Nematological Society of Southern Africa

Sixteenth Symposium

1–4 June 2003

Somerset Strand, South Africa

ABSTRACTS OF PAPERS

Estimation of nematode damage to sugarcane in sandy soil in KwaZulu-Natal

S D Berry[1], P Cadet[2] & V W Spaull[1]
[1]*South African Sugar Association Experiment Station, Private Bag X02, Mount Edgecombe 4300 South Africa*
[2]*Institute of Research for Development/Centre National Research Development Scientific, Private Bag X02, Mount Edgecombe, 4300 South Africa*

Previous estimates of yield loss in sugarcane due to nematodes have, for the most part, been derived from the response to treatment with aldicarb as a single application at the registered rate of 3 kg ha^{-1}. However, this rate is based on economics rather than the degree of control of plant-parasitic nematodes. As part of a study to assess the real impact of nematodes, two sugarcane varieties, N12 and N27, were treated with aldicarb at monthly intervals to eradicate all nematodes. Plots treated with a single application of 3 kg aldicarb ha^{-1} and untreated plots served as controls. The trial was conducted on a sandy soil. Repeated application of aldicarb reduced the numbers of endoparasitic nematodes. At six months after planting, there were almost no nematodes in the plots that received the monthly treatment. Repeated application also decreased damage caused by the stalk borer, *Eldana saccharina,* by 30 % for N12 and by 50 % for N27. The single treatment of 3 kg aldicarb ha^{-1} had no effect on borer damage. The mean cane yield for N12 was 103, 108 (5 % response) and 142 tonnes ha^{-1} (38 % response) for the untreated control, single aldicarb treatment and monthly treatment, respectively. Equivalent yields for N27 were 54, 64 (18 % response) and 130 tonnes ha^{-1} (136 % response), respectively. Increase in yield was due to an increase in both the height and number of stalks. Results show the full extent of loss in yield due to nematodes at this trial site.

Virus vector and non-vector longidorids and trichodorids: a current perspective

D J F Brown[1], R Neilson[2] & E Karanastasi[3]
[1]*Central Laboratory of General Ecology, 2 Gagarin Street, 1113 Sofia, Bulgaria*
[2]*Scottish Crop Research Institute, Invergowrie, Dundee, Scotland, UK*
[3]*Benaki Phytopathological Institute, 14561, Kifissia, Greece*

Feeding by longidorid and trichodorid nematodes causes substantial damage to a wide range of crop species. As importantly, 5 % of species comprising the nematode genera *Longidorus, Paralongidorus* and *Xiphinema* are vectors of 12 of the 37 members of the *Nepovirus* genus, and almost 20 % of the species comprising the nematode genera *Paratrichodorus* and *Trichodorus* are vectors of the three members of the genus *Tobravirus.* The transfer of a virus by a vector nematode from an infected to a healthy plant involves a series of complex interactions between the virus, vector, plant host and environment. Recently, molecular engineering has been used to identify the genetic components determining recognition of nematode-transmitted viruses by their natural vectors. Similarly, detailed study of vector nematode species has revealed the feeding

pattern resulting in successful transmission of a virus to a plant host. Once established at a site, these nematodes and their associated viruses are highly persistent, with conventional chemical control measures merely suppressing the pest and pathogen for a limited time. Some cultural practices such as fallowing and use of non-hosts for the viruses can provide effective control. Also, transgenic resistance has been shown to have potential for preventing nematode transmission of nepoviruses to host plants, but was not successful in preventing vector transmission of tobraviruses. Increasing interest in organic food production and globalisation of crop production, i.e. crops being grown in new areas, increases the potential of new nematode-transmitted viruses and their naturally associated vectors being discovered.

Termites and plant-parasitic nematodes in sugarcane in KwaZulu-Natal

P Cadet[1], L Guichaoua[2] & V W Spaull[2]
[1]*Institute of Research for Development/Centre National Research Development Scientific, Private Bag X02, Mount Edgecombe, 4300 South Africa*
[2]*South African Sugar Association Experiment Station, Private Bag X02, Mount Edgecombe, 4300 South Africa*

Patches of good growth are commonly observed in sandy sugarcane fields. Many of these patches correspond to old termite (*Macrotermes natalensis*) nests and are known locally as *isiduli.* To study the factors associated with exceptional growth, soil and sugarcane samples were collected along a transect crossing an *isiduli.* These were used to determine physical and chemical properties of the soil, numbers of nematodes, bacterial activities characterised with the 'Biolog' test, cane growth parameters and chemical properties of the leaves. Growth of sugarcane on *isiduli* was six times better than outside. *Meloidogyne javanica* was absent and *Xiphinema elongatum* less abundant within the *isiduli.* By contrast and paradoxically there were more *Helicotylenchus dihystera, Pratylenchus zeae* and *Paratrichodorus minor* in the *isiduli* than in the adjacent area. The data were subjected to principal component analysis using ADE4 software. The analysis showed that the limits of *isiduli* were defined most clearly by vegetative parameters. The correspondence was almost as good with the nematode analysis, followed by characteristics of the deeper (30–60 cm) soil layer. The boundary of *isiduli*, as defined by characteristics of the topsoil (0–30 cm), was less clearly distinguished. Bacterial activity gave the poorest discrimination between *isiduli* and the surrounding area. Although the termites changed the physical and chemical properties of the soil, these factors alone do not explain the extent of *isiduli*. Superior growth of sugarcane results rather from interactions between soil and biological factors.

Advances in yam and cassava nematology research at IITA

D Coyne, J Mudiope & B Hugues
International Institute of Tropical Agriculture (IITA), Oyo Road, Ibadan, Nigeria. Address for correspondence: c/o Lambourn & Co., Carolyn House, 26 Dingwall Road, Croydon, CR9 3EE, UK

Progress in pest management on cassava (*Manihot esculenta*) in Africa has witnessed remarkable achievements over recent years in the management of African cassava mosaic virus, cassava mealy bug, cassava green mite and overall germplasm improvement for yield improvements. From the scant information available, root-knot nematodes appear to pose potentially serious constraints to cassava production across Africa. Under heavy infection, 98 % yield losses have been reported and in a survey in Uganda, 100 % of fields observed were infected, yet little attention has been paid to this potential constraint. On yam (*Dioscorea* spp.), the yam nematode, *Scutellonema bradys,* is a primary constraint to production and increased adoption of the crop in West Africa. In East Africa the importance of yam has declined over the last few decades and efforts to increase its promotion are hampered by nematode pests. *S. bradys* has to date not been observed in East Africa, but *Pratylenchus sudanensis* has been identified, causing similar damage to *S. bradys. Meloidogyne* spp. also appear to be particularly damaging to introduced, high-yielding yam lines. Screening against these nematodes is currently in progress. Research at the IITA in East and West Africa has made progress towards improved knowledge on these pests. These include initiating work on the biology and epidemiology of *P. sudanensis* on yam, improving our knowledge of *Meloidogyne* spp. important on cassava, expanding information on the distribution and incidence of nematode pests on these crops and development of management options against them.

IPM strategy for nematode control in small-scale farming systems in South Africa

M Daneel, K de Jager & D Mdluli
ARC Institute for Tropical and Subtropical Crops, Private Bag X11208, Nelspruit, 1200 South Africa

A survey conducted in rural areas in the eastern and northern parts of South Africa revealed serious problems with nematodes, particularly *Meloidogyne* spp. Nematodes were found in high numbers, especially in vegetable gardens (up to 64 000 *Meloidogyne* juveniles 30 g^{-1} roots on tomatoes; 25 000 *Meloidogyne* juveniles 30 g^{-1} roots on peppers) and several gardens have been abandoned because of this. Nematodes can be controlled efficiently but people are not aware that nematodes are the cause of yield losses. Together with information days, field and farmers' days are presented where people are informed about the pest and its implications. Trials were done on banana and vegetables. In these trials several treatments were evaluated for reduction in nematode numbers in the soil. Treatments included plastic cover, kraal manure, chicken manure, *Tagetes,* untreated controls and aldicarb. Plastic cover gave significant control of the burrowing nematode *Radopholus similis* as well as improvement of banana yield. Preliminary observations in the vegetable trial with tomato and beetroot showed chicken manure, kraal manure and plastic cover to stimulate growth. Exotic weeds applied as extracts as well as indigenous plant material applied as mulches were evaluated concurrently in a greenhouse for nematicidal action. Although increased growth was observed, nematicidal action was less apparent. Mulches and manures tested in the greenhouse showed that addition of organic material was beneficial to plants. Chicken manure at rates of 30 and 45 t ha^{-1} also gave a significant reduction in nematode numbers.

Occurrence and pathogenicity of plant-parasitic nematodes on commonly grown banana cultivars in South Africa

M Daneel[1], K De Jager[1], I Van den Berg[2], M Desmet[2] & D De Waele[2]
[1]*ARC Institute for Tropical and Subtropical Crops, Private Bag X11208, Nelspruit, 1200 South Africa*
[2]*Laboratory of Tropical Crop Improvement, Catholic University Leuven, Kasteelpark Arenberg 13, 3001 Leuven, Belgium*

The predominant nematode species recorded on banana in South Africa are *Radopholus similis, Pratylenchus coffeae, Helicotylenchus multicinctus, Meloidogyne incognita* and *M. javanica.* A survey was conducted in the three main banana-production areas of South Africa, namely Onderberg, Hazyview and the South Coast of KwaZulu-Natal. Nematode samples were taken from different cultivars, including Chinese Cavendish (AAA), Dwarf Cavendish (AAA), Grand Nain (AAA), Williams (AAA) and Goldfinger (AAAB). *R. similis, P. coffeae, Helicotylenchus* spp. and *Meloidogyne* spp. occurred in the three areas, with the latter two being most abundant. Although *R. similis* is the most damaging nematode species on banana and was found in all three banana-production areas, mean numbers were low. Other species found were *Rotylenchulus reniformis* and *Paratrichodorus minor.* Chinese Cavendish, Williams, Grand Nain and High Noon (AAAB) were also tested in a greenhouse for resistance to *R. similis* and *Meloidogyne* spp. Grand Nain was more tolerant to *R. similis* and Chinese Cavendish seemed to be most susceptible to *R. similis.* An increase in *Meloidogyne* numbers did not have a negative effect on the growth of banana plants in a greenhouse. Chinese Cavendish and High Noon had high gall ratings and nematode numbers in the roots, but their root systems still appeared functional.

'Mobilising participatory ICM (Integrated Crop Management) for sustainable nematode management in household and community gardens of resource-poor farmers in South Africa': a joint new Flanders–South African project

D De Waele[1] & A H McDonald[2]
[1]*Laboratory of Tropical Crop Improvement, Catholic University Leuven, Kasteelpark Arenberg 13, 3001 Leuven, Belgium*
[2]*ARC Grain Crops Institute, Private Bag X1251, Potchefstroom, 2520 South Africa*

During the second half of 2003, a joint new Flanders–South African project will start with the following objectives: 1) to develop low-input and environmentally-friendly strategies for management of root-knot nematodes, 2) to capacitate provincial extension services in nematology so that they can disseminate improved crop management strategies, 3) to raise awareness by small-scale farmers of appropriate crop management practices in general and the occurrence of root-knot nematodes as a major constraint to crop production in particular, 4) to strengthen nematology capacity

and secure the continuity of nematology training in South Africa, 5) to disseminate knowledge and methodologies in the expert field of sustainable nematode management strategies for resource-poor farmers to the region, and 6) to measure the impact of improved crop management practices on the prosperity and well-being of households and communities. Participants in this project will be the Grain Crops Institute, University of the North, Institute for Tropical and Subtropical Crops, Departments of Agriculture of North West, Limpopo and Mpumalanga Provinces and the Food Gardens Foundation.

Reproductive fitness and pathogenic potential on *Musa* of different *Radopholus similis* populations in Uganda

C Dochez[1], J B A Whyte[1], M Pillay[1], D Coyne[2] & D De Waele[3]
[1]*International Institute of Tropical Agriculture (IITA) Eastern and Southern Africa Regional Centre (ESARC), PO Box 7878, Kampala, Uganda*
[2]*International Institute of Tropical Agriculture (IITA), Oyo Road, PMB 5320, Ibadan, Nigeria*
[3]*Laboratory of Tropical Crop Improvement, Catholic University Leuven, Kasteelpark Arenberg 13, 3001 Leuven, Belgium*

Radopholus similis is one of the most damaging nematode species to banana and plantain and poses a serious threat to sustainable *Musa* production. In Uganda it affects the East African Highland banana, which is the main staple food in the country. Use of host plant resistance provides promising prospects as a basis for nematode management and improved *Musa* production. However, different pathotypes may exist within a nematode species and resistance may only be effective against some pathotypes. If the target nematode species has a high level of genetic variability, the durability of resistance may be affected. Breeding efforts should focus on the most pathogenic nematode population. Therefore a study is being carried out to determine whether different *R. similis* pathotypes exist in Uganda. Populations of *R. similis* from different localities within Uganda were collected and cultured monoxenically on carrot discs. So far, the reproductive fitness of four populations has been compared on carrot disc cultures. Pathogenic potential has been tested in vivo on host plants. One population showed a higher reproduction potential compared to the other populations, both on carrot discs and in vivo. These data indicate that different pathotypes of *R. similis* may exist within Uganda. Further studies are ongoing to confirm these results. DNA fingerprinting will be done to determine the level of genetic variability among the different populations.

Arbuscular mycorrhizal fungi: a sustainable method to manage banana nematodes?

A Elsen & D De Waele
Laboratory of Tropical Crop Improvement, Catholic University Leuven, Kasteelpark Arenberg 13, 3001 Leuven, Belgium

Arbuscular mycorrhizal fungi (AMF) are obligate symbionts that biotrophically colonise the root cortex of host plants and develop an extraradical mycelium in the rhizosphere. These fungi help the plant to acquire water and mineral nutrients from the soil in exchange for carbon as an energy source. In addition, AMF increase the ability of a plant to overcome abiotic stress and to control the spread of soil-borne pathogens. Interaction of an AMF, *Glomus mosseae,* and two migratory nematodes, *Radopholus similis* and *Pratylenchus coffeae* was studied on 10 *Musa* varieties under greenhouse conditions. Early mycorrhizal colonisation resulted in improved plant growth, although the magnitude of this response depended on the *Musa* variety. Early root colonisation by *G. mosseae* suppressed population build-up of both *R. similis* and *P. coffeae* in roots of all tested varieties, while the effect on development of root necrosis was variable. In most varieties, *R. similis* and *P. coffeae* did not affect the percentage of root colonisation by the fungus. Based on our results, implementation of early mycorrhizal inoculation at nursery level can represent a rarely considered biotechnological alternative for the management of banana nematodes when banana plantlets are transplanted into infested soils.

Comparative penetration and development rates of *Meloidogyne incognita* race 2 on susceptible and resistant soybean hybrids

H Fourie[1], A H McDonald[1] & D De Waele[2]
[1]*ARC Grain Crops Institute, Private Bag X1251, Potchefstroom, 2520 South Africa*
[2]*Laboratory of Tropical Crop Improvement, Catholic University Leuven, Kasteelpark Arenberg 13, 3001 Leuven, Belgium*

Meloidogyne incognita race 2 is the predominant root-knot nematode on soybean in South Africa. The comparative penetration rate and

development of this species in roots of a susceptible (Prima2000) and resistant (LS5995) commercial South African soybean hybrid were determined. Six-day-old seedlings, grown in Styrofoam cups (350 ml), were inoculated with 3000 second-stage juveniles. Roots were harvested, weighed and stained with acid fuchsin 2, 4, 10, 16 and 20 days after inoculation (DAI). There were significant differences ($P \leq 0.05$) in terms of nematode numbers in the roots of these hybrids, number of juveniles present in root tips 2 and 4 DAI, number of females and juveniles present 20 DAI, as well as individuals invading rhizobium nodules. The penetration rate of *M. incognita* race 2 after 20 days was 64 % on Prima2000 and 12.2 % on LS5995. By 20 DAI, 73–82 % of all individuals that penetrated roots developed into females in Prima2000, compared to 2–9.5 % in LS5995. The differences demonstrated here confirm previous assessments under field as well as controlled conditions that considerable levels of resistance to *M. incognita* race 2 exist in commercial soybean hybrids in South Africa. Although this information could be of immediate practical application, the resistance needs to be introduced into other commercial material that is better adapted to areas where LS5995 is unsuitable and/or not well adapted to. Higher resistance levels are also pursued, as well as improved integrated control strategies where this resistance could be fully exploited to improve production of all crops involved in specific farming systems.

Present status of potato cyst nematode in South Africa

R Knoetze[1], A P Malan[2], A Swart[3] & W Pieterse[1]
[1]*Plant Health and Quality, Private Bag X5015, Stellenbosch, 7599 South Africa*
[2]*Department of Entomology and Nematology, University of Stellenbosch, Private Bag X1, Matieland, 7602 South Africa*
[3]*National Collection of Nematodes, Biosystematics Division, ARC Plant Protection Research Institute, Private Bag X134, Queenswood, 0121 South Africa*

Globodera rostochiensis (the golden cyst nematode) was first reported from South Africa in 1971 and was subsequently eradicated by means of strict quarantine measures. In 1999, 28 years later, this nematode was again reported from the Western Cape. Because of the implications of the occurrence of the nematode in South Africa with regard to international trade, as well as its potential as a pathogen of potato, a preliminary survey was conducted by the National Department of Agriculture to determine the extent of spread of the nematode. The results were used to compile a management plan for production of seed potatoes and management of infested plots. As soon as this protocol was finalised, a survey of commercial potato producers was undertaken in the Ceres area. To date, *G. rostochiensis* has been found only in the Sandveld and Ceres areas of the Western Cape. A quarantine order was served on all plots that tested positive for *G. rostochiensis* to prevent the production of seed potatoes for a period of eight years, after which such a plot must test free of viable cysts. All cyst nematodes found in the samples were identified by means of morphological characteristics, as well as the use of PCR techniques. No *G. pallida* was identified in any of the samples, but discrepancies were found in morphological characteristics between *G. rostochiensis* populations in the Sandveld and those from Ceres. The only other cyst nematode identified from potato soil samples was a species closely related to *G. achilliae.*

Three-factor interaction of organic amendments on suppression of *Meloidogyne incognita*

M D Mabitsela, P W Mashela & L A Pitse
School of Agricultural and Environmental Science, University of the North, Private Bag X1106, Sovenga, 0727 South Africa

Studies in our laboratory demonstrated that *Lippia javanica, Cucumis myriocarpus* and *Ricinus communis* each contain potent nematicidal compounds. Recorded potent chemicals in *L. javanica, C. myriocarpus* and *R. communis* are toxic triterpenoids, cucurbitacin and ricin, respectively. The interacting effects of these crops on suppression of *M. incognita* on tomato (*Lycopersicon esculentum*) were tested under field conditions. A three-factor factorial experiment with treatments arranged in a randomised complete block design with 15 replicates was planted on 20 February 2002. A day after transplanting, the two-week-old tomato seedlings were inoculated with approximately 5700 J2 of *M. Incognita,* and organic amendments alone or in combination was applied at a rate of 5 g per plant. The study was repeated on 30 September 2002. Each seedling was inoculated with approximately 4 300 J2. The three-factor interaction (*Lippia* x *Cucumis* x *Ricinus*) was significant ($P \leq 0.01$) for nematode numbers at harvest, 90 days after inoculation, in both studies. The results suggest that the potent nematicidal compounds in *L. javanica, C. myriocarpus* and *R. communis* act additively in

suppressing nematode numbers. This is possible because the three organic materials contain different potent chemical compounds.

Characterisation of a South African *Tylenchulus semipenetrans* race using differential host plants

G Makaepea, P W Mashela & M P Chabeli
School of Agricultural and Environmental Sciences, University of the North, Private Bag X1106, Sovenga, 0727 South Africa

Differential host plants used in evaluating *Tylenchulus semipenetrans* races include citrus species, *Poncirus trifoliata,* Carrizo citrange, Troyer citrange, grape, olive and persimmon. The 'citrus race' reproduces on all differential host plants except *P. trifoliata.* The 'Mediterranean race' does not reproduce on *P. trifoliata* and olive, whereas olive is a nonhost to the 'Poncirus race'. This study was initiated to determine the South African *T. semipenetrans* race. One-year-old host plants were inoculated with approximately 8200 J2 collected from a high-rainfall citrus-production region, Champagne Citrus Estate. Treatments were arranged in a randomised complete block design, with 15 replicates. At harvest, four months after inoculation, nematode eggs and juveniles were extracted in 1 % NaOCl, using the blending method. In the second study, plants were inoculated with approximately 8300 J2 collected from a low-rainfall citrus-production region, Zebediela Citrus Estate. Data were log $(x+1)$ transformed. In these studies, *T. semipenetrans* did not reproduce on olive, suggesting that the South African *T. semipenetrans* race is the 'Poncirus' race.

Role of *Bacillus* species in *Ricinus communis* suppression of *Tylenchulus semipenetrans*

M A Mofokeng, T J Tsilo, T Ndove &
P W Mashela
School of Agricultural and Environmental Sciences, University of the North, Private Bag X1106, Sovenga, 0727 South Africa

In previous studies, ground *Ricinus communis* fruits consistently suppressed densities of *Meloidogyne incognita* on tomato. The objective of this study was to evaluate the efficacy of *R. communis* with and without *Bacillus* species on *Tylenchulus semipenetrans* on citrus. Two three-factor factorial experiments were conducted under greenhouse conditions to determine the role of initial nematode population density (Pi), *Ricinus* and *Bacillus* species on final nematode population (Pf). The experiments were established as a completely randomised block design with 10 replicates. Six-month-old *Citrus jambhiri* seedlings were inoculated with approximately 7100 J2 in experiment 1 and with approximately 7500 J2 in experiment 2. *Ricinus*-amendment was applied at a rate of 5 g per plant and *Bacillus* species at 20 ml per plant on the day of nematode inoculation. At harvest, 23 weeks after inoculation, nematode juveniles and eggs were extracted in 1 % NaOCl, using the blending method. In both experiments *Bacillus* alone and its interaction with Pi and *Ricinus* were not significant. The sum of squares showed that *Ricinus* explained mean variation in Pf by 17.1 % and 16.6 % in experiments 1 and 2, respectively. As with both *Cucumis myriocarpus* and *Lippia javanica,* it appears that *Bacillus* species play no role in the efficacy of *R. communis* in suppression of nematode numbers.

Efficacy of *Cucumis myriocarpus* with and without *Bacillus* species on suppression of *Meloidogyne incognita*

M J Mphosi, P W Mashela & M K Shakwane
School of Agricultural and Environmental Science, University of the North, Private Bag X1106, Sovenga, 0727 South Africa

The efficacy of organic amendments on suppression of nematodes depends on microbial activities. However, it has been proposed that in ground organic amendments, leaching of potent chemicals may be the sole mechanism through which nematicidal compounds are released. This study was conducted under microplot and field conditions to test if the efficacy of ground *Cucumis myriocarpus* fruit on suppression of nematodes depended on microbial decomposition. Two two-factor factorial experiments were established in a randomised complete block design, with 10 replicates. Three-week-old Floradade tomato seedlings were each inoculated with approximately 6450 and 6850 J2 of *M. incognita* in microplot experiments 1 and 2, respectively, and with approximately 5400 and 6200 J2 in field experiments 1 and 2, respectively. On the day of inoculation ground *C. myriocarpus* fruit was applied at a rate of 5 g per plant and *Bacillus* species at 10 ml aliquots of 10^9 cfu ml^{-1} Biostart®. At harvest, 92 days after inoculation, nematode eggs and juveniles were extracted in 1 % NaOCl, using the blending method. *C. myriocarpus* accounted for mean variation in final nematode population density (Pf) of 49 % and 75 % in microplot experiments 1 and 2, respectively, and of 26 % and 78 % in field

experiments 1 and 2, respectively. In all experiments, microbes alone or *Cucumis* × *Bacillus* interaction was not significant. Results demonstrated that *Bacillus* species did not play a role in the efficacy of ground *C. myriocarpus* fruit for the suppression of nematode numbers.

Control of plant-parasitic nematodes in potato by the fungus *Paecilomyces lilacinus*

J V Neethling[1], A J Meyer[2] & A P Malan[2]
[1]*Biological Control Products SA (Pty) Ltd, PO Box 1561, Pinetown, 3600 South Africa*
[2]*Department of Entomology and Nematology, University of Stellenbosch, Private Bag X1, Matieland, 7602 South Africa*

The fungus *Paecilomyces lilacinus* race 251 was registered in South Africa in terms of Act 36 of 1947 for the control of plant-parasitic nematodes in tobacco, tomato, banana, citrus and papino. It is commercially available as PI Plus, the country's first-registered natural nematicide. A trial was conducted to evaluate the efficacy of PI Plus for the control of plant-parasitic nematodes in potato (*Solanum tuberosum* L.) in the Vredendal area of the Western Cape region. PI Plus was applied through centre-pivot irrigation on 6 ha of land and was compared to untreated control strips. Application was done before emergence of the crop at a rate of 3 kg ha^{-1} in mid-February. Soil samples for the estimation of nematode numbers were collected just before application and monthly thereafter until June when the trial was terminated. Determination of comparative yield results was done simultaneously. Significant control of *Meloidogyne javanica* was obtained. Numbers of *Pratylenchus zeae, Helicotylenchus dihystera* and *Scutellonema brachyurus* were recorded, but differences were not significant. Yield increase was significant. The importance of root-knot nematodes as a pest of potato was again emphasised in this trial. The results justify additional experiments towards registration of PI Plus for the control of root-knot nematode on potato. More investigations on ectoparasitic nematodes need to be done.

Trichodorids and 'spraing' disease

R Neilson[1], E Karanastasi[2] & I M Duarte[3], M T M Almeida[4] & D J F Brown[5]
[1]*Scottish Crop Research Institute, Invergowrie, Dundee, Scotland*
[2]*Benaki Phytopathological Institute, 14561, Kifissia, Greece*
[3]*Escola Superior Agrária de Coimbra, Coimbra, Portugal*
[4]*Universidade do Minho, Braga, Portugal*
[5]*Central Laboratory of General Ecology, Sofia, Bulgaria*

Trichodorids are a cosmopolitan nematode group but have distribution foci in North America and Europe. These nematodes are polyphagous, having an extensive plant host range, including weeds, annual and perennial crops. Of the approximately 90 species that represent the genera *Trichodorus* and *Paratrichodorus,* thirteen are of economic importance due to their ability to transmit three tobraviruses, including tobacco rattle virus (TRV) to a range of agricultural crops. Trichodorid nematodes are rarely found in soil as single-species populations. Consequently, populations are a mixture of vector and non-vector species. The identification to species level is not always simple. Even at generic level some of the important diagnostic features overlap. The incidence of TRV transmission to potato by trichodorid nematodes, known as 'spraing' disease, has increased significantly during the last decade to such a level that, for example in the UK, it is arguably the most economically damaging nematode-related disease in potato-growing areas.

Similarly, trichodorids are frequently recovered from potato and tobacco fields in Portugal. However, TRV transmission occurred in only 7 % of soil samples derived from the north and centre of the country. Transmission-efficacy at a population level varies markedly. Currently, molecular techniques are being evaluated to discriminate the nematode vector, both at species and population level, which may have potential to correlate with levels of transmission-efficacy. A unique videographic study demonstrating the mechanism of trichodorid feeding and probable mode of virus transmission will also be presented.

The effect of *Bacillus* species, *Lippia javanica* and *Meloidogyne incognita* on tomato growth and yield under field conditions

G L Ngobeni, T P Mafeo & P W Mashela
School of Agricultural and Environmental Sciences, University of the North, Private Bag X1106, Sovenga, 0727 South Africa

It has been suggested that irrigation water is required for leaching out potent nematicidal compounds from ground organic material. Two three-factor factorial experiments were conducted under field conditions to determine the role of initial nematode population density (Pi), *Lippia* and *Bacillus* species on tomato growth and yield parameters. The experiments were established as a completely randomised block design, with 10 replicates. Each seedling was inoculated with

approximately 350 J2 of *Meloidogyne incognita* and organic amendment was applied at a rate of 5 g per plant and *Bacillus* spp. at 20 ml per plant on the day of inoculation. At harvesting, 12 weeks after inoculation, data were analysed using step-wise regression. Initial nematode numbers and *Lippia* accounted for variation of 62 % and 65 % in experiments 1 and 2, respectively, in final nematode population density (Pf). *Lippia* and Pi accounted for variation of 87–90 % in dry shoot mass, 66–83 % in fresh fruit mass and 84–92 % in soil electrical conductivity (EC). *Bacillus* spp. had no effect on the efficacy of ground fever-tea leaves in the suppression of nematode numbers and of tomato growth and yield. The study also suggested that the hypothesis on the requirement of water for leaching of active ingredients from *L. javanica* leaves holds true.

Evaluation of *Burkholderia* spp. for the control of the root-knot nematode, *Meloidogyne incognita*

J-H Omarjee[1], J Vogel[1], J Balandreau[2] & P Cadet[2]
[1]*South African Sugar Association Experiment Station, Private Bag X02, Mount Edgecombe, 4300 South Africa*
[2]*Institute of Research for Development/Centre National Research Development Scientific, Private Bag X02, Mount Edgecombe, 4300 South Africa*

Some rhizosphere bacteria are able to directly or indirectly control root-knot nematodes. Direct modes of antagonism include production of anti-nematode metabolites that reduce egg-hatching, juvenile stage (J2) mobility or penetration of roots. Indirect modes of antagonism include the ability of rhizobacteria to stimulate the plant's induced systemic resistance against nematode infection by production of compounds such as salicylic acid (SA). A total of 1500 isolates of *Burkholderia* spp. were obtained from the rhizosphere of sugarcane from various localities in KwaZulu-Natal and screened for the ability to paralyse *Meloidogyne incognita*. One-hundred-and-fifty-two isolates were found to inhibit J2 movement after three hours incubation in a suspension of the bacteria. Eleven isolates that possess additional beneficial properties have been tested for other direct modes of antagonism, including inhibition of root penetration, presence of chitinase activity and ability to reduce egg hatching. Production of SA was also tested in selected isolates and the induction of systemic resistance in sugarcane was studied in split root-system assays.

A synopsis of research on the control of the citrus nematode, *Tylenchulus semipenetrans*

M C Pretorius
Citrus Research International, PO Box 28, Nelspruit, 1200 South Africa

Renewed concerns with regard to mammalian toxicity of nematicides and the fate of these materials in the environment have rekindled interest in alternative control measures for nematodes. Nematicides have been used for many years to control citrus nematodes worldwide. The first nematicide of significant importance was DBCP, which was withdrawn from the market due to its carcinogenic effect on workers in manufacturing plants. Next followed the granular nematicides such as aldicarb, fenamiphos and cadusafos which could be applied after planting. Success rate of nematode control depends to a large extent on the persistence of a nematicide in soil. Efficacy of these products vary from orchard to orchard because of problems caused by several factors such as poor movement through the soil profile as a result of adsorption to clay particles or organic matter and enhanced degradation rates because of high soil pH levels. Problems were also experienced with contamination of soil water and health risks when these products are handled. It is for this reason that Citrus Research International has adopted an integrated nematode management approach. The citrus nematode programme on control of *Tylenchulus semipenetrans* consists of the following research fields; genetic resistance screening of different rootstocks against the citrus nematode and *Hemicycliophora* in field and greenhouse trials, evaluation of biological control products on their own or in combination with chemical nematicides, evaluation of toxic and non-toxic chemical compounds, and the status of citrus nurseries in the Citrus Improvement Programme regarding the citrus nematode.

Advances in research on resistance to nematodes in *Musa* germplasm

P Queneherve
Institute of Research for Development, BP 8006, 97259 Fort-de-France Cedex, Martinique, French West Indies

Owing to the decreasing number of homologated nematicides and increasing concerns about the environment, more and more studies are focusing on the search for potential sources of nematode resistance in *Musa* germplasm, to be used in

breeding programmes. Most of these nematological evaluations take place in greenhouses, with various procedures. Increasing inconsistent or contradictory results on resistance/susceptibility of *Musa* accessions are now recorded. The objectives of these studies on *Musa* resistance or tolerance and nematode damage potential have to be clearly defined in order to adopt appropriate screening procedures. This paper presents a screening procedure conducted in a controlled growth chamber used in the French West Indies by IRD and CIRAD to look for resistance sources to the burrowing nematode, *Radopholus similis,* the lesion nematode, *Pratylenchus coffeae,* and the root-knot nematode, *Meloidogyne* spp. Promising resistance sources have been found for each nematode species in diploid *Musa* accessions (wild and cultivar), confirming earlier results. Surprisingly, significantly lower levels of susceptibility to nematodes have also been detected within the *Musa* AAA Cavendish subgroup, usually considered highly susceptible to nematodes. The results of the early screening procedure have now to be confirmed by identifying the resistance mechanisms and by heritability studies of *Musa* hybrids.

Association of plant-feeding nematode communities with environmental factors

V W Spaull[2], P Cadet[1] & C Gers[2]
[1]*Institute of Research for Development/Centre National Research Development Scientific, Private Bag X02, Mount Edgecombe, 4300 South Africa*
[2]*South African Sugar Association Experiment Station, Private Bag X02, Mount Edgecombe, 4300 South Africa*

A survey of nematodes associated with sugarcane in South Africa in 1978 revealed five genera of plant-feeding nematodes, namely *Helicotylenchus, Paratrichodorus, Pratylenchus, Rotylenchulus* and *Xiphinema* that were abundant as well as widespread. *Meloidogyne* was very common in sandy soils. The survey included a range of soil textures from 124 fields spread throughout the sugarcane-growing regions in KwaZulu-Natal. The data were originally published as a series of observations without statistical analysis. The survey data have been re-examined together with associated soil, climatic and topographic data, using principal component analysis (PCA). The objective was to identify associations between the distribution of nematodes and abiotic factors. When positive and negative F1 values of the PCA of data for abiotic factors and nematodes were projected onto a map of the survey area, two contrasting distributions were apparent. The one with factorial values of the abiotic data had a north/south split, with the northern part having greater evaporation, greater temperatures and a higher soil pH. The southern part was characterised by lower temperatures, lower evaporation, lower soil pH and higher soil organic matter content. The map of the factorial values of nematode data had a distinct split between a coastal + Pongola area, with positive factorial values and a high-altitude area with negative values. The high-altitude area had greater numbers of *Scutellonema, Rotylenchus, Rotylenchulus* and particularly, *Helicotylenchus* spp. The coastal area was characterised by higher numbers of almost all the other nematodes, but particularly *Pratylenchus* spp.

Nemlab – A nematode advisory service

S G Storey
Nemlab, PO Box 2825, Durbanville, 7551 South Africa

Nemlab is a privately owned nematode advisory service. An overview of the establishment of the laboratory is given, with special reference to planning, funding, legal requirements, marketing and administration. The advisory service has grown over the past 16 years. Various aspects of the running of the business are discussed. These points include those from a financial and a nematological point of view. Samples from various crops and areas and also different types of clients are received. Some of the problems and highlights encountered in running an advisory service are discussed. Various interesting aspects with regard to nematodes and crops are highlighted.

1,3-D products and application methods for control of nematodes and soilborne diseases

P Tsakonas [1]& F P J Snyman[2]
[1]*Dow AgroSciences, Thessaloniki, Greece*
[2]*Dow AgroSciences Southern Africa (Pty) Ltd, PO Box 912055, Silverton, 0127 South Africa*

1,3-Dichloropropene (1,3-D) is a widely used compound for effective control of nematodes in many crops across the world, applied by injection or drip irrigation. The phasing-out of methyl bromide according to the Montreal Protocol generated the need for additional control measures for soilborne diseases and weeds. Dow AgroSciences responded to the challenge and

launched C-35, which is a mixture of 1,3-D and chloropicrin as a methyl bromide alternative. Field results as well as commercial applications have proven that both formulations of C-35 (liquid and EC) provided yields comparable to methyl bromide treatments in the most important crops and soil pest complexes. Furthermore, new sealing and soil distribution monitoring methods provided high-value tools for enhanced performance and safe use of these fumigants. It is obvious that methyl bromide will not be replaced by a single compound or method. As nematode problems are still a serious threat to many crops, 1,3-D and its combinations with other compounds or non-chemical methods are reliable options for effective control of nematodes and soilborne diseases and weeds.

Suppression of *Meloidogyne incognita* on tomato using ground fever tea leaves under field conditions

T J Tsilo, G L Ngobeni & P W Mashela
School of Agricultural and Environmental Sciences, University of the North, Private Bag X1106, Sovenga, 0727 South Africa

Greenhouse studies demonstrated that ground fever tea (*Lippia javanica*) leaves reduced *Meloidogyne incognita* numbers by 78–80 %. Two field studies were conducted to evaluate the effects of ground *L. javanica* leaves on nematode numbers, tomato growth and yield, soil electrical conductivity (EC) and soil pH. The experiments were established as a completely randomised block design with 10 replicates. *L. javanica* leaves were oven-dried and ground to pass through a 1-mm mesh sieve. In experiments 1 and 2, three-week-old Floradade seedlings were inoculated with approximately 6750 J2 and 7050 J2, respectively. On inoculation day, ground tealeaf was applied around the crown at a rate of 5 g per seedling. At harvesting, 13 weeks after inoculation, fever tea amendment reduced nematode numbers by 89 % and 76 % in experiments 1 and 2, respectively. Tealeaf amendment increased dry shoot mass, plant height, stem diameter, fresh fruit mass and soil EC by 58–62 %, 22–27 %, 23 %, 41–60 % and 44–69 %, respectively. However, fever tea reduced soil pH in both experiments by 6 %. Results demonstrated that ground fever tea leaves have the potential of serving as an organic nematicide in organic farming systems.

Use of *Tagetes minuta* waste products for the control of *Meloidogyne* spp.

E R van Biljon, H J Beyleveld & I Madutlela
ARC Institute for Industrial Crops, Private Bag X82075, Rustenburg, 0300 South Africa

Secondary compounds in various *Tagetes* spp. are effective deterrents of numerous organisms, including nematodes. Nematode-suppressive plants may be utilised as soil amendments in the form of either green manure or dry plant residue. In a greenhouse trial, the composted waste product (essential oils extracted) of *T. minuta,* in the form of an organic amendment and an extract (distillation) were compared with a standard aldicarb treatment and an untreated control to determine their efficacy in the management of *Meloidogyne javanica* (root-knot nematode) on the tomato cultivar Moneymaker. Aldicarb and the composted waste product of *T. minuta* significantly reduced *M. javanica* numbers when compared with the untreated control. The fresh root mass of plants that received dry composted *T. minuta* realised a 33 % root mass increase compared to the untreated control. In a microplot experiment, three treatments, viz. composted waste product of *T. minuta* (essential oils extracted), composted waste product of *T. minuta* (essential oils not extracted) and an aldicarb treatment were compared with an untreated control on two soil types (sand and loam), with the hemp cultivar Kompolti as test crop. At harvesting root-knot nematode numbers were significantly higher in the compost treatments than in the untreated control. The number of root-knot nematodes in the sandy soil was much higher than in the loam soil. No significant differences in stem yield could be detected between the different treatments, although stem yield was significantly higher in the loam than sandy soil.

The sugar-beet nematode (*Heterodera schachtii*) in the Western Cape Province

J van Zyl[1] & A J Meyer[2]
[1]*Department of Agriculture: Western Cape, Private Bag X1, Elsenburg, 7607 South Africa*
[2]*Department of Entomology and Nematology, University of Stellenbosch, Private Bag X1, Matieland, 7602 South Africa*

In a survey of the Cape Peninsula and surrounding areas, *Heterodera schachtii* was found to be widespread on cauliflower, Brussels sprouts, beetroot and cabbage. The numbers extracted were always more than two eggs and/or juveniles per

gram of soil, which is generally accepted as a critical threshold level. The damage potential of *H. schachtii* on vegetables as well as the potential of certain weeds to serve as a source of infection on subsequent plantings were studied under greenhouse conditions. Reduction in yield, top and root mass of all vegetables increased with increasing nematode inoculum levels. Population densities increased with an increase in initial population and the reproduction ratio decreased. The most commonly occurring weeds all maintained the population of the nematode and stimulated reproduction, which is an additional reason for weeds to be a limiting factor in vegetable production. The biology of *H. schachtii* was studied by comparing its penetration and subsequent development on vegetables, weeds and trap crops. Five days after inoculation, penetration occurred in all hosts, being on average 37 % at high and 52 % at low inoculation levels. Subsequent development on weeds and vegetables was similar. The possible existence of pathological races was examined by comparing the rates of penetration and reproduction of geographically isolated populations. Results indicated that the Lynedoch and Philippi populations were distinct from the rest. However, subjecting representative individuals to PCR/RFLP revealed no differences between the populations at molecular level. The effects of soil texture, temperature and pH were also studied. A soil temperature of 20 °C led to the highest yield reduction in cabbage and beetroot. Nematode migration and penetration declined with an increase in clay and silt content of up to 37 % silt and clay, where these activities ceased. Soil pH of 7.2 and 4.2 led to a low penetration rate. Crop rotation is an essential component of non-chemical control but it required a one-in-four rotation for optimal results.

ABSTRACTS OF POSTERS

Evaluation of banana germplasm as part of an Integrated *Musa* Testing Programme (IMTP III) for nematode resistance

M Daneel[1], K De Jager[1], K Beullens[2], W Steyn[1] & D De Waele[2]

[1]*ARC Institute for Tropical and Subtropical Crops, Private Bag X11208, Nelspruit 1200 South Africa*

[2]*Laboratory of Tropical Crop Improvement, Catholic University Leuven, Kasteelpark Arenberg 13, 3001 Leuven, Belgium*

Banana germplasm originating from a wide range of *Musa* material was selected to be tested as part of an IMTP III programme for nematode resistance in PROMUSA, a global network for *Musa* improvement. Two series of trials were conducted in a greenhouse and 32 plants per genotype were screened. After 8–12 weeks, 24 plants were infested with approximately 1000 *Radopholus similis* per plant, while the remaining eight were left uninfested. At 6, 9 and 12 weeks, eight plants were evaluated for number of nematodes and root damage. During evaluation, leaf area of first and third leaves, root and plant mass, as well as root necrosis index (RNI) were determined. Grand Nain was used as the susceptible and Yangambi-km5 as the resistant standard. Results showed several genotypes, including FHIA 1, FHIA 18, Paka and Kunnan, to be more resistant to nematodes than Yangambi-km5.

Phylogenetic analysis of selected Longidoridae based on 18s rDNA gene sequences

J Hübschen[1], C M G Oliveira[2], A Auwerkerken[3], L Barsi[4], L C C B Ferraz[5], U Ipach[1], S Lazarova[6], M Liskova[7], V Peneva[6], R T Robbins[8], A Susulousky[9], M Tzortzakais[10], W Ye[11], J Zheng[12], Q Tasheen[13], H Fourie[14], F Lamberti[15], D J F Brown[6] & R Neilson[16]

[1]*Staatlisches Lehr- und Forschungsanstalt für Landwirtschaft, Weinbau und Gartenbau, Fachbereich Phytomedizin, Neustadt/W, Germany*

[2]*Instituto Biologico, Campinas, Brazil*

[3]*Institute of Tropical Agriculture, Port Harcourt, Nigeria*

[4]*Institute of Biology, Novi Sad, FR Yugoslavia*

[5]*Universidade de Sâo Paulo, Piracicaba, Brazil*

[6]*Laboratory of General Ecology, Sofia, Bulgaria*

[7]*Parasitlogical Institute SAS, Kosice, Slovak Republic*

[8]*University of Arkansas, Fayetteville AR, USA*

[9]*Museum of Natural History, Lviv, Ukraine*

[10]*Plant Protection Institute, Crete, Greece*

[11]*College of Agriculture, Zhejiang University, Hangzhou, China*

[12]*Purdue University, Indiania, USA;* [13]*AMU, Aligarh, India*

[14]*ARC Grain Crops Institute, Potchefstroom, South Africa*

[15]*CNR Instituto Nematologia Agraria, Bari, Italy;*

[16]*Scottish Crop Research Institute, Invergowrie, Dundee, Scotland*

The 18S rDNA gene is highly conserved within taxa, which makes it particularly useful for phylogenetic studies. Various authors have produced phylogenies of several groups of plant-parasitic nematodes, but these typically refer only to endo- or semi-endoparasitic nematodes and few utilise the 18S gene. The economically important family Longidoridae comprises five genera, with two of these, *Longidorus* and *Xiphinema,* comprising

over 100 and 200 species, respectively, and to date has not been subject to a comprehensive molecularly-based phylogenetic study. For each of the approximately 80 putative longidorid species used in this study, DNA was extracted from a minimum of two adult nematodes. Using a range of primers, the complete 18S rDNA gene (ranging from 1700–1770 bp, depending upon species) was sequenced according to direct PCR methodologies. Analyses of the sequence data revealed clear separation at generic level. Furthermore, geographically distinct populations of a sexually reproducing species (*X. diversicaudatum*) and two parthenogenetically reproducing species (*X. index* and *X. vuittenezi*) yielded identical species-specific sequences, with no inter-population variability. Also, species belonging to the *X. americanum* group formed a distinct cluster but inter-species heterogeneity of the 18S gene was minimal.

Prevalence of *Pratylenchus goodeyi* on banana and plantain in mixed cropping systems of the Cameroon Highlands

K Jacobsen[1], R Fogain[1] & D De Waele[2]

[1]*Centre Africain de Reserche sur Bananiers et Plantains Bureaux de Liason /INIBAP/VVOB, Njombé, BP 832 Douala, Cameroon*
[2]*Laboratory of Tropical Crop Improvement, Catholic University Leuven, Kasteelpark Arenberg 13, 3001 Leuven, Belgium*

In Cameroon most subsistence farmers apply a mixed cropping system, resulting in a range of possible nematode host plants, each with a specific effect on the nematode community. Banana and plantain (*Musa* spp.) are important components of these cropping systems, both as a source of cash income and as staple food and are found in almost every field. The Cameroon Highlands represent 10 % of the total land area in Cameroon, but accommodate roughly 30 % of the total population. In addition, more than 25 % of all plantain is produced in the region and more than 30 % of all banana. Nematodes have been identified as a major constraint to *Musa* production worldwide. In Africa, in production areas at higher elevation (lower temperature), *Pratylenchus goodeyi* is the dominant nematode species found associated with plantain, occurring almost exclusively in smallholder's fields. A survey was done throughout the Cameroon Highlands to identify types of crop management practices, crop associations and pest awareness of small-scale farmers. In addition, samples were taken to determine the prevalence of *P. goodeyi* on banana and plantain in home gardens and one field of each household was visited. This study reports on information gathered from more than 200 interviews and sampling visits in the West and North West Provinces of Cameroon.

Fallow or hot water treatment: a choice for small-scale plantain producers in Cameroon?

K Jacobsen[1], S Hauser[2], D Coyne[3] & D De Waele[4]

[1]*Centre Africain de Reserche sur Bananiers et Plantains Bureaux de Liason/INIBAP/VVOB, Njombé, BP 832 Douala, Cameroun.*
[2]*IITA HFC, BP. 2008, Yaoundé (Messa), Cameroun.*
[3]*IITA Ibadan, Nigeria, c/o Lambourn & Co., Carolyn House, 36 Dingwall Road, Croydon, CR9 3EE, UK*
[4]*Laboratory of Tropical Crop Improvement, Catholic University Leuven, Kasteelpark Arenberg 13, 3001 Leuven, Belgium*

Small-scale farmers in the Central Province of Cameroon traditionally plant their plantain in secondary or primary forests following slash-and-burn preparation of the land. Owing to increasing population pressure, however, fallow periods are declining and crop pest populations are increasing. This study reports on the effectiveness of hot water treatment in reducing plant-parasitic nematodes on two plantain varieties (*Musa* spp. AAB, French cv. Essong and AAB, False Horn cv. Ebang) in a short and long fallow system. Fertiliser was applied as a fourth factor. Sampling was done at 15 and 21 months after planting (MAP), respectively, coinciding with the flowering/harvesting of the first crop cycle and six months thereafter. Initially (15 MAP), hot water treatment of plantain suckers before planting significantly reduced nematode numbers in both fallow systems and increased overall root health, as indicated by the index of undamaged roots. However, at 21 MAP, population increases of plant-parasitic nematodes in short-fallowed plots outweighed these benefits, making the choice of field location the dominant factor. The question remains how long farmers will be able to make this choice. The importance of development of adapted, sustainable technologies for plantain production is underlined.

Video film on the feeding behaviour of *Paratrichodorus anemones*

E Karanastasi[1], U Wyss[2] & D J F Brown[3]
[1]*Benaki Phytopathological Institute, 14561, Kifissia, Greece*
[2]*Institute of Pathology, University of Kiel, Hermann-Rodewald-Str. 9, Germany*
[3]*Central Laboratory of General Ecology, 2 Gagarin Street, 1113 Sofia, Bulgaria*

Video-enhanced interference light microscopy was used to film the feeding behaviour of *Paratrichodorus anemones* to determine how the nematode transmits tobraviruses to plant hosts. Previous studies, particularly those with *Trichodorus similis,* revealed that the nematode destroys root cells that it feeds upon. Also, feeding on individual root cells lasted for about four minutes, thus preventing transmitted virus particles establishing an infection in the plant. Examination of the new film revealed the feeding behaviour of *P. anemones* from initially locating the host and feeding site through an entire feeding sequence. The entire feeding cycle has four distinct phases: (i) root exploration; (ii) cell exploration; (iii) cell sampling and (iv) cell feeding. Preceding initiation of phase (iv) the nematode perforates the wall of each of about four cells, but immediately abandons each cell. Also, during phase (iv) about 5 % of the perforated cells remain alive. These perforated cells provide a platform for the transmission and subsequent successful establishment of any virus associated with the nematode. Additional information revealed in the film is that occasionally cell contents 'leak' to the external environment through the feeding tube formed by *P. anemones* that is left in the cell wall. Also, the feeding tube is highly flexible and occasionally remains attached to the mouthparts of a nematode from where it has to be ejected. Several nematodes, upon completion of the feeding cycle, were observed ejecting pharyngeal gland secretions in an attempt to 'flush clean' the pharyngeal tract, presumably to remove the cell contents contained therein.

Distribution of nematode communities in microhabitats within an oak forest on Vitosha Mountain, Bulgaria

S S Lazarova[1], R G M de Goede[2], V K Peneva[1], T Bongers[3] & D J F Brown[1]
[1]*Central Laboratory of General Ecology, Bulgarian Academy of Sciences, 2 Gagarin Street, 1113 Sofia, Bulgaria*
[2]*Environmental Sciences, Sub-department of Soil Quality, Wageningen University, PO Box 8005, 6700 EC Wageningen, Netherlands*
[3]*Laboratory of Nematology, Wageningen University, PO Box 8123, 6700 ES Wageningen, Netherlands*

Variability in the spatial distribution of nematode communities was studied in relation to nine different microhabitats in a natural oak forest. Maturity and diversity indices (MI & DI), trophic structure and the distribution of coloniser-persister (cp) groups were analysed. Two main groups of nematode communities, below- and above-ground, were distinguished in terms of the location of the microhabitats. A higher percentage similarity between nematode communities inhabiting microhabitats was revealed, with a higher resemblance in substrate structure, abiotic and biotic conditions. The application of detrended correspondence analysis outlined two ecological gradients. The first one was from microhabitats having smaller fluctuations in microclimatic conditions and nutrient supply to microhabitats with more adverse abiotic conditions and dynamics of food resources. Along this gradient from below- to above-ground microhabitats, the proportion of general opportunists (cp two taxa) increased, whereas the diversity, MI and the proportions of persisters (cp three to five taxa) decreased. Along the second gradient the proportion of enrichment opportunists (cp one taxon) diminished, which we relate to a decrease in the decomposition rate within microhabitats. Nematode communities of decaying wood had the most specific cp groups' distribution characterised by a high proportion of enrichment opportunists (colonisers). Each microhabitat was inhabited by nematode communities with a characteristic trophic structure that was related to the relative importance of primary production and decomposition processes occurring within the microhabitat. The nematode communities of mosses growing on soil, stones and tree trunks had similar trophic structures dominated by bacteria-feeding nematode taxa. Our results support the role of nematode communities as indicators of environmental conditions.

Endosymbiont bacteria of the *Xiphinema americanum* group of nematodes

S S Lazarova[1], G Malloch[2], B Fenton[2], C M G Oliveira[3], R T Robbins[4], F Lamberti[5], D J F Brown[1] & R Neilson[2]
[1]*Central Laboratory of General Ecology, Sofia, Bulgaria*
[2]*Scottish Crop Research Institute, Invergowrie, Dundee, Scotland, UK*

[3]*Instituto Biologico, Campinas, Brazil*
[4]*University of Arkansas, Fayetteville AR, USA*
[5]*CNR Istituto Nematologia Agraria, Bari, Italy*

Intracellular endosymbionts (*Wolbachia*) are found in a wealth of arthropods and can alter the reproduction of their host in various ways, including cytoplasmic incompatibility, parthenogenesis induction, feminisation of genetic males and son killing. This group of bacteria has generated extensive interest as it has been suggested that they could be employed to reduce the reproductive potential of their hosts, or spread control genes into their populations. Less well-studied but potentially similar obligate symbiont bacteria are known to occur in the reproductive system of ectoparasitic *Xiphinema americanum* group nematodes. Previous studies on the bacterial 16S rDNA gene of three putative *X. americanum* group species (*X. americanum* s. str., *X. brevicolle* and *X. rivesi*) revealed that the bacterial species belonged to the genus *Candidatus* Xiphinematobacter (division Verrucomicrobia). The function of these bacteria is not known but it has been postulated that they may induce parthenogenesis in the host. To investigate this host–endosymbiont relationship throughout the *X. americanum* group, approximately 900 bp of the 16S bacterial gene were sequenced from 24 nematode populations collected from a number of geographically disparate locations. Preliminary phylogenetic analysis of the 16S sequence data, including three previously described *Candidatus* Xiphinematobacter species, suggests four distinct bacterial groupings that appear to reflect the geographic origin of the nematode host.

Host status of Vetiver grass to root-knot nematode species common in resource-poor crop production

C Leswifi & H Fourie
ARC Grain Crops Institute, Private Bag X1251, Potchefstroom, 2520 South Africa

Vetiver grass (*Chrysopogon zizanioides*) is an eco-friendly tool in pest management and soil conservation systems and is increasing in popularity. Inclusion of this species as a cover crop proved to be practical, inexpensive and effective in soil and water conservation, particularly in resource-poor farming systems. The host status of Vetiver grass to both *Meloidogyne javanica* and *M. incognita* race 2 was consequently investigated due to the abundance and importance of these nematode species in resource-poor production systems. Vetiver grass and the six crops included in the North Carolina Differential Host Range Test, viz. tomato cultivar Rutgers, groundnut cultivar Florunner, watermelon cultivar Charleston Gray, green pepper cultivar California Wonder, cotton cultivar Deltapine and the tobacco line NC 95 were evaluated in pots in a greenhouse. Each seedling was artificially inoculated with 10 000 ± 500 eggs and juveniles of the respective species, three weeks after emergence. Assessments were done 56 days after inoculation. Significant differences were recorded between various crops with regard to egg-mass counts, ELF-indices, egg counts per root system and RF-values for both species. Green pepper, groundnut and Vetiver grass exhibited RF-values below 1, indicating resistance to *M. javanica* and differed significantly from the susceptible tomato, watermelon, cotton and tobacco. RF-values lower than 1 were also recorded for Vetiver grass, groundnut and cotton when screened against *M. incognita* race 2, while tomato, watermelon and tobacco exhibited high RF-values. These results confirm Vetiver grass to be a poor host of the most abundant root-knot nematode species in resource-poor farming systems. Vetiver grass as a cover crop will therefore not enhance root-knot nematode population growth in small-scale fields or gardens. Ways to exploit this crop in integrated nematode management in the resource-poor sector need further investigation.

Plant nematodes as part of the Lusikisiki Land Care Project

M Marais & A Swart
Nematology Unit, Biosystematics Division, ARC Plant Protection Research Institute, Private Bag X134, Queenswood, 0121 South Africa

The vision of the National Land Care Programme is to have communities and individuals adopt an ecologically sustainable approach to the management of South Africa's environment and natural resources, while improving their livelihood. This means that people use soil, water and vegetation resources in such a manner that food security is achieved and quality of life is improved. The Nematology Unit (ARC PPRI) has been part of the research team since the launch of the project in 2000. During the first two seasons, our focus was to determine the presence and distribution of plant-parasitic nematodes and to inform the community about these organisms. The complex

of plant nematodes found in virgin soils was typical, in that a variety of species were found but none occurred in high numbers. The complex and population numbers of nematodes found at the participating farms differed vastly from that in virgin soil.

Plant nematodes of the Swartberg Nature Reserve

M Marais[1], E van den Berg[1], A Swart[1] & Z van der Walt[2]
[1]*Nematology Unit, Biosystematics Division, ARC Plant Protection Research Institute, Private Bag X134, Queenswood, 0121 South Africa*
[2]*Swartberg Nature Reserve, Cape Nature Conservation, Private Bag X658, Oudtshoorn, 6620 South Africa*

Since 1995, the Swartberg Nature Reserve was surveyed as part of the South African Plant-Parasitic Nematode Survey (SAPPNS) programme. This reserve is situated in the Oudtshoorn district, between the Little and Great Karoo. The vegetation is remarkably diverse, featuring renosterveld, mountain fynbos, Karoo veld, spekboomveld and numerous geophyte species. The Swartberg Nature Reserve is also an area of climatic extremes, with very cold winters and summers that can be uncomfortably hot. This diversity in climate and vegetation is also reflected in the diversity of plant nematodes found, with nearly all the families recorded in South Africa to date found in this area. *Longidorus jagerae* and *Caloosia exigua* were new species described from the Swartberg Nature Reserve. An interesting phenomenon is the difference in the nematode fauna between Gamkaskloof and that of the rest of the reserve. The nematode fauna of Gamkaskloof reflects the agricultural history of this valley.

Nematodes from an urban–rural gradient in Bulgaria

A Mladenov, S S Lazarova, V K Peneva & D F J Brown
Central Laboratory of General Ecology, 2 Gagarin Street, 1113 Sofia, Bulgaria

Nematode communities from mixed deciduous forests in Bulgaria were studied along an urban–rural gradient, from a city park in Sofia to a sparsely populated area in Plana Mountain. Three experimental plots were selected, viz. urban, suburban and rural, and samples from litter and four soil depths were collected. Generic composition, trophic structure, diversity and maturity indices (DI & MI) of nematode communities were determined. Overall, 101 genera were registered. The greatest diversity was observed in the urban stand (90 genera), followed by the rural (67) and suburban sites (62). Bacterial feeders were the most common, abundant and diverse (43 genera) group, followed by plant feeders (24). Total nematode numbers, both in litter and soil from the rural site significantly exceeded those from suburban and urban stands. Also, the generic diversity of nematodes from litter in the urban site was significantly lower compared to the other sites studied. The analyses revealed high taxonomic diversity and maturity of soil nematode communities. Furthermore, the nematode communities from urban and suburban sites were clearly separated from these in the rural site. Urbanisation impact was stronger on nematodes inhabiting litter. Total nematode abundance, generic richness and number of nematode genera (general colonisers) proved to be the most suitable parameters for assessing anthropogenic influence.

Taxonomic relationships of selected *Xiphinema* and *Xiphidorus* species from Brazil

C M G Oliveira[1], J Hübschen[2], D J F Brown[3], A R Monteiro[4], L C C B Ferraz[4], F G Wright[5] & R Neilson[6]
[1]*Instituto Biológico, PB 70, Campinas, SP, Brazil, 13.001-970*
[2]*SLFA Neustadt, Breitenweg 71, D-67435, Neustadt, Germany*
[3]*Central Laboratory of General Ecology, 2 Gagarin Street, 1113 Sofia, Bulgaria*
[4]*ESALQ/USP, 13418-900, Piracicaba, SP, Brazil*
[5]*Biomathematics and Statistics Scotland, Invergowrie, Dundee, DD2 5DA, Scotland*
[6]*Scottish Crop Research Institute, Invergowrie, Dundee, DD2 5DA, Scotland*

Fourteen *Xiphinema* and five *Xiphidorus* species were collected from different localities throughout Brazil to investigate their taxonomic relationships based on morphometrics and 18S rDNA gene sequences, and to provide an insight into their genetic diversity. A principal components analysis identified odontostyle and odontophore length, and to a lesser extent, vulva position as the main discriminant morphological characters that could be used to separate the *Xiphinema* and *Xiphidorus* species in this study. A cluster comprising all *Xiphidorus* and *X. americanum* species plus *X. elongatum* was distinct from the other clusters, based on short odontostyle length. A small cluster comprising three species, *X. brasiliense, X. ensiculiferum* and *X. surinamense,* was distinct from all other species based on a combination of a long odontophore and an anterior vulva. Maxi-

mum likelihood trees produced from 18S rDNA sequences separated *Xiphinema* and *Xiphidorus* species into distinct groups. Species belonging to the *X. americanum* group (*X. americanum* s. str., *X. brevicolle, X. diffusum, X. oxycaudatum* and *X. peruvianum*) formed a single group that had minimal differences in their 18S sequence. As with morphological characters, 18S rDNA sequence could not readily discriminate these species, perhaps suggesting that instead of putative species, the *X. americanum* group is in fact a species complex with large inter- and intra-population variability. Our data indicate that species of *Xiphidorus* are generally more genetically diverse than those from either the *Xiphinema* or *X. americanum* group.

Approaching root-knot nematode resistance in commercial maize material

M J Schoeman, H Fourie & A H McDonald
ARC Grain Crops Institute, Private Bag X1251, Potchefstroom, 2520 South Africa

Parasitism by root-knot nematodes (*Meloidogyne* spp.) is of economic importance in local maize production. Demand for the identification of resistant maize germplasm is increasing since chemical control is hardly cost-effective, especially under dry land production conditions. Thirteen local as well as various foreign maize genotypes were first evaluated for resistance to *M. javanica* in a greenhouse trial, after which twenty-two genotypes were screened for resistance to a mixed population of *M. javanica* and *M. incognita* race 2 in a uniformly infested field. These twenty-two maize genotypes also included crosses between resistant lines and inbred lines of appropriate heterotic groupings. In the greenhouse trial two lines were identified with significantly less eggs per root system, and lower reproduction factor (RF)-values than a susceptible standard, which maintained the highest number of *M. javanica* eggs and juveniles and had the highest RF-value of 24.2. The latter line also maintained the highest number of root-knot nematode eggs and juveniles per 50 g roots in the field trial, these numbers being significantly higher than those from 12 crosses and four lines. Identification of molecular markers associated with the resistance trait will be sought to facilitate marker-assisted selection and expediting breeding of root-knot nematode-resistant, commercial maize hybrids and varieties.

Screening of groundnut accessions for resistance to the pod nematode

S Steenkamp, A H McDonald & H Fourie
ARC Grain Crops Institute, Private Bag X1251, Potchefstroom, 2520 South Africa

The seedborne peanut pod nematode, *Ditylenchus africanus,* is omnipresent in groundnut-production areas of South Africa and is one of the economically most important pests of groundnut. Resistant genotypes could play an important role to keep *D. africanus* below economic threshold levels in groundnut crops. Numerous screenings have been done on local germplasm, selected elite breeding lines and hybrids. Fifteen new accessions were screened since the 2001 growing season against this parasite in microplots. The cultivars Sellie and Kwarts were used as susceptible and tolerant standards, respectively. Each seed was artificially inoculated with approximately 5000 *D. africanus* individuals at planting. At harvesting, no significant differences were observed in total *D. africanus* numbers in pods between any of the lines in relation to the susceptible cultivar Sellie. Tolerant Kwarts also did not differ significantly from the susceptible standard with regard to total numbers of nematodes in pods. Consequently, foreign germplasm and wild groundnut species have been acquired and will be screened. If available, sources of resistance will be incorporated into the breeding programme, hopefully with the aid of marker-assisted selection.

Hoplolaimid species of major Rwandan banana fields

E van den Berg[1], M Marais[1], S V Gaidashova[2] & L R Tiedt[3]
[1]*Nematology Unit, Biosystematics Division, ARC Plant Protection Research Institute, Private Bag X134, Queenswood, 0121 South Africa*
[2]*Institut des Sciences Agronomique du Rwanda, BP 138 Butare, Rwanda*
[3]*Laboratory for Electron Microscopy, University of Potchefstroom, Potchefstroom, 2520 South Africa*

During 2000 a survey was conducted in the major banana-growing areas of Rwanda, with the objective to identify factors responsible for a decline in banana production. Sixty farms in twelve districts were sampled. Twenty-two plant-feeding nematode species were found, of which 45 % were hoplolaimid species, viz. *Helicotylenchus dihystera, H. multicinctus, H. egyptiensis, H. variocaudatus, Rotylenchulus borealis, Hoplolaimus pararobustus, Scutellonema cavenessi* and *S. paralabiatum.*

Except for *H. multicinctus,* the other are all new records for Rwanda. The range of variation in certain characters, as well as the characters originally used to separate the genus *Rotylenchoides* from *Helicotylenchus* not being valid, resulted in the synonimisation of the species *H. affinis* with *H. variocaudatus.* This also resulted in the synonimisation of *Rotylenchoides* with *Helicotylenchus.* These two genera differed mainly in terms of the regression of the posterior ovary. *Rotylenchulus* was regarded either as a valid genus or a synonym of *Helicotylenchus* by several authors since its original description in 1958. *R. borealis* was abundant at 29 of the 60 localities. The male gubernaculum has a distinct hook-like distal end, similar to those found in Cameroon but it has not yet observed in South African specimens. *S. paralabiatum* was originally described from Kenya, with a projecting epiptygma as one of the main distinguishing characters. Only a few Rwandan females of this species showed this characteristic, while in the rest the epiptygma was folded over the vulva. When re-studying the types from Kenya it was noticed that the epiptygma was not projecting from the vulva of all females.

Criconematidae from the Nama and Succulent Karoo Biomes, South Africa

E van den Berg[1], M Marais[1] & L R Tiedt[2]
[1]*Nematology Unit, Biosystematics Division, ARC Plant Protection Research Institute, Private Bag X 134, Queenswood, 0121 South Africa*
[2]*Laboratory for Electron Microscopy, University of Potchefstroom, Potchefstroom, 2520 South Africa*

The Nama and Succulent Karoo Biomes are two of the most ecologically sensitive and least studied biomes in South Africa. Of all biomes, the nematode fauna of the two Karoo biomes is least known. The Nama Karoo, situated on the central plateau of the western half of South Africa, is a summer-rainfall area consisting of grassy, dwarf-shrubland where less than 1 % of the area is formally conserved. Most of the land is used for grazing, with agronomy confined to the Orange River Valley. The Succulent Karoo comprises the western and southern parts of the western escarpment, north of the Cape Fold Belt. It is a low winter-rainfall area consisting of dwarf, succulent shrubs with mass flower displays. There is some agriculture in the south and mining in the north, with only 0.5 % of the area formally conserved. The South African Plant-Parasitic Nematode Survey (SAPPNS) database contains 475 records of Criconematidae from the Nama Karoo Biome that consist of 27 species of the genera *Criconema, Criconemoides, Discocriconemella, Hemicriconemoides, Hemicycliophora, Mesocriconema, Ogma* and *Paratylenchus.* Two species, viz. *Criconema gariepense* and *Mesocriconema maskaka,* are indigenous to this area. Information on the criconematids of the Succulent Karoo Biome in the SAPPNS database is contained in 152 records and includes 15 species of the genera *Criconema, Criconemoides, Hemicriconemoides, Hemicycliophora, Mesocriconema* and *Paratylenchus. Hemicycliophora lamberti* is indigenous to this biome. Only six of the species, viz. *Criconema mutabile, C. sanctifrancisci, Hemicriconemoides brachyurus, Mesocriconema obtusicaudatum, M. sphaerocephalum* and *M. xenoplax,* are found in both biomes.

The effect of initial population density and growing season on root-knot nematodes of popular small-scale farmer crops

G A Venter, H Fourie & A H McDonald
ARC Grain Crops Institute, Private Bag X1251, Potchefstroom, 2520 South Africa

Root-knot nematodes (*Meloidogyne* spp.) are omnipresent in most resource-poor areas of South Africa. Demonstrations of significant crop yield losses emphasise an urgent need for development and application of integrated, effective nematode management strategies to enable sustainable food production. High and low *M. javanica* infestation levels were hence established in microplots during the 2000/2001 summer growing season, using a susceptible and resistant soybean genotype. Crops popular with small-scale farmers in many cooler areas in the country were planted during the following winter and summer growing seasons, until 2002. The carrot cultivar Chantenay Karoo, dry bean cultivar Mkuzi, cabbage cultivar 3306 and maize cultivar SC701 were used in these trials. Production of carrot and cabbage during winter reduced *M. javanica* numbers significantly, both under high and low nematode population densities. The susceptible dry bean crop in summer resulted in the opposite effect, namely a significant increase ($P \leq 0.05$) in *M. javanica* numbers to 111 000 eggs and juveniles per 50 g fresh root under high population pressure, compared to 8900 eggs and juveniles where the

M. javanica population pressure was low. The maize cultivar SC701, however, supported significantly higher *M. javanica* numbers under high nematode population pressure, but maintained the same population density compared to cabbage under low *M. javanica* population pressure. This information can be used to plan rotation sequences as part of integrated nematode management strategies for resource-poor producers in cooler areas of the country.