INITIAL PRODUCTIVE PERFORMANCE OF COFFEE PROGENIES IN AN AREA INFESTED BY *Meloidogyne paranaensis*

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ABSTRACT: In this study, we aimed to carry out a selection of *Coffea arabica* progenies in areas infested by *Meloidogyne paranaensis* in order to select materials that are resistant to this nematode, with desirable agronomic characteristics. The experiment was set on *Guaiçara* Farm, located in the Municipality of *Piumhi – MG*, in February 2012. Twenty-one coffee progenies were evaluated in the F5 generation and 5 commercial cultivars were used as a control. A randomized complete block design was used, with three replicates, totaling 78 plots, consisting of eight plants each. The spacing used was 3.00 x 0.50 m in the rows and between plants, respectively. The populations of *M. paranaensis* per gram of coffee roots, productivity (bags. ha^{-1}), plant vigor, maturation cycle, maturation uniformity, coffee ranking by grain size (sieve 17 and above), and classification of mocha coffee were evaluated. It was concluded that progenies MG 0179-3-R1-151 and MG 0185-2-R2-132 are resistant to *M. paranaensis* and have good agronomic characteristics in an area naturally infested by this nematode, thus indicated for plantations in this situation. Nine progenies reveal tolerance/resistance characteristics to *M. paranaensis.*

Termos para indexação: *Coffea arabica*, production, nematode, resistance, amphillo.

PERFORMANCE PRODUTIVA INICIAL DE PROGÊNIES DE CAFEEIRO EM ÁREA INFESTADA POR *Meloidogyne paranaensis*

RESUMO: Objetivou-se neste trabalho selecionar progênies de *Coffea arabica* em área infestada resistentes a esse nematóide, com características produtivas desejáveis. O experimento foi instalado na Fazenda Guaiçara, situada no Município de Piumhi - MG. Vinte e uma progênies de cafeeiro em geração F_5 e cinco cultivares comerciais (testemunhas) foram avaliadas por meio da população de *Meloidogyne paranaensis*, produtividade de um biênio ($sc.ha^{-1}$), vigor vegetativo, ciclo de maturação, uniformidade de maturação, classificação do café por tamanho do grão (peneira 17 e acima) e classificação do café moca. As progênies MG 0179-3-R1-151 e MG 0185-2-R2-132 apresentaram resistência a *M. paranaensis* e boas características agronômicas em área naturalmente infestada por esse nematoide, sendo indicadas para plantios nessa situação. Nove progênies apresentaram características de tolerância ao *M. paranaensis.*

Termos para indexação: *Coffea arabica,* produção, nematoide, resistência, amphillo.

1 INTRODUCTION

Meloidogyne spp. nematodes stand out as a limiting factor for coffee producing regions (SALGADO; REZENDE; NUNES, 2014). In Brazil, the main species harmful to coffee are *Meloidogyne exigua* Göldi1887 *Meloidogyne incognita* (Kofoid & White) Chitwood 1949 and *Meloidogyne paranaensis* Carneiro et al. 1996 (CAMPOS; VILLAIN, 2005).

M. paranaensis is one of the most harmful root-knot nematodes to the coffee tree, since it drastically reduces the root system and, consequently, plant development and productivity. This nematode is distinguished from other species by its aggressiveness and strong damage to the coffee root system, with a high degree of plant degradation, commonly culminating in its death (CARNEIRO et al., 2008; SALGADO et al., 2014). The roots parasitized by *M. paranaensis* show peeling and cracking, with some thickening points that show canker lesions and decortication (CASTRO et al., 2008). Lopez-Lima et al. (2015) called 'corky-root' the damage caused by *M. paranaensis*, first diagnosed in coffee trees in several regions of Mexico.

The main strategy for the management of phytonematodes is prevention, that is, to prevent the entry and dissemination of the nematode in the area it occurs through infested seedlings, contaminated soil adhered to machines and

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implements and mainly runoff water from plots or areas already infested (SALGADO; REZENDE, 2014). Cultural, biological and chemical management have been used as a strategy to reduce the nematode population (GOLÇALVES et al., 1996). However, all these strategies have low efficiency when compared to genetic control, which has been shown to be more efficient and economically viable (ITO et al., 2008).

The sources of resistance are present in some species of the genus *Coffea*, such as *Coffea canephora* Pierre ex A. Froehner *Coffea congensis* A. Froehner (SERA et al., 2007) and *Coffea dewevrei* De Wild. & T. Durand (KANAYAMA et al., 2009). Salgado et al. (2014) observed partial resistance of the Amphillo variety to breed 2 of *M. exigua*. For *M. paranaensis*, these genotypes showed good initial plant behavior in infested areas.

Studies on the behavior of coffee genotypes in relation to *Meloidogyne* spp., in majority, have been conducted under greenhouse conditions. However, there is little research on genetically improved materials in areas infested with *M. paranaensis* (REZENDE et al., 2013). Even if it requires more time, the selection work carried out in the field is necessary and extremely important for breeding programs, since the data on the performance of coffee progenies become more reliable (OLIVEIRA et al., 2011). Salgado et al. (2014) verified that some genotypes obtained in the active germplasm bank (BAG-Café) of Empresa de Pesquisa Agropecuária de Minas Gerais - EPAMIG present promising initial behavior in an area infested by *M. paranaensis* in the municipality of Piumhi, Minas Gerais.

In this study, we aimed to carry out a selection of *Coffea arabica* L. progenies in areas infested by *M. paranaensis* in order to select materials that are resistant to this nematode, with desirable agronomic characteristics.

2 MATERIAL AND METHODS

Research installation

The selected experimental area presents a high infestation of *M.paranaensis*, a species identified by electrophoresis (CARNEIRO and ALMEIDA, 2001). The area is located in the Southwest region of Minas Gerais, in the municipality of Piumhi, Fazenda Guaiçara, privately owned, located at 20° 25’ 28,7” South latitude, 46° 1’ 10,5” longitude and average altitude of 812 m, soil with clayey texture and flat terrain. The average annual temperature is 20.7°C.

From the 42 *C.arabica* progenies in generation F_4 evaluated by Salgado et al. (2014), 21 progenies in the F_5 generation were planted in February 2012, together with five commercial cultivars used as controls (Table 1) in a randomized complete block design with three replicates, totaling 78 plots, consisting of eight plants each. The spacing used was 3.00 x 0.50 m between rows and between plants, respectively.

Phytosanitary management was carried out preventively or curatively, using chemical products, accompanying the seasonality of the occurrence of pests and diseases. The chemical control of the nematode in the area was not carried out, aiming at the identification and selection of progenies resistant to these pathogens.

Quantification of *M. paranaensis* population in coffee roots and population biological indicator test in the plot soil

Aiming the quantification of *M. paranaensis* population, root samples were removed in October 2015, after the first plant production, avoiding to hinder the initial development of coffee trees. The samples were collected at a depth of approximately 30 cm (Freitas et al., 2007), at four plot points (sub-samples), in the projection of the plant crown, forming a composite sample conditioned in a plastic bag. The nematode extraction from these samples occurred according to the Hussey and Barker (1973) method to obtain the suspension of second-stage juveniles and eggs (J2) of *M. paranaensis*, which were quantified using a counting slide under an inverted objective microscope.

The biological indicator test (Bioteste) used soil samples taken from each experimental plot in trays with 100-mL cells, duly identified according to the representative field plot. A ‘Santa Clara’ tomato seedling per cell was used as a biological indicator of *M. paranaensis* population in the plot soil. This biotest was evaluated by the quantification of *M.paranaensis* population (eggs + second-stage juveniles - J2) in tomato roots at 50 days of planting.

Progeny performance in the infested area

The agronomic characteristics evaluated in the first two harvests, 2014/2015 to 2015/2016, represent: production in liters of “bica corrida” coffee, considering an average yield of 480 liters of “farm coffee” for each 60-kg bag of processed coffee.

TABLE 1 - Progeny relation and genealogy in generation F5 and of the five commercial cultivars evaluated in the municipality of Piumhi – MG, in an area naturally infested by *Meloidogyne paranaensis*.

Nº	Progenies	Origin
1	MG 0185-1-R2-847	C. V. X Amphillo MR 2-474
2	MG 0179-1-R1-776	C. V. X Amphillo MR 2-161
3	MG 0185-1-R2-849	C. V. X Amphillo MR 2-474
4	MG 0185-1-R2-138	C. V. X Amphillo MR 2-474
5	MG 0179-3-R1-151	C. V. X Amphillo MR 2-161
6	MG 0185-1-R2-1182	C. V. X Amphillo MR 2-474
7	MG 0179-1-R1-91	C. V. X Amphillo MR 2-161
8	MG 0185-1-R2-850	C. V. X Amphillo MR 2-474
9	MS Resplendor	Catuai IAC 86 x HT UFV 440-10
10	MG 0179-1-R1-90	C. V. X Amphillo MR 2-161
11	MG 0185-1-R2-132	C. V. X Amphillo MR 2-474
12	MG 0176-9--R2-1232	Amphillo MR X H. N. MR 36/349
13	Paraíso MG H 419-1	Commercial cultivar / EPAMIG
14	Mundo Novo IAC 379-19	Commercial cultivar / IAC
15	MG 0185-1-R2-139	C. V. X Amphillo MR 2-474
16	Catuai Amarelo IAC 62	Commercial cultivar / IAC
17	MG 0179-1-R1-1052	C. V. X Amphillo MR 2-161
18	MG 0179-1-R1-89	C. V. X Amphillo MR 2-161
19	MG 0179-5-R1-1004	C. V. X Amphillo MR 2-161
20	MG 0185-1-R2-137	C. V. X Amphillo MR 2-474
21	MG 0185-1-R2-1176	C. V. X Amphillo MR 2-474
22	MG 0179-1-R1-775	C. V. X Amphillo MR 2-161
23	MG 0179-1-R1-1051	C. V. X Amphillo MR 2-161
24	MG 0294-1-R1-342	Hibrido de Timor 408-01
25	MG 0176-8-R1-943	Amphillo X H. N. MR 36/349
26	H504-5-8-2	Catuai IAC 81 x HT UFV 438-01

After coffee processing in 2015 and 2016, a 300-g sample was passed through a set of sieves (8 to 13), and the material was retained in each sieve, determining the percentage of mocha grains (BRASIL, 2003); plant vigor, evaluated by assigning scores according to an arbitrary 10-point scale, with score 1 given to the worst plants, with very reduced plant vigor and marked degradation symptoms, and score 10 to plants with excellent vigor, more unveiled and with marked plant growth of productive branches, as suggested by Carvalho et al. (1979). In 2016, in the evaluation of the maturation cycle, scores were assigned according to an arbitrary 5-point scale, in which 1 = early; 2 = average to early; 3 = average; 4 = average to late and 5 = late; for maturity uniformity, scores were assigned according to an arbitrary 4-point scale, where 1 = uniform; 2 = moderately uniform; 3 = moderately uniform and 4 = uniform.

Data on the reproductive development of coffee plants and on progeny reaction to the nematode were submitted to analysis of variance by the statistical software SISVAR (FERREIRA, 2008).

From the detection of significant differences between treatments, the means were grouped by the Scott Knott test, at 5% probability. The data transformations (log(x)) and (√(x+1)) were used for data on nematode populations in coffee (PGR) and tomato roots (PGRBIOTESTE).

3 RESULTS AND DISCUSSION

The nematode population in coffee roots had a significant difference among progenies in two distinct groups: *M. paranaensis* population below 62 nematodes/g root in group G1, consisting of 15 progenies and genotype HT UFV 408-26; in group G2 are 6 progenies and 'Catuaí Amarelo' IAC 62, 'Mundo Novo' IAC 379-19, 'MS Resplendor' and 'Paraíso' MG H 419-1, with higher values of egg + second-stage juvenile population (J2) of the nematode (Table 2).

The biotest presents a significant difference for *M. paranaensis* population in the plots, indicating a variation in the parasitic population of 2.89 in the progeny soil for progeny 23 (MG 0179-1-R1-1051), up to 1264 individuals in progeny 12 (MG 0176-9-R2-1232), (Table 2).

For the nematode population in coffee roots, 16 treatments had smaller egg and second-stage juvenile populations (J2). Commercial cultivars used as susceptible controls had a high nematode population (Table 2).

According to Salgado, Rezende and Nunes (2014), the plant resistance mechanism to nematodes prevents high reproductive rate from nematode and, consequently, besides not causing damage to the crop, they lead to a decrease in its population in the soil. This explains the results of the biotest, when compared with the evaluations of the nematode population in coffee roots.

The average yields estimated in the biennium 2014/2015 and 2015/2016 ranged from 20.25 sc ha^{-1} (treatment 16) to 82.60 sc ha^{-1} (treatment 11), and approximately 40% of the progenies had a performance higher than the global average, suggesting a resistance/tolerance of these progenies to *M. paranaensis*. Progenies 4, 5, 11 and 12 had an average yield of 251.30%, higher than the 5 susceptible controls (Table 3).

The superiority in progeny production, associated with *M. paranaensis* population in the roots, indicates a resistance behavior of progenies 4 and 11 and a tolerance behavior of progenies 5 and 12 since, according to Trudgill (1991), tolerance refers to the inherent or acquired capacity of a plant to support pathogen infection (fungus, viruses, nematodes, bacteria, etc.), without significant damage to its production. On the other hand, the controls represented by susceptible commercial cultivars had low yield (Table 3), confirming the economic damage of this nematode. This marked reduction in yield indicates how much damage *M. paranaensis* can cause to susceptible cultivars, as a consequence of parasitism, with the destruction of the root system, which may cause general degradation.

Regarding vigor scores, the averages were grouped in two classes by the Scott-Knott test at 5% probability, with 10 treatments that showed higher scores. The most vigorous genotypes are 4, 5, 6, 10, 11, 12, 15, 21, 25 and 26, with average vigor scores ranging from 5.12 to 8.0 (Table 3). The susceptible controls obtained the lowest scores, on average, evidencing the impairment of their plant development in the presence of nematodes. In addition to influencing production, according to Carvalho et al. (2012) and Carvalho et al. (2008), plant vigor reduces, to a certain extent, coffee bienniality and is directly related to genotype yield and adaptability to the different edaphoclimatic conditions.

Progenies 4, 10 and 11 showed a low *M. paranaensis* population in coffee roots, good plant vigor and high yield in the biennium. This indicates that these progenies have the potential for continuation in generation advance and/or backcrossing within the coffee breeding program of EPAMIG. The smallest *M. paranaensis* population in the roots of these progenies can be attributed to Amphillo, since this genetic material is a possible source of resistance to *M. paranaensis*. Salgado et al. (2014) identified F_4 plants derived from the crossing between 'Catuaí Vermelho', 'Amphillo' MR 2161 and 'Híbrido de Timor' UFV 408-01 as promising, potentially resistant to *M. paranaensis* and, therefore, important to the coffee breeding program. Silva et al. (2015) observe that progeny 5, from the cross of 'Catuaí Vermelho' and 'Amphillo' 2-161, whose plant in the F_4 generation supplied progeny 5 with seeds in this research, had a capacity for acclimatization to the water deficit, as evidenced by the maintenance of water status, gas exchange and better photochemical performance, culminating in higher yield. Studies of these genotypes in areas infested by other *Meloidogyne* species should be carried out, as there is the possibility of obtaining coffee cultivars with resistance to several root-knot nematode species (Boisseau et al., 2009).

TABLE 2 - *Meloidogyne paranaensis* population (eggs + second-stage juveniles - J2) per gram of *Coffea arabica* progeny roots (PGR) and per gram of 'Santa Clara' tomato roots (PGR Bioteste), cultivated with soil removed from the rhizosphere of coffee plants at 30 months of planting in an experimental area located in Piumhi, MG.

Treatment	PGR	PGR Biotest
1	25.77 a	81.64 a
2	62.36 b	85.46 a
3	173.07 a	43.33 a
4	13.30 a	47.21 a
5	68.54 a	164.88 a
6	139.38 b	10.28 a
7	10.36 a	69.65 a
8	5.04 a	8.16 a
9*	194.14 b	123.99 a
10	17.23 a	33.46 a
11	23.28 a	70.47 a
12	68.85 a	1264.18 b
13*	219.65 b	1067.26 b
14*	171.28 b	740.15 b
15	278.82 b	128.90 a
16*	103.39 b	399.21 b
17	254.29 b	382.44 b
18	20.04 a	14.26 a
19	8.07 a	17.77 a
20	191.7300 b	144.95 b
21	148.7333 b	208.18 b
22	5.2900 a	51.91 a
23	9.8800 a	2.89 a
24	63.2266 b	316.15 b
25	95.7900 a	337.18 b
26*	97.8200 a	27.69 a
Mean	94.9773	224.6816
CV(%)	36.53	61.54

**: Controls. Means followed by the same letter, vertically, belong to the same group, by the Scott-Knott test at 5% probability.*

Progenies MG 0179-3-R1-151 (5), originated from the cross between C. V. X Amphillo MR 2-161 and MG 0185-2-R2-132 (11), coming from the cross between C. V X. Amphillo MR 2-474, were classified as resistant by Pasqualoto (2015) and Peres (2013), respectively, corroborating the results obtained in this study. Pasqualoto (2015) evaluated progenies in infested areas and greenhouse environments, and Peres (2013) evaluated the reproductive factor of *M. paranaensis* and *M. incognita*, breed 1, in a greenhouse and compared the results with those obtained from areas infested with *M. paranaensis*.

Progenies MG 0185-2-R2-138 (4), from the cross between C. V. X Amphillo MR 2-474 and MG 0176-2-R2-943 (25), obtained from the crossing of Amphillo X. H. N. MR 36/349, were pointed out by Peres (2013) as moderately resistant to M. paranaensis, and the latter was highlighted by Pasqualoto (2015) as potentially resistant.

Treatment 23 presents good yield and low nematode population in the roots, but with low vigor. However, Pasqualoto (2015) concluded that this progeny, MG 0179-1-R1-1051, from the cross between C. V. X Amphillo MR 2-161, is resistant to *M. paranaensis*.

Progenies 10, 18, 19 and 22 can be considered of intermediate performance, according to plant yield and vigor. Peres et al. (2017) concluded that plants of progenies MG 0179-1-R1-90, MG 0179-1-R1-89 and MG 0179-1-R1-775, from which seeds were obtained for treatments 10, 18 and 22 of this study, respectively, were resistant to the nematodes *M. paranaensis* and *M. incognita*.

TABLE 3 - Estimated average yield, in sc/ha, in the biennium 2015/16, vigor of coffee progenies evaluated in an area infested by *Meloidogyne paranaensis* in Piumhi, MG.

Progenies	Yield	Vigor
1	40.27 b	3.91 b
2	38.48 b	4.58 b
3	25.95 b	4.12 b
4	74.21 a	5.91 a
5	78.69 a	6.66 a
6	58.44 a	5.86 a
7	28.64 b	4.37 b
8	33.85 b	3.87 b
9	39.23 b*	3.79 b*
10	44.41 b	6.83 a
11	82.60 a	8.00 a
12	64.81 a	5.50 a
13	31.30 b*	3.25 b*
14	27.95 b*	3.08 b*
15	56.85 a	6.33 a
16	20.25 b*	2.46 b*
17	30.26 b	3.75 b
18	45.85 b	4.83 b
19	48.17 b	3.75 b
20	59.60 a	4.75 b
21	55.33 a	5.50 a
22	46.43 b	4.71 b
23	59.59 a	4.96 b
24	24.45 b	2.63 b
25	55.11 a	5.92 a
26	51.50 a	5.12 a
Means	46.9726	4.7896
CV(%)	35.47	31.99

**: Cultivars used as controls. Means followed by the same letter, vertically, belong to the same group, by the Scott-Knott test at 5% probability.*

In the evaluation and selection of coffee plants, researchers seek an ideotype whose performance includes, besides other characteristics, high yield and percentage of grains classified in high sieves (FERREIRA et al., 2005). In general, increased grain size provides greater uniformity of the batch to be processed and directly influences the physical appearance of the product, which is desirable, mainly for use in espresso machines (FERREIRA et al., 2013). For this characteristic, it was observed that three groups were formed, and only 'Mundo Novo' IAC 379-19 was in the superior group; in the intermediate group, there were 6 treatments, with 5 progenies and 'Catuai Amarelo' IAC 62 and, in the inferior group, 19 treatments, with 16 progenies and 'MS Resplendor', 'Paraíso' MG H 419-1 and HT UFV 408-26.

Mocha beans originate under lack of fertilization conditions or even when fruit development occurs in one of the stores GASPARI-PEZZOPANE et al., 2005). Carvalho et al. (2009) define mocha beans as grains that have ovoid shape, with a crack in the longitudinal format. The evaluation of their average percentage in the biennium 2014/2016 had two classes, and only three progenies with percentages above the average (Table 4). In addition to the percentage of mocha, grain size (% sieve 17 and above) may have been affected by rain scarcity in the period, compromising plant nutrition, flower setting and fruit granulation. During this period, there was a water deficit of approximately 500 mm in relation to the historical average (Table 4).

TABLE 4 - Mean values of sieve 17 and above, mocha grains, maturation cycle and maturity uniformity evaluated in the 2014/2015 to 2015/2016 harvests in an area naturally infested by *Meloidogyne paranaensis*, in the municipality of Piumhi-MG.

Treatment	Sieve 17	Mocha	Maturation	Maturity uniformity
1	13.61 c	21.16 a	1.61 a	1.82 a
2	27.02 b	24.90 a	3.33 a	3.21 b
3	24.28 b	32.49 b	2.72 a	2.65 a
4	7.38 c	18.01 a	2.89 a	3.54 b
5	17.85 c	19.12 a	3.22 a	3.41 b
6	11.96 c	27.30 b	3.62 a	3.00 b
7	27.98 b	18.08 a	2.44 a	2.51 a
8	15.60 c	22.35 a	2.55 a	2.86 a
9	8.16 c*	15.12 a*	2.40 a*	2.89 a*
10	16.22 c	16.78 a	2.44 a	2.16 a
11	9.78 c	14.53 a	3.37 a	3.96 b
12	21.99 b	25.42 b	3.23 a	3.70 b
13	14.06 c*	16.51 a*	2.77 a*	2.71 a*
14	36.51 a*	19.40 a*	2.39 a*	2.22 a*
15	12.53 c	15.22 a	2.88 a	3.15 b
16	20.21 b*	18.02 a*	2.56 a*	2.76 a*
17	8.36 c	20.89 a	2.10 a	2.27 a
18	23.35 b	19.31 a	2.36 a	2.06 a
19	14.84 c	18.46 a	1.78 a	2.70 a
20	10.16 c	18.79 a	2.85 a	3.52 b
21	8.21 c	19.15 a	3.10 a	2.75 a
22	7.72 c	22.23 a	2.82 a	3.10 b
23	13.67 c	17.37 a	2.99 a	3.25 b
24	14.26 c*	20.88 a*	3.33 a*	3.50 b*
25	13.95 c	19.55 a	2.82 a	3.31 b
26	12.79 c	18.47 a	3.09 a	3.76 b
Mean	15.8664	19.9843	2.7597	2.9557
CV(%)	36.35	24.50	24.13	18.30

**: Cultivars used as controls. Means followed by the same letter, vertically, belong to the same group, by the Scott-Knott test at 5% probability.*

For maturation season, the treatments did not present significant differences, occurring concurrently in 'Catuaí Amarelo' IAC 62, 'Mundo Novo' IAC 379-1, 'MS Resplendor', 'Paraíso' MG H 419-1 and HT UFV 408-26; the maturation cycle was classified as medium.

As for the average maturity uniformity scores, two distinct groups were formed: 9 progenies and the controls 'Catuaí Amarelo' IAC 62, 'Mundo Novo' IAC 379-1, 'MS Resplendor', 'Paraíso' MG H 419-1 were in the first group, with average scores ranging between 1.82 and 2.89, classified as moderately uniform; the other 12 progenies and cultivar HT UFV 408-26 make up the other group, with average scores ranging from 3.00 to 3.96, classified as moderately uneven to uneven.

4 CONCLUSIONS

Progenies MG 0179-3-R1-151 and MG 0185-1-R2-132 were resistant to *M. paranaensis* and had good agronomic characteristics in an area naturally infested by this nematode, being indicated for plantations in this situation.

Progenies MG 0185-1-R2-138, MG 0179-1-R1-90, MG 0176-9-R2-1232, MG 0179-1-R1-89, MG 0179-5-R1-1004, MG 0179-1-R1-775, MG 0179-1-R1-1051, MG 0176-8-R1-943 and MG 0294-1-R1-342 present tolerance characteristics to *M. paranaensis*.

The high yield of progeny MG 0185-1-R2-132, above 80 sc/ha, evidences its great productive potential in areas infested with *M. paranaensis*.

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6 REFERENCES

BOISSEAU, M. et al. Resistance to *Meloidogyne paranaensis* in wild *Coffea arabica*. **Tropical Plant Pathology**, Brasília, v. 34, n. 1, p. 38-41, Jan/Feb. 2009.

BRASIL. Ministério da Agricultura, Pecuária e Abastecimento. **Instrução Normativa nº 8, de 11 de junho de 2003.** Aprova o regulamento técnico de identidade e de qualidade para a classificação do café beneficiado Grão Cru. Brasília, 2003.

CAMARGO, L. E. A. Análise genética da resistência e da patogenicidade. In: BERGAMIN

CAMPOS, V. P.; VILLAIN, L. Nematode parasites of coffee and cocoa. In: LUC, M.; SIKORA, R. A.; BRIDGE, J. (Ed.). **Plant parasitic nematodes in subtropical and tropical agriculture.** 2nd ed. Wallingford: CABI, 2005. p. 189-204.

CARNEIRO, R. M. D. G.; ALMEIDA, M. R. A. Técnica de eletroforese usada no estudo de enzimas dos nematoides de galhas para identificação de espécies. **Nematologia Brasileira**, Campinas, v. 25, n. 1, p. 35-44, Jan./Jun. 2001.

CARNEIRO, R. M. D. G. et al. Pathogenicity of *Meloidogyne spp.* (Tylenchida: Meloidogynidae) from Brazil and Central America on two genotypes of *Coffea arabica.* **Tropical Plant Pathology**, Brasília, v. 33, n. 4, p. 309-312, July./Aug. 2008.

CARVALHO, A.; MÔNACO, L. C.; FAZUOLI, L. C. Melhoramento do café XL – Estudos de progênies e híbridos de café Catuaí. **Bragantia**, Campinas, v. 38, n. 22, p. 202-216, Nov. 1979.

CARVALHO, A. M. et al. Avaliação de progênies de cafeeiros obtidas do cruzamento entre 'Catuaí' e 'Híbrido de Timor'. **Scientia Agraria**, Piracicaba, v. 9, n. 2, p. 249-253, Apr./June. 2008.

CARVALHO, A. M. et al. Desempenho agronômico de cultivares comerciais de café resistentes à ferrugem no Estado de Minas Gerais. **Bragantia**, Campinas, v. 71, n. 4, p. 481-487, Oct./Dec. 2012.

CARVALHO, G. R. et al. MGS Travessia: nova cultivar de café com produtividade e responsiva a poda. In: SIMPÓSIO DE PESQUISA DOS CAFÉS DO BRASIL, 6., 2009, Vitória. **Anais...** Vitória: Consórcio Pesquisa Café, 2009. 1 CD-ROM.

CASTRO, J. M. C. et al. Levantamento de fitonematoides em cafezais do sul de Minas Gerais. **Nematologia Brasileira**, Piracicaba, v. 32, n. 1, p. 56-64, Jan./Mar. 2008.

FERREIRA, D. F. SISVAR: um programa para análises e ensino de estatística. **Revista Symposium**, Lavras, v. 6, n. 1, p. 36-41, 2008.

FERREIRA, A. D. et al . Desempenho agronômico de seleções de café Bourbon Vermelho e Bourbon Amarelo de diferentes origens. **Pesquisa Agropecuária Brasileira**, Brasília, v. 48, n. 4, p. 388-394, Apr. 2013.

FERREIRA, A. D. et al. Seleção simultânea de *Coffea canephora* por meio da combinação de análise de fatores e índices de seleção. **Pesquisa Agropecuária Brasileira**, Brasília, v. 40, n. 12, p. 1189-1195, Dec. 2005.

FREITAS, L. G. et al. Métodos em Nematologia Vegetal. In: ALFENAS, A.C.; MAFIA, R. G. (Eds.). **Métodos em Fitopatologia.** Viçosa: Editora UFV, 2007. p. 253-291.

GASPARI-PEZZOPANE, C. et al. Influências ambientais no rendimento intrínseco do café. **Bragantia**, Campinas, v. 64, n. 1, Jan./Mar. 2005.

HUSSEY, R. S.; BARKER, K. R. A comparison of methods of collecting inocula of *Meloidogyne* spp. including a new technique. **Plant Disease Reporter**, Washington, v. 57, p. 1025-1028, 1973.

ITO, D. S. et al. Progênies de café com resistência aos nematóides *Meloidogyne paranaensis* e raça 2 de *Meloidogyne incognita*. **Coffee Science**, Lavras, v. 3, n. 2, p. 156-163, July./Dec. 2008.

KANAYAMA, F. S. et al. Progênies de *Coffea arabica* cv. IPR 100 com resistência ao nematoide *Meloidogyne incognita* raça 1. **Ciência e Agrotecnologia**, Lavras, v. 33, n. 5, p. 1321-1326, Sept./Oct. 2009.

LOPEZ-LIMAS, D. et al. Corky-root symptoms for coffee in central Veracruz are linked to the root-knot nematode *Meloidogyne paranaensis*, a new report for México. **European Journal Plant Pathology**, v. 141, p. 623-629, 2015.

OLIVEIRA, A. C. B. et al. Prediction of genetic gains from selection in Arabica coffee progenies. **Crop Breeding and Applied Biotechnology**, Londrina, v. 11, n. 2, p. 106-113, June. 2011

PASQUALOTTO, A. T. **Desempenho agronômico e fisiológico de progênies de cafeeiro parasitadas por *Meloidogyne paranaensis.*** 2015. 85 p. Dissertação (Mestrado em Agronomia/Fitotecnia) - Universidade Federal de Lavras, Lavras, 2015.

PERES, A. C. J. Resistance of *Coffea arabica* genotypes against *Meloidogyne paranaensis* and *M. incognita* under controlled and field conditions. **Nematology** 19: 617-626. 2017.

REZENDE, R. M. et al. Resistance of *Coffea arabica* progenies in field conditions infested by *Meloidogyneexigua*. **Nematropica**, Bradenton, v. 43, n. 2, p. 233-240, July./Dec. 2013.

SALGADO, S. M. L.; REZENDE, J. C.; NUNES, J. A. R. Selection of coffee progenies for resistance to nematode *Meloidogyne paranaensis* in infested area. **Crop Breeding and Applied Biotechnology**, Viçosa, v. 14, n. 2, p. 94-101, Apr./June. 2014.

SERA, G. H. S. T. et al. Progênies de *Coffea arabica* cv. Ipr 100 com resistência ao nematoide *Meloidogyne paranaensis*. **Bragantia**, Campinas, v. 66, n. 1, p. 43-49, Jan./Mar. 2007.

SERA, G. H. et al. Reaction of coffee cultivars Tupi 1669-33 e IPR 100 to nematode *Meloidogyne paranaensis*. **Crop Breeding and Applied Biotechnology**, v. 9, p. 293-298, 2009.

SILVA, V. A. et al. Uso de características fisiológicas na identificação de genótipos de café arábica tolerantes ao *Meloidogyne paranaensis*. **Coffee Science**, Lavras, v. 10, n. 2, p. 242-250, Apr./June. 2015.

TUDGILL, D. L. Resistance to and tolerance of plant parasitic nematodes in plants. **Annual Review of Phitopathology**, v. 29, p. 167-192. 1991.