RESUMO - O manejo inadequado das plantas daninhas é uma das causas da baixa produtividade do feijoeiro, pois ele é muito suscetível à interferência delas, devido ao seu crescimento inicial lento. Objetivou-se com este trabalho avaliar a influência da trapoeraba na produção de grãos e acúmulo de nutrientes de cultivares de feijoeiro. O experimento foi conduzido em casa telada, nos vasos com capacidade de 5 litros, no esquema fatorial 2 x 4. O fator 1 correspondeu à presença ou ausência de planta daninha, e o fator 2, aos cultivares de feijão: BRS Pontal, BRS Agreste, BRS Ametista e BRS Estilo. O delineamento utilizado foi o inteiramente casualizado com cinco repetições. A convivência entre o feijoeiro e a planta daninha foi mantida durante todo o ciclo da cultura. Foi analisado o teor de clorofila, número de vagens por planta, número de grãos por planta, teor dos nutrientes (N, P, K, Ca, Mg, Mn, Fe e Zn) nos grãos. A competição com a planta daninha influenciou de forma negativa as seguintes variáveis do feijoeiro: teor de clorofila, número de vagens, produção e teor de N nos grãos. A interação foi significativa para os teores de P, Mg e Fe nos grãos, demonstrando que a competição com planta daninha pode prejudicar a alocação desses nutrientes, resultando em grãos de qualidade nutricional inferior. O cultivar BRS Agreste foi mais eficiente no acúmulo de fósforo e magnésio nos grãos do feijoeiro em competição com a trapoeraba.

Palavras-chave: absorção, *Commelina diffusa* L., grãos, *Phaseolus vulgares* L.

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INTRODUCTION

The bean crop has low competitive capacity due to the slow initial growth and superficial root system, which become the crop extremely impaired by weeds (Teixeira et al., 2009). Among environmental conditions, the competition with weeds may cause reductions up to 71% on yield (Scholten et al., 2011).

Occurrence of interference is characterized when weeds compete to essential resources to their development, such as allelopathic effects, parasitism, harvest difficulties and cultivation traits, or when they act as alternative hosts of pests and diseases (Cury et al., 2012; Braz et al., 2016).

Regarding different growth habits, the most sensitive varieties of beans are those belonging to types I and II, due to their erect size and presence of few axillary or lateral branches, which delay the speed of coverage area (Santos and Gavilanes, 2006).

Competition with weeds may cause morphophysiological changes according to Cury et al. (2013), who observed variation on accumulation efficiency, transport and use efficiency of N, P and K according to bean genotype and competing weed species.

Among weeds, that cause most crop damage are dayflower (*Commelina diffusa* L.) (Guimarães et al., 2007). This specie presents intensively hairy stem and leaf and elliptical leaf, which facilitate its installation and survival, perennial habit, easy propagation and capacity to survive in adverse conditions (Rocha et al., 2007).

In addition, dayflower is considered tolerant to herbicides such as glyphosate and other formulations with glyphosate (Dias et al., 2013; Carvalho et al., 2015), and its morphological characteristics, such as long branches and root system with large number of secondary roots that allow increasing nutrient absorption surface from soil (Martins et al., 2007).

Physiological changes caused by competition with weeds may result in nutritional deficiency, including in seeds (Melo et al., 2006). In general, nutritional requirement of crops is more critical at grain formation stage, when considerable amounts of nutrients are translocated (Salum et al., 2008). This greater requirement is due to the nutrients are essential to the formation and development of new reserve organs (Oliveira et al., 2010).

There are around 2 million bean producers in Brazil, 64% of that involve family farming (Stone et al., 2013), which produces with few resources and simpler technology. It becomes more interesting the studies about cultivars as for the competition ability, once good behavior of some cultivars regarding weeds has been observed.

The objective of this study was to evaluate the effect of weed competition on nutrient accumulation and production in different bean cultivars.

MATERIAL AND METHODS

The experiment was carried out in a screened house, without temperature and humidity control, installed in May 2014 in a 2 x 4 factorial scheme; the factor 1, presence and absence of dayflower; factor 2, bean cultivars (BRS Pontal, BRS Agreste, Ametista and BRS Estilo), in a completely randomized design with five replications, totaling 40 experimental units (40 pots). Pots 5 L) containing 4.5 kg of soil was used.

The soil used was collected from 0 to 20 cm depth classified as *Latossolo Vermelho-Amarelo* with medium texture (Embrapa, 2006). Then, chemical and physical analyzes of this soil were performed, whose results were: pH (H_2O) = 5.4; P = 10 mg dm^{-3}; K = 83 mg dm^{-3}; S = 6 cmol dm^{-3}; Ca = 1.5 cmol dm^{-3}; Mg = 0.4 cmol dm^{-3}; Al = 0.3 cmol dm^{-3}; V = 46.8%; B = 0.21 mg dm^{-3}; Cu = 2.0 mg dm^{-3}; Fe = 61 mg dm^{-3}; Mn = 47 mg dm^{-3}; Zn = 2.9 mg dm^{-3}; organic matter = 1.4 dag kg^{-1}; sand = 74 g kg^{-1}; silt = 4 g kg^{-1}; and clay = 22 g kg^{-1}.

Previously, a germination test was performed of bean seeds before planting, finding that all materials exceeded 90% of germination, according to the Rules for Seed Analysis - RAS (Brasil, 2009). Dayflower was the weed specie used.

The dayflower was planted by three-node stem sections, four per pot, planted simultaneously with five bean seeds. Ten days after planting, the bean plants were thinned to remain only one per pot.

The chlorophyll content was determined to establish the N concentration in leaves and, consequently, the cultivars performance under weed interference. For this, we used a portable device Clorofilog, model CFL 1030, from Falker®. According to Guimarães et al. (1999), the use of portable meters has been advantageous because of the efficiency to study several crops. The evaluation occurred at 30 days after emergence, with three fully expanded bean leaves from the middle third of each repetition.

The number of pods per plant at maturity stage, and after harvest, number of grains per plant were evaluated. Then, beans were packed in paper bags and placed in an oven at 65 °C during 72 hours; after that, they were weighed in analytical balance. In order to evaluate N, P, K, Ca, Mg, Mn, Fe and Zn contents in grains, the materials were ground in a knife mill, having these characteristics analyzed according to Malavolta et al. (1997).

The data were submitted to variance analysis supported by R 3.1.1 statistical program (R Development Core Team, 2014); there being significance, the treatments were compared by F test ($p \leq 0.05$) and, the Tukey test ($p \leq 0.05$) was adopted in case of interaction among factors.

RESULTS AND DISCUSSION

Coexistence with weeds resulted in lower chlorophyll contents in bean crop and the number of pods per plant, number of grains and, consequently, grain yield decreased (Table 1). The cultivar BRS Ametista presented lower chlorophyll content, regardless presence of dayflower. The bean crop presented lower N content with dayflower (Table 2).

Table 1 - Average values of chlorophyll content (CC), number of pods (NP), number of grains (NG) and production (PRO) of bean cultivars with and without dayflower

Cultivation	Chlorophyll content	N. pods	N. grains	Produção (g)
Without dayflower	39.82 a	9.80 a	48.45 a	21.06 a
With dayflower	35.43 b	7.05 b	32.50 b	14.17 b
Cultivars				
BRS Pontal	38.75 ab	8.30 a	44.40 a	18.99 a
BRS Agreste	37.02 ab	9.20 a	45.40 a	18.44 a
BRS Ametista	35.41 b	7.40 a	34.60 a	16.78 a
BRS Estilo	39.32 a	8.80 a	37.50 a	16.23 a
CV%	7.40	25.49	26.34	17.85

Means followed by the same letter, in column, do not differ from each other by Tukey test ($p \leq 0.05$)

Table 2 - Contents of N, K, Ca, Mn and Zn in grains, by bean cultivars, with and without dayflower

	N	K	Ca	Mn	Zn
	($g\ kg^{-1}$)			($mg\ kg^{-1}$)	
Without dayflower	17.52 a	16.90 a	1.59 a	12.81 b	24.25 a
With dayflower	14.84 b	17.92 a	1.80 a	21.06 a	24.93 a
Cultivars					
BRS Pontal	16.83 a	18.53 a	1.69 a	14.67 b	24.75 a
BRS Agreste	15.75 a	17.32 a	1.64 a	15.09 b	23.04 a
BRS Ametista	16.63 a	17.18 a	1.66 a	19.33 a	25.28 a
BRS Estilo	15.51 a	16.61 a	1.79 a	18.66 ab	25.29 a
CV%	11.67	17.61	22.91	20.58	15.13

Means followed by the same letter, in column, do not differ from each other by Tukey test ($p \leq 0.05$).

The decrease of chlorophyll content is related to lower N absorption, a fact also highlighted by Bastos et al. (2012) in cowpea. Despite good root development of bean crop, the reduction of absorption and accumulation of N, due to competition with dayflower, may have limited the yield variables such as number of pods and grains, therefore the yield. Similar behavior was noted by Sant'Ana et al. (2010) in a bean trial, when they observed that N deficiency was highly related to grain yield decreasing. Also Cury et al. (2013) reported that competition with weeds causes decrease on relative accumulation of N in bean cultivars.

High Mn contents occurred in grains from plants cultivated with weeds. It's noteworthy that nutrients are absorbed independently - each one has its optimal pH range, for example - and dayflower may have changed the environment, impairing the absorption of some elements, but different with Mn.

Due to its efficiency and competitive capacity, dayflower intercepted greater amount of light, absorbing the nutrients available in soil before bean emergence. After development, the bean plants had an erect growth habit, becoming a taller plant with greater leaves production; however, taller plants may not have a competitive advantage over nutrients, since absorption, transport and allocation toward grain are less efficient, because it's necessary to redistribute nutrients to whole plant.

Low concentrations of K, Ca and Mg may have facilitated Mn absorption, once, dayflower was planted with bean crop and its emergence and production was faster, it facilitated that dayflower was profited of the nutrients even before bean emergence.

The bean cultivars differed regarding absorption and accumulation of Mn. It's noteworthy that the cultivar BRS Ametista accumulated high amounts of Mn, regardless weeds presence, in other words, the genotype even in an competitive environment for nutrients, is efficient in its absorption and remobilization to the grains.

The other nutrients analyzed in grains, such as K, Ca and Zn, showed no significant differences when the cultivars were under dayflower interference. When the cultivars BRS Pontal, BRS Ametista and BRS Estilo were analyzed within each environment (without or with dayflower), they presented lower concentration of P in grains when cultivated with dayflower, something that does not happen with BRS Agreste.

For Mg content, among environments (without or with dayflower), the cultivar BRS Pontal presented lowest Mg content in grains when cultivated with weeds; the cultivar BRS Ametista, although showed no difference within environments, also presented lower content in grains. Regarding Fe content in grains, only the cultivar BRS Estilo presented low content when cultivated with weeds (Table 3).

Genetic variability among genotypes is a factor that influences nutrients absorption, such as P (Fageria, 1998). Zucareli et al. (2011) reported that bean seed productivity increased linearly in response to P supply, that is, the inexpressive P absorption may be one of the factors that influenced the reduction of bean production under dayflower interference (Table 1).

The presence of grains with high Mg content in the cultivar BRS Pontal indicates that this genotype has greater remobilization capacity to grains, being an important factor to study the

Table 3 - Content of P, Mg and Fe in grains, by bean cultivars, under dayflower interference

Cultivar (BRS)	Fósforo (g kg^{-1})		Magnésio (g kg^{-1})		Ferro (g kg^{-1})	
	Without dayflower	With dayflower	Without dayflower	With dayflower	Without dayflower	With dayflower
Pontal	3.64 aA	3.00 bA	2.78 aA	2.12 bA	49.64 aAB	55.80 aA
Agreste	2.80 aB	3.32 aA	2.07 aB	2.38 aA	52.76 aAB	50.64 aAB
Ametista	3.69 aA	2.55 bA	2.15 aB	1.77 aA	44.99 aB	46.31 aAB
Estilo	3.27 aAB	2.60 bA	1.93 aB	2.21 aA	55.14 aA	42.57 Bb
CV%	15.25		16.39		11.92	

Means followed by, uppercase letter in column and lowercase in row, do not differ from each other by Tukey test (p≤0.05).

biofortification of bean crop. However, due to interspecific competition, the cultivar did not perform as well, resulting in lower Mg absorption, consequently, reducing its accumulation.

The performance of the cultivar BRS Estilo when in high Fe content and cultivated without dayflower shows that this genotype is efficiency to absorb this nutrient in a non competitive environment. However, with weed, the cultivar is not efficient, obtaining lowest absorption among cultivars. In its turn, the cultivar BRS Pontal, even under weed stress competition, had highest Fe content than the others, demonstrating the cultivar's ability to extract nutrients from soil and remobilize to grains.

Plant breeding has sought about bean cultivars with high Fe content in grains, once it's an alternative to minimize problems with dietary deficiency of this mineral (Jost, 2009). However, Fe content in grains can also be affected by genetic constitution, by location where cultivation is carried out and genotype x environment interactions (Araújo et al., 2003).

As a short-cycle crop, the bean crop requires nutrients readily available at the most demanding stages, so there is no limitation on yield. The nutritional requirement of the crop is more intense at the beginning of reproductive stage, and more critical at seeds formation, when the nutrients are translocated to grains filling. This greater requirement is due to that nutrients are essential to the formation and development of new reserve organs.

The availability of minerals in soil may limit the efficiency of absorption, accumulation, transport and utilization of nutrients in bean crop, and may vary with genotype and competing weed species.

The conclusion is that presence of dayflower decreased production and N accumulation of the cultivars studied. The cultivar BRS Agreste was more efficient to accumulate P and Mg in grains of plants in competition with dayflower.

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