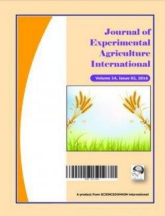

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Evaluation of Varieties of Caupi Bean to Meloidogyne Incognita Parasitism

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Authors' contributions

This work was carried out in collaboration among all authors. Authors GATJ and FAA designed the study, wrote the protocol and wrote the first draft of the manuscript. Authors EGS and FTL managed analyzes of the study. Authors MLTL and WLF conducted the tests. The authors AFB and FAN performed the statistical analysis. Authors FFP and RMC assisted in conducting the trials. Author AROG managed the bibliographic research. Author LMSX managed the fertilization part. All authors read and approved the final manuscript.

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ABSTRACT

The culture of Cowpea (*Vigna unguiculata* L.) of wide adaptation of the various edaphoclimatic conditions of Brazil is of fundamental importance for the socioeconomic development of the north and northeast regions, however, the productivity can be limited by pathogenic agents, such as phytonematodes, belonging to the genus Meloidogyne. Due to this condition, the objective was to

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evaluate the behavior of different varieties of cowpea against the parasitism of M. incognita. The reaction test was performed with inoculation of 5.000 eggs/juveniles in the region of the root. The experiment was carried out in a greenhouse, with a completely randomized design, with 14 varieties (Bastiãozinho; Mosqueado; Maravilha; Balinha; Garanhão; Sempre verde; Canapuzinho; Canapu branco; Paulistinha; Pujante; Canapu da Vagem Roxa; Rajado PE; Costela de Vaca e Setentão) with five replications. 60 Sixty days after inoculation, some agronomic characteristics and parasitism were evaluated. All varieties were susceptible to M. incognita, with RR > 1. However, the Paulistinha variety proved to be moderately resistant.

Keywords: Vigna unguiculata (L); root-knot nematode; resistance; pathogen.

1. INTRODUCTION

Cowpea (*Vigna unguiculata* L.) Walp) also known as Macassar bean or string bean, is a legume widely disseminated throughout the world, exerting presenting considerable importance to the populations of developing countries, being widely cultivated in the tropics of Africa and Brazil [1]. When compared to common bean (*Phaseolus vulgaris* L.), presents larger quantity of proteins (23% - 25%) and better digestibility, which makes it a basic constituent in food for people with low incomes in the north and northeast regions, as well as playing an important role of subsistence, generating jobs and income in these regions of the country [2,3].

The world production of the crop covers an area of 12.6 million hectares, which produce approximately 5.6 million tons. In Brazil, 1.388.2 million hectares are cultivated, obtaining 725.3 thousand tons [4,5]. However, the productivity results vary considerably in the country, due to low use of technology by the small producer, employment of traditional cultivars of low productive potential, lack of knowledge about agricultural inputs and the high incidence of climatic and biotic factors, as, for instance, the parasitic nematodes [2].

In recent decades, it is increasing the concern with the parasitic nematodes, which have as their main characteristic, in their great majority, parasitize the root system, causing annual losses in billions of dollars in the world agriculture [6]. In the cowpea crops, the damages are caused by three species of nematodes considered key in Brazil, *Pratylenchus brachyurus, Meloidogyne incognita* and *M. javanica* that together, may cause losses in the order from 10% to 50% [7].

Regarding the issue exposed, different measures of management are employed (crop rotation, biological control, resistant cultivars, etc.) in the areas of commercial production, to reduce the damages on the crops. Among the main methods of management, the chemical products are highlighted due to their fast results [8]. However, the high costs of their implementation, in addition to the negative effects on the environment and to consumers, have aroused the interest of new studies in substitution to agrochemicals. Therefore, in the case of a culture of subsistence, the use of pesticides to the neutralization of parasitic nematodes can be considered economically infeasible, which reinforces the need to identify new alternatives, such as genetic materials from the region, with potential for resistance to the parasite.

Unfortunately, in Brazil, meanwhile, no sources of resistance have been reported with high efficiency within the genus *Phaseolus*, the main species of nematodes of galls. However, there are promising results with cultivars presenting moderate resistance, even so, without satisfactory capacity reduction of reproduction of such plant-parasitic nematodes [9,10,11].

The objective of this work was to evaluate the reaction of different varieties of cowpea to parasitism by *M. incognita*, seeking to provide information on possible varieties that may be used in breeding programs to obtain cultivars with some degree of resistance and/or tolerance against nematode.

2. MATERIALS AND METHODS

2.1 Localization and Characterization of the Experiment Area

The experiment was carried out in a greenhouse and in the laboratory of Phytopathology, located at the Center of Agroalimentary Sciences and Technology of the Federal University of Campina Grande (UFCG), Campus of Pombal-PB, during the months of march to august of 2017.

The local climate is of the Tropical Semi-arid type with summer rains, in which the rainy season starts in November with end in April. The average annual rainfall is 749 mm and the geographic location is defined by the coordinates: 632.393 West longitude and 9.251.510 South latitude.

2.2 Experimental Procedures

The assay was conducted in a completely randomized design with 14 varieties of cowpea (Bastiãozinho; Mosqueado; Maravilha; Balinha; Garanhão; Sempre verde; Canapuzinho; Canapu branco; Paulistinha; Pujante; Canapu da Vagem Roxa; Rajado PE; Costela de Vaca and Setentão), called "creole", inoculated with *Meloidogyne incognita*, with five replications and two controls: tomato (*Solanum lycopersicum* L.) cv. Santa Clara, as a pattern of susceptibility for the confirmation of the feasibility of the inoculum and the second with carioquinha beans (*Phaseolus vulgaris* L.), negative control without the inoculum.

The inoculum (*M. incognita*), employed in the test, was given by Universidad Federal Rural de Pernambuco - UFRPE, where it was reared in the greenhouse for multiplication in tomato seedlings Cv. Santa Clara. *Meloidogyne incognita* was previously identified, with the aid of an optical microscope, in morpho-anatomical study by means of the examination of perineal pattern configuration [12] and in the phenotype, through isozyme Esterase, obtained by the technique of [13]. For the execution of the assay, a mixture was used of soil-sand-manure in the ratio 3:2:1, respectively, previously sterilized (120°C and pressure of 1.05 $Kgcm^2$ for 2 hours).

Then, the substrate was distributed in plastic pots with capacity of 4 dm^3, where 4 seedlings of tomato cv Santa Clara were transplanted, per pot, previously raised on tray with 128 cells and commercial substrate. After the tenth day of transplanting, the extraction of the specimen was performed according to the methodology of [14]. Soon after, the suspension was adjusted to 5000 eggs and juveniles/mL with *M. incognita*, determined by compound optical microscope, with the help of the chamber of Peters.

The nematode - inoculated tomato plants were continued for 60 days in all the plots, aiming to simulate an area naturally infested with the species *M. incognita*. However, every fifteen days, a plant from each treatment was eliminated, removing only the aerial part, keeping the infected roots in the soil. When one tomato plant left at 45 days, sowing was performed with 5 seeds of different varieties of cowpea per pot, corresponding to the treatments. After the tenth day emerged, the thinning of the plants was performed (bean and tomato), leaving only one plant (cowpea) per pot, considering the experimental unit.

2.3 Evaluation of Parasitism on Plants

After sixty days of cowpea plants in association with the species *M. incognita*, some variables were estimated of the parasitism such as: number of galls in roots quantified with the aid of a microscope stereoscope. The quantification followed the scale from 0 to 5 to characterize the various levels of root infection proposed by Taylor and Sasser [15], modified as follows: 1 = 1-2 galls and eggs mass (Resistant); 2 = 3-10 galls and eggs mass (Resistant); 3 = 11-30 galls and eggs mass (Susceptible); 4 = 31-100 galls and eggs mass (Susceptible) and 5 = >100 galls and/or eggs mass per root system (Susceptible).

For the number of juveniles and eggs on the ground, extracted from a sample with 100 cm^3 of soil for each treatment, the technique of flotation and centrifugation in sucrose solution was used [16]. While the estimate of the number of juveniles and eggs in the root system, employed the methodology proposed by Coolen and D'Herde [14]. Since the number of nematodes per gram of root was obtained dividing the final population (Pf) of nematodes present in the roots, by the fresh weight of roots in each plot. It was also calculated, the reproduction factor (RF) by the ratio: Pi/Pf, for determination of the reaction of varieties, where it is considered immune those varieties with RF equal to 0; resistant with FR lower than 1.0 and susceptible with RF equal to or greater than 1.0, according to Oostenbrink [17].

Regarding the variable reduction of reproduction factor (RFR), the methodology applied was the one proposed by Moura and Regis [18], in which plants that provide reduction of the nematode reproduction factor of 100% are classified as highly resistant or immune (Ar or I), 96 to 99% resistant (R), 76 to 95% moderately resistant (MR), 51 to 75% little resistant (PR), from 26 to 50% as susceptible (S) and 25% are classified as highly susceptible (AS). For the calculation of RFR, it was taken the greatest

value of RF as a pattern of susceptibility, considered as 0% reduction.

The reproduction rate (IR) was determined using the reproduction of nematodes in tomato plant cv. Santa Clara, standard control (100%) in comparison with the varieties of cowpea, according to methodology laid out by Taylor [19]. Therefore, the final population (Pf) found in varieties of beans was divided by the population found in tomato plant, thus defining the reproduction rates. The classification as to the levels of resistance of varieties of cowpea was obtained by reproduction criteria established by Taylor [19], in which: S - varieties with susceptible plant, normal reproduction, IR above 51%; LR - varieties with slightly resistant plants, IR from 26 to 50%; MoR - varieties with moderately resistant plants, with IR from 11 to 25%; MR - varieties with very resistant plant, IR from 1 to 10%; AIR/I - varieties with highly resistant/immune plant, IR below 1%.

2.4 Agronomic Characteristics of Plants

For the plant development, the following variables were evaluated: fresh biomass of aerial part (through the cut in the shape of bevel in the height of the colon) and root system (after washing the plants in tap water), obtained with the aid of a semi-analytical balance in grams. The root length, obtained by measuring the distance from the colon of the plant until the apex of the root, with the use of a ruler graduated in centimeters. Soon after the volume of root was evaluated, through the immersion of the radicular system in graduated beaker of 1000 mL, considering a fixed volume of 800 mL and performing the difference, thus obtaining the final volume in milliliters.

The data relating to the reproduction of the nematodes were subjected to analysis of variance and the averages grouped by Scoot-Knott test at 5% probability. The data concerning the plants development were subjected to analysis of normality using the Shapiro-Wilk test and, in the case of positive normality ($p > 0.05$), comparison of averages using the Student's t-test and, when normality was negative ($p < 0.05$), the comparison of the medians was performed, by the Mann-Whitney test.

3. RESULTS AND DISCUSSION

For the reaction of the varieties of cowpea in the presence of *M. incognita*, it is observed that all were substantially attacked, with number of galls ranging from 40 to 161.5. However, these values were statistically lower than those observed in tomato plant, which was used as susceptible to the presence of this nematode (608.50) (Table 1). Thus, it is important to point out that some varieties showed different reactions, as for example "Bastiãozinho", which caused a reduction in the number of galls corresponding to 93.43%, in relation to the control. This variety, in turn, did not differ statistically from "Mosqueado"; "Canapu Branco"; "Paulistinha"; "Costela de Vaca" and "Setentão". According to the scale proposed by Taylor and Sasser [15], all the studied varieties behaved susceptible to *M. incognita*, where 71.43% presented average scores of 5.0 and only 28.57% of these had scores with averages of 4.0 to 4.5, which even so, allowed the multiplication of the species in the area. The susceptibility of 54 cowpea genotypes to parasitic action of *M. incognita* and *M. javanica* was observed by Goulart et al.[20], considering the same reaction, concerning the formation of galls at the roots.

For the number of juveniles in the soil, no significant difference was observed among the varieties and the control (Table 1). Whereas, with respect to the number of eggs in the soil, all varieties, except for "Bastiãozinho", differed statistically from the control, with mean values ranging from 9.38 to 78.38. These figures represent a reduction in the order from 35.02% to 55.33%, even so, there is a high reproductive capacity. It was also found that "Pujante", "Canapu da Vargem Roxa", "Rajado PE" and "Setentão" were reduced by more than 71% of the number of eggs in the soil, in comparison to the control, not differing among themselves.

The genus *Meloidogyne* stands by the productive capacity of eggs in comparison to the great majority of the species of nematodes, which allows, after successive cycles with plants, the parasite to reach large effective populations, which causes damage in a short period of time [21]. Such information is of the utmost importance considering the succession of crops explored by small producers, mainly with the tomato plant, which can provide a significant increase of the phytoparasitic nematodes in the soil, resulting in premature decline of plants and consequently productivity [10].

The high number of juveniles and eggs in the root, points out that all the varieties are hosts and allow the completion of the life cycle of the

nematode (Table 1). For the number of juveniles in the root, apart from "Bastiãozinho", "Mosqueado" and "Pujante", a significantreduction was observed for the other varieties, with an emphasis on "Paulistinha" and "Setentão", statistically equal, with a decrease of more than 82.17% of juveniles per root system. As for the eggs in the root, the varieties "Pujante" and "Costela de Vaca", exhibited the highest values, statistically equal to the control. However, there was a reduction of 86.97%, for the other varieties in relation to the control. In view of the above, the use of these varieties in unaffected areas and/or with low infection would provide a rapid increase in population density of M. incognita, preventing the production after successive cycles of cultivation.

According to the number of nematodes per gram of roots (individuals / g root), Table 1, the variety "Costela de Vaca", was the most representative due to having exhibited the highest average (3459.81), which corresponds to 19.55% higher, when compared to the control and the other varieties. However, the varieties "Paulistinha" and "Setentão", showed the lowest averages (705.33 and 626.99), respectively, not differing among themselves, with reduction of parasitism in the order of 78.26% of nematodes per gram of root.

For most of the studies, the reproduction factor (RF = Pf/Pi), is considered the main criterion for the selection of resistant materials. In this study, all the tested varieties were highly susceptible to *M. incognita*, having been shown RF ranging from 2.43 to 14.08 (Table 2), which exceeds above the recommendation (FR < 1) [17].

In accordance with the same variable, greater attention should be given to the varieties "Pujante" and "Costela de Vaca" due to presenting the highest averages concerning the reproduction factor (RF = 14.08; 10.10), which did not differ statistically from the susceptible control "*Tomateiro*" (FR = 13.80). Research already conducted by Wanderley et al. [22] testing some cowpea cultivars as affected by *M. javanica*, found that two materials employed ("Costela de Vaca" and "Sempre Verde") were susceptible, certified by FR >1. However, it is known that some of bean cultivars have somewhat capacity for resistance to gall nematodes, as the cultivar EPACE 10 for *M. incognita* [9], six strains of snap-bean resistance for the species *M. javanica* and *M. paranaensis* [11] and for the materials (TE97 309G-6, TE97 323G-4 and Capela) and (TE 97 299 G-24), respectively, for *M. incognita* and *M. javanica* [20].

The analysis of the variables reductions of the reproduction factor (RFR) and reproduction rate (IR), corroborates with that exhibited by the reproduction factor (RF), where none of the varieties showed resistance or immunity, before the parasitic nematode action, of *M. incognita* (Table 2). According to the grouping proposed by [18], for (RFR), 7.14%, classified as highly susceptible (Pujante); 42.85%, Susceptible (Mosqueado, Maravilha, Balinha, Garanhão, Canapu Branco and Costela); 42.85%, slightly resistant (Bastiãozinho, Sempre Verde, Canapuzinho, Canapu da Vargem Roxa, Rajado and Setentão); and 7.14%, moderately resistant (Paulistinha). Similarity was obtained to the one reported upon analyzing the results found by [23], having been verified reactions in seven genotypes of *Phaseolus vulgaris*, parasitized by *M. incognita* breed 3, considering the RFR .

For the reproduction rate (IR), the classification according to the criteria proposed by Taylor [19] was: 57.14%, Susceptible (Bastiãozinho, Mosqueado, Maravilha, Balinha, Garanhão, Canapu Branco, Pujante and Costela de Vaca); 35.71%, Slightly Resistant (Sempre Verde, Canapuzinho, Canapu da Vagem Roxa, Rajado PE and Setentão) and 7.14%, moderately resistant (Paulistinha). The results are partially consistent with those found by Ferreira [21], study which evaluated the resistance of three cultivars of common bean and seven of snap-bean, encountering resistance only for two cultivars of common bean (Aporé and Talismã) in relation to *M. javanica*, not being found none for the snap-bean. For *M. incognita* Breed 1 and Breed 3, only resistance of cultivar (Macarrão Atiabaia) was verified, while the others were considered moderately resistant and susceptible.

For the agronomic variables shown in Table 3, there was variation among the reactions of the varieties parasitized in comparison to the control, showing a negative interference of the parasite on the proper development of the plants [11]. Concerning the fresh biomass of aerial part, the best results were found with the varieties “Bastiãozinho”, “Maravilha”, “Balinha”, “Garanhão”, “Canapu Branco”, “Pujante”, “Canapu da Vagem Roxa” and Setentão”, due to not presenting statistical difference in relation to the control. According to Almeida et al. [24], the minimum interference in the aerial part of the

plant ensures the proper physiological development, reflected in higher quantity of reproductive buds, allowing the plant to achieve all its productive potential.

However, for the varieties -"Mosqueado", "Sempre Verde", "Canapuzinho", "Paulistinha", "Rajado PE" e "Costela de Vaca" - a significant difference was observed, indicating that the attack resulted in a reduction in the weight of the aerial part due to, possibly, interference in the physiological development of the plant, which will result in a smaller number of reproductive buds and, consequently, a smaller number of pods and grains,leading these plants to a lower productivity [10].

In relation to the fresh biomass of the root system (Table 3), 42.85% of the varieties - "Bastiãozinho", "Maravilha", "Canapuzinho", "Canapu Branco", "Canapu da Vagem Roxa" and "Rajado PE" did not differ statistically from the control, demonstrating that despite the proven parasitic action, the plants have expressed the ability of satisfactory development. However, the other varieties presented results significantly higher than the control. Some authors describe that the pathogenic action by the deviation of nutritional substances and the toxic effect of substances secreted by esophageal glands of nematodes, has as a direct reflection on the roots, the formation of giant cells (hyperplasia and hypertrophy), with quantitative reduction of rootlets [25], which affects the vegetative and reproductive development of plants, according to the continuous nutritional deficit [25].

For the variable of root volume, the highest averages were verified in the varieties "Pujante", "Maravilha", "Balinha" and "Setentão", in contrast to the control, thus demonstrating high susceptibility to the parasite. Concerning the root length, 28.57% of the varieties were more influenced ("Sempre Verde, "Pujante", "Canapu da Vagem Rocha" and "Costela de Vaca"), as a function of the contrast caused to the control, exposing to a harmful action of erosion and compression of the conducting vessels, in particular the xylem, which, in most cases, causes a disruption of the vascular cylinder [26]. The genus *Meloidogyne* causes this reduction in root growth as result of lower biomass accumulation [24]. However, these damages may vary depending on the vigor of the plants reaction to environmental conditions prevailing in the plantation [27].

Table 1. Reaction of cowpea varieties to *Meloidogyne incognita*, as to the Number of Galls (NG); Number of Juveniles (NJS) and Eggs (NOS) in the soil; Number of Juveniles (NJR) and eggs (NOR) in root and nematodes per gram of root (NEM/g ROOT)

Varieties/Cowpea	NG**y	NOTE ns y	NJS**y	NOS **y	NJR**y	NOR**y	NEM/g ROOT *z
Tomato	608.50 a	5.00	75.25	73.88 a	7,785.000 a	33,716.25 a	2,893.90 ab
Bastiãzinho	40.00 d	4.25	63.50	78.38 a	5,678.75 a	7,016.25 b	1,995.00 ab
Mosqueado	43.50 d	4.00	53.75	48.00 b	5,238.75 a	11,098.75 b	1,814.72 ab
Maravilha	76.25 c	5.00	66.75	55.50 b	4,333.75 b	13,427.50 b	1,316.34 ab
Balinha	93.25 c	5.00	74.38	33.00 c	4,110.75 b	13,426.25 b	1,457.70 ab
Garanhão	91.50 c	5.00	52.13	49.50 b	4,163.75 b	10,721.25 b	1,371.69 ab
S. Verde	101.00 c	5.00	57.00	42.75 b	3,130.00 b	10,257.50 b	974.81 ab
Canapozinho	73.25 c	5.00	51.38	29.25 c	3,373.75 b	9,235.00 b	1,727.96 ab
C. Branco	49.25 d	5.00	89.25	34.13 c	3,687.50 b	10,168.75 b	2,646.56 ab
Paulistinha	41.25 d	4.50	42.25	25.50 c	1,850.00 c	4,392.50 b	705.33 b
Pujante	161.50 b	5.00	77.63	21.00 d	6,902.50 a	30,768.75 a	2,090.04 ab
C. V. Roxa	79.00 c	5.00	61.50	13.50 d	2996.50 b	9,246.50 b	1,561.70 ab
Rajado PE	75.00 c	5.00	55.88	13.88 d	3,668.75 b	8,936.25 b	1,874.71 ab
Costela V.	45.25 d	4.00	55.00	37.50 c	4,218.25 b	23,156.50 a	3,459.81 a
Setentão	57.00 d	5.00	27.75	9.38 d	1,388.00 c	8,087.50 b	626.99 b
CV (%)	19.25	13.13	24.94	23.01	20.86	23.43	28.48

*The letters are the representations of the data transformed into "(x + k) ^ 1/2", being for the variables k = 1. Z averages followed by the same letter in the column, do not differ from each other, by the Scoot-Tukey test at a level of 5% significance. The letters are the representations of the data transformed into "(x + k) ^ 1/2", being for the variables k = 1. * and * * Significant at 5% and 1%, respectively, by the F test, at a level of 5% significance NS data regarding the variables that did not present significant difference by the statistical test. Note-Data regarding the scale proposed by [15], which classifies the reaction of the varieties according to the number of galls and/or egg masses presented*

Table 2. Reaction of cowpea varieties to *Meloidogyne incognita*, for the characteristics of parasitism: Reproduction Factor (RR), reduction of the Reproduction Factor (RFR) and Reproduction Index (IR)

Varieties/ Cowpea	FR**[y]	Reaction	RFR**[y]	Reaction	IR**[y]	Reaction
Tmateiro	13.80 a	S	0.00 b	AS	100 a	S
Bastiãzinho	7.20 b	S	72.30 a	PR	0.69 b	S
Mosqueado	6.94 b	S	42.78 a	S	0.57 b	S
Maravilha	6.70 b	S	44.22 a	S	0.56 b	S
Balinha	6.70 b	S	46.10 a	S	0.54 b	S
Garanhão	6.65 b	S	45.29 a	S	0.55 b	S
S. Verde	5.61 b	S	55.05 a	PR	0.45 b	LR
Canapozinho	4.86 b	S	62.04 a	PR	0.38 b	LR
C. Branco	5.97 b	S	48.19 a	S	0.52 b	S
Paulistinha	2.43 b	S	81.51 a	MR	0.19 b	MoR
Pujante	14.08 a	S	16.74 b	AS	1.04 b	S
C. V. Roxa	5.63 b	S	53.17 a	PR	0.49 b	LR
Rajado PE	5.20 b	S	57.45 a	PR	0.43 b	LR
Costela V.	10.10 a	S	31.36 a	S	0.81 b	S
Setentão	4.84 b	S	57.97 a	PR	0.45 b	LR
CV (%)	15.07	-	35.16	-	4.62	-

*[x] data referring to averages of 4 repetitions, without transformation. [Y] averages followed by the same letter in the column, do not differ from each other, by the Scoot-Knott test of 5% significance. The letters are the representations of the data transformed into "(x + k) ^ 1/2", being for the variables k = 1. * and * * Significant at 5% and 1%, respectively, by the F test. Reduction of the reproduction factor (RFR), scale proposed by [18], Where: AS (highly susceptible), S (susceptible), PR (low resistant), MR (very resistant), R (resistant) and AR/I (Highly resistant or immune). Reproduction index (IR), scale proposed by [19], Where: S (susceptible), LR (lightly resistant), MoR (moderately resistant), MR (very resistant) and AR/I (highly resistant or immune)*

Table 3. Reaction of different varieties of cowpea tested, in relation to fresh Phytomous of Aerial Part (FFPA), Fresh Phytomy of the Root System (FFSR), root length (CR) and Root Volume (VR), the *Meloidogyne incognita* in comparison with the Values of the control *Phaseolus vulgaris* (T)

Varieties/Cowpea	FFPA		FFSR		CR		VR	
	Average	Test[k]	Averag	Test*	Averag	Test*	Averag	Test*
Bastiãzinho	36.58	0.921	5.19	0.685	31.50	0.053	5	0.874
Mosqueado	28.11	0.013	8.97	0.028	32.00	0.144	9	0.026
Maravilha	36.13	0.698	15.91	0.057	34.50	0.183	15	0.028
Balinha	37.41	0.838	14.54	0.028	31.50	0.242	14	0.027
Garanhão	30.00	0.204	12.28	0.028	32.50	0.233	12	0.028
S. Verde	46.80	0.007	13.83	0.028	28.75	0.029	14	0.024
Canapozinh	26.49	0.012	6.57	0.485	31.50	0.054	6	0.429
C. Branco	25.41	0.060	6.19	1.00	28.50	0.144	6	0.181
Paulistinha	23.52	0.035	8.69	0.028	34.00	0.459	8	0.024
Pujante	36.09	0.815	18.65	0.028	29.50	0.028	18	0.028
C. V. Roxa	24.68	0.052	7.50	0.146	32.50	0.029	6.5	0.088
Rajado PE	19.49	0.014	7.55	1.00	30.50	0.054	7	0.642
Costela V.	21.62	2.31e-05	8.13	0.028	27.60	0.029	8	0.024
Setentão	40.05	0.151	15.50	0.028	33.50	0.371	14	0.027
P. vulgaris (T)	35.73	-	5.99	-	35.5	-	5	-
Norm.[y]	0.079		0.001		0.006		0.0004	

*The values are represented in the form of mean or median (Med.) According to the test requirement. Y normality test: Norm. – Positive (p > 0.05) or negative (P < 0.05) by the Shapiro-Wilk test. Test – In this column are the critical odds observed (P-value), according to the T test (for averages) and the Mann-Whitney test (for medians) comparing each treatment with the control (t). K Test T-(significant p < 0.05) or (not significant p > 0.05), for normal cases. * Applied the Nonparametric Mann-Whitney test (median comparison) for non-normal cases, being (significant p < 0.05) or (not significant p > 0.05)*

4. CONCLUSIONS

All Cowpea varieties tested presented a reproduction factor (RF) > 1.0, which demonstrates the potential for susceptibility to *Meloidogyne incognita*. The variety "Paulistinha" has been shown to be moderately resistant, observed in the reduction of the reproduction factor (RFR), suggesting that it is recommended in future tests. Already for the varieties: "Always green", "Canapuzinho", "Canapu of the Purple pod", "Gust PE" and

"Setso", showed up as slightly resistant, according to the reproduction Index (IR).

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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