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# Agronomic traits of coffee tree progenies from Timor Hybrid x Catuaí crossing

## Características agronômicas de progênies de cafeeiro oriundas do cruzamento de Híbrido de Timor x Catuaí

**Ramiro Machado Rezende[I] Gladyston Rodrigues Carvalho[II] Juliana Costa de Rezende[II*] Cesar Elias Botelho[II] Allan Teixeira Pasqualloto[I] Jeanny Alice Velloso[I] Alex Mendonça de Carvalho[I]**

**ABSTRACT**

*The objective of this work was to evaluate the agronomic traits of coffee tree progenies. The experiment was set in Ouro Verde Farm, located at Campos Altos County, MG. Twenty three coffee progenies and seven control cultivars were used. These progenies are from the fourth generation of crossing between Timor Hybrid and Catuaí. The experiment was set in a randomized block design with four replicates, a total of 120 plots with 8 plants per plot. The yield of processed coffee sacks ha$^{-1}$ was evaluated in eight crop years from the 2003 to the 2011 harvests. The percentage of fruits at the cherry stage, floating fruits, coffee classification (sieve above 17), income and plant vigor were evaluated in the 2010 and in the 2011 harvests. It was concluded that the progenies showed a great variability for the agronomic traits. Progenies 514-7-4-C130, 493-1-2-C134 and 518-2-10-C408 had the highest yield in the four two-year periods. The progenies 436-1-4-C26, 516-8-2-C109, 493-1-2-C134, 518-2-10-C408, 514-7-16-C211 and 514-7-16-C208 presented the highest values for plant vigor. Progeny 493-1-2-C134 stood out in all analyzed traits, showing to be promising for the advance of the generations.*

**Key words**: *coffee, yield, breeding, progenies.*

**RESUMO**

*Objetivou-se com este trabalho avaliar o comportamento agronômico de progênies de cafeeiro. O experimento foi instalado na Fazenda Ouro Verde, situada no Município de Campos Altos-MG, compreendendo vinte e três progênies e sete cultivares utilizadas como testemunhas. Essas progênies referem-se à quarta geração do cruzamento entre Híbrido de Timor e Catuaí. Foi utilizado o delineamento de blocos ao acaso, com quatro repetições, totalizando 120 parcelas, sendo cada parcela constituída por oito plantas. A produtividade em sacas de café beneficiado ha$^{-1}$ foi avaliada em oito colheitas, de 2003 a 2011. Nas colheitas de 2010 e 2011 foram avaliadas a porcentagem de frutos no estádio cereja e de frutos chochos, a classificação do café (peneira 17 acima), renda e vigor vegetativo. Conclui-se que as progênies apresentaram grande variabilidade para as características agronômicas estudadas. As progênies 514-7-4-C130, 493-1-2-C134 e 518-2-10-C408 apresentaram os maiores valores de produtividade na média dos quatro biênios avaliados. As progênies 436-1-4-C26, 516-8-2-C109, 493-1-2-C134, 518-2-10-C408, 514-7-16-C211 e 514-7-16-C208 apresentaram as maiores notas de vigor vegetativo. A progênie 493-1-2-C134 se destacou em todas as características analisadas, mostrando-se promissora para o avanço de gerações.*

**Palavras-chave**: *café, produtividade, melhoramento, progênies.*

## INTRODUCTION

It is unquestionable the contributions coffee breeding has given to farmers and especially to the Brazilian economy (BOTELHO et al., 2010). Although some selected cultivars have already reached high levels of productivity, studies have shown that there is still a great demand by Brazilian farmers for better cultivars. This public wishes are justified by the fact that these new cultivars may contribute for the effective reduction of crop losses, by rationalizing the use of agriculture inputs and increment of yield and therefore reducing production costs, assuring a greater competition and sustainability of coffee crop with increases in the income of coffee producers and job creations.

The interspecific hybrid derived from a spontaneous crossing between ***Coffea arabica*** L. and ***Coffea canephora*** Pierre ex A. Froehner, termed Timor Hybrid, constitutes a source of genetic diversity

[I]Departamento de Agricultura (DAG), Universidade Federal de Lavras (UFLA), Lavras, MG, Brasil.
[II]Unidade Regional do Sul de Minas (URESM), Empresa de Pesquisa Agropecuária de Minas Gerais (EPAMIG), 37200-000, Lavras, MG, Brasil. E-mail: julianacr@epamig.ufla.br. *Autor para correspondência.

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for the development of new cultivars (RODRIGUES JÚNIOR et al., 2004). The breeding program developed by Empresa de Pesquisa Agropecuária de Minas Gerais (EPAMIG, Brazil) in a partnership with other institutions has achieved success with the crossing between Timor Hybrid and cultivars from Catuaí group. The progenies resulting from those crossings have shown promising productivities and resistance to leaf rust and ***Meloidogyne exigua*** nematodes (BONOMO et al., 2004; MIRANDA et al., 2005; SILVA et al., 2007).

The good adaptation of those genotypes, in different environmental conditions and the good combination capacity in hybridizations carried out by research institutions evidence the interest of research works in obtaining new selections from this crossing. Therefore, some methods, all of them using evaluation of progenies in the production sites have been used in the selection process for many years.

Productivity is the principal criterion of coffee selection (CILAS et al., 2010; GICHIMU & OMONDI, 2010). It is influenced by many abiotic factors and it usually ranges in two-year cycles. Plant vigor as well as size of the grains are important traits related to production. They are good evaluation criteria for productivity potential of ***C. arabica*** lineages (SEVERINO et al., 2002). Thus, the objective of this work was to evaluate the agronomic traits of progenies from the crossing between Timor Hybrid and Catuaí.

## MATERIAL AND METHODS

The experiment was set on December 2000 on Ouro Verde farm located at Campos Altos county in the region of Alto Parnaiba, Minas Gerais, Brazil, in a ***M. exigua*** infested area right after removal of an old coffee crop with no soil tillage. Twenty three potentially ***M. exigua*** nematode resistant coffee progenies and seven control cultivars were used. These progenies are from the fourth generation of a crossing between Timor Hybrid and Catuaí and they were obtained from the coffee tree breeding program carried out by Empresa de Pesquisa Agropecuária de Minas Gerais (EPAMIG) in a partnership with Universidade Federal de Viçosa (UFV) and Universidade Federal de Lavras (UFLA) in Minas Gerais, Brazil.

The experiment was set in a randomized block design with four replicates, a total of 120 plots with 8 plants per plot. It was used a 4x0.8m between rows and between plants, respectively, corresponding to a total area of 3,072m$^2$. The experiment was set and carried out according to local technical recommendations for coffee crops. Evaluations were done beginning from 30 months, involving the following traits: yield of processed coffee (60kg sacks) of 8 harvests (crop years from 2003 to 2011), percentage of cherry and floating grains, coffee classification (sieve above 17), income and plant vigor (evaluated in the crop years 2010 and 2011).

Production in liter of "farm coffee" per plot was evaluated yearly and harvest was performed on July every year. Afterwards, conversion of processed coffee.ha$^{-1}$ (into units of 60kg sacks) was done by value approximation, considering an average yield of 480L of "farm coffee" for each 60kg processed coffee sack (CARVALHO et al., 2009). The percentage of cherry fruit was calculated by counting in a sample of 300mL of fruit per plot. For the percentage of floating fruit, it was used the methodology proposed by ANTUNES FILHO & CARVALHO (1954), in which 100 cherry fruits are placed into water, being considered floating grains those which remain on water surface.

Coffee classification (sieve above 17) was carried out after coffee processing, passing a 300g sample through a set of sieves (17/64 to 19/64). The material retained in each sieve was weighted and the percentage of grains passing the sieve above 17 were determined (BRASIL, 2003). After being dried in the sun, a 5L sample of pulped coffee was weighed, processed and weighed again to estimate the income, which was obtained by dividing processed coffee sample weight by the pulped coffee weight and then multiplying by 100 to obtain the income in percentage. Plant vigor was evaluated by grading according to a 10 point arbitrary scale, in which 1 corresponds to the worst plants with a reduced plant vigor and a marked depletion symptom, and 10 corresponds to plants with excellent vigor, with more leaves and accentuated vegetative growth of productive branches as suggested by CARVALHO et al. (1979).

Data were analyzed using the SISVAR software (FERREIRA, 2008), with a ($P<0.01$) for the F test. In coffee crops, a significant factor interfering in the variation of its production is the two-year period alternation. This factor is commonly attributed to a reduction of plant storages in crop year with high yield, therefore, due to the lower growth of plagiotropic branches, the production in the following year is low (PEREIRA et al., 2011). Thus, by grouping harvests in two-year period has been suggested to reduce this effect, therefore, increasing experimental precision (BONOMO et al., 2004; BOTELHO et al., 2010). Thus, analysis of processed coffee yield was performed in time split-plot design (STEEL & TORRIE, 1980), in which plots were represented

by progenies and the split-plots were represented by the set of two harvests (two-year period). The mean between 2010/2011 and 2011/2012 harvests was considered for the other characteristics evaluated. When significant traits were found, the means were separated by the Scott-Knott test (P<0.05).

## RESULTS AND DISCUSSION

There was a significant effect for yield, for sources of cultivars variations, two-year periods and for the interaction cultivars x two-year period. This interaction shows the differences in the behavior of progenies in relation to the yield over years. This result reflects the different responses of the genotypes to environmental changes; therefore, it is an aggravating issue in breeding programs (CUCOLOTTO et al., 2007; CARVALHO et al., 2008).

It can be seen that in the first two-year period (Table 1), two distinct groups were formed, the higher group was made up by 13 progenies, and the lower group was made up by 17 genotypes in which the seven cultivars used as control are included. In the second two-year period, two groups were also formed, in which 16 progenies and 'Catuaí Amarelo IAC 62' stood out. In the third and fourth two-year periods, the distinction between progenies was greater than the previous period, with differentiation in three and four sets of means, respectively. In the third two-year period, progenies 514-7-4-C130, 514-7-16-C211, 514-7-8-C364 and 518-2-10-C408 stood out and in the fourth two-year period, progenies 514-

Table 1 - Productivity of processed coffee (sacks of 60kg per hectare) in 23 coffee progenies and seven control cultivars assessed in four biannual harvest periods at Campos Altos County, Minas Gerais.

| Progenies | 2003/2004 | 2005/2006 | 2007/2009 | 2010/2011 | Mean |
|---|---|---|---|---|---|
| 514-5-4-C25 | 7,94b | 11,60b | 18,82b | 39,67c | 19,51b |
| 436-1-4-C26 | 9,67a | 12,92a | 11,09c | 48,52b | 20,55b |
| 518-7-6-C71 | 11,22a | 14,40a | 13,91c | 40,04c | 19,89b |
| 514-7-14-C73 | 10,41a | 17,19a | 18,21b | 43,78b | 22,40b |
| 514-5-2-C101 | 12,78a | 15,65a | 15,12c | 42,70c | 21,56b |
| 516-8-2-C109 | 8,44b | 15,57a | 15,36c | 42,52c | 20,47b |
| 504-5-6-C117 | 6,92b | 11,29b | 14,95c | 39,67c | 18,21c |
| 514-5-4-C121 | 6,92b | 11,70b | 13,63c | 32,45d | 16,18c |
| 514-7-4-C130 | 12,62a | 20,55a | 22,89a | 49,90a | 26,49a |
| 493-1-2-C134 | 11,80a | 16,89a | 19,73b | 55,57a | 26,00a |
| 505-9-2-C171 | 3,56b | 9,16b | 12,72c | 41,30c | 16,68c |
| 518-2-6-C182 | 6,48b | 9,80b | 11,65c | 47,83b | 18,94c |
| 514-7-16-C208 | 9,71a | 14,78a | 17,44b | 46,25b | 22,04b |
| 514-7-16-C211 | 8,15b | 13,47a | 22,11a | 39,05c | 20,69b |
| 493-1-2-C218 | 9,87a | 15,46a | 16,28b | 46,08b | 21,92b |
| 438-7-2-C233 | 4,83b | 9,87b | 13,78c | 37,13c | 16,40c |
| 514-7-16-C359 | 7,63b | 13,63a | 14,85c | 46,08b | 20,55b |
| 514-7-8-C364 | 10,38a | 16,48a | 20,85a | 37,89c | 21,40b |
| 518-2-10-C408 | 13,36a | 14,88a | 24,15a | 50,52a | 25,73a |
| 514-5-2-C494 | 12,73a | 16,02a | 16,80b | 47,01b | 23,14b |
| 518-2-4-C593 | 9,39a | 12,96a | 16,54b | 40,66c | 19,89b |
| 516-8-2-C568 | 10,32a | 15,52a | 16,50b | 42,25c | 21,14b |
| 518-2-6-C685 | 6,06b | 8,22b | 10,46c | 37,52c | 15,57d |
| Catuaí Vermelho IAC 99 | 7,22b | 11,49b | 17,19b | 38,96c | 18,72c |
| Catuaí Amarelo IAC 62 | 7,53b | 12,51a | 19,53b | 42,32c | 20,47b |
| Topázio MG 1190 | 3,36b | 6,82b | 15,57c | 31,13d | 14,22d |
| Rubi MG 1192 | 5,92b | 8,07b | 13,68c | 40,02c | 16,92c |
| Acaia Cerrado MG 1474 | 4,89b | 7,32b | 8,70c | 32,86d | 13,44d |
| Icatu Precoce IAC 3282 | 5,42b | 6,82b | 10,16c | 36,88c | 14,82d |
| Icatu Amarelo IAC 2942 | 5,48b | 10,23b | 14,00c | 37,01c | 16,68c |
| Mean | 8,37D | 12,71C | 15,89B | 41,79A | |

Means followed by the same letter do not differ from each other by the Scott-Knott test (P<0.05).

7-4-C130, 493-1-2-C134 and 518-2-10-C408 showed the highest means of yield, overcoming the cultivars used as control.

By analyzing the performance of the three best progenies (514-7-4-C130, 493-1-2-C134 and 518-2-10-C408), overall, it was found that they always had been in the most productive group over the four biannual periods (Table 1). These results are in agreement with those reported by BONOMO et al. (2004), MIRANDA et al. (2005) and CARVALHO et al. (2008). Their results also showed that the coffee progenies resulting from the crossing between Timor Hybrid x Catuai are promising with a production equal to or higher than the best cultivars in Catuaí group. It is important to highlight that this experiment was set in an area infested by ***M. exigua*** and because some progenies showed satisfying yield means, it shows that they are likely resistance/tolerance to this root-knot nematode. Therefore, by comparing the productivity of progenies 514-7-4-C130, 493-1-2-C134 and 518-2-10-C408 to the seven control cultivars, it was found an increase by approximately 58% in the yield of progenies in the mean of the eight harvests (Table 1).

The assessment of yield for at least four consecutives crop years is necessary for a successful progenie selection, considering that coffee tree is a perennial plant and production stability is reached on the fourth harvest (CARVALHO, 1989; PEDRO et al., 2011). In our study, the means of productivity for the two-year periods showed a significant increase over the crop years, and the last two year periods (2007/2009 and 2010/2011) was expressively higher, indicating the efficiency of selection, if only the first six harvests were considered, since greater yield years are more favorable to selection (BONOMO et al., 2004; MISTRO et al., 2007).

By observing the other agronomic traits assessed (Table 2), it can be concluded that the percentage of cherry and floating grains, sieve above 17, income and plant vigor means are in agreement with the results on ***C. arabica*** progenies reported by other studies (CORRÊA et al., 2006; CARVALHO et al., 2006; CARVALHO et al., 2008). The other agronomic traits were also significant, revealing a differentiated performance of the progenies in the conditions of this trial. The coefficient of variation ranged from 6.13% to 17.93%, showing that evaluation of traits has a good precision.

Three groups were formed for the percentage of fruits harvested at the cherry stage (Table 2). The progenies with the best performance ranged from 52.45% to 66% and they were higher than the seven cultivars used as control. Five groups for the percentage of floating grains were also formed, in which the group with the best means showed a variation from 4% to 7%, a range considered ideal for this trait (CARVALHO et al., 2006).

Concerning the grains in sieve above 17 (Table 2), it was found that six groups were formed. This variability for sieve size in progenies derived from Timor Hybrid germoplasm has been reported by other authors (CARVALHO et al., 2008) and it shows that there are some possibilities for reaching genetic gains by selecting this trait.

Progeny 493-1-2-C134 showed the best results, with 58.69% of grains retained in sieve above 17. This progeny also stood out in yield. In coffee tree breeding programs, it is searched an ideotype whose performance covers, in addition to other traits, high yield and increase in the sieve size (FERREIRA et al., 2005).

It was observed that two groups were formed for the variable income (Table 2). According to MEDINA FILHO & BORDIGNON (2003), it is common to use pulped coffee grains income for processed coffee at a 2:1 relationship. In this work, the group with the highest means for this trait ranged from 45.46 to 50.28%, being within the standards reported in the literature (PAIVA et al., 2010; CARVALHO et al., 2011).

The progenies 436-1-4-C26, 516-8-2-C109, 493-1-2-C134, 518-2-10-C408, 514-7-16-C211 and 514-7-16-C208 showed the highest values for plant vigor, ranging from 7.56 to 8.13, overcoming values shown by the controls, which are regarded as medium-to-high vigor cultivars by MATIELLO et al. (2005). Results corroborate with those reported by BONOMO et al. (2004) and CARVALHO et al. (2008), who found coffee progenies with higher plant vigor than the control Catuaí Vermelho IAC 15, when working with progenies from the crossing between Timor Hybrid and Catuaí.

## CONCLUSION

The progenies showed a great variability for the agronomic traits. The progenies 514-7-4-C130, 493-1-2-C134 and 518-2-10-C408 showed the greatest mean values for yield in the four evaluated two-year periods. The progeny 493-1-2-C134 stood out in all analyzed traits, showing to be very promising for the advance of generations.

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Table 2 - Percentage of cherry fruits, floating fruits, screen grading (17 and above) and plant vigor of 23 coffee progenies and seven control cultivars in the 2010 and 2011 biannual harvests at Campos Altos County, Minas Gerais.

| Progenies | % Cherry | % Floating | % Sieve | % Income | Vigor |
|---|---|---|---|---|---|
| 514-5-4-C25 | 44,21b | 15,00d | 30,64e | 44,38b | 6,06c |
| 436-1-4-C26 | 58,69a | 15,00d | 21,73f | 45,52a | 7,63a |
| 518-7-6-C71 | 60,07a | 5,50a | 52,67b | 47,96a | 6,63c |
| 514-7-14-C73 | 53,88a | 12,00c | 40,97c | 42,79b | 7,38b |
| 514-5-2-C101 | 33,98c | 5,25a | 34,50d | 50,28a | 6,75c |
| 516-8-2-C109 | 56,90a | 7,00a | 21,48f | 42,00b | 8,13a |
| 504-5-6-C117 | 52,61a | 13,25c | 35,09d | 44,86b | 6,31c |
| 514-5-4-C121 | 43,76b | 19,25e | 33,01d | 43,54b | 6,94b |
| 514-7-4-C130 | 55,51a | 6,75a | 43,21c | 45,76a | 7,00b |
| 493-1-2-C134 | 62,00a | 4,25a | 58,69a | 45,46a | 8,06a |
| 505-9-2-C171 | 49,39b | 8,00b | 32,31e | 44,66b | 6,56c |
| 518-2-6-C182 | 59,14a | 8,00b | 42,28c | 40,23b | 7,13b |
| 514-7-16-C208 | 66,00a | 5,75a | 21,25f | 46,24a | 7,63a |
| 514-7-16-C211 | 63,63a | 7,00a | 17,41f | 45,61a | 7,94a |
| 493-1-2-C218 | 58,10a | 12,75c | 46,94b | 43,76b | 7,13b |
| 438-7-2-C233 | 55,55a | 11,00b | 27,64e | 44,27b | 5,75d |
| 514-7-16-C359 | 57,19a | 16,50d | 26,18e | 42,43b | 7,19b |
| 514-7-8-C364 | 41,98b | 6,25a | 15,53f | 44,20b | 7,38b |
| 518-2-10-C408 | 55,73a | 4,00a | 39,54c | 49,92a | 7,56a |
| 514-5-2-C494 | 44,60b | 6,00a | 41,22c | 46,40a | 7,19b |
| 518-2-4-C593 | 52,45a | 20,88e | 29,76e | 38,82b | 7,44b |
| 516-8-2-C568 | 58,47a | 20,25e | 44,84c | 43,45b | 7,13b |
| 518-2-6-C685 | 43,68b | 8,50b | 35,91d | 44,61b | 6,38c |
| Catuaí Verm. IAC 99 | 43,85b | 7,50b | 40,34c | 44,79b | 6,94b |
| Catuaí Amar. IAC 62 | 49,33b | 4,25a | 35,82d | 46,43a | 7,13b |
| Topázio MG 1190 | 49,33b | 9,00b | 28,02e | 47,16a | 6,44c |
| Rubi MG 1192 | 45,87b | 5,75a | 35,57d | 47,58a | 6,56c |
| Acaia Cerrado MG 1474 | 29,51c | 5,50a | 34,93d | 45,56a | 5,38d |
| Icatu Precoce IAC 3282 | 32,76c | 9,25b | 27,68e | 47,29a | 5,31d |
| Icatu Amar. IAC 2942 | 45,99b | 6,38a | 18,78f | 43,61b | 6,13c |
| Mean | 50,80 | 9,53 | 33,80 | 44,98 | 6,90 |
| CV(%) | 12,79 | 17,93 | 14,88 | 6,13 | 6,25 |

Means followed by the same letter do not differ from each other by the Scott-Knott test (P<0.05).

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