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

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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

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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 3,072m². 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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