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Article

Response of Arabica Coffee Cultivars to Competition from Beggarticks

Resposta de Cultivares de Café Arábica em Competição com Picão-Preto

BORGES, L.G.M.[1]
MIRANDA, F.R.[1]
BORGES, A.M.[1]
SILVA, J.R.O.[1]
CAMPOS, A.A.V.[1]
RONCHI, C.P.[1]*

ABSTRACT - The goal of this study was to analyze the response of Arabica coffee cultivars grown under three levels of *Bidens pilosa* (beggarticks) interference. At 30 days after transplanting (DAT) of 14 Arabica coffee cultivars into 11 L pots, beggarticks was seeded in the pots and soon after emergence, three levels of weed infestation were established: none, low (two plants per pot), and high (five plants per pot). Treatments were arranged in a 14 × 3 factorial scheme under a completely randomized design, with four replicates. Coffee plant growth was evaluated at both weed emergence and blossoming (90 DAT) when the experiment was completed. Regardless beggarticks infestation levels, significant effects of cultivars occurred on almost all the coffee growth variables. Specifically, the Arabica coffee cultivars Arara, Asa Branca, and Bourbon Amarelo exhibited greater values for root, leaf, shoot, and whole plant dry matter when compared with the other cultivars. The Arabica coffee cultivars presented lower leaf area increments, and also lower leaf, shoot, and whole plant dry matter accumulation when grown under either low or high infestation levels (between which there were no statistical differences, $p>0.05$) in comparison with that under the weed-free treatment. However, there were no significant interactions between Arabica coffee cultivars and weed infestation levels for those crop growth variables. We conclude that all Arabica coffee cultivars tested were equally susceptible to *B. pilosa* competition in this phase of crop implantation.

Keywords: *Bidens pilosa, Coffea arabica*, weed competition, cultural control, growth, integrated weed management.

RESUMO - Objetivou-se neste estudo analisar a resposta de 14 cultivares de café arábica sob três níveis de infestação de ***Bidens pilosa*** *(picão-preto). Aos 30 dias após o transplantio (DAT) das mudas de 14 cultivares de café arábica para vasos de 11 L, sementes de* ***B. pilosa*** *foram semeadas nos vasos, estabelecendo-se, logo após a emergência, três níveis de infestação: nulo; baixo – duas plantas/vaso; e alto – cinco plantas/vaso. O delineamento utilizado foi inteiramente casualizado com quatro repetições, e os tratamentos, distribuídos em esquema fatorial 14 x 3. O crescimento do cafeeiro foi avaliado no momento tanto da emergência quanto do florescimento da planta daninha, quando o experimento foi encerrado, aos 90 DAT. Independentemente dos níveis de infestação, houve efeito significativo do fator cultivar sobre praticamente todas as variáveis avaliadas relacionadas ao crescimento das mudas de café, destacando-se os cultivares Arara, Asa Branca e Bourbon Amarelo J9, que apresentaram maiores matéria seca de folhas, raiz, parte aérea e de planta inteira, em comparação aos demais cultivares. Independentemente dos cultivares, verificou-se menor incremento de área foliar, matéria seca de folha, matéria seca da parte aérea e matéria seca da planta inteira de café, seja em nível de infestação baixo ou alto, entre os quais não houve diferença, em comparação*

*** Corresponding author:**
<claudiopagotto@ufv.br>

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[1] Universidade Federal de Viçosa - Campus Florestal, Florestal-MG, Brasil.

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*ao tratamento livre de competição. Todavia, as interações entre cultivares e níveis de infestação para essas variáveis não foram significativas, permitindo concluir que todos os cultivares de café testados foram igualmente sensíveis à competição de **B. pilosa** na fase de implantação da cultura.*

Palavras-chave: *Bidens pilosa*, *Coffea arabica*, competição de plantas daninhas, controle cultural, crescimento, manejo integrado de plantas daninhas.

INTRODUCTION

Brazil is the world's largest coffee producer, with an estimated harvest of 58 million bags in 2018, 76.3% of which was *Coffea arabica* (Conab, 2018). Regardless of the species, coffee is a perennial crop and can continue to produce for longer than 30 years. In addition to having slow initial growth (DaMatta et al., 2007), this crop is widely spaced (Matiello, 2016), and thus, the cultivation area favors competition by weeds, which can seriously compromise plant growth and productivity (Ronchi and Silva, 2018). Severe reductions in the growth of coffee plant shoot and root system, as well as in nutrient content and coffee plant yield were observed owing to the weed competition (Moraima García et al., 2000; Ronchi and Silva, 2006; Ronchi et al., 2007; Fialho et al., 2010; Lemes et al., 2010).

Soon after transplanting in the field, the coffee plants are highly susceptible to weed competition (Ronchi and Silva, 2006; Ronchi et al., 2007; Fialho et al., 2010), and this is a critical period for competition. The negative interference is caused by the acquisition of resources by weeds, especially light, water, and nutrients, thereby limiting the access of coffee plants to these resources. It is worth noting that most of the root system of the coffee plant is concentrated in the soil close to the stem and up to 0.30 m deep (Ronchi et al., 2015). This indicates that the occurrence of weeds in the planting row following coffee transplantion to the field is undesirable and harmful to coffee plants because weeds increase competition. Therefore, weed management in newly planted crops is an important activity within the coffee production system.

Weed management recommends the combination of preventive and control measures, thereby resulting in integrated weed management. Thus, no weed control measures should be used alone because an efficient management program for these plants should integrate several control methods. Control measures should be chosen according to the individual conditions of each crop and the available resources because all control measures have advantages and disadvantages (Silva and Silva, 2007). Nevertheless, the effects of the different control methods on the environment must be taken into account given the method that is to be used, as demonstrated by Melloni et al. (2013).

Several control methods can be used to minimize weed competition with coffee plants in the critical phase, soon after planting, with a predominance of mechanical and chemical methods (Ronchi and Silva, 2018). Today, when dealing specifically with cultural control, which is one of the least costly measures and plays an essential role in any modern integrated weed management program, the practices are restricted to the growing of cultivars adapted to the climatic conditions. Furthermore, seedlings should be grown in suitable containers; have a well-developed root system; and be planted during the right season, with correct spacing, planting orientation, proper plant arrangement, and balanced fertilization during planting and early growth (Ronchi and Silva, 2018). With the adoption of these crop practices, we can directly or indirectly reduce infestation by weeds and deplete the soil seed bank.

The knowledge of cultivars with greater capacity to tolerate the presence of weeds can contribute to the selection of more competitive genotypes as a crop management practice for newly planted crops (Medeiros et al., 2016), especially in areas where weed competition is very high or where chemical and even mechanical methods of control are restricted. The varied ability of different cultivars to compete with plants has been studied in several crops, such as wheat (Lamego et al., 2013), soybeans (Bianchi et al., 2006; Fleck et al., 2007), barley (Galon et al., 2011), rice (Balbinot Jr et al., 2003), and eucalyptus clones (Medeiros et al., 2016), with the latter being a perennial plant similar to coffee. However, there are only a few studies on coffee plants.

We hypothesized that cultivars of arabica coffee have distinct responses when competing with the beggarticks weed and that coffee plant competition capacity is influenced by the infestation level of the weed under study. Thus, the objective of this study was to evaluate the response of 14 cultivars of arabica coffee under three levels of infestation of beggarticks.

MATERIAL AND METHODS

The experiment was conducted in a greenhouse coated with a transparent polyethylene cover and protected on the sides with 50% shading. The coffee seedlings at the stage of five leaf pairs formed in 350 mL polyethylene bags were transplanted into polyethylene pots with volume of 11 L. The pots were filled with soil substrate from the B horizon, sand, and bovine manure at the ratio of 3:1:1 (v/v/v); this was sieved to facilitate subsequent root washing. The soil was classified as dystrophic red-yellow Argisol and the chemical characteristics are shown in Table 1. Liming and soil fertilization were performed by adding 1.0 kg of dolomitic limestone, 0.5 kg of K_2O, and 5.0 kg of P_2O_5 m^{-3} in the form of limestone, potassium chloride, and simple superphosphate, respectively (Alvarez and Ribeiro, 1999). At 30 and 60 days after transplanting (DAT), the plants were fertilized with 5 g of N per pot in the form of ammonium sulfate. The plants were cultivated with periodic irrigation, to maintain the soil at field capacity. The meteorological variables, low, average, and high temperatures, as well as relative humidity (RH), were recorded daily from thermometers and psychrometers installed in a meteorological station located inside the greenhouse.

Table 1 - Physical and chemical characteristics of the soil used to fill the pots

Granulometric analysis (%)												
Coarse sand			Fine sand			Silt			Clay			
24.20			13.92			8.36			53.52			
Chemical analysis												
pH	P	K	Al^{3+}	Ca^{2+}	Mg^{2+}	H+Al	SB	t	T	V	m	
	(mg dm^{-3})		($cmol_c$ dm^{-3})							(%)		
5.8	0.6	49	0.03	0.95	0.28	1.74	1.35	1.38	3.09	43.79	2.18	

Analyses carried out at the Laboratory of Agricultural Chemistry - BR 040, km 527- CEASA - Contagem - MG. The method used in the granulometric analysis does not include soils of calcareous regions and soils with the content of organic matter greater than 5%. Granulometry - Adapted pipette method. 65 mesh sieve (0.22 mm). H in water, KCl and $CaCl_2$ - 1:2.5 ratio. SB = Sum of bases; t = Effective cation exchange capacity; T = cation exchange capacity; m = saturation index by aluminum; V = saturation index by base. Note: the calculation of SB, T, t, m, and V did not consider Na values. Extraction solution: P and K - Mehlich; Ca, Mg, and Al - KCl 1 N. H+Al – pH in S.M.P.

The experimental design was completely randomized, with four replicates. The experimental plot consisted of a pot containing a coffee plant and it was randomized twice a week inside the greenhouse. Fourteen cultivars of *Coffea arabica* L. (Acauã, MGS Aranãs, Arara, Asa Branca, Bourbon Amarelo J9, Catuaí Amarelo IAC 62, Catuaí Vermelho IAC 99, Guará, Tupi RN IAC 1699 13, IPR 103, IPR 100, Oeiras MG 6851, Paraíso MG H 419-1, and Topázio MG 1190) in a 14 × 3 factorial design, with the second factor referring to three levels of infestation of *Bidens pilosa* (null - coffee plant free from competition, low - two plants per pot, and high - five plants per pot). These levels were defined based on the work of Ronchi and Silva (2006). Beggarticks seeds collected in a non-agricultural area were soaked in water for 24 h and seeded at 30 DAT of the coffee plant. The desired density for each level of infestation was established by thinning after the weed emergence when the weeds had two pairs of leaves. The characteristics of each cultivar have been described by Carvalho (2008) and Matiello (2016).

Coffee plant height, stem diameter, and leaf area were measured at the emergence of the weed and flowering, which occurred at approximately 90 DAT. The height was measured with a ruler, being the distance between the root collar and the apex of the seedlings. Stem diameter was measured with a digital caliper at the base of the root collar and two measurements were taken: E-W and N-S. Leaf area (LA) of coffee plants was estimated non-destructively (at the time of the emergence of the weed) using the equation proposed by Antunes et al. (2008), $LA = 0.6626 \times (LL \times LW)^{1.0116}$, where LL and LW are the leaf length and width, respectively. The initial and final growth measurements were used to calculate the height increase (HI), leaf area increase (LAI), and coffee tree stem diameter increase (SDI), in addition to the stem diameter:plant height ratio (RSDTH). At 60 and 90 DAT, the mean height of *B. pilosa* individuals in each pot was also estimated.

The period of competition between the coffee plant and the weeds was considered to be the period from the emergence to the flowering of the weed, which occurred at 90 DAT of the coffee plants. At that time, the shoot of the coffee tree and weeds were cut at ground level. The roots were washed in running water in 1 mm mesh sieves. The total leaf area of the plant was measured using a bench leaf area meter (LI-3000 CAP, Li-COR, Lincoln, Nebraska USA). The shoot (with stem and leaf separation) and the coffee plant root system were dried in a forced air circulation oven for 72 h at 70 ^{o}C and then weighed to determine the dry matter mass of each organ, as well as the root:shoot plant ratio, leaf area ratio, and specific leaf area of the coffee plant. The dry matter mass of the shoot and the root system of the weeds was also determined.

Verification of assumptions of the analysis of variance was performed by graphical residual analysis (Neter et al., 1990), in addition to conducting the maximum F test for determining the homogeneity of variances, which did not require data transformation. Then, an analysis of variance was conducted by performing the F test. The means of the treatments were compared by Tukey's test at 5% probability using SAEG software (SAEG, 2004).

RESULTS AND DISCUSSION

There were no significant effects ($p>0.05$) for the level of infestation alone on HI and SDI, and consequently, on the stem diameter:coffee tree height ratio (RSDTH). Likewise, the level of infestation in isolation did not affect stem dry matter (SDM) or root dry matter (RDM) (Table 2). However, regardless of the cultivar seedling submitted to *B. pilosa* competition from emergence to flowering of the weed, compared with that of the null competition treatment, lower values were verified ($p<0.01$) for LAI (19%), leaf dry matter (LDM) (5%), shoot dry matter (ADM) (16%), and dry matter of the whole plant (DMWP) (12%), both at low (two plants per pot) and high infestation levels (five plants per pot), between which there were no significant differences ($p>0.05$; Table 2). The results also showed a small (11%) but significant ($p<0.01$) increase in the root dry matter:shoot dry matter ratio (RDMRS) of the plants under competition relative to the control treatment, as well as the absence of an infestation level effect ($p>0.05$) on leaf area ratio (RLA) and specific leaf area (SLA) (Table 2).

In a study conducted under similar experimental conditions that tested the susceptibility of coffee trees to beggarticks, more severe competitive effects of this weed occurred on young coffee

Table 2 - Effect of infestation levels on height increase (HI), leaf area increase (LAI), stem diameter increase (SDI), leaf dry matter (LDM), stem dry matter (SDM), shoot dry matter (SDM), root dry matter (RDM), root dry matter:shoot dry matter ratio (RDMRS), dry matter of the whole plant (DMWP), leaf area ratio (RLA), specific leaf area (SLA), stem diameter:coffee tree height ratio (RSDTH), regardless of the cultivar

Infestation level	Variable					
	HI (cm)	LAI (dm^2)	SDI (mm)	LDM (g)	SDM (g)	SDM (g)
Null	0.11 a	8.67 a	2.12 a	11.84 a	20.55 a	16.01 a
Low	0.10 a	7.11 b	2.37 a	10.36 b	18.79 a	14.12 b
High	0.10 a	6.95 b	2.55 a	9.88 b	17.93 a	13.55 b
Average	0.10	7.58	2.35	10.69	19.09	14.56
-	RDM (g)	RDMRS	DMWP (g)	RLA (dm^2 kg^{-1})	SLA (dm^2 kg^{-1})	RSDTH (mm cm^{-1})
Null	3.08 a	0.19 b	19.08 a	8.06 a	12.96 a	0.20 a
Low	3.03 a	0.21 a	17.10 b	8.33 a	13.61 a	0.21 a
High	2.87 a	0.21 a	16.42 b	8.72 a	14.27 a	0.20 a
Average	2.99	0.20	17.53	8.37	13.61	0.20

Means followed by the same letter in a column do not differ according to Tukey's test at 5% probability.

crops (Ronchi and Silva, 2006); however, it was noted that the growth of the coffee tree was reduced linearly or exponentially (depending on the measured variable) with the increase of beggarticks density in the pot. According to Ronchi and Silva (2006), the total dry matter of beggarticks per pot increased exponentially with the increase in its density in the pot. In the present experiment, although the number of beggarticks plants per pot differed between low infestation (two plants per pot) and high infestation (five plants per pot), the total dry matter of the weed accumulated per pot was higher ($p<0.01$) at the low level of infestation (30.6 g per pot) relative to that at the high level of infestation (22.1 g per pot), indicating larger plant size at lower density (Table 3). Plastic responses such as these are common in plants subjected to density variation (Radosevich et al., 1997) and characterize intraspecific competition (Ronchi and Silva, 2006).

Table 3 - Effects of infestation levels (low and high), regardless of cultivar, on the dry mass of the shoot, root, and whole plant per pot and per plant, and on the height of the beggarticks at 60 DAT and 90 DAT

Average of the variable				
-	Dry matter of the shoot	Dry matter of the root	Dry matter of the whole plant	Average height of the plants
Infestation level	Per pot (g)			60 DAT (cm)
Low	26.2 a	4.4 b	30.6 a	27.74 a
High	14.0 b	8.1 a	22.1 b	26.16 a
Overall average	20.1	6.2	26.3	26.95
-	Per plant (g)			90 DAT (cm)
Low	13.1 a	2.2 a	15.3 a	94.36 a
High	2.8 b	1.6 b	4.4 b	93.15 a
Overall average	7.9	1.9	9.9	93.75

Means followed by the same letter in a column do not differ according to Tukey's test at 5% probability.

Even with the likely higher competition potential for nutrients (greater accumulation) at the lower infestation level, the net degree of competition (Pitelli, 1985) on the coffee tree was similar between low- and high-infestation levels (Table 2). It is suggested that this occurred because of the reduced competition for light imposed on the coffee tree at the low level of infestation relative to that at the high level of infestation. The canopy formed by two individual beggarticks plants caused less shade on the coffee tree than that created by five individuals. This occurred even though the mean heights of the beggarticks plants were not different ($p>0.05$) between the levels of infestation, both at 60 DAT (26.95 cm high) and 90 DAT (93.73 cm high) (Table 3), and regardless no significant effect of this factor (level of infestation) was observed on the SLA of the coffee tree (Table 2). It is important to note that the average height of the coffee trees (including all cultivars) was 28.1 and 33.7, at 60 DAT and 90 DAT, respectively, without any significant effect of infestation levels (Table 4). Therefore, in the final 30 days of the competition period, the beggarticks plants reached a height 2.78 times higher than the coffee seedlings, either by rapid growth of the weed because of favorable environmental conditions (high temperatures in the experimental period - Figure 1) or by the slow growth of the coffee tree after transplanting (DaMatta et al., 2007), as shown in Table 4.

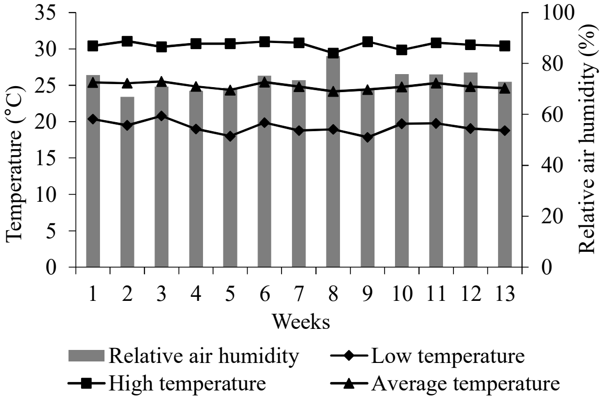

Figure 1 - Variations in meteorological conditions (relative air humidity and low, average, and high temperatures) within the greenhouse during the experimental period by weeks after the transplanting on December 15, 2017.

A significant effect ($p<0.01$) of the cultivar factor was verified for all variables related to the growth of the coffee seedlings, except for SLA, regardless of infestation level. For example, LAI of the coffee tree is an important variable related to light competition between plants, and some cultivars had a 43% higher

(Asa Branca) or 32% lower LAI (Topázio MG) when compared with that of the average LAI of the tested cultivars (Table 5). As expected, the only tested cultivar that was tall (Bourbon Amarelo J9) had significantly higher HI and significantly lower RSDTH than the other cultivars (Table 5). The cultivars Arara, Asa Branca, and the Bourbon Amarelo presented higher LDM, RDM, SDM and, consequently, DMWP, when compared with the other cultivars (Table 5). The large growth variation of the root system, for example, appears to occur between cultivars of arabica coffee depending on the cultivation conditions (Ronchi et al., 2015). However, for the newly transplanted young coffee trees, it appeared that morphophysiological differences among cultivars may not necessarily assure different competitive abilities with perennial fast-growing weeds, such as the beggarticks.

Table 4 - Effects of null, low, and high infestation levels on the average height of coffee trees at 60 and 90 DAT, regardless of the cultivar

Infestation level	Average height (cm)	
	60 DAT	90 DAT
Null	28.75 a	34.25 a
Low	27.51 a	33.04 a
High	28.04 a	33.79 a
Overall average	28.1	33.69

Means followed by the same letter in a column do not differ according to Tukey's test at 5% probability.

The increase in crop competition capacity is one of the pillars of cultural weed control because it reduces the degree of competition from the weed community (Mohler, 1996). Among the various practices to increase the competitive ability of the crops, cultivar choice simply may represent the first step, and this aspect has been explored for several crops, such as wheat (Lamego et al., 2013), soybeans (Fleck et al., 2007), barley (Galon et al., 2011), rice (Balbinot Jr. et al., 2003), and eucalyptus (Medeiros et al., 2016). Usually, researches explore the fact that the cultivars can present different morphophysiological characteristics of the root system and canopy, which could guarantee different responses to weed competition (Bianchi et al., 2006).

Despite variation in growth characteristics of the cultivars presented in Table 5, the only significant interaction ($p<0.01$) was between coffee cultivars and infestation levels for RDM (Table 6). Of the 14 tested cultivars, 12 (Acauã, MGS Aranãs, Asa Branca, Catuaí Amarelo IAC 62, Catuaí Vermelho IAC 99, Guará, Tupi RN IAC 1699 13, IPR 103, IPR 100, Oeiras MG 6851, Paraíso MG H 419-1, and Topázio MG 1190) did not exhibit a reduction in RDM due to beggarticks competition at either infestation levels, in keeping with the trend of the overall non-significant ($p>0.05$) effect of the level of infestation on RDM when considering all cultivars (Table 2). In addition, the RDM increased both in the Arara cultivar at the low infestation level and in the Bourbon Amarelo J9 cultivar at the high infestation level when compared with the coffee tree free of competition (Table 6).

In the first analysis, considering the conditions under which this work was conducted (e.g., adequate level of both nutrient content and water availability in the substrate, short competition period because of the rapid weed growth, and critical period of competition in the third month after transplanting), the results suggest a low susceptibility of the root system of the coffee tree, regardless of the cultivar, to the competition by beggarticks. However, this was not a general response of the coffee tree root system to competition by *B. pilosa* (Ronchi et al., 2007) and other weed species (Fialho et al., 2010). Other important variables related to coffee tree growth, such as LAI, LDM, and DMWP, were significantly affected by competition, but without distinction among cultivars. The greater accumulation of RDM in the cultivars Arara, Asa Branca, and Bourbon Amarelo J9 seemed to be a natural characteristic of these cultivars, but that was not altered consistently by the levels of infestation. Therefore, it was concluded that all tested coffee cultivars were equally susceptible to the competition at the given stage of crop plantation, regardless of the level of infestation to which they were submitted.

As shown in this study, several other studies have verified the susceptibility of the coffee tree, after transplanting, to competition by *B. pilosa* and several other weedy species (Aguilar et al., 2003; Sarno et al., 2004; Ronchi et al., 2007; Ramírez, 2009; Fialho et al., 2010; Lemes et al., 2010). Therefore, it is a common practice to manage weeds in strips in the planting rows after plantation of the crop. Although several integrated management strategies are available to coffee growers and technicians (Ronchi and Silva, 2018), management is often restricted to mechanical and chemical methods.

Table 5 - Comparison among cultivars regarding the variables: height increase (HI), leaf area increase (LAI), stem diameter increase (SDI), leaf dry matter (LDM), stem dry matter (SDM), shoot dry matter (SDM), root dry matter (RDM), root dry matter:shoot dry matter ratio (RDMRS), dry matter of the whole plant (DMWP), leaf area ratio (RLA), specific leaf area (SLA), stem diameter:coffee tree height ratio (RSDTH), regardless of the infestation level

Cultivar	Variable					
	HI (cm)	LAI (dm^2)	SDI (mm)	LDM (g)	SDM (g)	SDM (g)
Acauã	9.34 c	9.36 ab	1.66 cd	10.71 cdef	19.71 bcde	14.37 cdef
MGS Aranãs	11.89 bc	6.51 bcd	1.27 d	8.80 efgh	13.63 cdef	11.60 defg
Arara	9.17 c	9.48 ab	2.99 a	15.34 a	29.09 a	20.67 a
Asa Branca	11.13 bc	10.82 a	2.93 abc	14.32 ab	26.91 ab	19.70 ab
Bourbon Amarelo J9	15.92 a	8.47 abcd	2.95 ab	13.09 abc	26.84 ab	21.30 a
Catuaí Vermelho IAC 62	11.10 bc	7.09 bcd	2.67 abc	10.61 cdefg	18.03 cdef	14.13 cdef
Catuaí Amarelo IAC 99	9.79 bc	7.39 abcd	2.84 abc	12.29 bcd	21.46 abc	16.44 bc
Guará	12.25 b	7.08 bcd	2.43 abcd	10.26 defg	17.92 cdef	13.91 cdef
Tupi RN IAC 1699-13	9.60 bc	9.24 abc	2.40 abcd	11.18 cde	20.68 bcd	14.70 cde
IPR 103	10.97 bc	6.55 bcd	2.08 abcd	8.35 fgh	13.27def	10.88 fg
IPR100	10.53 bc	7.17 abcd	2.13 abcd	8.71 efgh	16.13 cdef	11.41 efg
Oeiras MG 6851	10.29 bc	5.59 cd	1.71 bcd	8.05 gh	12.38 ef	10.90 fg
Paraíso MG H 419-1	10.41 bc	6.16 bcd	3.04 a	11.13 cde	19.80 bcde	15.13 cd
Topázio MG 1190	10.65 bc	5.16 d	1.69 bcd	6.83 h	11.42 f	8.75 g
Overall average	10.93	7.58	2.34	10.69	19.09	14.56

Cultivar	Variable					
	RDM (g)	RDMRS	DMWP (g)	RLA (dm^2 kg^{-1})	SLA (dm^2 kg^{-1})	RSDTH (mm cm^{-1})
Acauã	2.84 cd	0.20 ab	17.21 bcde	8.88 a	14.29 a	0.22 a
MGS Aranãs	2.41 cde	0.20 ab	14.01 cdef	8.33 ab	13.29 a	0.19 a
Arara	4.53 a	0.22 ab	25.20 a	7.82 ab	12.82 a	0.21 a
Asa Branca	4.34 a	0.22 ab	24.04 a	8.31 ab	13.95 a	0.19 a
Bourbon Amarelo J9	3.82 ab	0.18 b	25.12 a	6.78 b	13.01 a	0.13 b
Catuaí Vermelho IAC 62	3.06 bc	0.22 ab	17.20 bcde	8.08 ab	13.06 a	0.22 a
Catuaí Amarelo IAC 99	3.01 bc	0.19 ab	19.46 b	7.58 ab	12.02 a	0.20 a
Guará	2.84 cde	0.20 ab	16.75 bcde	8.07 ab	13.19 a	0.19 a
Tupi RN IAC 1699-13	2.85 cd	0.20 ab	17.55 bcd	9.09 a	14.30 a	0.23 a
IPR 103	2.35 cde	0.22 ab	13.24 ef	9.00 a	14.22 a	0.20 a
IPR100	2.36 cde	0.21 ab	13.77 def	9.19 a	14.52 a	0.22 a
Oeiras MG 6851	2.07 de	0.19 ab	12.97 ef	8.32 ab	13.38 a	0.20 a
Paraíso MG H 419-1	3.11 bc	0.21 ab	18.25 bc	7.38 ab	12.11 a	0.20 a
Topázio MG 1190	1.96 e	0.23 a	10.72 f	9.21 a	14.41 a	0.21 a
Overall average	2.97	0.21	17.53	8.29	13.47	0.20

Means followed by the same letter in a column do not differ according to Tukey's test at 5% probability.

The choice of a cultivar that has, besides the traditional requirements usually taken into account (e.g., plant vigor; productive potential; fruit and grain quality; and tolerance to diseases, pests, and abiotic stresses) (Carvalho, 2008; Matiello, 2016), higher tolerance to weed competition in the early stage of crop plantation could represent a low-cost strategy for weed management. However, considering the conditions under which this study was conducted, the cultivars tested appear to be equally susceptible to weed competition when they are established at low or high levels of infestation in the second and third month after transplanting.

Table 6 - Interactions between cultivars and infestation levels for the dry matter of coffee root evaluated at 90 DAT

Cultivar	Infestation levels		
	Null	Low	High
Acauã	3.44 A abc	2.49 A cd	2.61 A bcde
MGS Aranãs	2.34 A c	2.27 A cd	2.63 A bcde
Arara	4.14 B ab	5.41 A a	4.04 B ab
Asa Branca	4.24 A a	4.75 A ab	4.02 A ab
Bourbon Amarelo J9	2.77 B abc	3.56 AB bc	4.55 AB a
Catuaí Vermelho IAC 62	3.40 A abc	3.32 A bcd	2.47 A cde
Catuaí Amarelo IAC 99	2.76 A abc	2.86 A cd	3.42 A abc
Guará	3.45 A abc	3.48 A cd	2.98 A bcde
Tupi RN IAC 1699-13	2.52 A c	2.88 A cd	3.17 A abcd
IPR 103	2.94 A abc	2.27 A cd	1.86 A de
IPR100	2.65 A bc	2.12 A cd	2.32 A cde
Oeiras MG 6851	2.54 A c	1.91 A d	1.76 A de
Paraíso MG H 419-1	3.38 A abc	3.16 A cd	2.80 A bcde
Topázio MG 1190	2.49 A c	1.89 A d	1.51 A e
Overall average	3.07	3.03	2.87

Means followed by the same letters, uppercase in rows and lowercase in columns, do not differ at 5% probability according to Tukey's test.

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