**Multistate Project W4186**

**2023 Annual/Final Report**

**Project/Activity Number**: W4186/ W5186 (renewed)

**Project/Activity Title**: Variability, Adaptation and Management of Nematodes Impacting Crop Production and Trade

**Period Covered**: 2023

**Date of This Report**: January 11, 2024

**Annual Meeting Date(s)**: November 13-14, 2023

**Venue:** Santa Fe, New Mexico

**Officers**

Chair: Shahid Siddique

Vice Chair: Haddish Melakeberhan

Secretary: Brent Sipes (filling-in for Niels Groen)

USDA Administrator: Isgouhi Kaloshian

**W4186 Meeting Participants:**

Gleason, Cynthia (Washington State University)

Lawrence, Kathy (Auburn University)

Melakeberhan, Haddish (Michigan State University)

Siddique**,** Shahid (University of California-Davis)

Sipes, Brent (University of Hawaii)

Groen, Niels (University of California-Riverside) (zoom)

Desaeger, Johan (University of Florida)

Powers, Tom (University of Nebraska)

Beacham, Jacqueline (University of New Mexico)

Kudd, Johanna (Asia) (University of Arkansas)

Hodson, Amanda (University of California-Davis)

Gorny, Adrienne (North Carolina State University) (zoom)

Vieira, Paulo (USDA) (zoom)

Guests: DeLay, Paul (retired, UCR) and Thomas, Steve (retired UNM)

Absent: Dandurand, Louise-Marie (University of Idaho), DiGennero, Peter (University of Florida), Watson, Tristan (Louisiana State University)

Retired members:

Hafez, Saad

Ingham, Russ

Roberts, Phil

Thomas, Steve

**Brief summary of minutes of annual meeting:**

**Welcome**

Steve Thomas thanked Jacki Beacham for organizing the Santa Fe venue. He reviewed the agriculture in NM with differences between north and south. Agriculture is the number 3 income in the state. Recent shift in cropping; big pecan production and increasing vineyard acreage. Water is the issue. The state is the number 2 producer of oil/natural gas in the US. NM has one of the highest proportion of Native Americans and large reservations in the US.

**State Reports**

S. Siddiqui UCD - Tomato and root-knot nematode (RKN) interactions, *Mi*-mediated resistance; loss of susceptibility; *Meloidogyne hapla* (Mh) genetics with chromosome focus virulence genes; peptide mimicry in root-knot; genetic transformation of Mh as model; nematode microbe interactions, RKN-Ralstonia interaction. *Mi-*mediated resistance in processing tomato (90% of US production). RKN caused a 5% reduction or $75 mill. The *Mi* gene confers resistance to RKN, aphid, and whitefly. Why and how Mi resistance breaking happens? Effector Guard-Guardee hypothesis, evading detection is perhaps more appropriate explanations than resistant breaking. In non-*Mi* plants the *Mi-*breaking nematode populations seem less fit; looking for the missing *Cg-1*. Genome sequencing revealed that the region of *Cg-1* in thesubgenome B is similar between the wild type and resistance breaking RKN populations VW4 and VW5 - difference is in the subgenome A which seems to lack signal peptides. In resistance evading populations, the effector Avr genes does not interact with Guardee so Guard is not activated.

C. Gleason WSU - RKN on potato, *M. chitwoodi* (Mc) has patchy world distribution. Mc has broad host range. No resistance exists in russet potatoes. Races 1, 2, 3 of Mc is based on host range test. Several genetic data sets available (genomes, transcriptomes, and in situ hybridizations). Genome analysis indicated that the existing Mc genome was not well annotated, so was re-annotated. The genomes of 3 races were sequenced and markers for the different races was developed. Sampling across OR and WA states, yielded 10/20 positive for Mc Roza and Race 1 as most common. Alfalfa no longer grown in the area sampled, so no Race 2 was found. No clear geographical distribution - just wide spread. Some populations of Mc did not map to the current 3 races.

K. Lawrence AU - RKN resistance in cotton [M. incognita (Mi) and *Rotylenchulus reniformis* (Rr)]. Resistant cv yields well in infested fields. Velum seed treatments are preferred by growers but in furrow treatments of Velum are more effective. Temick (AgLogic) is the best performer, perhaps because of added insect effects. Majestine increases plant growth and this reflects in yield. Rr resistance is similar with resistant cultivar giving much greater yield. Similar effects with use of nematicides. In cv comparison, Rr reduces yield by 50%. Genetic resistance is very important. Resistance is not manifested as a HR. Concern is to add a nematicide to preserve host plant resistance. If resistance is cell wall related, resistance breaking may be less of a worry. Commercially, now coops can sell seeds under their own names which maybe the same cultivar even as seed companies. Cover crops and biologicals in sweet potato to control Sweet potato weevils and nematodes. Black oats, daikon radish and mustard did not increase nematode numbers. Variety trials of soybean and Mi - some varieties have resistance, some are tolerant, some varieties are very susceptible. Multiple companies are testing a variety of biologicals and a few synthetic chemicals (Tyrium = same as Velum; Nimitz works but is same as fumigant). Fluopyram is having resistance build up.

Asia G. UA - Molecular host pathogen interactions. Range of work as a postdoc. Building lab at UA. Will work on cotton, soybean, black berries, nematodes and viruses (Hg, Mi, Rr, Xi). Rr and Hg resistance seem to be linked - but Mi resistance is not. Rmi1 on chromosome 10 but specific genes not known. Interested in NAMPs. Looking for RHA1B effector homolog in Hg. Looking at metaeffectors and effector networks as well as Rhabdovirus in Hg.

B. Sips UH - Dominus (ally isothiocycanate) was an effective preplant treatment for Rr in pineapple. Entomopathogenic nematodes (EPN) were affective against sweet potato weevil larvae.

T. Powers UN - AltEn the ethanol disaster. Unused seed corn used for ethanol production A One Health project now - look at effects on soil and water. One challenge is a base line. 12 genera exclusive to sediments. Tobrillids seem to be increasing in contaminated areas. Tobrillibs live in extreme environments. Eumonhystra and Monhystra are also for interest. Persistent Biocontrol using *Heterorhabditis bacteriophora* as an EPN. Not much difference with EPN application. Most EPN recovered are native EPN not those applied in the Persistent Biocontrol. Cyst nematodes found in Montana survey - *Heterodera flilipevi* found in canola-wheat rotation.

H. Melakeberhan MSU - What is suitable soil health? - need to be defined. Need to integrate multiple disciplines for sustainable soil health. Mh and Parasitic Variability relative to soil health. Testing to identify bacteria that are associated with soil health. Several bacteria show the relation between soil type and nematode abundance. Disturbed soil had 89 bacteria OTUs unique to themselves. No bacteria shared by three soils or between disturbed and degraded soils. Stable soil had the most OTUs.

J. Desaeger UF – *M. enterolobii* (Me) one of 17 species found in FL. Me found in every continent including Australia. Netherlands was found in house plants being imported. In the US Me is found in FL, NC, LA, SC and GA. In FL, Me is as common as Mi. Sampling was done and most samples were from commercial tomato fields. Me was most common in Asian vegetable growers fields. For chemical controls, nematode genera/species do not make much difference. For cover crop approaches, the nematode species matters.

A. Hodson UCD - Resistance breaking RKN and fusarium wilt was investigated in tomato in which many cultivars should have RKN resistance. Resistance breaking is a widespread problem in tomato with the *Mi* gene. Resistance breaking is not due to high temperature. Not just nematode resistance but also Fusarium resistance may be breaking. Looking at co-management options such as biosolarization using olive pressing waste, which is a type of waste a challenge to deal with. Biosolarization with olive pressing waste was tested in the field and resulted in reduction in RKN population.

N. Groen UCR – Rice-RKN as a system to study plant-nematode interactions. Irrigated and dryland rice land races were screened to identify resistance. Irrigated rice land races are more susceptible to RKN compared to dryland land races. Maybe dryland rice were exposed to more RKN and so have been selected for resistance. An evolutionary fitness approach and gene expression were used to identify genes that are associated with defense against RKN. In dry field cultivation, nematodes were found on roots. Plants were evaluated for various traits and sampled for RNA extraction. Many differentially expressed genes were identified with clear division between wet and dryland cultivation. Coexpressed gene module data sets were identified; two of these modules are correlated with wax biosynthesis and microbial pathogen interactions. Further narrowing down the expressed genes, identified a gene in suberin biosynthesis that could be a target for deletion studies. Less suberin may result in increased RKN resistance.

J. Beacham UNM – did not present orally due to illness.

P. Vera USDA - First reported in Ohio in 2012, beech leaf disease is caused by the nematode *Litylenchus spp* which infects American, European and Asian beeches resulting in tree mortality within 2-5 years. The nematodes overwinter in buds, move locally by rain but the long distance transport not clear yet. Nematode feeding causes cell enlargement and cause changes in cell layer number by inducing cell division. This is similar to other nematodes in the Anguinidae family. Looking for effectors/signal peptides identified 100 candidate genes and 25 are pioneer genes. Currently, collaborating with other US labs and Japanese labs on this project.

A. Gorny NCSU - Me identified in NC in 2011 and currently mostly found in the central coastal plain. Nematode infected sweet potato cannot be exported to Europe. Difficult to use rotation of control damage. Evaluating different chemicals for control. Velum, Salibro and Telone are top performers. However, nematicides do not solve the Me problem in sweet potato. Host plant resistance screening is ongoing in tobacco. Rotations and cover crops being investigated for Me population reductions. Peanut and corn are poor Me hosts. Recent survey of tobacco identified 10 nematode species including lesion, stubby root, stunt, dagger, spiral, ring and tobacco cyst; Mi being the most common and only two samples were positives for Me.

Special Presentation by Paul De Ley. Camera and lenses for 21st century. 1X to 5X lense is similar to the dissecting scopes we are familiar with. Good for recording symptoms.

**Business Meeting: Nov 14, 2023**

Following items were discussed,

**Location:** Hawaii was selected as a location for 2024 meeting. Brent will check potential dates (beginning to mid November 2024).

**Officer’s Election**

Haddish Melakeberhan – chair

Niels Groen – vice chair

Johan Desaeger -was voted to secretary by acclamation.

**Other business:**

Thanks given to Jacki Beacham for organizing a wonderful meeting at a great venue. Steve Thomas was thanked for his efforts hosting the meeting. Cynthia Gleason was recognized for her efforts with the renewal of the project. Cynthia received a letter of support from Sergei Subotin indicating his willingness to provide diagnostic expertise to the project if needed. We will invite him to future meetings. Thanks was given to Shahid Siddique for his leadership.

The NMISS project web page needs updating. Several former participants are still listed. Additional new members were discussed.

Shahid proposed undertaking a joint effort group project like a web page dedicated to the project. A page should have members and then be general subject matter. Include impact statements. A 2-3 person subcommittee (Haddish, Asa, Shahid, Niels) can draft further details including costs, content.

A single document for the final report for W4186. Includes Needs to summarize annual progress, and then cumulative impact of project. We have 60 days to submit. Haddish will work with Cynthia to develop the final termination report for W4186. Send reports to Cynthia and Haddish. Isgouhi is willing to edit a draft.

Nomination of W4186 group for regional project award. A webpage would strengthen the case. Isgouhi will check on the required material and process.