MORPHOLOGICAL PLASTICITY OF THREE COFFEE CULTIVARS UNDER LIGHT GRADIENT

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ABSTRACT: The aim of this study was to fill in gaps in knowledge regarding the interaction among shading systems, stages of development and cultivars on the initial growth of coffee plantlets, with due attention to adequate mathematical models, and to allow interpretations in light of currently emerging knowledge on this theme. The cultivars Catuaí (IAC 144), Catucaí 2SL, and Acauã were subjected to levels of light restriction of 30%, 50%, and 70%, and to full sunlight. The experiment was conducted from January to June 2007 in the experimental field at the Universidade Estadual do Sudoeste da Bahia – UESB, Vitória da Conquista, the state of Bahia, Brazil. In each trial defined by level of light restriction, a randomized block experimental design was used with five replicates, and the treatments were arranged in a split-plot design in which the main plot consisted of cultivars and the assessment times constituted the split-plots. Each experimental unit consisted of 12 plants. Vegetative development assessments began 30 days after emergence and were conducted at 15-day intervals until 90 days. The light restriction levels and assessment periods, as well as the interaction between those factors, affected all the growth characteristics evaluated. With the exception of stem diameter, all other growth parameters had similar behavior in relation to the number of days after emergence and levels of light restriction. In general, the morphological changes in the initial growth of the coffee plantlet were more intense under light restriction values from 30% to 50%, and Catucaí 2SL presented greater development in comparison to Catuaí (IAC 144) and Acauã.

Index terms: *Coffea arabica*, shading, insolation, ecophysiology.

PLASTICIDADE MORFOLÓGICA DE TRÊS CULTIVARES DE CAFEEIRO SOB GRADIENTE DE LUZ

RESUMO*: Objetivou-se, neste estudo, preencher as lacunas de conhecimento sobre a interação entre regimes de sombreamento, estágios de desenvolvimento e cultivares para o desenvolvimento de mudas de cafeeiros, com a devida atenção ao tratamento matemático e possibilitar interpretações, à luz do conhecimento atual emergente sobre este tema. Diante disso, conduziu-se este trabalho para avaliar o crescimento inicial de cultivares de cafeeiro, cultivadas sob diferentes níveis de restrição luminosa. O experimento foi conduzido de janeiro a junho de 2007, na Universidade Estadual do Sudoeste da Bahia – UESB, em Vitória da Conquista, BA. Quatro ensaios foram definidos por níveis de 30%, 50% e 70% de restrição luminosa e plantas mantidas a pleno sol. Para cada ensaio utilizaram-se as cultivares Catuaí (IAC 144), Catucaí 2SL, e Acauã, procedendo-se com coletas dos dados a partir dos 30 dias após emergência, em intervalos de 15 até 90 dias. Em cada ensaio, definidos pelos níveis de restrição de luz, utilizou-se o delineamento experimental em blocos casualizados, com cinco repetições, sendo os tratamentos dispostos em esquema de parcelas subdivididas, com as cultivares nas parcelas e as épocas de avaliação nas subparcelas. Cada unidade experimental foi constituída por 12 plantas úteis. Os níveis de radiação e os períodos de avaliação, bem como a interação entre esses fatores, afetaram todas as características avaliadas. Com exceção do diâmetro do caule, todos os outros parâmetros de crescimento tiveram um comportamento semelhante em relação ao número de dias após a emergência e níveis de restrição luminosa. Em geral, as alterações morfológicas no crescimento inicial do café foram mais intensas sob valores de restrição luminosa entre 30% e 50% e Catucaí 2SL apresentou um maior desenvolvimento em comparação com Acauã e Catuaí (IAC 144).*

Termos para indexação: *Coffea arabica, sombreamento, insolação, ecofisiologia.*

1 INTRODUCTION

Brazil is the world's largest coffee producer and exporter with 2,351.3 hectares planted with coffee, and the State of Bahia is a potential area of focus for expansion of the country's coffee production (COMPANHIA NACIONAL DE ABASTECIMENTO - CONAB, 2012). The main producing areas are in this region, the high plains of Conquista, the western region, and the coastal region, though productivity indices are not homogeneous. Even in areas where there is intense demand for technology, the sustainability of cultivated coffee systems has been questioned.

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In order to increase competitiveness and to benefit the coffee sector, a clear-sighted evaluation, since the phase of seeding, of the coffee production system in the State of Bahia must be conducted. According to Marcuzzo et al. (2005), the production healthy and vigorous seedlings is one important factors to the development coffee crop. In doing so, some basic aspects, though of utmost importance, must be analyzed with for example the radiation level. In the State of Espírito Santo, producers of Robusta coffee have indicated the effectiveness of restricting light in the establishment of seedlings, arguing that light restriction causes plants to adapt more quickly to the fields.

In studies conducted in the State of Espirito Santos by Braun et al. (2007), it was observed that initial seedling growth was more robust under 75% light restriction. Paiva, Guimarães e Souza (2003) evaluated Arabica coffee seedlings in the region of Lavras, Minas Gerais, and observed higher vigor in seedlings submitted to a 50% light restriction. However, this higher vegetative growth in shoots and root parts must be evaluated with caution. The direct relation between such characteristics and adaptability to transplanting conditions is not clear., whence, there is a requirement to conducted studies in climatic condition in State of Bahia.

Plants with larger leaf area can have intense transpiration, resulting in higher stress potential under field conditions. With respect to root system vigor, not only mass, but also total root length and lateral root development should be analyzed because the restriction of light incidence can reduce this and, consequently minimize the water and nutrients absorption. Despite their low saturation irradiation (300 to 600 μmol photons m^{-2} s^{-1}), coffee plants show morphological and physiological adaptations under shading conditions (MATSUMOTO; MOREIRA; VIANA, 2002).

According to Baliza et al. (2012), the major values of CO_2 assimilation were verified in coffee plants cultivar Catucaí Amarelo 2SL submitted to artificial shading in a dry and rainy season. Araújo et al. (2008) described that variations in specific leaf area and leaf inclination that occur in response to light gradient should be associated to diffusive alterations of gas exchange in plant-atmosphere interaction. However neither mesophyll capacity for CO_2 fixation nor photoinhibition of photosynthesis were able to maintain the photosynthetic apparatus in a range of light gradient. So, morphological or anatomical plasticity may have a greater acclimative importance than physiological plasticity of leaves submitted to shading. It may be adverse that in the present study, the structure of canopy and root system of plantlets were different of those older plants, in a field condition.

The use of nurseries with 50% shading/ light restriction is a standard management practice for the production of seedlings in all of Brazil. Nevertheless, it must be emphasized the need to evaluate the interface between light restriction, stage of development and new cultivars of plants being cultivated, for the reason that the amplitude of variation due to light gradient. This fact was exposed by Moraes et al. (2010) with an elegant argument, let a thinking that a full sunlight exposure of coffee seedling may be viable option to coffee grower, because in this study, it coming a superior performance when compared to seedlings grown in the shade.

Based on explained above, this study was carried out in order to evaluate by means a mathematical models, in a period of 90 days, the effect of artificial light gradient on morphological plasticity of coffee plantlets cultivar Catuaí (IAC 144), Catucaí 2SL, and Acauã.

2 MATERIAL AND METHODS

The experiment was carried out during the period from January to June 2007 in the agricultural field of Universidade Estadual do Sudoeste da Bahia – UESB, in Vitória da Conquista, BA, located at 14º 53' South and 40º 48' West, at a 870-meter elevation, with annual average temperature of 20.2ºC and annual precipitation of 900 mm. This city has tropical climate of altitude (Cwb), according to Köppen classification. After preparing seedling containers, these were placed in nurseries covered with screens and in an area with direct sunlight, and were watered daily during 15-day period before planting the seeds.

Seeding was done by the direct method with two seeds per mini bag, which were covered with thin layer of washed sand and straw from dry hay in order to conserve substrate moisture and prevent the seeds from being exposed by the impact of water during irrigation. When germination started, the dry straw mulch was removed and the more vigorous plant was pruned, while the other was cut even with the ground, leaving a single plant per bag. Seedlings were cultivated in small polyethylene bags (11 × 22 cm) containing a

substrate consisting of 700 liters of sifted soil, 300 liters of sifted farmyard manure, 6 kg of single superphosphate, and 1.0 kg of potassium chloride. Weeds were controlled manually and the plants were watered daily so as to maintain the substrate at field capacity.

The study consisted of four trials represented by different light restriction levels and one area in direct sunlight. The restricted light conditions were obtained through nurseries (6.0 × 9.0 × 2.20 m) covered with black screens that provided 30%, 50%, and 70% light restriction. The nurseries were constructed perpendicularly to the apparent sun daily path with a minimum distance between each other, in such manner that the shade of one did not reach the other. Each trial, consisting of one light restriction level, randomized block design was utilized, with five replicates and the treatments (cultivars and times of evaluations) were delineated in a split plot design, where cultivars Catuaí (IAC 144), Catucaí 2SL, and Acauã were defined as the main plot, and the evaluation periods in days after emergence were characterized as subplots In the experimental unit it was evaluated 12 plants (Figure 1) (BANZATTO; KRONKA, 1992).

Measurements of height, stem diameter, and total leaf area were done during the period from 30 to 90 days after seedling emergence in 15-day periods, totaling 5 collections. At 45, 60, 75, and 90 days after emergence, two plants per plot were collected to characterize plant dry weight. Plant height was measured by the distance from plantlet root collar to the apex (cm); stem diameter was determined with a caliper rule (mm). Leaf area was determined on a section of all plantlet leaves using a LI-3100 Area Meter, LI-COR, USA, (cm^2); number of leaves was determined by direct count. Shoot dry weight (SDW), root dry weight, and total dry weight were determined by collecting data from two seedlings in each plot, which were placed into labeled plastic bags and immediately taken to the laboratory. The seedlings were separated into shoots and root system; the latter was washed in order to eliminate attached soil. After that procedure, the material was submitted to 65ºC for 48 hours to determine dry weight in (g).

The data were submitted to analysis of variance in each treatment, and subsequently a grouped analysis of experiments was done when the ratio between the residual squared mean values was less than or equal to 1:6 (BANZATTO; KRONKA, 1992). The mean varietal trait values were compared by Tukey's test and the light restriction levels and evaluations of the numbers of plantlet post-emergence days were investigated by regression analysis of variance, with models defined according to their biological event and coefficient of determination values.

3 RESULTS AND DISCUSSION

Radiation level effects were observed for all growth parameters and dry weight of the shoot, roots and total plant were verified to days after emergence, and the interaction between these factors. When cultivars were evaluated, effects were observed for root dry matter, height and number of leaves. Light restriction (S) X Cultivars (C) effect was verified only for height; for height and diameter effects between C and days after emergence (D) were observed (Table 1).

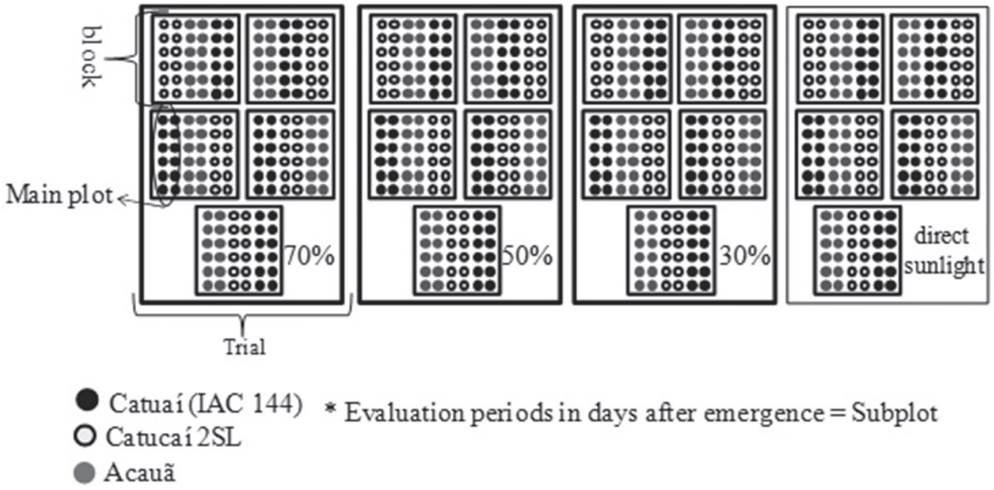

FIGURE 1 – Experimental design.

TABLE 1 – Mean squares in grouped analysis of experiments for shoot dry weight (SD), root dry weight (RD), total weight (TD), height (HG), stem diameter (DIA), leaf area (LA) and number of leaves (NL), of coffee seedlings (*Coffea arabica*), for Catuaí (IAC 144), Catucaí 2SL, and Acauã cultivars (C), produced under 0, 30, 50 and 70% of light restriction (S), evaluated at 30, 45, 60, 75, and 90 days after emergence (D).

Cause of Variation	DF	Variables			DF	Variables			
		(SD)	(RD)	(TD)		(HG)	(DIA)	(LA)	(NL)
S	3	1.65*	0.44^{*}	3.39^{*}	3	98.61^{**}	6.04^{*}	45557.02^{**}	30.22^{**}
Bl d S	16	0.06^{ns}	0.02^{ns}	0.11^{ns}	16	1.21^{ns}	0.05^{ns}	838.95^{**}	0.49^{ns}
C	2	0.03^{ns}	0.07^{*}	$0.19^{n.s}$	2	37.89^{**}	0.21^{ns}	799.87^{ns}	10.32^{**}
S × C	6	0.06^{ns}	0.01^{ns}	0.11^{ns}	6	1.22^{*}	0.06^{ns}	637.63^{ns}	0.29^{ns}
Res(a)	32	0.08	0.03	0.18	32	1.09	2.62	614.78	0.46
D	3	9.71^{**}	2.08^{**}	20.66^{**}	4	373.23^{*}	35.72^{*}	173238.80^{**}	175.95^{**}
C × D	6	0.03^{ns}	0.01^{ns}	0.06^{ns}	8	1.27^{**}	0.05^{*}	109.48^{ns}	0.23^{ns}
S × D	9	0.14^{*}	0.06^{*}	0.29^{**}	12	4.23^{**}	0.87^{**}	1597.28^{*}	0.47^{**}
S ×C×D	18	0.04^{ns}	0.02^{ns}	0.07^{ns}	24	$0.16^{n.s}$	0.02^{ns}	478.30^{ns}	0.98^{ns}
Res(b)	144	0.03	0.011	0.056	192	0.13	6.21	488.71	0.14

$^{n.s}$, * and ** Non significant and significant at $p \leq 0.05$ and $p \leq 0.01$ probability, respectively, by the F test.

Different responses were obtained for number of leaves and root dry weight for three cultivars under study, regardless of light incidence gradient-related environmental alterations (Figure 2). Acauã was characterized by a smaller number of leaves associated with higher root dry weight in relation to Catuaí (IAC144). The higher tolerance to dry and hot periods previously described by Matiello et al. (2000) was related to the simultaneous expression of such characteristics that, in short, are associated with reduced transpiration and higher water absorption capacity.

The cultivar Catucaí 2SL was that more detached because it was the only one that showed both a greater number of leaves as higher root dry weight compared with other cultivar, which confirms its high capacity for vegetative growth under the conditions described. Although a high number of leaves was observed in the Catuaí 2SL cultivar, root dry weight was lower than in the other cultivars.

In studies on rootstock evaluations of Coffee genotypes, Alfonsi et al. (2005) observed a similar happening for Catuaí cultivar, when compared with Apoatã-IAC-2258 (C. canephora Pierre ex. A. Froehner); Bangelan -IAC- col 5 (C. congensis A. Froehner X C. canephora); Catuaí (IAC-144) (C. arabica); Excelsa (C. liberica var. dewevrei (**De Wild**, et Th. Durand Lebrun); and Piatã -IAC-387 col 6 (C. arabica X C. liberica var. dewevrei), at 90 and 150 days after transplanting. Under a root-system volumetric-restriction condition, the lower photosynthetic capacity per unit area in Catuaí (IAC144) was associated with smaller values of the ratios dry matter weight of the shoot (g) / leaf area and root system dry matter weight (g) / dry matter weight of the above-ground shoot in relation to the other cultivars evaluated.

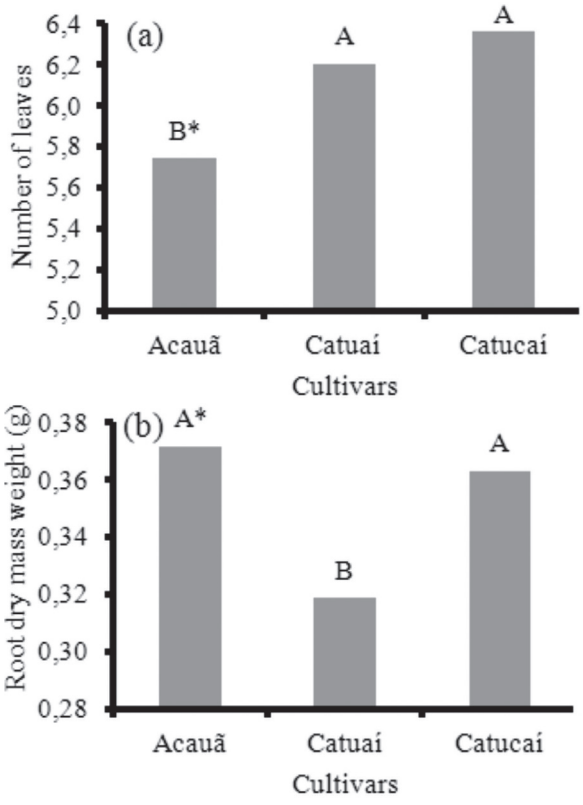

FIGURE 2 – Number of leaves (a) and root dry weight (b) in coffee cultivars Catucaí 2SL, Acauã, and Catuaí (IAC144) (*Coffea arabica*), evaluated during 90 days after emergence.

*Means followed by distinct letters differ by Tukey's test at $p \leq 0.05$.

For CxS interaction, when the effect of cultivars was isolated, a quadratic model was fitted to the ratio between height and light restriction. Greater plant height values (0,104, 0,093, and 0,090 m) were observed for light restriction indices of 39.71%, 39.56%, and 43.75% in cultivars Catucaí 2SL, Catuaí (IAC144), and Acauã, respectively (Figure 3). In the three cultivars studied, a linear model was assigned for the height and stem diameter with the D (Figures 4a, 4b).

According to Morelli and Ruberti (2000), the higher plant growth under light restriction is explained by the action of auxin, a growth-regulating substance which controls different aspects of plant development, including cell division, expansion, and differentiation. As is already known, auxin is synthesized in young leaves of the shoot and on the apex of stems, and transported to the roots in polar form. Light is a particular stimulus for this directional transport. When light restriction occurs, auxin is redistributed laterally to the epidermis and cortical cells of the hypocotyls, which reduces the intensity of this transport to the roots, causes these two tissues to become extended and results in etiolated plants.

The greatest height values were observed in the Catucaí 2SL cultivar at 90 days and the greatest stem diameter values were also observed at 90 days in the Acauã cultivar (Figures 3a, 3b). This was verified by means of a higher slope coefficient in the model defined for Catucaí 2SL cultivar under light-incidence-gradient conditions and during the growth period, was associated with the tall-size origin of this material (line Icatu).

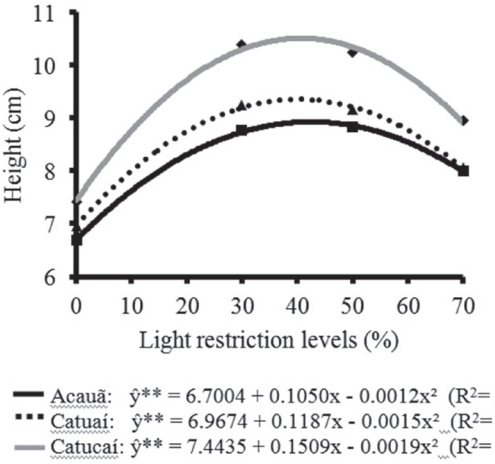

FIGURE 3 – Height estimates for coffee seedlings (*Coffea arabica*) of Catuaí (IAC 144), Catucaí 2SL, and Acauã cultivars evaluated in relation to light restriction levels, during 90 days after emergence.

** Significant at p≤0.01 by regression analysis of variance.

The tendency of greater stem diameter values observed in the Acauã cultivar (verified from the smaller slope coefficient) was associated with its smaller size and a wider, less branched canopy in relation to the other cultivars under study. Therefore, although the light restriction

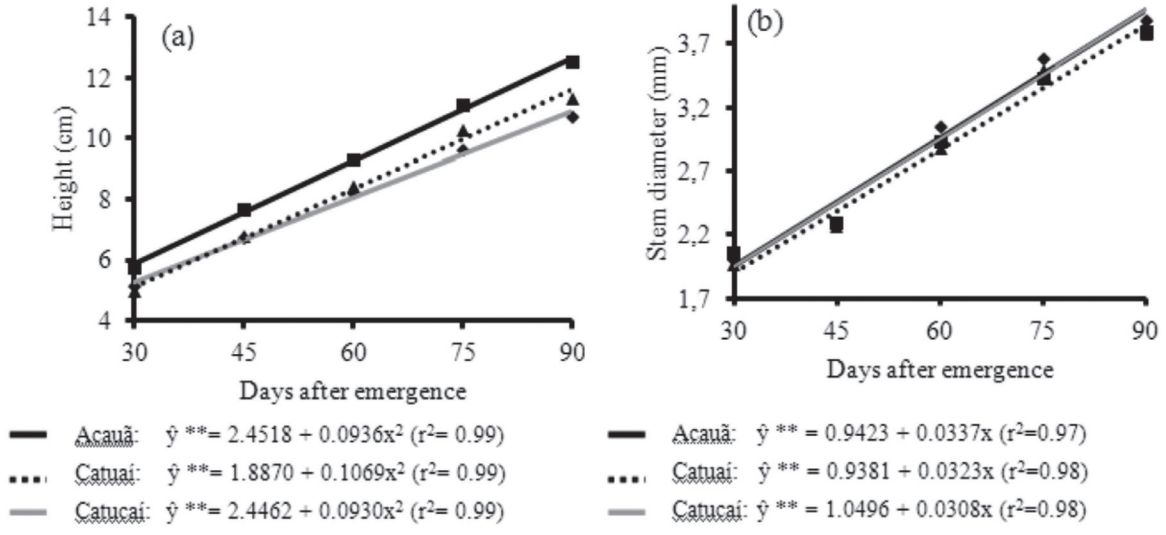

FIGURE 4 – Height estimates (a) and diameter (b) of coffee seedlings (*Coffea arabica*), Catuaí (IAC 144), Catucaí 2SL, and Acauã cultivars evaluated in relation to the number of days after emergence during a 90-day period.

** Significant at p≤0.01 by regression analysis of variance.

effect became evident when plant height and stem diameter were analyzed, the original genotypic characteristics were preserved in the cultivars under study.

When SxD factor was evaluated, a linear model was defined (Figure 5a, 5c, and 5e). In order to analyze the height, leaf area, and number of leaves in relation to restriction levels, a quadratic model was fitted (Figure 5b, 5d, and 5f).

The greatest height values (0.56 to 0.13m) evaluated in the period from 30 to 90 D occurred in the light restriction range from 38.16 to 50.76%, and a reduced light restriction demand was observed to reach greater heights in the plant's continued development (Figure 5b). There wasn't difference in the interaction between C and D.

The light factor response is specific characteristic of each species, though several authors who studied various species have obtained similar results to those in the present study (ALVARENGA et al., 2003; BALIZA, 2011; CARON et al., 2010; CHAVES; PAIVA, 2004).

When the SxD factor was established for the relation between light restriction and number of leaves (Figure 5f), the greatest values observed at each evaluation time (4.21 at 30 D and 8.76 at 90 D) occurred in the range from 22.97 to 27.58% light restriction. While evaluating the cultivars were observed differences that the NL in Catucaí 2SL had a tendency to be higher, followed by the values found in Catuaí (IAC144) and Acauã (Figure 2a). Similar circumstance to the present study was observed by Paiva, Guimarães e Souza (2003), who verified higher number of leaves in coffee seedlings under a 50% light restriction treatment, followed by 30%, while the lowest number was observed in a treatment with maximum restriction (90%). The highest number of leaves in treatments with lower light restriction may have occurred due to greater light availability, which increased total photosynthetic rate in the plant canopy and consequently produced more leaves.

For SxD interaction, a quadratic model was defined only from 60 until 90 D, for the relation between leaf area and light restriction, with highest leaf area values of 161.77 at 60 days and 245.89 cm^2 at 90 days under light restriction values between 42.83 and 51.72% (Figure 5d). The increase in leaf area in a restricted sunlight environment is a plant adaptation mechanism, which allows a rapid increase of the photosynthetic surface in search for greater light capture. In the present study, the fact that the treatment with greater light restriction (70%) presented higher total leaf area than treatments with 30% and 50% is due to smaller numbers of leaves in this treatment.

The canopy's leaf area is an important parameter in determining the physiological processes related to growth and development, as well as transpiration intensity, net assimilatory rate, leaf area index, and others. According to Mohotti and Lawlor (2002), sunlight restriction caused a leaf temperature reduction in tea plants and increased air humidity, resulting in a direct correlation with shorter transpiration rates. This fact occurs because stomatal movement is highly responsive to factors that influence water loss rates from the leaves into the atmosphere.

Dias et al. (2007) observed that a higher reduction in leaf transpiration capacity in Siriema cultivar (drought tolerant) contributed to higher water use efficiency as compared to Catucaí cultivar (drought susceptible). Although a contrasting effect caused by water restriction and sunlight radiance to individual leaf areas was observed, the tendency regarding total leaf area was similar in both conditions. The reduction in leaf numbers in coffee plants under intense light restriction contributed toward this event.

For the relation between days after emergence and stem diameter, an analysis of the SxD interaction involved adjusting a cubic model to the four light restriction levels evaluated (Figure 6a). Similar results were verified by Hummel (2000) in Cordia alliodora (Ruiz et Pavón) Cham. stem diameter in that was a enlargement with increasing age. In the same study, a diverse event occurred with increasing tree density.

At 30 days after emergence, a greater diameter was observed in the treatment under 70% light restriction, at 2.48mm. However, in the final evaluation at 90 days after emergence, the treatment with 50% restriction showed the highest values, achieving 4.02mm. This performance was determined by lower amplitude of values verified in the 70% treatment (1.16 mm) in relation to the treatment with 50% light restriction (2.21mm).

When an evaluation date was set, a quadratic model was adjusted for the relation between S and stem diameter, in all evaluation stages except at 30 D (Figure 6b). At that evaluation date, the linear model was adjusted and achieved the greatest diameter (2.35mm) in the treatment with 70% light restriction. The highest values in each evaluation stage tended to decrease in relation to light restriction level, and reached the highest value at 90 D with 4.01mm at 35.17%.

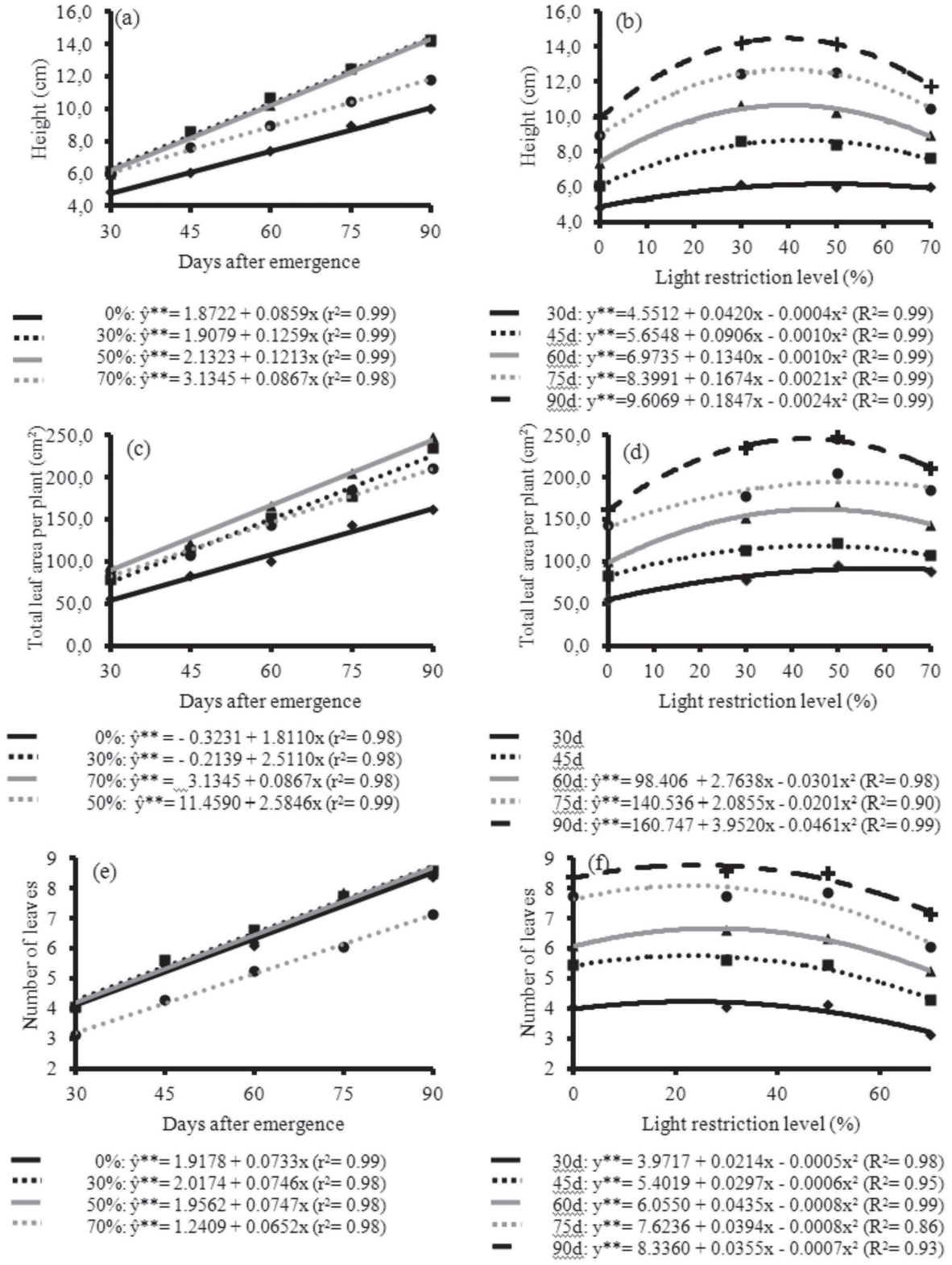

FIGURE 5 – Height (a, b), leaf area (c, d), and number of leaves (e, f) of coffee seedlings (*Coffea arabica*), Catuaí (IAC 144), Catucaí 2SL, and Acauã cultivars, evaluated during 90 days after emergence in relation to the number of days after emergence and light restriction levels.

** Significant at $p \leq 0.01$, by regression analysis of variance.

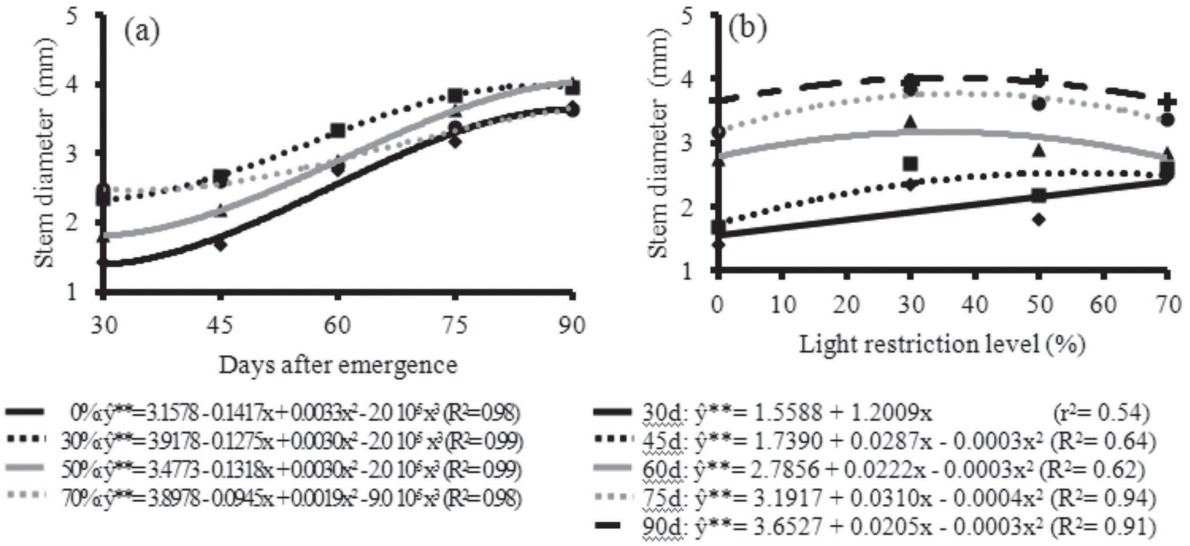

FIGURE 6 – Stem diameter estimates (a, b) for coffee seedlings (*Coffea arabica*) evaluated during 90 days after emergence, in relation to the number of days after emergence and light restriction levels.

*, ** Significant at p≤0.05 and p≤0.01, respectively, by regression analysis of variance.

Similar results were checked by Baliza (2011), for coffee in training (cultivar Yellow Catucaí), the maximum values of stem diameter occurred in 28% light restriction. According to the author 30% light restriction (moderate shading) improved the physiological processes, hence the growth of coffee.

When evaluating shoot, root and total dry weight, and considering the interaction between light restriction levels (S) and days after emergence (D), a quadratic effect was delineated for all light restriction levels where the S factor was isolated, and gradual weight accumulation was observed over the plant development period (Figure 7a, 7c, and 7e). For SxD interaction, as isolation of D factor continued (Figure 7b), a quadratic model was fitted for 60 and 90 D with maximum values of 1.05 and 1.88g observed for 32.15 and 36.02% respectively. There wasn't difference for stem diameter in C x D and C x S analysis.

Costa (2004) observed greater shoot dry weight for cultivar Icatu-4045 coffee seedlings cultivated in test tubes under 40% thermo-reflective meshes, and lower under 70%; those results are similar to the results obtained in the present study. Paiva, Guimarães e Souza (2003) observed a different fact in Rubi MG – 1192 cultivar coffee seedlings grown in polyethylene bags, where shoot dry weight was superior in the 90% light restriction treatment and lower in a treatment under direct sunlight. Factors related to the container which the seedlings were formed and cultivars and species were determinant in such differentiated comportment.

When the light restriction was set for the interaction between S and D, a quadratic model was defined from 75 D and root dry weight was evaluated (Figure 7d), with the largest values (0.53 and 0.66g) observed for 14.71 and 15.05% at 75 and 90 D, respectively. By comparing the C factor means, Catuaí (IAC144) showed a lower root dry weight value in relation to Acauã and Catucaí 2SL (Figure 4b). This observation can be explained by the decreased descendent flow of auxins as shading increased, resulting in smaller number of lateral roots and, eventually, main root growth, as reported by Morelli and Ruberti (2000).

For SxD, with set evaluation dates, a gradual and increasing accumulation was also observed between number of days after emergence and total dry weight, which fitted a quadratic model in all light restriction levels (Figure 7e). When light restriction levels were set, a quadratic model was fitted from 60 D, at which the highest values (1.37 and 1.93g) were observed at 60 and 90 D under levels of 29.72 and 34.02% light restriction.

No difference was observed between cultivars for total dry weight. In the present study, the greatest total dry weight accumulation estimated from 29.72 to 34.02% of light radiation restriction may have occurred due to a better adaptation of the photosynthetic apparatus of coffee plants under conditions of moderate light restriction, resulting on higher net photosynthesis

index. By means of total biomass accumulation it was possible to verify that the light gradient induced occurrence of plasticity of performance in coffee plantlets.

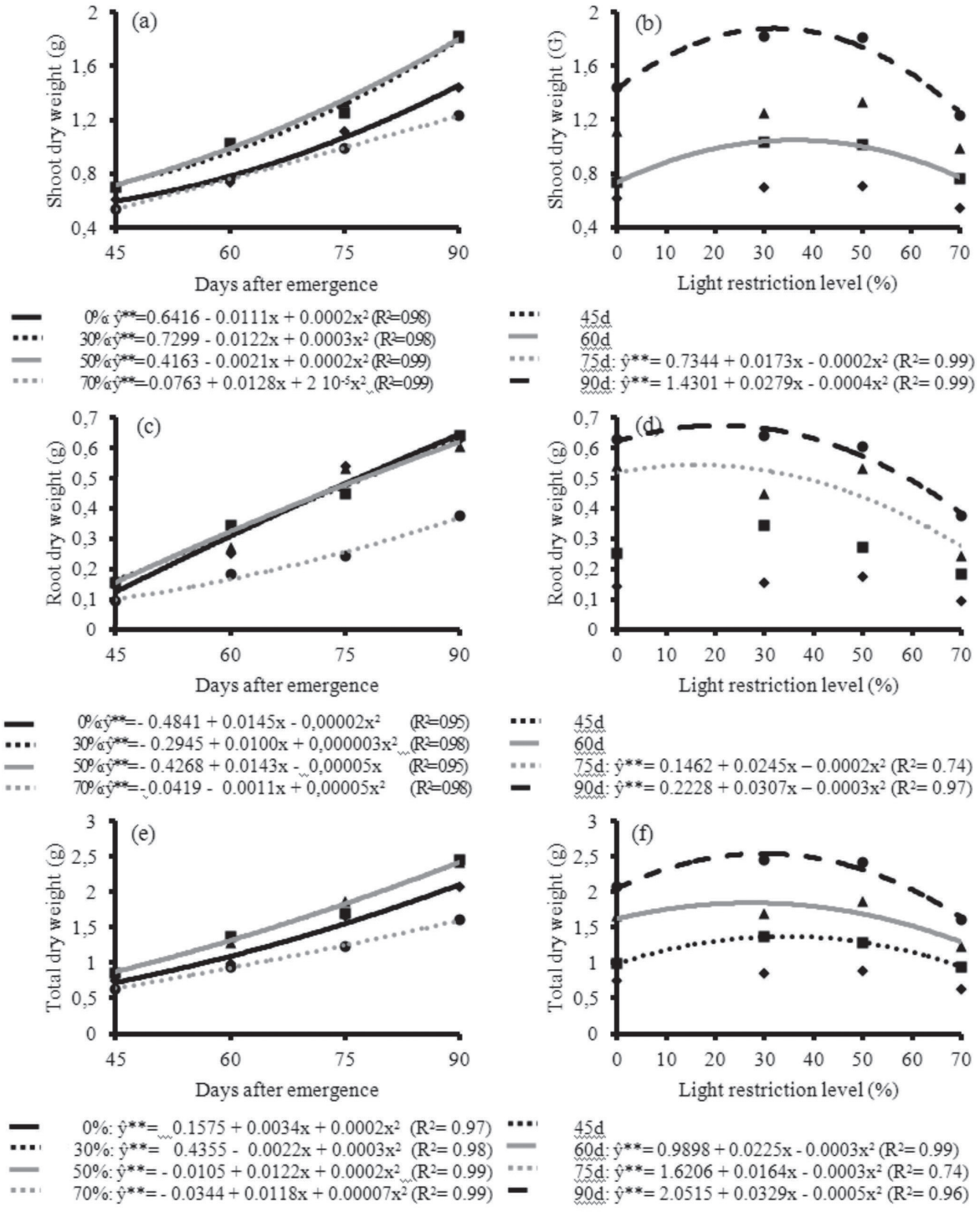

FIGURE 7 – Shoot dry weight (a, b), root dry weight (c, d), and total dry weight (e, f) estimates for coffee seedlings (*Coffea arabica*), Catuaí (IAC 144), Catucaí 2SL, and Acauã cultivars, evaluated for 90 days after emergence in relation to the number of days after emergence and light restriction levels.

* Significant at $p \leq 0.05$ and $p \leq 0.01$, respectively, by regression analysis of variance.

Despite the strong light restriction effect on morphological characteristics observed in this study, Chaves et al. (2008) postulated that the photosynthetic apparatus of the coffee tree (Coffea arabica cv. Red Catuaí) had low phenotypic plasticity for varying irradiance in Viçosa, Minas Gerais, during the period from August to December. Araújo et al. (2008) observed that the acclimation value expression for the morphological and anatomical plasticity of coffee plants was more intense than the physiological plasticity of coffee leaves to respond to changing irradiance.

Despite all assertions formerly postulated, it must be considered that plants evaluated in this trial were at initial vegetative development and the trial was conducted under conditions of artificial shading, in small pots that providing root growth restriction. Consequently, facts such as shoot/root rate and incipient self shading were distinct from those found in mature coffee plants under field conditions. Ronchi et al. (2006) described the effect of increased physical restriction of young coffee roots, simulated in small pot, suggesting general reductions in plant growth associated with increasing root/shoot ratios and a severe decrease in photosynthesis. Understanding how those morphological alterations induced by light restriction are associated with coffee plants shading avoidance syndrome under field conditions requires further studies focusing on those aspects.

4 CONCLUSIONS

For all characteristics the effect of artificial light gradient underlies a quadratic model indicating that intermediate level of shading results on major estimative of coffee plantlets growth.

Morphological plasticity of plant is result of interaction between shading and cultivars, delineated by means a quadratic model, occurring higher values to Catucaí 2SL followed by Catuaí (IAC 144) and Acauã cultivars.

To all others characteristics, the light incidence gradients and evaluation periods, as well as the interaction between those factors, affect growth, on similar manner, of coffee plantlets of Catuaí (IAC 144), Catucaí 2SL, and Acauã cultivars.

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