Screening Resistance of Several Accessions Eggplant (*Solanum melongena* L.) Against Root-Knot Nematodes (*Meloidogyne incognita*)

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ABSTRACT

One of the causes of the decrease in eggplant production is the attacked of root-knot nematodes (*Meloidogyne incognita*). The one of steps to developing eggplant plants resistant to nematode attack is by screening various eggplant accessions which aims to assess the level of resistance between eggplant vegetable germplasm against nematodes. This research was conducted by testing the effect of root exudates from eggplant accessions on the inhibition of nematode egg hatching and testing the response of 30 eggplant accessions against *Meloidogyne incognita* attack. Evaluation of plant resistances based on the number of eggs hatch, egg inhibition, gall index and nematode reproductive factors. The results showed that the highest egg hatching were found in SL-TE 28 OP by 23.33%, while the lowest was in accession of SL-TE 230 OP by 8.33%. The highest hatching inhibition value was found in the accession of SL-TE 830 OP by 80%, while the lowest inhibition value was found in the accession of SL-TE 23 by 48.33%. This shows that root exudates in accession plants have certain factors that trigger inhibition egg hatching. The highest number of galls/roots in SL-TE 231 accession was 51.67 while the lowest number of galls/roots was in SL-TE 85 OP accession of 16.33. The highest reproductive factor value was indicated by the accession of SL-TE 231 OP of 1.60% and the lowest value was indicated by the accession of SL-TE 81 OP of 0.5%. The results of the calculation of reproductive factors, plant resistance from 30 accessions tested obtained 1 accession of resistant plants, 17 accessions of plants that were quite resistant, and 12 accessions of plants that were quite susceptible.

Keywords: Screening, Resistance, *Meloidogyne incognita*, *Solanum melongena*

1. INTRODUCTION

Eggplant (*Solanum melongena* L.) is one of the indigenous vegetables that is part of Indonesia's biodiversity. At present, there is very little attention to national indigenous vegetables, and even tends to be abandoned. Actually, the existence of these indigenous vegetables is less well known and some are threatened with extinction. Indonesia is one of the largest eggplant producing countries after China, India, Egypt, Turkey, Iran and Japan [4]. Indonesia has a diversity of eggplant germplasm, the database involves more than 200 accessions collected by the Center for Research and Development of Genetic Resources Biotechnology (BB-Biogen) and 78 eggplant cultivars have been registered in the Plant Variety Protection information

system of the Indonesian Ministry of Agriculture [3]. Eggplant varieties can be obtained from domestication, mutation, natural crossing, human selection and hybridization have brought a wide genetic diversity in order to increase eggplant varieties for sustainable production and adaptation to the challenges of climate change and attacks by plant-disturbing organisms.

Eggplant cultivation is growing rapidly in Southeast Asian countries, including Indonesia. However, the productivity of eggplant in Indonesia is still not able to meet the existing demand, this cannot be separated from the role of eggplant as a horticultural commodity that can be used as a daily vegetable. Based on data from the Central Statistics Agency and the Directorate General of Horticulture, the national production of eggplant-

type vegetables in 2019 was 575.392 tons, an increase of 4.33% compared to 2018 with a land area of 43.95ha. National eggplants production tends to increase every year, but eggplant production in Indonesia is still low and only accounts for 1% of world needs [2].

Plant parasitic nematodes are one of the important pests because they cause heavy losses to plants, 500-800 larvae of *Meloidogyne* spp. per kilogram of soil can reduce the production of Solanaceae plants by up to 40% [11]. According to Winarto, (2008) [11], the loss on eggplant plants attacked by root-knot nematodes (*Meloidogyne* sp.) reaches 23%, in tropical and subtropical countries the attack of root-knot nematodes reaches 22-27% [8]. However, in Indonesia, crop damage due to parasitic nematodes is not recognized by both the farmers and the officers working in the agricultural sector. One of the causes is the symptoms of nematode attack which are difficult to observe visually because of the very small size of the nematodes. In addition, the symptoms of nematode attack are very slow and non-specific, similar or mixed with symptoms of lack of nutrients and water, damage to roots and stem vessels [14]. Plant parasitic nematodes have an important meaning for crops, namely as pests, vectors that cause disease, and opening the way for other pathogens to enter. In addition, the presence of nematodes can also cause environmental conditions to be suitable for the growth and development of other pathogens [13].

The root-knot nematode *Meloidogyne incognita* is considered as one of the main pests of the genus Meloidogyne in causing production losses of horticultural crops [12]. Eggplant plants that are attacked by *M.incognita* will become stunted, chlorosis, and can reduce the transfer of nutrients in plants. *M.incognita* has a wide distribution and many host plants. The low level of eggplant production itself can be caused by accumulation of nematode inoculum and repeated planting of the same cultivar on the same land every year [10]. The population of *M.incognita* in infested land can be controlled using several approaches such as nematicides, use of antagonistic plants, use of resistant plants and use of biocontrols. Among these approaches, the use of resistant plants is referred to as an environmentally friendly and economically feasible method of suppressing *M.incognita* attacks [9].

Host plant resistance is one of several ways to be used in integrated control for the management of root-knot nematodes. As a result, nematologists are constantly on the lookout for nematode-resistant vegetable germplasm, evaluating the economic thresholds and tolerance limits of locally cultivated cultivars as well as newly imported cultivars and hybrids [10]. Generally, yield losses due to nematode attack, can be suppressed through crop rotation.

Susceptible plants should only be planted once every 2-8 years. Therefore, to suppress the proliferation of certain nematodes, resistant cultivars must always be available as alternatives that do not cause negative impacts on the environment [15]. One of the steps of the method that can be done in developing eggplant plants resistant to nematode attack is by screening various eggplant accessions which aims to assess the level of resistance between eggplant vegetable germplasm against nematodes.

2. MATERIALS AND METHODS

2.1. Preparation inoculum of Root Knot Nematodes

The inoculum was derived from the egg collection of the root-knot nematode *Meloidogyne incognita*, Laboratory of Nematology, Department of Plant Pests and Diseases, UGM which was propagated on tomato plants grown in sterile soil media. Propagation of the nematode *M.incognita* by inoculating egg mass on tomato plants and maintained in a greenhouse. *M.incognita* eggs for the test material were prepared from the results of the propagation of these nematodes, by isolating rootknot nematodes from the root system of the host plant which showed the presence of galls. Isolation was carried out using the Hussy & Barker method with a filtering technique combined with the use of NaClO (Hussey, 1973). The sieve result is a collection of eggs in the form of *M.incogita* suspension. The eggs were then separated into two petri dishes. The first petri contains root-knot nematode eggs. One petri is stored for 4 - 10 days until the eggs hatch into stage 2 (L2) larvae. Nematode eggs and larvae of stage 2 were used as inoculum in this study.

2.2. Test plants

A pot culture experiment was conducted to screening resistance of 30 accessions eggplants from the seed bank of the Agrotechnology Innovation Center of Gadjah Mada University (PIAT-UGM) to *M.incognita*. Seedlings were maintained for each accessions in a greenhouse and 3 seeds of each accessions were used for the inhibition rate of nematode egg hatch.

2.3. Inhibition rate of M.incognita egg hatch

The test of the plant's ability to inhibit the hatching of root-knot nematode eggs was started by preparing several vials as a place to place each eggplant accession to be tested with 3 replications for each seed accession. Plant seeds were put in glass vials according to the treatment as much as 1 seed/vial. Furthermore, sterile water is added to help the seed germination process. The seeds are allowed to start to germinate. After the seeds germinated, as many as 20 eggs of the nematode *Meloidogyne incognita* were put into the vial.

Observations were made 9 days after inoculation and observed using a microscope. Observations included the ability of plant accessions in inhibiting egg hatching. Analysis of egg hatching inhibition was measured based on the percentage of the number of eggs that could not hatch, calculated by the following formula:

$$\frac{(\text{number of unhatched eggs})}{(\text{number of eggs})} \times 100\% \quad [17]$$

2.4. Screening test

Plant seeds were planted in prepared pots for three replications in each accession number and control plant. Inoculation was carried out on plants aged 30 days after plant roots adapted to the new environment when transplanting [6]. Inoculation was done by pouring nematode suspension at three points around the pre-injured root area. The number of rootknot nematodes inoculated into each treatment was 1000 nematodes larvae stage two (L2)/pot. 30 days after nematode inoculation, all plants were uprooted and the root system of each plant was washed to remove soil particles by tap water to observations.

To categorize the tested accessions eggplant as susceptible or resistance to *M.incognita* we used two scales; the first was root gall index ranges which determinted according to Hussain (1986) [1] as follow : Index gall 0 = highly resistant (HR), 1 = 110 galls = resistant (R), 2 = 11-20 galls = Moderate resistant (MR), 3 = 21-30 galls = Moderate susceptible (MS), 4 = 31-100 galls = susceptible (S), 5 = >100 galls = highly susceptible (HS). The second scale was depending on the rate of build-up (Pf/Pi) according to Taylor & Sasser (1978) [12] : $\geq$ 3 = highly susceptible (HS), 2-3 = susceptible (S), 1-2 = moderate susceptible (MS), 0.5-1.0 = moderate resistant (MR), 0.3-0.5 = resistant (R), dan $\leq$0.3 = highly resistant (HR).

2.5. Nematode assay

2.5.1. Nematode population

Observations were made on (1) the population of root-knot nematodes in 100 grams of soil, (2) the mass population of root-knot nematode eggs in root tissue. Observation parameters included the population of *Meloidogyne incognita* larvae L2, L3, L4 and females. Nematode population analysis was carried out by extraction-isolation of *M.incognita* larvae of the second stage (L-2), referring to Southey (1986), by taking 100gr of soil for each accession and then extracting it using a modified White-head tray method for soil samples. Observations were made with three replications. Each replication was taken as much as 5 ml of suspension and placed on a counting dish to be ready to be observed and then counted by hand-counter.

Observation of the mass population of root-knot nematode eggs in the root tissue was carried out using the painting technique (Byrd, 1983). The roots were weighed as much as 0.5gr and then cleaned by soaking in a NaClO solution for 4 minutes, then rinsed with running water until there was no NaClO odor. After that, the roots were put in a paint solution (fuchin acid and acetic acid) for 1 minute, then soaked in glycerin added with HCl. Observation of egg mass was carried out 3 days later.

2.5.2. Number of Galls and Root Length

Evaluation of germplasm resistance were done at 30 days after inoculation by uprooted the plant and separating the planting medium and roots. The roots were cleaned using running water, then the root length of each plant was measured and the number of galls formed on the roots was calculated and then determined by the gall index according to Hussain (1986) [1]. These observation parameters are used to support qualitative data.

2.6. Statistical analysis

The experimental data were analyzed statistically used ANOVA for parameters whose residuals met the assumption of normality and Kruskal-walis for parameters that did not meet the assumptions of normality. Further test analysis used if the data were significantly different was DMRT ($\alpha = 0.05$).

3. RESULT AND DISCUSSION

In general, the mechanism of plant resistance to nematodes is in the form of resistance before infection (pre-infection defense mechanism) and resistance after infection (post-infection defense mechanism) (Kaplan and Keen, 1980) [5].The results of the bioactivity test of root exudates from 30 eggplant accessions numbered against hatching eggs of *Meloidogyne incognita* showed significantly different results at the lowest and highest egg hatching values (**Table 1**). The highest number of hatched eggs was in the accession of SL-TE 28 OP by 23.33%, while the lowest number of eggs hatched in accession SL-TE 230 OP was 8.33%. The average number of eggs hatched in each accession was between 13-17%. The highest hatching value was not significantly different from the control plant used, namely TE Silila, which showed the number of eggs hatched by 25% and 20% in tomato plants. Root exudates have various kinds of compounds such as esters and phenols that are able to stimulate the development of *M.incognita* embryos. In addition to these compounds, tomato plant root exudates also contain compounds that are able to provide an allelopathic effect/inhibit hatching of M.incognita eggs, namely the compound L-ascorbyl 2,6dipalmitate [18]. In the treatment without root exudate, 56.67% of *M.incognita* eggs hatched. The highest hatching

inhibition value was found in the accession of SL-TE 830 OP by 80%, while the lowest inhibition value was found in the accession of SL-TE 23 by 48.33%. This value was significantly different from the control used, TE Silila had inhibition of egg hatching by 60% and in tomato plants by 65%. Inhibition of hatching eggs in other accessions tested had an average of 60%-72%. This indicated that the root exudates of accession plants contained resistance genes or secondary metabolites that were able to inhibit hatching of different eggs and were also capable of dissolving eggs. According to Lopez (2005) [7] that secondary metabolites in the form of tannins and peptides produced by plant root exudates can dissolve proteins in nematode egg shells, causing egg hatching failure. Lower levels of plant resistance can be increased by the presence of compound factors that are in the vicinity such as in the soil, but the suppression depends on the homology between transgene and endogenous genes in each plant cultivar (Stam *et al.*, 1997) [16].

The highest number of galls/roots in the accession of SL-TE 231 was 51.67 indicating that the plant accession was susceptible to *M.incognita*, while the lowest number of galls/roots in accession SL-TE 85 OP of 16.33 indicated that the accession was included in the accession which is moderate resistant. Control plant (TE Silila) had the number of galls/roots was 36.33 this indicates that the number of galls/roots in each plant was significantly different (**Table 2**). The results of the calculation of the gall index showed that the resistance of the 30 accessions tested showed 4 accessions that were moderate resistant consisting of SL-TE 561, TE 230 OP, TE 85 OP, TE 81 OP, 13 accessions were moderate sustainable consisting of SL-TE 222 OP, TE 227 OP, TE 46, TE 260, TE 28 OP, TE 223 OP, TE 228 OP, TE 53, TE 130 OP, TE 86 OP, TE 77 OP, TE 78 OP, TE 91 OP, and 13 sustainable accessions consisting of SL -TE 34, TE 15, TE 18, TE 231 OP, TE 221 OP, TE 420 OP, TE 23, TE 20, TE 830 OP, TE 840 OP, TE 93, TE 80 OP, TE 90.
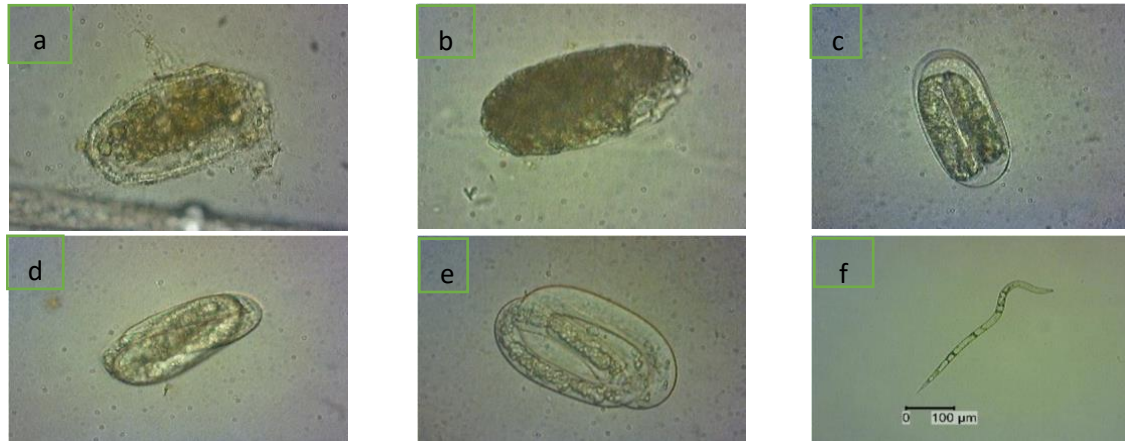
Figure 1. Observations on the effect of root exudates on hatching eggs of *M.incognita* , a) Broken eggs (40x), b) Undeveloped eggs (40x), c) 2nd fold egg stage (40x), d) Old eggs (40x), e) L1 (40x), f) L2 hatched (10x).

Table 1. Effect of root exudate on egg hatch *M.incognita* (*Mean±SE*)

No.	No. Accessions	Number of egg hatch (%)	Inhibition egg hatch (%)
1	SL-TE 222 OP	13.33 ± 4.4 cd	71.67 ± 4.4 i
2	SL-TE 227 OP	16.67 ± 1.7 ef	63.33 ± 1.7 h
3	SL-TE 46	15 ± 0.0 de	70 ± 0.0 i
4	SL-TE 34	18.33 ± 4.4 fg	56.67 ± 1.7 c
5	SL-TE 15	13.33 ± 3.3 cd	71.67 ± 3.3 i
6	SL-TE 18	16.67 ± 4.4 ef	68.33 ± 4.4 h
7	SL-TE 260	15 ± 5.8 de	73.33 ± 6.7 k
8	SL-TE 561	16.67 ± 4.4 ef	68.33 ± 4.4 h
9	SL-TE 28 OP	23.33 ± 4.4 h	63.33 ± 6.0 e
10	SL-TE 223 OP	16.67 ± 4.4 ef	68.33 ± 4.4 h
11	SL-TE 228 OP	16.67 ± 4.4 ef	68.33 ± 4.4 h
12	SL-TE 53	11.67 ± 4.4 c	73.33 ± 4.4 k
13	SL-TE 230 OP	8.33 ± 1.7 a	76.67 ± 1.7 l
14	SL-TE 130 OP	13.33 ± 1.7 cd	71.67 ± 1.7 i
15	SL-TE 231 OP	15 ± 7.6 de	70 ± 7.6 i
16	SL-TE 221 OP	13.33 ± 1.7 cd	71.67 ± 1.7 i
17	SL-TE 420 OP	15 ± 7.6 de	76.67 ± 1.7 l
18	SL-TE 23	20 ± 2.9 gh	48.33 ± 6.7 b
19	SL-TE 85 OP	10 ± 2.9 ab	71.67 ± 1.7 i
20	SL-TE 20	18.33 ± 6.0 fg	66.67 ± 6.0 g
21	SL-TE 830 OP	18.33 ± 1.7 fg	80 ± 2.9 m
22	SL-TE 840 OP	16.67 ± 1.7 ef	68.33 ± 1.7 h
23	SL-TE 93	16.67 ± 3.3 ef	68.33 ± 3.3 h
24	SL-TE 86 OP	11.67 ± 9.3 c	73.33 ± 9.3 k
25	SL-TE 77 OP	13.33 ± 1.7 cd	71.67 ± 1.7 i
26	SL-TE 78 OP	16.67 ± 1.7 ef	68.33 ± 1.7 h
27	SL-TE 80 OP	13.33 ± 1.7 cd	71.67 ± 1.7 i
28	SL-TE 81 OP	16.67 ± 3.3 ef	68.33 ± 3.3 h
29	SL-TE 91 OP	20 ± 2.9 gh	65 ± 2.9 f
30	SL-TE 90	16.67 ± 1.7 ef	68.33 ± 1.7 h
31	TE Silila (Control)	25 ± 7.6 h	60 ± 7.6 d
32	Tomato	20 ± 5.0 gh	65 ± 5.0 f
33	Aquades	56.67 ± 4.4 i	31.67 ± 1.7 a

The mean followed by the same letter shows no significant difference (DMRT α=0.05)

Table 2. Eggplant accession gall index against *Meloidogyne incognita (Mean±SE)*

No.	No. Accessions	Root lenght	Numbers of gall/root	*Gall index	Resistance level
1	SL-TE 222 OP	16.2 ± 0.8 f	30 ± 5.8 j	3	Moderate Sustainable
2	SL-TE 227 OP	16.3 ± 2.4 f	24.33 ± 2.2 f	3	Moderate Sustainable
3	SL-TE 46	12.7 ± 0.9 c	28.67 ± 2.7 i	3	Moderate Sustainable
4	SL-TE 34	10.7 ± 1.9 b	33 ± 4.2 k	4	Sustainable
5	SL-TE 15	12.6 ± 3.0 c	45.67 ± 5.8 q	4	Sustainable
6	SL-TE 18	12.8 ± 1.9 c	36.33 ± 4.7 m	4	Sustainable
7	SL-TE 260	12.3 ± 1.7 c	27.67 ± 0.9 h	3	Moderate Sustainable
8	SL-TE 561	10.9 ± 4.7 b	19 ± 3.8 b	2	Moderate Resistant
9	SL-TE 28 OP	11 ± 1.4 b	33 ± 8.7 k	3	Moderate Sustainable
10	SL-TE 223 OP	15.2 ± 1.6 e	24 ± 2.3 f	3	Moderate Sustainable
11	SL-TE 228 OP	12.7 ± 1.1 c	21.33 ± 1.8 d	3	Moderate Sustainable
12	SL-TE 53	9 ± 0.6 a	22.67 ± 3.2 e	3	Moderate Sustainable
13	SL-TE 230 OP	13.3 ± 3.5 cd	20.33 ± 0.3 c	2	Moderate Resistant
14	SL-TE 130 OP	18.3 ± 3.9 g	24.67 ± 3.7 f	3	Moderate Sustainable
15	SL-TE 231 OP	17.4 ± 1.3 fgh	51.67 ± 8.0 r	4	Sustainable
16	SL-TE 221 OP	14.6 ± 3.9 d	35 ± 7.5 l	4	Sustainable
17	SL-TE 420 OP	20.8 ± 0.2 h	37.33 ± 2.0 n	4	Sustainable
18	SL-TE 23	12.7 ± 2.0 c	34.33 ± 6.4 l	4	Sustainable
19	SL-TE 85 OP	14.3 ± 3.2 d	16.33 ± 1.2 a	2	Moderate Resistant
20	SL-TE 20	13.3 ± 2.0 cd	38.67 ± 2.6 o	4	Sustainable
21	SL-TE 830 OP	15.3 ± 1.2 e	43.33 ± 4.4 p	4	Sustainable
22	SL-TE 840 OP	16.8 ± 1.2 fg	36 ± 4.6 m	4	Sustainable
23	SL-TE 93	13.5 ± 1.8 cd	34.33 ± 3.8 l	4	Sustainable
24	SL-TE 86 OP	12.3 ± 3.2 c	26.67 ± 2.9 g	3	Moderate Sustainable
25	SL-TE 77 OP	18.7 ± 0.9 g	22.67 ± 4.2 e	3	Moderate Sustainable
26	SL-TE 78 OP	12.7 ± 1.5 c	24 ± 7.4 f	3	Moderate Sustainable
27	SL-TE 80 OP	16 ± 2.0 f	34.67 ± 7.3 l	4	Sustainable
28	SL-TE 81 OP	17.3 ± 2.9 fgh	19 ± 3.1 b	2	Moderate Resistant
29	SL-TE 91 OP	16.3 ± 1.8 f	22.67 ± 3.2 e	3	Moderate Sustainable
30	SL-TE 90	12.2 ± 2.5 c	43 ± 2.9 p	4	Sustainable
31	TE Silila (Control)	11.3 ± 0.9 b	36.33 ± 6.1 m	4	Sustainable

[1]The mean followed by the same letter shows no significant difference (DMRT α=0.05)

*Based on gall index 0 (Resistant), 1 (1-2 Resistant), 2 (Moderate Resistant), 3 (Moderate Sustainable), 4 (Sustainable), 5 (Highly Sustainable) Hussain (1986) [1].

Typical symptoms of an attack *M.incognita* is a gall/purulent or swollen root. The more gall, more severe the attack rate [11]. According to Bakker *et al.*, (2006) [6] that the resistance of a plant depends on the interaction between the host and the pest if *M.incognita* does not succeed in creating a feeding site for the nutritional needs for its development, the host plant has resistance to *M.incognita* attack. Resistance after infection is influenced by several factors there are synthesis and accumulation of phytoalexin compounds in response to pest infection, allelopathic compounds produced in plant tissues before infection with nematodes are usually from the phenol group, which is characterized by necrotic symptoms in the epidermis, hypersensitivity reactions that develop near cells where the nematodes take food, then L2 Meloidogyne will fail to form a feeding site and cannot develop or die.

In addition to the number of galls in the roots, the response of plant resistance was also able to influence the nematode population. The results of different accession tests showed different responses in the nematode population consisting of the number of egg masses and the amount of L2 in the soil which then affected the nematode reproduction (**Table 3**). Accession response to the nematode population showed the highest egg mass/0.5g root in SL-TE 231 OP accession of 433 individuals and the lowest in SL-TE 227 OP accession of 42 individuals. In the population of L2/100gr soil, the highest value was obtained in the accession of SL-TE 231 OP of 2127 individuals and the lowest was in accession of SL-TE 81 OP of 130 individuals. The results of statistical analysis showed that the effect of eggplant accession was significantly different on the final nematode population. The highest total nematode population was shown by the accession of SL-TE 231 OP with 2560 individuals and the lowest in the accession of SL-TE 85 OP with 267 individuals. The highest reproductive factor value was indicated by the accession of SL-TE 231 OP of 1.60% with the category of plants being quite susceptible and the lowest value was indicated by the accession of SLTE 81 OP of 0.5% with the category of resistant plants. The control plant used (TE Silila) had 200 eggs/0.5g root mass, 2125 L2/100gr soil population, 2325 nematode population total, and the reproductive factor value of 1.45% which was included in the moderate susceptible category. The resistance and susceptibility of a plant can be seen from the ability to develop and reproduce *Meloidogyne incognita*, the test results showed the low reproduction factor of SL-TE 81 OP accessions compared to other accessions.

The results of the calculation of reproductive factors, plant resistance from 30 accessions tested obtained 1 accession of resistant plants that is SL-TE 81 OP. 17 accessions of moderately resistant plants consisting of accessions SL-TE 46, TE 34, TE 15, TE 18, TE 561, TE 230 OP, TE 130 OP, TE 221 OP, TE 23, TE 85 OP, TE 20, TE 840 OP, TE 86 OP, TE 77 OP, TE 78 OP, TE 80 OP, TE 90, and 12 accessions moderate susceptible plants which consists of SL-TE 222 OP, TE 227 OP, TE 260, TE 28 OP, TE 228 OP, TE 53. TE 231 OP, TE 420 OP, TE 830 OP, TE 93, TE 91 OP.

Based on observations of the final population of *M.incognita*, the highest value was directly proportional to the number of galls in the formed roots. The higher the number of galls formed, the final population showed a high value, so it can be said that *M.incognita* was able to penetrate and developed so well. However, the differences in the reactions shown from all parameters of each other accession were very specific, not always a high number of gall followed by the number of egg mass, high number of nematodes and the opposite happened. According to Wibowo (2015) [11] stated that not all nematodes in the soil have high penetrant power. On susceptible plants can form a few gall, but nematodes can develop properly. On the other hand, in resistant plants many gall can form but nematodes didn't develop properly. Differences in root tissue structure, chemical compounds possessed by host plants, and the presence of intra-specific competition between nematodes affect population development and the level of plant damage.

The effect of *M.incognita* inoculation on the different eggplant plant accessions tested showed a significantly different response. Based on the difference in responses, there is a relationship between the observation parameters seen from the accession of TE 230 OP. The implementation of suitable plant accessions to suppress the population of *M.incognita* is the accession of SL-TE 230 OP. In hatching egg parameters, accession 230 OP showed the lowest value but did not show the lowest value in inhibition of hatching eggs could be due to the content of genes that inhibit hatching/allelopathic in nematodes not as much as accessions with the highest inhibition value accession TE 230 OP is included in the plant that is moderate resistant/tolerant. This shows that in the accession there was a mechanism of resistance before and after *M.incognita* infection which was influenced by several things such as the presence of chemical compounds that had been formed in the plant, the presence of nutrients, the presence of phytoalexin compounds, and hypersensitivity reactions (HR). According to Canto-Saenz (1985) [12] a host plant was considered tolerant when the gall index and nematode reproduction index values were not statistically significant but were still able to suppress damage below the economic limit.
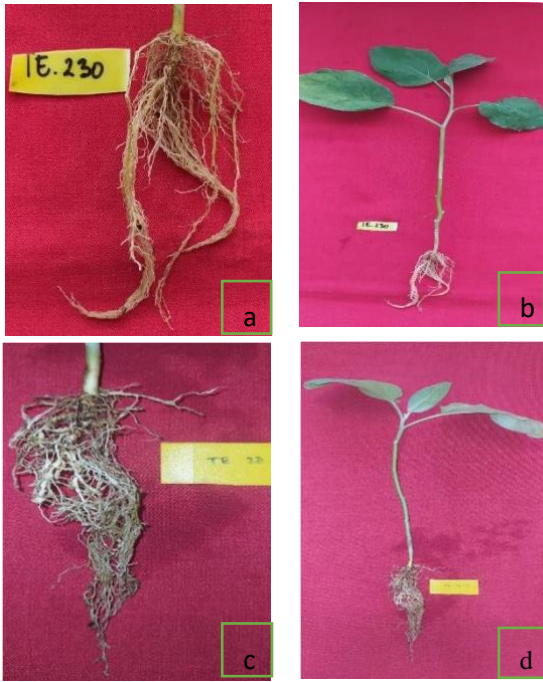
Figure 2. Response of plant resistance sample. a) resistant plant roots. b) resistant plants. c) moderate sustainable plant roots. and d) moderate sustainable plants.

Table 3. Resistance response based on the reproduction factor of 30 eggplant accession numbers against *Meloidogyne incognita* (*Mean±SE*)

No.	No. Accessions	Nematode Population		Numbers of Nematode Population	(R=Pf/Pi) (%)	*Plants Statue
		Egg mass/0.5 gr roots	L2/100gr soil			
1	SL-TE 222 OP	141 ± 27.6 g	1085 ± 435.9 e	1226 ± 424.2 g	1.06 ± 0.22	MS
2	SL-TE 227 OP	42 ± 7.9 a	1080 ± 563.4 e	1122 ± 562.2 f	1.00 ± 0.25	MS
3	SL-TE 46	151 ± 7.9 g	680 ± 123.3 d	831 ± 118.9 e	0.91 ± 0.06	MR
4	SL-TE 34	166 ± 16.5 g	418 ± 69.1 c	584 ± 85.6 c	0.76 ± 0.06	MR
5	SL-TE 15	277 ± 8.5 i	331 ± 61.5 c	608 ± 69.3 c	0.78 ± 0.04	MR
6	SL-TE 18	171 ± 61.3 g	334 ± 34.1 c	505 ± 94.7 c	0.70 ± 0.07	MR
7	SL-TE 260	212 ± 6.0 h	1267 ± 156.8 f	1479 ± 162.7 i	1.21 ± 0.07	MS
8	SL-TE 561	96 ± 37.7 d	429 ± 227.9 c	525 ± 247.1 c	0.69 ± 0.16	MR
9	SL-TE 28 OP	240 ± 126.2 i	867 ± 356.2 e	1107 ± 399.5 f	1.00 ± 0.22	MS
10	SL-TE 223 OP	119 ± 17.4 f	1094 ± 472.9 e	1213 ± 472.4 g	1.06 ± 0.20	MS
11	SL-TE 228 OP	74 ± 24.8 c	1034 ± 268.0 e	1108 ± 291.9 f	1.04 ± 0.13	MS
12	SL-TE 53	159 ± 27.1 g	1481 ± 531.2 g	1640 ± 533.3 i	1.25 ± 0.20	MS
13	SL-TE 230 OP	167 ± 35.0 g	320 ± 52.0 c	487 ± 59.1 c	0.70 ± 0.04	MR
14	SL-TE 130 OP	77 ± 5.0 c	321 ± 34.9 c	398 ± 37.6 b	0.63 ± 0.03	MR
15	SL-TE 231 OP	433 ± 118.8 k	2127 ± 236.4 h	2560 ± 270.91	1.60 ± 0.08	MS
16	SL-TE 221 OP	163 ± 26.5 g	476 ± 131.9 c	639 ± 148.7 c	0.79 ± 0.10	MR
17	SL-TE 420 OP	209 ± 24.0 h	1149 ± 31.2 e	1358 ± 7.4 h	1.17 ± 0.00	MS
18	SL-TE 23	219 ± 16.0 h	373 ± 156.8 c	592 ± 148.0 c	0.76 ± 0.10	MR
19	SL-TE 85 OP	54 ± 5.2 b	213 ± 21.8 b	267 ± 18.8 a	0.52 ± 0.02	MR
20	SL-TE 20	106 ± 4.7 e	704 ± 241.1 d	810 ± 242.3 e	0.88 ± 0.14	MR
21	SL-TE 830 OP	173 ± 39.4 g	1462 ± 325.3 g	1635 ± 293.3 i	1.27 ± 0.11	MS

No.	No. Accessions	Nematode Population		Numbers of Nematode Population	(R=Pf/Pi) (%)	*Plants Statue
		Egg mass/0.5 gr roots	L2/100gr soil			
22	SL-TE 840 OP	178 ± 45.2 g	525 ± 223.7 c	703 ± 225.0 d	0.82 ± 0.13	MR
23	SL-TE 93	285 ± 137.7 i	1057 ± 463.0 e	1342 ± 600.7 h	1.10 ± 0.25	MS
24	SL-TE 86 OP	163 ± 25.6 g	577 ± 246.8 c	740 ± 224.3 d	0.84 ± 0.14	MR
25	SL-TE 77 OP	208 ± 23.6 h	302 ± 75.5 c	510 ± 98.7 c	0.71 ± 0.07	MR
26	SL-TE 78 OP	150 ± 84.4 g	227 ± 82.2 b	377 ± 13.4 b	0.61 ± 0.01	MR
27	SL-TE 80 OP	146 ± 21.7 g	640 ± 33.1 d	786 ± 12.1 e	0.89 ± 0.01	MR
28	SL-TE 81 OP	140 ± 40.1 g	130 ± 46.4 a	270 ± 80.1 a	0.50 ± 0.09	R
29	SL-TE 91 OP	148 ± 34.1 g	1260 ± 396.0 f	1408 ± 428.1 h	1.16 ± 0.17	MS
30	SL-TE 90	229 ± 16.0 i	500 ± 102.0 c	729 ± 117.8 d	0.85 ± 0.07	MR
31	TE Silila (Kontrol)	200 ± 7.9 h	2125 ± 1078.3 h	2325 ± 1084.5 k	1.45 ± 0.34	MS

[1] The mean followed by the same letter shows no significant difference (DMRT α=0.05)

*Based on reproduction factor (Pf/Pi): ≥ 3 = highly susceptible (HS). 2-3 = susceptible (S). 1-2 = moderate susceptible (MS). 0.5-1.0 = moderate resistant (MR). 0.3-0.5 = resistant (R). dan ≤0.3 = highly resistant (HR) (Taylor & Sasser. 1978) [12].

AUTHORS' CONTRIBUTIONS

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REFERENCES

[1] Akhter, G., and T.A. Khan. 2018. Response of brinjal (*Solanum melongena* L.) varieties for resistance against root-knot nematode, *Meloidogyne incognita* race 1. *The Journal of Phytopharmacology*. **7**(3):222-224.

[2] Badan Pusat Statistik. 2019. Luas Panen dan Produksi Sayuran 2015-2019. https://www.pertanian.go.id. Accessed on 21 Maret 2021.

[3] Ditbenih. 2017. Database varietas terdaftar hortikultura. Direktorat Perbenihan Hortikultura Kementerian Pertanian Republik Indonesia. http://varitas.net/dbvarietas/. Accessed on 21 Maret 2021.

[4] FAO. 2016. FAOSTAT crops data. Food and Agriculture Organization of the United Nations. http://www.fao.org/faostat/en/#data/QC. Accessed on 21 Maret 2021.

[5] Fitriyanti, D. 2014. Suatu tinjauan tentang respon ketahanan tanaman terhadap adanya infeksi dari nematoda parasit tanaman. *Agroscientiae Journal*. **21**(1): 48-53.

[6] Irmawatie, L., R. R. Robana, dan N. Nuraidah. 2019. Ketahanan tujuh varietas tomat terhadap nematoda puru akar (*Meloidogyne* spp.). *Agrotechnology Research Journal*. **3**(2):61-68.

[7] [7] Istiqomah, D., dan A. P. Pradana. 2015. Review: Teknik pengendalian nematoda puru akar (*Meloidogyne* spp.) ramah lingkungan. *Prosiding Seminar Nasional Pencapaian Swasembada Pangan Melalui Pertanian Berkelanjutan.* 1-10.

[8] Kayani, M.Z., Mukhtar, T. and Hussain. M.A. 2017. Effects of southern root knot nematode population densities and plant age on growth and yield parameters of cucumber. *Crop Prot*. **92**: 207-212. https://doi.org/10.1016/j.cropro.2016.09.007.

[9] Khan, F., M. Asif, A. Khan, M. Tariq, and M. A. Siddiqui. 2018. Screening of carrot cultivars against root-knot nematode *Meloidogyne incognita*. *Indian Phytopathology*. **71**:415-421.

[10] [10] Khan, M. T. A., T. Mukhtar, and M. Saeed. 2019. Resistance or susceptibility of eight auberine cultivars to *Meloidogyne incognita*. *Pakistan Journal of Zoology*. **51**(6):2187-2192.

[11] [11] Khotimah N., I.N. Wijaya, dan M. Sritamin. 2020. Perkembangan populasi nematoda puru akar (*Meloidogyne* spp.) dan tingkat kerusakan pada beberapa tanaman familia solanaceae. *Jurnal Agroekoteknologi Tropika*. **1**(9):23-31.

[12] Montasser, S.A., A.S.M. El-Nuby, and I.A.M. El-Khadrawy. 2019. Response of certain genotypes to the root knot nematode, *Meloidogyne incognita*. *J. Plant Prot. And Path*., Mansoura Univ. **10**(3):177-186.

[13] Mulyadi. 2009. Nematologi Pertanian. Yogyakarta: Gadjah Mada University Press.

[14] Mustika, Ika. 2005. Konsepsi dan strategi pengendalian nematoda parasit tanaman perkebunan di Indonesia. *Perspektif*. Vol. **4** No. 1: 20-32.

[15] Öçal, S., and Z. Devran. Response of eggplant genotypes to avirulent and virulent populations of *Meloidogyne incognita* (Kofoid & White. 1919) Chitwood. 1949 (Tylenchida: Meloidogynidae). *Türk.entomol.derg*. **43**(3): 287-300.

[16] Papolu, K. P., T. K. Dutta, A. Hada, D. Singh, and U. Rao. 2020. The production of a synthetic chemodisruptive peptide in planta precludes *Meloidogyne incognita* multiplication in *Solanum melongena. Physiological and Molecular Plant Pathology*. Vol. **112**.

[17] Treger, S. R., J. Otchere, M. F. Keil, J. E. Quagrine, G. Rai, B. T. Mott, D. L. Humphries, M. Wilson, M. Cappello, and J. J. Vermiere. 2014. Short Report: in vitro screening of compounds against laboratory and field isolates of human hookworm reveals quantitative differences in anthelmintic susceptibility. *J.Trop. Med. Hyg*. **90**(1):71-74.

[18] Yang, G., B. Zhou, X. Zhang, Z. Zhang, Y. Wu, Y. Zhang, S. Lu, Q. Zhou, Y. Gao, and L. Teng. 2016. Effect of tomato root exudates on *Meloidogyne incognita*. *Journal Pone*. 1-16.