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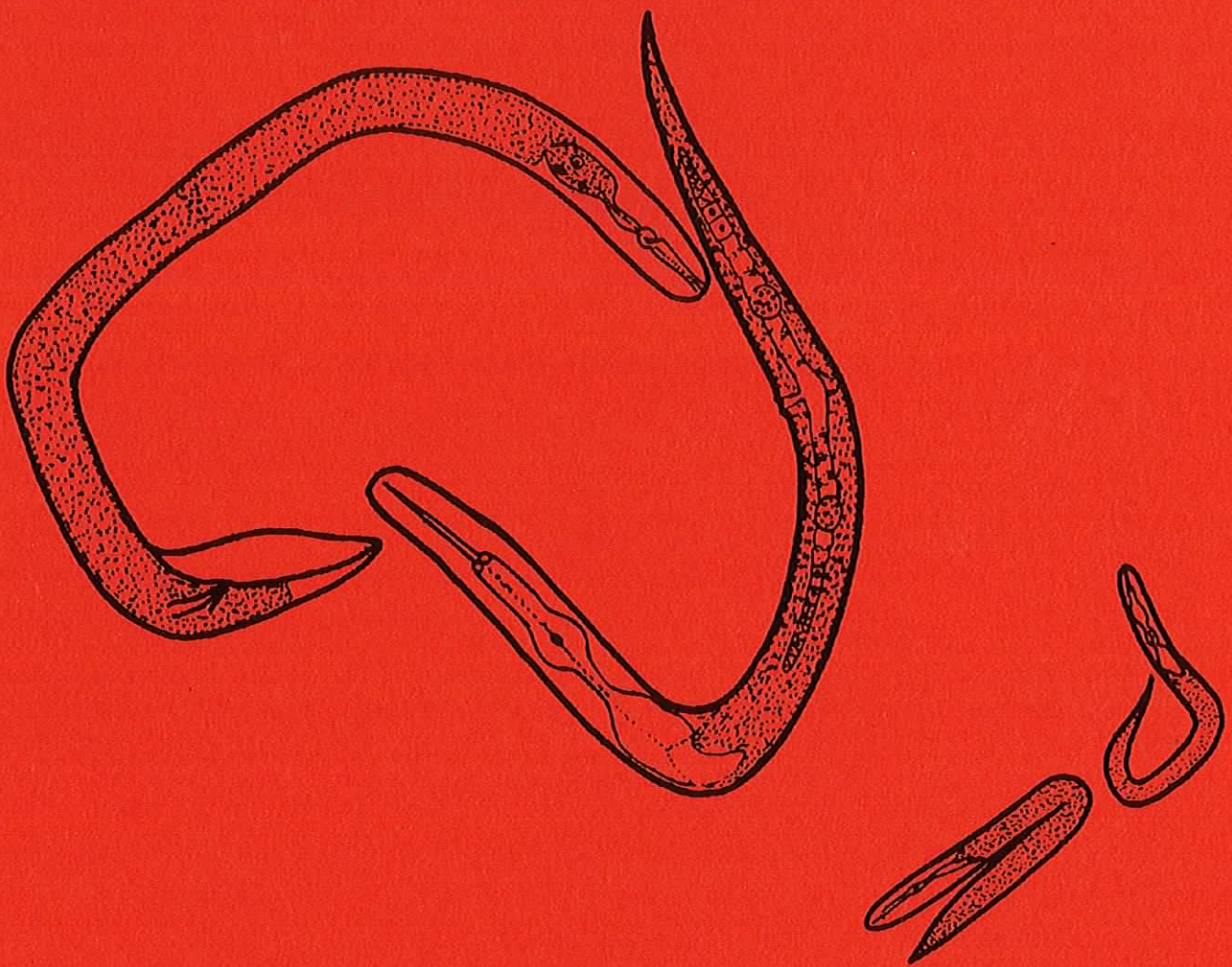
AUSTRALASIAN NEMATOLOGY NEWSLETTER



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From the Editor

Contributions for this issue were somewhat harder to extract than is normal and consequently the issue does not contain the breadth of material that would be desirable. Nevertheless there is some interesting news and articles and those that have contributed are thanked for their efforts. Along with other positions the editor's job will be available for a newcomer at the AGM to be held in Perth 28 September, so the next issue should receive strong support.

Australasian Association of Nematologists AGM

The AGM will be held Sunday 28 September 5.00 – 6.30 p.m. at the Radisson Observation City Hotel, Perth. The AGM precedes the Nematology Workshop dinner, however, members not involved in the workshop are more than welcome to attend the AGM and the dinner. Most positions will need to be re-elected at the AGM, so come willing to be involved or send your expression of interest in a position with a member who will be attending.

January Issue

The deadline for the January issue is December 15. Please send material as it comes to hand and plan well in advance to prepare your contribution. You be notified in a 'call for contributions' of the contact details and arrangements for the new editor.

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Association News

FROM THE PRESIDENT

AAN workshop and APPS conference

Ian tells me that the organisation is well advanced for the WA meeting and I hope by now that you all will have been successful with your applications for conference and travel funds from your respective funding bodies.

Once again thanks go to RIRDC for providing generously to support invited keynote speakers. The invited speakers will no doubt bring some interesting perspectives to our conference.

The International Federation of Nematology Societies is now in existence and officers have been elected (see attached news item). I am currently the AAN representative councillor on the Federation. If you have any suggestions on what you expect this Federation to do for you please be ready to discuss them at the AAN AGM as Thierry Vrain (Vice President IFNS) will be with us in Perth and he will be able to give us a good overview of the aims of the Federation.

See you in Perth.

John Marshall, AAN President, Crop & Food, Lincoln

FROM THE SECRETARY

This time of year is always a busy time for all, with all the conferences, let alone writing a thesis (Nora) and looking after a baby (Diana). It also marks the last of our time as secretary and treasurer for the AAN, as we prepare to relinquish the task for others to take over at the Perth conference. Needless to say it has been a packed four years and the association has maintained a healthy membership and bank balance. As well as queries about the AAN and our activities from across Australasia, there has been considerable interest in the AAN from Europe and the U.S.A and particularly, in the light of the fledgling international nematology society, there will be an opportunity for greater communication and interaction with our colleagues. The new nematology discussion group and web sites have already made a significant contribution to developing ideas and improving communication among nematologists globally. Hopefully this trend will continue in the years to come.

We thank all those who have been helpful in the last four years and wish all the best to the new AAN committee members.

Nora Galway, AAN Secretary and Diana Hartley, CSIRO Entomology, Canberra

INTERNATIONAL FEDERATION OF NEMATOLOGY (IFNS)

The last twelve months brought historic developments for nematology. After much discussion over a prolonged period that commenced in 1984 in Guelph, Canada, an International Federation of Nematology Societies was established on 10 July 1996 at the Third International Nematology Congress in Guadeloupe. The first IFNS nominations and election of officers were completed during January-May 1997. Although the nominees of officers were nominated by the councillors and within the Council, the international mails resulted in this being a long process. The newly elected officers are: President – Kenneth R. Baker, Vice-President – Thierry C. Vrain and Secretary-Treasurer – Martie S. Botha-Greeff. We are indebted to Dr Charles Taylor, Ms Sheena Lamond and Ms Irene Geoghegan for serving as our Federation's first Election Committee.

Presently, twelve Nematology Societies with a total of seventeen representatives/councillors are affiliated with this newly organised Federation. The respective representatives for these Societies are: Afro-Asian Society of Nematologists – Safia F. Siddiqi and Shashi B. Sharma, Australasian Association of Nematologists – John W. Marshall, Brazilian Society of Nematologists – Carlos C. B. Ferraz, Egyptian Society of Nematology – Sanaa Haroon, European Society of Nematologists – Maurice G. J. Moens and Thierry C. Vrain, Italian Society of Nematology – Maria T. Vinciguerra, Japanese Nematological Society – Nobuyoshi Ishibashi and Yasuhara Mamiya, Nematological Society of Southern Africa – Martie S. Botha-Greeff, Organization of Nematologists of Tropical America – Rodrigo Rodriguez-Kabana and A. Forest Robinson, Pakistan Society of Nematologist – M. A. Maqbool, Russian Society of Nematology – Derek J. F. Brown and Society of Nematologists – David J. Chitwood and Kenneth R. Baker.

During the coming months, the IFNS Councillors will consider numerous issues and activities such as the structure of the Federation, suggestions from affiliated Societies, an on-going 'IFNS Newspage' for Nematology Societies, budget (minimal), guidelines for selection of future International Nematology Congress sites, the possibility of developing an international e-mail directory of nematologists and affiliation of other Nematology Societies with IFNS. The Federation Councillors would like to express our appreciation for the support and work of the members of the 'IFNS Study Group', officers and members of interested Societies that resulted in the establishment of this Federation. [Please continue to forward your suggestions on IFNS to your representative Society Councillor(s) or to Ken Barker, Box 7616, Plant Pathology Department, N. C. State University, Raleigh, NC 27695-7616 USA, e-mail kenneth_barker@ncsu.edu]

Ken Baker, President, IFNS

NEMATOLOGY WORKSHOP, PERTH 28-29 SEPTEMBER, 1997

Nematode control - genes and microbes

RIRDC has been generously provided funding to support the involvement of Dr Thierry Vrain, Agriculture and Agri-Food Canada, Summerland, BC and Dr Graham Stirling, Biological Crop Protection Pty Ltd, Moggill, Qld in the workshop. The workshop will be examining genetic and biological control of nematodes, with the keynote speakers providing authoritative overviews and participants forming small groups to examine options for novel control in specific case studies. Groups with the most convincing proposals will be undoubtedly rewarded for their efforts.

On the Sunday evening 28 September (5.00 – 6.30 p.m.) we will hold the AGM of the Australasian Association of Nematologists at the Radisson Observation City Hotel before relocating to the city for the workshop dinner. The workshop will be held on Monday 29 September at the State Agricultural Biotechnology Centre, Murdoch University from 8.30 a.m. to 4.30 p.m. with transfers to and from the Radisson (back in time for the start of the APPS conference).

There are about 25 participants registered for the workshop, but the is still scope for a few more. See you there.

Workshop Convenors, Ian Riley and Rob Potter

SEVENTH AUSTRALIASIAN CONFERENCE ON GRASSLAND INVERTEBRATE ECOLOGY

The Seventh Australasian Conference on Grassland Invertebrate Ecology is being planned for September 1999 in Perth. The first formal circular will be issued early 1998. If you are interested in being kept up to date with developments have your name added to the mailing list. Contact John Matthiessen, preferably by email (johnm@ccmar.csiro.au with ACGIE in the subject field of the message header) or by phone (08) 9387-0641.

John Mattiessen, CSIRO Division of Entomology, Wembley

QUARANTINABLE NEMATODES

A draft list of quarantinable plant pathogens was recently circulated by AQIS to quarantine plant pathologists in each State for comment. This list included bacteria, fungi, viruses, phytoplasmas and plant parasitic nematodes. The nematode list was notable for its brevity. It included only seven nematode species whereas there were several hundred species of quarantinable fungi.

The quarantinable nematodes included on the list were *Aphelenchoides besseyi* (white tip of rice), *Bursaphelenchu xylophilus* (pinewood nematode), *Ditylenchus angustus* (Ufra disease of rice), *Globodera pallida* (potato cyst nematode), *Globodera rostochiensis* (potato cyst nematode), *Heterodera glycines* (soybean cyst nematode) and *Heterodera zeae* (maize cyst nematode).

Organisms included on the final list will have an important status. Some of the implications of an organism being classed as quarantinable are: the species will be considered in the development of protocols for importation of agricultural commodities, the species will included in pest risk assessments, the species will be considered for targeted surveillance, the species will be considered for active containment or eradication following the detection of an incursion, and there will be a notification obligation following the detection of an incursion so the States are informed and can take appropriate action on interstate quarantine if justified.

To highlight the point that the draft list was grossly under-worked for plant parasitic nematodes, the following list of *Heterodera* species and their potential pest status was prepared. The assessment is based on a brief and limited review of the literature and is intended only to illustrate that the quarantine status of *Heterodera* spp. has not been adequately addressed.

Heterodera sp.	Common name	Hosts	Present in Australia	Quarantine pest status
H. avenae	Cereal cyst nematode	Wheat, barley	**NSW, SA, TAS, VIC, WA**	Races are likely
H. bifenestra		Grasses and cereals	Not present	Apparently of low pest status
H. cajani	Pigeonpea cyst nematode	Pigeonpea, Cowpea, Mungbean	**SA**	Limited distribution in Australia
H. carotae		Carrot	Not present	Potential serious pest
H. ciceri	Chickpea cyst nematode	Chickpea and some other legumes	Not present	Potential pest
H. cruciferae		Cruciferous hosts	Not present	Minor pest
H. cynodontis		*Cynodon dactylon*	Not present	?
H. cyperi		*Ligustrum japonicum*	Not present	Low pest status
H. daverti		Subclover	Not present	Serious in Tunisia
H. elachista		Rice	Not present	Potential pest
H. fici		*Ficus* spp.	**NSW**	?
H. galeopsidis			Not present	?
H. glycines	Soybean cyst nematode	Soybean	Not present	**Quarantine**
H. goettingiana	Pea cyst nematode	*Pisum sativum*	Not present	Considered a serious pest

H. graminis			Not present	?
H. hordecalis		Cereals and grasses	Not present	Apparently of low pest status
H. humuli	Hop cyst nematode	*Humulus lupulus*	**TAS**	Host limited
H. iri		Grasses, including turf grasses	Not present	Potential pest
H. latipons		Cereals and grasses	Not present	Potentially a serious pest
H. lespedeza		*Lespedeza* spp.	Not present	?
H. leucilyma		*Stenotaphrum secundatum*	Not present	?
H. longicaudata			Not present	?
H. mani		*Agrostis* spp. and ?other	Not present	?
H. marioni			Not present	?
H. maydis			Not present	?
H. medicaginis		Lucerne	Not present	Potential pest
H. oryzae	Rice cyst nematode	Rice	Not present	Serious pest, limit distribution
H. oryzicola		Rice, banana	Not present	Potential pest
H. sacchari	Rice cyst nematode	Rice	Not present	Potential pest
H. salixophila		*Salix* sp.	Not present	?
H. schachtii	Sugarbeat cyst nematode	Various	**NSW, QLD, SA, VIC, WA**	Should be non-quarantinable
H. sorghii		Sorghum	Not present	?Pest, limited distribution
H. trifolii	Clover cyst nematode		**NSW, QLD, VIC, WA**	Should be non-quarantinable
H. urticae	Nettle cyst nematode		Not present	?
H. vigna		Cowpea	Not present	?
H. zeae	Corn cyst nematode	Maize and other cereals	Not present	**Quarantine**

Given that the above list is restricted to *Heterodera* spp., it suggests that there is likely to be a large number exotic plant parasitic nematodes identified as potential quarantine pests if a wider analysis was done. Although few nematodes are likely to be introduced through normal agricultural trade, there are many routes of entry, most outside the control of Australian quarantine authorities. Without adequate recognition of the potential pest status of exotic plant parasitic nematodes, it is possible for new pest to become widely established before its importance is recognised and the option for response considered.

I would pleased to hear comment of members on the above situation and to explore options by which the association can bring to the attention of AQIS the need for giving exotic plant parasitic nematodes due consideration.

Ian Riley, Agriculture Western Australia

Regional News

NEWS FROM NEW SOUTH WALES

Since retiring from NSW Agriculture last January, I am continuing my research, linked with Dr Chris Steel, Charles Sturt University, and Dr John Kirkegaard, CSIRO, Canberra. Experimental work is proceeding using facilities at Macquarie University, thanks to the kind offices of the nematology group of Professor Keith Williams, Rita Holland and Allamgir Khan based there.

The work continues and extends research begun with the support the Grape and Wine Research and Development Corporation on the application of biofumigation to management of nematode damage in vineyards. Biofumigation is the use of brassica crops to reduce soil pest and disease levels. Efficacy is attributed to the glucosinolates in brassica plants.

Areas covered in the research include variation in effectiveness of green manures of diverse brassicas, egg production (root knot nematode) on brassicas, stability of the nematode/host status relationship amongst vineyard root knot nematode populations, invasion of brassicas by root knot, in-plant growth of root knot in brassicas, strategies for reducing infection and increase on biofumigant crops, field performance of interrow biofumigant crops in vineyards and application of biofumigation to treating the vine row. Particular attention is being given to the role of glucosinolates in effectiveness of brassica green manures and in host and nematode relationships.

Rod McLeod, Macquarie University

NEWS FROM NEW ZEALAND

Root knot nematode in fresh carrots has been given high priority with growers and I have been successful with an application to optimise the application of Nemacur for the control of root knot nematodes (RKN) on carrots. In addition to RKN preliminary work showed that the presence of *Pratylenchus* and other pasture derived nematodes also have a profound effect on growth and shape of carrots. Most growers only recognise root knot nematodes so we have a chance to raise the damage potential of other less obvious nematodes, especially in the area of quality. For this project I have linked up with NZ MAF Qual nematologist Karen Knight to assist with the nematode counts. It is somewhat ironic that I shifted away from the applied aspects of Nematology as the funding bodies did not think that it was sufficiently scientific, original or innovative and now 6 years down the track the farmers are starting to want me to do these types of trials. It is good that the MAF have kept up its ability to identify nematodes as part of the quarantine skill base but even they are now under pressure to turn a dollar. By subcontracting Karen to do the counts we both win. I firmly believe that as nematologists we must help each other because no other discipline will look out for us.

In addition to the nematicide trial The NZ Vegetable and Potato Growers Federation allocated a small sum to look at the species of RKN present in NZ vegetable crops. I have linked up with Chris Mercer (specialist in root knot and clover cyst nematodes on clover) to do this preliminary study. I intent to make application to the PGSF (main government funding agency) to pursue the RKN diagnostic study. Time will tell if I am successful.

Potato cyst nematode studies continue and we have completed our PCR diagnostic project and are now focussing on the virulence of *G. pallida*. Over recent years we have generated some highly virulent populations and Simon Bulman will begin a study to see if we can isolate the virulence "factor." We will be rebidding this work in October along with the RKN project.

The HRDC project on "Characterisation and detection of PCN" is now completed and the final report will be provided before Christmas. We did not find any *G. pallida* nor was their any indication that the *G. rostochiensis* populations were anything but Ro1.

Comings and goings

Karen Knight has been given a travel/study grant to attend a Nematology diagnostics and systematics course at St Albans England and after this course will visit Deiter Sturhan's laboratory at Munster Germany to continue work on some nematode groups of mutual interest. Chris Mercer and Gregor Yeates will be attending the SON meeting in Tuscon USA.

John Marshall, Crop & Food, Lincoln

NEWS FROM VICTORIA

Russell Eastwood has recently changed jobs from Nematologist to Wheat breeder. This will mean a change in focus for Russell, but a continued interest in nematology. Grant Hollaway will be taking on the Root Lesion Nematode work and Russell's work in developing CCN resistant wheats continues within the wheat breeding program. The most advanced lines with the *T. tauschii* source of resistance are now in stage 3 trials and possible varietal releases in 2000. We are using molecular markers with apparent complete linkage to the *Cre1* (Aus 10894) and *Cre3* (*T. tauschii*) genes for selection of CCN resistance in the wheat breeding program. The challenge now is to determine how most effectively to integrate this new technology into the plant breeding process. Double haploid wheat populations with the GS50A resistance to *Pratylenchus thornei* are being developed in association with Neil Howes at SARDI. We will be evaluating these for resistance to *P. thornei* other disease and agronomic traits from the 1998 season. This season Grant will continue to evaluate field crop varieties for their resistance and tolerance to P. *thornei*.

Grant Hollaway, Agriculture Victoria, Horsham

NEWS FROM WESTERN AUSTRALIA

Our IWS/GRDC project on biocontrol of annual ryegrass toxicity has progressed to a new stage. About 1 tonne of *Dilophospora* inoculum was produced on sterilised ryegrass and rice. This has been applied by ground rig and air to about 5,000 ha of wheatbelt paddocks infested with *Anguina funesta* and *Clavibacter toxicus*. There are sufficient data from pot an field experiments to indicate that *Dilophospora* will provide a useful level of control of the ARGT organisms. The greatest impact being on the level of bacterial colonisation of nematode galls. Next season, George Yan and I hope to produce sufficient inoculum for 15 to 50 thousand hectares and to have it applied by property owners and to develop a program for the longer term provision of the fungus to farmers.

A survey of plant parasitic nematodes in cereals in Western Australia is being funded by GRDC. The object is to look at cropping systems with a high frequency of cereal production to determine the levels and importance of root lesion nematode and cereal cyst nematode.

Ian Riley, Agriculture Western Australia, Perth

Research

DAMAGE THRESHOLDS FOR *RADOPHOLUS SIMILIS* ON BANANAIN NORTH QUEENSLAND

Julie Stanton, Department of Primary Industries, Indooroopilly, Tony Pattison and Stewart Lindsay, Centre for Wet Tropics Agriculture, South Johnstone.

Abstract

Existing banana crops in north Queensland were used to determine the economic and action thresholds. At a crop value of $25,000/ha/year and with nematicide application costs of $1,600-1,900/ha/year, the yield loss to *Radopholus similis* must be 6-9% to warrant nematicide application. By sampling plants just after bunching, we found that 6-9% yield loss is caused when the disease index is 15 - 20. To prevent this loss, nematicide must be applied to that pseudostem as it is developing, ie. in the previous bunching cycle. We found that disease index increases about 4.5 in nine months, which is the length of the bunching cycle in north Queensland. Therefore, the action threshold for nematicide application is a disease index of about 10 - 15.

Introduction

Nematicide application for control of burrowing nematode on bananas costs $1,600-1,900/ha/year. At the present crop value of $25,000/ha/year, this equals about 6-9% of crop value. If growers do not know the severity of their nematode problem, they cannot make informed decisions on whether or not to apply nematicide. To warrant nematicide application, the yield loss to be prevented should be at least 6-9%.

The disease index (Broadley 1979a) of a crop is determined by taking root samples from the bunching pseudostem. Sampling is best done at bract fall which is the physiological stage at which no new roots are produced but before older roots have senesced. Because of the asynchrony of bunching in north Queensland, this may be done every 3-4 months. To obtain an estimate of the nematode status of a crop with 80% accuracy, twenty samples are taken uniformly throughout the crop (Stanton *et al.* unpublished). Roots are split lengthwise and rated for the proportion of cortex occupied by *R. similis* lesions and disease index calculated (Broadley 1979a).

Estimates of populations of *R. similis* which cause yield loss to banana is very variable worldwide. In West Africa, 1000 *R. similis*/100 g roots are considered to cause serious yield loss while 20,000 *R. similis*/100 g roots are required to cause similar loss in central America (Gowen 1995). However, Gowen and Quénéhervé (1990) consider that 2000 *R. similis*/100 g roots are a potential cause of yield loss in commercial cultivars.

In north Queensland, previous work has shown a response to nematicide with 500 *R. similis*/100 g roots (Broadley 1979b). In nematicide trials, no response to nematicide was seen when the disease index (Broadley 1979a) was about 25. However, there was a response when the disease index was about 40 (Schipke & Ramsey 1994).

The aim of this study was to determine the action threshold of the nematode. To achieve this, it was necessary to determine:

1. the **Economic Threshold**, i.e. the nematode severity at bract fall which causes yield loss equal to the cost of controlling the nematodes.

2. the **Action Threshold**; nematicide application at this stage will prevent the nematode severity reaching the economic threshold during the following bunching cycle. To determine the action threshold, we need to know the rate of increase of nematode severity from year to year.

Population dynamics of burrowing nematode was studied in two ways.

1. Mixed growth stage sampling used small areas in a crop which were used to collect information on changes in disease index. However, they consisted of plants at various growth stages so were not useful for collecting information on plant growth.

2. Bract fall stage sampling used whole crops so that there were always a number of plants at bract fall growth stage to determine the relationship between plant growth and nematode severity. These sites were not useful for determining changes in nematode populations because nematicide was applied to these sites by growers.

Materials and methods

Fourteen sites in existing crops in north Queensland were chosen to represent the range of soil management types in the region. These were used for mixed growth stage sampling and/or bract fall stage sampling as indicated below.

Mixed growth stage sampling Three adjacent rows of 20 mats were marked in each crop and used throughout the project. Where possible, these were maintained free of nematicide. In crops where nematicide was applied, two rows were kept free of nematicide to allow assessment of the effect of nematicide.

Every three months from February 1994 to August 1996, four plants in each row were sampled to determine the disease index of roots, no. nematodes/100 g root and no. nematodes/200 g soil.

Bract fall stage sampling Six crops were sampled every three months from March 1995 to determine the disease index of roots, no. nematodes/100 g root, plant girth at 75 cm and estimated no. fingers/bunch (Table 1). The last two characters were used to estimate potential bunch weight (Table 1). Only plants at the bract fall stage, i.e. just before bagging bunches, were sampled.

Table 1. Estimates of potential bunch weight at bract fall (J. Daniells unpublished)

$$Fingers/bunch = Hands * (Fingers\,on\,hand\,3 + Fingers\,on\,hand\,n - 1)/2$$
$$Bunch\,weight = (Fingers/bunch - 52.2)/3.29$$
$$Bunch\,weight = 0.76 * Girth - 13.5 (r = 0.4472)$$

Results

Mixed growth stage sampling There was no consistent seasonal effect on disease index. Nor was there a relationship between population dynamics and soil type (data not shown). Comparison of disease index over time showed that disease index in the most heavily infested crops increased from an average of 15 to 22 in the 30 months of monitoring. However, the range

of change in disease index over the 30-month sampling period was -27 to +29. Of those farms where an increase was observed, the mean increase was 14 over 30 months which is about 0.5 per month and about 4.5 in nine months, the average bunch cycling time in north Queensland.

Bract fall stage sampling Most pairs of variables were significantly correlated (Table 2).

Calculating economic and action thresholds The correlation between disease index and bunch weight estimated on no. fingers was greater than that between disease index and bunch weight estimated on girth so the former was used to calculate economic threshold and action threshold (Table 3) using the equations in Table 2.

To calculate economic threshold, it is necessary to determined the disease index when yield loss equals the cost of nematode control. At current prices, this is about 6-9% yield loss. Table 3 shows the calculation of economic threshold for six crops using no. of fingers to estimate bunch weight.

Table 2. Equations relating variables measured in bract fall stage sampling.

All slopes are significantly different from 0 ($P<0.05$), $r = 0.088$, correlation significant ($P<0.05$);

$$Girth = 80.3 - 0.14 * Disease\ index\ (r = -0.1931)$$

$$Girth = 79.2 - 0.001 * Nematodes / 100\,g\ root\ (r = -0.1581)$$

$$Girth = 51.3 + 0.14 * No.\ fingers\ (r = 0.5695)$$

$$No.\ fingers = 199 - 0.9 * Disease\ index\ (r = -0.3028)$$

$$No.\ fingers = 193.7 - 0.006 * Nematodes / 100\,g\ root\ (r = -0.2768)$$

$$Nematodes / 100\,g\ root = 57.1 * Disease\ index + 387.9\ (r = 0.4409)$$

$$Bunch\ wt\ (estimated\ on\ no.\ fingers) = 44.5 - 0.27 * Disease\ index\ (r = 0.3028)$$

$$Bunch\ wt\ (estimated\ on\ girth) = 46.9 - 0.1 * Disease\ index\ (r = 0.1931)$$

$$Bunch\ wt\ (estimated\ on\ no.\ fingers) = 0.998 * Bunch\ wt\ (estimated\ on\ girth) - 4.1\ (r = 0.5695)$$

$r = 0.115$, ($P<0.01$).

Therefore, when yield loss is 6-9%, disease index (i.e. economic threshold) is approximately 15 - 20. Using data obtained in the mixed stage sampling which showed that disease index increased 4.5 in nine month, the action threshold in north Queensland occurs when the disease index is about 10 - 15, i.e. 4.5 less than the economic threshold.

Discussion

There was great variability in the rate of change in disease index over time. In some crops, the disease index increased, in some it decreased while there was little change in others. This variability was not obviously due to soil type or nematicide use. Differences in crop management affect plant growth and, therefore, reproduction of the nematode and this could contribute to the variability. In addition, the sampling technique is only 80% accurate.

A moderately conservative approach to recommendations of nematicide application would be based on an action threshold derived from the average change in disease index on crops where an increase in disease index was found, i.e. about 0.5 index point/month. However, it is likely that growers could finetune the action threshold for individual crops by monitoring the crop over several seasons and using that information to predict how quickly the economic threshold will be reached.

Table 3. Relationships between disease index (DI) and bunch weight (BW) estimated on no. of fingers/bunch on six crops in north Queensland and estimated disease index of the bunching pseudostem when yield loss is reduced by 6-9% (i.e. at the economic threshold)

Farm	Relationship between bunch weight and disease index	Maximum yield at economic threshold	Disease index at economic threshold
DE	BW = 45.6 - 0.25 * DI	41.5 - 42.9	6.1 - 11.1
DN	BW = 48.2 - 0.19 * DI	43.8 - 45.3	-2.8 - 2.5
LR	BW = 38.6 - 0.28 * DI	35.1 - 36.3	29.9 - 34.2
MY	BW = 43.7 - 0.18 * DI	39.8 - 41.1	12.4 - 17.2
RS	BW = 31.4 - 0.002 * DI	28.6 - 29.5	54.7 - 58.1
SO	BW = 50.6 - 0.31 * DI	46.1 - 47.6	-11.2 - -5.6
Mean	BW = 43.0 - 0.2 * DI	39.1 - 40.4	14.9 - 19.6

Equations developed in this study show that, when the disease index was 10, 15 and 20, root populations of *R. similis* were about 1800, 2700 and 3600, respectively, when all growth stages were assessed. When only plants at bract fall were assessed, the equivalent populations were approximately double. These values are consistent with those estimated to cause yield loss in other parts of the world (Gowen and Quénéhervé 1990).

References

Broadley, R.A. (1979a) - A simple method for estimating banana root rot. *Australasian Plant Pathology* **8**: 24-25.

Broadley, R.A. (1979b) - Non-volatile nematicides for control of burrowing nematode in banana plantations in north Queensland. *Australasian Plant Pathology* **19**: 626-630.

Gowen, S.R. (1995) - *Bananas and plantains*. Chapman & Hall, London.

Gowen, S.R. and Quénéhervé, P. (1990) - Nematode parasites of bananas, plantains and abaca. In *Plant parasitic nematodes in subtropical and tropical agriculture*. (eds. Luc, M., Sikora, R.A. and Bridge, J.) CAB International, Wallingford.

Schipke, L.G., and Ramsey, M.D. (1994) - Control of banana burrowing nematode (*Radopholus similis*) by fenamiphos applied through micro-irrigation. *Australian Journal of Experimental Agriculture* **34**: 109-114.

ROOT LESION NEMATODE: TOLERANCE, RESISTANCE AND MANAGEMENT STRATEGIES: WHAT DID WE LEARN IN 1996

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In 1996 field trials were conducted in the Victorian Wimmera to determine crop species and varieties with resistance and/or tolerance to *Pratylenchus thornei*, one of the two species of root lesion nematode (RLN) of importance in broadacre crop production in south-eastern Australia. Long term rotation field trials have also been conducted to determine the effects of the rotation on the population of *P. thornei* and the effect of the *P. thornei* population on the yield of a following crop. These studies provide useful information on management strategies that farmers can use to control root lesion nematodes.

Tolerance to *P. thornei*

Tolerance of crop varieties to *P.* thornei was determined by comparing the grain yield of each variety in the presence and absence of nematicide which was used to reduce the population of RLN's in the soil. Varieties without a yield difference between the treated and untreated plots were regarded as tolerant while those with a yield difference were regarded as intolerant.

Cereals

Overall grain yield was reduced by 5% in the presence of nematodes, with yield reductions of 17%, 14% and 11% for the varieties Kellalac, Meering and Frame respectively indicating that these varieties are most intolerant of *P. thornei*. This trial showed that *P. thornei* can reduce the yield of cereals, especially if intolerant varieties are grown. However, the extent of yield loss can be reduced if farmers grow tolerant varieties.

Pulses

At two sites the presence of *P. thornei* reduced grain yield of pulse crops by 12 and 5%. These trials showed that vetch is intolerant to *P. thornei*. For most of the other pulses *P. thornei* did not have a significant effect on yield. There was a bigger effect of *P. thornei* at the Swanwater site where the pulses suffered herbicide damage, suggesting that the plants are more susceptible to *P. thornei* attack when they are stressed.

Resistance to *P. thornei*

Resistance to *P. thornei* was determined by assessing the population of nematodes present in the soil in each plot at the end of the season (at harvest). For varieties where there was no or very low multiplication that variety was regarded as being resistant to *P. thornei*. This study was conducted at Swanwater, in the Victorian Wimmera, where cereals, pulses, pastures and oilseeds were grown.

Cereals

The effects of each cereal variety on the population of nematodes is presented in Figure 1. The barleys Durum, GS50a (resistant wheat) and Excalibur and Krichauf wheats were all resistant to *P. thornei* and reduced the size of the nematode population. In most cases, except for Excalibur and Krichauf, the population of *P. thornei* increased under wheat.

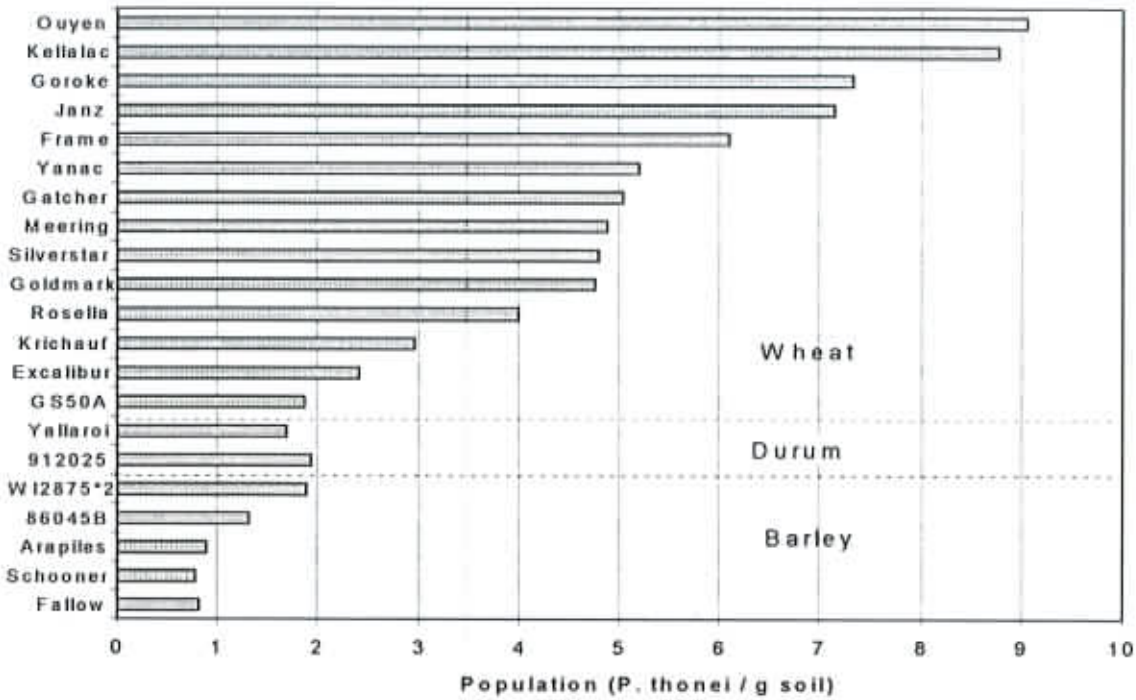

Figure 1. Effect of cereal varieties on the population of *P. thornei* in the soil following harvest in a field trial at Swanwater in 1996. The dotted line represents the population of *P. thornei* at sowing

Legumes

The effects of each legume variety on the population of nematodes is presented in Figure 2. Vetch was most susceptible to *P. thornei*. Faba beans were moderately susceptible, while the lentils and field peas were all resistant to *P. thornei*.

Pastures

The effects of each pasture variety on the population of nematodes is presented in Figure 3. The subterranean clovers were found to be susceptible while the medics were found to be resistant to *P. thornei*.

Rotations and Management

A long-term rotation trial was completed in 1996/97. This trial was conducted to determine management strategies that farmers can use to reduce the populations of *P. thornei* and the effects of various populations of *P. thornei* on crop yield. The site was sown with either Gatcher (susceptible wheat) or GS50a (resistant wheat) in 1994. In 1995 the trial was sown with Gatcher, GS50a, chickpeas, canola, field peas and faba beans. In 1996 the whole trial was sown with chickpeas and grain yields measured. The population of RLN was assessed under each plot before sowing in 1996. The effect of the various rotations on the population of RLN is shown in Table 1. This trial showed that crops and varieties within crops can affect the population of nematodes and that farmers can use variety selection to prevent losses from *P. thornei* and reduce the population of *P. thornei* in their soil.

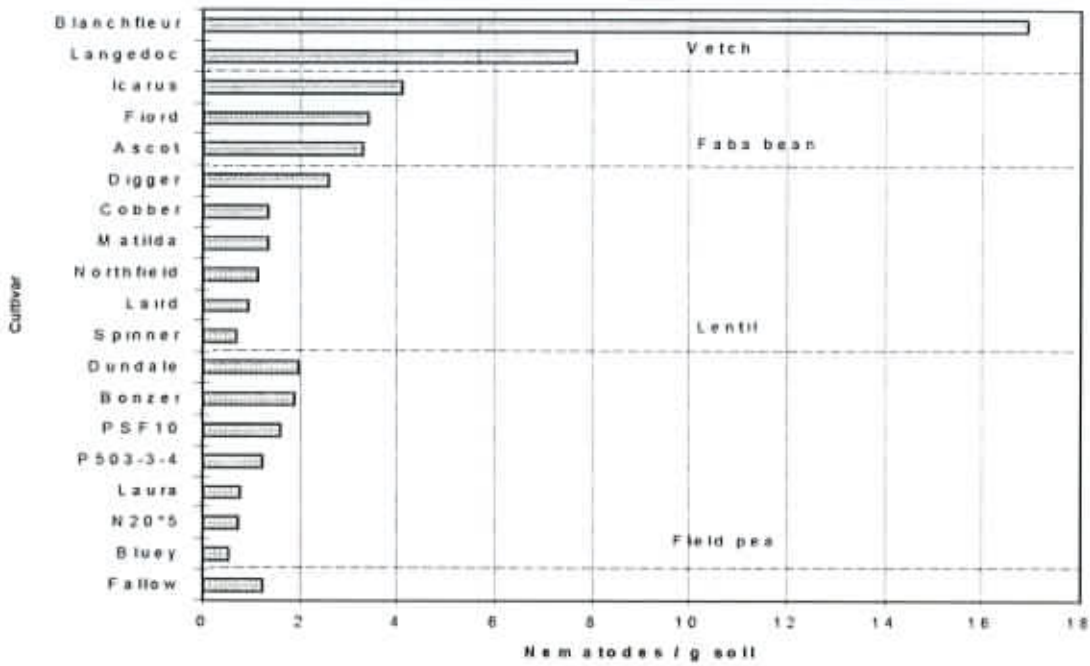

Figure 2 Effect of pulses on the population of *P. thornei* following harvest in a field trial at Swanwater in 1996. The dotted line represents the population of *P. thornei* at sowing

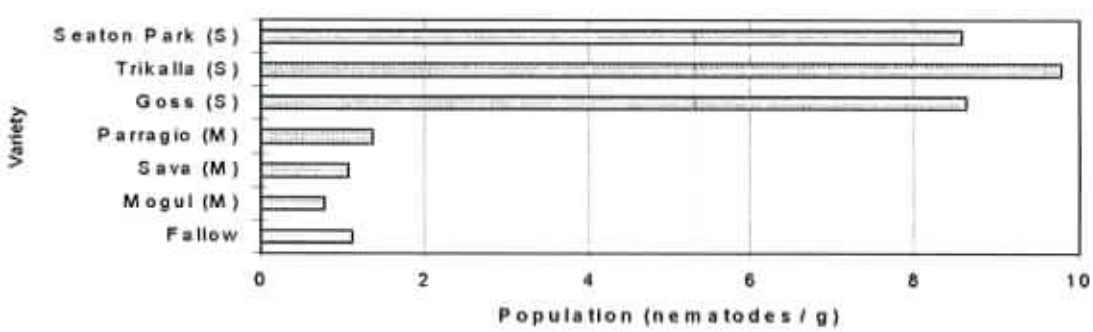

Figure 3. Effect of pasture variety (s = subterranean clover, m = medic) on the population of *P. thornei* at the end of the season in a field trial at Swanwater in 1996. The dotted line represents the population of *P. thornei* at sowing

Table 1. Effect of different two year rotations on the population of RLN in the soil and on the yield of Desavic chickpeas in 1996 at Vectis

1994	1995	1996 Population of RLN	1996 Grain yield (t/ha) of Desavic
Gatcher	Gatcher	10.3^{cd}	1.4^{cd}
	GS50a	7.5^{bc}	1.4^{cd}
	Dunkeld	7.6^{bc}	1.0^{ab}
	Desavic	12.1^{d}	0.9^{a}
	Fiord	10.2^{cd}	1.0^{ab}
	Bonzer	$6.2b^{c}$	1.0^{ab}
GS50a	Gatcher	12.2^{d}	1.1^{ab}
	GS50a	3.4^{a}	1.5^{d}
	Dunkeld	5.5^{ab}	1.2^{bc}
	Desavic	8.9^{cd}	1.1^{b}
	Fiord	6.2^{b}	1.1^{b}
	Bonzer	4.6^{ab}	1.2^{bc}

Acknowledgments

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RECENT STUDIES ON *PAECILMYCES LILACINUS* AS A BIONEMATICIDE. SUPPRESSION OF *HETERODERA AVENAE* POPULATIONS, INFECTION OF *MELOIDOGYNE JAVANICA* EGGS, FEMALES AND JUVENILES IN A POT TRIAL AND *RADOPHOLUS SIMILIS* EGGS IN LABORATORY STUDIES.

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Currently, biocontrol offers an alternative approach for controlling plant parasitic nematodes, considering the innate problems related to the pollution hazards of chemical control. Among opportunistic soil Hyphomycetes consistently associated with the pathology of cyst and root knot nematodes in some parts of the world and known to be an effective egg parasite is *Paecilomyces*.

We have shown effective control of cereal cyst nematode, *Heterodera avenae*, by *P. lilacinus* (BIOCAT strain 251) in a pot trial. Nematode populations were drastically reduced by *P. lilacinus* in both sterilised and unsterilised soils. At harvest, 80% of white cysts were found infected with the fungus. Eggs from highly infected cysts were found to be infected by *P. lilacinus* when incubated at 26°C in the lab on semi-selective medium.

Light Microscopy, scanning electron microscopy (SEM) and transmission electron microcopy (TEM) are being used to study the infectivity and mode of penetration of various life stages of *H. avenae*, *M. javanica*, and *R. similis* by *P. lilacinus*. Excised *M. javanica* females, 3rd and 4th stage juveniles and egg masses were inoculated with *P. lilacinus* and both females and juveniles became infected. The fungus had penetrated the female through the body wall as shown by TEM micrograph. Eggs within infected female and 1st and 2nd stage juveniles (from egg mass) were infected with fungus. Unhatched 2nd stage juveniles were found covered with mycelium within the eggs but the fungus was not observed within the larvae. However with time lapse imaging, 2nd stage unhatched juveniles were later found to be full of fungal hyphae, with no sign of the pre-existing juvenile. Infection of *R. similis* eggs only occurred after prolonged exposure to *P. lilacinus*. To better understand the efficacy of *P. lilacinus* against *R. similis* we are undertaking a port experiment with banana plants.