ANTECIPATION OF THE PRODUCTION AND DEVELOPMENT OF COFFEE PLANTATION IMPLANTED WITH DIFFERENT TYPES OF SEEDLINGS

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ABSTRACT: The objective of this work was to seek anticipation of production and to evaluate the development of coffee plantations implanted with different types of seedlings. The seedlings were produced between June 2003 and December 2005 when the experiment was installed in the field. The experimental design was randomized blocks with 15 treatments constituted by different types of plants in three replications. The types of plants tested refers to different periods in nursery (six to thirty months), and volumes of various containers (27 bags x 32 cm, 16 x 25 cm, 11 x 22cm and tubes 120ml), trimmed and not trimmed (driven with one or two stems), seeds stored in cold, or with seedlings cultivated in a controlled environment, grafted, grafted or self-standing Franco, with rooted cuttings, formed with the full sun or "forcing" with nitrogen. We evaluated: the productivity (bags.ha-1) of the years 2007, 2008, 2009 and 2010, the accumulated productivity of these four years and the percentage of green fruits, cherries, raisins, dry and hollow in the year 2010. We conclude that: it is possible to increase productivity in the first harvests of coffee by utilizing pruned trees (with two steams) and a stay of 18 months in nursery bags 16x25cm, with ripening of the fruit similar to that of conventional seedlings without the the occurrence of hollow grains.

Index terms: *Coffea arabica* L., types of seedlings, anticipating production.

ANTECIPAÇÃO DA PRODUÇÃO E DESENVOLVIMENTO DA LAVOURA CAFEEIRA IMPLANTADA COM DIFERENTES TIPOS DE MUDAS

RESUMO: *Objetivou-se com este trabalho buscar a antecipação da produção e avaliar o desenvolvimento da lavoura cafeeira implantada com diferentes tipos de mudas. As mudas foram produzidas no período de junho de 2003 a dezembro de 2005 quando o experimento foi instalado em campo. O delineamento experimental utilizado foi em blocos ao acaso, com 15 tratamentos constituídos pelos diferentes tipos de mudas em três repetições. Os tipos de mudas testados referem-se a diferentes períodos de permanência em viveiro (seis a trinta meses), diferentes recipientes e volumes de substrato (sacolas de 27 X 32cm, 16 X 25cm, 11 X 22cm e tubetes de 120mL), podadas e não podadas (conduzidas com uma ou duas hastes), com sementes conservadas em câmara fria, ou ainda com plântulas cultivadas em ambiente controlado, enxertadas, autoenxertadas ou em pé franco, com estacas enraizadas, formadas à pleno sol ou com "forçamento" com nitrogênio. Avaliou-se a produtividade (scs.ha^{-1}) dos anos de 2007, 2008, 2009 e 2010, a produtividade acumulada desses quatro anos e o percentual de frutos verdes, cerejas, passas, secos e chochos do ano de 2010. Concluiu-se que é possível aumentar a produtividade nas primeiras safras da lavoura cafeeira com a utilização de mudas podadas (conduzidas com duas hastes), com permanência de 18 meses no viveiro em sacolas de 16x25cm, com maturação dos frutos semelhante à proporcionada pela utilização de mudas convencionais e sem o comprometimento pela ocorrência de grãos chochos.*

Termos para indexação: *Coffea arabica* L., *tipos de mudas, antecipação da produção.*

1 INTRODUCTION

The coffee culture has great economic and social importance in Brazil, as for more than 150 years, this country is the largest producer and the largest exporter of coffee. The expected national production for the year of 2011 is of 43.31 million sacs of processed coffee, and Minas Gerais must contribute to up to 50.71% of this production (COMPANHIA NACIONAL DE ABASTECIMENTO - CONAB, 2011).

Since it is facing increasing global competitiveness, it is necessary to search for technological innovations for the coffee sector, aiming to increase production efficiency.

Carvalho et al. (2008) comment that the formation stage of the crop, aside being very expensive, has the peculiar aspect of the absence of production of the coffee tree, making options such as intercropping a good strategy for income generation capable of covering, totally or partially,

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the expenses made during this stage. Therefore, the initial phase of the crop is very long until the return of the invested capital, ie, from the sowing, through formation of seedlings, planting in the field until the first production is around 36 months. It should still be considered that due to the small initial yield of coffee, return on invested capital may be even longer.

A plantation installed in the appropriate time, at the beginning of the rainy season, may have reduced the percentage of replanting and anticipate its development, this because the duration of these seedlings under favorable weather conditions will be higher, and will occur, hence, a possible increase to the yield in the first crop. However, the coffee seeds have slow germination and difficult storage, which hinders the formation of seedlings in time for the crop establishment in favorable weather (GUIMARÃES et al., 2002).

Several studies have been developed with the objective of seeking the anticipation of planting seedlings in the field, coinciding with the beginning of the rainy season. Rena and Maestri (1986) state that the scroll removal, combined with temperature increase to 30°C, provides germination in shorter periods. Also Carvalho et al. (1998, 1999) and Guimarães et al. (1998) searched for better technologies in seedling production which could provide plantings in more adequate periods and, hence, increase of the first productions, after the period of plantation formations.

Another attempt to take seedlings of lesser juvenility to the field is the usage of "dried" seedlings (those with size larger than nowadays pattern for seedling production) and pruned seedlings, which could in the same way provide better harvests in the first productions. Carvalho et al. (2007) state that recovered seedlings by the process of pruning, show superior develpment to normal seedlings planted in proper time at the greenhouse.

Other technique that could provide more strength, development and initial productivity is the usage of grafting, which is also a tool to produce coffee in areas with the presence of nematoids. Fahl et al. (1998), with the objective to evaluate the effect of grafting in cultivars of *Coffea arabica* L. Over progenies of *Coffea canephora* Pierre and *Coffea congensis* A. Froehner, in plants productivity, concluded that in an average of five harvests, grafting increased plants' productivity.

These data point out to promising results with the use of grafting in the search of productivity increase of coffee plantations also during the first harvests, for faster return of invested capital.

Other attempts of forming stronger and consequently more productive seedlings for the first harvests were made such as: larger volume of substratum and the use of tubes (MARCHI et al., 2003; VALLONE et al., 2009), "one year" seedlings, stake rooting (REZENDE et al., 2010), nitrogen induced growth and seedlings formed at full sun (PAIVA; GUIMARÃES; SOUZA, 2003).

The higher or lower occurrence of empty locule beans could be due to characteristics of the used cultivar and enough and balanced fertilization being that, according to Laviola et al. (2006) the fertilization level influences the formation of beans and alerts to the influence of other factors, such as nutritional status of the plant and pending load of fruits. By using different types of seedlings, with different degrees of juvenility and root sytems of different formations (seeds in bags or tubes, stakes, pruned seedlings, nitrogen induced, and of different ages) have direct influence in the nutrition of plants, the assessment of fruits ripeness and occurrance of empty locule beans from different treatments was pursued.

From what has been exposed, the objective of this work was the anticipation of production and evaluation of development of coffee plantation implanted using different types of seedlings.

2 MATERIALS AND METHODS

The study was conducted in the Coffee Culture Sector of the Agricultural Department of the Lavras Federal University (Setor de Cafeicultura do Departamento de Agricultura da Universidade Federal de Lavras), in Lavras, MG, whose geographic coordinates are: 21º 14' S and 45º 00' W, with average altitude of 918 m. The experimental lining used was of random blocks, with 15 treatments, being constituted by the different types of seedlings in three repetitions (Table 1).

The plantation was implemented in 3,8 x 0,7 m spacing. The *Coffea arabica* cultivar used was Topázio MG1190 and *Coffea canephora* was Apotã IAC 2258. The seedlings used in the experiment were produced in a greenhouse of the Coffee Culture Sector (Setor de Cafeicultura), between June 2003 and December 2005. The experiment was set up on camp on December 20th 2005. Each parcel had 3 lines of plants with 6 plants each, being the useful area formed by the center 4 rows.

TABLE 1 - Description of seedling types used as treatments.

Treat.	Description of seedling used
1	Spread in June 2003, bags 27 x 32 cm, pruned in June 2005, lead by two sticks (30 months in greenhouse).
2	Spread in June 2003, bags 16 x 25cm, pruned in June 2005, lead by two sticks (30 months in greenhouse).
3	Spread in June 2004, bags 16 x 25cm (18 months in greenhouse).
4	Spread in June 2004, bags 16 x 25cm, pruned in June 2005, lead by two sticks (18 months in greenhouse).
5	Grafted, bags 16 x 25cm, spread in August 2004, pruned in June 2005, lead by two sticks (18 months in greenhouse).
6	Seedlings in tubes 120ml, spread in August 2004, pruned in June 2005, single stick (18 months in greenhouse);
7	Seeds picked in June 2004, stored in cold chamber, spreading performed in December 2004, in sand germinator and then transplanted to 16 X 25 cm bags (12 months in greenhouse);
8	Grafted in January 2005 and conducted in bags 16 x 25 cm (12 months in greenhouse).
9	Seedlings produced from seedlings formed in controlled environment with seeds picked im May 2005 and replicated to tubes 120ml (8 months in greenhouse).
10	Grafting of seedlings formed in controlled environment with seeds of 'Apoatã IAC-2258' stored in the previous year, grafting in July 2005 and replicated to tubes 120ml (8 months in greenhouse);
11	Half year old seedlings self-grafted with two roots (two graft-carriers and one graft per plant), replicated to tubes 120ml in July 2005, after grafting (8 months in greenhouse);
12	Rooted stakes transplanted to plastic bags 15 x 20 cm, three months after rooting induction (6 months in greenhouse);
13	Half year old seedlings, bags 11 x 22 cm, spread in June 2005 and brought to full sun (6 months in greenhouse);
14	Half year old seedlings in bags 11 x 22 cm in June 2005 and nitrogen induced in two applications, with 30g of ammonium sulfate in 10 litres of water for each 1000 seedlings (6 months in greenhouse).
15	Witness – half year old seedlings, bags 11 x 22cm in June 2005 (6 months in greenhouse).

The production was assessed in litres of coffee per parcel, harvests carried out in May 2007, July 2008, July 2009 and June 2010. For productivity, it was considered, for conversion, 480 litres of coffee for each sac of processed coffee, later on, it went to the productivity conversion (60 kg sacs of processed coffee ha^{-1}). The cumulative productivity was considered, hence, the sum of the amounts in procesed coffee sacs in each parcel during the years of 2007, 2008, 2009 and 2010, to assess the productivity in the first four harvests of the different types of seedlings used in the experiment.

For the maturation percentuals, the four central plants of each parcel were assessed in June 2010. A sample was used of 300 mL from the production of each parcel to obtain the percentual of green beans, and mature (cherry, dry and in-between) by the counting of the number of beans in each stage and also the percentual of empty locule beans, using the technique used by Antunes Filho and Carvalho (1957) modified. This technique consists of putting a sample of 100 cherry beans in a water bowl, counting the ones that floating and then checking manually each bean.

Statistic analyses were conducted according to used lining, being the data variance analysis to the significance of 5% probability by the F test, using the software "SISVAR", developed by Ferreira (2000). When there was a significant effect in the treatments, the averages were compared by the Scott-Knott test ($P<0,05$). Data on the maturation percentual and empty locule beans were transformed into $\sqrt{(x + 1)}$.

3 RESULTS AND DISCUSSION

In Table 2, shows the production results of the first four seasons, from different types of seedlings. Considering the productivity of the 2007, the best results were obtained with the treatments 1, 3, 4 and 7, with a difference of up to 94.75% over the control treatment. In 2008, treatment with 2 seedlings pruned, formed in 2003 in bags of 16 x 25 cm, had a yield higher than others, but with a difference of only 10.50% compared to treatment 4, in that year , was in the group of the worst treatments and 11.56% compared to control. In 2009, treatments 1, 2, 3, 4, 7, 13 and 14, obtained the best results differing significantly from the other treatments, with a productivity gap of up to 34.25% higher than the control treatment. In 2010, there was no significant difference between treatments. However, since one of the main goals of the present study is to increase productivity in the first crops of coffee plantation, using differemnt types of seedlings, for a faster return of capital invested, cumulative data was analysed from the four first harvests where was observed the superiority of treatment 4 which had, in planting, pruned seedlings formed in 2004 (18 months in greenhouse) in 16 x 25cm bags, with a productivity up to 50,75% superior to the other treatments and 35,16% superior to the control treatment.

It was noticed that the dried seedlings (seedlings bigger than the standard size for seedling production) and the pruned ones provided higher productivities, however, showed higher production costs. More studies should be conducted, in order to prove if this higher productivity provided by these plants compensate the higher production costs**.**

One of the explanations for these results is that the pruned seedlings have a root system more developed related to the half year old seedlings (CARVALHO et al., 2007), however the permanence of seedlings pruned in the greenhouse

TABLE 2 - production values (scs.ha^{-1}) dof the four first harvests, in coffees from different types of seedlings.

Treatments	2007 sc/ha	2008 sc/ha	2009 sc/ha	2010 sc/ha	cumulative sc/ha
1. Pruned, 30 months, bags 27x32 cm	4,73 a	6,16 b	63,30 a	34,5 9 ^{ns}	108,92b
2. Pruned, 30 months, bags 16x25 cm	1,60 b	6,40 a	67,43 a	29,37 ^{ns}	104,94b
3. 18 months, bags 16x25 cm	6,20 a	5,93 b	76,60 a	11,75 ^{ns}	100,48b
4. Pruned, 18 months, bags 16x25 cm	3,80 a	5,73 c	84,00 a	34,59 ^{ns}	130,45a
5. Grafted pruned, 18 months, bags 16x25 cm	2,83 b	5,90 b	60,00 b	20,23 ^{ns}	88,97b
6. Pruned, 18 months, tubes 120 ml	0,63 b	6,00 b	57,83 b	31,98 ^{ns}	96,38b
7. 12 months, bags 16x25 cm	6,87 a	5,50 c	73,96 a	18,27 ^{ns}	104,47b
8. Grafted, 12 months, bags 16x25 cm	2,17 b	6,03 b	56,13 b	27,41 ^{ns}	91,98 b
9. tubes 120 ml, 8 months	0,00 b	5,90 b	53,50 b	21,86 ^{ns}	81,30b
10. Grafted, 8 months, tubes 120 ml,	0,03 b	5,60 c	31,33 b	27,41 ^{ns}	64,25b
11. grafted, 8 months, tubes 120 ml,	0,02 b	5,46 c	47,83 b	18,27 ^{ns}	71,36b
12. Rooted stakes, 6 months, bags 15x20 cm	0,97 b	5,93 b	50,90 b	20,88 ^{ns}	78,75b
13. Full sun, 6 months, bags 11x22 cm	0,87 b	5,30 c	67,86 a	18,27 ^{ns}	92,28b
14. N induced, 6 months, bags 11x22 cm	1,27 b	5,73 c	68,30 a	23,50 ^{ns}	98,63b
15. Control, 6 months, bags 11x22 cm	0,36 b	5,66 c	55,23 b	23,49 ^{ns}	84,59b
CV	23,54	3,20	20,03	23,82	18,97

Averages followed by the same letter in the columns do not differ from wach other by the Scott-Knott test (P<0,05). CV: variation coefficient; ns: non significant.

for longer (30 months), seems to have hindered the development of the seedling (treatments 1 and 2) in relation to 18-month stay (treatment 4). In this case, treatment provided a cumulative productivity in the 4 harvests of 130,45 sacs.ha^{-1} , with an average yield of 32,61 sacs.ha^{-1} which, for plantations with sacing of 3,8 x 0,7m, represents high yield, while the control treatment reached an average of 21,15 sacs.ha^{-1}.

Therefore, the usage of pruned seedlings (lead by two sticks),remaining 18 months in greenhouse, in 16x25cm bags becomes an alternative, mostly for family farms, for a faster return to the invested capital, as for the seedling production alternatives for plantation formation, they did not reach yields superior to the control, which discredits those options specifically for yield increase during formation period, for the control (6 months seedlings, multiplied by seed from the year in 12x22cm bags) is lower in cost and better in production easiness.

In Table 3, the data are percentage of of bean maturation and empty locule beans for 2010. For the percentage of green fruit, it was found that the types of plants represented by treatments 3, 8, 9, 10, 12 and 13 showed a higher percentage, differing significantly from the other treatments.

It can be seen from Table 3, that there was variation in the percentage of green fruit among different treatments. According to some authors, the percentage of green fruit remaining on the plant during the early crop should be a maximum of 5%, others admit percentage up to 20% (GUIMARÃES; MENDES; SOUZA, 2002). It is also observed that treatment 4 had the highest productivity in the first four seasons and was in the group of nine treatments with a lower percentage of green fruit, and, of these nine, seven (77.80%) are treatments that had seedlings with permanence in greenhouse for more than the six months of the control. Another interesting fact is that only one treatment, planting seedlings that remained 30 months in nursery (treatment 2), showed less than 5% of green fruits, probably due to juvenility lower than other types of seedlings.

TABLE 3 - Percentuals of green, cherry, passed, dry and empty locule beans picked from plants from diferent types of seedlings during 2010.

Treatments	Green	Cherry	Passed	Dry	Empty locule
1. Pruned, 30 months, bags 27x32 cm	13,17 a	47,06 ^{ns}	30,67 b	9,75 ^{ns}	4,67 ^{ns}
2. Pruned, 30 months, bags 16x25 cm	4,20 a	51,77 ^{ns}	35,27 b	8,76 ^{ns}	2,00 ^{ns}
3. 18 months, bags 16x25 cm	24,92 b	52,58 ^{ns}	16,38 a	6,12 ^{ns}	4,00 ^{ns}
4. Pruned, 18 months, bags 16x25 cm	9,10 a	48,50 ^{ns}	27,97 b	14,44 ^{ns}	10,00 ^{ns}
5. Grafted pruned, 18 months, bags 16x25 cm	7,22 a	65,79 ^{ns}	22,01 a	4,98 ^{ns}	10,67 ^{ns}
6. Pruned, 18 months, tubes 120 ml	16,25 a	51,12 ^{ns}	22,06 a	10,57 ^{ns}	5,33 ^{ns}
7. 12 months, bags 16x25 cm	15,21 a	59,71 ^{ns}	18,37 a	6,70 ^{ns}	2,67 ^{ns}
8. Grafted, 12 months, bags 16x25 cm	26,14 b	50,55 ^{ns}	19,88 a	3,42 ^{ns}	6,00 ^{ns}
9. tubes 120 ml, 8 months	26,80 b	57,43 ^{ns}	12,11 a	3,66 ^{ns}	8,00 ^{ns}
10. Grafted, 8 months, tubes 120 ml,	27,78 b	45,62 ^{ns}	20,42 a	6,18 ^{ns}	2,00 ^{ns}
11. grafted, 8 months, tubes 120 ml,	18,50 a	56,56 ^{ns}	19,47 a	5,47 ^{ns}	8,00 ^{ns}
12. Rooted stakes, 6 months, bags 15x20 cm	24,72 b	50,56 ^{ns}	13,21 a	11,51 ^{ns}	6,00 ^{ns}
13. Full sun, 6 months, bags 11x22 cm	23,05 b	44,75 ^{ns}	19,80 a	12,37 ^{ns}	8,67 ^{ns}
14. N induced, 6 months, bags 11x22 cm	13,94 a	59,04 ^{ns}	19,54 a	7,48 ^{ns}	6,00 ^{ns}
15. Control, 6 months, bags 11x22 cm	13,67 a	48,54 ^{ns}	28,89 b	8,90 ^{ns}	6,00 ^{ns}
CV	17,30	9,62	18,08	28,91	29,10

Averages followed by the same letter in the columns do not differ from wach other by the Scott-Knott test (P<0,05). CV: variation coefficient; ns: non significant.

All the other treatments in this group with lower green fruits percentage showed values below 20% indicating that the harvesting of plants from this group (including control) should be earlier when compared to the other treatments.

The group of treatments of higher percentages of green fruits showed values that varied from 23,05% to 27,78%, signaling that, in case of using these types of seedling for crop implantation, the harvest should be delayed, for high green fruit values could incurr higher amount of defects (black, green and spicy beans), besides the losses in type classification, providing lower quality beverages, leading the producer to economic loses (GUIMARÃES; MENDES; SOUZA, 2002).

No significant difference between the treatments was found for the cherry and dry beans percentages (Table 3).

As for the passed fruits, it was verified that treatments 1, 2 and 4, together with the control (15), showed earlier maturation than the other treatments. This result indicates the viability of using these types of seedlings for plantation set up, expecting similar precocity to the type of seedling most used nowadays.

The differences found between the different treatments for the green and passed beans during this stage of culture could be explained, in general, by the loss of juvenility of the seedlings that stayed longer in greenhouse and by the different architectures given to the plants, due to the different types of seedlings used.

As for the empty locule percentage, there was no significant difference between the types of seedlings, so, none of the types tested for crop implantation compromised the fruits graining, which could hamper yielding (amount of coffee needed to obtain 60kg of procesed coffee).

4 CONCLUSIONS

It is possible to increase productivity in the first harvests of coffee by using pruned seedlings (lead by two sticks) remaining 18 months in greenhouse, obtaining normal bean maturation and without compromising by empty locule beans.

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