ABSTRACTS OF THE 51th ONTA Annual Meeting
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Fruits, vegetables, ornamentals and other high-value specialty crops are very expensive to grow, with a considerable portion of input costs going towards managing pests and diseases. In Florida, one of the main concerns for fruit and vegetable growers are often plant-parasitic nematodes. Florida’s favorable climate and deep sandy soils provide an ideal habitat for nematodes such as root-knot (Meloidogyne spp.) and sting nematodes (Belonolaimus longicaudatus), both of which can cause considerable damage to a wide range of crops. Since the phase-out of methyl bromide, soilborne pest and disease problems, and nematodes in particular, have increased in many fields. Fumigation is still favored by the majority of Florida growers, because of the broad-spectrum control it provides, and due to the historic lack of non-fumigant nematicide alternatives. However, increasing label restrictions and overall regulatory and societal pressure, are putting more strain on the use of soil fumigants. In addition, the recent introduction of new non fumigant nematicides now provides a more selective and safer alternative to soil fumigants. Whether this will reduce the use of fumigants remains to be seen, as these new nematicides are more selective, and lack the broad-spectrum activity of soil fumigants. If growers are to abandon fumigants all together, it will be necessary to integrate the new nematicides with other products and incorporate them into a more integrated nematode and soil management plan. This could include the use of biological nematicides, cover crops, soil amendments, resistant cultivars and sanitation practices. The emphasis needs to be on understanding the relationship between the production system and nematodes over time and how changes in management practices can reduce crop loss, and benefit farm economics as well as soil health. The development of such integrated nematode management plans with reduced reliance on soil fumigants will be discussed.
The population in sub-Saharan Africa (SSA) is escalating, as is the rate of rural-urban migration. Agriculture is dominated by smallholders and characterised by low input systems with sub-optimal productivity. The amount of food produced per person is either stagnant or decreasing. Low yields are due to various reasons, including particularly substantial losses to pests and diseases. This situation is not sustainable. In order to achieve food security, attention towards sustainably intensifying these systems is necessary. However, with such diversity of production systems and agro-ecologies, this proves a challenge. Furthermore, more intensified cropping systems tend to increase the selection pressures for pests and diseases emergence. In the tropical and sub-tropical conditions across SSA, pest and disease threats are a major concern, including of nematode pests. However, while nematode pests are paradoxically among the more important threats, they are among the least known or understood. Commonly overlooked and/or misdiagnosed, nematode damage results in huge losses to crop production, with farmers regularly unaware of them. Nowhere is this neglect more marked than in SSA under resource limited conditions. To address this issue, it is necessary to increase awareness on the damage that nematodes inflict, towards the implementation of sustainable nematode management options. Farmers will need to be increasingly aware of these threats, and how to deal with them using reliable IPM options, chemical or otherwise, to reduce production losses to nematodes. However, not only are innovative IPM options required but greater capacity in nematology is equally necessary.

Creating awareness across the agricultural sector, fostering greater capacity in the discipline and strengthening links between the public and the private sectors (e.g. agro-input industry) will be key to achieving this goal.
Deborah Neher

- "Progreso y prioridades para los nematodos como indicadores"
- "Nematodos: cola de la función del ecosistema / Nematodes: tail of ecosystem function"


Nematode communities were proposed as biological indicators of soil health about 40 years ago. Research in the 1990’s empirically verified that 1) indices of successional maturity and food web structure have the greatest statistical reliability and correlate with ecosystem function, 2) long-term perennial crop and un till ed soils serve as undisturbed references for agricultural lands, and 3) calibrations need not be coarser than major land resource area and ecosystem type. Advances in sequencing of marker genes for free-living nematodes helps make identification more accessible to a non-specialist. However, calibration and interpretation lag behind, impeding implementation at large regional scales. Meta analysis of existing community data provide candidate taxa to verify for sentinel status and calibration. Interpretation will require empirical validation of index weights (e.g., colonizer persister values) by natural history studies and/or independent biomarker assessments. This knowledge will create a data-driven decision tool that simplifies indices to contain only taxa that consistently detect particular types and magnitudes of disturbances.


Nematodes are an example of functional and anatomic economy. A hallmark of the phylum is its exceptional diversity and ubiquity on the globe. A key to their success is their ability to survive extreme temperature and moisture regimes. When environmental conditions are favorable, species that feed on decomposer microbes contribute up to 19% in nitrogen mineralization. Composition of their communities reflects disturbance to soil by land management practices making them reliable indicators. Formerly, a science focused on control of parasitic and harmful species, soil nematodes can be a tool for testing ecological hypotheses and understanding biological mechanisms in soil.
Los fitonematodos, solos o en interacción con Fusarium oxysporum f. sp. Physali constituyen un limitante al cultivo de la uchuva (Physalis peruviana L.) en Colombia, frutal de importancia económica para mercado de exportación y local. En estudios previos se realizó análisis nematológico y pruebas de parasitismo a muestras provenientes de las principales zonas productoras de uchuva. Con el material recolectado se estableció una colección in vivo constituida por 50 poblaciones y se realizó el estudio de fluctuación poblacional durante seis ciclos cada uno de 4-5 meses, excepto el último, de 12 meses. En macetas conteniendo suelo de las 50 fincas con su respectiva población de fitonematodos (Pi-1), se sembraron plástulas de uchuva de 1,5 meses de edad procedentes de semilleros esterilizados. Las plantas se fertilizaron al momento del trasplante y 30 días después, además se les suministró riego diario. Pasados 4-5 meses se estimaron las poblaciones de fitonematados (Pf-1) y el factor de reproducción (Rf-1), y en el mismo suelo se renovaron las plántulas, durante seis ciclos. Ocho taxones se presentaron en la Pi-1, en orden de abundancia: Helicotylenchus, Meloidogyne, Pratylenchus, Hemicyclophora, Trichodoridos, Xiphinema, Criconematidos y Heterodera. En el primer ciclo (prueba de parasitismo) se reprodujeron todos los taxones excepto Heterodera y Criconematidos. En todos los ciclos, Helicotylenchus y Meloidogyne fueron los géneros predominantes, con abundancia estable; las poblaciones de Pratylenchus y Hemicyclophora disminuyeron paulatinamente. En el ciclo de 12 meses, la población de Xiphinema se incrementó considerablemente en suelo de dos localidades; sin embargo, Hemicyclophora no se presentó.
We evaluated the behavior of eight populations of Nacobbus aberrans from different geographic origin on tomato plants cv. Miroma. The tomato plants (29-days old) were inoculated with populations of the nematode from different agricultural regions of Mexico with 0.5 g of galls. The plants were distributed in a completely randomized design with four replicates and kept in a greenhouse for 45 days. Three assessments at intervals of 15 days after inoculation were conducted to determine the penetration and invasion of juveniles in the tomato roots. Fifteen days after inoculation (DAI), juveniles from the populations of Romita, Tetela and Chapingo showed higher rates of penetration and invasion with 50 individuals/g root, while in the 30 DAI, the juveniles in the roots was significantly reduced, and only the population of Silao increased its penetration with 66 juvenile/g root. After 45 DAI, there was an increase in the number of juveniles and swelling in the roots, mainly with the Romita and Tetela populations, with 102 and 158 juveniles/g of root, respectively. In general, all populations except the control, managed to penetrate and invade the root system of tomato plants, confirming the viability of eggs and biological stages of the nematode, with clear differences in their behavior. The population of Romita, Guanajuato showed the greater parasitic capacity on the roots of tomato cv Miroma.

• Gary D Pack

USING SPARSE SAMPLING AND DENSE ESTIMATION TO STUDY SPATIAL RELATIONSHIPS BETWEEN Pratylenchus penetrans AND THE PHYSICAL SOIL ENVIRONMENT [MUESTREO Y ESTIMACIÓN Densa PARA ESTUDiar RELACIONES Espaciales ENTRE Pratylenchus penetrans Y EL AMBIENTE FÍSICO DEL SUELO]. G. D. Pack, I. A. Saeed and A. E. MacGuidwin. Department of Plant Pathology, University of Wisconsin, Madison, WI, USA. 53706 aem@plantpath.wisc.edu.

We modeled spatial patterns of Pratylenchus penetrans population density, 30 soil properties, and their relationship in fields with sandy soils to study the influence of the physical soil environment on high density hotspots of this important species. A global logistic model for nematode density per 100 cm3 soil was developed using data from georeferenced samples collected before crops were planted from seven fields. The binary dependent variable for nematode density was determined by a threshold value and the independent variables were selected using the least absolute shrinkage and selection operator. Four versions of the model were constructed using thresholds of 25, 75, 100, and 150 P. penetrans per 100 cm3 soil for the classification. The discrimination ability was > 0.84 for all models, as evaluated by area under the receiver operating characteristic curve. The number of independent variables selected ranged from 7 - 19. Using the kriged values of the independent variables and the designated thresholds, the global logistic model was used to generate probability maps at a one-m2 resolution for each field. Subsequently, each field map was refined by re-estimating the probability at each point using autologistic regression that included neighborhood structure. The probability heat maps and the above-threshold hotspots were analyzed. The 28
maps, one per threshold value per field, showed outcomes consistent with the sparsely-collected original nematode data. Our results suggest it is possible to build generalizable global models to inform spatially dependent activities such as sampling or precision management for P. penetrans.

**Ponencias / Abstracts**

**Diversidad, Biología, Ecología y Taxonomía / Diversity, Biology, Ecology and Taxonomy**

- Ingrid Varela-Benavides

**COMUNIDADES DE NEMATODOS EDÁFICOS DE DIFERENTES ECOSISTEMAS EN EL PARQUE NACIONAL DEL AGUA, COSTA RICA [SOIL NEMATODE COMMUNITIES WITHIN DIFFERENT ECOSYSTEMS IN THE DEL AGUA NATIONAL PARK IN COSTA RICA].**

I. Varela-Benavides1, H. Ferris2, R. Peña- Santiago3 y J. Abolafia3. 1Laboratorio de Nematología, Instituto Tecnológico de Costa Rica sede San Carlos, Apartado Postal 223-21001, Alajuela, San Carlos, Costa Rica. 2Department of Entomology and Nematology, University of California Davis, Davis, CA 95616 USA. 3Departamento de Biología Animal, Biología Vegetal y Ecología, Universidad de Jaén. Campus “Las Lagunillas” s/n. 23071-Jaén, Spain. invarela@itcr.ac.cr.

Se presenta un estudio de la nematofauna encontrada en los suelos del área de manejo sostenible de los recursos naturales en el Parque Nacional del Agua en Costa Rica. Se muestrearon cuatro tipos de hábitats (bosque primario, bosque secundario, plantación forestal y pastizal) en cinco localidades situadas en los bordes del parque. Se recolectaron un total de 100 muestras de suelo. Para los análisis de comunidad se utilizaron los índices de madurez, red trófica, diversidad y huella metabólica. Se identificaron un total de 130 géneros pertenecientes a 59 familias y 8 órdenes. Los más abundantes fueron Helicotylenchus (15%), Mesocriconema (13%) y Discocriconemella (7%). Destaca el número de criconematídos en todos los hábitats y localidades, pero Mesocriconema mostró una menor abundancia en el bosque primario, en contraste con Discocriconemella que fue dominante en los bosques. Además, la abundancia de dorilámidos herbívoros fue alta en los pastizales y en las plantaciones forestales, si bien tendió a ser menor en estas últimas. Los géneros que presentaron mayores abundancias en ecosistemas alterados con respecto al bosque representan varios grupos tróficos y estrategias de vida: Alaimus (Enoplida), Aphanolaimus (Plectida), Metateratocephalus (Plectida), Monotrichodorus (Triplonchida), Oriverutus (Dorylaimida), Pristionchus (Rhabditida) y Teratocephalus (Rhabditida). Los índices que incluyen los nematodos fitoparásitos alcanzaron valores más elevados en pastizales, intermedios en plantaciones de árboles y menores en bosques. La huella de enriquecimiento fue mayor en el bosque secundario, seguido del bosque primario y los ecosistemas perturbados.
**Qing Yu**

**TAXONOMIC STUDIES OF THE PLANT PARASITIC NEMATODE SPECIES OF DORYLAIMIDA IN THE DOMINION ARBORETUM OF CANADA**

Q. Yu. Agriculture and Agri-food Canada, Ottawa Research and Development Center, Ottawa, Ontario, Canada, Qing.Yu@Canada.ca.

The Dominion Arboretum of 40 hectares in size is located at the Central Experimental Farm of Agriculture and Agri-Food Canada in Ottawa, Ontario, Canada. Originally in 1889, it served as a testing ground of those introduced plants from Europe, and then around the world for their suitability of the Canadian climate, and now it is mostly a display site of about 10,000 kinds of the remaining introduced but mostly tree and shrub plants to the public, although its special collections of flowering crabs, lilacs, lilies, and hedge plants are still as much for experimental work and study as for display to the public. In 2017 and 2018, a survey for nematodes was conducted, and this presentation focus on the plant parasitic nematodes belonging to Dorylaimida. The species discovered and identified are *Xiphinema americanus*, *X. riversi*, and *X. diversicaudatum*, *Longidorus elnogatus*, *Paratrichodorus pachydermus*, and *P. sp.*, by using morphology and molecular methods. This is the first report of *P. pachydermus* in Canada.

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**Ignacio Cid del Prado**

**ANHYDROBIOSIS IN Nacobbus aberrans (NEMATODA: PRATYLENCHIDAE)**

Cid del Prado V.I. Colegio de Postgraduados, Mexico, icid@colpos.mx.

Nematodes are a highly diverse group of organisms that have adaptations for survival in extreme conditions in the environments that they inhabit. Nematodes that inhabit plant organs, or soils in dry climates, often are capable of withstanding prolonged periods of desiccation by entering into a state of anhydrobiosis. Examples include *Anguina tritici* and *Ditylenchus dipsaci*. During our previous research with *Nacobbus aberrans*, we noted that some tomato plant roots have galls containing mature females 15 days after planting in infested soils. On the other hand, when plants are grown in sterile soil, females are only present in the roots 30 days after inoculation with second-stage juveniles. To determine whether some juvenile stages of *N. aberrans* are capable of surviving in dry roots, we collected a large amount of galled roots in March 2016 and stored them in dry conditions.

One year later, at the end of February 2017, we inoculated soil around the roots of tomato seedlings (cv Cid) with 20 and 40 g of moistened or dry galled roots, with three replicates of each treatment. After 21 days, roots of plants inoculated with dry and moistened roots were evaluated. The gall index of the two treatments was
between 3 and 4, respectively (on a 1-5 scale) for both treatments. In 2018, we
used the galled roots collected in 2016 to inoculate soil around tomato cv Rio
Grande. The gall index 66 days after inoculation was 1 to 2. After three years of
storage in dry conditions, our present work shows that the nematode is still surviving
in a state of anhydrobiosis. Future work will evaluate the roles of carbohydrates
and lipids in anhydrobiotic nematodes.

- Nathalia Fitoussi

DECIPHERING THE INTIMATE DIALOGUE OF THE ROOT-KNOT NEMATODE-PLANT
INTERACTION. [DESCIFRANDO EL DIALOGO ÍNTIMO DE LA INTERACCIÓN PLANTA-
NEMATODO NODULADOR]. N. Fitoussi1,2, E. Borego,3 M. V. Kolomiets3, P. Bucki1, N.
Sela4, E. Belausov5 and S. Braun Miyara1*1Department of Entomology, Nematology and
Chemistry units; Agricultural Research Organization (ARO), the Volcani Center, Bet Dagan,
50250, Israel. 2Department of Plant Pathology and Microbiology, the Faculty of Agriculture Food & Environment, the Hebrew University of
Jerusalem, Rehovot, 76100, Israel. 3Department of Plant Pathology and Microbiology, Texas A&M University, TAMU 2132, College Station, 77843-2132, U.S.A.
4Department of Plant Pathology and Weed Research, Agricultural Research
Organization (ARO), the Volcani Center, Bet Dagan, 50250, Israel. 5Department of
Plant Sciences, Ornamental Plants and Agricultural Biotechnology, Agricultural
Research Organization (ARO), the Volcani Center, Bet Dagan, 50250, Israel.
sigalhor@agri.gov.il

Meloidogyne spp., a biotrophic sedentary endoparasitic root-knot nematodes
(RKN), has many strategies specialized for a successful long-term interaction with
their hosts related on the synthesis of effectors protein predominantly secreted by
esophageal glands. Previous studies have shown that effectors interfere with and
mimic multiple physiological and morphological mechanisms, leading to
modifications and reprogramming of the host cells' functions, thus enslaving the
cells to complete their life cycle. Herein, we aimed to reveal novel effectors that
might promote parasitism.

For that purpose, RNAseq was performed and generated a total of 4810
differentially expressed genes (DEGs) of M. javanica second stage juveniles (J2s)
exposed to tomato protoplast and 9-HOT oxylipins. Among DEGs carrying a
predicted secretion signal peptide, several had homology with known effectors in
other nematode species, as cell wall degradation and hormone metabolism. In
order to localize other unknown potential effectors secreted, FISH technique was
used to detect signal in the RKN's esophageal glands. Those effectors were over-
expressed in planta. Moreover, since recent findings revealed new functions of
lipids as defense signaling molecules, a metabolic profiling of fatty acid derived
molecules composition in tomato hairy roots was conducted resulted in
identification of oxylipin products that are specifically altered upon tomato root
inoculation with the RKN, M. javanica, using LC-MS/MS, suggesting that different
oxylipins are maneuvered by the nematode-secreted effectors. This research will
provide novel nematodes effectors underlying the manipulation of the host
physiology and defense and a better understanding of oxylipins function in regulating the outcome of the parasitic interaction.

**Ponencias / Abstracts**

**Agricultura de Precisión / Precision agricultura.**

- Joseph W. Noling

**ASSESSING NEMATODE AND DISEASE INCIDENCE, SEVERITY, AND CROP IMPACTS IN FLORIDA STRAWBERRY USING HIGH RESOLUTION AERIAL IMAGING** [EVALUACIÓN DE LA INCIDENCIA DE NEMATODOS Y ENFERMEDADES, SEVERIDAD, E IMPACTO EN FRESA EN FLORIDA CON EL USO DE IMÁGENES AÉREAS DE ALTA RESOLUCIÓN]. J. Noling1, J. S. Baggio2, and N.A. Peres2. University of Florida, IFAS, 1Citrus Research & Education Center, Lake Alfred, FL 33850, 2Gulf Coast Research and Education Center, Wimauma, FL 33598. jnoling@ufl.edu.

In Florida, nematodes and soilborne fungal diseases such as Colletotrichum, Phytophthora, and Macrophomina, and the sting nematode, Belonolaimus longicaudatus, are very important yield limiting pests of strawberry. For these studies, digital color imaging and in-field assessments of plant size were used to characterize the distribution and degrees of plant stunting, strawberry yield, and within row measures of green plant canopy cover associated with the sting nematode. Disease incidence, severity, and crop impacts were assessed from ground survey and analysis of aerial imagery. Aerial imaging surveys of over 20 commercial field locations were seasonally conducted from November 2017 to March 2018 and Nov 2018 to March 2019, using a DJI™ Phantom 4 Pro UAS drone equipped with a DJI 24mm 20MP camera with an Exmor R CMOS sensor. Image orthomosaics were created using DroneDeploy™ cloud software platform with an image resolution of 10 to 20 mm per pixel. Processed RGB and NDVI maps were oftentimes both visually evaluated and impacted plants enumerated and or analyzed using ESRI™ ArcGIS v10.33. Strawberry canopy cover, relative yields and enumerations of disease incidence and plant stunting were derived from inspection of drone images and then compared using regression analysis with ground truth field surveys. It will be demonstrated that these new aerial imaging techniques and greenness analysis have great potential to facilitate and increase accuracy and precision in quantifying nematode and plant disease incidence, plant growth response, performance of fumigant and nonfumigant pest management practices, and of long term impacts within the strawberry cropping system.
Ponencias / Abstracts

Control Biológico / Biological control

- Patricia Bucki

DEVELOPING OF A NEW BIOLOGICAL CONTROL PRODUCT BASED ON SOIL BORNE BACTERIAL CONSORTIA AGAINST PLANT PARASITIC NEMATODES. [DESARROLLO DE UN NUEVO PRODUCTO CONTROLADOR BIOLÓGICO A BASE DE UNA BACTERIA DEL SUELO CONTRA NEMATODOS PARÁSITOS DE PLANTAS]. P. Bucki1, A. Gamliel2, D. Minz3, M. Benichis2, R. Kumar Jain3, B. Chippandi1, S. Gabay1, G. Inbar1 and S. Braun1. 1Department of Entomology, Nematology and Chemistry units; Agricultural Research Organization (ARO), the Volcani Center, Bet Dagan, 50250, Israel. 2Laboratory for Pest Management Research, Institute of Agricultural Engineering, ARO, The Volcani Center, Bet Dagan 50250, Israel. 3Department of Soil Chemistry, Plant Nutrition and Microbiology; Agricultural Research Organization (ARO), the Volcani Center, Bet Dagan, 50250, Israel. sigalhor@agri.gov.il.

Root-knot nematodes (RKN), Meloidogyne spp., are extremely destructive pathogens with a cosmopolitan distribution and a host range that affects most crops. Safety and environmental concerns related to the toxicity of nematicides along with a lack of natural resistance sources threaten most crops. This emphasizes the need to identify new alternatives to control this devastating plant parasitic nematodes. Bacterial sources included 120 bacteria from suppressive soil from banana plantation and from healthy tomato plants in vicinity to RKN infected plants. Four screening methods were conducted to study bacteria bionematicidal activity against the RKN: a. in vitro activity. b. in terra activity in small pots containing soil, nematodes and bacteria. c. on tomato seedlings short term experiments. d. tomato plants in pots, long term experiments. Up to date, in vitro screening resulted in selection of 40 potential bacteria possessing bionematicidal activity against second stage juveniles. Next in terra experiments indicate that out of 40 studied bacteria, 21 have demonstrated bionematicidal activity against second stage juveniles within soil. Out of the 21 potential bacteria, 12 bacteria have shown to reduce gall appearance and eggs production on tomato seedlings roots. Antagonistic test among 12 bacteria were conducted in order to reveal any antagonistic activity between different bacteria, then seven consortia were generated consisting different bacteria combination and they tested for their activity to reduce RKN disease occurrence on tomato plants in pot experiments. Among all tested consortia, three consistently demonstrate activity in reducing
galling. Currently, these potential consortia are further developed to generate a formulation adjusted to field application.

- **Carolina Cedeno**

**SUSCEPTIBILITY OF LARVAE AND ADULTS OF Paranomala undulata peruviana (GUÉRIN-MÉNEVILLE) TO Heterorhabditis indica (POINAR).**


La extensa superficie instalada con caña de azúcar en el proyecto de irrigación e hidroenergético Olmos en el norte del Perú, ha favorecido el establecimiento del escarabajo Paranomala undulata peruviana (Guérin-Méneville), cuyas larvas se ubican en el suelo, se alimentan de las raíces y los adultos que son de hábito nocturno migran hacia los campos vecinos de palto y vid cuando están en brotamiento y en este último cultivo cuando está el racimo listo para cosecha, causando grandes pérdidas económicas. En este estudio se evaluó la susceptibilidad de las larvas de Paranomala undulata peruviana a Heterorhabditis indica aplicando con un nebulizador manual 150 juveniles infectivos (JI)/larva al suelo y 150, 500 y 1000 JI/adulto. Se registró diariamente los síntomas y el porcentaje de mortalidad. Los síntomas en las larvas fueron menor movimiento, muerte y coloración rojiza a las 48 horas después de la inoculación alcanzando un 71.4 % de mortalidad. Los adultos dejan de alimentarse, presentan descoordinación para caminar y volar, realizan movimientos torpes y mueren 48 a 72 horas después de la inoculación y emiten un olor putrefacto, registrando 54.5, 66 y 76 % de mortalidad. Estos resultados demuestran que H. indica puede constituirse en una alternativa biológica importante para el control de larvas y adultos de esta plaga.

- **Timothy Ave-Lallemant**

**DEVELOPMENT OF A SCREENING PIPELINE TO IDENTIFY MICROBES TO COMBAT ROOT-KNOT NEMATODES IN SUB-SAHARAN AFRICA**


West Africa, specifically Nigeria and Benin, is responsible for over 95% of the world’s yam production. The plant-parasitic nematode Meloidogyne spp. (root-knot nematode) is a major contributing factor to yield losses in West African root and tuber crops. The tools available to smallholder farmers in Africa to combat
nematodes have been limited, creating a need for the management of these agronomically devastating pests. At AgBiome, our goal is to harvest the potential of the plant microbiome to develop biological crop-protection solutions. AgBiome has established a discovery pipeline developed around the biology of Meloidogyne spp. And their interactions with microbes. Our innovative approach to discovery of a biological nematicide involves the design and implementation of high-throughput *in vitro* and quick-read *on-plant* assays to identify potential strains that target the vulnerable second-stage juvenile. Candidate strains are then confirmed using greenhouse and field screening trials to measure effects on yield and subsequent Meloidogyne spp. Generations. By including African yam-associated microbes from plant tissue and field soils in our screens, we can expand the reach of our product Discovery to help yam production in West Africa.

- **Larry Duncan**

*CAN THE FUNGUS* *Fusarium solani* *MODULATE TROPHIC CASCADES INVOLVING ENTOMOPATHOGENIC NEMATODES AND INSECT HERBIVORES?* [PUDE EL HONGO *Fusarium solani* MODULAR CASCADAS TRÓFICAS QUE INVOLUCRAN NEMATODOS ENTOMOPATÓGENOS Y HERBIVOROS DE INSECTOS?]. S-Y. Wu1, F. E. El-Bora1,2,3, J. H. Graham1 and L W. Duncan1. 1Citrus Research and Education Center, University of Florida, Lake Alfred, FL, United States. 2Gulf Coast Research and Education Center, University of Florida, FL, United States. 3Plant Protection Department, Faculty of Agriculture, Zagazig University, Zagazig, Egypt. sywu@ufl.edu.

Olfactory signals are critical for soil inhabitants to communicate and respond to the environment. In addition to the well-documented volatile cues from herbivores and herbivore-induced plants, the attraction of entomopathogenic nematodes (EPNs) to their insect prey can also emanate from other sources. Using headspace solid-phase microextraction (HS-SPME) combined with gas chromatography mass spectrometry (GC-MS) analysis, two insect-attracting volatile organic compounds (VOCs) were detected from the insect-parasitic fungus *Fusarium solani*. Bioassays showed that both compounds attract entomopathogenic nematodes (EPNs) on a species-specific basis. In two-choice olfactometers, more *Steinernema diaprepesi* infective juveniles were attracted to both VOCs, whereas the closely related and often sympatric *S. khuongi* was not. Attraction to the VOCs was greater in saturated soil than in soil at field capacity. Although both compounds are highly attractive to fungivorous insects such as fruit flies, fungus gnats and rove beetles, the non-fungivorous *Diaprepes abbreviatus* root weevil was strongly repelled by one compound and unresponsive to the other. EPNs may have evolved to exploit these VOCs as a means of encountering fungivorous insects. Non-fungivorous arthropods may have evolved to avoid the compounds. These compounds have the potential of serving as baits to facilitate host finding of fungivorous arthropod pests by EPNs, especially in poorly drained soils where such pests may be prevalent.

- **Maria G. Medina-Canales**

Se evaluó la efectividad de la cepa Pcp21 de P. chlamydospora var. Mexicana sola y en combinación con hojas de brócoli (HB) y Furadan® para el control de M. arenaria en zanahoria en un campo hortícola en Puebla, México. De la zona de estudio se colectó suelo, se esterilizó e hicieron determinaciones físico-químicas antes y después del experimento.

Se diseñaron doce tratamientos con cuatro repeticiones aplicando el hongo por separado y en combinación con HB (fresco y composteo) y Furadan®. Las unidades experimentales (UE) fueron bolsas de polietileno con 2 kg de suelo estéril, siete semillas de zanahoria, 1x107 clamidosporas (cepa Pcp21), 2300 huevos de M. arenaria, 6 g de HB y 2 mg de Furadan® según tratamiento. Las UE se llevaron al campo, se enterraron y 12 semanas después se evaluó: peso freso de la raíz (PFR), peso del follaje fresco (PFF) número de agallas en la raíz (AR), unidades formadoras de colonias (UFC) del hongo por gramo de suelo y raíz y juveniles de segundo estadio (J2). Se realizó una ANOVA unifactorial utilizando la prueba de LSD P<0.05. Las características físico-químicas del suelo no variaron entre los tratamientos al igual que el PFF y PFR (P<0.05). El AR y J2 en suelo disminuyeron en los tratamientos que contenían el hongo. Las UFC/g de suelo y raíz aumentaron en los tratamientos con HB en fresco y composteo. La cepa Pcp21 contribuye a disminuir el AR y J2 en el suelo y su efecto aumenta al combinarlo con HB en composteo.

• Luis Pocasangre-Enamorado

THE NEED OF JOIN VENTURE ALLIANCE IN THE PUBLIC AND PRIVATE FOR SECTOR FOR DEVELOPING COMMERCIAL BIOLOGICAL CONTROL PRODUCTS [LA NECESIDAD DE AVENTURARSE EN UNIÓN DE ALIANZAS EN EL SECTOR PUBLICO Y PRIVADO PARA DESARROLLAR PRODUCTOS COMERCIALES DE CONTROL BIOLÓGICO]. L. E. Pocasangre-Enamorado, Director of Research, EARTH University, Costa Rica. lpocasangre@earth.ac.cr.

It is very well establish that most of research and work needed for developing a biological control product such as: sampling, isolation, purification, identification of biological control agent as well as the screening of the biological activity against pathogens started in universities, national research center and international center belonging to the public sector. However, few universities and research institutes and scientists had started an enterprise related to development and scaling up a biological control product. Most common cases the final phase of mass production and registering the products is done by the private sector due to they
have experience in this matter and have the whole platform for scaling up, distribution, application and commercialization of the products. Therefore, there is a need that universities and research institute can establish more functional and effective join venture alliance with the private sector in order to speed up the development of biological control product to managing pests and disease and the agricultural sector. Currently, the consumer are demanding healthy foods and on the other side several chemical products not only nematicides but also fungicides and herbicides will be banned in the near future. Therefore, it is a great opportunity for the public sector and small enterprises to establish relationships with the private sector to scaling up new biological products. Otherwise, thousands of biological control agent with potential will remain in the mycotec of universities and research institute and will not reach the final user who are the farmers.

Ponencias / Abstracts

Genómica / Genomics

- Ke Dong

A DNA BARCODING APPROACH TO SOIL NEMATODE COMMUNITY ON MT. SEORAKSAN, SOUTH KOREA. [CÓDIGO DE BARRAS DEL ADN PARA EL ESTUDIO DE COMUNIDADES DE NEMATODOS EN EL SUELO EN MT. SEORAKSAN, COREA DEL SUR]. K. Dong, H. Zhao and S. Lee. Kyonggi University. dongke@kgu.ac.kr.

Nematodes are the most ubiquitous and abundant invertebrates, playing an important role in ecosystems. Since studies on nematode diversity are laborious and inefficient using classical morphological methods, the DNA barcoding approach has been suggested to be an attractive alternative. By sequencing the 18S rRNA gene, we characterized soil nematode communities on Mt. Seoraksan, South Korea, along a ~1,400 m fine-scale-sampling elevational range and a ~1,200 m broad-scale-sampling elevational range. We are interested to find out how the diversity and community composition of soil nematode vary along the elevational gradient.

Our results indicated that the nematode community on Seoraksan Mountain was dominated by the family Prismatolaimidae, followed by an Enoplean family (unclassified), Nygolaimidae, Qudianematidae, Chromadoridae, Mononchidae and other 32 nematode families. Although the diversity of the nematode community of each elevational isocline band were not significantly different, nematode community structure indicated some differentiation according to the different elevational isochline bands, for example, the nematodes on low elevation are significantly different from other higher isocline bands. Our study also confirmed the effectivity and reliability for using DNA barcoding approach to investigate nematode communities.

- Sigal Braun Miyara
BIOGEOGRAPHY AND MOLECULAR SPECIES DELIMITATION OF Pratylenchus capsici N. SP. A NEW - OLD ROOT-LESION NEMATODE IN ISRAEL ON PEPPER (Capsicum annuum).

Q. Xue1, A. Gamliel2, P. Bucki1, S. Duvrinin3, O. Abraham1,2,4 and S. Braun1. 1Department of Entomology, Nematology and Chemistry units; Agricultural Research Organization (ARO), the Volcani Center, Bet Dagan, 50250, Israel. 2Laboratory for Pest Management Research, Institute of Agricultural Engineering, ARO, The Volcani Center, Bet Dagan 50250, Israel. 3Extension Service (Shaham); Israel Ministry of agriculture & Rural development, Israel. 4Plant Pathology and Microbiology, Faculty of Agriculture, Food and Environment, Rehovot. sigalhor@agri.gov.il.

Root-lesion nematodes of the genus Pratylenchus parasitize the roots of various plants and can cause severe damage and yield loss. Here, we report on a new species Pratylenchus capsici n. sp. from Arava rift, Israel, which was characterized by integrative methods, including detailed morphology, molecular phylogeny, population genetics and biogeography. We found this species widely spread along the Arava rift, causing significant infects in pepper (Capsicum annuum) roots and inhibits plant growth. Both morphological and molecular species delimitation support the recovered species as a new species. We recovered a high COI (cytochrome oxidase subunit I) haplotype diversity and biogeography analysis suggests that contemporary gene flow was prevented among different agricultural farms while population dispersal from weeds to pepper was found on relatively small scale. Our results suggest that weeds are important for the dispersal of P. capsici n. sp., either as the original nematode source or at least to maintain the population in between growing seasons.

- Amy B. Peetz

INCREASING RESOLUTION WITHIN THE Xiphinema americanum-GROUP COMPLEX (NEMATODA; LONGIDORIDAE) AS INFERRED FROM MITOCHONDRIAL DNA

A. B. Peetz and I. A. Zasada. U.S. Department of Agriculture. Horticultural Crops Research Unit. Corvallis, OR. USA. Inga.Zasada@ARS.USDA.GOV

Nematodes within the Xiphinema americanum-species complex are economically important because they parasitize a wide range of agricultural crops worldwide and may vector nepoviruses among plants. These nematodes are notoriously difficult to visually identify to species due to phenotypic overlap among characteristic traits. The development of DNA sequence based identification methods will allow for more accurate species determination within the group. Unfortunately, commonly used loci for nematode identification do not provide adequate sequence divergence for species-level differentiation within the X. americanum complex. Previous research endeavors lead us to target a larger portion of mitochondrial (mt) genome than previously reported for phylogenetic
studies for primer development. For this study, nematodes belonging to the Xiphinema americanum-species complex found across the Pacific Northwest of North America were collected from eight geographically disparate locations. Molecular characterization was done on individuals from each population which were first examined morphologically and morphometrically to positively identify each individual as within the Xiphinema americanum-species complex. Genus-specific primers targeting a 2800 base pair (bp) region were designed from accessions deposited in GenBank which included the entire mt genome, portions of the cytochrome oxidase 1 (CO1) gene, partial sequences from the 3' end of the ribosomal small subunit (mtSSU), and the cytochrome b (CYTB) gene. PCR amplicons from individual isolates were cloned and sequenced in multiple reactions. With the expanded mtDNA sequence dataset, phylogenetic inference analyses were used to reconstruct evolutionary relationships among these populations and with other species from the Xiphinema americanum group.

**Ponencias / Abstracts**

**Control Químico, manejo integrado / Chemical control and Integrated pest management**

- David A. Moreira

**EFFECT OF NEW NON-FUMIGANT NEMATICIDES ON DIFFERENT TROPHIC GROUPS OF NEMATODES. [EFECTO DE NUEVOS NEMATICIDAS NO FUMIGANTES EN DIFERENTES GRUPOS TRÓFICOS DE NEMATODOS].** D. A. Moreira and J. Desaeger. Department of Entomology and Nematology, Gulf Coast Research and Education Center, 14625 CR 672, Wimauma, FL 33598. daanmoca94@ufl.edu.

Plant parasitic nematodes cause more than $100 billion dollars per year in damage to crops (>14% global crop production). Non-parasitic, free-living nematodes, that coexist with plant-parasitic nematodes in soil, are critical components of the soil food web and play important roles in nutrient cycling and making inorganic chemicals available to plants. Management of plant parasitic nematodes has traditionally relied on the use of broad-spectrum soil fumigants, and organophosphate and carbamate insecticides.

Recently, new selective contact nematicides have emerged that offer alternatives to these restricted use pesticides. The effect on mortality of varying concentrations of three new nematicides and the carbamate nematicide Vydate® L on different trophic groups of nematodes (bacterivore, fungivore, entomopathogenic and plant-parasitic) was tested in-vitro. Using 48-well tissue culture plates, nematodes were exposed to varying concentrations of the products and evaluated at five different time points (24h, 48h, 72h, 96h and 168h). Living and dead nematodes were determined by adding 1 N NaOH to each well and counting the nematodes that were able to react (alive) and the nematodes that were not able to respond (dead) to NaOH. Results indicated that all nematicides affected the plant-parasitic nematode Meloidogyne javanica more than the free-living nematodes
(Cephalobus sp., Aphelenchus sp. and Steinemema sp.). At low concentrations (1-1.25ppm, representative of soil water concentration following field applications) the overall effect of Velum® on all nematode taxa was greater than that of Nimitz® and Salibro™. Nematodes that responded to 1 N NaOH were often sluggish and lethargic; although they were technically not dead, their infectivity was likely affected; this will be investigated in follow-up studies. In addition, we will continue to evaluate other nematode species/taxa.

- Erwin Aballay

**ASSESSMENT OF THE RESISTANCE OF THREE WALNUT ROOTSTOCKS TO Pratylenchus vulnus AND A MIXTURE OF THREE Meloidogyne POPULATIONS** [EVALUACIÓN DE LA RESISTENCIA DE TRES PORTAINJERTOS DE NOGALES A Pratylenchus vulnus Y A UNA MEZCLA DE TRES POBLACIONES DE Meloidogyne]. E. Aballay y Jacobo Olave. Facultad de Ciencias Agronómicas, Universidad de Chile, P.O. BOX 1004, Santiago, Chile. eaballay@uchile.cl.

Walnuts (Juglans regia) is one of the fruit trees with greater growth in Chile in the last ten years, reaching a cultivated surface of more than 35,000 ha. Root damages are associated to several plant-parasitic nematodes, mainly Pratylenchus vulnus and different Meloidogyne species. Their presence is associated to medium and light soil textures, previously cultivated with sensitive crops. The aim of this work was to compare the sensitivity of the rootstocks RX1, VX211, VLACH recently introduced to Chile with ungrafted plants of J. regia. Two month old plants were obtained from a nursery in a container with steamed peat and transplanted to 5-L pots with a substrate consisting of a steamed mixture of sand and soil in the same proportions. Once stablished, plants were inoculated with 2,000 Meloidogyne eggs obtained from fields cultivated with tomatoes and grape vines. For P. vulnus, plants were planted in the same pots, filled with naturally infested soil, and maintained under controlled conditions in a greenhouse during spring and summer and harvested after 110 days to determine number of nematodes in substrate and roots for P. vulnus and also eggs for Meloidogyne spp. Results showed that the four rootstocks were parasitized by both nematodes, with a reproductive factor (Pf/Pi) greater than 2 for soil populations in P. vulnus but with respect to Meloidogyne spp., VLACH showed some resistance, with a Pf/Pi value lower than 1, different from the other three rootstocks (p<0.05). According to these results, new walnut orchards must be under some nematodes management program.

- Ricardo F. Espino

**EFECTOS DEL DESPUNTE SOBRE EL RENDIMIENTO DE GRANO Y POBLACIONES NEMATOLOGICAS EN PALLAR (Phaseolus lunatus L) VARIEDAD GENEROSO DE ICA.** R. F. Espino-Caballero R.F.1 y P. Aquije2. 1 Profesor Nematología UNSLG (Universidad Nacional San Luis Gonzaga). Facultad de Agronomía. Fundo
En el cultivo de pallar de Ica que tiene denominación de origen, en el 2018 se evaluaron el efecto del despunte de los tallos principales sobre el rendimiento de grano y su influencia sobre las poblaciones nematológicas. Los tratamientos experimentados fueron ocho, originados por tres momentos de despuntes, por dos números de plantas por mata, más dos testigos sin despuntes, con cuatro repeticiones y con un diseño de bloques completos al azar. Las poblaciones nematológicas en suelos se evaluaron a los 10, 60 y 160 dds (días después de la siembra) y en raíces a los 160 dds y se utilizó la técnica del Embudo Baermann Modificado para la separación y cuantificación de nematodos. En suelos se cuantificaron en estas tres evaluaciones nematodos que fueron agrupados en seis grupos con poblaciones en N° /100 cm3 de: 1- Rh (Rhabditis spp.) (Bacteriófagos) de 121 a 197, 2- Ap (Aphelenchus spp.) (Vida libre) de 25 a 158, 3- Do (Dorylaimus spp.) (Omnívoros) de 0 a 41, 4-Tch (Tylenchorhynchus sp.) (Ectoparásito) de 11 a 161, 5- Pr (Pratylenchus sp.) (Endoparásito migratorio) de 0 a 53, y 6 Ty (Tylenchus spp.) (Vida libre) de 0 a 38. En raíces las poblaciones de nematodos en N° /10 g fueron: 1- Rh de 0 a 11, 2- Ap de 0 a 2 y 3- Ty de 0 a 4. Los resultados mostraron diferencias significativas entre los seis grupos de nematodos, entre las tres evaluaciones, y entre los ocho tratamientos, en general las poblaciones nematológicas disminuyeron desde la primera a tercera evaluación, y las mayores poblaciones correspondieron a Rh en los no parásitos, y a Tch en los parásitos de plantas. Los mejores tratamientos para Tch fueron el 1 (Despunte a 65 dds x 2 plantas) y el 4 (Despunte a 95 dds x 3 plantas) y para rendimiento de grano el 2 (Despunte a 65 dds x 3 plantas). Al no haberse detectado nematodos parásitos en raíces la tendencia de los niveles poblacionales de los nematodos en suelos fue a la disminución se podría considerar al pallar como un cultivo tolerante a los nematodos parásitos de plantas en Ica, y por lo tanto debería de considerarse dentro de un programa de rotación de cultivos temporales.

- Juan C. Magunacelaya

Meloidogyne ethiopica, debido a su agresividad es el nematodo más importante en la vitivinicultura chilena, y el cv. Chardonnay la variedad que más se afecta por este nematodo. Se evaluó la eficacia nematicida de fluazaindolizina (Salibro™), a dosis de 2, 3, 4, 5 y 2+2 litros/ha, y su efecto sobre raíces, rendimiento y aspectos vegetativos en plantas de vid cv. Chardonnay. Todas las dosis de Salibro™ mantuvieron las poblaciones de Meloidogyne ethiopica deprimidas durante el estudio. El mejor tratamiento de Salibro™ sobre los nematodos fitoparásitos fue con la dosis alta (4 y 5 L/ha), y cuando se aplicó dos veces con 32 días de diferencia. En la segunda temporada SalibroTM disminuyó las poblaciones de M. ethiopica a menos de 100 J2/250 mL de suelo. Los tratamientos de Salibro™ también mantuvieron bajas las densidades de Mesocriconema xenoplax, Paratylenchus sp y Xiphinema americanum. La calidad de las raíces mejoró en proporción al incremento de dosis de Salibro™. En la segunda temporada los tratamientos de SalibroTM incrementaron los beneficios en aspectos vegetativos. En la primera temporada (2016-2017) no hubo diferencias en fruta, pero en la segunda temporada (2017-2018), los tratamientos de Salibro™, presentaron mejor rendimiento que el testigo no tratado y el testigo químico, lo que se correlacionó con mejora de raíces. El producto Salibro™ no presentó síntomas de fitotoxicidad. El producto SalibroTM demostró excelentes cualidades como protector de las raíces y como nematicida sobre los nematodos fitoparásitos más importantes en la agricultura de Chile.
nemátodos fitoparásitos, si se utiliza de la manera adecuada, de dosis y concentración de ingrediente activo en solución, en los estanques de aplicación o en los sistemas de riego tecnificado. Esto se puede lograr capacitando técnicos que guíen a los productores agrícolas y decidan hacer uso del producto, en fechas adecuadas para uso, concentraciones a las que el producto debe ser aplicado desde los sistemas de riego tecnificado y condición de humedad del suelo de acuerdo a su tipo que mejora la eficacia del producto. La mejora en la calidad de las raíces evaluada en cada fecha de muestreo, se tradujo en incremento del material vegetativo expresado como peso de poda, y en la fruta cosechada de la segunda temporada.

- Tim C. Thoden

SALIBRO™ - A NOVEL SULFONAMIDE NEMATICIDE - AND ITS COMPATIBILITY WITH VARIOUS SOIL HEALTH RELATED ORGANISMS [SALIBRO™ - UN NUEVO NEMATICIDA SULFONAMIDA - Y SU COMPATIBILIDAD CON VARIOS ORGANISMOS BENÉFICOS DEL SUELO]. T. C. Thoden1, C. Vassallo2 and J. A. Wiles3. 1Corteva Agriscience™, Agriculture Division of DowDuPont, Truderinger Str. 15, 81677 München, Germany. 2Carlos Vassallo, Corteva Agriscience™, Agriculture Division of DowDuPont™, Dow AgroSciences, Boulevard Cecilia Grierson 355, Dique IV, Piso 25, Puerto Madero (C1107CPG), Buenos Aires, Argentina. 3Corteva Agriscience™, Agriculture Division of DowDuPont™, CPC2 Capital Park, Fulbourn, Cambridge, CB21 5XE, England. tim.thoden@dupont.com.

Healthy soils are an important factor in reducing soilborne plant diseases and supporting plant growth. This has been linked to well-developed soil food webs (e.g. different nematode feeding groups), the presence of natural antagonists (e.g. nematophagous fungi), as well as plant growth promoting microbial organisms such as mycorrhizal fungi (AMF) or plant growth promoting bacteria (PGPR). The integrated management of plant-parasitic nematode populations can highly benefit from these natural antagonists and plant symbionts.

Consequently, it’s important to understand how soil applied nematicides interact with organisms that contribute to the overall soil health network and to include both into an integrated nematode management approach. Salibro™ is a novel sulfonamide nematicide containing the active ingredient fluazaindolizine (Reklemel™ active) that has been developed by Corteva Agriscience™ and which has shown excellent control of plant-parasitic nematodes in hundreds of field trials around the globe. During its development, we also thoroughly investigated its effects on various players within the soil health complex and evaluated its compatibility with commonly used antagonists of plant parasitic nematodes, plant diseases and insects. Some results of those studies will be shown in this presentation.

- Julian Mejía
According to the Food, Agriculture and Fishing Information Service SIAP in Mexico, this country is the largest exporter of tomato, second largest exporter of chili and third largest exporter of cucumber in the world. Production of these crops is highly threatened by the damage of plant-parasitic nematodes, with the root-knot nematode “RKN” *Meloidogyne* spp. being the most important in terms of economic losses. Market research in 2017 in the main vegetable producing regions in Mexico concluded that more than 75% of vegetable growers are highly dependent on nematicides and need several applications of chemical and biological products to deal with this pest. Corteva Agriscience™, the Agriculture Division of DowDuPont, has discovered and developed the novel sulfonamide nematicide Reklemel™ active (fluazaindolizine, ISO name), offering a new solution for the management of plant-parasitic nematodes. Reklemel™, besides controlling plant-parasitic nematodes, has a favorable toxicological and ecotoxicological profile and is very gentle with many other beneficial organisms or bioagents occurring in or applied to the soil, and therefore can be an important tool for nematode management in Mexican export crops. Reklemel™, formulated as Salibro™ 500 SC nematicide, has been broadly tested for the control of RKN in tomato, chili and cucumber crops in both protected and open field conditions, and with a variety of application timings in Mexico. This paper will summarize trends in nematode management in Mexico and highlight trial results with Salibro™ in key export crops, as a new tool to improve crop establishment and a foundation for integrated nematode management programs.

- **Carlos Vassallo**
In Brazil, row crops such as soybean and sugarcane can sustain significant yield losses due to infestation by root-knot and root lesion nematodes. In soybean, integrated nematode management relies primarily on resistant varieties, nematicide seed treatments, biological control agents, crop rotation and some limited use of soil-applied nematicides. Whereas in sugarcane nematode control is mainly dependent on the use of antagonistic plants (e.g. Crotalaria spectabilis), application of organic waste products (e.g. vinasse and filter cake) as well as the infurrow application of nematicides. Salibro™, a novel sulfonamide nematicide containing the active ingredient fluazaindolizine (Reklemel™ active) is currently being developed by Corteva Agriscience™, Agriculture Division of DowDuPont in Brazil for use in these crops. With its remarkable toxicological and environmental profile Salibro™ can become a new, sustainable part of integrated nematode control in these crops. Trials conducted across multiple years, in agriculturally important regions of Brazil, and in varying levels of pressure, have measured the efficacy of Salibro™ against *Meloidogyne javanica* and *Pratylenchus brachyurus* in soybean and *Pratylenchus zeae* in sugarcane. Treatments were applied infurrow at planting at a spray volume of 150 L ha⁻¹ for sugarcane and 40 L ha⁻¹ for soybean. Crop-relevant parameters including yield, root damage and nematode root counts were assessed to determine the efficacy of the treatments as compared to local standards. Overall, Salibro™ applied infurrow at-planting, reduced the number of nematodes in the roots, demonstrated benefits in root vigor and contribute to increased yield in soybean and sugarcane. The results of these trials will be discussed in this paper.

- Catherine L Wram

**DIFFERENTIAL RESPONSE OF PLANT-PARASITIC NEMATODES TO THE NEMATICIDE FLUAZADIOZINE** [RESPUESTA DIFERENCIADA DE NEMATODOS FITOPARÁSITOS AL NEMATICIDA FLUAZADIOZINE]. C. L Wram and I. A. Zasada. Department of Botany and Plant Pathology, Oregon State University, Corvallis, Oregon 97331 USA; Agriculture Research Service, USDA, Corvallis, Oregon 97330 USA. wramc@oregonstate.edu.

Although widespread and economically important, there are few control measures to combat plant-parasitic nematodes (PPN). To fill this void, there are several newly discovered nematicides. To ensure these compounds longevity, more information is required regarding the impacts of these compounds on reproduction and mobility of different PPN genera. In this study, a microwell assay system was used to generate 24-hr dose-response curves for four PPN genera exposed to the nematicide, fluazaindolizine. Dose-response curves were generated for second stage juveniles (J2) of three Meloidogyne species (*M. incognita*, *M. chitwoodi*, and *M. hapla*); additionally, 3 and 6 geographically distinct populations of *M. chitwoodi* and *M. hapla*, respectively, were included.
The response of one population each of Pratylenchus neglectus (mixed stages), Globodera ellingtonae (J2), and Xiphenema americanum (mixed stages) were also determined. The 24-hour effective dose (ED) of fluazaindolizine that resulted in the immobility of 25%, 50%, 75%, and 100% of M. incognita J2 (ED25, ED50, ED75, and ED100) were then used to expose J2 of M. incognita, M. hapla, and M. chitwoodi for 24-hrs. Exposed J2 were then inoculated on a susceptible tomato ‘Rutgers’ to quantify reproduction post exposure. Meloidogyne incognita was the most sensitive to fluazaindolizine, with an ED50 2X lower than M. chitwoodi, and 3X lower than M. hapla. Pratylenchus neglectus seemed unaffected by fluazaindolizine with a predicted ED50 of >90,000 ppm. A 24-hr exposure to fluazaindolizine ED25, ED50, ED75, and ED100 were effective in preventing reproduction of M. hapla and M. incognita, but were ineffective against M. chitwoodi.

- Tristan Watson

EVALUATION OF FLUOPYRAM AS A RESCUE NEMATICIDE FOR MANAGING STING NEMATODE (Belonolaimus longicaudatus) ON STRAWBERRY IN FLORIDA [EVALUACIÓN DEL FLUOPYRAM COMO NEMATICIDA RESCATE PARA EL MANEJO DEL NEMATODO Belololaimus longicaudatus EN FLORIDA]. T. T. Watson1, J. W. Noling 2 and J. A. Desaeger1.1 University of Florida, Department of Entomology and Nematology, Gulf Coast Research and Education Center, Wimauma, Florida, 33598, United States.2 University of Florida, Department of Entomology and Nematology, Citrus Research and Education Center, Lake Alfred, Florida, 33850, United States. tristan.watson@ufl.edu.

In Florida, plant-parasitic nematodes are one of the main limiting factors for economically successful production of strawberry. Sting nematode (Belonolaimus longicaudatus Rau) is widely distributed within the sandy soils of Central Florida's strawberry production region and causes significant injury to strawberry. A relatively new tactic for nematode management is the use of synthetic non-fumigant nematicides with an in-crop application label, such as fluopyram. In the 2017 - 2018 growing season, drip application of fluopyram at transplant followed by 40 days after transplanting at a rate of 0.5 L/ha increased fruit yield and reduced sting nematode populations in soil. In the 2018 - 2019 growing season the fluopyram was evaluated as an in-crop rescue nematicide for managing sting nematode on commercial strawberry farms. Fluopyram was drip applied at seven commercial strawberry farms into nine fields with a history of sting nematode infestation, or where the nematode had subsequently been detected during the growing season. Soil treatments were arranged in a randomized paired design, with plots consisting of entire planting rows. The soil treatments were: (1) untreated soil, or (2) fluopyram (0.5 L/ha) applied through the grower's irrigation system. At two farms, fluopyram reduced population densities of sting nematode one month after application. At two different farms, post-application nematode population densities did not differ between the soil treatments; however, plant vigor was increased in the fluopyram treated soil. Results from the end-of-season soil
sampling will be discussed. Overall, fluopyram shows potential as a rescue nematicide for managing soilborne disease on strawberry in Florida.

- **Yuji Oka**

**ARE INACTIVE SECOND-STAGE JUVENILES OF Meloidogyne SPP. MORE TOLERANT TO FLUENSULFONE?** [SON LOS JUVENILES SEGUNDO ESTADO DE Meloidogyne SPP. MAS TOLERANTES AL FLUENSULFONE?]. Y. Oka. Gilat Research Center, Agricultural Research Organization, M.P. Negev 8528000, Israel. okayuji@agri.gov.il.

Efficacy of nematicides can be affected by environmental factors and nematodes' physiological state. Inactive nematodes, such as those in quiescence or at low temperatures, seem to be more tolerant to nematicides than active ones. Second-stage juveniles (J2) of Meloidogyne hapla and M. javanica were exposed to five concentrations of fluensulfone at 5, 15 and 25 °C for 24 and 48 h, and immobilized J2 (%) was recorded after exposure followed by incubation in water. Lettuce seedlings were inoculated by treated and untreated J2, and the number of root galls was counted. J2 of both species became 100% inactive in water at 5 °C. Incubation of M. hapla and M. javanica in water at 15 °C immobilized 26 and 92% of J2, respectively. Decreasing temperature lowered the percentage of immobilized nematodes in fluensulfone solutions, and increased the number of root galls on lettuce seedlings. The increase in the number of root galls at 15 and 5 °C was greater with M. javanica than M. hapla, which is more active at 15 °C. EC50 of fluensulfone for reduction in root galls by 50% at 15 and 5 °C were higher by 8.9- and 19.6-fold for M. javanica, and 2.1- and 5.6-fold for M. hapla than that at 25 °C. These differences in changes of EC50 between the nematodes may be caused by the difference in their optimum temperatures. Effect of fluensulfone on J2 immobilized by other methods will be discussed.

- **Marisol Quintanilla**

**NEMATICIDE AND CROPPING SYSTEM PRACTICES EVALUATION ON PLANT PARASITIC NEMATODES AND SOIL HEALTH** [EVALUACIÓN DE NEMATICIDAS Y PRÁCTICAS DE SISTEMAS DE CULTIVO EN LOS NEMATODOS FITOPARASITOS Y BENÉFICOS]. M. Quintanilla, E. Cole, K. Poley and B. Levene. Michigan State University, Entomology Department, East Lansing, MI. Marisol@msu.edu.

Plant parasitic nematodes (PPN) limit yields in crops in Michigan and USA. Soybean Cyst Nematode (SCN) is considered to be the most damaging pathogen in N. America. Root lesion nematode (RLN) and Northern root knot nematode (NRKN) are common in crops and cause yield losses. The Michigan Applied Nematology lab has conducted trials to evaluate the effect of cropping systems on these nematodes and soil health to provide applied solutions. We have evaluated compost and manures, nematicides and seed treatments, rotations of SCN resistant varieties, surveys of vegetable and field crops, and evaluation of cover crops. A compost blend by Morgan Composting has resulted in death of RLN in lab trials, even in concentrations as low as 5%. An SCN trial identified a reduction of SCN juveniles after the incorporation of two tons/acre of chicken manure ahead
of corn. Several nematicides have been evaluated, and results detected for PPN control. Conversely, we rarely observed a reduction of nematodes (i.e. SCN or Beet Cyst Nematode (BCN)) with seed treatments with the exception of a trial with Abamectin.

We have looked at rotation of resistant varieties. Rotating sources of resistance for SCN resulted in a reduction of SCN and yield increases. We have conducted two state-wide surveys in vegetables and field crops. Some conclusions: NRKN nematode where low in soil from vegetable fields rotated with com. Cover crops increased beneficials. In the field crops survey, we are correlating tillage and soil type with com needle nematode. Finally, cover crops are being evaluated for host status to PPN and soil health.

- Karen R. Barzola


En el presente estudio se evaluó el efecto del producto Blocker, que contiene enzimas proteasas como ingrediente activo sobre *Meloidogyne incognita* en *Capsicum annum* cultivar Paprika. El diseño experimental fue al azar con cuatro tratamientos y seis repeticiones. Los tratamientos fueron Blocker (1 kg de extracto + 2 L de activador/200 L), Oxamyl (3 L/200L), testigo *M. incognita* sin nematicida y testigo absoluto (sin inoculación). Las plántulas de *C. annum* de 35 días de edad se sembraron en bolsas que contenían 4 kg de una mezcla de arena, musgo y humus de lombriz. Cada bolsa se inoculó con 4 000 huevos de *M. incognita*. Sesenta días después de la inoculación, se determinó la densidad poblacional de nematodos en 100 cc de suelo, el número de huevos y juveniles en 5 g de raíz y el índice de nodulación. Además, se evaluaron parámetros biométricos de las plantas. Blocker redujo el número de juveniles (J2) en 100cc de suelo en 45,5% (P=0.01) y el número de huevos en las raíces en 27% (P=0.01). Así mismo, el número de nódulos por gramo de raíz, en plantas tratadas con Blocker fue menor (P=0.01) y representó solamente el 10.9 % de lo determinado en las plantas sin tratamiento. Además, favoreció la altura de planta en 4,07 cm; la longitud de raíces en 5,19 cm; el peso fresco y seco del follaje en 16,34 y 7,1 g y el peso fresco y seco de raíces en 6,8 y 0,73 g respectivamente, con respecto al tratamiento testigo (*M. incognita* sin nematicida).

- Roy Artavia-Carmona

Las pérdidas económicas en la producción de café debido a nematodos fitoparásitos se estiman de un 10 a un 25%. El combate de nematodos es complejo y se necesita integrar diferentes técnicas para reducir las poblaciones a niveles que no afecten los sistemas radicales de las plantas. Determinar líneas con capacidad de resistencia o tolerancia a nematodos es necesario en programas de mejoramiento genético. Se evaluaron variables de crecimiento del cafeto como altura de planta (cm), diámetro del tallo (mm) y número de hojas, a 120 días después de la inoculación. Además, se evaluaron el Índice de Agallamiento Radical (ÍAR), peso fresco del sistema radical, densidades poblacionales y el Factor de Reproducción (FR). Se observaron diferencias significativas tanto entre líneas como entre tratamientos (inoculado y sin inocular). En la variable altura de planta, el testigo Caturra (CT) presentó la menor altura en ambos tratamientos (inoculado 7.27 cm y sin inocular 10.84 cm). Al comparar solo las líneas San Isidro (SI) (derivadas del Sarchimor T5296), para tratamiento inoculado, la SI35 fue la mejor con altura de planta de (12.5 cm), mientras tanto la que creció menos en presencia de nematodos fue la SI34, (9.31 cm). Para la variable diámetro de tallo, no se presentaron diferencias significativas. Para la variable ÍAR, el porcentaje de severidad mostró que la línea SI35 fue la menos agallada (5.3%), comportamiento del genotipo “resistente” mientras tanto la SI34, fue la más agallada (59.9%), comportamiento “susceptible”. En la variable peso fresco de sistemas radicales, la línea SI27 presentó el mayor peso radical (6.1 g), mientras tanto el testigo, tuvo el menor peso promedio de raíces (2.6 g). Los conteos poblacionales de nematodos en raíces, presentaron diferencias estadísticamente significativas (P<0.05), la SI35 fue la que presentó en promedio menor cantidad de nematodos con 168, mientras tanto la SI34, presentó un promedio de 1 436 juveniles. Con la variable FR, las líneas SI35, SI31 y SI32, se comportaron como resistentes, mientras tanto las líneas SI27, SI34 y Caturra, resultaron ser susceptibles, según la clasificación de Oostenbrink. La línea más promisoria para futuras investigaciones fue la SI35, ya que mostró las características más sobresalientes en las variables evaluadas.

Simposio de banano / Banana Symposium

Mario Ayaya

- “Frecuencias y densidades poblacionales de nematodos fitoparásitos en plantaciones de banano (Musa AAA) en Honduras durante los años 2010 a 2016/ Frequencies and population densities of plant-parastic nematodes in banana (Musa AAA) plantations in Honduras during the years 2010 to 2016"
An analysis of plant-parasitic nematodes occurring in the commercial banana (Musa AAA) farms in Honduras from 2010 to 2016 was undertaken. Nematode extraction was done using 25 g of fresh roots macerated in a kitchen blender followed by sugar-centrifugal flotation recovering the nematodes with a 0.038 mm sieve. The data were subjected to frequency analysis in PC-SAS and the absolute frequency for each genus was calculated as a percentage (number of samples containing a species / numbers of samples collected) * 100. Four plant-parasitic nematode species were detected and based on their frequencies and population densities their relative importance was established as: Helicotylenchus multicinctus > Pratylenchus spp. > Radopholus similis > Meloidogyne spp. Helicotylenchus multicinctus and Pratylenchus spp. were the most abundant species, accounting for 17.9 to 72.1% and 11.6 to 55.3%, respectively, of the overall root nematode population throughout each study year. From a total of 425 root samples, 320 (75%) contained H. multicinctus, 249 (59%) Pratylenchus spp., 248 (48%) Meloidogyne spp., 172 (40%) R. similis, and when the nematodes present in the samples were pooled (total nematodes) only 3 (0.7%) of the samples were free of nematodes. A larger number of samples with a nematode population above the economic threshold suggested by the laboratory of 1,000-2,000 (for this extraction procedure) nematodes per 100 g of roots were observed in all the years, months and the two sampled Departments where bananas are grown in Honduras. Statistical differences were detected for the frequencies among the years (P<0.0001), and months (P<0.0001), and between departments (P<0.0001) in most of the nematode genus detected.
AMVAC Chemical Corporation. 4Catedrático Universidad Nacional, Escuela Ciencias Agrarias, Costa Rica. maraya@life-rid.com

In a randomized complete block design with six treatments and six replicates, the nematicide rotation in different applications per year were evaluated. Treatment one and two, consisted of two different nematicide rotations per year, three and four, consisted of three different nematicide applications per year, in five, nematicide application was based on nematode economic threshold, and six the untreated control. Root samples from three follower suckers in each repetition, were taken before treatment application, and then, every 30 days until the 24 months that the experiment lasted. Three harvests were done.

Averaging the 24 root nematode samplings, the nematicide applications (WICH TREATMENTS?) reduced R. similis (P< 0.0007) from 20 to 49%, Helicotylenchus spp. (P<0.0001) from 31 to 51% and total nematodes (P<0.0001) populations from 29 to 49% Accordingly, in the treated plants there was an increase of 16-21% in FUNCTIONAL? Live root weight (P= 0.0003), and its percentage (P< 0.0001) from 74.5 to 81.7% in the follower suckers, and NON-FUNCTIONAL? death of roots by nematodes was decreased (P= 0.0009) from 20 to 46%. At harvest, nematicide applications increased bunch weight (P= 0.0002; P= 0.0467), ratio (P= 0.0003 at 12 months), ratooning (P< 0.0001; P< 0.0001) and the number of BOXES? of 18.14 kg (P<0.0001; P= 0.0005) ha-1 year-1 at 12 and 24 months after treatment application, respectively. Plants treated with nematicides increased from 671 to 1,158 (12.2-21.0 tm) and 545 to 1,046 (9.9-19.0 tm) BOXES? of 18.14 kg ha-1 year-1 at 12 and 24 months after treatment application, respectively.

Randall Vargas

- “Eficacia de VERANGO® 50 SC (FLUOPYRAM) en el combate de nematodos, la producción de plantaciones de banano (Musa AAA) subgrupo CAVENDISH y la reducción de la carga química / EFFICACY OF VERANGO® 50 SC (FLUOPYRAM) IN THE CONTROL OF NEMATODES, PRODUCTION OF BANANA PLANTATIONS (Musa AAA) CAVENDISH SUB-GROUP AND REDUCTION OF CHEMICAL LOAD"
fluopyram has been used. An experiment was performed in a commercial banana plantation. A randomized complete block design with 5 replicates was used. The doses by production unit (PU) used were 0.6 ml fluopyram 50 SC (F), 10 ml oxamyl 24 SL (O) and untreated control (UTC). During seven months fluopyram showed the highest weight (P= 0.0512) and percentage (P= 0.0009) of functional root and the lowest (P≤ 0.0001) number of R. similis and total nematodes. Untreated control showed 22,145 R. similis/100 g root and were reduced in 48 and 68% with O and F, respectively. Plants applied with O and F increased (P= 0.0032) bunch weight from 1.5 to 1.7 kg, respectively, compared with UTC. In addition, in pits (60x40x60 cm) fluopyram increased the weight (P≤ 0.0337) and percentage (P≤ 0.0796) of functional root to 0-10, 11-30 and 31-60 cm depth, respect to UTC. From 2014 to 2018 in commercial banana plantations 141,322 ha have been applied with fluopyram, 141,322 L of commercial product (CP) and 70,661 L of active ingredient (AI) were used. If in this same area an organophosphate (15 GR) had been applied to 20 g of CP per PU (3 g of AI), instead it would have been applied 34 and 10 times more CP and AI, respectively. The use of F represented a reduction of 97% in CP and 90% in AI. Thus, fluopyram is a good option to control nematodes, improve production, reduce chemical load, protect the environment and reduce occupational exposure.

Pedro Emilio Torres

- “Oportunidades para el manejo integrado de la sanidad radical del banana Musa AAA cv Grande Naine, mediante estimulación microbiana del suelo y su entorno / Opportunities for the integrated management of the root health of the banana Musa AAA cv Grande Naine, by microbial stimulation of the soil and its environment”


Un sistema radical sano y funcional en la planta de banana es una necesidad primaria. Tradicionalmente, su manejo se ha focalizado en agentes químicos convencionales para combatir los nematodos parásitos de la raíz. La Corporación Bananera Nacional (CORBANA), en sus objetivos estratégicos, apuesta al fortalecimiento de la salud del suelo y al incremento de su diversidad microbiológica, para estimular el sistema radical y activar la potencial supresividad natural presente en los suelos bajo un apropiado esquema de manejo. Al respecto, se realizó una investigación para evaluar estimulantes biológicos del sistema radical. En condiciones de invernadero en suelo no estéril, con plantas in vitro de banana cv Grande Naine en fase IV y con un diseño completamente al azar y 15 repeticiones, se evaluó contra un testigo el efecto de
dos rizoestimulante ensilados con microbiota tanto de suelo supresivo como de suelo conducente, sobre los nematodos y la sanidad radical. Al final fue posible transferir y estimular la microbiota supresora mediante la aplicación de dichos rizoestimulantes biológicos. Con esto se redujo el número de R. similis hasta en un 83% (P < 0,0001) y se incrementó la biomasa con respecto al tratamiento testigo. En una finca comercial, durante tres años, se incorporó trimestralmente al suelo, en frente del hijo de sucesión: polvo de piedra, biocarbón, compost y ensilados con microbiota nativa. Se compararon contra un tratamiento testigo absoluto y el Vydate Azul 24SL® (oxamil). Se obtuvo incremento del peso de raíz total y funcional y el porcentaje de raíz funcional en 10, 17 y 3% respectivamente (P ≤ 0,0051), con respecto al tratamiento testigo. Las variables de biomasa (peso de racimo, número de manos) no difirieron del tratamiento convencional. No se encontraron diferencias (P> 0,0500) en el peso de racimo, ni el número de manos entre los rizoestimulantes y el Vydate.

Danny Coyne

- “Dinámica de nematodos plaga en banano, plátano y enset en áfrica y su manejo / Nematode pest dynamics on banana, plantain and enset in africa and their management”

NEMATODE PEST DYNAMICS ON BANANA, PLANTAIN AND ENSET IN AFRICA AND THEIR MANAGEMENT [DINÁMICA DE NEMATODOS PLAGA EN BANANO, PLÁTANO Y ENSET EN ÁFRICA Y SU MANEJO]. Danny Coyne. International Institute of tropical Agriculture, Kasarani, P.O. Box 30772-00100, Nairobi, Kenya d.coyne@cgiar.org.

Banana, plantain and enset are important staple food sources in sub-Saharan Africa, which millions of people across the region are dependent on for food and income. Plant parasitic nematodes are a major threat to their production however, reducing yields, extending production cycles and shortening plantation longevity. Although our knowledge and understanding of plant parasitic nematodes remains limited for some crops in Africa, their characterisation and distribution banana, plantain and enset is quite well documented, in comparison for some crops. The community profiles tend to differ however, between lowland plantain dominated areas in West Africa and Highland cooking banana and enset areas in East and Central Africa. But a gradual shift in the dominance and composition of nematode species appears to be occurring. Traditionally the burrowing nematode, Radopholus similis, a thermophilic species has been a major pest. At higher cooler altitudes the less aggressive thermophobic lesion nematode Pratylenchus goodeyi, tends to replace R. similis. However, this species is being increasingly recovered from lowland, tropical areas and the relative dominance of R. similis appears to be gradually being replaced by Pratylenchus species across the continent. The implications of this shift and temperature tolerances are
discussed in relation to nematode management efforts, such as breeding for resistance, biological control and through transgenic options.

Free-living soil nematode diversity has scarcely been explored in Mexico. Only two studies related with nematode communities in Mexican soils have been published. After a thorough research it was found that there is one work that dates back to the eighties and contains unpublished data on the presence of 50 genera of soil and plant parasitic nematodes associated with roots of an extensive variety of crops from the Western region of the State of Michoacán. The second work recently published records data and diversity analyses of nematodes associated with both disturbed and undisturbed rainforest in Los Tuxtlas rainforest, Veracruz that includes 124 genera belonging to 53 families. A third work from Central Mexico where includes 41 genera, belonging to 29 species and 22 families. The present work includes new data from two additional regions in Central Mexico. The first region, a former pine-oak forest severely disturbed by goat grazing activities now a recreative park that sits in the bottom of an extinct ancient volcanic cone in Joya-La Bamera.
Park in Querétaro and a second region from the southernmost North American desert that sits in the Biosphere Reserve of Valle de Tehuacán-Cuicatlán in Puebla. Approximately 65 genera and up to 70 genera have been found in these two regions, respectively. Dominant genera seem to be vary according to vegetation types or managed agricultural sites during distinct seasons of the year.

Thomas Powers

- “Código de barras del ADN como herramienta para el diagnóstico de nematodos, el descubrimiento de especies y la distribución de mapeos / DNA barcoding as a tool for nematode diagnostics, species discovery, and mapping distribution”

DNA BARCODING AS A TOOL FOR NEMATODE DIAGNOSTICS, SPECIES DISCOVERY, AND MAPPING DISTRIBUTION [CÓDIGO DE BARRAS DEL ADN COMO HERRAMIENTA PARA EL DIAGNÓSTICO DE NEMATODOS, EL DESCUBRIMIENTO DE ESPECIES Y LA DISTRIBUCIÓN DE MAPEOS] T. Powers, T. Harris, R. Higgins, P. Mullin, and K. Powers. Department of Plant Pathology, University of Nebraska – Lincoln, Lincoln, NE, USA. tpowers1@unl.edu.

DNA barcoding using the mitochondrial gene COI is increasingly being applied to questions of nematode species identity and distribution. As a diagnostic marker, the COI gene was instrumental in the discovery of Heterodera medicaginis, the alfalfa cyst nematode, in western US agricultural regions. These irrigated production areas had previously been surveyed and collection records indicated the presence of Heterodera schachtii, the sugar beet cyst nematode, Heterodera avenae, the cereal cyst nematode, and unverified reports of Heterodera glycines, the soybean cyst nematode. In this case, it was the initial observation of a unique DNA sequence within the context of a reference database and the construction of a phylogenetic tree that led to species discovery. Similarly, a DNA barcoding survey of the central Great Plains Region of the US has revealed that a minimum of 14 Pratylenchus species or haplotype groups exist in the region, but corn, soybean, and wheat production is dominated by just two species Pratylenchus neglectus and Pratylenchus scribneri. In corn-soybean rotations, both species are frequently observed in the same field. However, the increasingly common observation of undescribed taxa, in these and other DNA barcoding surveys, emphasizes the importance of constructing DNA reference libraries that are validated and representative of the geographic range of the taxa. The development of a COI reference library for the suborder Criconematina illustrates the advantages and difficulties associated with library construction.

Reyes Peña Santiago

- “Diversidad nematológica: ¿mito o realidad? / Nematode Diversity: Myth or truth?”

NEMATODE DIVERSITY: MYTH OR TRUTH? [DIVERSIDAD NEMATOLÓGICA: ¿MITO O REALIDAD?] R. Peña-Santiago. Departamento de Biología Animal,
With 1.552.319 named species until 2011, animal diversity is the most important component of both continental and marine biodiversity. The contribution of the different animal phyla to animal diversity is, however, totally unbalanced. Only eight out of 38 animal phyla exceed 10.000 named species each and concentrate most animal taxa. With 24.783 named species, Nematoda are the fifth most diverse animal group, after Arthropoda, Mollusca, Craniata and Platyhelminthes. Nevertheless, the existing nematode diversity of the group has been matter of controversy and frequent speculation, with estimations ranging from half a million to one hundred millions species. Thus, if only one of these estimations is approximate, Nematoda would be the second richest animal phylum. The point is, however, that such estimations are based on subjective appreciations rather than the result of rigorous analyses. This contribution provides new insights for a more reliable estimation of nematode diversity by studying available information about species richness of relevant representative taxa, in particular the genera Bursaphelenchus, Meloidogyne, Steinemema, Xiphinema and the entire order Dorylaimida. In all the cases, the number of species described per year reached its maximum at the second half of the past century, but underwent an appreciable decrease at the end of the millennium, a trend that continues nowadays. It means that a more precise extrapolation might be done now to elucidate the existing nematode diversity.

Nevertheless, the impact of the so-called ‘taxonomic impediment’ on the reliability of available data is also a serious handicap to go further in this extrapolation.

Alejandro Esquivel

- "Reseña histórica de la diversidad nematológica descubierta en Costa Rica / Historical overview of nematological diversity discovery in Costa Rica."


Costa Rica es reconocida a nivel mundial por su rica biodiversidad. En las últimas dos décadas, se han realizado avances importantes en los inventarios de diferentes grupos de animales y plantas. Los nematodos también han sido objeto
de estudio, no obstante, el conocimiento de la diversidad nematológica del país ha avanzado lentamente. La primera especie nueva descrita en Costa Rica fue Xiphinema costaricense n. sp. por Lamberti y Tarjan en 1974. Dieciséis años después de este primer descubrimiento, el país apenas registraba 8 especies de nematodos nuevas para la ciencia, siete de las cuales correspondía a nematodos fitoparásitos. La creación del Instituto Nacional de Biodiversidad (INBio), responsable de desarrollar y ejecutar el inventario nacional de biodiversidad y descubrir usos sostenibles de la riqueza biológica, dio un enorme impulso al conocimiento de la nematofauna costarricense. El inventario actualizado de los nematodos de Costa Rica registra 209 géneros y 219 especies detectadas a la fecha, con 5 géneros y 60 especies nuevas para la ciencia. De las especies nuevas 60% pertenecen al orden Dorylaimida, 15% Tylenchida, 9,0 % Rhabditida, 6,7 % Araeolamida, 3,4 % Mononchida, 3,4 % Enoplida y 1,7 % Aphelenchida. El conocimiento taxonómico de familias, géneros y especies, son la base para la implementación de estudios ecológicos con nematodos en ambientes tropicales y para la identificación de los principales géneros y especies de nematodos fitoparásitos asociadas a cultivos de importancia agrícola en Costa Rica.

**Wilfrida Decraemer**

- "La diversidad oculta en TRICHODORIDAE: estado del arte en la familia vectora de virus / The hidden diversity in TRICHODORIDAE: state of the art on the virus-vector family"

**THE HIDDEN DIVERSITY IN TRICHODORIDAE: STATE OF THE ART ON THE VIRUS-VECTOR FAMILY.** [LA DIVERSIDAD OCULTA EN TRICHODORIDAE: ESTADO DEL ARTE EN LA FAMILIA VECTORA DE VIRUS] W. Decraemer1 and S. A. Subbotin2. 1 Ghent University, Department of Biology, Belgium; 2 California Department of Food and Agriculture, Sacramento, CA, USA. wilfrida.decrarem@ugent.be

In the 1950s, Trichodoridae were recognized as polyphagous root ectoparasites. Ten years later, their major pest status as vector of Tobraviruses became evident and boosted the interest in the family. This is reflected in the increase in species descriptions. By the end of the 20th century however, it became clear that the number of virus vector species (11%) is rather limited. This resulted in a decrease of interest for the family and reduction in species descriptions. Up to the end of last century, species descriptions were based on morphological and morphometric features. Identification of Trichodus, and even more so for Paratrichodus species, is hampered by the general difficulty to fix specimens properly, their largely conserved morphology and restricted number of diagnostic morphological features, overlap of measurements and co-occurrence of at least two species of the same genus in the same soil sample, often with a restricted number of specimens. In the last two decades, molecular analyses mainly based on nuclear ribosomal RNA genes (D2-D3 expansion segments of 28S and partial 18S gene)
clearly direct the comparative morphological study while morphology and
morphometric help the molecular research to interpret the results when dealing
with co-occurrence of several species. This more recent integrated approach
leads to the discovery of cryptic species and to interpret formerly described
species with wide range in diagnostic characters to represent species complexes.
It also provides a better insight in the relationships at genus level. We will illustrate
this using the Trichodorididae of California as case study.

Simposio Combate biológico y manejo integrado /
Symposium of Chemical and Integrated Management of
Nematodes

Aurelio Ciancio

- “Estudio metagenómico sobre antagonistas de nematodos del banano en las Islas
  Canarias / A metagenomic study of banana nematode antagonists in Canary
  Islands”

A METAGENOMIC STUDY OF BANANA NEMATODE ANTAGONISTS IN CANARY
ISLANDS [ESTUDIO METAGENÓMICO SOBRE ANTAGONISTAS DE NEMATODOS DEL
BANANO EN LAS ISLAS CANARIAS]. A. Ciancio1, M. Colagiero1, L. C. Rosso1, L.
Pentimone1 and J. López Cepero2. 1CNR, Istituto per la protezione sostenibile delle
piante, Bari, Italy. 2Coplaca, Tenerife, Spain. aurelio.ciancio@ipsp.cnr.it

A study was carried out on the ecology of microbial antagonists associated to
phytoparasitic nematodes of banana crops in Canary Islands, Spain. Samples
included rhizosphere soil from cv Pequeña enana and controls collected from
adjacent sites, without banana roots. Total RNA was extracted from soil and
retrotranscribed. To characterize bacterial communities, the variable V3 and V4
regions of the 16S rRNA ribosomal gene were amplified. The ITS region was used for
classification of fungal communities. Libraries were sequenced with an Illumina
MiSeq™ in paired ends with 300-bp read length, and analyzed with QIIME and
STAMP. Nematodes were extracted from soil by the sieving and decanting
technique, counted and identified with light microscopy.
Phytoparasitic nematodes were found mostly in banana rhizosphere. Pratylenchus goodeyi was present in 75% of samples from northern farms, at densities of 200-1750 specimens/100 cc soil, with lower prevalence (22%) and densities in the southern fields. Helicotylenchus spp. included H. multicinctus found in northern and southern farms. Metagenomic data showed several fungal OTUs belonging to Sordariomycetes, including Clavicipitaceae such as Pochonia chlamydosporia and Metarhizium anisopliae. Other taxa were Trichoderma harzianum, T. longibrachiatum, T. virens, Beauveria sp. and Fusarium spp., together with mycoparasites such as Acrostromus luteoalbus.

Dominant bacterial phyla were Proteobacteria, Actinobacteria, Planctomycetes, Bacteroidetes, Chloroflexi and Acidobacteria. Principal coordinate analysis of microbial communities showed a direct effect of cropping on the samples profiles. Beta-diversity also indicated latitude-related factors, that clearly separated northern and southern controls from banana rhizosphere samples.

Lee Simmons

- “Tendencias de los pesticidas biológicos en los Estados Unidos / Trends of biological pesticides in the U.S. market”

**TRENDS OF BIOLOGICAL PESTICIDES IN THE U.S. MARKET** [TENDENCIAS DE LOS PESTICIDAS BIOLOGICOS EN LOS ESTADOS UNIDOS]. L. J. Simmons and N. Balachander. AgBiome Innovations, Research Triangle Park, NC, 27709, USA. lsimmons@agbiome.com.

Availability and usage of biological products in U.S. agriculture continues to increase. Environmental sustainability, food safety, regulatory pressures, and other factors have led to biologicals being one of the fastest growing market segments of agricultural inputs, with some regions in the Americas trending over 15% market growth annually. Product segments including biofertilizers and biostimulants have arisen creating increased grower awareness of the soil microbiome, plant-microbial interactions, and the importance of soil health. Large, multinational pesticide corporations all have biological pesticides and products in their portfolios and are expanding their capabilities to produce and develop biological products. Regulators are adapting with new processes suited to biological products and growers are learning new ways to extract value from production with the use of these biological tools in addition to their existing practices. What once had limited acceptance, the entire U.S. agricultural market has now begun to implement biological inputs as standard practice in commercial production.

Luis Payan
BRINGING A NEW CROP PROTECTION PRODUCT TO THE MARKET [LLEVAR UN NUEVO PRODUCTO DE PROTECCIÓN DE CULTIVOS AL MERCADO]. **Luis A. Payan.** Syngenta Crop Protection, 410 Swing Rd, Greensboro, NC, USA. luis.payan@syngenta.com

Crop protection is one of the most highly regulated industries in the world. Development of a new product involves many steps: discovery and formulation of the product; trials and field development; toxicology—the study of the effects of the compound; environmental impacts; and final registration. To register a new product, we must show that it is safe for workers, for the environment, for the crops that are being protected, and for the food that is eventually eaten. Sophisticated risk assessments are undertaken and approximately 30% of the cost of a new active ingredient is spent on product safety. It takes a long time, and much effort and expertise, to get a crop protection product to market. When it is intended to solve the long-term needs of farmers, we must take advantage of the collective experience, as well as scientific and cultural knowledge, therefore the industry must work with a collaborative approach with universities, institutes of research and commercial organizations, in order to engage in a new type of dialogue with scientists and researchers. The next generation bio-controls are a new technology example that could bring significant benefits to farmers and the environment.

**Simposio de Genómica de Nematodos / Symposium of nematode genomics**

**Ethienne Danchin**

- “Que hemos aprendido luego de 10 años de genómica de nematodos formadores de agallas / What have we learned after more than 10 years of root-knot nematode genomics?”

WHAT HAVE WE LEARNED AFTER MORE THAN 10 YEARS OF ROOT-KNOT NEMATODE GENOMICS? [QUE HEMOS APRENDIDO LUEGO DE 10 AÑOS DE GENOMICA DE NEMATODOS FORMADORES DE AGALLAS]. **E.G.J. Danchin.** Institut Sophia Agrobiotech, INRA, Université Côte d’Azur, CNRS. etienne.danchin@inra.fr

Plant-parasitic nematodes are responsible for the destruction of ca. 11% of the worldwide lifesustaining crop production every year. Plant parasitism has evolved at least four times independently in the phylum Nematoda and the root-knot nematodes (RKN) are the most devastating of them. Curiously, the RKN that display the wider range of compatible host plants and the broader geographic distribution reproduce without sex and meiosis. This parasitic success without sex has long been considered an evolutionary mystery. In 2008, we coordinated the genome sequencing and analysis of the RKN Meloidogyne incognita, using 1st generation sequencing technology (Sanger). This was the first genome for a plant-parasitic animal and the first for a metazoan species reproducing without sex and
meiosis. In 2017, we published a more complete genome assembly for M. incognita and produced genome sequences for two other devastating asexually reproducing RKN, M. javanica and M. arenaria, using 2nd generation sequencing technology (illumina + 454). This provided the most comprehensive set of protein-coding genes for a plant-parasitic nematode and enabled comparative genomics analyses. However, because the genome assemblies were still fragmentary and far from chromosome-level resolution, structural genomics analyses and annotation of repetitive elements were still limited. We have recently deployed efforts to re-sequence RKN genomes using 3rd generation ONT long read technology, which already yielded remarkable progress in the contiguity of genome assemblies and opened new perspectives. In this presentation, I will summarize what the 1st, 2nd and 3rd generation genomics analyses have allowed to learn and understand about the genome structure of parthenogenetic RKN in relation to the evolution of plant parasitism and their surprising parasitic success despite their lack of sexual reproduction.

Inga Zasada

• “Como un nematólogo de campo utiliza herramientas de la genómica para abordar la investigación de nematodos fitoparásitos / How an applied nematologists uses genomic tools to address plant-parasitic nematode research”

HOW AN APPLIED NEMATOLOGISTS USES GENOMIC TOOLS TO ADDRESS PLANTPARASITIC NEMATODE RESEARCH [COMO UN NEMATOLOGO DE CAMPO UTILIZA HERRAMIENTAS DE LA GENÓMICA PARA ABORDAR LA INVESTIGACIÓN DE NEMATODOS FITOPARÁSTICOS]. I.A. Zasada. Agricultural Research Service, USDA, Corvallis, Oregon 97330 USA. inga.zasada@ars.usda.gov.

The advancements in molecular plant pathology have created an environment in which applied, field-based research programs have the opportunity to utilize genomic tools in their programs. There are potential rewards for incorporating genomics into a research program including enhanced nematode diagnostics, population genetics of infestations, and novel biological discoveries. However, along with these rewards come many considerations including cost, tempered expectations, and the capacity to generate and analyze data. A cautionary tale of such a journey will be presented. Efforts to characterize the nematode microbiomes from a diversity of plant-parasitic nematodes, understand the population genetics of a potato cyst nematode infestation, and sequence and annotate nematodes genomes will be presented to highlight the rewards and challenges of this type of research. Underpinning all of these efforts is the need to establish and maintain productive collaborations with scientists with diverse backgrounds.

Eric Grenier
MONITORING AND TACKLING GENETIC SELECTION IN THE POTATO CYST NEMATODE
Globodera pallida

E. Grenier1, S. Kiewnick2, G. Smant3, S. Fournet1, J. Montany1, M. Holtermann3, S. van de Elsen3, J. Helder3 and A. Goverse3. 1INRA UMR IGEPP - Institute of Genetic, Environment and Plant Protection – Domaine de la Motte, BP35327, 35653 Le Rheu, France; 2Julius Kühn Institute, Federal Research Centre for Cultivated Plants, Institute for Plant Protection in Field Crops and Grassland, Messeweg 11/12, 38104 Braunschweig, Germany; 3Wageningen University, Laboratory of Nematology, Droevendaalsesteeg 1, 6708 PB Wageningen, The Netherlands. eric.grenier@inra.fr

Management of plant pathogens is probably the most serious challenge in sustainable food production and the maintenance of food security. Due to the strict regulation of or ban on major categories of pesticide, the potato cyst nematode Globodera pallida has been managed by a combination of crop rotation and the potato resistance locus Grp1, a relatively narrow range resistance gene which was introgressed into a range of commercial potato cultivars in Europe. However, in 2014, G. pallida populations were described from Emsland (Germany) that can no longer be controlled by Grp1. Most likely similar highly virulent populations will also emerge in all major potato growing areas in North Western Europe where production practices are very similar. Except for laborious, costly and often moderately accurate pot experiments, there is currently no rapid and reliable method to identify virulent populations. This represents a strong limitation and prevents an accurate and durable management of infestations. The PALADAPT project funded by EFSA represents the first step of a European battle plan against the emergence of virulent G. pallida populations and aims at improving the methods and tools for a fast identification of virulence outbreaks. In this talk we will present results obtained on life history traits of these nematodes and answer the question whether resistance breaking populations present a fitness cost. We will also present data on recently identified DNA polymorphisms that can be useful to design molecular tools for an accurate virulence monitoring.

Sergei Subbotin

PHYLOGENY AND PHYLOGEOGRAPHY OF THE CYST NEMATODES FROM THE GENUS
Globodera

S. A. Subbotin1, J. Franco2, R. Knoetze3, T. V. Roubtsova4, R. M. Bostock4 and I. Cid Del Prado Vera5. 1Plant Pest Diagnostic Center, California Department of Food and Agriculture, 3294 Meadowview Road, 95832, Sacramento, CA, USA; 2NGO "BIOSOMA" (Biodiversity, Sustainability and
The genus **Globodera** presently contains fourteen valid and three still undescribed species. Three species, **G. rostochiensis**, **G. pallida** and **G. ellingtonae** are named as potato cyst nematodes and cause significant economic losses on potatoes around the world. In our study we provided comprehensive phylogenetic analyses of more than 380 ITS rRNA, 220 COI and 160 cytb gene sequences of 14 species from the genus **Globodera** using Bayesian inference, maximum likelihood and statistical parsimony. New gene sequences were obtained from 154 populations. The genus **Globodera** displayed two main clades in phylogenetic trees: i) **Globodera** from South and North America parasitizing plants from Solanaceae and ii) **Globodera** from Africa, Europe, Asia and New Zealand parasitizing plants from Asteraceae and other families. Based on the results of phylogeographical analysis and age estimation of clades with a molecular clock approach, it was hypothesised that the **Globodera** species was originated and diversified from several centers of speciation located in mountain regions and dispersed from these regions across the world. Possible pathways, including a long-distance dispersal via oceans and secondary centres of diversification are proposed and discussed. Analysis of phylogenetic relationships of **G. pallida** populations revealed incongruence of the COI and cytb gene trees, which might be the result of recombination and selective introgression of mtDNA through gene flow between previously isolated populations. It might limit the use of the mtDNA marker as universal DNA barcoding identifier for potato cyst nematodes.

**Benjamin Mimee**

- "Genómica del nematodo del quiste de la soya, formando soluciones futuras / Genomics of the soybean cyst nematode, shaping future solutions"

**GENOMICS OF THE SOYBEAN CYST NEMATODE, SHAPING FUTURE SOLUTIONS [GENÓMICA DEL NEMATODO DEL QUISTE DE LA SOYA, FORMANDO SOLUCIONES FUTURAS]. B. Mimee1, A.-F. Gendron St-Marseille1, P.-Y. Véronneau1, É. Lord1, V.-T. Boucher St-Amour1, G. Trépanier1, and R. Masonbrink2. 1Agriculture and Agri-Food Canada, St-Jean-sur-Richelieu Research and Development Centre, St-Jean-sur-Richelieu, QC, Canada J3B 3E6. 2Iowa State University, Ames, IA, USA. benjamin.mimee@canada.ca.

Soybean is the fourth most cultivated crop on earth and production has had a spectacular growth in some regions. For example, soybean acreage has increased 2.5-fold in the last 10 years in Canada. However, soybean cyst nematode (SCN), **Heterodera glycines**, threatens soybean production worldwide and is the most damaging pest of soybean in North America where it causes over $1.5 billion of losses each year. The main approach to tackle SCN is the use of resistant cultivars. However, a very limited number of lines is adapted to northern
conditions and the overuse of a single resistance source has led to the selection of virulent SCN populations. Using the latest genomic tools and modeling approaches, we have identified key elements to consider in developing novel management strategies. SCN populations were found to be very diverse, facilitating their adaptation to various bioclimatic conditions and establishment in new soybean-producing areas. Gene flow was persistent across North America, contributing to large scale dissemination of virulence alleles. The genome sequence of SCN has revealed highly duplicated regions that could be implicated in the diversification of parasitism genes. Exploring gene expression using single-nematode RNA-sequencing suggested that different alleles are expressed in virulent/avirulent individuals and could potentially be used as diagnostic markers for virulence. Combined with the identification of promising resistance sources, this information will allow the development of an integrated strategy to reduce losses associated with SCN and to extend the lifetime of current resistant cultivars.

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**Competición de Carteles Estudiantiles / Student Poster Competition**

- **L. A. Núñez-Rodríguez**


In Costa Rica, information related with morphology, inter- and intra-specific variability, biology and distribution of cyst nematodes is missing (excepting Globodera pallida). Two populations of Heterodera were found in the Central Valley of Costa Rica, one extracted from Trifolium repens (currently under studied) and other from Rumex sp. All cysts from soil showed a lemon shape and dark brown coloring. The morphological characterization is being described and compared with other cyst nematodes. Two molecular markers were sequenced, the nuclear region ITS1-5.8S-ITS2 and the mitochondrial gene cox1, and compared with sequences retrieved from GenBank. Divergence levels vary between 0.1% (1 nt) and 1.4% (10 nt), compared with H. schachtii, 0.1% (1 nt) and 1.0% (7 nt) compared with H. trifolii, and 0.3% (2 nt) and 0.4% (3 nt) compared with H. daverti. The Bayesian phylogenetic analysis based on the ITS region grouped the Heterodera sp. From Rumex sp. within the Schachtii group, with a high support
value (PP = 100). The partial cox1 gene showed more resolution than the ITS region, with divergence levels of 2.1% (8 nt), 3.3-3.6% (13-14 nt) and 8.7% (34 nt) compared with H. daverti, H. trifolii, and H. schachtii, respectively. The phylogenetic analysis based on the partial cox 1 gene resulted in a clade composed with the Heterodera sp. sequence from Rumex and sequences of H. daverti (PP = 93). However, a subclade was formed only with H. daverti sequences (PP = 98), which may indicate the presence of cryptic species.

- Kanan Saikai

A SEARCH FOR THE BEST YIELD PREDICTOR FOR ROOT LESION NEMATODES. A CASE STUDY OF Pratylenchus penetrans ON SOYBEAN [UNA BÚSQUEDA DEL MEJOR PREDICTOR DE RENDIMIENTO PARA LOS NEMATODOS DE LESIÓN DE RAÍCES. UN ESTUDIO DE CASO DE Pratylenchus penetrans EN SOYA]. K. Saikai, and A. E. MacGuidwin. Department of Plant Pathology at University of Wisconsin- Madison, 492 Russell Laboratories, 1630 Linden Dr., Madison, WI 53706, USA. kutsuwa@wisc.edu.

Pratylenchus penetrans feeds as an ecto- and endoparasite so nematode population densities are routinely determined for both soil and root habitats. The objective of this study was to determine which density measures best predicted soybean yield in loamy sand soils. Soil samples were collected between soybean rows spaced 75 cm apart at plant emergence (VE). Numbers of P. penetrans from 100 cm³ soil, root fragments sieved from 100 cm³ soil, and the sum of the two counts were compared with relative seed weight from two fields for two years in Wisconsin. The number of nematodes from soil and root fragments from the same 100 cm³ soil volume were only weakly correlated (r<0.55). Soybean yield did not correlate with the nematode density in soil whereas there was a significant negative relationship (P<0.05) for both analyses that included root fragments. This result indicated the danger of using nematode densities from soil alone as a predictor of yield loss. Based on three goodness of fit measures, the sum of nematode numbers in soil and root fragments were both good predictors. The estimated yield loss by the sum of the two counts was 0.016% per nematode (P=0.006). This value was similar to the estimate determined by a nested component model (0.015%, P<0.0001) based on data from five site-years. The yield loss estimate by the numbers from root fragments alone was 0.025% per nematode (P=0.003). Our study confirms dead roots contain a reservoir of nematodes that should be considered when estimating initial population densities.

- González Córdoba

DETERMINATION IN VITRO OF THE BIOLOGICAL EFFECTIVENESS OF DIFFERENT NEMATOPHAGOUS MICROORGANISMS ON Pratylenchus brachyurus IN PINEAPPLE CROP [DETERMINACIÓN IN VITRO DE LA EFECTIVIDAD BIOLÓGICA DE DIFERENTES MICROORGANISMOS NEMATOFAGOS SOBRE Pratylenchus brachyurus EN EL CULTIVO DE LA PIÑA]. E. González Córdoba and X. Mata Granados. Instituto
In Costa Rica, pineapple cultivation is affected by phytonematodes, mainly *Pratylenchus brachyurus*. Therefore, the percentage of mortality exerted in vitro by *Bacillus subtilis*, *Clonostachys rosea*, *Pochonia chlamydosporia*, *Purpureocillium lilacinum* and two isolates of *Trichoderma* on *P. brachyurus* was evaluated at 72 and 96 hours after inoculation; controls included the insecticide-nematicide Ethoprophos and sterile distilled water (an absolute control). In Petri dishes containing Agar-Water medium, each microorganism was inoculated at a concentration between 1.8x10^5 conidia/ml and 6.4x10^6 CFU/ml, and 20 phytonematodes per dish. A completely randomized design was used, consisting of eight treatments and eight repetitions. Data were analyzed using the technique of Mixed and General Linear Models (MLMix) and the Bonferroni media comparison tests (0.05%). Treatments statistical differences were determined using the statistical package InfoStat/P (p <0.0001). Results showed that at 96 hours *C. rosea* treatment was statistically the same as Ethoprophos both causing a mortality of 96.25% and 96.88%, respectively. Overall microorganisms tested exerted a greater mortality on *P. brachyurus* at 96 hours. The percentage of mortality exerted by the nematophage microorganisms could be due to the capacity they have to produce proteolytic and chitinolytic enzymes that may cause immobility, degradation and eventual death of the nematode.

**Rebeca Sandoval Ruiz**

**IMPACT OF WINTER BRASSICA CARINATA AND SUMMER CROP ROTATION ON Rotylenchulus reniformis AND FREE-LIVING NEMATODES**

[IMPACTO DE LA SIEMBRA INVERNAL DE BRASSICA CARINATA Y LA ROTACIÓN DE CULTIVOS DURANTE EL VERANO, EN EL MANEJO DE *Rotylenchulus reniformis* Y NEMATODOS DE VIDA LIBRE]

R. Sandoval Ruiz1, Z. J. Grabau1, R. Seepaul2, D.L. Wright2, and I. Small2

1 Entomology and Nematology Department, University of Florida 2 North Florida Research and Education Center-Quincy, University of Florida, FL, USA. rebeca.sandovalr@ufl.edu.

*Brassica carinata* is an emerging crop in the Southeastern United States. However, the host status of this plant for most nematodes is unknown. In the Southeast, reniform nematode (*Rotylenchulus reniformis*) is one of the most important yield-robbing pathogens of cotton. The objective of this research was to determine the effect of the winter *Brassica carinata* in a summer rotation system -com (Cr), cotton (Ct), peanut (P) and soybean (Sy)- on reniform (RN) and free-living nematodes abundances. Winter field systems were: carinata-fallow, oats-carinata and fallow-fallow. These crops were crossed with a 2-year rotation of Cr, Ct, Pe and Sy where each crop phase was present each year. Soil samples were taken during summer 2018 using a Geoprobe®. The abundances of RN populations were measured in two soil depth: 0-30 cm and 30-120 cm. The results showed that RN abundances varied according to each crop. Ct had the greatest RN abundance
(1376 nematodes/100 cm3 of soil). P, Cr and Sy did not have statistical differences in the abundance of RN. Reniform nematode, bacterivore and fungivore abundances were greater in the soil profile in the 0-30 cm depth than in the 30-120 cm depth. Winter crops influenced the RN and the bacterivore populations. The greatest populations of RN were seen in the fallow (1089 nematodes/100 cm3), while the greatest bacterivore populations were seen in the oats-carinata (156 nematodes/100 cm3). These initial results suggest carinata could be considered as a winter cover crop to decrease RN populations. To support this, more samples will be taken over a 4 years period.

- Leonardo Freire

MORPHOLOGICAL AND PHYSIOLOGICAL STATUS OF SOYBEAN CULTIVARS PARASITIZED BY Pratylenchus brachyurus AND INOCULATED WITH Pseudomonas fluorescens BRM 32111. [ESTADO MORFOLÓGICO Y FISIOLÓGICO DE CULTIVARES DE SOJA PARASITIZADAS POR Pratylenchus brachyurus E INOCULADAS CON Pseudomonas fluorescens BRM 32111]. L. L. Freire¹, M. C. C. de Filippi², A. C. Lanna², and M. R. da Rocha¹. ¹Laboratório de Nematologia, Escola de Agronomia, Universidade Federal de Goiás, Campus Samambaia, Rodovia Goiânia-Nova Veneza, Km 0, CEP 78690-900, Goiânia – GO. ²Embrapa Arroz e Feijão, GO 462, Km 12, CEP: 75375-000, Santo Antônio de Goiás - GO. leolfreire@hotmail.com.

Pratylenchus brachyurus (lesion nematode) is an important soybean root pathogen in Brazil. Studies have shown that inducing plant defenses and stimulating physiological processes with growth-promoting rhizobacteria can be a viable tactic for managing plant-parasitic nematodes. The objective of this study was to evaluate the physiological response and the development of two soybean cultivars (BRSGO Caiapônia and BRSGO 8560 RR) subjected to P. brachyurus parasitism and inoculated with Pseudomonas fluorescens BRM 32111 (Pf). The experimental design was a completely randomized 2 x 4 factorial with treatments consisting of the combination of two soybean cultivars as follows: Control (plants without nematode and bacteria), Pb (plants with nematode), Pf (plants with bacteria) and PbPf (plants with nematode and bacteria). The treatments with Pf were inoculated 24 hours after the nematode inoculation. Plants were evaluated weekly over a period of 63 days after inoculation. Decay of the photosynthetic rate, internal carbon and evapotranspiration in the plants were observed during their development. The soybean genotype BRSGO Caiapônia showed highest indices of chlorophyll content, height, fresh shoot weight and fresh root weight (RFW). The bacteria P. fluorescens stimulated plant growth, however, in PbPf treatment, height and RFW were lower. The reproduction factor and nematode density in roots were higher in plants inoculated with P. fluorescens.

- C. Oliveira
MORPHOLOGICAL AND MOLECULAR IDENTIFICATION OF TWO FLORIDA POPULATIONS OF FOLIAR NEMATODES (Aphelenchoides spp.) ISOLATED FROM STRAWBERRY WITH NOTES ON THEIR BIONOMICS. IDENTIFICACIÓN MORFOLÓGICA Y MOLECULAR DE DOS POBLACIONES DE NEMATODOS FOLIARES (Aphelenchoides spp.) EN FLORIDA, AISLADOS DE FRESA CON NOTAS EN SU BIONÓMICA. C. Oliveira1,2, S. A. Subbotin3, J. Desaeger1, J. A. Brito4, K. V. Xavier5, L. G. Freitas2 and R. N. Inserra4. 1Entomology and Nematology Department, University of Florida, Gulf Coast Research and Education Center, Wimauma, FL, 33568, USA, 2Dept. Fitopatología, Univ. Federal de Viçosa, Viçosa, MG, 36570-900, Brazil, 3Plant Pest Diagnostic Center, California Department of Food and Agriculture, 3294 Meadowview Road, Sacramento, CA 95832-1448, USA and Center of Parasitology of A.N. Severtsov Institute of Ecology and Evolution of the Russian Academy of Sciences, Leninskii prospect 33, Moscow 117071, Russia; 4Florida Department of Agriculture and Consumer Services, DPI, Nematology Section, P.O. Box 147100, Gainesville, FL 32614-7100, USA; 5Dept of Plant Pathology, Gulf Coast Research and Education Center, University of Florida, Wimauma, FL 33598, USA. clemendeoliveira@ufl.edu.

The genus Aphelenchoides contains at least 153 species of foliar nematodes. Late 2016, two populations of foliar nematodes were isolated from symptomatic strawberry plants growing in a commercial field in Florida. The populations were tentatively identified as putative A. besseyi and A. fujianensis. The morphological characters of the Florida population of A. besseyi fit those of the original description and re-descriptions. The population of putative A. fujianensis did not fit the morphology described for the type population of A fujianensis in China because it was male-less and with females lacking a functional spermatheca, whereas type A. fujianensis is an amphimictic species and with females having a large spermatheca. The results of phylogenetic analyses using SSU, LSU and COI genes, showed that the Florida and other populations of A. besseyi from different hosts and geographical areas clustered in different clades suggesting that A. besseyi is a species complex. The putative A. fujianensis from Florida did not cluster in the same clade of the type A. fujianensis confirming that it is a different species, as inferred by the results of the morphological analysis. This Florida population is considered a new species and its description is in progress. In bionomic studies, the Florida A. besseyi population re-infected strawberry and reproduced well on gerbera daisy. Soybean and alfalfa were poor and non-host of the nematode, respectively. This new Aphelenchoides sp. from Florida is mainly mycetophagous, although it was found into the trichomes and the mesophyll of soybean leaves in plants inoculated with this nematode.

- S. Oliveira

Ditylenchus gallaeformans PHYLOGEOGRAPHY [FILOGEOGRAFÍA DE Ditylenchus gallaeformans]. S. A. Oliveira¹, P.M. Agudelo¹ and S. J. DeWalt¹. 1Clemson University, Clemson, SC, 29630 USA. solivei@clemson.edu.
How important is coevolution between host and parasite? Ditylenchus gallaeformans is a migratory ectoparasite nematode that induces galls in the stem, leaves and flowers of several Melastomataceae species, including invasive species from Miconia and Clidemia genera. D. gallaeformans is a possible biological control agent against these invasive plant species. However, the culture of this nematode in artificial conditions is challenging, and has not been established yet. For this reason, it is important to focus on studies about D. gallaeformans biology and distribution to better understand its relation with the host and the environment. A more comprehensive understanding of the phylogeography of D. gallaeformans may provide insight about the coevolution between nematode and host, nematode phylogeny and genetic differences among the populations, which may have influence on host preference, virulence and pathogenesis. D. gallaeformans populations used in this study were collected from Brazil, Costa Rica, Dominica and Trinidad. DNA was extracted from individual nematodes and the COI region was amplified and sequenced. Phylogenetic analysis was done using maximum-likelihood (ML) and haplotype networks were constructed for each population according to geographical location and host species. Phylogenetic reconstruction using the COI sequences yielded trees with similar topologies and revealed four major clades determined by location. Haplotype networks for COI were congruent with the phylogenetic reconstructions, showing segregation of the mitochondrial haplotypes according to locality. The results show us that Ditylenchus gallaeformans are genetically different among geographical location, and that the host species does not influence the populations haplotypes.

**Posters**

- Helen Guardia Casas

CONTROL DE Anomala spp. EN EL CULTIVO DE ARÁNDANO (Vaccinium corymbosum) UTILIZANDO Heterorhabditis spp. (NEPs). [CONTROL OF Anomala sp. ON BLUEBERRIES (Vaccinium corymbosum) USING Heterorhabditis sp. (NEPs)]. H. Guardia, R. Ruiz, U. Rodriguez y C. Cedano. Agroberries Perú Sac., Virú Km.534, La Libertad, Perú. hguardia3@gmail.com.

En el Perú, la producción de arándanos ha crecido vertiginosamente, a una tasa promedio de 206% anual entre el 2012 al 2018. Una de las regiones con más auge es La Libertad con un crecimiento de 78.4% y un promedio de 16.8 toneladas/hectárea. Algunos de los factores que ocasionan pérdidas en la producción de este cultivo es la larva del escarabajo Anomala spp., que se alimenta de las raíces de la planta. En ocasiones, se ha reportado poblaciones entre 70 a 140 larvas por planta; para su control se utiliza gran cantidad de insecticidas y en muchos casos no se logran disminuir los daños, siendo este tipo de control ineficiente. Los nematodos entomopatógenos (NEPs), debido a su
amplio rango de acción, y gran capacidad de búsqueda han demostrado ser una alternativa en el manejo de plagas insectiles que pasan gran parte de su ciclo de vida en el suelo. En ese contexto, el objetivo de esta investigación fue evaluar el efecto de la aplicación de Heterorhabditis sp. sobre el control de Anomala sp. frente a la utilización de agroquímicos. Los tratamientos fueron Chlorpyrifos (2.5%), Fipronil (0.4%) y Heterorhabditis a razón de 3 millares/hectárea. La aplicación se realizó por inyección vía válvula de riego con un tanque de aplicación a un volumen de 200 L agua y una lámina de riego de 1.02 mm, todo el proceso de inyección duró 20 minutos. Para una población inicial de 70 larvas de Anomala spp. por planta se logró disminuir con los NEPs un 64%, mientras que con Chlorpyrifos y Fipronil se disminuyó en un 10%

- Reyes Peña Santiago

THE PHARYNGO-INTESTINAL JUNCTION IN DORYLAIMS, WITH COMMENTS ON ITS TAXONOMICAL INTEREST [LA UNIÓN FARÍNGE-INTESTINAL EN DORILÁIMIDOS, CON COMENTARIOS SOBRE SU INTERÉS TAXONÓMICO]. R. Peña-Santiago. Departamento de Biología Animal, Biología Vegetal y Ecología, Universidad de Jaén, Jaén, Spain. rpena@ujaen.es

Pharynx and intestine are the largest and the most important sections of digestive system in nematode body plan. Pharyngeal base connects the anterior end of intestine, their junction being very often guarded by a valve, the cardia. In dorylaims, the representatives of the order Dorylaimida, the pharyngo-intestinal junction displays relevant variations, which, in general, have not received too much attention. It basically consists of a variably shaped and sized cardia, but a ring-like structure is usually present, and other (more) specialized elements or differentiations (glands, lobes, etc.) may occur too. The cardia derives from the posteriormost part of the stomodeum, it controls the food flow from pharynx to intestine, and is a rounded-conoid, conical or cylindroid structure usually enveloped by intestinal wall. A fibrous tissue of variable consistency very often embraces the pharyngo-intestinal junction, and occasionally may form three radial lobes or only one dorsal lobe. Nygolaims, the members of the suborder Nygolaimina, show three large, ovoid cells (glands) at this region, certainly an autapomorphic condition of the group. Other very special modifications, for instance intestine joining posterior part of cardia, appear in particular taxa. The tentative interest of these variations for the classification of dorylaims is briefly discussed.

- Mara Rubia

Heterodera glycines is one of the major problems in soybean crop worldwide. Crop rotation and resistant varieties have been the main measures to reduce its population although they haven’t been sufficient. The search for new alternatives for sustainable management, such as the biological control may be of great value to be included as a control measure. Thus, this study had the purpose to evaluate the potential of the Orchid Mycorrhizal Fungi (OMF) Waitea circinata for controlling H. glycines in vitro. Two experiments were carried out in order to evaluate the effect of different concentrations of W. circinata mycelial suspension on H. glycines J2 mortality and hatching. Experiment design was a completely randomized, in a factorial scheme 6 x 3, with ten replications. Factor A was OMF mycelial suspension concentrations (0, 5, 10, 15, 20, 25 g. L⁻¹) and Factor B, the evaluation timings (24, 48 and 168 hours of incubation). Higher concentrations of the fungus were more efficient on the nematode control and better results were found at early evaluations. J2 mortality was higher at 24 hours after OMF application, reaching 31%, compared to 13% and 10% at 48 and 168 hours, respectively. The J2 mortality rate increased over 100% with the use of OMF mycelial suspension. At 24 and 48 hours of incubation the J2 hatching was very low (5.4% and 7.3% respectively). At 168 hours of incubation J2 hatching was 36.2% and was reduced with the concentrations of 15 and 20 g. L⁻¹ of OMF mycelial suspension.

- María de Lourdes Mendes


The objective of this study was to determine the host suitability of limpograss (Hemarthria altissima), bahiagrass (Paspalum notatum) and bermudagrass (Cynodon spp.) to Meloidogyne graminis. The experiment was carried out under greenhouse conditions, in a completely randomized design with five replications. Nematode-free cuttings of limpograss (‘Floralta’ and ‘Kenhy’), bahiagrass (‘Argentine’ and ‘Pensacola’), and bermudagrass (‘Tifton-85’, and PI 322) were planted in 15-cm-diam. clay pots containing 1, 400 cm³ of sand. Rice (Oryza sativa) ‘Carolina Gold’ and ‘Rex’ were used as check controls. The plants were inoculated with 3,000 J2 per pot. After 98 days the plant roots were assessed for egg masses using a 0 to 5 scale (Taylor & Sasser, 1978) and J2/g of root. The fresh weight of the root system of each plant was recorded. The egg mass indices were 5 on both rice cultivars, on ‘Pensacola’ and on PI 322, 3 on ‘Argentine’, 2 on ‘Kenhy’, 1 on ‘Floralta’, and 0 on ‘Tifton-85’. The highest number of nematodes/g of root were collected from ‘Carolina Gold’ (1,124/g) and ‘Pensacola’ (2,166/g), and the lower numbers were recovered from ‘Tifton-85’ (<1/g), ‘Floralta’ (5/g) and ‘Kenhy’ (86/g). The reproduction factor (RF = Pf/Pi) was 0 or <1 for ‘Tifton-85’ (0.0), ‘Floralta’ (0.04), and ‘Kenhy’ (0.7). Meloidogyne graminis reproduced very well on both rice cultivars, ‘Carolina Gold’ (RF = 17.4) and ‘Rex’ (RF = 7.7), and on
‘Pensacola’ (RF = 6.0). The PI 322 (RF = 3.5) and ‘Argentine’ (RF = 2.7) also were good hosts of M. graminis.

- Paula Angudelo

IDENTIFICATION OF MOLECULAR BIOMARKERS ASSOCIATED WITH RENIFORM NEMATODE (Rotylenchulus reniformis) RESISTANCE IN SOYBEAN [IDENTIFICACIÓN DE BIOMARCADORES MOLECULARES ASOCIADOS CON LA RESISTENCIA A EL NEMATODO RENIFORME (Rotylenchulus reniformis) EN SOYA]. J. Wilkes\(^1\), B. Fallen\(^2\), C. Saski\(^3\), M. Klepadlo\(^3\) and P. Angudelo\(^1\). \(^1\)Biosystems Research Complex, Clemson University, Clemson, South Carolina 29634. \(^2\)Pee Dee Research and Education Center, 2200 Pocket Rd., Florence, South Carolina 29506. \(^3\)University of Missouri, 25 Agriculture Bldg, Columbia, MO 65211. jfultz@clemson.edu

Reniform nematode (Rotylenchulus reniformis) is a yield-limiting pathogen of soybean (Glycine max) in the Southeastern region of the United States. Several studies have identified soybean germplasm with resistance to reniform nematode and only a few studies have explored the soybean genome for quantitative trait loci (QTL) linked to reniform nematode resistance. Our objective for this study was to identify high resolution single-nucleotide polymorphism (SNP) biomarkers that correlate with reniform nematode resistance in soybean using genotyping-by-sequencing (GBS). A set of 250 recombinant inbred lines (RIL, F\(_{2}:8\)) developed from a cross between reniform nematode resistant soybean cultivar ‘Forrest’ and susceptible cultivar, ‘Williams 82’ was utilized to correlate reduced nematode reproduction to SNP markers, thereby localizing specific QTL regions in the soybean genome. The phenotype was determined by inoculating three replicates of each line with 2000 vermiform reniform nematodes and quantifying final populations from the soil and root 60 days after inoculation. Resistant lines were identified using an optimal univariate cluster analysis. DNA was extracted from leaf tissue collected of each line and digested using specific restriction enzymes MseI and PstI to prepare gene libraries, then sequenced on the Illumina HiSeq 2500 platform and sequences were analyzed to generate population genomic summary statistics. Three SNP markers were significantly associated with reniform nematode resistance, one on chromosome 11 (LG B1) and two on 18 (LG G). These genetic markers can be used by soybean breeders in marker assisted selection to enhance efforts in selecting and employing lines with known resistance to reniform nematode.

- Wálter Peraza Padilla.

CONFIRMACIÓN TAXONÓMICA Y MOLECULAR DE Meloidogyne exigua (GÖELDI 1887) EN CAFÉ, EN HEREDIA, COSTA RICA. [TAXONOMIC AND MOLECULAR CONFIRMATION OF Meloidogyne exigua (GÖELDI 1887) IN COFFEE IN HEREDIA, COSTA RICA]. R. A. Carmona, \(^2\)W. P. Padilla. Universidad Nacional de Costa Rica, Laboratorio de Nematología. 86-3000, Heredia, Costa Rica. walter.peraza.padilla@una.cr.
El nematodo agallador (Meloidogyne spp.), es una de las plagas económicamente más importantes que afecta una amplia gama de cultivos en todo el mundo causando daños generalizados. El objetivo de este trabajo fue realizar estudios morfológicos, taxonómicos y moleculares para confirmar la especie de Meloidogyne asociada con una plantación de café en Barva, Heredia durante el 2016. Se examinaron sistemas radicales y se observaron pequeñas agallas ubicadas en el extremo apical de la raíz. En promedio se contabilizaron un total de 30 J₂/100cc de suelo y 1000 J₂/10g. Los estudios morfológicos (diseño perineal de las hembras), taxonómicos y moleculares (secuenciación) mostraron que las hembras y los juveniles pertenecían a la especie M. exigua. La amplificación de la región ribosomal del ADN mitocondrial (ADNm) entre COII y 16S, produjo un único fragmento de 580 pb en todas las muestras analizadas. Los productos de PCR digeridos con la enzima Drai generaron fragmentos de 160 pb y 420 pb. El análisis de la secuencia reveló una similitud del 99% con M. exigua al compararlas con otras secuencias de Costa Rica y Nicaragua. Se logró la identificación de M. exigua asociada a una plantación de café mediante el uso integrado de técnicas taxonómicas y moleculares. Debido a la amplia distribución de la especie en las plantaciones de café, se recomienda prestar especial atención a las áreas donde está presente este nematodo para conocer su distribución y propagación e implementar estrategias de manejo. Finalmente, es necesario estar alerta a la infección de este nematodo para evitar su diseminación en otros sitios.

• Carlos Vassallo

SALIBRO™ (REKLEMEL™ ACTIVE) - A NOVEL SULFONAMIDE NEMATICIDE FOR THE CONTROL OF Meloidogyne spp. IN GRAPES IN PERÚ [SALIBRO™ (REKLEMELTM ACTIVE) – UN NUEVO NEMATICIDA SULFONAMIDA PARA EL CONTROL DE Meloidogyne spp. EN UVAS EN PERÚ]. C. N. Vassallo¹, J. Mejía², J. A. Wiles³, T.C. Thoden⁴, J. Llontop⁵ and L. A. Alvarez⁶. ¹Corteva Agriscience™, Agriculture Division of DowDuPont™, Dow AgroSciences Argentina SRL, Boulevard Cecilia Grierson 355, Dique IV, Piso 25, Puerto Madero (C1107CPG), Ciudad Autónoma de Buenos Aires, Argentina. ² Corteva Agriscience™, Agriculture Division of DowDuPont™, DuPont de Colombia. Calle 113 # 7-21 Torre A Piso 14, Bogotá, Colombia. ³¹Corteva Agriscience™, Agriculture Division of DowDuPont™, Truderingerstr 15; 81677 München; Germany Corteva Agriscience™, Agriculture Division of DowDuPont™, DuPont (U.K.) Limited, 4th Floor, Kings Court, London Road, Stevenage, SG1 2NG,
The cultivation of table grapes is highly important in Perú. Plant-parasitic nematodes are a threat through the crop cycle decreasing fruit yields and quality. There are several species of plant-parasitic nematodes affecting vines, however, Meloidogyne spp. has the highest incidence. Most commonly used products for nematode management belong to the chemical groups of the carbamates and organophosphates. Therefore, new products are needed that combine efficiency and safety for users and the environment. Salibro™, a 500 SC formulation containing the active ingredient fluazaindolizine (Reklemel™ active) is a novel sulfonamide nematicide that is being developed by Corteva AgriScience™, Agricultural Division of DowDupont. The present study summarizes the Salibro™ performance when applied by drip irrigation in table grapes to control Meloidogyne spp. in comparison with cadusaphos and oxamyl. Two trials were established in Ica and another two in Lambayeque and La Libertad departments. The experimental set up was a complete randomized block design with 4 replications and 10 plants per plot. Crop-relevant parameters including root damage and nematode root counts, were assessed. Results indicated that Salibro™ demonstrated excellent control of Meloidogyne spp. by significantly reducing the number of nematodes in the soil at 30 (4.45 to 8.92-fold reduction) and 90 days after application (9.35 to 18.42-fold reduction) compared to untreated plots and providing performance similar to the tested standard products (P=?). Therefore, Salibro™ will be a novel and effective tool for nematode management in table grapes in Perú.

Reyes Peña Santiago

NEMATODES ASSOCIATED TO RED PALM WEEVIL IN SOUTHERN IBERIAN PENINSULA

The red palm weevil, Rhynchophorus ferrugineus, is the most damaging pest of palm species in the world. This beetle is native of tropical areas in Southeast Asia and started its expansion 25 years ago. In 1995, the pest was introduced in the Iberian Peninsula through palm trees imported from Egypt, and spread fast to other European countries too. Leaving aside entomopathogenic species, few
other nematodes have been previously recorded in association with this beetle. Adult specimens and larvae cocoons of R. ferrugineus, collected from one ornamental Canarian palm (Phoenix canariensis) affected by the pest near Jaén town (southern Iberian Peninsula), were examined to explore the presence of nematodes associated with them. Nematodes were extracted by a modified trays technique. Two species, Mononchoides macrospiculum and Teratorhabditis synpapillata, recorded for the first time in Spain, were identified using morphological, morphometrical and molecular (18S and 28S rDNA) data. These findings agree with those recently reported in Italy, where the presence of R. ferrugineus is detected since 2004, and suggest a close association, with no adverse effect, between both nematode species and the weevils. Thus, the nematodes probably live and feed on the cocoons and the galleries of weevil larvae, being carried (phoresy) by adult beetles to other palm trees. Nematodes might originally come from southern Asia as at least one of the species, T. synpapillata, has been also recorded there in soil.

Gerardo Alcides Sanchez Monge

UNRAVELING THE WHOLE STORY: AN ULTRASTRUCTURAL STUDY OF THE COMMON BEAN “AMACHAMIENTO” DISEASE CAUSED BY Aphelenchoïdes besseyi [DESCIFRANDO LA HISTORIA COMPLETA: UN ESTUDIO ULTRAestructURAL DE LA ENFERMEDAD DEL AMACHAMIENTO DEL FRIjOL CAUSADA POR Aphelenchoïdes besseyi]. A. Sánchez-Monge¹², P. Calderón-Mesén² and E. Sánchez². ¹Cellular and Molecular Biology Research Center and Humanities School, University of Costa Rica, CR. ²Microscopic Structures Research Center, University of Costa Rica, Costa Rica. gerardoalcides.sanchez@ucr.ac.cr

Foliar nematodes (genus Aphelenchoïdes) are known as facultative endoparasites in a wide range of plant hosts, on which they feed and induce several symptoms and diseases. Aphelenchoïdes besseyi has been reported in association with almost a hundred plant species, in one of them, i.e. common bean (Phaseolus vulgaris), this nematode is regarded as the causal agent of the so called “amachamiento”. Such disease is characterized by foliar abnormalities combined with a reduction in the number of bean pods, causing significant yield losses (up to 80-85%) when mishandled or misdiagnosed. Despite the identification of A. besseyi as the causal agent and its impact on bean crops, the damage to the leaves tissues remained unstudied and unknown. In this research (currently ongoing) we aim to characterize the damage caused by the nematode to the foliar tissues at ultrastructural level, by using Transmission (TEM) and Scanning Electron Microscopy (SEM) techniques. Preliminary micrographs show alterations of several organelles (chloroplasts, vacuoles and mitochondria among others) as well as abnormalities in vascular tissues. Additionally, ultrastructural features of A. besseyi ex. P. vulgaris are given and discussed.
El nematodo lesionador de la raíz Pratylenchus, es considerado el segundo de mayor importancia económica a nivel nacional. El objetivo de este estudio fue identificar especies de Pratylenchus asociadas a un cultivo de arroz en Puntarenas; plátano en Talamanca, piña en Limón y Alajuela y finalmente pasto estrella en Alajuela. Se realizaron estudios taxonómicos (morfológico, morfométrico) y moleculares. Se llevaron a cabo un total de 3500 mediciones morfométricas, que facilitaron la elaboración de un análisis estadístico descriptivo. Además, un total de 2000 microfotografías de hembras y machos que permitieron discriminar entre las especies de Pratylenchus. Los análisis PCR-RFLP del ITS1 indicaron que la especie asociada al cultivo del plátano fue P. coffeae con un peso molecular de 700 pb; en arroz y pasto estrella fue P. zeae con 500 pb; en piña P. brachyurus con 500 pb. El análisis de RFLP con la enzima Ded I reveló para P. coffeae fragmentos de 100 y 250 pb; para P. zeae 200 y 250 pb y para P. brachyurus 450 pb. Las enzimas de restricción Pst I y Hind III, no permitieron la discriminación entre las tres especies de nematodos. Además, se amplificaron los segmentos de expansión D2-D3 del 28S ADNr, usando los cebadores D2A y D3B, y se amplificó la región ITS1 utilizando los cebadores 18S y rDNA1. La secuenciación generó resultados similares a la identificación morfológica, morfométrica y de PCR-RFLP para las tres especies analizadas. Además, se establecieron relaciones filogenéticas entre especies de Pratylenchus a partir de segmentos de expansión D2-D3 de la región 28S del ARNr y genes de secuenciación de la región ITS del ARNr, utilizando los métodos de Inferencia Bayesiana (IB). De las tres especies de Pratylenchus identificadas, P. zeae encontrada en pasto estrella, es el primer reporte para Costa Rica, no así las demás especies de las cuales se tienen reportes. La detección de especies de nematodos en plantaciones agrícolas permite el establecimiento e implementación de una estrategia de manejo para la toma de decisiones que minimice los daños ocasionados y evite la propagación de estos microorganismos.
In Central America historically the economy is based on agriculture, tourism and some small industries. It is an area that, due to its geographical position and climatic conditions presents risks associated with the development of pests and diseases in the crops, and among them the nematodes stand out because of their impact on the yields and the costs associated with their control. Therefore, it is important to develop research aimed at establishing indicators that allow to have an idea of the "State of Nematology in Central America". The databases then become an important tool for systematizing and analyzing different indicators that will be used to compare the activity in the different countries, as well as identifying the actors to integrate knowledge networks. A first step to generate an important indicator is to search the Final Graduation Work (thesis) presented on the last 20 years in the main universities in the region, using the different tools that provide the Information and Communication Technology (ICT’s). This is possibly one of the most complicated steps in the investigation, given the lack of systematization and the conditions of each Central American country. It is expected that as a result of this preliminary analysis, we can identify most of the nematologists who work in universities in the Central American area, to increase and strengthen the network of specialists and facilitate the exchange of knowledge for the development and construction of specialized know-how, to generate skills that allow in the future to attend more effectively the problems associated to the control of nematodes.

• Lorena Flores Chaves

**PLANT-PARASITIC NEMATODES ASSOCIATED WITH BLACK PEPPER (Piper nigrum L.) IN COSTA RICA** [NEMATODOS FITOPARÁSITOS ASOCIADOS A PIMIENTA NEGRA (Piper nigrum L.) EN COSTA RICA]. **L. Flores-Chaves**, L. A. Núñez-Rodríguez, O. Castro-Zúñiga, D. A. Humphreys-Pereira. 1Laboratory of Nematology-CIPROC, Agronomy school, University of Costa Rica, San José, Costa Rica, 2060. 2Laboratory of Nematology-CIPROC, Agronomy school, University of Costa Rica, San José, Costa Rica, 2060. [danny.humphreys@ucr.ac.cr](mailto:danny.humphreys@ucr.ac.cr)
In Costa Rica, the black pepper production acquired great interest due to its high piperine content. Several plant pathogens have been identified associated with black pepper. Unfortunately, information regarding plant parasitic nematodes associated with this crop in the country is missing. A total of 49 composite samples have been processed until now (26 of soil and 23 of roots). Galls symptoms were observed in the roots. The plant-parasitic nematodes identified in roots were Meloidogyne, Aphelenchus, Aphelenchoides, Criconematidae, Helicotylenchus, Hoplolaimus, Pratylenchus, Rotylenchulus, Tylenchus y Tylenchulus. The same nematodes found on roots plus Hemicicliophora, Heteroderinae, Scutellonema, Trichodoridae, Tylenchorhynchus and Xiphinema were identified in soil surrounding the roots. In roots, the genus with the highest frequency of occurrence was Meloidogyne with 78%, followed by Helicotylenchus with 43%. Similarly, in soil the same genera had the highest frequency with 88 % and 85% respectively. In roots, Meloidogyne had the highest average population density with 1169 J2/100g of roots (ranged from 10 to 197240), followed by Tylenchulus with 270 nematodes (ranged from 10 to 790 nematodes). In soil, Rotylenchulus presented the highest average population density with 303 nematodes/100cc of soil (ranged from 191 to 415 nematodes), followed by Helicotylenchus with 56 nematodes (ranged from 3 to 196). Molecular methods were used to identify the species of Tylenchulus and Meloidogyne in black pepper. Sequencing results showed a 99% of similarity with the citrus nematode, T. semipenetrans. Six populations of Meloidogyne were processed with the method PCR-RFLP. Restriction patterns corresponded to M. incognita. Subsequently, it was corroborated with species-specific primers. To our knowledge this is the first report of plant parasitic nematodes associated with black pepper in Costa Rica.

### Ricardo Brenes

**IDENTIFICATION AND DISTRIBUTION OF PLANT-PARASITIC NEMATODES ASSOCIATED WITH STRAWBERRY (Fragaria spp.) IN COSTA RICA. [NEMATODOS FITOPARÁSITOS ASOCIADOS A FRESA (Fragaria spp.) EN COSTA RICA]. R. Brenes-Campos, L. Flores-Chaves, L. A. Núñez-Rodríguez, Danny A. Humphreys-Pereira. Laboratory of Nematology-CIPROC, Agronomy School, University of Costa Rica, San José, Costa Rica, 2060. danny.humphreys@ucr.ac.cr**

Plant-parasitic nematodes are one of the main problems that affect strawberries worldwide. In Costa Rica, there is no information related with the nematodes associated with this crop, their distribution, damage and the diversity of nematode species. Roots, soil and foliage samples have been collected in the main strawberry production areas of Costa Rica (Cartago, Alajuela and Heredia). No nematodes were found in foliage samples. Three genera have been found on roots, Meloidogyne, Pratylenchus and Helicotylenchus. In addition to the genera mentioned above, Aphelenchoides, Criconematidae and Hemicicliophora were identified in soil. In both soil and root samples, the genera with the highest frequency of occurrence were Meloidogyne and Pratylenchus with 81% and 54%, respectively. Meloidogyne and Pratylenchus had an average population density
of 11897 nematodes per 100 g of roots (ranged from 20 to 77520) and 1808 (from 540 to 3,490), respectively. PCR-RFLP was performed on four populations of Meloidogyne using the primers C2F3/1108 and the amplification product (~520 bp) was digested with the restriction enzyme Drai. The restriction pattern corresponded to M. hapla and was confirmed using species-specific primers. The Pratylenchus populations found on strawberries are currently characterized with several molecular markers.

- Mariella Finetti Sialer

NEW REPORTS OF ROOT-KNOT NEMATODES FROM ORNAMENTAL PLANTS [NUEVOS REPORTES DE NEMATODOS AGALLADORES EN ORNAMENTALES]. M. F. Sialer, N. Rapaná1 and A. Ciancio2. 1CNR, Istituto di Bioscienze e Biorisorse and, 2Istituto per la Protezione Sostenibile delle Piante, Bari, Italy. mariella.finetti@ibbr.cnr.it

A number of ornamental or succulent plants from urban garden pots or planters were found as new hosts of root-knot nematodes. Ficus microcarpa grown in pots was found parasitized by a population of Meloidogyne arenaria. A specimen of the cactus Stetsonya coryne showed parasitism by a M. incognita population, with visible galling induced on roots. The nematode also parasitized associated plants of Graptopetalum paraguayense, present in the same planter. Finally, galls produced by Meloidogyne spp. were found on roots of Sedum dendroideum and S. spectabile in pots. Nematodes were identified by PCR amplification of the 18S ribosomal gene regions, using juveniles and females collected from galls, and/or by the morphology of males, when present. Apart of G. paraguayense, the species reported represent new host records for root-knot nematode parasitism. Implications for quarantine issues and nematode pest spreading are briefly discussed.

- Nahum Marban Mendoza

MORPHOLOGICAL IDENTIFICATION, MOLECULAR ANALYSIS AND REDUCTION OF DAMAGE CAUSED BY Globodera rostochiensis IN THE POTATO CROP [IDENTIFICACIÓN MORFOLÓGICA, ANÁLISIS MOLECULAR Y REDUCCIÓN DEL DAÑO DE Globodera rostochiensis EN EL CULTIVO DE PAPA]. A. J. Cabrera-Hidalgo1, N.
Cyst nematodes are considered one of the most important pests in the cultivation of potatoes (*Solanum tuberosum* L.) in cold and temperate climate areas. A phyto-nematological prospecting study will be carried out in Mexican main potato-producing regions. Soil and plant samples with evident signs and symptoms associated with the cyst nematode will be collected. Nematode populations will be identified morphologically and molecularly using CTAB and molecular markers (RAPD and PCR-RFLP) methodology. Amplified and digested bands will be encoded in a binary matrix, from which a similarity matrix will be made with the NTSyS pc. 2.0 program. The similarity between samples will be evaluated using the Dice coefficient. An *in vitro* study will be developed to evaluate the nematicide effect of different products on *Globodera rostochiensis* juveniles by estimating the proportion of inactive nematodes 24 hours after product exposure. Next, a study will be established in greenhouse based on the laboratory results, and finally a field validation process will be carried out to ratify the results obtained in greenhouse. The population density of juveniles and females/nematode cysts, as well as the effectiveness of the treatments will be evaluated as indicators to develop pest management practices that can support the reduction of damage caused by *G. rostochiensis* in the potato crop.

**Luna Aballay**

**EFFICACY OF THREE ISOLATES OF Steinemema SPP. IN THE CONTROL OF Naupactus xantographus, IMPORTANT PEST OF GRAPEVINE ROOTS IN CHILE [EFICACIA DE TRES AISLADOS DE Steinemema SPP. PARA EL CONTROL DE Naupactus xantographus, PLAGA DE ALTA IMPORTANCIA EN RAÍCES DE LA VID EN CHILE].**

L. Aballay, G. Lankin y E. Aballay. Facultad de Ciencias Agronómicas, Universidad de Chile, P.O. BOX 1004, Santiago, Chile. eaballay@uchile.cl

Among the various pests and diseases that attack grapevines in Chile, *Naupactus xantographus* (Coleoptera: Curculionidae) is one of the most serious. This insect presents a long life cycle with a subterranean larval phase of more than one year. During this period this insect feeds on new roots severely affecting plant growth, while the adult feeds on the foliage of the plants. Current control is based mainly on synthetic insecticides applied to the soil and foliage with poor results, especially in the soil. Entomopathogenic nematodes (EPN) have previously been assessed showing great potential as an alternative to chemical treatments. The aim of this work was to evaluate the efficacy of three Chilean native isolates of two species, the cosmopolitan *Steinemema feltiae* isolates Licanray (LR) and Chillan 4 (CH4) and the native *S. unicornum*, isolate Chillan 3 (CH3). Assays were performed in petri dishes, using the last larval instar of the insect, and two concentrations of Infective juveniles (IJ), 100 and 300/larva. After inoculation Petri dishes were
maintained at 20ºC and evaluated after two days to determine mortality percentage. The production on new IJ/cadaver was also evaluated. Assay was performed under a completely randomized design. The most effective isolate was LR, with over 65% mortality, while the other two isolates ranged between 35 and 65% two days after inoculation. These results suggest that *S. feltiae* LR should be assessed under real field conditions to establish the optimum concentration and opportunity of application.

- Paula Agudelo

**PHYLOGENETIC INFORMATIVENESS INVESTIGATION OF MITOCHONDRIAL PROTEIN-CODING GENES IN NEMATODA PHYLUM** [INVESTIGACIÓN FLOGENÉTICA INFORMATIVA DE GENES DE CODIFICACIÓN DE PROTEÍNAS MITOCONDRALES EN EL PHYLUM NEMATODA]. M. Xinyuan¹, J. Baeza², V.P. Richards² and P. Agudelo¹.

¹Department of Plant and Environmental Sciences, Clemson University, Clemson, South Carolina 29634. ²Department of Biological Sciences, Clemson University, Clemson, South Carolina 29634. xm@g.clemson.edu

The analysis of phylogenetic relationships based on mitochondrial genes is widely utilized to identify species, elucidate population structure, and infer evolutionary histories. To improve our understanding of the utility of mitochondrial protein-coding genes (PCGs) when reconstructing phylogenetic relationships in the Nematoda, we explored phylogenetic informativeness (PI) in a total of 12 PCGs from 93 species of nematodes whose mitochondrial genomes were available in GenBank plus two recently sequenced mitogenomes from plant-parasitic nematode species (*Hoplolaimus columbus* and *H. galeatus*). We used two methods to explore PI. First, we used concatenated sequences of all PCGs to generate a phylogenetic tree of Nematoda Phylum as calibration for studying topological distances and similarities among 43 trees of different phylogenetic markers, using the software Environment for Tree Exploration v3. Second, we calculated PI values of all those phylogenetic markers using the server PhyDesign. Results from the two methods were in agreement and suggests that the PI signal embedded in a phylogenetic marker should be considered in order to reconstruct a reliable phylogenetic relationship. Also we found that phylogenetic signal is gene-specific, and independent of the gene size. The nad5 and nad4 genes are highly informative for nematode phylogeny. Traditional mitochondrial markers, such as the cox1 or cytb gene, contain medium phylogenetic informativeness. We recommend not using nad3, nad4L, cox2 or nad6 for phylogenetic reconstruction given their low phylogenetic signal.

- Martin Augusto Delgado

**HABILIDAD PARASÍTICA DE ESPECIES FUNGOSAS NEMATÓFAGAS SOBRE HUEVOS Y JUVENILES DEL NEMATODO AGALLADOR (Meloidogyne spp.)** [PARASITIC ABILITY OF
El nematodo agallador (Meloidogyne spp.) es una de las mayores amenazas fitosanitarias en cultivos que constituyen la oferta exportable en el Perú, por las favorables condiciones ecobiológicas, entre ellas, grandes extensiones de monocultivos de especies susceptibles. La demanda por agentes biológicos que deprimen la población de este nematodo es cada día mayor, pero se hace necesario estimar permanentemente su eficiencia como biocontroladores. El propósito de este trabajo fue evaluar el potencial parasítico de los hongos nematófagos Pochonia clamydiospora, Purpureocillium lilacinum (cepa SENASA), Purpureocillium lilacinum (cepa Lilanova), Clonostachys roseum, Trichoderma harzianum, Trichoderma viride 1, Trichoderma viride 2, sobre huevos y juveniles de Meloidogyne spp, extraídos del tomate (Solanum lycopersicum L.). Para tal efecto se empleó un diseño completamente al azar (DCA) con cinco repeticiones y nueve tratamientos que fueron: 1) Pochonia clamydiospora; 2) Purpureocillium lilacinum (cepa SENASA); 3) Purpureocillium lilacinum (cepa Lilanova); 4) Clonostachys roseum; 5) Trichoderma harzianum; 6) Trichoderma viride 1; 7) Trichoderma viride 2; 8) Oxamylo, y 9) Testigo (sin nematófago). Después de la extracción, los huevos de Meloidogyne se mezclaron con una suspensión de 10⁶ conidias/mL de cada uno de estos nematófagos. De la mezcla se tomó una gota que fue depositada en un recuadro dibujado en el centro de una placa de Petri con líneas adicionales para facilitar las observaciones y contaje. Los resultados de siete evaluaciones indican que Trichoderma harzianum con 81% Pochonia clamydiospora con 80% Trichoderma viride 1 con 70%, Purpureocillium lilacinum (cepa Lilanova) con 64% y Trichoderma viride 2 con 54% inhibieron significativamente la eclosión de huevos de Meloidogyne spp. También hubo diferencias significativas respecto al número de juveniles muertos, con 47% en oxamyl, 15% en Purpureocillium lilacinum (cepa Lilanova) y 5% con Pochonia clamydiospora. Por los resultados, se considera que la metodología empleada puede contribuir al mejor manejo biológico de Meloidogyne spp. en los sistemas agroproductivos de la costa del Perú.

Elizabeth González Córdoba

MORPHOLOGICAL AND MORPHOMETRIC IDENTIFICATION OF THE MAIN FITONEMATODES ASSOCIATED WITH THE PINEAPPLE CROP IN THE NORTHERN REGION OF COSTA RICA [IDENTIFICACIÓN MORFOLÓGICA Y MORFOMÉTRICA DE LOS PRINCIPALES FITONEMATODES ASOCIADOS AL CULTIVO DE LA PIÑA EN LA ZONA INFERIOR DE COSTA RICA]
The objective of this research was to identify the main phytonematodes present in farms dedicated to pineapple production. Six farms located in the North Zone of Costa Rica were selected. Three plots per farm, with plants between six and eight months of age, were chosen for sampling and samples included five plants with roots and soil per plot. The extraction of the nematodes was carried out using the centrifugation-flotation technique, the average density and absolute frequency of the phytonematode genera were quantified, and, in addition, specimens were fixed in anhydrous glycerin by the Seinhorst method for morphometric identification. The genera *Meloidogyne*, *Aphelenchus*, *Pratylenchus*, *Helicotylenchus* and *Mesocriconema* were morphologically identified. The genus with highest absolute frequency and average density in the root samples was *Pratylenchus*, while for soil samples it was *Helicotylenchus*. The species identified were: *Pratylenchus brachyurus*, *Pratylenchus neglectus*, *Mesocriconema ornatum* and *Mesocriconema onoense*. Species belonging to the genus *Helicotylenchus* could not be identified since morphometrical results overlapped for species. Precise species identification will require of molecular studies.

• **Deborah A. Neher**

**NEMATODES ARE BIOINDICATORS OF SOIL FUNCTION** [LOS NEMATODOS SON BIOINDICADORES DE LA FUNCIÓN DEL SUELO]. **D. A. Neher**, University of Vermont, Burlington, Vermont, USA. [dneher@uvm.edu](mailto:dneher@uvm.edu)

The Nematode Maturity Index is a promising indicator for measuring soil disturbance in cropland soils. Ground-breaking research in the 1990’s empirically verified the statistical reliability of index variations, sample sizes, appropriate references, and calibration by ecosystem and land use type. Nematode community structure and function respond to land management practices such as nutrient enrichment through fertilization by organic or inorganic nitrogen, cultivation, liming, drainage, plant community composition and age, and toxic substances such as heavy metals, pesticides, and petroleum products. With the renewed interest in soil health and expanding databases of amplicon sequences, it is time to complete the research to identify and verify sentinel taxa that predictable respond to specific disturbance types so molecular-based tool kits to can be developed for non-specialists.