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TYPES OF STEM CUTTINGS AND ENVIRONMENTS ON THE GROWTH OF COFFEE STEM SHOOTS

EFEITOS DE TIPOS DE ESTACAS CAULINARES E DO AMBIENTE SOBRE O CRESCIMENTO DE MUDAS DE CAFÉ

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ABSTRACT

Looking to contribute to the formation of an appropriate methodology for *Coffea arabica* L. stem shoots production through vegetative propagation, this work aimed to evaluate the effect of different types of stem cuttings used for the formation of Arabic coffee stem shoots obtained from stem cuttings, under two different environments. The experiment was carried out in an completely random design, in a 3 x 2 factorial experiment, corresponding to three types of segments (herbaceous, semi-woody and woody) and two environments (shaded nursery and greenhouse). The experiment was conducted for 90 days. At conclusion the following variables were evaluated: plant height, number of nodes, number of leaf pairs, length of the principal root and the plant dry matter. It was observed that for the longest root of the semi-woody cutting presented the highest average, differing significantly from the other cuttings. For total dry matter, the semi-woody and woody cuttings did not present significant difference amongst themselves, but they were superior to the herbaceous cuttings. The shaded nursery stood out as the best local for the development of these seedlings.

Key-words: *Coffea arabica* L.; vegetative propagation; coffee plant clones.

RESUMO

Buscando a adequação de uma metodologia para produção de mudas de *Coffea arabica* L. via propagação vegetativa, objetivou-se avaliar neste trabalho o efeito de diferentes tipos de estacas caulinares utilizadas para a formação de mudas de café arábica. O experimento foi instalado em delineamento inteiramente casualizado, disposto em esquema fatorial 3 x 2, correspondentes a três tipos de segmentos (herbáceos, semilenhosos e lenhosos) e dois ambientes (telado de sombrite e casa de vegetação). O experimento foi conduzido por 90 dias. No encerramento foram avaliadas as seguintes variáveis: altura da planta, número de nós, número de pares de folhas, comprimento da raiz principal e a matéria seca da planta. Através dos resultados observa-se que a estaca semilenhosa apresentou a maior média para comprimento da raiz principal, diferindo significativamente dos outros segmentos. Para matéria seca da planta, as estacas semilenhosa e lenhosa não diferiram entre si significativamente, mas foram superiores as herbáceas. O telado de sombrite destacou-se como o melhor local para condução dessas mudas.

Palavras-chave: *Coffea arabica* L.; propagação vegetativa; clones de cafeeiro.

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INTRODUCTION

The production of healthy and vigorous seedlings is the first step for the formation of a productive coffee crop. In *C. arabica*, an autogamous plant, the formation of new crops depends basically on seedlings originating from seeds, because the variability among the descendants in future generations is low, and also due to the low viability of the use of vegetative multiplication without adequate treatments (Bergo et al., 2000). However, with the possibility of using hybrid vigor for productivity in that species, the vegetative propagation of hybrid F_1 is very important in commercial scale. It is known that hybrids can be more productive than the parents when they are genotypically well complement (Bueno et al., 2006). In these hybrids, characteristics of interest can be introduced, such as resistances to disease and pests, dwarf plants or uniform fruit ripening (Jesus, 2003), under heterozygous conditions, and to guarantee, through cloning, that the respective phenotypes are expressed in the descendants. The cloning in *C. arabic* can be produced by rooting of stem cuttings (Jesus, 2003) or somatic embryogenesis (Pereira et al., 2007 and Rezende et al., 2008). Thus, the cloning of *C. arabic* hybrid F_1 can represent a revolution in the cultivation of the coffee plant in near future. However, some aspects of the rooting technique have not been studied at now and, if they have, the results have not been conclusive.

It is known that the capacity of the stem cutting to emit roots is a function of the interaction of endogenous factors and the environmental conditions offered to the rooting. It has been observed that the formation of adventitious roots is due to the in the tissues factors interaction and the translocation of substances synthesized in the leaves and buds under development. Among these factors, the carbohydrate, water, phytohormone and mineral nutrient levels are very important (Fachinello et al., 1995).

Tofanelli et al. (2002), studying the rooting of plum cuttings (*Prunus salicina*), using woody and semi-woody cuttings, concluded that the semi-woody cuttings provided the best results during whole the rooting process. Also Oliveira et al. (2005), working with *P. persica*, observed that the root system formed on semi-woody cuttings surpassed the system formed on woody cuttings.

The chemical composition of the tissue varies along the branch, causing rooting differences in cuttings originating from its different parts (Fachinello et al., 1995). Therefore, the cutting type becomes important and has been evaluated in various research papers (Tofanelli et al., 2002; Gontijo et al., 2003; Oliveira et al., 2005; Pio et al., 2005; Neves et al., 2006).

For *C. canephora* Pierre Oliveira et al. (2001), verified that the herbaceous cuttings with a node were superior to woody cuttings with a node. For *C. arabica,* Vilanova (1959), comments that in most of the works carried out in El Salvador, satisfactory results have been obtained in the rooting of the *arabic coffee* using semi-woody cuttings. However, there are no results showing the effect of different types of cuttings on their rooting and in the growth of the root cuttings under cultivation conditions used in our country. Experiments should be carried out in order to confirm these results.

As for the effect of the environment on the conduction of these root cuttings, it is known that for *C. canephora*, the shaded nursery is being employed in a commercial way (Fonseca et al., 2007). However, for *C. arabica* the few accomplished studies were made in greenhouses and acclimatized incubators (Bergo et al., 2000; Pereira et al., 2001).

This work aimed to evaluate the effects of different types of stem cuttings and environments on the growth of *Coffea arabica* L. stem shoots.

MATERIAL AND METHODS

The experiment was carried out in the Department of Agriculture (DAG) at the University of Lavras (UFLA), located in Lavras-MG, Brazil, at 21º 14'S and 45º 00'W, mean altitude of 918 m. The climate of the area is classified, according to Köppen, as the Cwa type, but it presents Cwb characteristics, with two different seasons: dry (April to September) and rainy (October to March).

The experiment was set up in December 2008 in two environments: a) greenhouse, under intermittent nebulization, with control of the relative humidity (between 85-90%) and temperature (24 ° C); b) shaded nursery with 50% shade, without lateral covering, watered by an automatic system activated twice a day.

Three types of segments were utilized (herbaceous, semi-woody and woody) from Catuaí Amarelo IAC-62 plants, obtained from orthotropic branches.

Catuaí Amarelo IAC-62 plants were pruned for sprout production in November 2007. In June 2008 the collection of the orthotropic branches and placement of the cuttings in a greenhouse for rooting was set up in a sand and vermiculite bed (1:1 proportion). At this time, the cuttings presented around 6-7 cm in length, one pair of leaves, cut to 1/3 of the area, and one node pair per cutting. The cuttings were treated in a 0.2 % sodium hypochlorite solution for 15 min and submitted to three washings in pure water. About 1.5 cm of the basal part of each cutting was dipped in inert talc with Indol Butyric Acid (IBA) at the concentration of 4.000 mg dm^{-3}. Weekly sprayings with 3 cm^3 dm^{-3} of foliar fertilizer (153.00, 13.50, 6.75, 54.00, 0.67 and 81.00 g dm^{-3} of N, B, Cu, Mn, Mo and Zn, respectively), 1.5 g dm^{-3} methylic tiofanato 70 % and 1.5 g dm^{-3} of oxytetracycline 1.5% + streptomycin 15%.

In December 2008 the cuttings were transferred from the sand and vermiculite bed to 10 x 20 cm polyethylene bags, containing Plantmax® commercial substrate, hillside soil and manure at a 5:3:2 proportion, adding 5.0 kg of Simple

Superphosphate and 0.5 kg of Potassium-Chloride per cubic meter of substrate, when they were put for root cuttings formation in the shaded nursery and greenhouse.

Evaluation of the stem shoots growth was made at the end of the experiment, 90 days after the transfer of the cuttings to the bags. The following variables were evaluated:

Height of aerial part (AP) measured with a ruler (cm), from the collar of the plant to the apex; number of nodes per plant (NN) obtained by counting the number of nodes in each plagiotrophycal branch, and multiplying by the number of branches; number of leaf pairs (NL) the pairs of leaves of each plant were counted, resulting in the average number for each plot; longest root (RL) measured with a graduated ruler (cm), from the collar of the plant to the end of the longest root; total dry matter (DM) all plants were conditioned in paper bags, properly labeled and dried in a forced-air oven at 60 °C, until constant weight. The material was weighed on a precision scale and results expressed in grams per plot.

An completely random design was used, with six replicates, in a 3 x 2 factorial experiment, made up of three types of segments (herbaceous, semi-woody and woody) and two environments (greenhouse and shaded nursery). Each plot was composed of four cuttings.

The statistical analyses were done according to the design used, constructing the analysis of variance to 5% significance of probability by the F test, using the "SISVAR" statistical software developed by Ferreira (2003). When there was significant effect of the treatments, the averages were submitted at cluster analysis Scott-Knott test (Scott & Knott, 1974).

RESULTS AND DISCUSSION

According to ANOVA the non-existence of significant interaction between types of segments and environments can be observed, in other words, these factors act on the evaluated variables in independent ways.

It is verified that the effect of segment types was significant for longest root and total dry matter. For the longest root the semi-woody cutting presented the highest average, differing significantly from the other cuttings (Table 1).

TABLE 1 - Average results for aerial part height (AP), number of nodes (NN), number of leaves (NL), the longest root (LR), total dry matter (DM), coefficients of variation and and overall averages from different types of orthotropic branch segment.

Cuttings	AP	LR	NL	NN	DM
Semi-woody	9.38 a	16.91 a	3.75 a	4.33 a	1.46 a
Woody	8.33 a	14.59 b	3.66 a	4.50 a	1.43 a
Green	8.64 a	14.75 b	3.41 a	4.25 a	1.19 b
General Average	8.78	15.41	3.61	4.36	1.36
CV (%)	18,34	12,69	18,69	16,83	21,17

Means followed by same letter in columns do not differ by Scott-Knott test at 5% probability.

These results were similar to those observed by Tofanelli et al. (2002) and Oliveira et al. (2005), in *Prunus salicina* and *P. persica*, respectively, in which the semi-woody cuttings presented longer root length when compared to the woody cuttings.

For total dry matter, the semi-woody and woody cuttings did not present significant difference amongst themselves, but they were superior to the herbaceous cuttings (Table 1). Vilanova (1959), affirmed that most of the authors observed satisfactory results in the rooting of the coffee (*C. arabica)* using cuttings from orthotropic semi-woody branches. However, for Brazilian edaphoclimatic conditions, more studies evaluating the development of coffee seedlings obtained using different types of root segments are necessary.

There were no significant differences among the averages for the other evaluated variables (Table 1).

As for the environments used in the development of the stem shoots, it is verified that for all the evaluated variables, except for the principal root length, there was a significant effect by the F test. The shaded nursery was evidenced as the best environment for the conduction of those stems shoots, for providing the higher growth (Table 2).

It was observed lower irradiance inside the shaded nursery when compared to the greenhouse. Coffee is a C3 plant originated from understory conditions. As a result, it does not tolerate high radiation levels, which explains the higher adaptation of the coffee plants to the shade, justifying the higher cuttings growth when cultivated in the shaded nursery. Such a fact corroborates the results obtained by Paiva et al. (2003), who evaluated the influence of different shade levels (0, 30, 50 and 90%) on the growth of C. *arabica* plant seedlings, and concluded that the best shade level for seedling development is 50%. This result differs from the results observed by Matiello et al. (1997), in which coffee seedlings (*C. arabica*) produced under full light present higher development. The production of coffee plant seedlings under full light is

already a technique used by some nurseries and producers. However, their results and uses are most of the time based on empiric observations. Thus, other researches must be made to know the real possibility of use of the method.

TABLE 2 - Average results of aerial part height (AP), number of nodes (NN), number of leaves (NL), the longest root (LR), total dry matter (DM), coefficients of variation and and overall averages, obtained in different environments.

Cuttings	AP	RL	NL	NN	DM
Shaded Nursery	10.30 a	15.49 a	3.83 a	4.77 a	1.62 a
Greenhouse	7.26 b	15.34 a	3.38 b	3.94 b	1.09 b
General Average	8.78	15.41	3.61	4.36	1.36
CV (%)	18,34	12,69	18,69	16,83	21,17

Means followed by same letter in columns do not differ by Scott-Knott test at 5% probability.

For the species *C. canephora,* Braun et al. (2007) evaluated the growth of stem shoots of the variety Conilon, under different shade levels (30, 50 and 75%) and under full light, and concluded that at 75% shade, the plants vegetative growth was higher than growth observed in other light levels. The same result was verified in commercial nurseries, in which the stem shoots were conducted in a shade covered nursery, for a reduction of about 50 % of the insolation, receiving constant irrigations using nebulization by the micro sprinkler method, with relative humidity close to 100% (Fonseca et al., 2007).

Fahl & Carelli (1994), studying the effect of 30, 50 and 100% shade from solar light, evaluated the growth (foliar area and height) in several cultivars of *C. arabica* and *C. canephora.* The results verified that 150 days after the beginning of the experiment, the various cultivars studied responded differently to the light levels. The cultivar Apoata C-3597 (*C. canephora)* presented the best development when cultivated under 50% light, while the cultivars of *C. arabica* (Catuai H 2077 - 2-5-81 and New World LCP 388-17) did not show significant differences in growth under 50 and 100% light. The excessive shade (30% light) reduced the development of the *C. arabica* cultivars, but it did not alter that of *C. canephora,* in relation to the cultivation total sunny. The growth of cultivar Icatu LC-3282 increased linearly with the light levels.

CONCLUSIONS

1. The shaded nursery is the best environment for rooting of cultivar Catuaí Amarelo IAC-62 stem cuttings.

2. The semi-wood and wood cuttings provide the highest seedling growth.

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