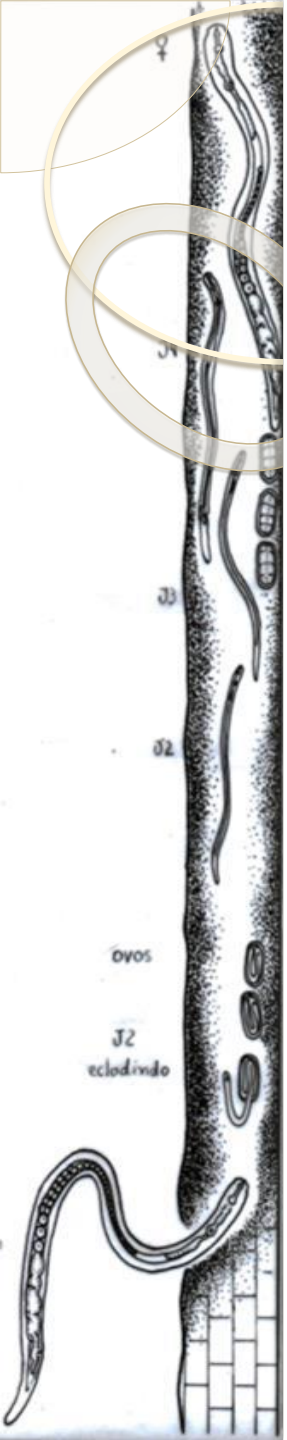


LFN-0512 Nematologia

Gênero *Radopholus*. *Radopholus similis* em Bananeira

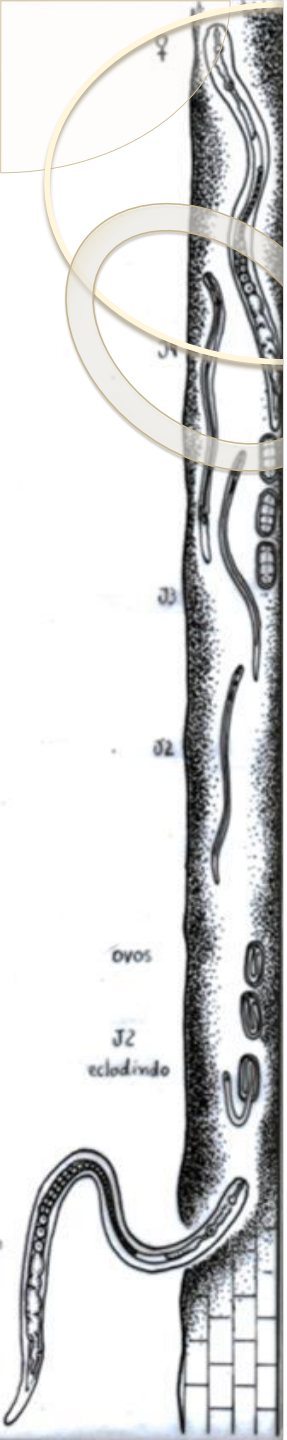


Universidade de São Paulo
Escola Superior de Agricultura Luiz de Queiroz
Departamento de Fitopatologia e Nematologia
Piracicaba 29 Setembro 2023



Aula	Dia	Assunto LFN-0512		
1	11 Ago	Informações sobre a disciplina / Diversidade de nematoides / Gênero <i>Meloidogyne</i>		<i>Meloidogyne</i> em cafeeiros
2	18 Ago	Raças de <i>Meloidogyne</i> / Interações entre nematoides e fungos		<i>Meloidogyne</i> em algodoeiro
3	25 Ago	<i>Meloidogyne</i> em soja	Gênero <i>Heterodera</i>	Nematoide-de-cisto da soja
4	1 Set	Prova 1	Gênero <i>Tylenchulus</i>	<i>Tylenchulus semipenetrans</i> em citros
5	15 Set	Gênero <i>Rotylenchulus</i>		<i>Rotylenchulus reniformis</i> em algodoeiro
6	22 Set	Gênero <i>Pratylenchus</i>		<i>Pratylenchus brachyurus</i> em soja
7	29 Out	Gênero <i>Radopholus</i>		<i>Radopholus similis</i> em bananeira
8	6 Out	Prova 2	Nematoides espiralados	<i>Helicotylenchus muticinctus</i> em bananeira
9	20 Out			Nematoides em cana-de-açúcar e milho
10	27 Out			Nematoides em solanáceas, apiáceas e cucurbitáceas
11	10 Nov	Prova 3	Gênero <i>Mesocriconema</i>	<i>Mesocriconema xenoplax</i> em pessegueiro
12	17 Nov	Gênero <i>Ditylenchus</i>		<i>Ditylenchus dipsaci</i> em alho e cebola
13	24 Nov	Gênero <i>Bursaphelenchus</i>	<i>Bursaphelenchus cocophilus</i> em palmáceas e <i>B. xylophilus</i> em <i>Pinus</i>	Nematoides em ornamentais
14	1 Dez	Gênero <i>Aphelenchoides</i>	<i>Aphelenchoides besseyi</i> em soja	<i>Meloidogyne</i> em arroz
15	8 Dez	Prova 4		
16	15 Dez	Prova Repositiva		

Gênero *Radopholus*



Radopholus similis é a única espécie importante do gênero

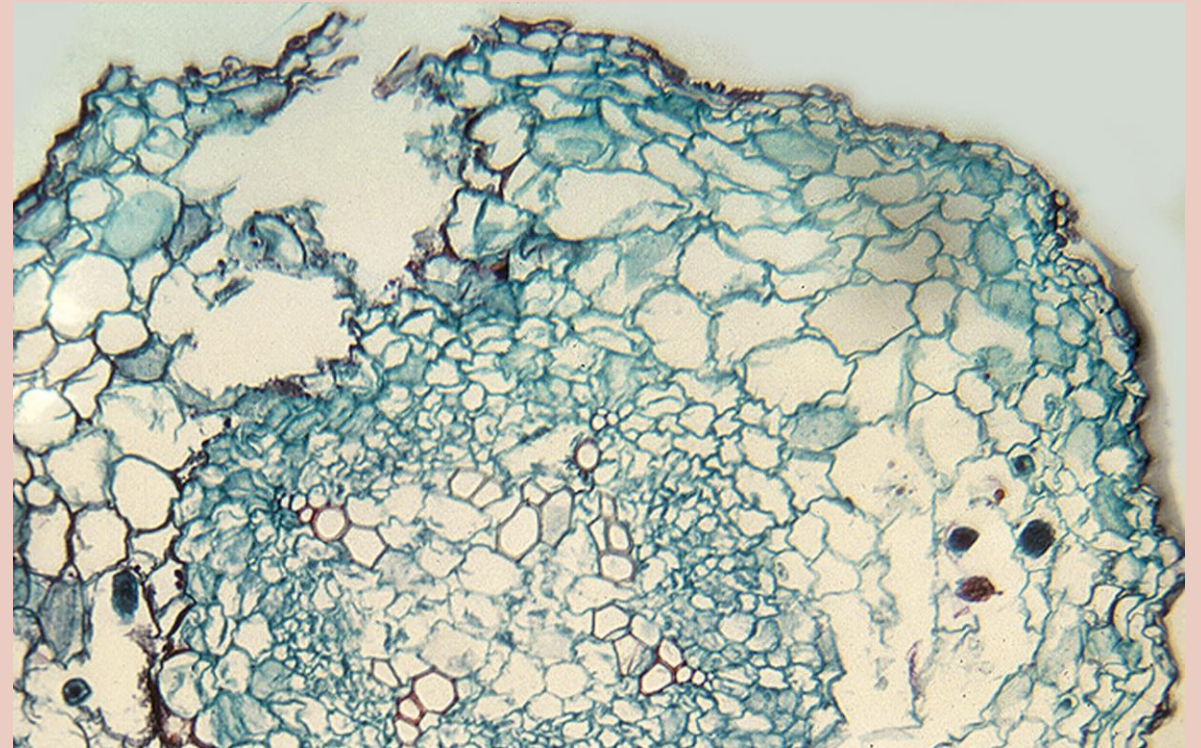
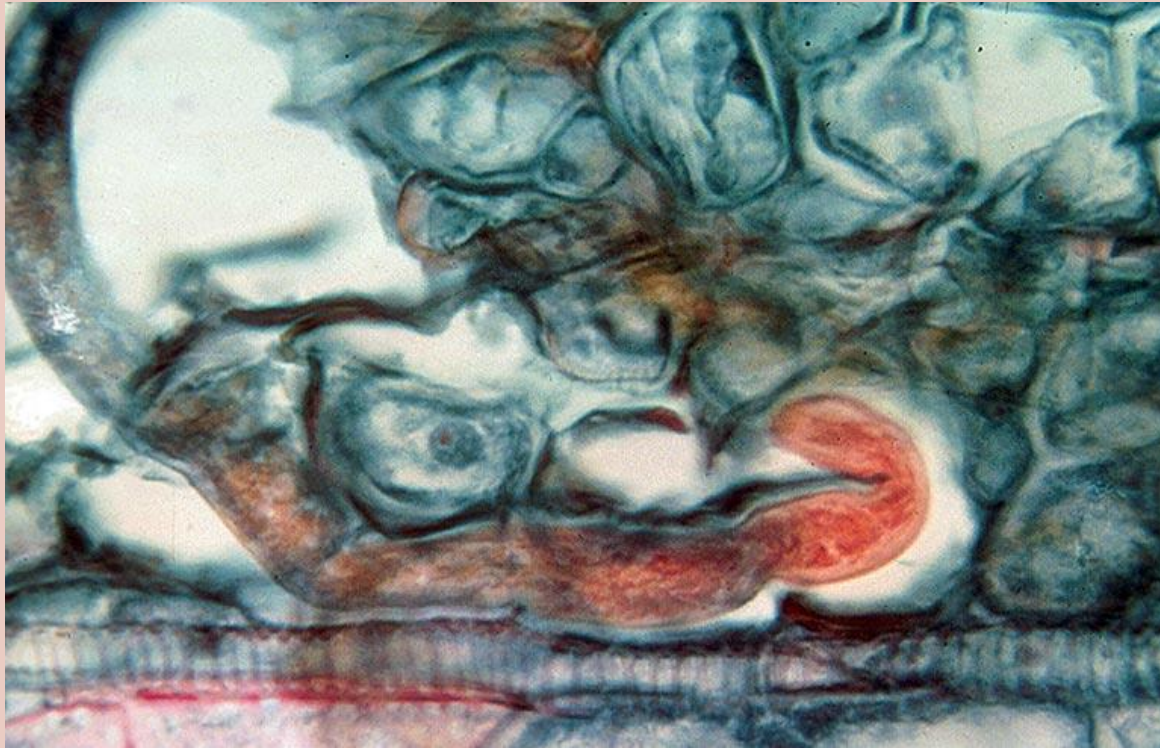
R. similis é polífago, mas bananeira e outras musáceas são as principais hospedeiras.

Debate sobre a validade de *R. citrophilus* (raça citros de *R. similis*?)

R. similis (n=4) / *R. citrophilus* (n=5)

R. citrophilus em "plantain" mas não em *Citrus* spp. (5 spp.) (1985) / em *Anthurium* spp. mas não em *Citrus limon* e *C. aurantium* no Havaí (1986)

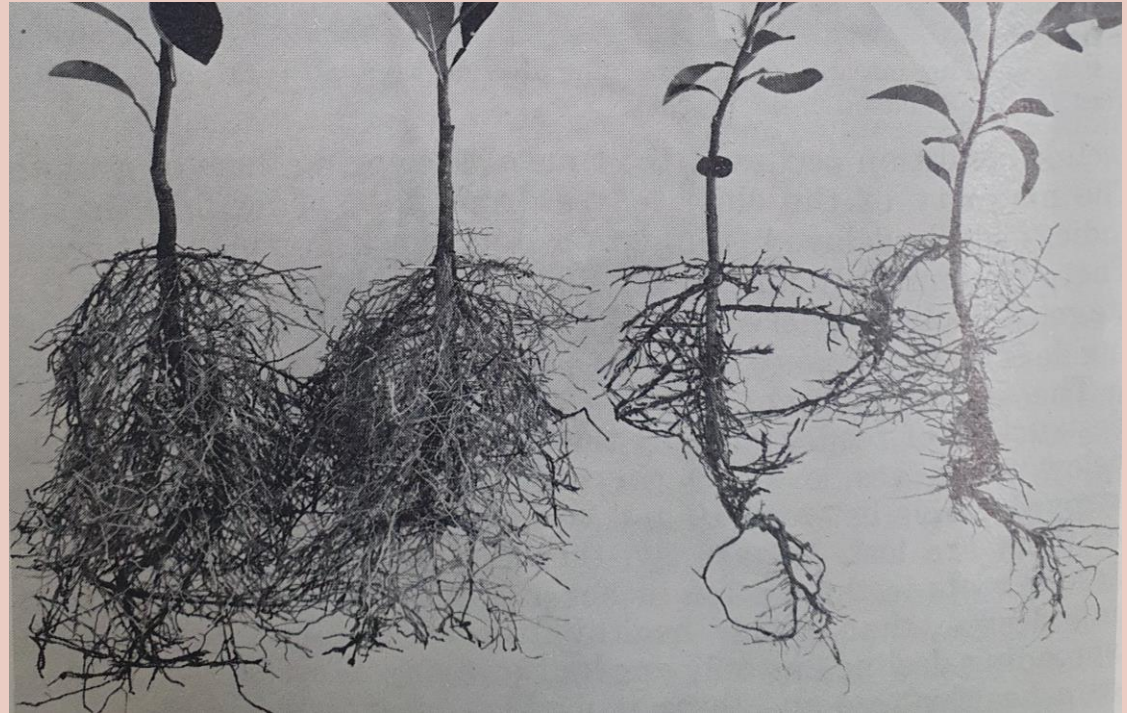
Nematoide-Cavernícola



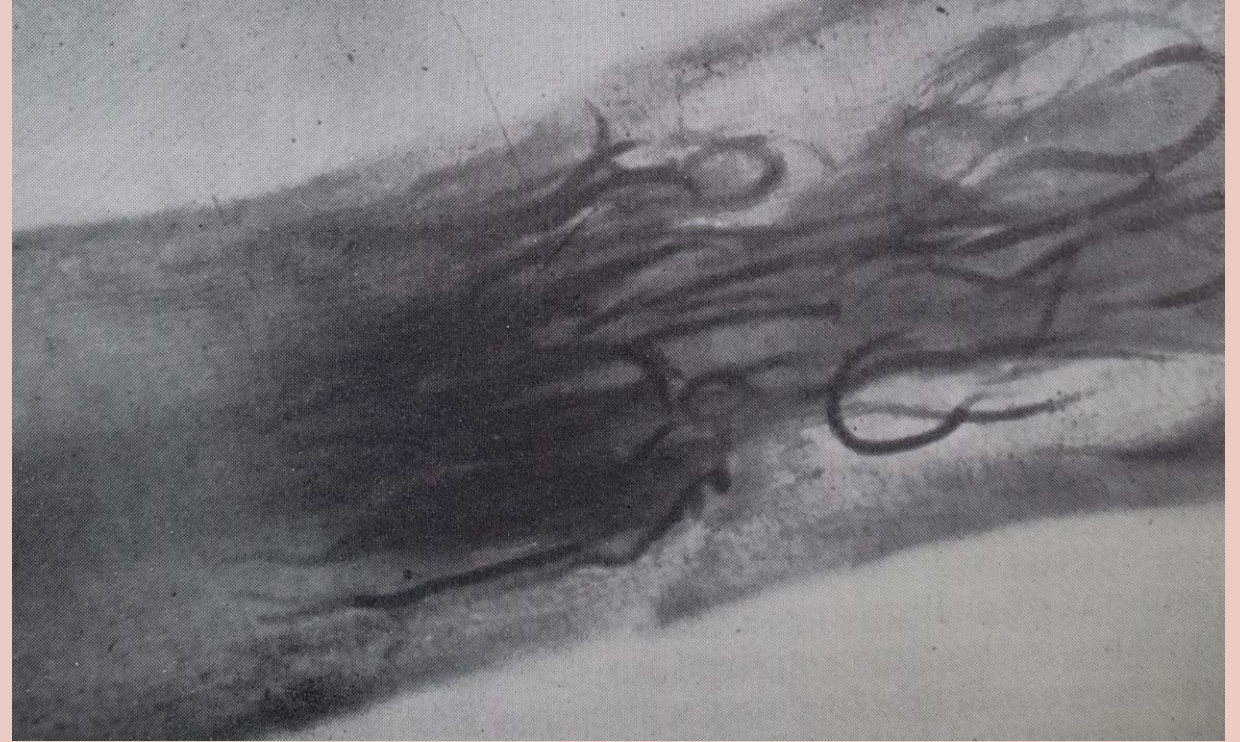
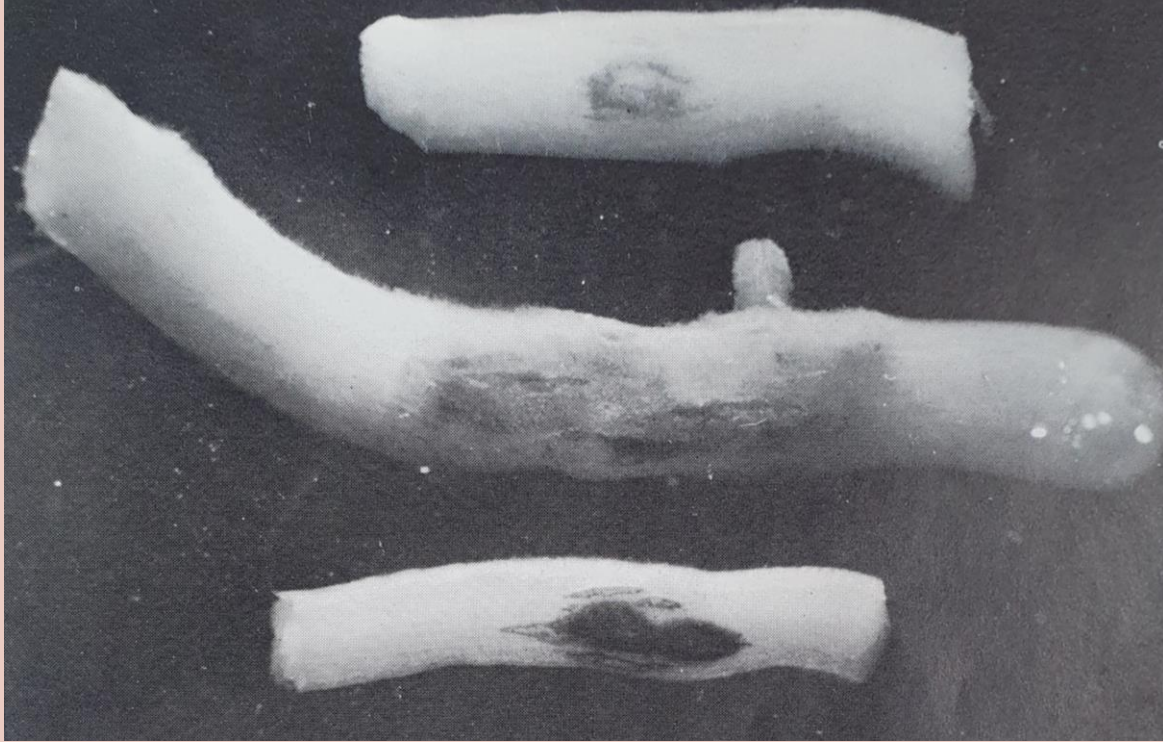
<https://www.ipmimages.org/browse/subthumb.cfm?sub=10859>

Cítricos

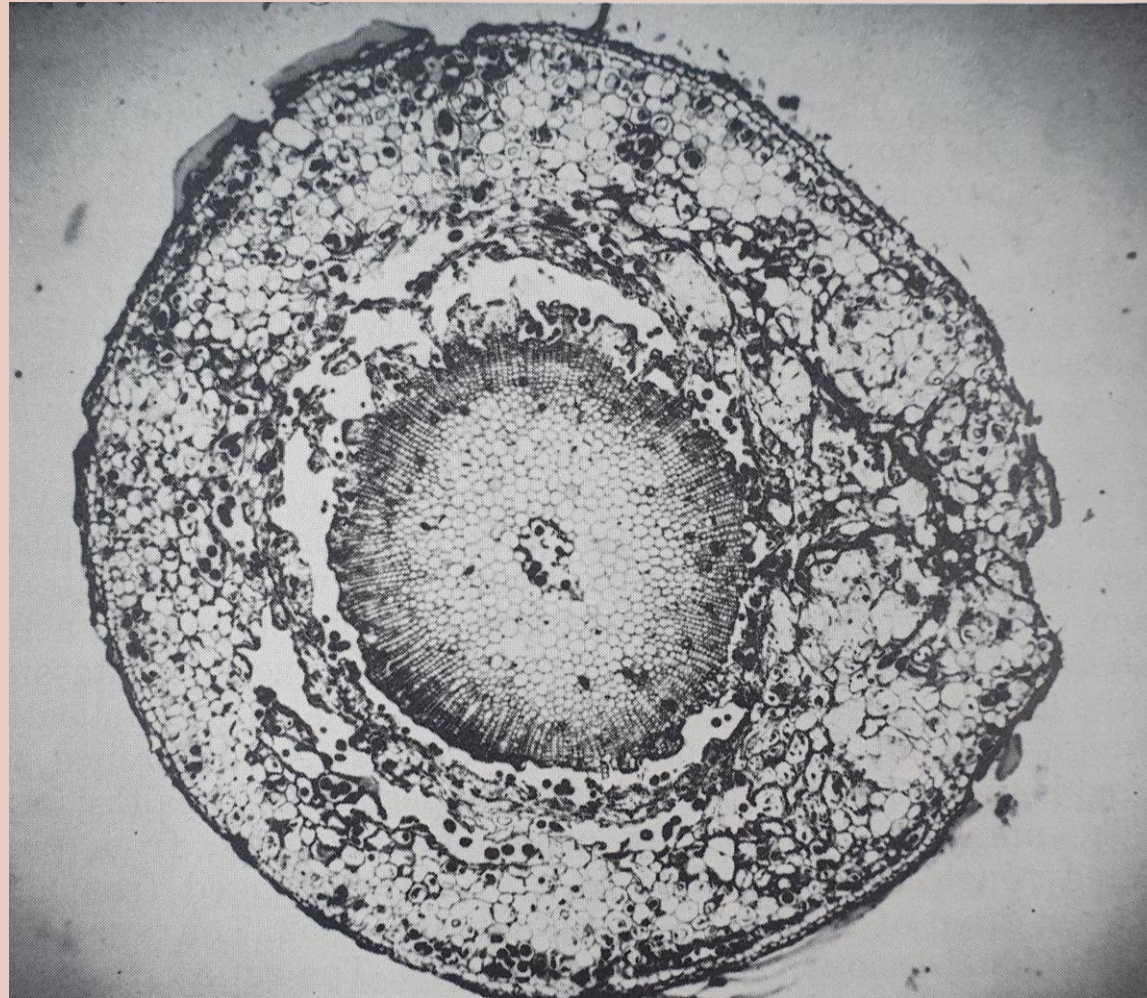
Flórida (EUA)



Poucher, Ford, Suit & Ducharme (1967). Burrowing Nematode in Citrus



Poucher, Ford, Suit & Ducharme (1967). Burrowing Nematode in Citrus



Poucher, Ford, Suit & Ducharme (1967). Burrowing Nematode in Citrus

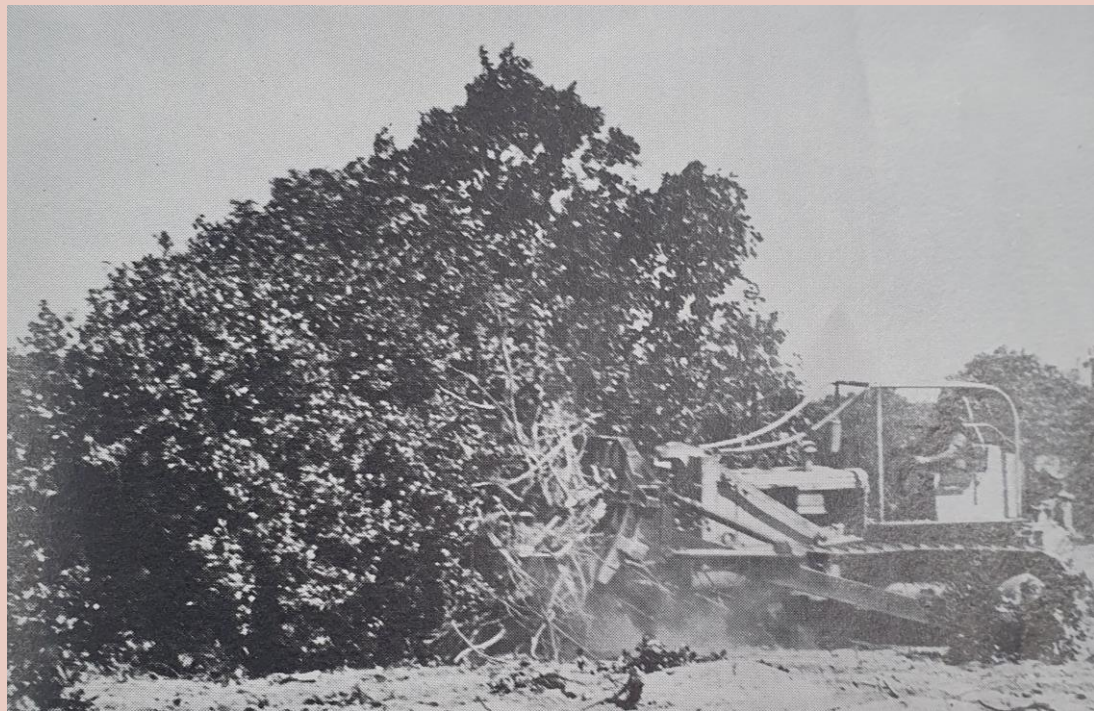


Poucher, Ford, Suit & Ducharme (1967). Burrowing Nematode in Citrus



<https://www.forestryimages.org/browse/subthumb.cfm?sub=10859>

Controle *R. citrophilus* Flórida (EUA)



Poucher, Ford, Suit & Ducharme (1967). Burrowing Nematode in Citrus

Perguntas?

***Radopholus similis* em
Bananeiras**



http://entnemdept.ufl.edu/creatures/NEMATODE/Radopholus_silmilis05.JPG



http://www.infonet-biovision.org/sites/default/files/styles/juicebox_small/public/plant_health/cropsfruitsvegetables/424.400x400_7.jpeg?itok=LmjkDQ2U



<https://www.apsnet.org/edcenter/disandpath/nematode/pdlessons/Pages/Burrowingnematode.aspx>

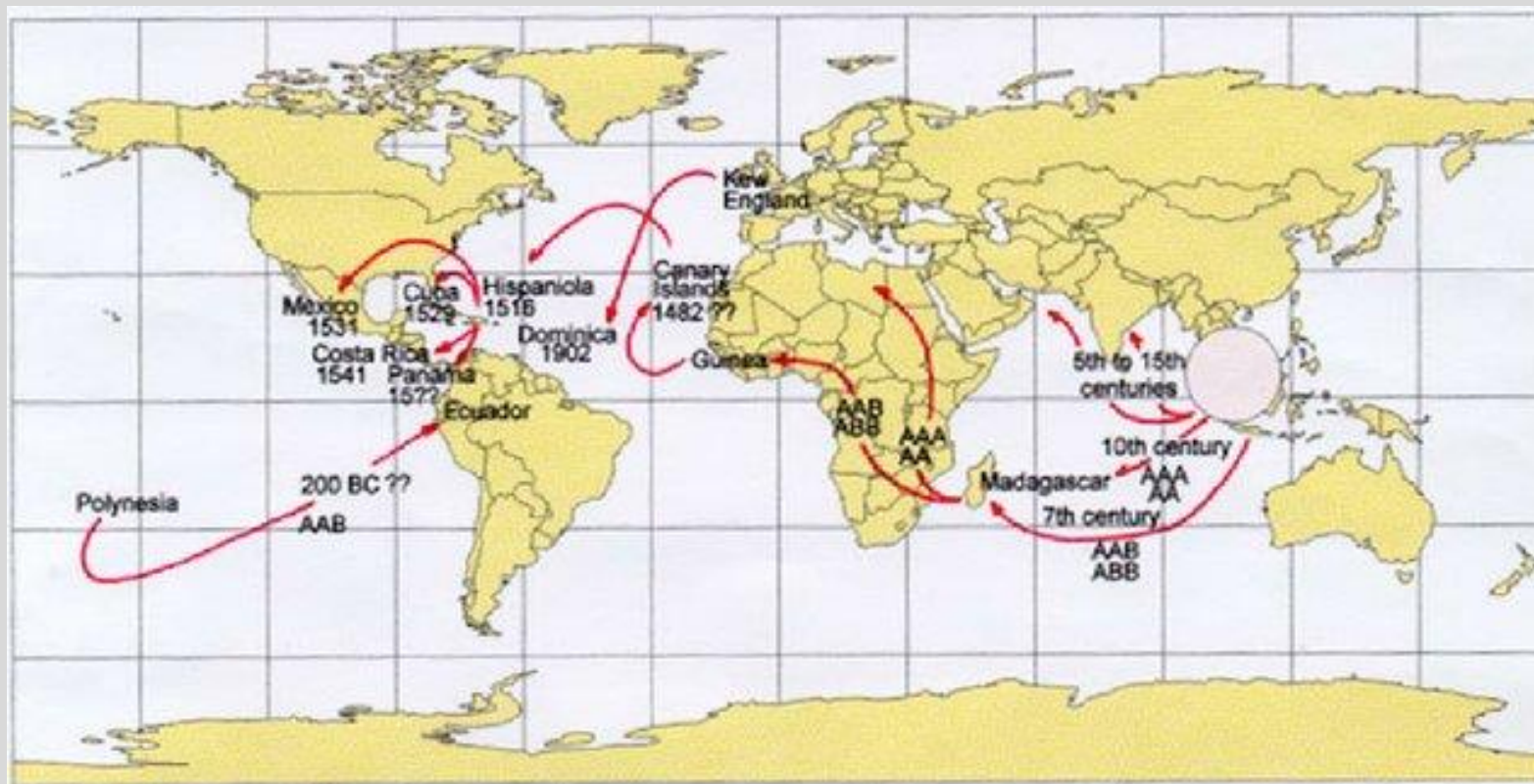


Nematoide

+Cacho

+Vento

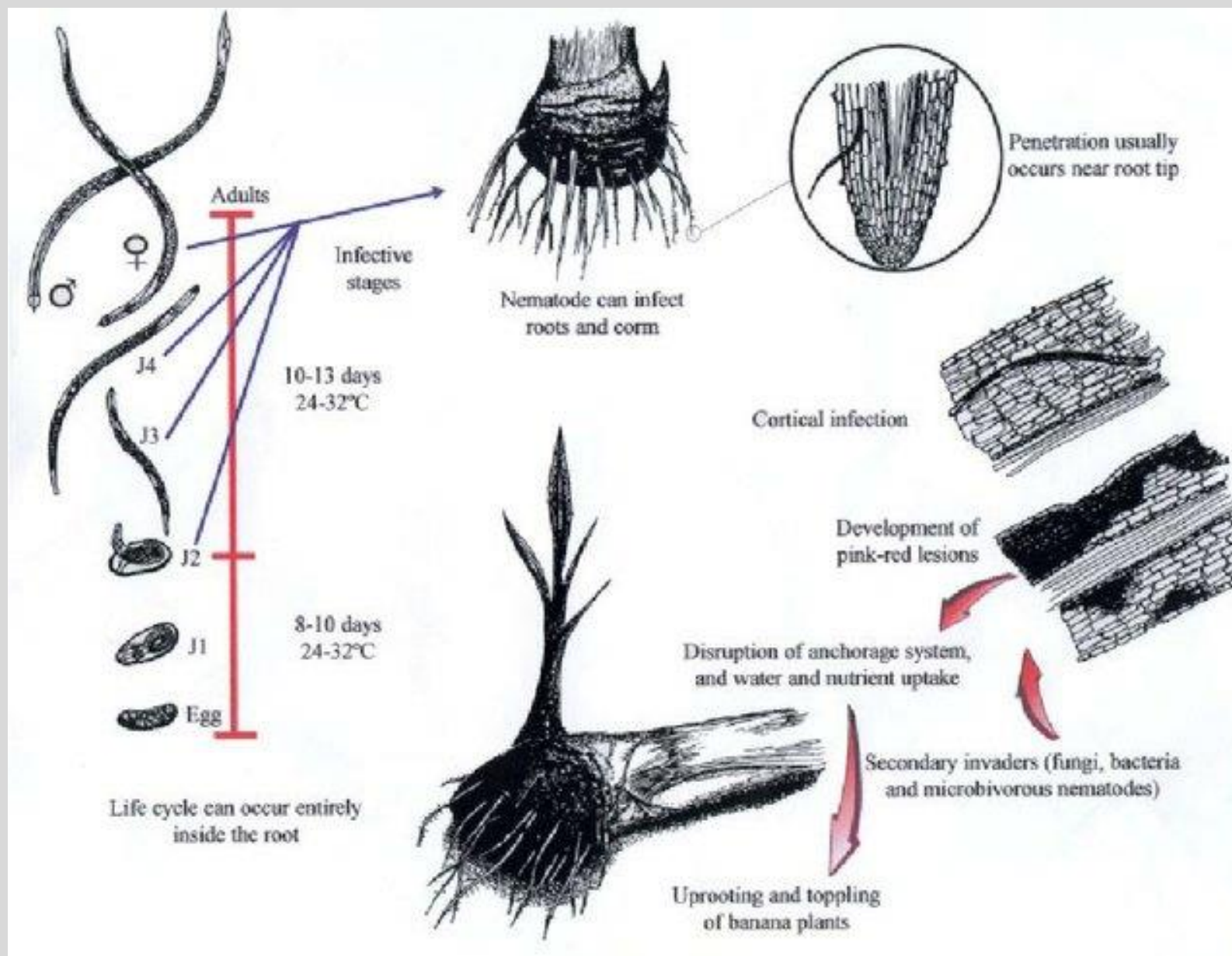
<https://www.hfbrasil.org.br/br/banana-cepea-ventania-atinge-banana-is-no-vale-do-ribeira-061118.aspx>



https://www.researchgate.net/publication/249303227_Dissemination_of_Bananas_in_Latin_America_and_the_Caribbean_and_Its_Relationship_to_the_Occurrence_of_Radophouls_similis/figures?lo=1

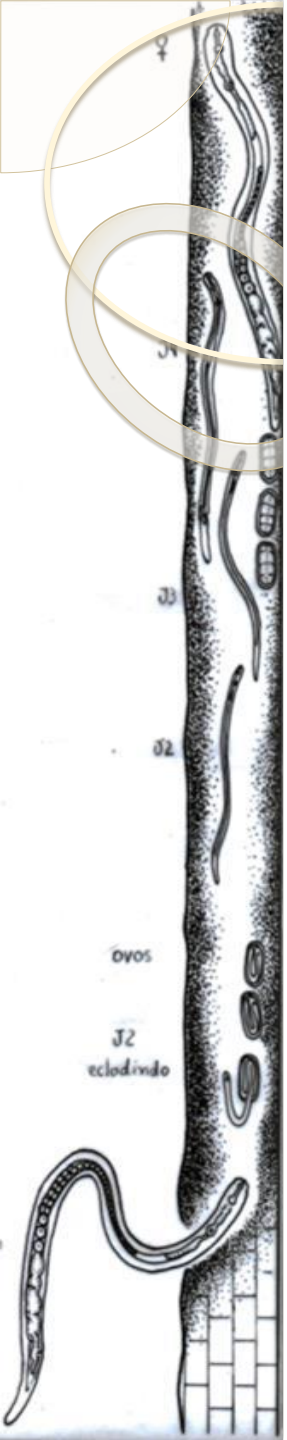
Austrália e ilhas da Oceania (Fiji, Nova Caledônia) são o centro de origem do gênero *Radopholus*

R. similis foi disperso por mudas de bananeira



https://www.researchgate.net/publication/249303227_Dissemination_of_Bananas_in_Latin_America_and_the_Caribbean_and_Its_Relationship_to_the_Occurrence_of_Radophouls_similis/figures?lo=1

Perguntas?



Controle

Preventivo

Tratamento de mudas
Mudas de laboratório

Áreas em produção

Nematicidas
Escoramento
Adubação orgânica

Medidas adicionais

Controle de invasoras
Cobertura vegetal
Valas de contenção de água
Manejo da touceira / desbrote

Tratamento de Mudas



Fig. 5-2. Hot water tank with heater and temperature-control device.



Fig. 5-3. Roots of banana keiki infected with plant-parasitic nematodes are wrapped in solarization plastic so as to suppress pests and pathogens. Control was wrapped in black plastic.

Mudas de Laboratório



<http://www.multipianta.com.br/>



<https://www.embrapa.br/busca-de-noticias/-/noticia/49343503/hidroponia-reduz-tempo-de-producao-de-mudas-de-banana-nas-biofabricas>

Nematicidas

R. similis

Fostiazato
Terbufós

Bacillus licheniformis + *B. subtilis*

M. incognita
M. javanica

Vários biológicos



Figura 3. Localização do adubo nas bananeiras: Planta nova (A) e Planta adulta (B).



Phytochemical control of *Radopholus similis* in banana by *Azadirachta indica* and *Allium sativum* extracts

Ezra S. Bartholomew¹, Richard A.I. Brathwaite¹ & Wendy-Ann P. Isaac^{1*}

¹ Department of Food Production, The University of the West Indies, St. Augustine, Trinidad and Tobago

*email: wendy-ann.isaac@sta.uwi.edu

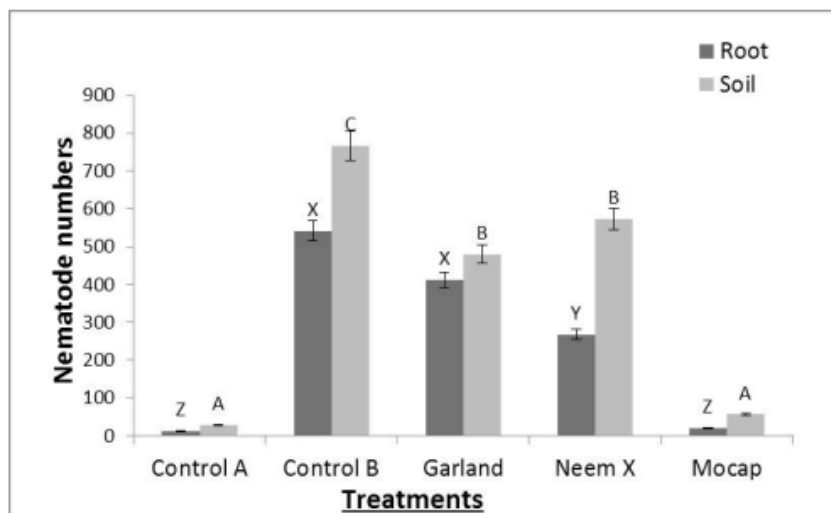


Figure 1. Effects of nematicidal treatments on *R. similis* density in the roots and soil of banana plants. Values are the average of 6 replicates. Bars with the same letter are not significantly different ($P > 0.05$).

Table 2: Mean roots necrosis index values and root and corm fresh weight (kg).

Treatments	Mean Necrosis Index		Mean Root and Corm Weight (kg)	
	Trial 1 (SD)	Trial 2 (SD)	Trial 1 (SD)	Trial 2 (SD)
Control A	1.33 (0.52)	1.83 (0.75)	2.2 a (0.75)	2.1 a (1.11)
Control B	2.67 (0.75)	2.17 (0.75)	1.4 b (0.58)	1.6 b (0.80)
Garland	2.17 (0.82)	1.83 (0.98)	1.6 b (0.60)	2.2 a (1.24)
Neem-X	1.83 (0.75)	1.67 (0.82)	1.8 ab (0.71)	2.1 a (0.56)
Mocap	1.83 (0.98)	2.17 (0.98)	2.0 a (0.33)	2.1 a (1.14)

Escoramento



Fig. 5- 1. An old banana farm with plants propped up with sticks to avoid toppling due to severely nematode-damaged root systems that cannot handle heavy bunch weight.

<https://cms.ctahr.hawaii.edu/wangkh/Research-and-Extension/Banana-IPM/Guidebook/CHPT5-IPM-Nematodes>



Figura 10. Escoramento da bananeira utilizando fita de polipropileno.

<https://www.infoteca.cnptia.embrapa.br/infoteca/bitstream/doc/1015213/1/DOC21429114AnaLucia20152APEM12052015.pdf>

Controle de Invasoras

MANEJO INTEGRADO DE MALEZAS



Figura 6. Principales arvenses hospedantes de *R. similis* en la Granja Montelindo de la Universidad de Caldas (Colombia). A. *Borreria laevis*. B. *Phyllanthus corcovadensis*. C. *Lantana camara*. D. *Sida acuta*.

Cobertura Vegetal



Association of bananas with the perennial legume *Neonotonia wightii*. © Jean-Michel Risède, CIRAD, France.



Left: Shade-tolerant *Impatiens* do not compete with banana and are being tested in the highlands of Guadeloupe. In addition to being unsuitable for the build up of *R. similis* populations, *Impatiens* species may lessen or even avoid herbicide applications. © Jean-Michel Risède, CIRAD, France.

https://agritrop.cirad.fr/553878/1/document_553878.pdf

Valas de Contenção de Água

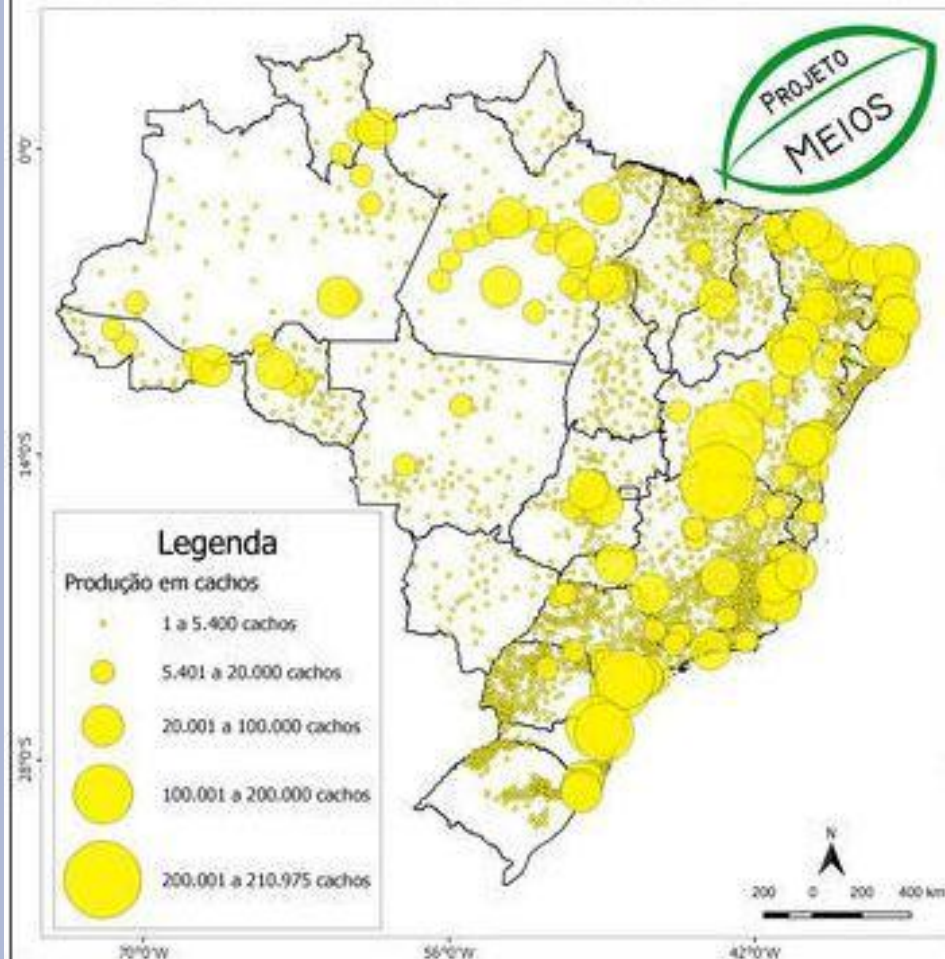


Water isolation ditches to delay the recontamination of fallows and plots that have already been sanitized: Run-off water from nematode-infested banana plots can disseminate *R. similis* and re-contaminate sanitized plots. As a consequence, fallows being sanitized and plots that are already sanitized must be protected against incoming water from nematode-infested plots. Digging 50-80cm deep ditches around plots efficiently prevents the dispersion of *R. similis*. In this way, re-infestation of banana fields by parasitic nematodes can be reduced and delayed by more than three years.

Perguntas?

Outros Nematoides *da* Bananeiras no Brasil

Brasil Produção de cachos de bananas. 2018



Principais Produtores

São Paulo	1.061.410 ton.
Bahia	825.422 ton.
Minas Gerais	766.966 ton.
Santa Catarina	709.127 ton.
Pernambuco	429.338 ton.
Pará	423.383 ton.

Organização: Projeto Meios - projetomeios@gmail.com
Sistema de coordenadas geográficas / datum SIRGAS 2000
Fonte: IBGE - Instituto Brasileiro de Geografia e Estatística
PAM - Produção Agrícola Municipal (2018)

<https://www.facebook.com/noticiascartograficas/photos/a.1608058286105253/2725704487673955/?type=3>

Área 457 mil ha (IBGE, 2020)

Valor 8,6 bilhões reais

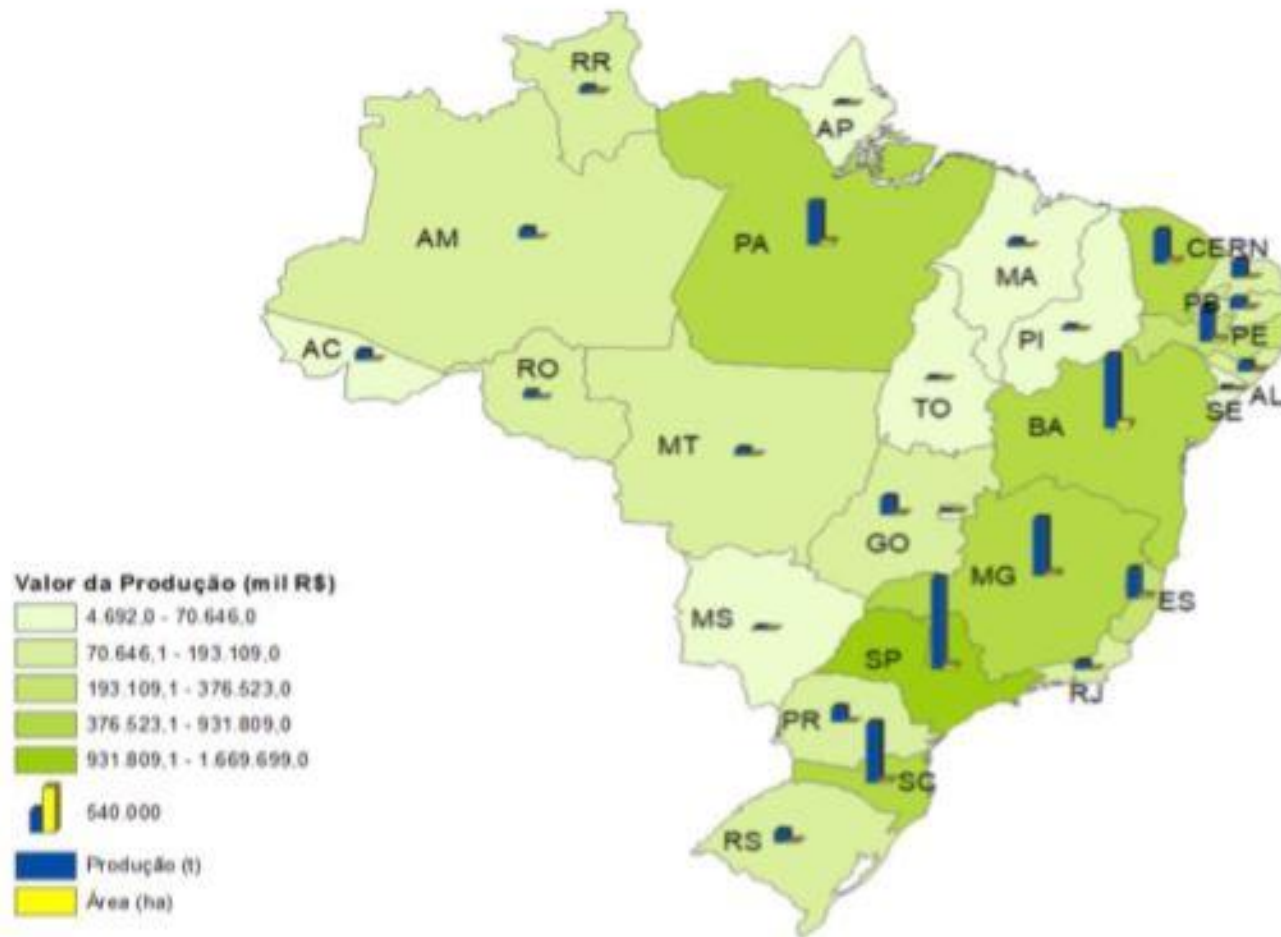


Figura 2 - Distribuição Espacial da Produção, Área e Valor da Produção de Banana, Unidade Federativa, Brasil, 2017
Fonte: INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA. Produção Agrícola Municipal. Rio de Janeiro: IBGE, 2019.
Disponível em: <https://www.ibge.gov.br/>. Acesso em: 17 jun. 2019.

Meloidogyne spp.



https://www.researchgate.net/publication/319677494_Pochonia_chlamydosporia_Microbial_Products_to_Manage_Plant-Parasitic_Nematodes_Case_Studies_from_Cuba_Mexico_and_Brazil



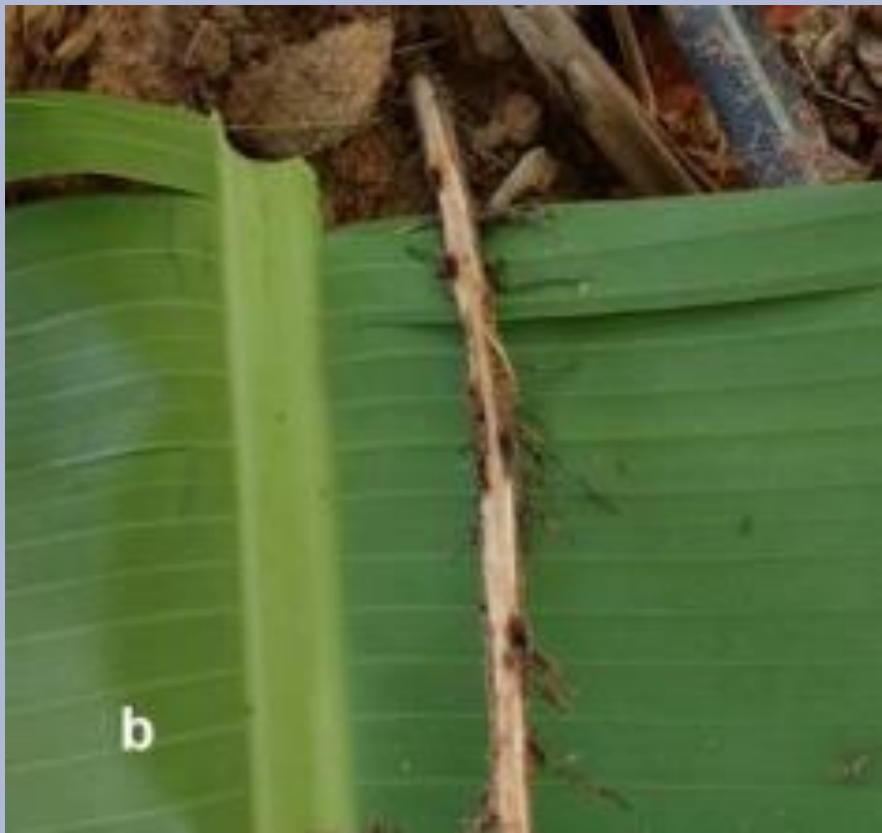
Figure 22. Banana roots infected with *Meloidogyne* spp. showing irregular root disfigurement and swollen roots, which are necrotic and blackened in places; females surrounded by necrotic tissue (halo's) observable in split root.



Figura 56 – Tombamento de plantas pelo ataque de nematoides (A). Dano provocado pelo *R. similis* em raízes (B). Dano provocado pelos *Helicotylenchus* spp. em raízes (C). Dano provocado pelos *Helicotylenchus* spp. em raízes (D).

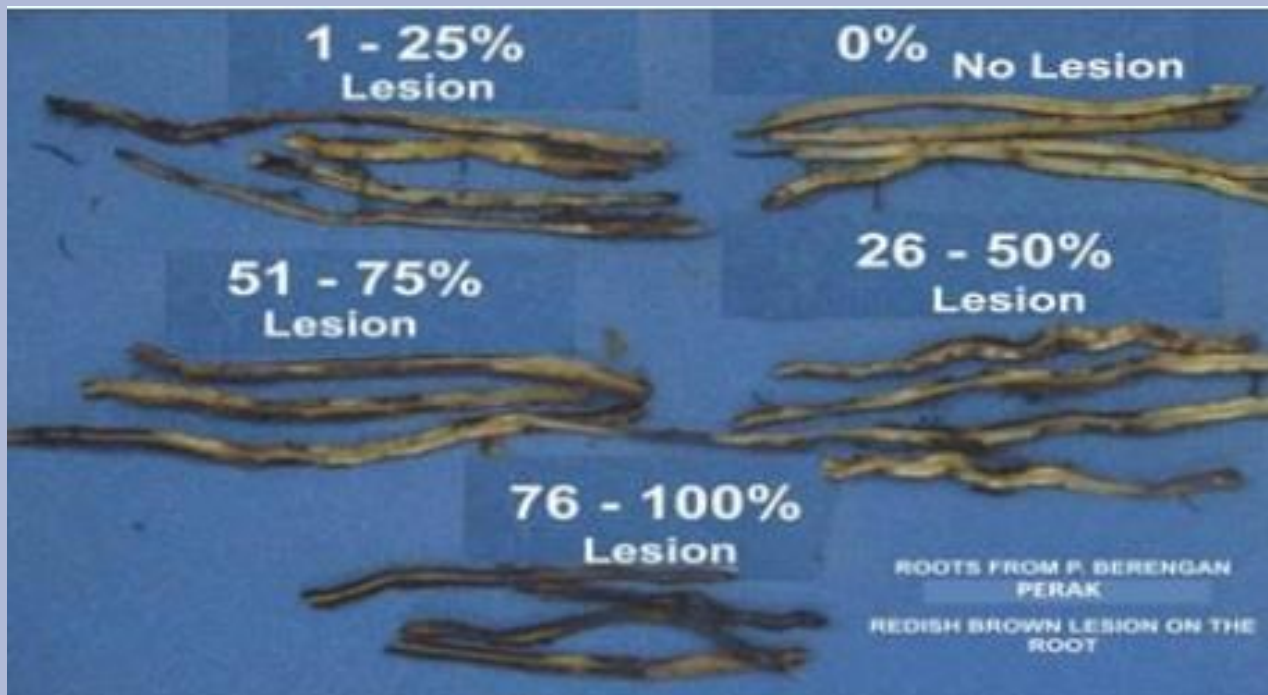
Fotos: Raul Soares Moreira e Edson Shigueaki Nomura

Helicotylenchus multicinctus



<https://www.ifbaiano.edu.br/unidades/guanambi/files/2019/04/Ant%C3%B4nio-Lopes-de-Souza.pdf>

Pratylenchus coffeae



https://plantpathologyquarantine.org/pdf/PPQ_9_1_2.pdf



Figure 20. Stunting/reduced height of plantain (plants on left) caused by *Pratylenchus coffeae*.

https://www.researchgate.net/publication/316788019_Banana_Diseases_and_Pests_Field_Guide_for_Diagnostics_and_Data_Collection_Improvement_of_banana_for_smallholder_farmers_in_the_Great_Lakes_Region_of_Africa_Improvement_of_banana_for_smallholder_farmer

Infestações Mistas

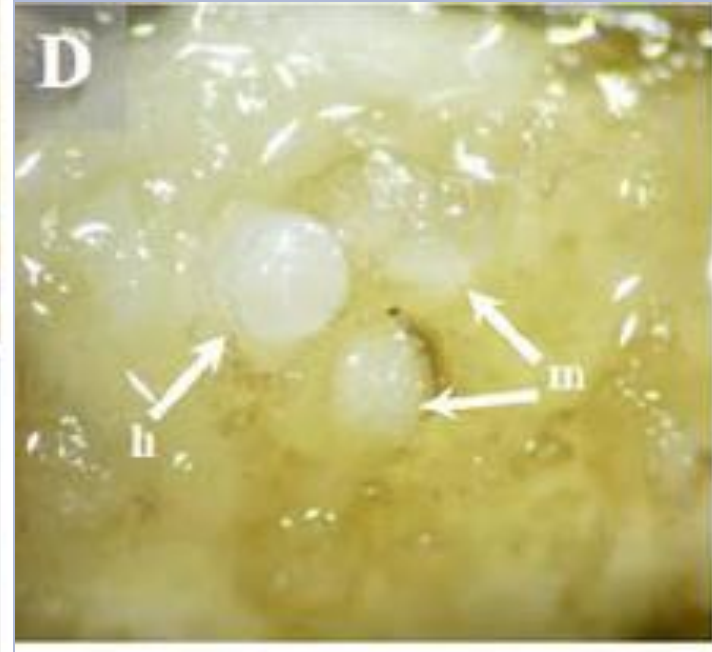
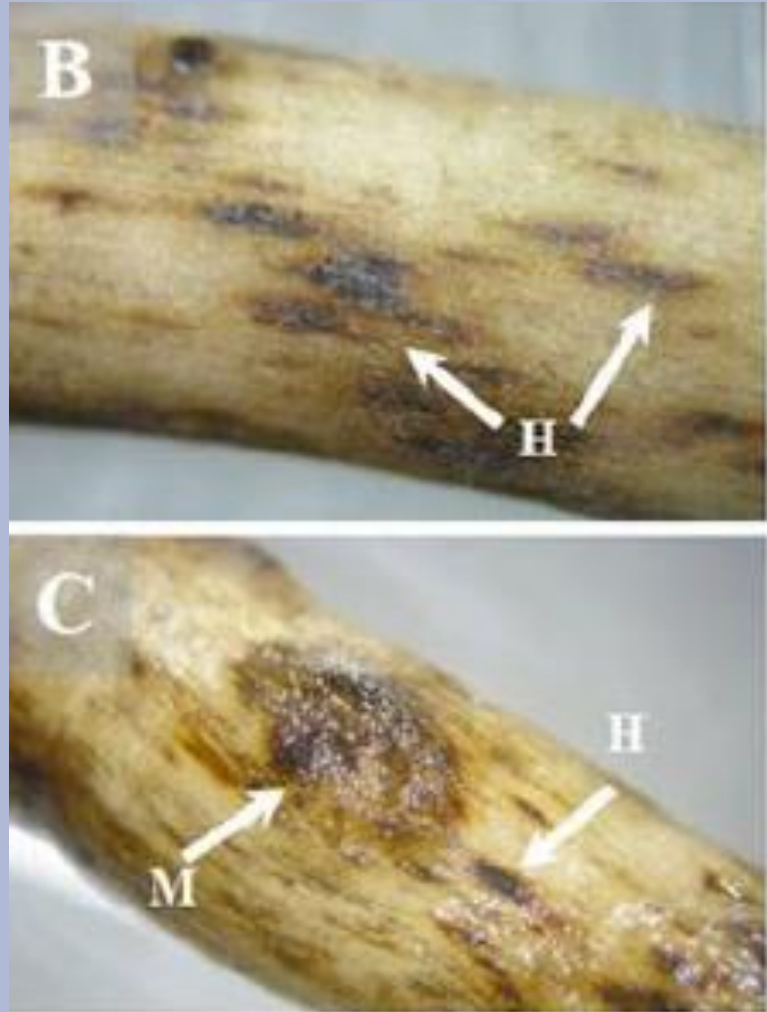


TABELA 2. FREQUÊNCIA ABSOLUTA E DENSIDADES POPULACIONAIS MÉDIA E MÁXIMA DOS NEMATÓIDES EM AMOSTRAS DE RAÍZES E SOLO DE BANANEIRAS NO LESTE DO PARANÁ - 2005/2006

NEMATÓIDE	FREQUÊNCIA (%)		DENSIDADE POPULACIONAL ⁽¹⁾			
			Média		Máxima	
	Raiz	Solo	Raiz	Solo	Raiz	Solo
<i>Helicotylenchus</i>	93	98	453	258	4 080	1 484
<i>Meloidogyne</i>	68	95	71	128	652	624
<i>Radopholus</i>	50	45	548	28	13900	348
<i>Pratylenchus</i>	37	29	286	35	5 760	540
<i>Tylenchus</i>	11	42	1	12	24	200
<i>Aphelenchus</i>	4	4	0	0	12	8
<i>Discocriconemella</i>	1	6	0	1	4	32
<i>Rotylenchulus</i>	0	1	0	0	0	24
<i>Mesocriconema</i>	0	42	0	19	0	272
<i>Xiphinema</i>	0	7	0	1	0	40
<i>Trichodorus</i>	0	6	0	0	0	24
<i>Hemicyclophora</i>	0	4	0	0	0	16
<i>Scutellonema</i>	0	5	0	4	0	160
NPP ⁽²⁾	96	97	99	213	1 450	1 068

(1) Em 10 g de raiz e 100 cm³ de solo.

(2) Nematóides não parasitos de plantas

FIGURA 11 – COBERTURA DO SOLO COM *Impatiens balsamina* EM BANANAIS DA REGIÃO LESTE DO PARANÁ - 2005/2006

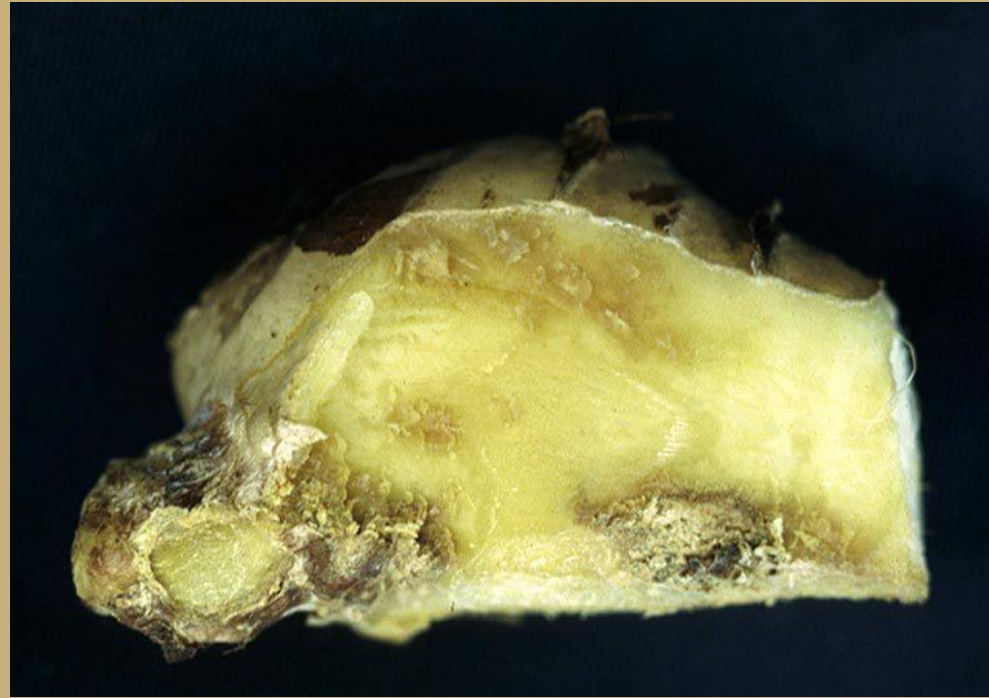


FIGURA 12 - GALHAS de *Meloidogyne* spp. EM RAÍZES DE *Impatiens balsamina* EM BANANAIS DO LITORAL DO PARANÁ - 2005/2006



Perguntas?

***Radopholus similis* em Gengibre**
etc



<https://www.ipmimages.org/browse/subimages.cfm?sub=10859>



<http://www.planetorganic.com/web-ginger-piece-100g/10081/>

R. similis ataca as raízes e o rizoma

No rizoma, inicialmente pequenas manchas encharcadas.



Depois, as manchas tornam-se castanhas, coalescem e destroem o rizoma.

http://www.pestnet.org/fact_sheets/ginger_burrowing_nematode_161.htm



Folhas pequenas e amareladas

Perfilhamento e crescimento lento

Ponteiro seca e morre

Maturação precoce

<https://link.springer.com/article/10.1007%2Fs13313-013-0206-2>

Perdas → Danos rizoma

Fiji

Origem de *R. similis* ?



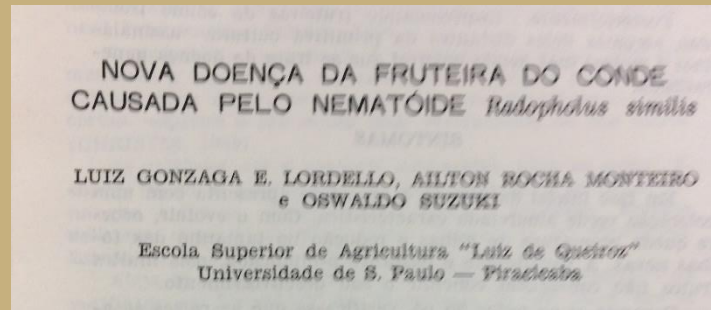
http://www.pestnet.org/fact_sheets/ginger_burrowing_nematode_161.htm

Biribá

Rollinia mucosa (sin. *R. deliciosa*)



http://www.fruitipedia.com/2018/10/biriba_rollinia_mucosa/



1960 Pomar 40 plantas
→ 1 planta sintomática

1961 Metade do pomar
com sintomas

Maranta



<https://www.forestryimages.org/browse/subthumb.cfm?sub=10859>

Nematoídes fitoparasitos em áreas de cultivo de antúrio dos estados de São Paulo, Paraná e Santa Catarina

Plant parasitic nematodes in anthurium growing areas from
São Paulo, Paraná and Santa Catarina States, Brazil

Claudio Marcelo Gonçalves de Oliveiraⁱ Rosana Bessiⁱⁱ Juliana Magrinelli Osório Rosaⁱ
Roberto Kazuhiro Kuboⁱ Antonio Fernando Caetano Tombolatoⁱⁱⁱ

Nematoídes fitoparasitos em áreas de cultivo de antúrio dos estados de São Paulo, Paraná e Santa Catarina. 1351

Tabela 1 – Número de nematoídes fitoparasitos associados ao antúrio, extraídos de 10 gramas de raiz e 250 cm³ de solo.

Espécie	Cultivar de antúrio	Raiz	Solo	Procedência
<i>Helicotylenchus erythrinae</i>	'IAC Isla'	0	310	Caraguatatuba (SP)
	'IAC Netuno'	0	120	Caraguatatuba (SP)
	'IAC Juréia'	0	40	Caraguatatuba (SP)
<i>Helicotylenchus multicinctus</i>	'IAC Isla'	20	100	Caraguatatuba (SP)
	'IAC Juréia'	10	10	Caraguatatuba (SP)
<i>Helicotylenchus californicus</i>	'IAC Netuno'	0	20	Caraguatatuba (SP)
<i>Radopholus similis</i>	'IAC Juréia'	210	10	Pariquera-Açu (SP)
	'IAC Iguape'	110	10	Pariquera-Açu (SP)
	'IAC Isla'	30	10	Pariquera-Açu (SP)
	'Anthur Champion'	620	10	Pariquera-Açu (SP)
	'IAC Isla'	620	10	Caraguatatuba (SP)
	'IAC Netuno'	363	10	Caraguatatuba (SP)
	'IAC Juréia'	230	10	Caraguatatuba (SP)
<i>Meloidogyne paranaensis</i>	'IAC Eidibel'	1000	50	Pariquera-Açu (SP)
	'IAC Astral'	18000	120	Pariquera-Açu (SP)
<i>Paratylenchus</i> sp.	'IAC Eidibel'	120	0	Garuva (PR)
	'IAC Luau'	60	0	Garuva (PR)
	'IAC Eidibel'	230	140	Joinville (SC)
	'IAC Juréia'	10	10	Joinville (SC)



1. Healthy young anthurium plant with a good root system.



2. Typical root rots caused by the burrowing nematode on several anthurium plants. Note the extensive, brown root rots, yellow leaves, and stunted plants.

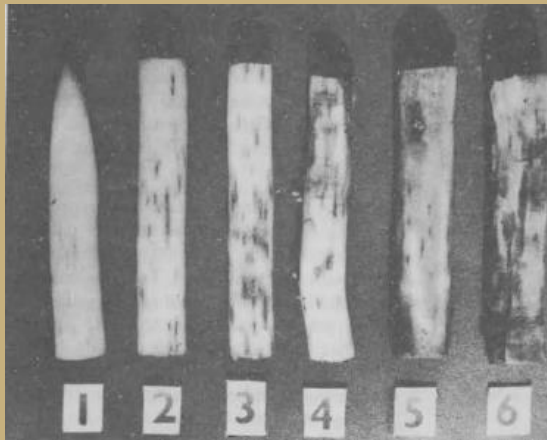
<https://www.ctahr.hawaii.edu/oc/freepubs/pdf/PD-24.pdf>

Coqueiro

Cocos nucifera



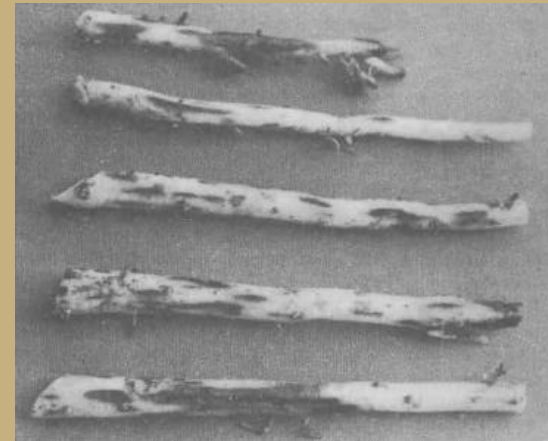
[http://www.cpsskerala.in/OPC/pages/Coco nutPestBurrowingnematode.jsp](http://www.cpsskerala.in/OPC/pages/Coco%20nutPestBurrowingnematode.jsp)



Koshy et al. (1990) MANAGEMENT OF NEMATODE DISEASES IN COCONUT AND ARECA UT BASED FARMING SYSTEMS

Areca

Areca catechu



Koshy et al. (1990) MANAGEMENT OF NEMATODE DISEASES IN COCONUT AND ARECA UT BASED FARMING SYSTEMS

Importante em palmáceas na Índia

Sem registro em palmáceas no Brasil

Perguntas?

Bom Almoço!