

# Infestation of Black Peppers by the Root-knot Nematode in Brazil\*

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The author visited Brazil during a period of nearly 70 days since November 1974 under a Tropical Agriculture Research Programme of the Ministry of Agriculture and Forestry, Japan. One of the purposes of the visit was to examine a disease occurring on black peppers (*Piper nigrum* L.) at Tomé-Açu located 150 km south of Belém, Pará.

Cultivation of black peppers by the immigrants from Japan at Tomé-Açu has a long history extending to nearly 40 years. It is said that only a couple of seedlings first brought into Brazil in 1933 were the origin of the present cultivation of 3 million plants covering the acreage of 3,000 ha, which constitutes approximately 10% of the world production.

A disease occurred in these fields nearly 20 years ago, and the plants began to die as early as within 10 years of age. This disease can be characterized by yellowish discoloration of leaves followed by complete defoliation, and by the so-called "foot rot" in the underground part. Investigation has been made by Fernando C. de Albuquerque\* from IPEAN (Instituto de Pesquisa Agropecuária do Norte, Belém) and also by Tatsuo Watanabe\*\*, a visiting plant pathologist from Japan, since 1960, and the pathogen of the disease has been referred to *Fusa-*

*rium solani* f. *piperi*. Despite of many trials to control the disease, the death of trees is still spreading year after year. Concerning the nematode species associated with black peppers, Goodey et al.<sup>3)</sup> recorded *Meloidogyne incognita* v. *acrita* and van der Vecht<sup>10)</sup> did *Radopholus similis* as a parasite causing "yellow disease" of black peppers in Indonesia. In Brazil, Sharma & Loof<sup>8)</sup> reported 9 species, including *M. incognita* and *Helicotylenchus* spp., from the cocoa region in Bahia. None of the study has been made on this disease in Pará from the standpoint of nematology.

Microscopical examination previously conducted by the author at IPEAN and vicinity of Belém based on dozens of affected plants revealed a heavy infestation of roots by the root-knot nematodes and also no evidence for the occurrence of *Radopholus similis*. Accordingly, the author attempted to know severity of the root-knot nematodes at Tomé-Açu by cooperating with those who had been trained previously by the author for root examination. This paper is to report the results of the examination.

Four examination teams, consisted of 3 persons each, were set up, and each team conducted examination independently accord-

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\* Albuquerque, F. C. (1961) Podridão das raízes e do pé da pimenta do reino. *Circ. Inst. Agron. Norte*, No. 5.

\*\* Watanabe, T. (1973) Report from specialist for diseases and insect pests of black peppers in Brazil (in Japanese). OTCA, Tokyo, 73-6, 49 pp.



Plate 1. Black pepper fields at Tomé-Açu, Pará, Brazil



Plate 2. Examination of roots of a black pepper vine

ing to the following procedures during two days, 6 and 7th January 1975. (1) Many of the black pepper fields were arbitrarily picked up on a map of four zones of Tomé-Açu so that the number of fields to be examined each zone roughly corresponded to the size of plantation. (2) For examination in a field, 10 plants were arbitrarily chosen from an entire field. (3) A small portion of feeder roots of a plant was taken off, and the infestation by the root-knot nematodes was rated after peeling the root tissue with a knife, because the swelling of roots caused by the nematodes was not always remarkable, and for the rating it was necessary to disclose adult females, egg masses, or decayed nematode-surrounding tissue by taking off the surface layer of the root. (4) According to the criteria shown in Table 1, the



Plate 3. A root, from which the surface layer was removed, indicating the infestation by the root-knot nematode

Table 1. Criteria for the root-knot index

Root-knot index	Criteria
0	No nematodes found even by a thorough examination.
1	Only few nematodes found after a thorough examination.
2	Nematodes moderately found.
3	Many nematodes readily found. Infestation severe.
4	Nematodes extremely numerous. Infestation very severe.

root-knot index for each of 10 plants was recorded. (5) Soil type and age of plants of the fields examined were also recorded.

The results are shown in Tables 2 and 3. These results indicate that the root-knot nematodes on black peppers at Tomé-Açu are so widespread that (1) only one out of 74 fields examined was found uninfested by the root-knot nematodes, as far as arbitrary 10 plants and only a small portion of rhizosphere were examined (Table 2), (2) 91% of plants examined were infested by the nematodes, i.e., the infestation can be found at a rate as high as 9 of 10 plants (Table 3), and (3) since 75% of plants examined indicated more than "3" of the root-knot index, three fourths of entire plants are likely to be suffering from severe infestation (Table 3).

**Table 2. Degree of infestation of black pepper fields by the root-knot nematodes**

Name of zone		South of Cross	Breu	Ipiranga	Cuxiu	Total
Number of fields* examined		15	15	14	30	74
Root-knot index	0	0	0	0	1	1
	≤1	0	1	0	3	4
	≤2	2	1	0	1	4
	≤3	8	3	2	6	20
	≤4	5	10	12	19	45
Ave. root-knot index of zone		2.8±0.6	3.0±1.1	3.5±0.6	2.9±1.3	3.0±1.0

\* An average of 10 plants for a field.

**Table 3. Degree of infestation of black pepper vines by the root-knot nematodes**

Name of zone		South of cross	Breu	Ipiranga	Cuxiu	Total
Number of vines examined		150	150	136	301	737
Root-knot index	0%	5%	13%	0%	14%	9%
	1	10	3	3	5	5
	2	21	7	7	9	11
	3	27	29	24	22	25
	4	37	48	66	50	50

Table 4 shows relationships between nematode infestation and plant age, indicating a tendency that the degree of infestation

**Table 4. Degree of infestation by the root-knot nematodes and the age of black pepper fields**

Year-old	Number of fields examined*	Average root-knot index**
2	5	2.4±1.0
3	15	2.2±1.5
4	12	2.9±1.0
5	12	3.5±0.5
6	8	3.7±0.3
7	5	3.7±0.3
8	3	3.4±0.6
9	2	3.4±0.6
10	4	3.7±0.4
11≤	4	3.1±0.8

\* Four fields excluded due to mixture of ages.

\*\* Root-knot index for each field based on an average of 10 plants.

increases as young plants grow up to 6 or 7 years of age. It is said that since that age plants enter into the peak yielding stage.

Table 5 shows degree of infestation by the root-knot nematodes in different soil types, indicating no correlations with soil types.

Applications of fensulfotion at a rate of 100 g of 5% granular formulation per plant to the foot of plant were also conducted at 4 locations in Tomé-Açu on 8th Jan., 1975.

**Table 5. Degree of infestation by the root-knot nematodes and the soil type of black pepper fields**

Soil type	Number of fields examined	Average root-knot index*
Sandy	31	3.0±1.1
Loamy	35	3.0±1.1
Clayey	8	3.2±0.9

\* See Table 4\*\*.

Each experiment consisted of 100 treated and 100 untreated plants. By these experiments, the author attempted primarily to find the effect of the root-knot nematodes on the plant growth and eventually the yield, regardless of the suspected pathogenic fungi. These experiments are now under way, and examination has been succeeded by the co-workers.

Identification of the nematode species has been made based on the specimen brought to Japan. Examination of posterior cuticular (perineal) patterns of about 50 females revealed *Meloidogyne incognita* as the most predominant root-knot nematode, and also a few specimen of another species resembling *M. thamesi*.

Possibility of association between the root-knot nematodes and the soil-borne fungi in relation to the incidence of the disease on black pepper vines is very likely, because previous investigation has proved that several pathogenic forms of *Fusarium oxysporum* cause or intensify the disease on cotton<sup>5</sup>, tomato<sup>4</sup>, tobacco<sup>7</sup>, watermelon<sup>9</sup>, cucumber<sup>4,6</sup>, or cabbage<sup>2</sup> by the association of *Meloidogyne incognita*, although no reports have been made whether *F. solani* associates or not with nematodes.

It is worthy to note that none of *Radopholus similis* has been found from this area of black pepper plantation, despite of common plant symptoms in yellowing leaves at both places of Tomé-Açu and the island of Banka in Indonesia, except that distinctive circular or spreading patches of decline in the affected fields shown in photographs by van der Vecht<sup>10</sup> and Christie<sup>1</sup> at the latter place is not seen at Tomé-Açu.

According to Christie<sup>1</sup>, the "yellow disease" has been causing a serious damage to the black pepper vines on the island of Banka in Indonesia where 22 million pepper vines once flourished, but in 1953 it was reported that only two million remained. This has been considered to be one of the

remarkable instances in the history of agriculture that an important industry was almost destroyed by a single species of nematode.

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