Final Report : Sugar Research and Development Corporation

Title of project: Preparation of a CD-Rom library of plant parasitic nematodes

Project references number: SAI001

Name of the Research Organisation: South Australian Research and Development Institute (SARDI)

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Executive summary

Plant parasitic nematodes are of considerable importance to all cropping industries within Australia. Losses caused by plant parasitic nematodes currently recorded in Australia is estimated at between $300 to 450 million. The correct identification of nematodes is essential not only in developing risk management programs, but also for preventing the introduction of plant disease. This project affected Program 3.1 (Crop Protection) within the program SRDC and assists with the design and implementation of pest monitoring systems by developing a CD-Rom for the identification of plant parasitic nematodes and the symptoms they cause. The CD-Rom provides information regarding specific nematode pests and their distribution, host range, symptoms and life cycle. It is also the first step in identifying potential nematode problems by researchers in state government agricultural organisations and AQIS. It can be used as a training tool for personnel interested in plant disease and quarantine. Diagrams and photographs are included in the CD-Rom to explain characteristics of the groups of plant parasitic nematodes recorded from Australia and illustrate the disease symptoms they cause.

The CD-Rom is designed in a similar way to a Web Site. It contains sections on Techniques, Nematodes and Crops which can be accessed by clicking on icons or headings. Each page contains an index to assist with navigating within the page to areas of particular interest

The main outputs of this project have been the CD-Rom and a new edition of "Plant Parasitic Nematodes – sugarcane". The CD-Rom is to be formally launched at the 3rd Australasian Soilborne Disease Symposium at Tanunda in February, 2004. The availability of the CD-Rom will be published in growers magazines such as the Sugarcane Growers Magazine and will be available for sale in November, 2003. A diagnostic service has been made available during this project which was advertised using a pamphlet (Appendix B). This service provided specimens of sugarcane nematodes for description in the CD-Rom.

The CD-Rom will provide training and educational benefits to researchers and industry members and provides information concerning identification and control methods, that will assist with management strategies and allow incursion risks to be assessed. With increased understanding of the role of nematodes in sugarcane crops, cost reduction and economic savings will occur.

Background

Plant parasitic nematodes are an important limiting factor in the production of sugarcane in Australia. Losses caused by nematodes in the sugarcane industry in 1992 were estimated at $13 million (Stirling et al, 1992). Within this review article, it was noted that nematodes had not been studied extensively in sugarcane crops and that, with the use of nematicides, yields could be increased by 20 – 30% depending on soil type. In a recent survey of sugarcane crops in southern Queensland (Blair et al 1999), 100% of crops were found to have root lesion nematode present (*Pratylenchus zeae*) and over 60% were found to have root knot nematode (*Meloidogyne* sp). Other plant parasitic nematodes were also present and their effect is still to be determined.

While several damaging pests have been identified in Australia there are many recorded overseas but not in Australia. These include tropical cyst nematode species (*Heterodera oryzae* and *H. sacchari*) as well as *Hirschmaniella* species (related to the root lesion nematodes). Constant monitoring of nematode pests is required to prevent incursions into Australia and assess existing nematode pests. To achieve this correct identification is essential. Accurate identification of species of nematodes requires the collection of information concerning the morphology and measurements characteristic of these species. Training in nematode techniques for species identification takes over eight years and retention of skilled personnel is an ongoing problem.

To aid in training and provide information about the plant parasitic nematodes recorded from sugarcane in Australia, a CD-Rom was developed within this project which provided information about nematode species (measurements and morphology), host plants, disease symptoms, illustrations, life cycle an dimages of nematodes specimens. Control strategies were also included where available. Material for inclusion in the CD-Rom was obtained from the literature, fellow researchers and collections from the field. Samples were also obtained from the field as part of the diagnostic service. The project also included updating a new edition "Plant parasitic nematodes of Australia – sugarcane".

References used:
Stirling G.R., Stanton J.M and Marshall J.W. (1992) The importance of plant parasitic nematodes to Australian and New Zealand agriculture. Australasian Plant Pathology 21: 105 – 115.
Blair B.L., Stirling G.R. and Whittle P.S.L (1999) Distribution of pest nematodes on sugarcane in south Queensland and relationship to soil texture, cultivation, crop age and rotation. Australian Journal of Experimental Agriculture 39: 43 – 49.

Objectives as stated in the original proposal, and a statement of the extent to which the project has achieved them.

- To develop a CD-Rom library of nematodes found in Australian sugar, cropping, viticultural, horticultural industries and pasture systems as well as provide information about potential plant-parasitic nematode threats from other countries. The CD-Rom will be ready for publishing by the end of November 2003 and launched at the 3rd Australasian Soilborne Diseases Symposium.
- To provide diagnostic expertise and aid in the prevention and monitoring of exotic plant parasitic nematode incursions into Australia. The diagnositic service was available to growers and researchers for the duration of the project.
- To retain nematode taxonomy skill base. The taxonomist was retained for the duration of the project
- To publish a new edition of "Plant Parasitic Nematodes of Australia – sugarcane". The new edition is included with this report and will be formally launched with the CD-Rom in February at the Disease Symposium above.

Methodology.

Database/Datsheets

The information contained within the CD-Rom concerning plant parasitic nematodes was collected from published articles in scientific journals. For each species, articles containing the original description or re-description/recent publication including measurements, was obtained and datasheets filled in. The proforma for these datasheets is presented in Appendix D. Information from these datasheets were then added to a database program purchased specifically for this project (BIOTA -). The database program allowed images to be added for each dataset to allow important characteristics used in species identification to be recorded.

The CD-Rom

The CD-Rom was designed to resemble a Web Site, with sections linked to pages. HTML was used and the CD-Rom was edited using Microsoft Front Page. As there are sometimes problems with microsoft programs and alternate computer systems, specific Microsoft commands were removed.

The CD-Rom is separated into sections (Appendix A) on Techniques, Nematodes and Crops. The Techniques section includes a Glossary which provides a definition of specific nematological terms used, an Appendix which details the main characters used in identifying species within genera and a page which allows access to datasheets for those plant parasitic nematodes recorded from grain, vegetable and sugarcane crops in Australia. The Nematode section contains a Control page which includes information about general control strategies used on nematodes, a description of Plant Nematodes page which separates nematodes into their main groupings and explains the defining characters for each group and a page which includes access to the new edition of "Plant Parasitic Nematodes of Australia".

The Crops section is divided into Sugarcane, Vegetables and Grains. For each industry, information is given on the importance of plant parasitic nematodes to the industry, how nematodes are controlled, what plant parasitic nematodes are of importance in Australia, some of the important plant nematodes occurring overseas. Fact sheets with information about the major species of plant parasitic nematodes provides information on the lifecycle, disease symptoms and damage, host range, distribution in Australia and comments about its importance.

"Plant parasitic nematodes of Australia – sugarcane"

The new edition of "Plant Parasitic Nematodes of Australia – sugarcane" provides information about the plant parasitic nematodes recorded from sugarcane in Australia. This information is provided in the form of lists. The Table of contents is provided in Appendix C. List 1 includes information concerning the distribution of sugarcane nematodes within Australia (grouped by state). List 2 details with plant parasitic nematodes recorded from Australia (grouped by nematode species). List 3 supplies information on the species of plant parasitic nematodes recorded from sugarcane overseas, reported to occur in Australia but not on sugarcane. List 4 provides information on the plant parasitic nematodes recorded from sugarcane overseas but not recorded in Australia. This edition is undergoing final editing and will be printed in November 2003. List 5 provided information (obtained from CAB Abstracts) concerning the countries which the nematodes in List 4 have been reported, not always from sugarcane.

Diagnostic service

The Diagnostic service was provided throughout the duration of the project free of charge. A pamphlet was prepared to publicise the service (Appendix B). Specimens were used from samples sent by researchers (J. Cobon, BSES; G. Stirling BCP), to illustrate sections of the CD-Rom. Also taxonomic measurements were made to compare with those of published species to confirm species identity.

Outputs

The project has produced a CD-Rom Library of plant parasitic nematodes of sugarcane. It has also retained a skilled nematode taxonomist. The CD-Rom will be published by end of November (currently in the final editing stage) and a minimal cost of $20 per copy will be charged to cover publication costs.

Expected outcomes.

The expected outcome of this project is an increased awareness of the many plant parasitic nematodes present in sugarcane fields as well an appreciation of the skill and knowledge required to identify plant parasitic nematodes to species level. Knowledge of the species of plant parasitic nematodes within soil is essential when determing management strategies. This is especially relevant if application of nematicides is to be reduced. It is recommended that before applying nematicides, levels of plant parasitic nematodes should be assessed as use of nematicides as a routine management strategy is not recommended unless a known nematode problem is present.

Future Research Needs

Monitoring of plant parasitic nematodes within sugarcane crops is required to determine levels of nematodes within the soil and effect of different nematode species on crops. The Techniques and Nematode sections will require updates on the addition of new techniques (especially molecular) and new records of plant parasitic nematodes in Australia. There will also be a need to monitor the literature for information concerning the discovery of new species of nematodes overseas.

Recommendations on activities or other steps to further develop, disseminate or exploit the project outputs and/or to achieve benefits.

It is recommended that the CD-Rom be publicised more in grower magazines and nematology newsletters. With this resource, researchers and growers will be able to better understand the role of plant parasitic nematodes in sugarcane crops. The Control section of the CD-Rom may need to be updated as management strategies change with continuing research into nematodes as pests of sugarcane.

List of publications arising from the project.

Walker G.E., Cobon J. and **Nobbs J.M.** (2002) "New Australian Record for *Meloidogyne javanica* on *Portulacea oleracea*." Australasian Plant Pathology 31 : 301

Nobbs J. M., Liu Q., Hartley D., Handoo Z., Williamson, Taylor S., Walker G. and Curran J. (2001). "First record of *Meloidogyne fallax* in Australia". Australasian Plant Pathology 30 : 373

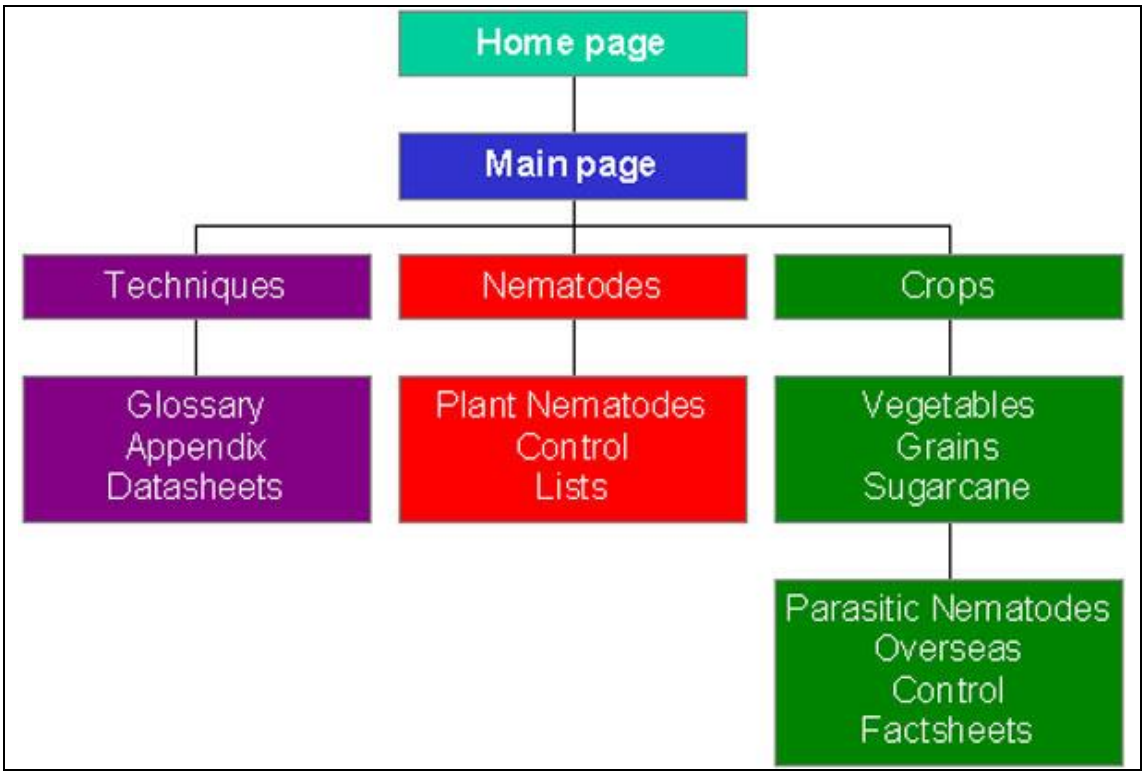
Nobbs J. and Taylor S.P. (2001) "Production of a CD-Rom for disseminating information about plant parasitic nematodes in Australia." 13th Biennial Plant Pathology Conference, Cairns Australia.

Nobbs J., Hartley D., Liu Q., Williamson V., Handoo Z. and Taylor S.P. (2001) "A new record of Meloidogyne fallax in Australia. " 13th Biennial Plant Pathology Conference, Cairns Australia.

Zahid M. I., **Nobbs, J.**, Gurr G. M., Hodda M., Nikandrow A., Fulkerson W. J. and Nicol H. I. (2001) "Effect of the clover root-knot nematode (*Meloidogyne trifoliophila*) on growth of white clover" *Nematology* 3 (5) , 437 – 446.

Zahid M.I., **Nobbs J.**, Stanton J.M., Gurr G.M., Hodda M., Nikandrow A. & Fulkerson W.J. (2000) "First Record of *Meloidogyne trifoliophila* in Australia" Australasian Plant Pathology 29 : 280

Appendix A : Outline of CD-Rom : Plant parasitic nematodes of Australia.



The home page within the CD-Rom gives a brief explanation of the purpose of the CD-Rom and how to navigate through the various sections. The Main page provides explanation of the layout of the CD-Rom and a description of each section.

The CD-Rom is divided into three main sections. Each section has its own colour which is repeated in the colour of headings and borders for each page within that section.

Appendix B: Pamphlet advertising Diagnostic Service

Appendix C: Content page for New edition of "Plant Parasitic Nematodes of Australia – sugarcane".

Appendix D : Proformas for the datasheets – General plant parasitic nematode.

Species Code:	Family
Genus	
Species	
Author & Publication	
Type Host	
Type Locality	
Location in Australia	
Location around world	
Measurements :- • Female – Body length Stylet length Tail Length %V c' Lip annules Tail annules Shape on death Position of phasmid • Male - +/- Body Length Stylet Spicules Gubernaculum Capitulum	
Female	
Male	

Description Female : Male : Juvenile :
Location in Australia :

Plant parasitic nematodes recorded from sugar cane in Australia

First edition 2003

Compiled by J. M. Nobbs

Acknowledgements

The lists presented in this edition relate to plant parasitic nematodes recorded from sugar cane throughout the world. The first list details information about plant parasitic nematodes recorded from sugarcane in Australia. List 2 details information concerning those plant parasitic nematodes that have been recorded from all plants in Australia. List 3 details those plant parasitic nematodes that have been recorded from sugar cane overseas but not in Australia and list 4 details nematodes recorded on sugarcane that have been reported overseas but not in Australia. List 5 contains information about the countries from which those nematodes recorded from sugarcane overseas but not in Australia have been recorded from (not always reported from sugarcane).

Resources and funding from the Sugar Research and Development Corporation (project number AA0001) has made this compilation possible.

We acknowledge the foundation work provided by G.T. Khair's original edition of "List of plant parasitic nematodes of Australia" and the list compiled in 1994 by R. McLeod et al "Plant Nematodes of Australia listed by plant and by genus".

We thank the many colleagues who assisted including Graham Stirling (Biological Crop Protection, Queensland), Jenny Cabon (Queensland Depatment of Primary Industry) and Brendon Blair (Queensland Depatment of Primary Industry) who have provided information for inclusion. The CABI Nematology Abstracts were searched for plant parasitic nematodes reported to occur on sugar cane overseas.

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Plant parasitic nematodes recorded from sugar cane in Australia

First edition 2003

Compiled by J. M. Nobbs

PRIMARY INDUSTRIES AND RESOURCES SA

Introduction

The following publications were used to compile plant parasitic nematodes present in Australia on sugarcane:-

Johnson T. H. (1938) – A census of the free-living and plant parasitic nematodes recorded as occurring in Australia. *Transactions of the Royal Society of Australia* 62: 149 – 167

Blake C. D. (1963) – Identification and distribution of root knot nematodes (Meloidogyne) in New South Wales with special references to the Richmond-Tweed region. *Proceedings of the Linnean Society New South Wales* 88: 373 – 378

Colbran R. C. (1964) – Studies of plant and soil nematodes. 7. Queensland records of the order Tylenchida and the genera Tricodorus and Xiphinema. *Queensland Journal of Agricultural Science* 21: 77 – 123

McLeod R. W (1979) – *Plant and soil nematodes found in New South Wales.* Science Bulletin 87, Department of Agriculture New South Wales

Khair G. T. (1981) - *List of plant parasitic nematodes of Australia.* Australian Plant Quarantine Service, Canberra

Khair G. T. (1986) – *List of plant parasitic nematodes of Australia.* Third Edition, Department of Primary Industries, Canberra

McLeod R., Reay F. and Smyth J. (1994) – *Plant Nematodes of Australia listed by plant and by genus*. RIRDC. 201 pages.

Blair B.L., Stirling G.R. and Whittle P.J.L. (1999) Distribution of pest nematodes on sugarcane in south Queensland and relationship to soil texture, cultivar, crop age and region. *Australasian Journal of Experimental Agriculture* **39** : 43 – 9.

Stirling G., Nicol J. & Reay F. (1999) – *Advisory Services for Nematode Pests.* Operational Guidelines. RIRDC publication No 99/41.

Stirling G.R., Blair B.L., Pattemore J.A., Garside A.L. and Bell M.J. (2001) Changes in nematode populations on sugarcane following fallow, fumigation and crop rotation and implications for the role of nematode in yield decline. *Australasian Plant Pathology* **30** : 323 - 335

The publication includes records of nematodes associated with plants or soil extracts received for diagnostic or research purposes as well as those published as new descriptions and research papers. Identifications of host were compiled based on the predominant plant type or vegetable crop present at sampling and, therefore, may not indicate the primary host for the nematode species.

This edition provides information concerning all the plant parasitic nematodes recorded from sugarcane in each Australian state. It also provides records of other plant parasitic nematodes and where they occur within states. All lists are arranged in alphabetical order using scientific names.

No attempt has been made to authenticate the identifications. If specimens are required, contact needs to be made first with the relevant State Department of Agriculture, then the main collections of nematodes held in Brisbane (QLD), Knoxfield (VIC), Canberra (ACT) or Waite (SA).

Many of the most damaging species of plant parasitic nematodes to sugarcane have been recorded from Australia. The exceptions are *Heterodera sacchari, H. oryzae, Meloidogyne brevicauda, M. coffeicola, M. inornata, Hirschmaniella spinicaudata* and *H. oryzae*. Within this publication there are records which do not identify specimens to species level and require more thorough identification.

The naming of nematodes has been based upon information from *The Catalog of the Order of Tylenchida (Nematoda)* by E.B. Ebsary (1991), Agriculture Canada for the members of the Tylenchida and *Aphelenchida*, *Longidoridae and Trichodoridae* by D.J. Hunt (1993), CAB International, for the Longidoridae, Trichodoridae and Aphelenchidae.

Naming of plants has been based upon information from *CSIRO handbook of Economic plants of Australia* edited by L. Lazarides and B. Hince CSIRO publications (1993) and the *Australian Plant Name Index Australian Flora and Fauna Series* by A.D. Chapman, Australian Government Publishing Service (1992).

Naming of localities has been based upon *Australian 1:250,000 Map Series Gazetter* published by the Australian Government Publishing Service, 1975.

Funding for this publication has been provided through the Sugar Research and Development Corporation, SAI001.

List 1 : Records of plant parasitic nematodes on sugar cane : occurrence within states.

(QLD = Queensland, WA = Western Australia, NSW = New South Wales).

Achlysiella williamsi
QLD : Innisfail, Mackay, Burdekin area

Aphelenchoides coffeae
QLD : Ayr

Aphelenchoides sp.
QLD : Ayr

Aphelenchus avenae
QLD : Ayr, Ingham, widespread within Australia, often the most commonly found fungal feeder in soil

Hemicycliophora truncata
QLD : Brisbane

Ditylenchus anchilospomosus
QLD : Imbil

Filenchus minutus
NSW : Harwood

Filenchus uniformis
NSW : Harwood

Helicotylenchus dihystera
NSW : Harwood, Broadwater
QLD : Bundaberg, Coolum, Tully, Mackay

Helicotylenchus erythrinae
QLD : Coastal Queensland

Hemicriconemoides mangiferae
QLD : Pioneer, Lower Burdekin

Hemicriconemoides obtusus
QLD : Bundaberg

Hemicriconemoides squamosus
QLD : Pioneer

Hemicycliophora labiata
QLD : Pioneer, Lower Burdekin

Heterodera sp.
WA : Kununurra

Macroposthonia onoensis
QLD : Mirriwinni, Tully

Macroposthonia ornata
QLD : Nambour, Eight Mile Plains

Macroposthonia sphaerocephala
QLD : Ayr, Pioneer, Lower Burdekin

Macroposthonia sp.
QLD : North Queensland

Meloidogyne arenaria
QLD : Root knot widespread on sugar cane in Queensland. Bundaberg

Meloidogyne incognita
QLD : Root knot widespread on sugar cane in Queensland

Meloidogyne javanica
QLD : Root knot widespread on sugar cane in Queensland. Most common species.

Neopsilenchus magnidens
NSW : Harwood

Paralongidorus sacchari
QLD : Herbert River District, Mossman

Paratrichodorus minor
NSW : Green Forest
QLD : Bli Bli, Eight Mile Plain, southern Queensland

Paratrichodorus porosus
QLD : Eight Mile Plain, Ayr, Childers, Isis, Mackay

Paratrichodorus sp.
NSW : Broadwater

Paratylenchus colbrani
QLD : Burdekin

Pratylenchus brachyurus
QLD : Bundaberg

Pratylenchus zeae
QLD : Widespread on sugar cane in southern Queensland. Tully, Ingham, Burdekin, Mackay, Bundaberg.

Radopholus similis
QLD : Innisfail, Mackay

Radopholus sp.
QLD : Innisfail, North Queensland

Rotylenchulus reniformis
QLD : Bundaberg

Rotylenchulus parvus
QLD : Gympie

Rotylenchulus sp.
QLD : North Queensland

Rotylenchus brevicaudatus
QLD : Imbil, Pioneer, Lower Burdekin

Tylenchorhynchus annulatus
NSW : Harwood
QLD : Yandina, Ayr, Bundaberg, Mackay, Fowler, Tully, Ingham Burdekin.

Tylenchorhynchus claytoni
QLD : Burdekin, Ingham, Mackay

Tylenchorhynchus coffeae
QLD : Fowler, Tully

Tylenchorhynchus sp.
QLD : North Queensland, Tully

Xiphinema americanum
QLD : Russell River

Xiphinema elongatum
QLD : Bundaberg, Pioneer Lower Burdekin, Russell River

Xiphinema monohysterum
NSW : Broadwater, Green Forest

List 2 : Plant parasitic nematodes recorded from Australia and their occurrence by state.

(Abbreviations A = Australian Capital Territory; N = New South Wales, NT = Northern Territory, Q = Queensland, S = South Australia, T = Tasmania, V = Victoria, W = Western Australia)

A

Achlysiella williamsi Q
Acontylus vipriensis V
Acontylus sp. N, S, V
Aglenchus agricola N, Q, W
Anguina australis W
Anguina funesta S, W
Anguina microlaenae N, V
Anguina tritici S, T, V, W
Anguina sp. N, Q, S, V, W
Aphelenchoides besseyi NT, Q
Aphelenchoides bicaudatus N, Q, V, W
Aphelenchoides blastophorus N
Aphelenchoides coffeae N, Q
Aphelenchoides composticola N,Q,V, W
Aphelenchoides dactylocerus V
Aphelenchoides fragariae N, Q, S, T, V, W
Aphelenchoides hylurgi Q
Aphelenchoides limberi N
Aphelenchoides parietinus N, Q, W
Aphelenchoides ritzemabosi N, NT, Q, T, V, W
Aphelenchoides saprophilus N, Q
Aphelenchoides subtenuis Q
Aphelenchoides sp. N, Q, V, W
Aphelenchus avenae N,NT,Q,S,V,W
Aphelenchus sp. NT, Q
Arboritynchus simpsonii N

B

Basiria duplexa Q
Basiria gracilis Q
Basiria graminophila Q
Basiria tumida Q, V, W
Basiria sp. N, Q, W
Belonolaimus lolii N, W
Belonolaimus longicaudatus N, W
Belonolaimus sp. N, V, W
Blandicephalanema bossi N
Boleodorus thylactus Q, V
Boleodorus volutus Q
Boleodorus sp. N, Q, V

C

Cactodera cacti N
Caloosia nudata N, NT, Q, V
Carphodorus bilineatus N, Q
Carphodorus sp. Q
Cephalenchus brevicaudatus N
Cephalenchus emarginatus N, Q
Cephalenchus sp. N
Colbranium truncata N, Q, S, T, V, W
Coslenchus alacinatus W
Coslenchus costatus N, Q, S, W
Criconema eucalypti A
Criconema lanxifrons N, Q, S, V
Criconema mutabile N, Q, S
Criconema pacificum Q
Criconema pasticum N, S, T, W
Criconema permistum Q
Criconema sp. N, Q, S, V, W
Criconemella avicenniae N
Criconemoides sp. N, Q, S, W
Cryphodera eucalypti Q, V
Cryphodera sp. N, Q, V

D

Discocriconemella colbrani Q
Discocriconemella limitanea N, Q
Discocriconemella sp. N, Q
Ditylenchus anchilisposomus N, Q, W
Ditylenchus australiae N
Ditylenchus desctructor T
Ditylenchus dipsaci N, Q, S, T, V, W
Ditylenchus intermedius N, T, V
Ditylenchus myceliophagus N, Q, V
Ditylenchus obesus W
Ditylenchus triformis N
Ditylenchus sp. N, Q, S, V, W

E

Ecphyadophora tenuissima N, Q
Ecphyadophora sp Q
Eutylenchus africanus N, Q
Eutylenchus setiferus A, N, Q
Eutylenchus sp. Q

F

Fergusobia curriei S
Fergusobia fiheri S, V
Fergusobia magna Q
Fergusobia tumefaciens A, N, Q, S, V
Fergusobia sp. Q, S
Filenchus baloghi Q
Filenchus discrepans Q
Filenchus exiguus N, Q

Filenchus filiformis Q, S, T, V
Filenchus infirmus N
Filenchus micoletzkyi N
Filenchus minutus N
Filenchus polyhypnus N, Q
Filenchus thornei Q
Filenchus unifromis N
Filenchus sp. N, Q, V, W

G
Globodera rostochiensis V, W
Globodera sp. Q
Gracilacus mutabilis Q
Gracilacus peperpotti N, Q
Gracilacus steineri N, Q
Gracilacus sp N, NT, Q, S, V, W

H
Helicotylenchus australis W
Helicotylenchus californicus Q
Helicotylenchus digonicus N
Helicotylenchus dihystera N, NT, Q, S, V
Helicotylenchus erythrinae Q, S
Helicotylenchus exallus N, Q, S
Helicotylenchus labiatus NT
Helicotylenchus minzi N, Q
Helicotylenchus multicinctus N, NT, Q, S, T, V, W
Helicotylenchus pseudorobustus S, V, W
Helicotylenchus tumidicaudatus Q
Helicotylenchus variabilis N, Q
Helicotylenchus varicaudatus N, NT
Helicotylenchus sp. N,NT,Q,S,T,V,W
Hemicriconemoides brachyurus NT, Q, W
Hemicriconemoides chitwoodi Q
Hemicriconemoides cocophilus NT,Q, W
Hemicriconemoides communis Q
Hemicriconemoides coronatus N, Q
Hemicriconemoides digitatus Q
Hemicriconemoides insignis N, Q, S, V
Hemicriconemoides intermedius Q
Hemicriconemoides mangiferae N, NT, Q
Hemicriconemoides minor N,S,T,V,W
Hemicriconemoides obtusus N,NT,Q,S,W
Hemicriconemoides squamosus Q
Hemicriconemoides sp. Q, W
Hemicycliophora acuta S
Hemicycliophora arenaria N, Q, S, V
Hemicycliophora biloculata Q
Hemicycliophora brevicauda N, Q, V
Hemicycliophora charlestoni S, T
Hemicycliophora eucalypti S
Hemicycliophora halophila Q, S, V
Hemicycliophora iwia N, W
Hemicycliophora labiata N, Q, S, W
Hemicycliophora litoralis S
Hemicycliophora natalensis N, Q, S, T, V, W
Hemicycliophora ovata N, Q, S
Hemicycliophora saueri V
Hemicycliophora striatula S
Hemicycliophora tesselata S, V
Hemicycliophora thornei N
Hemicycliophora typica S
Hemicycliophora vitiensis N
Hemicycliophora wallacei S
Hemicycliophora sp N, Q, V, W
Heterodera avenae N, S, T, V, W
Heterodera cruciferae S
Heterodera fici N
Heterodera graminis N
Heterodera humuli T
Heterodera schachtii N, Q, S, V, W
Heterodera trifolii N, Q, S, V, W
Heterodera sp. N, Q, V, W
Hexatylus sp. Q
Hirschmaniella diversa Q
Hoplolaimus pararobustus Q
Hoplolaimus seinhorsti NT, Q, W
Hoplolaimus sp N, Q, W
Hoplotylus sp. V

L
Lelenchus leptosoma N, Q
Longidorus elongatus S
Longidorus taniwha S
Longidorus sp. N, Q

M
Macroposthonia caballeroi NT
Macroposthonia curvata N, Q, W
Macroposthonia onoensis NT, Q
Macroposthonia ornata N, NT, Q, W
Macroposthonia rustica Q, S, V, W
Macroposthonia similis N, Q, S, V, W
Macroposthonia sphaerocephala NT,Q
Macroposthonia teres N
Macroposthonia xenoplax N,Q,S,V,W
Macroposthonia sp. N, NT, Q, S, V
Macrotrophurus sp. Q
Malenchus bryophilus N, Q, S
Meloidogyne arenaria N, Q, S, T, V, W
Meloidogyne exigua N
Melodiogyne fallax S, T, V
Meloidogyne hapla N, Q, S, T, V, W
Meloidogyne hispanica Q
Meloidogyne incognita N,NT,Q,S,T,V, W
Meloidogyne javanica A, N, NT, Q, S, V, W
Meloidogyne thamesi N, Q, V
Meloidogyne trifoliophila N, S, V

Meloidogyne sp N, NT, Q, S, T, V, W
Merlinius brevidens N, Q, S, V, W
Merlinius nothus N
Merlinius sp. W
Morulaimus arenicolus N, S, T, V, W
Morulaimus geniculatus N, S, T, V, W
Morulaimus gigas N, V, W
Morulaimus sclerus S, V, W
Morulaimus simplex N, S
Morulaimus simpsoni S
Morulaimus soldus Q
Morulaimus whitei N, NT, Q, S, T, V
Morulaimus sp. Q, S, V

N
Nagelus obscurus N
Neodolichodorus adelaidensis N, Q, S, V
Neodolichodorus cassati N
Neodolichodorus obtusus N, Q
Neodolichodorus sp. N, Q, V
Neopsilenchus magnidens N, Q
Neopsilenchus minor N, W
Neopsilenchus sp. Q

O
Ogma australis A
Ogma civellae N, Q, W
Ogma melanesica W
Ogma octangulare N, Q
Ogma vexillatrix V
Ogma sp. N, Q

P
Paralongidorus australis Q
Paralongidorus eucalypti N, NT, Q, S,V, W
Paralongidorus sacchari Q, S
Paralongidorus sp. Q, S, V, W
Paraphelenchus pseudoparietinus N,Q
Pararotylenchus hopperi N
Paratrichodorus lobatus N, Q, S, V, W
Paratrichodorus minor N, Q, S, V, W
Paratrichodorus mirzai N
Paratrichodorus orrae W
Paratrichodorus porosus N, Q, W
Paratrichodorus queenslandensis Q,S, W
Paratrichodorus sp N, Q. S, T, V, W
Paratrophurus dissitus Q
Paratrophurus sp. Q
Paratylenchus arculatus Q
Paratylenchus baldaccii V
Paratylenchus colbrani Q
Paratylenchus coronatus N, Q
Paratylenchus curvitatus Q
Paratylenchus dianthus Q
Paratylenchus elachistus Q
Paratylenchus hamatus Q, S
Paratylenchus lepidus N
Paratylenchus macrophallus Q
Paratylenchus microdorus Q
Paratylenchus nanus N, Q, S
Paratylenchus nainianus N, Q
Paratylenchus neoamblycephalus W
Paratylenchus projectus N, Q, S
Paratylenchus vandenbrandei N
Paratylenchus sp. N, Q, S, T, V, W
Pateracephalanema alticola N, Q
Pateracephalanema australe N, Q
Pateracephalanema imbricatum N, Q, S, V
Pateracephalanema pectinatum N, Q, V
Paterocephalanema pellitum N, V
Paurodontus apiticus Q, S
Paurodontus densus Q
Paurodontus gracilis Q
Paurodontus sp. N, Q
Pratylenchoides leiocauda N
Pratylenchoides sp. W
Pratylenchus alleni N
Pratylenchus brachyurus N, NT, Q, W
Pratylenchus coffeae N, Q, S, V, W
Pratylenchus crenatus N, T, V, W
Pratylenchus flakkensis T
Pratylenchus goodeyi N, Q
Pratylenchus hexincisus N
Pratylenchus jordanensis N,NT,Q,S,V
Pratylenchus loosi N
Pratylenchus neglectus N,Q,S,T, V,W
Pratylenchus penetrans N,Q,S,T,V,W
Pratylenchus pinguicaudatus N
Pratylenchus pratensis N, V
Pratylenchus pseudopratensis N
Pratylenchus thornei N, Q, S, V
Pratylenchus vulnus N, Q, S, V, W
Pratylenchus zeae N, NT, Q, V
Pratylenchus sp N, Q, S, T, V, W
Prothallonema asymmetricum Q
Prothallonema sp Q
Pseudhalenchus minutus N, Q
Pseudhalenchus sp Q
Psilenchus hilarulus Q
Psilenchus minor Q
Psilenchus sp. N, Q, T, V, W

R
Radopholus brevicaudatus Q
Radopholus capitatus Q, W
Radopholus clarus N, Q
Radopholus crenatus N, Q, V, W
Radopholus inaequalis Q, V, W
Radopholus inanis Q
Radopholus intermedius Q

Radopholus laevis Q
Radopholus magniglans N, Q, S, V, W
Radopholus megadorus Q
Radopholus nativus NT, W
Radopholus neosimilis Q, V
Radopholus nigeriensis NT
Radopholus rectus N, Q, W
Radopholus rotundisemenus V
Radopholus serratus Q
Radopholus similis N, NT, Q, S, W
Radopholus trilineatus N, Q, S, V
Radopholus vacuus Q
Radopholus vangundyi N, S, V, W
Radopholus vertexplanus Q, V, W
Radopholus sp. N, NT, Q, T, V, W
Rotylenchulus parvus Q
Rotylenchulus reniformis NT, Q, W
Rotylenchulus sp. N, Q
Rotylenchus brevicaudatus N, Q, W
Rotylenchus buxophilus N, S
Rotylenchus gracilidens N, Q, S, V,W
Rotylenchus incultus NT, W
Rotylenchus robustus N, T, V, W
Rotylenchus uniformis V
Rotylenchus unisexus Q
Rotylenchus wallacei S
Rotylenchus sp. N, NT, Q, S, V, W

S
Sakia sp. N, W
Sauertylenchus labiodiscus N
Sauertylenchus sp. V
Scutellonema brachyurum N,NT,Q,S,V,W
Scutellonema clariceps N, Q
Scutellonema impare N, NT, Q, S
Scutellonema incisicaudatum N,NT,Q,S,W
Scutellonema insulare Q, S, V, W
Scutellonema laeviflexum Q, S
Scutellonema magniphasma N
Scutellonema minutum N, Q, S, V, W
Scutellonema sp. N, NT, Q, S, V, W
Sphaeronema sp. Q
Subanguina mobilis S
Subanguina radicicola T

T
Thada sp. Q
Trophonema arenarium Q
Trophonema sp. Q
Trophotylenchulus clavicaudatus N, Q
Trophotylenchulus obscurus Q
Trophotylenchulus sp. Q
Trophurus sp. Q
Tylenchorhynchus annulatus N, Q, V
Tylenchorhynchus brevilineatus N,Q,W
Tylenchorhynchus capitatus N, Q, V
Tylenchorhynchus clarus Q, S
Tylenchorhynchus claytoni Q
Tylenchorhynchus coffeae Q
Tylenchorhynchus curvus Q
Tylenchorhynchus dubius S
Tylenchorhynchus ewingi Q
Tylenchorhynchus hastulatus N, Q, S
Tylenchorhynchus latus N
Tylenchorhynchus mashoodi Q
Tylenchorhynchus novenus S
Tylenchorhynchus robustus N
Tylenchorhynchus siccus S
Tylenchorhynchus striatus N, Q
Tylenchorhynchus sulcatus N
Tylenchorhynchus tobari N, S, V
Tylenchorhynchus triglyphus NT
Tylenchorhynchus velatus N, Q
Tylenchorhynchus ventralis Q
Tylenchorhynchus sp N, Q, S, T, V, W
Tylenchulus semipenetrans N,NT,Q,S
Tylenchulus sp. Q
Tylenchus davainei Q, T, V, W
Tylenchus sp. N, Q, S, T, V, W
Tylodorus acuminatus V
Tylodorus fisheri S

X
Xenocriconemella macrodora N, Q, V
Xiphinema americanum N,NT,Q,S,V,W
Xiphinema basiri Q
Xiphinema brasiliense Q
Xiphinema brevicolle N, Q, V, W
Xiphinema diversicaudatum V
Xiphinema elongatum N, NT, Q, W
Xiphinema ensiculiferum N, Q
Xiphinema index V
Xiphinema insigne N, NT, Q, W
Xiphinema italiae N
Xiphinema krugi N
Xiphinema monohysterum N,NT,Q,S,V
Xiphinema obtusa S
Xiphinema pachtaicum N, S, V
Xiphinema radicicola N,NT,Q,S,V,W
Xiphinema setariae NT
Xiphinema truncatum W
Xiphinema sp. N, Q, V, W
Xiphinemella sp. N, Q, W

Z
Zygotylenchus sp. W

List 3 : Species of Plant parasitic nematodes recorded on sugar cane from overseas, reported to occur in Australia but not on sugar cane.

Aphelenchoides bicaudatus
Aphelenchoides besseyi
Aphelenchoides blastopthorus
Ditylenchus dipsaci
Helicotylenchus varicaudatus
Hemicriconemoides brachyurus
Hemicycliophora arenaria
Hoplolaimus pararobustus
Macroposthonia curvata
Macroposthonia xenoplax
Meloidogyne exigua
Paratylenchus nanus
Pratylenchus crenatus
Pratylenchus pratensis
Pratylenchus scribneri
Tylenchorhynchus curvus
Tylenchorhynchus dubius
Tylenchorhynchus mashoodi
Tylenchorhynchus ventralis
Xiphinema basiri
Xiphinema diffusum
Xiphinema ensiculiferum
Xiphinema index
Xiphinema insigne
Xiphinema krugi

List 4 : Species of plant parasitic nematodes recorded from sugar cane overseas but not occurring in Australia.

Discocriconemella mauritiensis
Helicotylenchus crenacauda
Helicotylenchus digitatus
Helicotylenchus digitiformis
Helicotylenchus egyptiensis
Helicotylenchus girus
Helicotylenchus indicus
Helicotylenhcus microcephalus
Helicotylenchus pseudodigonicus
Helicotylenchus retusus
Heterodera oryzae
Heterodera sacchari
Hirschmaniella oryzae
Hirschmaniella spinicaudata
Hoplolaimus colombus
Hoplolaimus indicus
Hoplolaimus tylenchiformis
Longidoroides hooperi
Longidoroides latilabiatus
Longidoroides pulcher
Longidoroides strelitiziae
Longidorus laevicapitatus
Longidorus pisi
Meloidogyne brevicauda
Meloidogyne coffeicola
Meloidogyne inornata
Paralongidorus agni
Paralongidorus buchae
Paratrophurus loofi
Paratylenchus minutus
Paratylenchus variatus
Siddiqia deborae
Siddiqia natalensis
Siddiqia paramaximus
Siddiqia spaulli
Tylenchorhynchus cylindricus
Xiphinema brevistylus
Xiphinema mampara
Xiphinema silvaticum
Xiphinema parasetariae
Xiphinema vulgare

List 5 : Species of plant parasitic nematodes recorded from sugar cane overseas but not occurring in Australia.

Plant parasitic nematode	Country recorded from (CAB Abstracts 1972 onward)
Discocriconemella mauritiensis	Guadaloupe, Solomon Islands, USA
Helicotylenchus crenacauda	Fiji, Samoa
Helicotylenchus digitatus	Guadaloupe, China, Venezuela, India, Brazil, Thailand, Trinidad, Spain, Malaysia, Taiwan, Turkey
Helicotylenchus digitiformis	China, Tadzhikistanm Turkmenistan, Uzbekistan, Iran
Helicotylenchus egyptiensis	Fiji, India, Guadaloupe, Thailand, Sudan, Brazil
Helicotylenchus girus	India
Helicotylenchus indicus	Fiji, Tonga, India, Pakistan, Thailand, Bangladesh
Helicotylenchus microcephalus	Fiji, Tonga, South Africa, Guadaloupe, Kenya, Sudan, India, Jordan, Oman, Brazil, Thailand
Helicotylenchus pseudodigonicus	Egypt, Russia, Iran, Poland
Helicotylenchus retusus	Fiji, India, Lesser Antilles, Turkmenistan, Thailand
Heterodera oryzae	India, Japan, Bangladesh, Senegal, Iran
Heterodera sacchari	Ivory Coast, Guinea, Benin, Togo, Pakistan, Liberia, Thailand, Burkino Faso, Nigeria, Upper Volta
Hirschmaniella oryzae	India, Japan, Bangladesh, Africa
Hirschmaniella spinicaudata	West Africa
Hoplolaimus colombus	USA, India, Trinidad, Pakistan
Hoplolaimus indicus	India, Pakistan, China, Iran, Libya, Thailand
Hoplolaimus tylenchiformis	Brazil, Martinique, South East Asia, Pacific region, USA
Longidoroides hooperi	Botswana, South Africa
Longidoroides latilabiatus	South Africa
Longidoroides pulcher	South Africa
Longidoroides strelitiziae	South Africa
Longidorus laevicapitatus	Egypt, French West Indies, Mauritius, Italy, Swaziland, Sudan, South Africa, Colombia
Longidorus pisi	South Africa, India, Cameroon, Egypt, Bulgaria, Botswana, Mozambique, Sudan, Malawi
Meloidogyne brevicauda	India, Sri Lanka, Azerbaijan
Meloidogyne coffeicola	Brazil
Meloidogyne inornata	Brazil
Paralongidorus agni	India
Paralongidorus buchae	Mauritius
Paratrophurus loofi	Spain, Bulgaria, Trinidad, Turkey, Venezuela
Paratylenchus minutus	South Africa, French Caribbean, Indonesia, India
Paratylenchus variatus	Nigeria
Siddiqia deborae	South Africa
Siddiqia natalensis	South Africa
Siddiqia paramaximus	South Africa, India
Siddiqia spaulli	South Africa
Tylenchorhynchus cylindricus	Slovakia, Bulgaria, Phillipines, Uzbekistan, Taiwan, Iran, Egypt, Moldavia
Xiphinema brevistylus	Nigeria
Xiphinema mampara	South Africa
Xiphinema silvaticum	Mauritius
Xiphinema parasetariae	Congo, Niger, Senegal
Xiphinema vulgare	Botswana, Brazil, Peru, India, Mauritius, USA

Comments: