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ABSTRACTS OF PAPERS

How to survive as a nematologist in the new millennium

D de Waele
Laboratory of Tropical Crop Improvement, Catholic University Leuven, Kasteelpark Arenberg 13, 3001 Leuven, Belgium

In the new millennium, plant-parasitic nematodes will remain a hidden enemy and nematologists will continue to belong to an endangered species. Jumping on the molecular-genetics bandwagon to avoid extinction is not the solution it seemed a few years ago when public opinion was not yet as critical about genetically modified organisms as it is today. In fact, there is no single cure to save a nematologist's career, only a number of initiatives a nematologist can take to bolster his or her position in the eyes of the decision-makers. Build-up of sufficient critical mass to investigate and solve nematological problems, training of young people, collection of basic data related to damage caused by plant-parasitic nematodes to important agricultural crops, positioning of nematodes in a broader (eco-) system and the internationalisation of research are initiatives nematologists should consider to reinforce their position in the scientific community. Examples related to *Musa*-nematology will be given to illustrate what can be done.

About the importance of nematology courses

N Smol
Nematology Course, Vakgroep Biologie, Universiteit Gent, K.L. Ledeganckstraat 35, B-9000 Gent, Belgium

Although nematodes are very abundant and important in agriculture as well as in terrestrial and aquatic ecology, nematology is often restricted to some lectures within the framework of plant pathology. An overview of specific nematology courses worldwide is given, with special reference to the duration, periodicity, number and origin of participants and target groups of nematodes. An overview of the number and disciplines of nematologists at the start of the third millennium reveals remarkable differences between countries as well as between continents. The abundance of nematologists is partly a reflection of the impact of some international courses.

Effect of *Bacillus chitinosporus* on cysts and eggs of *Globodera rostochiensis*

L R Tiedt
Laboratory for Electron Microscopy, Potchefstroom University for CHE, Private Bag X6001, Potchefstroom, 2520 South Africa

A suspension of soil microbes containing the bacterium *Bacillus chitinosporus* was tested for its effect on the cysts as well as egg walls in the cysts of *Globodera rostochiensis.* Cysts were exposed to the suspension for 72 hours. Exposed and unexposed cysts were fixed for 24 hours in a glutaraldehyde/formaldehyde mixture at 4 °C for transmission electron microscopy (TEM) and for 12 hours in 70 % ethanol for scanning electron microscopy (SEM). Cyst walls were opened and eggs spilled onto the carbon tape on a SEM-stub and coated with carbon and gold/palladium. Results showed egg walls to be thick, opaque structures consisting of a thin outer and thick inner

layer. Only few bacteria can enter through openings if shrinking of the dried-out cyst wall does not close the openings. When the bacteria do enter, dead tissue of the female cyst nematode adhering to egg walls protects most eggs. In the TEM results there was no visible difference in the egg walls of the untreated control and samples exposed for 72 hours. Hatched juveniles were observed in some of the exposed cysts. In conclusion, *B. chitinosporus* had no effect on the egg or cyst walls of *G. rostochiensis,* even after 72 hours of exposure.

Effect of *Chromolaena odorata* on parasitism of *Pratylenchus brachyurus* on pineapple in Côte d'Ivoire

G P Gnonhouri[1], A Adiko[1] & S Ake[2]
[1]*Laboratoire de Nématologie CNRA (Centre National de Recherche Agronomique), 01 B.P. 1740 Abidjan 01, Côte d'Ivoire*
[2]*Université de Cocody (Abidjan), UFR Biosciences, 22 B.P. 582 Abidjan 22, Côte d'Ivoire*

In Côte d'Ivoire, fallow fields are dominated by *Chromolaena odorata,* a pan-tropical shrub. The host status of this member of the family Asteraceae with respect to *Pratylenchus brachyurus,* the principal nematode parasite of pineapple in the country, was assessed. In a pot experiment, inoculation of *P. brachyurus* on seedlings of *C. odorata* resulted in 3–7.5 % root infection during the first 15 days. Beyond that period, nematode infection rate declined progressively to undetectable levels. In the field, abandoned pineapple plots were covered within 12 months by *C. odorata.* Pineapple cropping systems involving *C. odorata* led to both a significant reduction in residual populations of *P. brachyurus* during fallow and a delay in pineapple re-infestation by the nematode.

Identification of root-knot nematode species occurring in South Africa by SCAR–PCR

H Fourie[1], C Zijlstra[2] & A H Mc Donald[1]
[1]*ARC–Grain Crops Institute, Private Bag X1251, Potchefstroom, 2520 South Africa*
[2]*Plant Research International, PO Box 16, 6700 AA Wageningen, the Netherlands*

Availability of well-defined nematode populations is essential for research on host plant resistance screening and breeding as well as for crop rotation purposes. Identification of mono-specific root-knot nematode populations occurring in South African soils and differentiation between species in mixed populations were done by means of the sequence characterised amplified regio–polymerase chain reaction (SCAR–PCR) technique. *Meloidogyne fallax, M. chitwoodi, M. javanica, M. incognita, M. arenaria* and *M. hapla* were identified. A multiplex internal transcribed spacer (ITS)–PCR analysis amplified a fragment in an unknown root-knot nematode species for which no SCAR marker is presently available. *M. fallax,* regarded as a quarantine organism in Europe, was thus recorded for the first time in South Africa. Resulting from this study, the geographic distribution of *M. chitwoodi* was confirmed at four localities in South Africa. *M. hapla, M. fallax* and *M. chitwoodi* occurred in a mixed population on groundnut at Vaalharts, while both *M. arenaria* and *M. incognita* were detected on *Impatiens* spp. from Durban. *M. javanica, M. incognita* and an unidentified species were discerned in mono-specific greenhouse populations. Owing to the presence of *M. fallax* in the Vaalharts region, its incidence needs to be quantified, especially in areas where potato is included in crop rotation systems. Root-knot nematode species composition in fields or in greenhouse cultures can be determined more accurately using the SCAR-PCR technique, which allows for routine analyses of root-knot nematode species.

Taxonomic status of the genus *Helicotylenchus*

M Marais[1] & A J Meyer[2]
[1]*National Collection of Nematodes, Biosystematics Division, ARC–Plant Protection Research Institute, Private Bag X134, Pretoria, 0001 South Africa*
[2]*Department of Entomology and Nematology, University of Stellenbosch, Private Bag X1, Matieland 7602, South Africa*

Although Steiner described the genus *Helicotylenchus* in 1945, species belonging to this genus have been known for longer than a century. In 1961, Sher amended the description of the genus and listed eleven species. Over the last 40 years the number of species have increased almost to the 200-mark. *Helicotylenchus* has guided other plant-parasitic nematodes into the computer age, with two simultaneous projects in 1983 utilising computerised identification of nematodes. The taxonomic status of the genus, differences to and similarities with related genera within the family Hoplolaimidae have been discussed by various authors. Overlapping taxonomic characteristics are making it more difficult to distinguish

between *Helicotylenchus* and some of the other genera in the subfamily Hoplolaiminae.

Detection of a *Hemicycliophora* species on citrus in the Gamtoos River Valley

M C Pretorius[1], L Huisman[1], H F Le Roux[1], E Van den Berg[2] & L R Tiedt[3]
[1]*Citrus Research International, PO Box 28, Nelspruit 1200, South Africa*
[2]*Biosystematics Division, ARC–Plant Protection Research Institute, Private Bag X134, Pretoria, 0001 South Africa*
[3]*Laboratory for Electron Microscopy, Potchefstroom University for CHE, Private Bag X6001, Potchefstroom 2520, South Africa*

The genus *Hemicycliophora,* collectively referred to as sheath nematodes, is common in many parts of the world and has a wide host range, including citrus. Specimens of this genus were recently detected in the Gamtoos River Valley. *H. typical* was identified as well as *H. halophila,* making this the first report of the latter species on citrus. Further identification and taxonomic studies are being conducted. Readily recognisable swellings or galls are present on lateral and terminal roots. Samples taken in the Gamtoos River Valley indicated that the nematode is frequently found in sandy soils at a depth of 30–60 cm. The citrus nematode, *Tylenchulus semipenetrans,* was also present in all samples. Although the genus *Hemicycliophora* was previously identified in association with citrus in South Africa, *T. semipenetrans* was regarded as the principle nematode problem on citrus. The nematode-trapping fungus, *Arthrobotrys* spp., was present in most of the soils.

Verification of soybean host suitability to *Meloidogyne javanica* and identification and validation of genetic markers linked to the resistance trait

H Fourie, C Mienie & A H McDonald
ARC–Grain Crops Institute, Private Bag X1251, Potchefstroom, 2520 South Africa

The soybean cultivar Gazelle was identified as a poor host to *Meloidogyne javanica* in greenhouse screening trials. A7119 and SNK60 followed closely behind Gazelle in this regard. The poor host-suitability of these cultivars was consequently verified in a greenhouse in soil naturally infested with *M. javanica,* while A7119 was also evaluated in a field trial. Prima was included as the susceptible control in both experiments. Results showed that Gazelle, A7119 and SNK60 supported the lowest *M. javanica* numbers, differing significantly from numbers maintained by Prima. Evaluation of crosses between Prima and Gazelle resulted in the identification of three genetic markers associated with resistance to *M. javanica.* These markers were subsequently validated in commercial soybean cultivars screened for *M. javanica* host suitability in greenhouse trials. Application of these markers yielded an 80 % similarity with greenhouse screening results. The markers can be applied cost-effectively and is a quick technique to identify cultivars or other germplasm for exhibition of resistance to nematodes.

PI Plus as an environmentally compatible nematicide

H Botha
Biological Control Products SA (Pty) Ltd., PO Box 1561, Pinetown, 3600 South Africa

The efficacy of PI Plus [*Paecilomyces lilacinus* strain 251 (PI251) combined with a specially formulated PI growth medium] was investigated as a biological control agent for nematodes in banana, citrus, papino, tobacco and tomato. Treatments included an untreated control, a chemical nematicide, PI Plus on its own and PI Plus in combination with various chemical nematicides. A number of trials were conducted for each of the selected crops. In banana, a bunch mass increase of only 2 % was achieved with the PI Plus treatment when compared with the untreated control. However, with the PI Plus treatment, the time that elapsed between flowering and harvesting was reduced by 39 days compared to the untreated control. The cadusafos treatment reduced time between flowering and harvesting by 28 days compared to the untreated control and increased mean bunch mass by 3 %. When tested on citrus, an 86 % decrease in nematode numbers in the roots relative to the initial counts, a 33 % increase in yield and a 5 % increase in mean fruit size over the control were recorded with the combination of fenamiphos and PI Plus. In the papino trial, where the PI Plus treatment was compared with fenamiphos and an untreated control, 23 and 20 % increases in yield relative to the control were achieved with the PI Plus and fenamiphos treatments, respectively. PI Plus gave a 28 % yield increase in the tomato trial, but with the aldicarb treatment no yield increase was reported. In tobacco trials, PI Plus was used on its own and in combination with EDB. These treatments were compared with EDB and untreated controls. Six

weeks after planting, increases of 62, 68 and 74 %, in the root-knot nematode numbers relative to the initial population density were reported for the untreated control, EDB (before planting) and PI Plus (single application), respectively. However, the root-knot nematode counts decreased by 46 % in the plots treated with PI Plus in combination with EDB fumigation. Using this combination, a 21 % increase in yield was achieved. Following the successful efficacy trials, PI Plus was registered for use on a number of crops and it is currently the only biological nematode control agent registered in South Africa. Furthermore, it is the only biological agent registered for nematode control in organic farming in terms of EU regulations. Extension of PI Plus registration to other crops is currently being investigated, as are application timing and methods.

Current status of Nematology in Cuba

E Fernandez
Instituto de Investigaciones de Sanidad Vegetal, Calle 110 # 514 entre 5ta B y 5ta F. Miramar, Playa, Ciudad de la Habana, Cuba

Nematology is a relative young science in Cuba. Several institutions, including the Ministry of Agriculture and the Ministry of Higher Education, are working on plant-parasitic nematodes, with a total of about 30 nematologists. Nematology in Cuba includes diagnosis, research, training and advice to technicians and farmers. The genus *Meloidogyne* is very important to economic crops such as tobacco, tomato and other vegetables, coffee, ornamental plants and banana. *M. incognita, M. arenaria, M. javanica* and *M. mayaguensis* have been identified. *Radopholus similis* and *Pratylenchus coffeae* are associated with damage in banana and plantain, respectively. Other important nematodes are *Cactodera cacti* (in ornamental plants), *Scutellonema bradys* on yam and different species of *Pratylenchus* in tobacco, coffee and sugarcane. Research includes the study of non-chemical alternative control measures against plant-parasitic nematodes such as crop rotation, soil tillage, trap crops, soil solarisation and different biological control agents (fungi and bacteria). All imported plant material is analysed for nematode infestations to prevent new species to enter the country. Production of in vitro-cultured plants is enhanced to reduce infestations and nurseries are kept clean.

Observations on the use and efficacy of *Paecilomyces lilacinus* against nematodes of peaches

M S Botha[1], H Hugo[2] & D Neethling[3]
[1]*ARC–Institute for Industrial Crops, Private Bag X82075, Rustenburg, 0300 South Africa*
[2]*ARC–Infruitec-Nietvoorbij, Private Bag X5013, Stellenbosch, 7599 South Africa*
[3]*Biological Control Products SA (Pty) Ltd., PO Box 1561, Pinetown, 3600 South Africa*

Efficacy of the biological control agent *Paecilomyces lilacinus* in management of nematodes on peaches was evaluated, using *P. lilacinus* at various dosage rates in conjunction with different growth media and comparing these treatments with a fenamiphos (standard nematicide) treatment and an untreated control. A long-term field trial was done on fruit-bearing peach trees in an established orchard, infested with a natural population of nematodes. The trial commenced during the 1998 season with application of each of the various treatments after harvesting, followed by two applications during the following spring, prior to the next harvest. The treatments were repeated during the following growing season. Nematode population densities were monitored over a two-year period. Fruit yield was determined and additional observations on leaf development and chemical characteristics were made. The highest fruit yield for 1999 (35.4 tonnes ha^{-1}) and 2000 (38.1 tonnes ha^{-1}) was obtained with the treatment combination of one application of fenamiphos (5 g m^{-2}) and two applications of *P. lilacinus* (3 g $tree^{-1}$) plus Growth Medium A (1.5 ml $tree^{-1}$) [F+P3GA15], compared to the untreated control, which gave a mean yield of 20.3 and 24.9 tonnes ha^{-1} for the 1999 and 2000 seasons, respectively. Leaves with the highest water content were found on trees treated with F+P3GA15. The untreated control trees had the highest calculated leaf area and dry leaf mass, indicating a possible retention of nutrients for vegetative growth. The dominant nematode species found in the soil and roots of the peach trees were *Meloidogyne* and *Criconemella* spp. The lowest *Meloidogyne* population densities were found on roots of trees treated with fenamiphos in combination with *P. lilacinus* and Growth Medium A (F+P3GA15) and the standard fenamiphos treatments resulted in the best yields. The positive response of fruit-bearing peach trees infested with *Meloidogyne* and *Criconemella* spp. to treatment with *P. lilacinus* (3 g $tree^{-1}$) in conjunction with growth medium A (1.5 ml $tree^{-1}$) supports the con-

tinuation of field trials and registration of *P. lilacinus* for use on peach trees.

Effect of a seaweed extract on growth of nectarine trees in *Meloidogyne javanica*-infested soil

H J Hugo
ARC–Infruitec-Nietvoorbij, Private Bag X5013, Stellenbosch, 7599 South Africa

The extreme toxicity of nematicides registered for use on peach and nectarine trees poses problems to resource-limited producers who do not have the necessary equipment to handle these products. A seaweed extract (Kelpak) that is known to stimulate root growth was therefore compared with fenamiphos for its efficacy to reduce nematode damage. A site was selected where Fiesta Red nectarine trees were to be planted in soil known to be infested with *Meloidogyne javanica.* The extract was applied as a 0.5 % and 1 % Kelpak drench to the tree roots at planting. As an alternative, roots were dipped in a 1 % Kelpak solution prior to planting. Five 0.2 % foliar sprays of Kelpak, applied at two-weekly intervals, followed all treatments. The 0.5 % drench was re-applied during the second season. All treatments received a further five foliar sprays during the second season. At the end of the second season, tree growth was compared with trees treated with the registered dosage of fenamiphos and an untreated control. Shoot mass in the fenamiphos and two drench treatments did not differ and was significantly higher than the untreated control trees. These results confirm that the beneficial effect of Kelpak on nectarine trees is such that the trees can better withstand the detrimental effect of *M. javanica* as a parasite of the roots.

Problems associated with the use of biological control products against nematodes in cotton

E R Van Biljon
ARC–Institute for Industrial Crops, Private Bag X82075, Rustenburg, 0300 South Africa

Certain biological control products have not been registered in terms of Act No. 36/1947. These products have, therefore, never been subjected to an extensive evaluation programme, neither has their full potential been investigated. This was illustrated in a trial done in the northern Cape during the 1999/2000 season to evaluate the efficacy of nematicides and some biological control products for the management of nematodes on cotton and to determine their effect on yield. EDB followed by aldicarb, aldicarb followed by oxamyl EC, oxamyl EC, Biostart 2000 (four applications), Biostart 2000 (four applications) followed by oxamyl EC, Biostart 2000 (six applications), Biostart 2000 (six applications) followed by oxamyl EC, PL Plus and PL Plus followed by oxamyl EC were compared with an untreated control. With the exception of the EDB followed by aldicarb and aldicarb followed by oxamyl treatments, no significant differences or tendencies were found in root-knot nematode numbers of the treated and untreated plots 12 weeks after planting as well as at the end of the season. A respective 39 and 28 % increase in yield was realised by EDB fumigation followed by aldicarb and aldicarb followed by an oxamyl application, compared to the untreated control. Cotton yield in some of the Biostart treatments was even lower than that of the untreated control. Methods to modify the rhizosphere to make it more accessible for the establishment of introduced microorganisms are, therefore, of the utmost importance for efficacy of biological control products.

Control of root-knot nematodes on soybean

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

Soybean yield losses of up to 25 % were recorded during the three planting seasons of 1998/99 to 1999/2000 in three field trials where natural infestations of *M. javanica* occurred. The following nematicides were applied to cultivars Prima (good host) and A7119 (poor host) at these sites during the 1999/2000 season: 1) EDB at 45 l ha^{-1}, 2) aldicarb at 100 g m^{-2}, 3) terbufos 15G at 100 g m^{-2}, 4) chlorpirifos at 3 l ha^{-1}, 5) Pl Plus at 2 kg ha^{-1} and 6) Biostart at 2 l ha^{-1}. An untreated control treatment was also included. Nematode population levels and soybean yield were assessed and data subjected to an analysis of variance. EDB treatments consistently resulted in the lowest root-knot nematode numbers and highest yields. Although the aldicarb and terbufos treatments generally resulted in the second and third lowest root-knot nematode numbers, respectively, they did not always differ significantly from the untreated control or other treatments. In all three trials the biological control agents Pl Plus and Biostart failed to reduce root-knot nematode numbers compared to the untreated control. No

nematicide is currently registered on soybean, therefore crop rotation and planting of cultivars that are poor hosts to root-knot nematode species are the only management strategies available for sustainable soybean production in root-knot nematode infested areas. Evaluation of other nematicides such as Telone also needs further investigation.

Nematode control in Queen pineapple in northern KwaZulu-Natal

E C Rabie & H A Tustin
Pineapple Research Station, PO Box 194, Hluhluwe, 3960 South Africa

Nematodes are considered a major pest of pineapples worldwide, responsible for considerable losses in pineapple production. In northern KwaZulu-Natal, *Pratylenchus brachyurus* causes substantial yield losses in Queen pineapple, especially on sandy soils. *P. brachyurus* is endemic to this region and therefore land not previously cultivated can therefore already be infested with nematode numbers exceeding damaging levels. To date, soil fumigation has been the major nematode management strategy in Queen pineapple production in northern KwaZulu-Natal. Recent research focused on the evaluation of other non-volatile nematicides as a potential alternative to EDB. Two nematicides were consequently registered. To be able to follow an integrated nematode management programme the population dynamics of *P. brachyurus,* the effect of cultivation practices such as application of lime to modify soil pH, pre-plant land preparation and thrash incorporation was studied. pH of soil had an effect on the development of *Pratylenchus* populations and the method of land preparation affected the severity and rapidity of nematode infestation after planting.

Application of nematicides through drip-irrigation in tobacco

Z Sibanda
Tobacco Research Board, PO Box 1909, Harare, Zimbabwe

Recommended rates of ethylene dibromide and fenamiphos were applied in the conventional manner and through drip-irrigation to tobacco. Degree of root galling was consistently higher when nematicides were applied through drip-irrigation at 5–10-cm depths, compared to application by conventional methods. The best nematode control, resulting in lowest root gall ratings (3.72 on a scale of 0 to 8) was observed when EDB was applied through tines, followed by a supplementary treatment of fenamiphos cupped to the base of the plant. The highest root gall rating (5.08) was obtained when EDB and fenamiphos were both applied through drip-irrigation. With surface drip (lines 5–10 cm below soil surface), chemicals were lost through the soil surface, resulting in inadequate nematode control. Comparison of nematode control and plant growth was then carried out with drip lines buried at three different depths. A uniform stand of tobacco was obtained when drip lines were buried 20 or 40 cm below each crop row. At topping, tobacco in these plots had a mean plant height of 41 cm and 34.5 cm, respectively, whereas tobacco in plots with surface drip was as short as those in the untreated plots. When one drip line was placed between two rows of tobacco, crop growth and ripening was very uneven. Application of nematicide through drip lines buried at a depth of 20 cm appears to give the best overall results.

Comparison of accelerated degradation rates of nematicides applied through drip- and micro-irrigation

H F Le Roux, M C Pretorius & L Huisman
Citrus Research International, PO Box 28, Nelspruit, 1200 South Africa

The citrus nematode, *Tylenchulus semipenetrans,* limits production of citrus in many orchards in South Africa. Nematicides such as cadusafos, fenamiphos and ethoprophos are used in integrated control programmes. An increasing number of citrus producers are changing to conventional or open hydroponic drip-irrigation systems. Application of chemicals through these drip systems is becoming common practice and the question arose whether nematicides could be applied through these systems. Cadusafos, fenamiphos and ethoprophos were applied three times at two-monthly intervals, either through the drip systems or broadcast over 1 m^2 around the dripper. Soil samples were taken before the third treatment application and tested for accelerated microbial degradation (AMD), using a bioassay with *Aphelenchus avenae.* The test was repeated again after three and seven months. Fenamiphos developed accelerated degradation on the two sites tested, whether it was applied through the

drip system or broadcast. Ethoprophos, tested only on a more clayey soil also developed AMD. In this case AMD was first noted in drip-irrigated soil and occurred only later in the micro-irrigation plots. AMD of cadusafos did not develop in the clay soils of the Gamtoos Valley but did so under the drip system in sandy soils in the Citrusdal area. This substantiated the manufacturer's warning that fenamiphos is more prone to AMD when applied as a concentrate through drip-irrigation systems. Application of nematicides through drip systems is therefore not recommended.

Review of the crop protection benefits of Temik® to South African agriculture

R K Jones
Aventis CropScience, PO Box 10441, Centurion, 0046 South Africa

Temik® has been available for use in South Africa for over 30 years and has become established as a leading nematicidal control option on many crops. The active ingredient, aldicarb, was first synthesised in 1962 and has a combination of physical, chemical and biological properties that are the basis of the activity of the product. These include the fact that it is a carbamate product, its favourable solubility profile in soil and biotic systems, its chemical stability in a wide range of environments and its biological activity that includes nematicidal, insecticidal, miticidal and plant growth stimulatory benefits. The most important crop usages for Temik® are as a nematicide on sugarcane, as a nematicide and systemic insecticide and/or miticide on potato, citrus, banana, tobacco, cotton, groundnut and tomato and as a systemic insecticide and/or miticide on coffee and citrus. Growth stimulatory benefits have been recorded locally on potato, citrus and cotton. The product has been marketed during this period with strict controls but due to various off-label misuse problems, the future availability of Temik® is threatened.

Integrated management of parasitic nematodes affecting yams

J C Meerman, P R Speijer(†) & R Asiedu
International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria. c/o Lambourn & Co., Carolyn House, 26 Dingwall Road, Croydon CR9 3EE, England

Yams (*Dioscorea* spp.) are among the major starchy food crops in West Africa. Nematodes and secondary diseases cause harvest losses of about 40 % and could reduce the mass of tubers that are sold for consumption or planting material by 63 % and 100 %, respectively. Major nematode species affecting yams include *Scutellonema bradys* and *Meloidogyne incognita.* They cause cracking and flaking of the skin, dry rot or abnormal tuber shapes, necrotic spots and internal tuber rotting. Nematode-infested planting material is the major source of inoculum. Control methods include: sufficient fallow, planting cover crops like *Tagetes* and *Aeschynomene,* intercropping with maize or ginger, increasing soil fertility and pest-free planting material. At IITA, screening for resistance or tolerance to nematodes is an important part of the yam-breeding programme. To date, 220 genotypes have been tested, but no resistance has been found. The screening is associated with work in molecular genetics of yams that aims, amongst others, at identifying molecular markers with good linkage to genes for nematode resistance. Farmers have been trained in producing and selecting quality seed yams, as well as applying hot-water therapy to infested yams. Prior to planting or storage, tubers are emerged for 25 minutes in water at 53 °C. Farmer participatory experiments were carried out to adapt the technology to specific needs of the target groups. An economic benefit analysis will be set up in 2001 to investigate labour requirements, costs of equipment and materials as well as the effect on yields and in-storage losses.

Relationship between soil factors and nematode abundance in sugarcane fields

V W Spaull[1] & P Cadet[2]
[1]SA Sugar Association Experiment Station/ [2]IRD, Private Bag X02, Mount Edgecombe, 4300 South Africa

The relationship between numbers of nematodes and various soil chemicals was investigated in sugarcane fields in South Africa. Soil samples were collected from small- and large-scale farms at several localities in KwaZulu-Natal. Each sample was assayed for the numbers of various genera of nematodes, pH and levels of Al, Ca, Fe, K, Mg, Mn, Na, P and Zn. Relationships between nematodes and soil factors were identified by co-inertia analyses using ADÉ4 software. This showed that certain combinations of nematode and soil factor were strongly associated but the nature of the relationship was not consistent in the two farming systems. However, for certain chemicals and nematodes the type of relationship was

the same in both small- and large-scale farms. Thus, in both farming systems the abundance of *Pratylenchus, Helicotylenchus* and *Paratrichodorus* was inversely related to soil pH and positively related to Fe levels. Numbers of *Meloidogyne* were positively related to pH and inversely related to Fe in the two systems. Consistent but weaker relationships occurred between Al, Mn and the four nematode genera in the two farming systems. Numbers of *Xiphinema* showed no association with any of the soil characters in either the small- or large-scale farms.

Effect of *Meloidogyne* on annual yield loss and sustainability of sugarcane production in KwaZulu-Natal

P Cadet[1] & V W Spaull[2]
[1]IRD/[2]SA Sugar Association Experiment Station, Private Bag X02, Mount Edgecombe, 4300 South Africa

Nematode communities and sugarcane yields were studied over five and six years in two variety × nematicide trials located on similar sandy soils in the same area in KwaZulu-Natal. The cane was harvested at intervals of approximately 12 months. There were six varieties in each trial, with varieties N12 and N16 common to both sites. The plant-parasitic nematode communities were similar except that *Meloidogyne* was absent from one site. On the site without *Meloidogyne,* yields were lower when the relative proportion of *Xiphinema* was high. At the other site, numbers of *Meloidogyne* were inversely related to yield. Higher proportions of *Helicotylenchus dihystera* tended to be associated with higher yields at both sites. Annual losses were similar over successive crops. Comparison of the two sites showed that *Meloidogyne* alone was responsible for 30 % of the losses, equivalent to 15 tonnes cane ha^{-1} $annum^{-1}$. The effect of nematodes on sustainability of sugarcane production was measured after modelling the decline in yield of successive ratoons. In the absence of a nematicide the time taken for the yield to decline to a threshold of 40 tonnes $cane^{-1}$ ha^{-1} ranged from one year for N27 in the *Meloidogyne*-infested site, to nine years for NCo376 in the other site. Treatment with a nematicide increased this period considerably. Thus for N23 it took a projected 55 years before the yield reached the threshold at the site without *Meloidogyne* and 20 years for N16 on the other site. *Meloidogyne* was responsible for about 50 % of the loss in sustainability.

Screening *Musa* germplasm for resistance to *Radopholus similis*

C Dochez[1], D Makumbi[1], A Tenkouano[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) – High Rainfall Station Onne, Nigeria, c/o Lambourn & Co., Carolyn House, 26 Dingwall Road, Croydon CR9 3EE, England
[3]Katholieke Universiteit Leuven, Laboratory of Tropical Crop Improvement, Kasteelpark Arenberg 13, 3001 Leuven, Belgium

Worldwide, plant-parasitic nematodes comprise one of the most important biotic constraints to sustainable *Musa* production. In the lowlands of central Uganda the most damaging nematode species is *Radopholus similis,* while at higher elevations *Pratylenchus goodeyi* is the most prevalent species. Use of nematicides to control nematodes has adverse environmental effects and is too costly for subsistence farmers. A promising alternative is the use of nematode-resistant varieties. Such varieties can be obtained either by evaluating the host response of existing genotypes or by classical breeding. However, for screening all available germplasm a rapid and reliable screening method is needed. An early screening method was developed at IITA, which is based on the inoculation of individual roots and needs less nematode inoculum and less plant material per genotype compared to classic pot trials. By using single roots for inoculation, the host response to nematode attack is not affected by differences in root growth rates between *Musa* genotypes. Germplasm is currently being screened for resistance to *R. similis* at IITA-ESARC in Uganda. The germplasm includes East African highland bananas (EAHB), hybrids derived from those and from diallel crosses, including a segregating population. Each genotype is tested in comparison with a resistant cultivar (Yangambi-km5) and a susceptible one (Valerie). Nineteen hybrids, of which five are EAHB, have been identified with the early screening method as resistant to *R. similis.* Pot trials are in progress for confirmation of this resistance.

In vitro and in vivo screening for resistance to *Radopholus similis* in *Musa*

N T Tuyet
Vietnam Agricultural Science Institute, Van Dien, Thanh Tri, Hanoi, Vietnam

Two greenhouse experiments were carried out with five *Musa* cultivars belonging to the Mysore

group (*Musa* AAB) and five *Musa* cultivars from the Philippines (*Musa* AA) to determine sources of resistance and tolerance to *Radopholus similis.* The susceptible cultivar Grande Naine was included as reference. Each in vitro micro-propagated plantlet was transplanted to a 12-cm-diameter plastic pot containing approximately 1 l autoclaved substrate and maintained at a temperature of 25–30 °C with a 12-hour photoperiod. Eight weeks (for Mysore cultivars) and 10 weeks (for cultivars from the Philippines) after inoculation with 1000 vermiform *R. similis* per plant, the plants were harvested and the number of nematodes per 10 g root, fresh root mass and percentage root necrosis were assessed. Variability was observed between cultivars belonging to the Mysore group in terms of root nematode populations. Gorolo was considered the least susceptible to *R. similis,* the total number of nematodes recovered being 32 562 and the percentage of root necrosis 22.8 %. Lady Finger (Nelson) was shown to be highly susceptible to *R. similis,* with a final population of 99 009 nematodes and 33.1 % root necrosis. This susceptibility was not significantly different from Grande Naine. The results of five cultivars from the Philippines demonstrated that most of them were as susceptible to *R. similis* as Grande Naine. An additional experiment was conducted to investigate if resistance to *R. similis* is expressed in plantlets growing in vitro in root-stimulating medium. Resistant and susceptible sources such as Yangambi-km5, SH-3142, Pisang Jari Buaya, Gros Michel, Grande Naine and Catchaco were tested in this study. The micro-propagated plantlets were maintained in a growth chamber at 26 °C with a 16-hour photoperiod (one replicate = one jar with two plantlets). After four weeks when plantlets had formed enough roots, each plantlet was inoculated with 25 *R. similis* females. Total nematode populations in the roots and medium were determined eight weeks after inoculation. Preliminary results confirmed the resistance to *R. similis* of Pisang Jari Buaya and SH-3142 and susceptibility of Grande Naine under in vitro conditions. However, Yangambi-km5, which showed resistance in vvio or in-field tests, showed less resistance in the in vitro test. This study showed that although the in vitro procedure has several advantages compared to greenhouse or field screening, discrepancies may occur.

Current status of the nematological situation with plantain and banana in Latin America.

L Pocasangre[1], R A Sikora[2] & A Araya[3]
[1]*International Network for the Improvement of Banana and Plantain (INIBAP)/Centre Agronomico Tropical de Investigacion Y Enseñanza (CATIE), Unidad de Biotecnologia 7170, Turrialba, Costa Rica*
[2]*Institut für Pflanzenkrankheiten, University of Bonn, Nussallee 9, 53115 Bonn, Germany*
[3]*Corporación Bananera Nacional (CORBANA S.A.), Apdo 390, 7210 Guápiles, Costa Rica*

Nematodes are responsible for yield reductions of up to 50 % in commercial banana plantations in Latin America. Typical nematode control measures consist of two or three applications of nematicides per year. Most nematological research in Latin America has been conducted in large commercial banana plantations and information is sparse about nematode species attacking plantain. In this survey nematological studies were conducted in commercial banana and plantain plantations in several countries in Latin America, viz.. Bolivia, Costa Rica, Guatemala, Honduras and the Dominican Republic. The results of this survey showed that *Radopholus similis* is the nematode species of major concern in commercial banana plantations. Densities of *R. similis* of up to 45 000 100 g^{-1} of fresh roots were found in Guatemala and Costa Rica. In plantain, however, several species of *Pratylenchus* were the most frequently found nematodes in root systems. Densities of *Pratylenchus* spp. of up to 5400 nematodes 100 g^{-1} of fresh roots were found in the Dominican Republic, Honduras and Costa Rica. *R. similis* was also found in plantain but at lower densities than in banana roots. More studies are needed in plantain in order to design adequate strategies for nematode control in small plantations in Latin America.

Correlation between nematode numbers and damage to banana (*Musa* AAA) roots under commercial conditions

T Moens[1], M Araya[2] & D de Waele[3]
[1]*Agreement: Vlaamse Vereniging voor Ontwikkelingssamenwerking en Technische Bijstand (VVOB) – International Network for the Improvement of Banana and Plantain (INIBAP) – Corporación Bananera Nacional (CORBANA S.A.), Apdo 390, 7210 Guàpiles, Costa Rica*
[2]*Corporación Bananera Nacional (CORBANA S.A.), Apdo 390, 7210 Guàpiles, Costa Rica*
[3]*Laboratory of Tropical Crop Improvement, Katholieke Universiteit Leuven, Kasteelpark Arenberg 13, 3001 Leuven, Belgium*

The correlation between *Radopholus similis,* total number of nematodes, extent of root necrosis

and root damage in commercial plantations with mixed *Musa* AAA cultivars Grand Naine and Valerie was investigated in a series of four experiments. Three different root damage indices, viz. the Australian index, the Bridge and Gowen index and a local index were compared, assessing 100 randomly selected root samples. Correlations for the three indices were highly significant and the correlation coefficients varied between 0.38 and 0.40. In a subsequent experiment with the local index, the correlation between *R. similis* and total nematodes, as well as root necrosis and damage was not improved when measuring one or both root halves. Using the local index, the above correlation was evaluated in randomly selected root samples from mother plants and their respective follower suckers in a third experiment. Mean root necrosis and damage index in mother roots were double those of follower sucker roots. Correlation coefficients between *R. similis* and total nematodes, root necrosis and damage in follower suckers ranged between 0.41 and 0.48 and were always significant. By contrast, the correlations using mother roots were never significant. In the last experiment, roots from mother plants and their respective follower suckers were arranged in 10 different damage classes. *R. similis* and total nematode numbers were correlated with root necrosis and damage for 0–5, 6–10 and 0–10 damage groups. Correlations were highest for root necrosis and *R. similis* in a 0–5 interval, ranging between 0.62 ($P < 0.0002$) for mother roots and 0.75 ($P < 0.0001$) for sucker roots.

Effects of castor bean fruit residues on population densities of *Meloidogyne incognita*, soil properties and growth of tomato plants

P W Mashela & K W Mpati
Department of Plant Production, University of the North, Private Bag X1106, Sovenga, 0727 South Africa

Castor bean (*Ricinus communis*) fruits are highly toxic to various animals. Effects of castor bean fruit organic amendment were tested on population densities of the root-knot nematode *Meloidogyne incognita,* soil pH, soil electrical conductivity and growth of tomato plants under greenhouse conditions. Castor bean organic amendment reduced nematode population densities by 73 % and 75 % in two experiments, respectively. The organic amendment increased dry matter, plant height, stem diameter and fruit yield of tomato plants, but had no effect on soil pH or soil electrical conductivity. Castor bean organic amendment has the potential to serve as an organic nematicide in organic farming systems.

Wild cucumber fruit residues reduce population densities of *Meloidogyne incognita* on tomato plants

P W Mashela & M S Mposi
Department of Plant Production, University of the North, Private Bag X1106, Sovenga, 0727 South Africa

The highly toxic contents of wild cucumber (*Cucumis myriocarpus*) fruits have excellent cutaneous adsorptive properties. Three experiments were conducted to evaluate the effects of wild cucumber fruit organic amendment on population densities of the root-knot nematode *Meloidogyne incognita* under greenhouse conditions. The organic amendment reduced nematode juvenile numbers by 67, 92 and 93 % in soils and by 53, 96, and 98 % in roots, respectively, in three experiments. It increased various plant growth variables and soil electrical conductivity, but had no effect on soil pH. The results of these experiments showed that wild cucumber organic amendment has the potential for serving as an organic nematicide in organic farming systems.

Effects of fever tea organic amendment on population densities of *Meloidogyne incognita*, soil properties and growth of tomato plants

P W Mashela & G L Ngobeni
Department of Plant Production, University of the North, Private Bag X1106, Sovenga, 0727 South Africa

Most efficacious inorganic nematicides enhance ozone breakdown and pose various health hazards. Many nematologists are evaluating the effects of alternative control strategies on nematode population densities. Residues from highly toxic organs in plants are being evaluated by the Department of Plant Production, University of the North, for their effect on nematode populations. Two experiments were conducted under greenhouse conditions to evaluate the effects of fever tea (*Lippia javanica*) leaf residues on population densities of the root-knot nematode *Meloidogyne incognita,* growth of tomato plants, soil pH and soil electrical conductivity. The experiments were established as a completely randomised block design, including 10 replicates. Fever tea organic amendment reduced nematode juvenile numbers by 76 and 80 % in the two experiments, respectively, as well as soil pH. Fever tea increased fruit

yield, shoot mass and soil electrical conductivity in both experiments, and stem diameter in one experiment, but had no effect on plant height. The results showed that this organic amendment has the potential for serving as an organic nematicide in organic farming systems, particularly in the Limpopo Province with generally alkaline soils.

ABSTRACTS OF POSTERS

Micro-variation of soil structure under irrigation and effects on the distribution of *Pasteuria penetrans*

K R Dabiré[1], T Mateille[2], S Fould[3], M T Diop[4] & J L Chotte[5]
[1]*Institut d'Environnement et de Recherches Agricoles, BP 208, Bobo-Dioulasso, Burkina Faso*
[2]*CBGP c/o CSIRO European Laboratory, Campus de Baillerguet, 34980 Montferrier-sur-Lez, France*
[3]*Laboratoire d'Ecologie Microbienne, Université Claude Bernard, Lyon, 43, Bd du 11 Novembre 1918, 69622 Villeurbanne Cedex, France*
[4]*Département de Biologie Animale, Université Cheikh Anta Diop, B.P. 5005, Dakar, Senegal*
[5]*Laboratoire de Bio-Pédologie, B.P. 1386, IRD Bel-Air, Dakar, Senegal*

Pasteuria penetrans, a bacterial parasite of nematodes, is used to control populations of *Meloidogyne* spp. in vegetables. Agronomic results are variable, however, mainly due to the patchy distribution of spores in cultivated areas. A study carried out in the field on the epidemiology of *P. penetrans* showed a relationship between abiotic factors such as irrigation, soil fraction size, water-holding capacity and the infectivity of *P. penetrans.* A study to determine the relationship between these abiotic factors, the density of the infective spores of *P. penetrans* and the proportion of infected nematode juveniles revealed that irrigation induced a specific distribution of *P. penetrans* spores according to soil structure. An experiment conduced in a laboratory on the passive transport of spores confirmed that intensive irrigation leached down the soil colloids as well as the spores. This led to a dilution of the inoculum. Taking into account that *Pasteuria* is a non-motile organism, soil must have a heterogeneous structure, permitting good conservation of infective spores and enabling infection of nematodes. Soil colloids increasing the water-holding capacity would enhance the efficacy of *P. penetrans.* Suppressiveness of soils can be enhanced through management of the indigenous organisms in the soil. Improved soil structure by increasing organic control and by regulating irrigation can be integrated into tillage systems.

New *Musa* hybrids with resistance to *Radopholus similis*

A Auwerkerken[1], I Rotifa[1], D de Waele[2] & A Tenkouano[1]
[1]*International Institute of Tropical Agriculture (IITA), c/o Lambourn & Co., Carolyn House, 26 Dingwall Road, Croydon CR9 3EE, England*
[2]*Laboratory of Tropical Crop Improvement, Catholic University of Leuven, Kasteelpark, Arenberg 13, 3001 Leuven, Belgium*

The burrowing nematode *Radopholus similis* is one of the major nematode species attacking banana and plantain. Incorporation of resistance through plant breeding is an advantageous form of nematode control. A screening experiment was established in a shade house at the IITA High-Rainfall Station at Onne in southern Nigeria (7° E, 5° N, 10 m above sea level). Three suckers from each hybrid and two reference cultivars, Yangambi-km5 (resistant) and Valerie (susceptible) were planted together in sawdust in wooden boxes. Four weeks after planting a small plastic cup was placed on three of the emerged roots about 5 cm from the corm. A suspension of 50 females of *R. similis* was poured onto each individual root. Eight weeks later, the number of nematodes was counted and a Dunnett's T-test was done to compare the square root transformed mean reproduction ratio. Fourteen hybrids showed a reproduction rate not significantly different from Yangambi-km5. These hybrids included four hybrids from 2–4× crosses, seven hybrids that have the resistant hybrid TMP2 × 9128-3 in their pedigree and the tetraploid hybrids A10-SPS-548-9 and 7152-2. The latter is known as the promising hybrid PITA 14. The selected hybrids supported a significantly lower nematode reproduction rate and are therefore be considered for further evaluation.

In-field fluctuations between nematode species and associated soil factors on sugarcane in KwaZulu-Natal

P Dana[1], P Cadet[2] & V W Spaull[3]
[1]*School of Life and Environmental Science, University of Natal, Private Bag X10, Durban, 4000 South Africa*
[2]*IRD, Private Bag X02, Mount Edgecombe, 4300 South Africa*
[3]*SA Sugar Association Experiment Station, Private Bag X02, Mount Edgecombe, 4300 South Africa*

Soil samples were collected at 5-m intervals

along a 200-m row of sugarcane in a field with sandy soil. The soil and the row of cane did not show obvious variation. The first sampling was done about three months after the previous crop had been harvested and the second after five months. On each occasion, 40 samples were analysed for nematodes. Soil from the first sampling was also used to measure pH and levels of P, K, Ca, Mg, Al, Na, Zn, Mn and Fe. Analysis of the data showed a marked trend in the distribution of two of the most abundant ectoparasitic nematodes. *Xiphinema elongatum* tended to dominate one half of the transect and *Helicotylenchus dihystera* the other. To identify soil chemical factors associated with nematode community structure the biotic and abiotic data were coupled, using co-inertia analysis. Nematode species that related to soil factors were *H. dihystera* (that represented between 3 and 65 % of the soil nematode community), *X. elongatum* (3 and 53 %) and *Pratylenchus zeae* (15 and 63 %). The relative proportion of *H. dihystera* increased with increasing levels of Mg, whereas that of *X. elongatum* decreased. There was an inverse relationship between levels of P and relative proportions of *H. dihystera* and between levels of Fe and relative proportions of *P. zeae.* Species belonging to *Scutellonema, Criconemella, Paratrichodorus, Neodolichodorus* and *Hemicycliophora* were either not or only weakly associated with the soil factors.

Preliminary results of treatments for replanting in bananas

M Daneel, D Mdluli, K De Jager, J Husselman & C Neethling
ARC–Institute for Tropical and Subtropical Crops, Private Bag X11208, Nelspruit, 1200 South Africa

Replanting of banana has always been problematic, especially where *Radopholus similis* is present. Nematode infestation of tissue-cultured plants is a significant problem because of low tolerance levels of the small plantlets. Several replant treatments for both commercial and rural farmers are being tested. Treatments included are methyl bromide (MB), metham-sodium (Herbifume), plastic cover, sugarcane, kraal manure, deep hole, PL Plus, aldicarb, water pasteurisation and fallow. Treatments commenced in September 1999 with planting of sugarcane, followed by plastic cover in November and the application of kraal manure in December. Herbifume was applied at the end of February and MB during April. PL Plus and aldicarb were applied at planting, which was done in June 2000. Preliminary results showed great differences in initial growth rate between the different treatments, with MB yielding the tallest plants followed by plastic cover, Herbifume and kraal manure. The lowest nematode numbers in roots were found in the MB treatment, followed by aldicarb, plastic cover, kraal manure and Herbifume.

Pest and disease complexes of *Musa* in rural farming systems

M Daneel[1], N Dillen[2], J Husselman[1], K De Jager[1] & D de Waele[2]
[1]*ARC–Institute for Tropical and Subtropical Crops, Private Bag X11208, Nelspruit, 1200 South Africa*
[2]*Katholieke Universiteit Leuven, Laboratory of Tropical Crop Improvement, Kasteelpark Arenberg 13, 3001 Leuven, Belgium*

A survey was carried out in rural areas of South Africa to determine production, cultivars and the pest and disease complexes on *Musa* spp. Bananas are found from the northern part of the Limpopo Province (former Venda), southwards into the eastern part of the Limpopo Province and Mpumalanga, in Swaziland as well as the coastal areas of KwaZulu-Natal to as far south as the Eastern Cape (former Transkei). However, bananas are never found in more than two to five mats per household. Nematodes were present in all samples, with *Meloidogyne* spp. being the most abundant. Other species found were spiral nematodes and in a few cases *Radopholus similis* and *Pratylenchus coffeae.* The most commonly planted cultivar is a triploid Pisang Awak (ABB), followed, to a much lesser extent, by Cavendish (AAA). Plantains were found at five sites. The less sweet-tasting Pisang Awak seems to be tolerant to nematodes and leaf diseases and is also more drought resistant. It therefore appears to be more adapted to the climatic and environmental conditions as well as the specific cultural practices applied by communities in rural areas.

Is a growth stimulant an effective agent to reduce nematode damage on banana plants?

M Daneel, A De la Bretesche, J Husselman, K De Jager & C Neethling
ARC–Institute for Tropical and Subtropical Crops, Private Bag X11208, Nelspruit, 1200 South Africa

Several products were tested for control of nematodes on banana plantlets in the green-

house. Plants were infested with a mixed population of *Radopholus similis, Meloidogyne* spp. and *Helicotylenchus* spp. One month later, applications were made at two intervals, 14 days apart, and plants were evaluated two months later. Treatments were Agent X combined with PL Plus, PL Plus, Agent X combined with PL251, Agent X, fenamiphos GR and an untreated control. Results showed that plants treated with fenamiphos GR had the lowest numbers of nematodes in the roots, followed by PL Plus, Agent X combined with PL Plus and Agent X. Plants treated with Agent X alone or in combination had the highest plant mass. However, a root necrosis index confirmed that the combination of Agent X and PL Plus is a better option for bananas as it reduced nematode numbers and increased growth potential, making the plant more tolerant to nematodes.

Host suitability of soybean genotypes and lines to *Meloidogyne incognita* race 2

H Fourie, A H Mc Donald, A De Lange & C Leswifi
ARC–Grain Crops Institute, Private Bag X1251, Potchefstroom, 2520 South Africa

Until recently, no commercial South African soybean cultivar had been identified as being a poor host to *Meloidogyne incognita* race 2. Consequently, 19 new commercial cultivars and 24 breeding lines were evaluated in the greenhouse for host suitability to this nematode species. The breeding lines were derived from a cross between a local soybean line with good combining ability and D82–3298, resistant to an unspecified *M. incognita* race, from the USA. In vivo-reared *M. incognita* race 2 larvae and eggs were inoculated on soybean seedlings in pots and assessments were made after 56 days. Considerable variation between the cultivars and lines with regard to ELF-indices and RF-values was recorded. Three cultivars and 19 lines were identified with RF-values lower than 1. Although nearly all these 19 lines exhibited high ELF-indices, their low RF-values indicate low egg numbers per egg-mass produced, which indicates a low nematode reproduction rate. These poor-host cultivars and lines are currently being tested under field and micro-plot conditions for verification of the greenhouse screenings. Further efforts are also underway to identify genetic markers responsible for the poor-host trait.

Effect of different cleaning techniques for planting material on banana plant growth and nematode damage

S V Gaidashova, C M Gatarayiha, A Nsabimana & B Uwimpuhwe
Institut des Sciences Agronomiques du Rwanda (ISAR), B.P.138, Butare, Rwanda

Nematodes are recognised as major banana pests, usually transmitted to new fields through infested suckers. Different techniques for cleaning of planting material were suggested by scientists but small-scale farmers rarely apply them because they are costly and labour/resource-intensive. The objective of this study was to compare different cleaning techniques for banana planting material in terms of their effect on plant growth parameters and nematode damage. An on-station trial was established in Rubona with the highland cultivar Mbwaziruma and comprised four treatments, viz. 1) paring of suckers before planting; 2) paring and sun-drying for three days at 25–30 °C; 3) hot-water treatment for 20 minutes at 55 °C and 4) normal farmers' planting methods. Emergence of suckers was determined at two and four weeks after planting. Plant growth parameters and nematode damage were evaluated five, 10 and 14 months after planting (MAP). Sun-dried suckers showed a significantly lower level of emergence two weeks after planting. However, no difference was observed between the treatments two weeks later. Sun-exposed suckers showed significantly lower growth parameters than the other treatments five MAP but later no differences were observed. Nematode damage was significantly higher in the untreated control than in any of the other treatments 10 and 14 MAP. Preliminary results indicate that the effects of all cleaning techniques were comparable and showed a significant reduction in nematode damage. Therefore, the cheapest and least labour/resource-intensive technique could be recommended to small-scale farmers.

Meloidogyne mayaguensis, a root-knot nematode causing severe decline of guava trees in the Caribbean

P Quénéhervé[1], Y Bertin[2] & A Kermarrec[3]
[1]*IRD, BP 8006, 97259 Fort-de-France Cedex, Martinique*
[2]*CIRAD-FLHOR, BP 153 97202 Fort-de-France Cedex, Martinique*
[3]*INRA-URPV, Domaine Duclos, 97270 Petit Bourg, Guadeloupe*

Since 1998 the root-knot nematode *Meloido-*

gyne mayaguensis was more frequently found in association with guava (*Psidium guajava*) decline on the Caribbean islands of Martinique and Guadeloupe. Typical symptoms associated with guava decline caused by *Meloidogyne mayaguensis* are stunting, lack of vigour, yellow or reddish foliage, dieback of branches and very restricted and distorted root systems, with an almost complete destruction of fine roots. Infested trees usually decline over a period of some years, but occasionally trees may die suddenly. All guava cultivars, including local varieties from the Caribbean, seem susceptible to this root-knot nematode. In orchards, nematode infestation can be very severe, from 10 to 3 2000 eggs/juveniles gram^{-1} of dry roots. Greenhouse experiments confirmed the high pathogenicity level of *M. mayaguensis* on guava. Nematicide applications have also been used in an attempt to control root-knot nematodes but those tested were not sufficient for control of *M. mayaguensis.* Research is now focussed on the possible use of *Psidium friedrichstalianum* as a rootstock since experiments have shown that this *Psidium* sp. is immune or resistant to different *Meloidogyne* species present in the Caribbean, including *M. mayaguensis.*

Field observations of *Paratrichodorus lobatus* on sweet potato (*Ipomoea batatas*)

A P Malan[1], S Storey[2] & A J Meyer[3]
[1]*Directorate Plant Health and Quality, Private Bag X5015, Stellenbosch, 7599 South Africa*
[2]*Nemlab, 2 Patou Ave, Chantecler, Durbanville, 7550 South Africa.*
[3]*Department of Entomology and Nematology, University of Stellenbosch, Stellenbosch, 7600 South Africa*

Field symptoms in the form of conspicuous circular patches of chlorotic and poorly growing vines of sweet potato (*Ipomoea batatas),* variety Ribbok, were observed in the Sandveld area of the Western Cape. Visual symptoms on storage roots had the appearance of typical insect feeding damage. Soil and root samples were taken from poorly growing patches for analysis. Sieving of the soil and visual inspection of tubers showed no infection of either larvae or adult insects. Microscopic examination of tubers showed hollows filled with nematodes. These nematodes were identified as *Paratrichodorus lobatus,* the stubby root nematode. Soil analysis revealed *P. lobatus* to be the only plant-parasitic nematode present. Pot-inoculated sweet potato, also of the variety Ribbok, supported a 300-fold increase in nematode numbers within a 30-day period. This is the first report of a stubby root nematode causing damage to sweet potato.

Host suitability of commercial South African dry bean cultivars to *Meloidogyne javanica* and *M. incognita* race 2

M B Mtshali H, Fourie & A H Mc Donald
ARC–Grain Crops Institute, Private Bag X1251, Potchefstroom, 2520 South Africa

Dry bean is an economically important small-scale and commercial crop in South Africa. Root-knot nematodes are an important production constraint of this crop. Twenty-two dry bean cultivars were evaluated in the greenhouse for host suitability to *M. javanica* and *M. incognita* race 2. Dry bean seedlings were inoculated with 10000 ± 500 root-knot nematode eggs and larvae 16 days after planting. Assessments were done after 56 days. Significant differences were observed between cultivars with regard to egg-mass counts. Most cultivars exhibited ELF indices of 5, while Mkuzi had the lowest index of 4.0 to *M. javanica* and 2.8 to *M. incognita* race 2. Even though Mkuzi had the lowest number of egg-masses per root system for these two nematode species (91 and 43), this cultivar is still highly susceptible to both species. No significant differences were observed between cultivars with regard to the number of eggs per root system. RF-values ranged from 3.01 for Mkuzi to 82.35 for PAN182 when evaluated against *M. javanica* and were 3.46 for Mkuzi and 40 for Gadra when screened against *M. incognita* race 2. No cultivar exhibited an RF-value lower than 1, indicating generally good host-suitability to these two species. Further screening of dry bean breeding material from a broader genetic background than the available commercial cultivars is therefore needed, as resistance is the only sustainable solution to nematode problems on this crop.

Incidence of root-knot nematodes in resource-poor agriculture in South Africa

M B Mtshali, H Fourie & A H Mc Donald
ARC–Grain Crops Institute, Private Bag X1251, Potchefstroom, 2520 South Africa

Limited nematological research has been conducted in resource-poor agriculture in South

Africa. In some communities, vegetable production had to be terminated despite acceptable production and cultivation practices implemented by farmers. Consequently a nematode survey was conducted in Mpumalanga, KwaZulu-Natal and the North West Province of South Africa. High root-knot nematode populations were generally present at all localities sampled, except one. The highest number of root-knot nematodes was counted on potato at Tshetshe near Ventersdorp (1 042 878 50 g^{-1} roots). Turnips sampled at the Bethal community near Coligny maintained low numbers of root-knot nematodes (93 50 g^{-1} roots). Identification of root-knot nematodes was done using perineal pattern morphology as well as molecular techniques. According to these results, *M. javanica* was the predominant root-knot nematode species in all areas sampled, followed by *M. incognita.* The survey will be extended to Gauteng, the Eastern Cape and Limpopo Province during the 2000/2001 season.

Furfural as a safer alternative to standard nematicides

A Steyn[1], E R Van Biljon[2] & C L N Du Toit[2]
[1]ARC–Roodeplaat Vegetable and Ornamental Plant Institute, Private Bag X293, Pretoria, 0001 South Africa
[2]ARC–Institute for Industrial Crops, Private Bag X82075, Rustenburg 0300, South Africa

Root-knot nematodes, (*Meloidogyne* spp.) are economically the most important plant-parasitic nematodes on tomato in South Africa. Environmentally safer but effective alternatives to highly toxic nematicides used in South Africa must be found. Furfural (2-furfuralhyde) is a compound found in many essential oils isolated from plants and is obtained as a by-product from the heat-treatment of different carbohydrates. A field trial was conducted by ARC–Roodeplaat at the ARC–Institute for Tropical and Subtropical Crops, Friedenheim, Nelspruit, to determine the efficacy of furfural at different concentrations for the most effective control of nematodes on tomato. Three concentrations of furfural, viz. 37.5 l ha^{-1}, 75 l ha^{-1} and 150 l ha^{-1} were compared to a commercial nematicide, aldicarb, in a randomised block trial. Although there were no significant differences in the yields of marketable fruit between the different furfural and aldicarb treatments, the 75 l ha^{-1} furfural treatment performed best overall. It is recommended that 75 l ha^{-1} furfural be used as a nematicide when nematode infestations are not too high. Where heavy nematode infestations occur, furfural could be used as a follow-up treatment to a standard nematicide.

Telopic as an alternative to methyl bromide

A Steyn
ARC–Roodeplaat Vegetable and Ornamental Plant Institute, Private Bag X293, Pretoria, 0001 South Africa

The phasing-out of methyl bromide towards the end of 2010 requires testing of alternatives for the control of nematodes in soil. Dow AgroSciences-Sanachem has developed different mixtures of chloropicrin for this purpose. A field trial on chloropicrin (Telopic) was conducted by ARC–Roodeplaat on a nematode-infested, sandy soil. Application of Telopic was according to the requirements for methyl bromide, with an aeration period of three weeks after removal of the plastic covers. Concentrations of Telopic used were 325 kg ha^{-1}, 406 kg ha^{-1} and 528 kg ha^{-1}. Plant growth, nematode infestation (soil), root gall indexing and weed control were assessed on tomato, beetroot, carrot and strawberry. Telopic used at these rates showed no phytotoxicity and effectively controlled nematodes and weeds in the sandy soil. Statistically similar results to methyl bromide were obtained.

A preliminary study of indigenous entomopathogenic nematodes

S H Taylor & V M Gray
School of Molecular and Cell Biology, University of the Witwatersrand, Private Bag 3, Wits, 2050 South Africa

Entomopathogenic nematodes of the families Steinernematidae and Heterorhabditidae are symbiotically associated with bacteria of the genera *Xenorhabdus* and *Photorhabdus,* respectively. On infection, the bacteria are introduced into the body cavities of the insect host, killing it within 48 hours. Entomopathogenic nematodes have a host range that includes most insect orders and families. Thus these nematodes have been exploited in insect pest management. The aim of this study was to isolate and identify indigenous entomopathogenic nematodes. Soil samples were collected and entomopathogenic nematodes were isolated from them using *Galleria mellonella* larvae as live bait. Isolates have successfully been cultured in the laboratory using both in vivo and in vitro techniques. The pathogenicity of the isolates was confirmed using a modification of Koch's postulates. The symbiotic bacterium associated with each isolate has been identified by RFLP analysis.

Isolates are currently being identified using RAPD analysis in conjunction with morphological characteristics, as viewed with scanning electron microscopy.

Confusing cuticular structures in some ring nematode genera

E Van den Berg
Biosystematics Division, Nematology Section, ARC–Plant Protection Research Institute, Private Bag X134, Pretoria, 0001 South Africa

Identification of nematode species is done on internal and external morphological characters. Superficial cuticular structures are usually simple but in some ring nematode genera cuticular sculptures and lobes with a great range of variation have developed. While one should think that this would make identification easier, it sometimes creates more problems. Female and juvenile stages have different kinds of ornamentation. This especially is a problem when more than one species is found in one sample. In the past taxonomists were not aware of this phenomenon and only females were included in the description of a new species. Incorrect identifications have been and are still being made, especially where females of two species appear similar but juveniles differ completely. It is only since recently that as many stages as possible of a new species are included in species descriptions. The SEM is a handy tool to illustrate these cuticular structures and should be used as far as possible in the description of a new species. The differences in cuticular structure of four species are illustrated.

Reproduction of *Pratylenchus brachyurus* at various temperature regimes and inoculation on in vitro carrot disc cultures

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

Pratylenchus brachyurus damages several agricultural crops, including groundnut, maize, soybean, dry bean and sunflower. Large numbers of this species are required for research on pathogenicity, host-plant resistance and efficacy of nematicides, and they must be produced cost-effectively. The effect of temperature and inoculation density on a culture of a *P. brachyurys* population from Viljoenskroon was consequently studied. Multiplication of *P. brachyurus* on carrot-disc cultures was done in growth chambers at various temperature regimes, viz. 15, 20, 25, 30 and 35 °C. Twenty-five females were inoculated per disc. In an initial inoculation density trial, densities of 5, 10, 20, 50 and 100 individuals were inoculated per disc. The optimal temperature for reproduction was 30 °C, where the highest population density and RF-value were recorded. The lowest population density and RF-value were recorded at 15 °C. Although *P. brachyurus* numbers decreased to 31 individuals per disc at 35 °C, an RF-value of 1.2 indicated that the initial population density was maintained at this high temperature regime. The maximum growth rate of a *P. brachyurus*-population occurred when 50 individuals were inoculated per carrot disc and maintained at 25 °C. According to these results the reproduction rate of *P. brachyurus* is optimal at 30 °C, whereas 50 individuals per carrot disc is the optimum inoculation density. Tendencies were the same at both assessment times but nematode numbers increased 13-fold when maintained for an additional four weeks.

Ecological profiles of the plant-parasitic nematodes from Guadeloupe

P Quénéhervé[1], M Viala[2], E Van den Berg[3], M Marais[3], A Swart[3], P Topart[1], B Martiny[1], P Constant[2] & H Mauleon[2]
[1]IRD, BP 8006, 97259 Fort-de-France Cedex, Martinique
[2]INRA-URPV, Domaine Duclos, 97270 Petit Bourg, Guadeloupe
[3]ARC–Plant Protection Research Institute, Private Bag X134, Pretoria, 0001 South Africa

A systematic survey of a 2-km^2 grid of the nematofauna of Guadeloupe was carried out during a nematode species–environment interaction study. This study involved the analysis of two data sets, viz. a nematode data set of the occurrence of 31 plant-parasitic species from 497 plots and an environmental data set consisting of values of seven environmental variables (altitude, rainfall, soil type, pH, vegetation, distance from the sea, conductivity) in the same plots. This analysis, using the Ecological Profiles Procedure (correspondence analysis) of the ADE-4 software, showed a very close association of some nematode communities with all environmental characteristics of Guadeloupe (coastal area, dry forest, moist forest, rain forest and mountains). The analysis can i) explain the presence of some rare or uncommon species (e.g. *Pratylenchus jordanensis* and *P. projectus* in arid areas), ii) highlight some nematode communities of a specific ecolog-

ical niche (e.g. the species restricted to mountain sites or to vertisols) and iii) show the range of nematode communities comprising more ubiquitous species.

Development of an aeroponic system to study the dynamics of the host-pathogen relationship in Fusarium wilt of banana

A A Severn-Ellis
ARC–Institute for Tropical and Subtropical Crops, Private Bag X11208, Nelspruit, 1200 South Africa

The main benefits of aeroponic culturing of plants are accessibility and non-destructive observation. An inexpensive aeroponic system was developed to enable the evaluation of reaction of banana roots to *Fusarium oxysporum* f.sp. *cubense* (*Foc*) races 1 and 4. Hardened-off banana tissue-culture plants of the cultivar Grand Nain, resistant to *Foc* race 1 and susceptible to race 4, were aeroponically grown for four weeks at 26 °C. Two different inoculation techniques were evaluated over a period of two weeks. Plants were inoculated with a spore suspension of *Foc* race 1 and 4. Root inoculation by an incision made in the root, severing the vascular tissue before removing the rest of the root 2 mm below the incision increased the number of infected roots and improved root colonisation. Preliminary light microscopy observations showed that browning of vascular tissue of roots infected with *Foc* races 1 and 4 were far more extensive than discoloration of the control. Browning of vascular tissue extended to smaller lateral roots. Vascular discoloration was followed by extensive fungal colonisation of the cortex and epidermal cells. Chlamydospores were found on roots infected with *Foc* races 1 and 4. Histological staining showed that phenolics were deposited within 24 hours after infection. Very little difference was observed between sections of the wounded control, *Foc* race 1 and *Foc* race 4.

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