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Resistance of *Coffea canephora* as a sustainable tool for *Meloidogyne incognita* control

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ABSTRACT

Many factors can affect coffee production, such as the root-knot nematode, a soil pathogen that can kill plants up to two years old. In infested areas, the cultivation of resistant genotypes is an economical and ecologically appropriate alternative. The present study aims to evaluate the resistance of *Coffea canephora* clones to *Meloidogyne incognita*. Evaluations were carried out in a greenhouse at Embrapa Rondônia (Porto Velho -RO) between September 2019 and November 2020. Genotypes were inoculated with *M. incognita* in four experiments with six replications with a completely randomized design. Root dry weight (RDW), the number of galls (NG) and the reproduction factor (RF) were evaluated. Eighty-six coffee clones were evaluated, with 50 clones showing resistance to *Meloidogyne incognita* and 36 clones showing susceptibility. Clones classified as resistant had an average reproduction factor of 0.33 with a range of 0.00 to 0.95, while clones classified as susceptible had an average reproduction factor of 3.48 with an amplitude ranging from 1.02 to 14.46. The number of galls was also higher in susceptible clones than in resistant clones. Considering the ten most cultivated clones, the genotypes GJ8, GJ25, P50, SK80, AS2, P42 and LB10 were classified as resistant, and the genotypes GJ3, GJ5 and SK41 were classified as susceptible. Taken together, the results identify resistant *C. canephora* clones as an important and sustainable tool for controlling *M. incognita*.

Key words: Genetic control; Plant resistance; Coffee.

1 INTRODUCTION

Brazil is the world's largest producer and exporter and second largest consumer of coffee, producing more than 46.8 million bags, representing approximately one-third of all coffee exported in the world. The two main coffee species grown in Brazil are *Coffea arabica* (81%) and *Coffea canephora* (19%) (Companhia Nacional de Abastecimento - CONAB, 2022). *C. canephora* is cultivated at altitudes of 50 to 550 m, which are typical of the western Amazon (Veloso et al., 2020).

The coffee growing in the western Amazon is characterized by the hybrid nature of employed genotypes, which originate from hybridizations of the Conilon and Robusta botanical varieties. The botanical variety Robusta is characterized by erect growth, larger leaf size, a higher average sieve, late maturation, less tolerance of water deficits, and greater resistance to diseases and pests. The botanical variety Conilon is characterized by shrub growth, early maturation, elongated leaves, greater tolerance to drought, and greater susceptibility to pests and diseases (Rocha et al., 2021).

A survey carried out by (Dalazen et al., 2019) identified 74 clones in the public domain, selected by coffee growers themselves and multiplied in the western Amazon. Although widely cultivated, these genotypes are still poorly understood in many respects, such as in terms of their resistance to pests and diseases. Despite the large number of identified genotypes, in practice, a smaller number of genotypes are present in most crops of this region. In their survey, (Dalazen et al., 2019) observed that clones GJ8, GJ25, GJ3, P50 and GJ5 were present in 89%, 88%, 80%, 64% and 41% of the studied crops, and clones SK80, SK41, AS2, P42 and LB10 showed participation levels of 20% to 30% in the sampled crops, distributed across an area of approximately 71 thousand hectares.

The large-scale cultivation of a smaller number of clones increases the importance of characterizing genotype resistance to pests and diseases. Several factors can affect coffee production, such as nematodes of the genus *Meloidogyne spp.* and soil pathogens of a wide range of plant species (Rudnick et al., 2020). This phytopathogen severely reduces the production of the host plant, causing significant economic losses globally (Elling, 2013). *M. incognita*, *M. paranaensis* and *M. exigua* are the main species due to damage caused and their widespread occurrence in coffee-producing areas (Santos et al., 2018). In Rondonia, studies carried out by (Vieira Júnior et al., 2015) found some of the main *Meloidogyne* species, with *M.*

incognita race 2 found to be present in several municipalities. Although root-knot nematodes (*Meloidogyne* spp.) can be effectively controlled by chemical nematicides, they have many disadvantages, as many of them are costly and pose diverse risks to fauna, flora and humans (Peiris et al., 2020). Thus, genetic resistance appears to be an important strategy for disease management.

Given the occurrence of *M. incognita* in coffee plantations in the state of Rondônia, the identification of genotypes that are resistant and adapted to infested areas is of great importance for associated crop management (Santos et al., 2017). The genetic improvement provides science that contributes to the adaptation and increased production of crops (Ferrão et al., 2021, Rocha et al., 2021, Grenier et al., 2015). In infested areas, the use of resistant cultivars is an economically viable and environmentally appropriate tactic for nematode control. However, there are currently few coffee cultivars with known nematode-resistance traits (Teixeira et al., 2020).

In this sense, the objective of this study was to evaluate resistance to *M. incognita* (Est I2) among the *C. canephora* clones widely cultivated in western Amazonia.

2 MATERIAL AND METHODS

2.1 Genetic resources

The genetic resource evaluated in this work includes cultivars developed by Embrapa, genotypes kept in a germplasm bank (BAG) and clones commercialized in the public domain selected by coffee growers themselves. Cultivars developed by Embrapa were identified by the prefix BRS, and clones kept in a germplasm bank were identified by the prefix BAG. The other prefix identifies genotypes in the public domain cultivated in the western Amazon (Table 1).

2.2 Evaluation of resistance of *C. canephora* genotypes to *M. incognita*

To identify the root-knot nematode species, enzymatic characterization of the esterase profile was carried out at the Phytopathology Laboratory of EMBRAPA Clima Temperado - RS according to the methodology of (Carneiro et al., 1996). Using female *M. javanica* as control samples, the esterase profile observed was of a single pattern typical of *M. incognita* (Est I2) (Santos et al., 2017). The inoculum was kept in a greenhouse, alternating its multiplication in tomato and coffee plants, forming an inoculum bank. This inoculum was registered under the National System for the Management of Genetic Heritage and Associated Traditional Knowledge - Sisgen under access code number AF69FBC.

To quantify the resistance of the *C. canephora* clones to *M. incognita*, multistep evaluations were performed at Embrapa Rondônia - Porto Velho, RO (8°47'38, 44"S, 63°50'47.93 "W) from September 2019 to November 2020. All steps were carried out in a "chapel model" greenhouse covered with 120 micron anti-UBV plastic film with front and side ventilation.

For the evaluations, seedlings with six months of development and six pairs of leaves were transplanted into 8-liter pots containing sterilized substrate composed of natural soil and sand (1:1). Each coffee plant was inoculated separately with 10 ml of suspension containing 5000 eggs + second-stage juveniles (J2) of *M. incognita* (Est I2). In the evaluations, the roots of each plant were separated from the shoot, washed and weighed, and the number of galls was counted in 3 g of root. The roots were then processed according to the methodology of Boneti and Ferraz (1981) to determine the number of eggs and the reproduction factor (RF) of *M. incognita* (RF = final population/initial population) (Oostenbrink, 1966). To calculate the RF, the number of nematode eggs extracted from each coffee plant was counted on a Peter slide under a light microscope.

Each genotype inoculated with *M. incognita* represented one treatment, using six replicates for each clone arranged in a completely randomized design. Cultivars BRS2299 and BRS 3210 were used as resistance standards due to their already known levels of resistance to *M. incognita* (Santos et al., 2017), and BRS 2336 was set as the susceptibility pattern, as this response was observed in assessments carried out by Rudnick et al. (2020).

2.3 Statistical methods

To quantify the resistance response, a completely randomized design was used with six replications for each treatment considering the following model:

$$Y_{ij} = u + G_i + e_{ij} \quad (1)$$

Y_{ij} = observation of the i-th clone in the j-th repetition, u = general average, G_i = i-th clone effect, e_{ij} = random error that affects the i-th clone and the j-th repetition.

3 RESULTS

According to the analysis and variance, the effects of clones, controls and the contrast clones x controls were significant at 1% probability in all the evaluations for root dry weight (RDW), the number of galls (NG) and the reproduction factor (RF). The significance of the contrast clones × controls indicates that the genotypes showed significant differences from the resistant and susceptible controls. Reproduction factor (RF) estimates of the coefficient of variation ranged from 27 to 32%, indicating experimental precision comparable to those of evaluations carried out in other studies (Rudnick et al., 2020; Santos et al., 2017; Santos et al., 2018).

Table 1: Clones of *Coffea canephora* evaluated for *Meloidogyne incognita* resistance in four experiments performed in the municipality of Porto Velho - RO.

Experiment 1		Experiment 2		Experiment 3		Experiment 4	
Treatment	Genotype	Treatment	Genotype	Treatment	Genotype	Treatment	Genotype
1	AR106	1	Apoatã 1	1	AS3	1	BRS125
2	AS2	2	Apoatã 2	2	AS5	2	BRS2299
3	BRS2299	3	Apoatã 3	3	AS6	3	BRS2336
4	BRS2336	4	AS2	4	AS7	4	BRS3210
5	BRS2357	5	BAG15	5	AS10	5	CA1
6	BRS3193	6	BAG19	6	AS12	6	GJ1
7	BRS3210	7	BAG21	7	BG180	7	GJ2
8	GB7	8	BAG22	8	BRS2336	8	GJ8
9	GJ3	9	BAG23	9	BRS3210	9	GJ20
10	GJ5	10	BAG24	10	GB1	10	GJ30
11	GJ8	11	BAG26	11	GB4	11	LB7
12	GJ25	12	BAG27	12	GJ31-131	12	LB12
13	P42	13	BAG28	13	L1	13	LB15
14	SK41	14	BAG29	14	LB10	14	LB20
15	SK80	15	BAG30	15	LB15	15	LB22
16	WP6	16	BAG31	16	LB80	16	LB30
17	Catucaí	17	BAG32	17	N1	17	LB33
		18	BAG33	18	N2	18	LB60
		19	BAG34	19	N12	19	LB68
		20	BAG35	20	N13	20	LB88
		21	BAG38	21	N16	21	LB102
		22	BAG39	22	P50	22	LB110
		23	BAG40	23	R152	23	LB160
		24	BAG41			24	N7
		25	BAG72			25	N11
		26	BRS130			26	N17
		27	BRS160			27	N32
		28	BRS189			28	VP156
		29	BRS1216				
		30	BRS2336				
		31	BRS3210				
		32	BRS3220				
		33	GJ8				
		34	GJ25				

The prefix BAG identifies clones of the Active Germplasm Bank, and the prefix BRS identifies cultivars developed by Embrapa. The other prefix identifies genotypes in the public domain cultivated in the western Amazon.

The *C. arabica* of the Catucaí variety, used as a susceptible control, was the genotype that obtained the highest reproduction factor (RF) (Table 2). In Experiment 1, the genotypes BRS 3210 and BRS 2299 were used as resistant controls, and the genotypes BRS 2336, BRS 2357, and BRS 3193 were used as susceptible controls (Rudnick et al., 2020). In this evaluation, eight genotypes were classified as resistant (P42, BRS2299, GB7, AS2, BRS 3210, GJ8, GJ25, and SK80), and nine genotypes were classified as susceptible (WP6, BRS3193, BRS2357, BRS2336, AR106, SK41, GJ5, GJ3, and Catucai) (Table 2).

In Experiment 2, the BRS 3210 and BRS 2336 genotypes were used as resistant and susceptible genotypes, respectively. Of the 34 clones evaluated in this experiment, only five genotypes were classified as susceptible (BRS 189, BAG21, BRS130, BRS2336, and BRS160) (Table 3).

In Experiment 3, of the 25 evaluated genotypes, 11 genotypes were classified as resistant (GB4, R152, LB15, LB10, BRS3210, N16, LB10, P50, BG180, N13, and GB1), and 14 genotypes were classified as susceptible (AS10, GJ31-131, BRS2336, LB80, N1, AS6, AS12, N2, L1, AS10, N12, AS5, AS3, and AS7) compared to the resistant and susceptible controls BRS3210 and BRS2336, respectively.

Table 2: Root dry weight (RDW), number of galls (NG) and reproduction factor (RF) of 17 *Coffea canephora* genotypes evaluated 150 days after inoculation with 5000 eggs of *Meloidogyne incognita* (Experiment 1).

Genotype	RDW (g)	NG	RF	Classification
P42	8.31	0.00	0.11	Resistant
BRS2299[1]	12.94	0.28	0.28	Resistant
GB7	8.88	0.00	0.32	Resistant
AS2	9.58	32.06	0.34	Resistant
BRS 3210[1]	13.64	0.12	0.34	Resistant
GJ8	14.67	0.50	0.69	Resistant
GJ25	4.82	0.00	0.82	Resistant
SK80	5.87	0.83	0.95	Resistant
WP6	7.19	0.44	1.14	Susceptible
BRS3193[2]	10.46	3.10	2.27	Susceptible
BRS2357[2]	8.90	22.33	2.75	Susceptible
BRS2336[2]	7.54	19.06	3.28	Susceptible
AR106	9.21	3.00	4.29	Susceptible
SK41	10.01	7.67	5.33	Susceptible
GJ5	12.81	12.39	7.45	Susceptible
GJ3	7.98	24.94	9.10	Susceptible
Catucai[2]	5.63	41.92	14.46	Susceptible

[1]Resistance control. [2]Susceptibility control. Classification according to Moura and Regis (1987).

Table 3: Root dry weight (RDW), number of galls (NG) and reproduction factor (RF) of 34 *Coffea canephora* genotypes evaluated 150 days after inoculation with 5000 eggs of *Meloidogyne incognita* (Experiment 2).

Genotype	RDW (g)	NG	RF	Classification
BAG30	9.29	4.90	0.00	Resistant
BAG24	19.01	12.04	0.00	Resistant
APOATÃ 2	22.70	14.85	0.01	Resistant
BAG 34	20.27	3.76	0.01	Resistant
GJ25	16.87	7.23	0.02	Resistant
BAG41	7.30	3.80	0.04	Resistant
BAG28	9.36	6.38	0.04	Resistant
BAG31	14.49	4.23	0.04	Resistant
BAG29	12.48	21.42	0.04	Resistant
BAG32	12.22	26.00	0.08	Resistant
BAG38	25.85	8.71	0.08	Resistant
BAG35	22.97	8.90	0.09	Resistant
AS2	58.69	19.80	0.11	Resistant
BAG26	24.36	5.95	0.12	Resistant
BAG33	25.45	1.57	0.15	Resistant
BAG27	24.46	7.09	0.16	Resistant
BAG40	47.56	17.66	0.17	Resistant
BAG19	25.67	31.76	0.19	Resistant
BRS 3210[1]	28.65	9.95	0.19	Resistant
BAG23	28.29	10.23	0.22	Resistant
BRS 3220	73.79	11.28	0.23	Resistant
BAG22	29.17	16.23	0.25	Resistant
GJ8	36.64	20.66	0.26	Resistant
APOATÃ 3	25.46	21.23	0.28	Resistant
BRS 1216	31.14	14.19	0.31	Resistant
BAG72	43.23	74.28	0.32	Resistant
BAG39	45.28	34.76	0.39	Resistant
APOATÃ 1	11.65	23.23	0.42	Resistant
BAG15	44.42	35.04	0.56	Resistant
BRS 189	19.58	27.66	1.33	Susceptible
BAG21	36.05	61.28	1.60	Susceptible
BRS130	8.80	74.23	1.62	Susceptible
BRS2336[2]	24.52	1.83	2.25	Susceptible
BRS160	14.80	54.23	2.77	Susceptible

[1]Resistance control. [2]Susceptibility control. Classification according to Sasser et al. (1984).

In Experiment 4, the genotypes BRS 3210 and BRS 2299 were used as resistant controls, and the genotype BRS 2336 was used as a susceptible control. From the 25 genotypes, 13 resistant genotypes (LB7, VP156, N7, LB60, CA1, LB15,

LB102, LB33, BRS3210, N32, BRS2299, GJ8, GJ30, LB88, and LB68) and 12 susceptible genotypes (LB30, LB160, LB12, BRS2336, LB22, N17, LB110, GJ2, GJ21, GJ20, BRS125, N11, and LB20) were observed.

4 DISCUSSION

As expected, the *C. arabica* cultivars were susceptible hosts to *M. incognita*, exhibiting values of RF = 14.46 and NG = 41.92 150 days after inoculation (DAI). As most *C. arabica* cultivars are hosts susceptible to *Meloidogyne* spp. (Santos et al., 2017), the cultivar Obatã was considered a good host (GH) of *M. incognita* according to the classification of Seinhorst (1967) and susceptible (S) according to the classification of Sasser, Carter and Hartman (1984). These results also indicate the quality of the inoculum of *M. incognita* (Est I2) used in inoculation trials.

In contrast, the *C. canephora*-resistant controls were classified as nonhosts (NHs) for *M. incognita* according to the classification of Seinhorst (1967) or as resistant according to Sasser, Carter and Hartman (1984). Additionally, fewer gall symptoms were observed among the resistant controls (Tables 1, 2, 3 and 4). Such results confirm the resistance of these genotypes, which have been used as alternatives in the control of root-knot nematodes. The genotypes identified by the prefix BRS are cultivars developed by Embrapa with known resistance responses (Teixeira et a., 2020).

Although *C. canephora* is considered a species more resistant to root-knot nematodes, of the 86 clones evaluated, 36 genotypes (42%) were considered good hosts of *M. incognita* (Table 4). Among these materials, the genotypes SK41, L1, GJ5, AS10, GJ3, N12, AS5, AS3, and AS7 showed high susceptibility to *M. incognita* with an RF value of > 5.00. These clones can also be used as susceptible comparisons in new trials of responses to *M. incognita* (Est I2). The clone GJ3, evaluated as very susceptible to nematodes, has been replaced in the field due to plant death, especially in years of high production (Espindula et al., 2022).

Several studies point out that clones of *C. canephora* present a variable rate of resistance to *M. incognita*, resulting in lower plant productivity and plant death in areas infested with this pathogen (Santos et al., 2017, Rudnick et al., 2020). This variability is due to the segregation of resistance genes from the botanical variety Robusta with greater resistance and the botanical variety Conilon with less resistance to nematodes (Santos et al., 2018). Santos et al. (2017) also observed that genotypes from the Conilon and Robusta botanical varieties exhibited significant differences in estimates of the RF. The Robusta botanical variety exhibited higher resistance ($RF_{Robusta}$= 0.16) than the intervarietal hybrids ($RF_{Hybrids}$= 0.63) and the Conilon botanical variety ($RF_{Conilon}$= 1.24) (Santos et al., 2017).

C. canephora is a cross-fertilized species with high genetic variability and self-incompatibility mechanisms that naturally favor allogamy. The cultivation of vegetatively propagated clones allows the use of the superior traits of selected genotypes in the entire crop, which in practice results in the large-scale cultivation of a smaller number of clones with favorable attributes. The use of resistant cultivars is considered the most efficient, economically viable and ecologically correct means of control (Sera et al., 2006). In the field, damage caused by *Meloidogyne* spp. can vary according to the plant species, population density, and susceptibility of the host cultivar (Salgado; Resende; Nujes, 2014).

Table 4: Root dry weight (RDW); number of galls (NG) and reproduction factor (RF) of 25 *Coffea canephora* genotypes evaluated 150 days after inoculation with 5000 eggs of *Meloidogyne incognita* (Experiment 3).

Genotype	RDW (g)	NG	RF	Classification
GB4	15.19	130.83	0.10	Resistant
R152	13.19	47.16	0.20	Resistant
LB15	15.05	303.83	0.27	Resistant
LB10	10.89	405.00	0.47	Resistant
BRS3210[1]	25.36	18.50	0.49	Resistant
N16	18.25	97.16	0.61	Resistant
LB10	28.70	381.66	0.62	Resistant
P50	10.57	25.66	0.63	Resistant
BG180	9.92	3.00	0.83	Resistant
N13	21.57	87.66	0.86	Resistant
GB1	20.62	185.66	0.89	Resistant
AS10	11.14	227.66	1.02	Susceptible
GJ31-131	11.07	132.16	1.03	Susceptible
BRS2336[2]	12.02	303.66	1.85	Susceptible
LB80	11.30	113.00	2.19	Susceptible
N1	22.22	223.50	2.29	Susceptible
AS6	8.64	183.66	2.30	Susceptible
AS12	31.36	195.50	4.12	Susceptible
N2	17.56	387.00	4.34	Susceptible
L1	26.37	232.00	5.41	Susceptible
AS10	12.15	368.50	5.73	Susceptible
N12	26.35	144.33	7.02	Susceptible
AS5	12.66	386.16	7.07	Susceptible
AS3	19.80	171.66	7.46	Susceptible
AS7	16.65	312.40	8.56	Susceptible

[1]Resistance control. [2]Susceptibility control. Classification according to Sasser et al. (1984).

The susceptible and resistant genotypes had 1.57 to 74.28 galls (Table 3). According to (Santos et al., 2017), the evaluation of the number of galls should not be done alone because resistant plants can form galls in the presence of few nematodes, and susceptible plants may not produce galls. These authors also found that some of the clones considered resistant (RF<1) were susceptible when considering only the number of galls.

The resistant controls Apoatã 1, Apoatã 2, and Apoatã 3 were classified as resistant (RF<1) and had a reduced number of galls (Table 3). *C. canephora* genotypes of the botanical variety Robusta Apoatã have been used as an alternative means to control the root-knot nematode. Among these, the cultivar IAC 2258 is recommended for planting in areas infested with nematodes *M. exigua*, *M. incognita* (Kofoid & White) Chitwood, and *M. paranaensis* (Sera et al., 2006).

In nematode-infested areas, nongrafted susceptible genotypes produced up to 55% less than those genotypes grafted on IAC Apoatã 2258 (Barbosa et al., 2014). In a study carried out in an area naturally infested with *M. incognita* in Paraná, Dias et al. (2009) found that the cultivar Iapar 59 grafted on Apoatã 2258 obtained a grain yield 448% higher than the treatment with the nongrafted cultivar Iapar 59. This study demonstrates the efficiency of Apoatã rootstock in maintaining graft production, even in areas infested by the nematode.

Genotypes classified as resistant according to the reproduction factor had an average of 46.6 galls, while genotypes classified as susceptible had an average of 109.8 galls. According to Araujo Filho and Dallagnol (2018), the plant resistance response does not prevent the penetration of roots by juveniles (J2). Lima et al. (2015) showed that the defense response of *C. canephora* roots was later activated by the formation of giant cells (galls), inhibiting nematode feeding sites rather than obstructing root infection.

The resistant genotypes N7, LB68, LB88, C1, and LB07 achieved root development superior to that of genotypes BRS 2299 and BRS 3210, which were used as resistance standards (Table 5). According to Sera et al. (2006), there is a possibility of success in selecting genotypes that present the most voluminous root systems, as this is a characteristic of a good cultivar. However, tolerance to damage may be separate from resistance because it refers to the ability of a given host plant to compensate for or recover from adverse effects of an attack from a determined nematode and, nevertheless, produce well (Vanstone et al., 2008)

According to Santos et al. (2017), management strategies to reduce the population of nematodes are cultural, biological, chemical and genetic, with the latter being the most efficient and economically viable. Therefore, the selection of resistant clones is one of the most promising alternative means to minimize damage caused by nematodes in coffee crops, as it allows the maintenance of nematode populations below the economic injury level (Wangai et al., 2014). However, it is important to note that the resistance responses are related to the *Meloidogyne* species and/or races. Sera et al. (2006) found that 24 clones of *C. canephora* showed resistance to *M. incognita* race 1 but that when exposed to *M. incognita* race 2, only 12 clones were resistant.

Table 5: Root dry weight (RDW); number of galls (NG) and reproduction factor (RF) of 28 *Coffea canephora* genotypes evaluated 150 days after inoculation with 5000 eggs of *Meloidogyne incognita* (Experiment 4).

Genotype	PMSR (g)	NG	RF	Classification
LB7	20.15	57.33	0.06	Resistant
VP156	12.91	28	0.06	Resistant
N7	25.58	46.5	0.17	Resistant
LB60	14.17	48.55	0.11	Resistant
CA1	22.23	37.22	0.26	Resistant
LB15	12.38	12.83	0.31	Resistant
LB102	14.34	99.72	0.39	Resistant
LB33	10.42	20.61	0.40	Resistant
BRS3210[1]	12.78	33.44	0.46	Resistant
N32	17.73	65.27	0.51	Resistant
BRS2299[1]	14.37	54.11	0.61	Resistant
GJ8	14.77	69.91	0.69	Resistant
GJ30	11.37	39.94	0.72	Resistant
LB88	17.21	82.66	0.76	Resistant
LB68	16.44	48.5	0.85	Resistant
LB30	17.03	82.44	1.14	Susceptible
LB160	8.67	21.88	1.16	Susceptible
LB12	17.47	40.66	1.25	Susceptible
BRS2336[2]	7.28	78.93	1.26	Susceptible
LB22	14.81	76.33	1.54	Susceptible
N17	20.39	51.66	1.56	Susceptible
LB110	14.29	85.5	1.60	Susceptible
GJ2	15.2	45.5	1.64	Susceptible
GJ21	9.92	79.38	1.95	Susceptible
GJ20	8.91	34.5	2.03	Susceptible
BRS125	8.69	53.77	2.08	Susceptible
N11	26.81	69.16	2.65	Susceptible
LB20	14.12	47.38	2.86	Susceptible

[1]Resistance control. [2]Susceptibility control. Classification according to Sasser et al. (1984).

Although widely cultivated, the clones selected by the coffee growers are poorly understood in many ways, and the characterization of resistance to nematodes provides greater

security for this crop, allowing the coffee grower to consider the cultivation of resistant genotypes in areas with a history of this pest. Considering the ten most cultivated clones, the genotypes GJ8, GJ25, P50, SK80, AS2, P42 and LB10 were classified as resistant, and the genotypes GJ3, GJ5 and SK41 were classified as susceptible.

5 CONCLUSIONS

At 150 DAI, the following 36 genotypes of *C. canephora* showed susceptibility to the root-knot nematode: AR106, AS3, AS5, AS6, AS7, AS10, AS12, BAG21, BRS125, BRS130, BRS160, BRS189, BRS2336, BRS2357, BRS3193, GJ2, GJ3, GJ5, GJ20, GJ21, GJ31-131, L1, LB12, LB20, LB22, LB30, LB80, LB110, LB160, N1, N2, N11, N12, N17, SK41, and WP6. In contrast, the following 50 genotypes of *C. Canephora* expressed a resistance response to root-knot nematodes: AS2, BAG15, BAG19, BAG22, BAG23, BAG24, BAG26, BAG27, BAG28, BAG29, BAG30, BAG31, BAG32, BAG33, BAG34, BAG35, BAG38, BAG39, BAG40, BAG41, BAG72, BG180, BRS1216, BRS3210, BRS3220, BRS2299, CA1, GB1, GB4, GB7, GJ8, GJ25, GJ30, LB7, LB10, LB15, LB33, LB60, LB68, LB88, LB102, N7, N13, N16, N32, P42, P50, R152, SK80, and VP156. Such resistant genotypes can be used as alternative means to control *Meloidogyne incognita* without the use of commercial nematicides.

6 AUTHORS' CONTRIBUTION

DMS wrote the manuscript, DMS, MCE, VASR, CFF, FPU, JSFB, TCF, SCS, ASF performed the experiments, JRV supervised the experiments and co-work the manuscript, MCE and RBR review and approved the final version of the work, RBR conducted all statistical analyses.

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