United States Department of Agriculture

National Institute of Food and Agriculture

A Multi-state Effort to Contain and Manage the Invasive Guava Root Knot Nematode in Vegetable Crops

Specialty Crop Research Initiative (SCRI)

January 28th, 2020

Advisory Board

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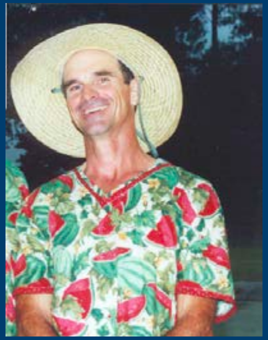

Charles Hall
Georgia Fruit and Vegetable Growers Association

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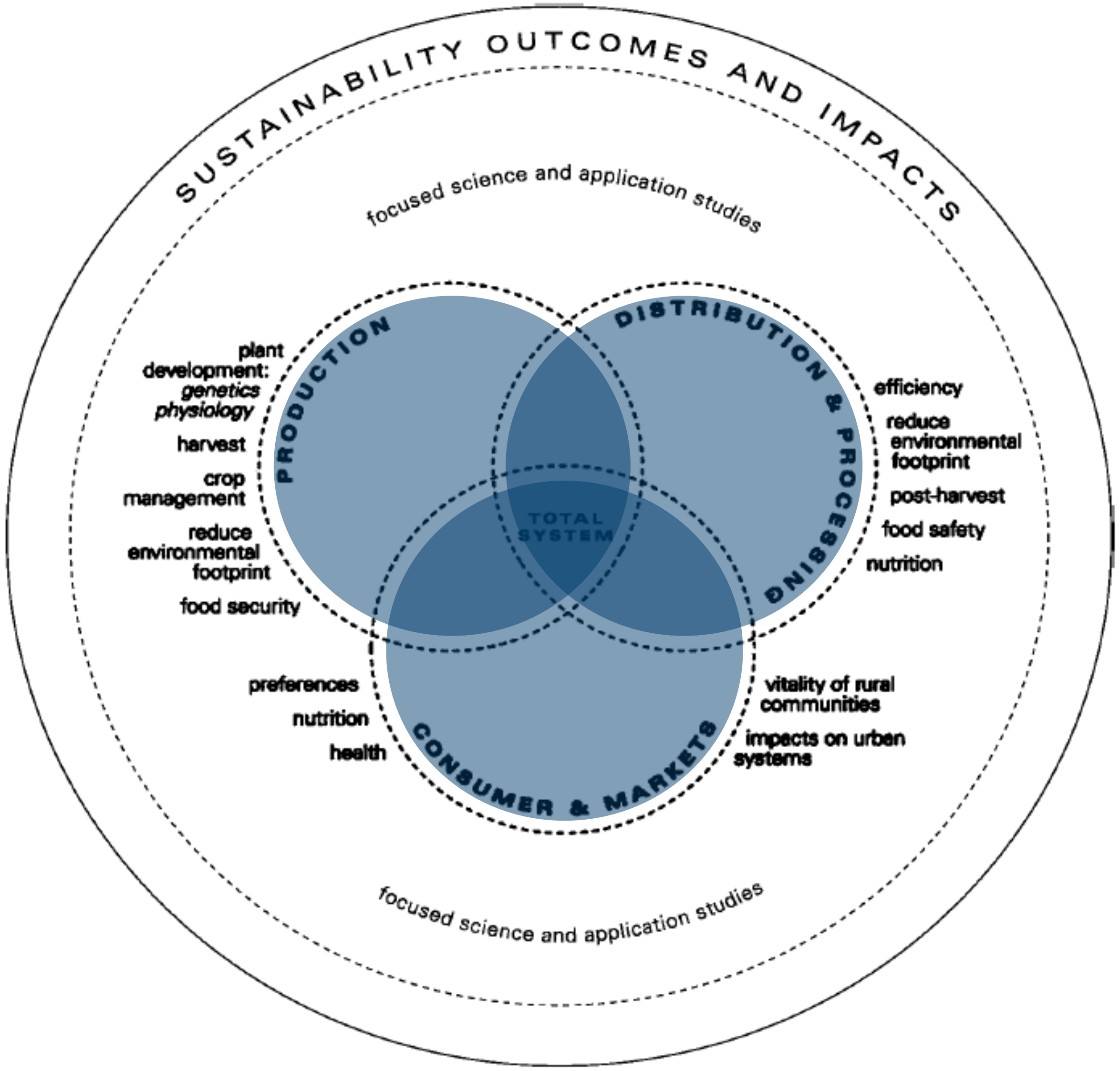
Purpose and Priorities

1. **Integration of research *and* extension activities**
2. **Systems-based, trans-disciplinary approach**
   - brings biological and physical scientists together with economists and social scientists to address challenges holistically
3. **Projects should focus on entire primary systems, or areas where two or more primary systems overlap**
4. **Consider entire system when addressing industry challenges**



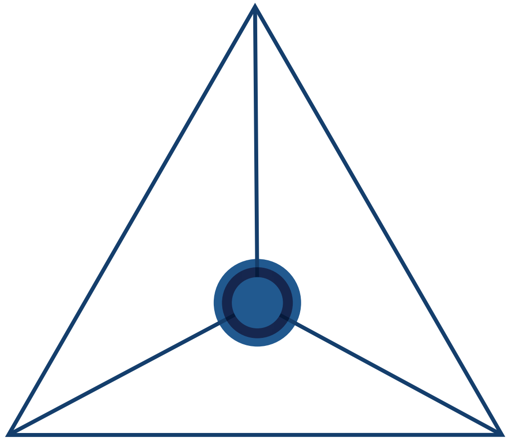
Rationale

- Potential impact on vegetable growers in southeastern states is significant
  - average 10% yield loss due to addition of this RKN for these crops in just Florida and North Carolina ($142 Million in losses)
- Losses for sweetpotato in the top four producing states (NC, MS, CA, LA)
  - two cultivars account for over 75% of the acreage grown in these states, both of which are susceptible to GRKN
- Critical to be *proactive*, rather than *reactive*, to the newly emerging nematode pest

Search for the **presence** of GRKN in the southeast United States (the Carolinas, Florida, Georgia), to screen accessions of cucurbit (cucumber and watermelon), pepper and sweetpotato **germplasm for resistance**, and to demonstrate that GRKN can be **managed and contained** efficiently and effectively.

Scope

Reduce the vulnerability of growers to the agricultural threat posed by GRKN



Schedule

Four-year Coordinated Agricultural Project Award

Budget

$7.274M (1:1 match) to Clemson University; supports four subawards

Guava Root Knot Nematode (GRKN)


Female and stained eggs


Female under gall & egg mass

Photo credit: Camilo Parada and Lina Quesada, NC State University

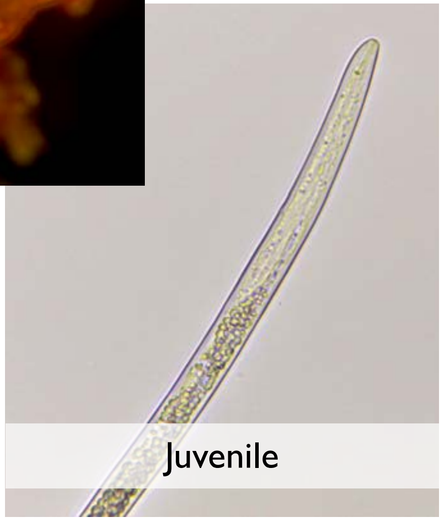
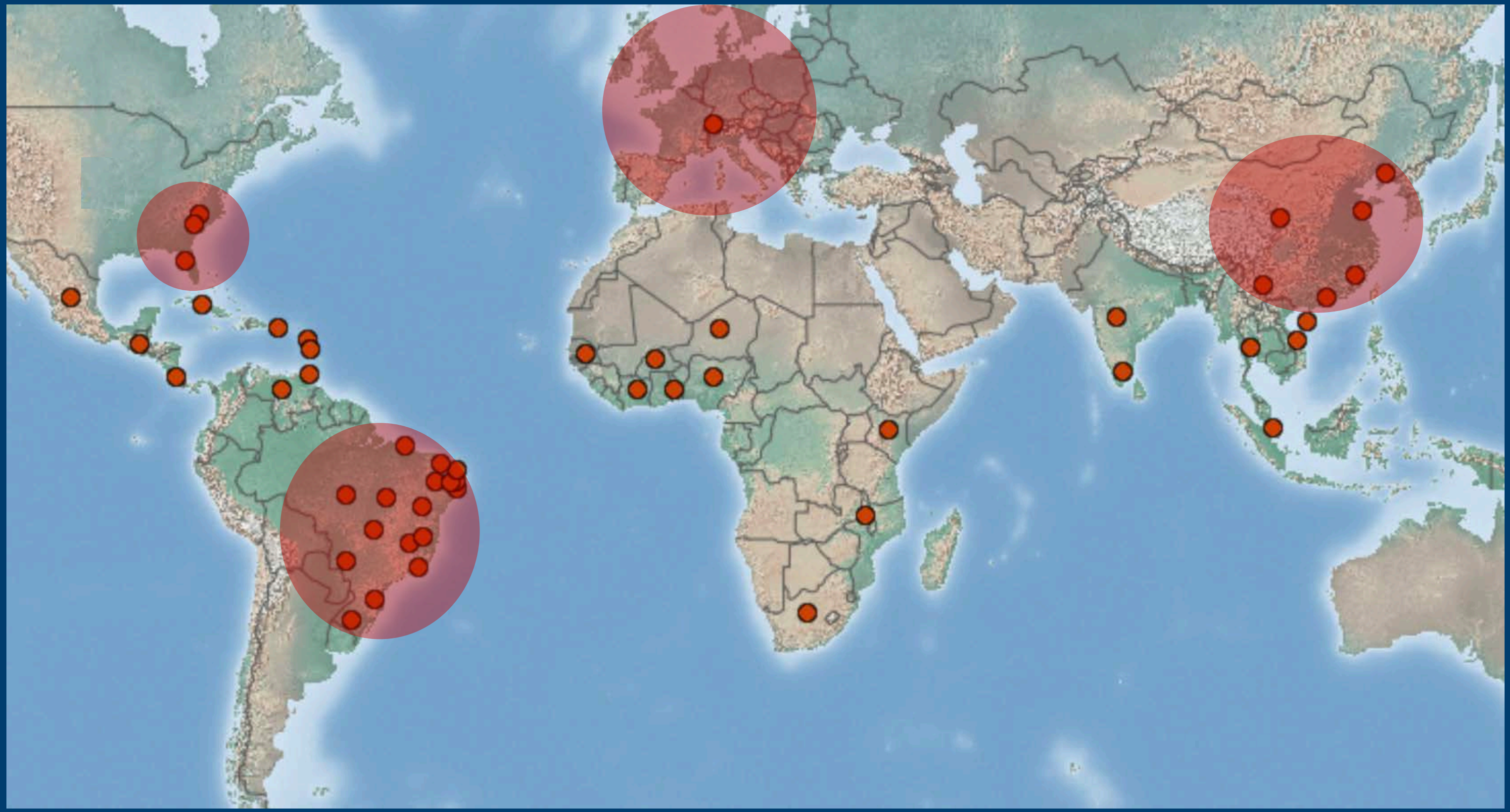

Juvenile

Photo credit: Sammi Wong and Lina Quesada, NC State University

Characteristics

- Polyphagous – tomato, pepper, watermelon, fruit trees, row crops, ornamental plants
- Highly virulent in resistant crop varieties
- Highly aggressive – induces more severe root galling than other species of RKNs

GRKN History and Distribution



Distribution of *M. enterolobii*. Source: cabi.org

Thought to have originated in China

Infection of guava orchards in Brazil in early 2000s led to collapse of entire industry

High virulence and broad host range → quarantine pathogen in EU

Mounting problem in southeastern US

Hosts and other affected plants

Artocarpus heterophyllus (jackfruit)
Byrsonima cydoniifolia
★ Capsicum annuum (bell pepper)
★ Citrullus lanatus (watermelon)
Coffea (coffee)
★ Cucumis sativus (cucumber)
Daucus carota (carrot)
Dioscorea rotundata
Enterolobium contortisiliquum (tamboril)
Euphorbia punicea
Glycine max (soyabean)
Gossypium hirsutum (Bourbon cotton)

★ Ipomoea batatas (sweet potato)
Malpighia
Manihot esculenta (cassava)
Maranta arundinacea (West Indian arrowroot)
Morus (mulberrytree)
Morus nigra (black mulberry)
Musa spp.
Phaseolus (beans)
Psidium guajava (guava)
★ Solanum lycopersicum (tomato)
Solanum pseudocapsicum (Jerusalem-cherry)
Zingiber officinale (ginger)
Ziziphus jujuba (common jujube)

GRKN Infection

Symptoms

- Reduced quality and quantity
  - Galling
  - Stunted growth
  - Leaf chlorosis
  - Deformation of plant organs

Tomato

Sweetpotato

Photo credit: Camilo Parada, Quesada Lab

GRKN Infection and Movement

- Soilborne pathogen
  - Infected tissue
  - Infested soil
- Sweetpotato confirmed as a vector for movement

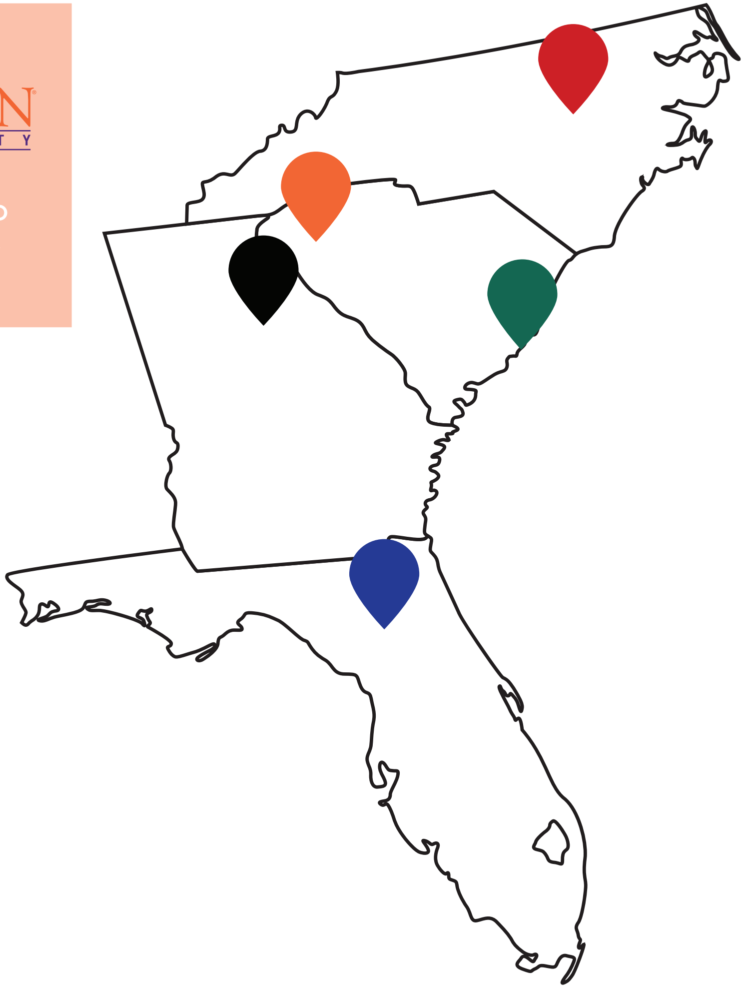
Photo credit: Camilo Parada, Quesada Lab

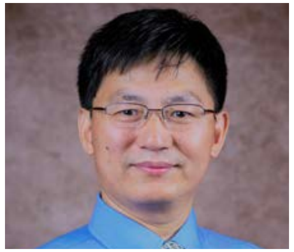
GRKN found in fresh market sweetpotato: Sweetpotato infected with GRKN originated from a grower in North Carolina and collected in South Carolina.

Partners

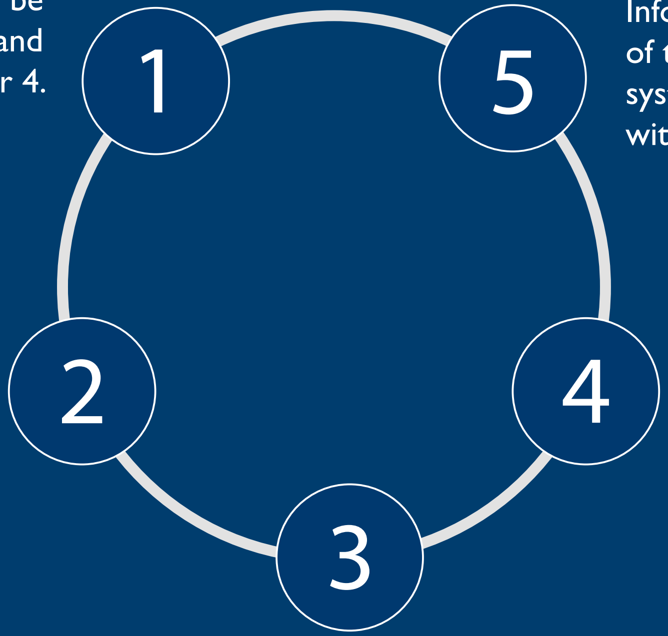
CLEMSON
UNIVERSITY

Paula Agudelo
John Mueller





Approach



Germplasm Phenotyping
GRKN phenotyping of target species will be started in year 1 and continue through year 4.

Mapping of GRKN Resistance
GWAS for GRKN resistance will start in year 3 as finalized phenotyping data becomes available, and will continue through year 4.

Germplasm Improvement
Germplasm identified as resistant to GRKN will be used for designing crosses for introgression into breeding lines for cucumber, pepper, sweet-potato, and watermelon. Sweetpotato crosses will begin in year 1 and continue through year 4.

Economic Analysis
To evaluate the on-farm economic viability of management practices, information on costs and yields from research experi-ments and stakeholders will be utilized.

Extension and Outreach
Information regarding the progress and impact of the outreach plan will be supported with systematic evaluation by the Project Manager with input from the Industry Advisory Panel.

Objectives

1. Study the **prevalence** and **distribution** of GRKN in vegetable crops in the Carolinas, Florida, and Georgia; characterize the genetic variability encountered
2. Evaluate and develop vegetable **germplasm** with resistance against GRKN
3. Evaluate the efficacy of rotations, cover crops, and nematicides as **management strategies** for GRKN
4. Assess the **costs and returns** of rotations, cover crops, and nematicides for the management of GRKN on sweet potato, cucumber, watermelon, and tomato crops
5. Develop print and web-based materials to **disseminate** suggested management/ containment strategies for GRKN

Objective 1

Study the prevalence and distribution of GRKN in vegetable crops in the Carolinas, Florida, and Georgia; characterize the genetic variability encountered

- Identify dissemination pathways
- Determine crops at risk of infection
- Determine potential green bridges
- Provide baseline species adaptation data
- Provide insight into host resistance for management, and evaluate containment and sanitation measures

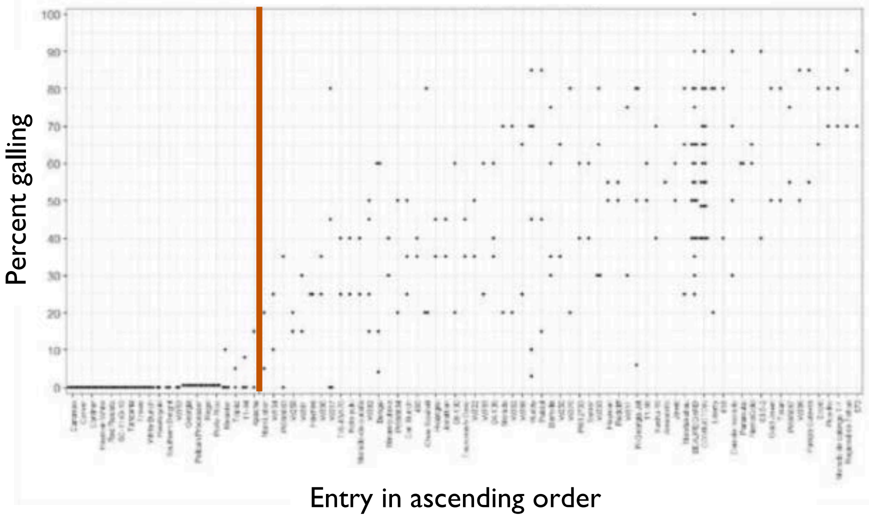
Objective 2

Evaluate and develop vegetable germplasm with resistance against GRKN

- Identify sources of GRKN resistance in susceptible crops
- Develop high-throughput phenotyping tools to accelerate GRKN-resistant vegetable breeding efforts
- Map GRKN resistance genes and develop new makers to aid ingression of resistance genes
- Develop new GRKN resistant germplasm

Objective 2

- **Identify sources of GRKN resistance in susceptible vegetable crops by screening representative core sets of PI lines from the USDA-GRIN germplasm collections of sweetpotato, pepper, watermelon, and cucumber**



Susceptibility of 83 sweetpotato plant introductions (PIs) to a GRKN isolate from SC.

SWEETPOTATO	RESISTANCE
Beauregard	*M. arenaria*
Caro Gold	*M. incognita, M. arenaria, M. javanica*
Covington	Moderately resistant to *M. incognita*
Jewel	*M. incognita, M. arenaria, M. javanica*
Regal	*M. enterolobii, M. incognita,*
350 GRIN accessions	
PEPPER	**RESISTANCE**
Criollo de Morelos 334 (Me3 gene)	*M. incognita, M. arenaria, M. javanica*
Charleston Belle (N gene)	*M. incognita, M. arenaria, M. javanica*
HDA330 (Me1 gene)	*M. incognita, M. arenaria, M. javanica*
PM687 (Me4 gene)	*M. arenaria*
350 GRIN accessions	
WATERMELON	**RESISTANCE**
Citrullus lanatus var. *citroides*	
Bulldog	*M. incognita*
RKVL-301	*M. incognita*
RKVL-302	*M. incognita*
100 GRIN accessions	
CUCUMBER	**RESISTANCE**
Cucumis metuliferus	*M. incognita*
Cucumis hystrix	*M. incognita*
Cucumis sativus var. Hardwicky	
Manteo (MJ gene)	*M. arenaria, M. javanica*
100 GRIN accessions	

Germplasm with known resistance to root-knot nematodes and other accessions representing the core set for screening.

GRKN Resistance

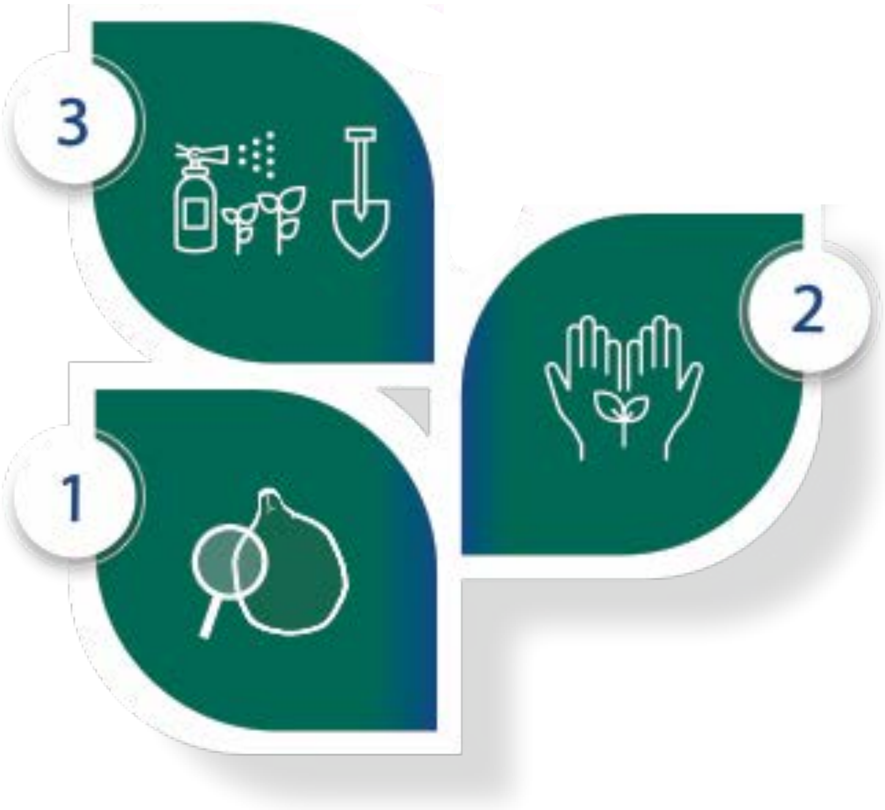
None of the RKN resistance genes are effective against GRKN: Root-knot nematode resistant pepper cultivar Charleston Belle infected with GRKN. Heavy root galling and numerous nematode egg masses (stained red) were observed on all pepper lines tested, which included lines carrying RKN resistance genes.

RKN-resistant sweetpotato ‘Covington’ infected with field-collected GRKN eggs in the greenhouse, demonstrating that sweetpotatoes can carry infective GRKN

Objective 3

Evaluate the efficacy of rotations, cover crops, and nematicides as management strategies for GRKN

- Evaluate chemical control options
- Examine impact of cover crops antagonistic to *Meloidogyne* spp. in sweetpotato rotational crops
- Assess impact of management of nematodes in rotational crops



Objective 3

- **Evaluate chemical control options (fumigant and non-fumigant nematicides)**

Sweetpotato

No.	Treatment	Active Ingredient	Product rate	Mode of application
1	Untreated	-	-	-
2	Telone II	1,3-dichloropropene	6 gal/A	Fumigation
3	Telone II	1,3-dichloropropene	9 gal/A	Fumigation
4	Chloropicrin	Chloropicrin	3 gal/A	Fumigation
5	Velum Prime	Fluopyram	6.5 floz/A	Drench
6	Salibro	Fluazaindolizine	30.7 fl oz/A	Drench
7	Nimitz	Fluensulfone	1.3 pt/A	Pre-plant spray
8	Telone II	1,3-dichloropropene	9 gal/A	Fumigation
	Velum Prime	Fluopyram	6.5 floz/A	Drench
9	Telone II	1,3-dichloropropene	9 gal/A	Fumigation
	Salibro	Fluazaindolizine	30.7 fl oz/A	Drench
10	Experimental	Experimental	Experimental	Drench

Fumigant and non-fumigant nematicide treatments to test in 'Covington' sweetpotato field experiments for control efficacy of *M. enterolobii* in NC and FL.

Other vegetables

No.	Treatment	Active Ingredient	Product rate	Mode of application
1	Untreated	-	-	-
2	PiClor60	1,3-dichloropropene	200 lbs/A	Fumigation
3	Kpam	metam	40 gal/A	Fumigation
4	Pic100	Chloropicrin	200 lbs/A	Fumigation
5	Velum Prime	Fluopyram	6.5 floz/A	Drip
6	Salibro	Fluazaindolizine	61.4 fl oz/A	Drip
7	Nimitz fb Velum	Fluensulfone / Fluopyram	5 pt/A + 6.5 fl oz	Drip
8	Kpam fb Salibro	Metam / fluzaindolizine	40 gal/A + 30.7 fl	Fumigation + drip
9	Experimental		Experimental	Drip

Fumigant and non-fumigant nematicide treatments to test in vegetable field experiments for control efficacy of *M. enterolobii* in NC and FL.

Objective 3

- **Examine the impact of cover crops antagonistic to *Meloidogyne spp.* in sweetpotato rotational crops including Sunn Hemp, Oilseed Radish, and Winter Rye**

Zane Grabau, UF

Patchy necrosis (dead or dying plants) and chlorosis (yellowing) in a peanut field with severe root-knot nematode infestation.

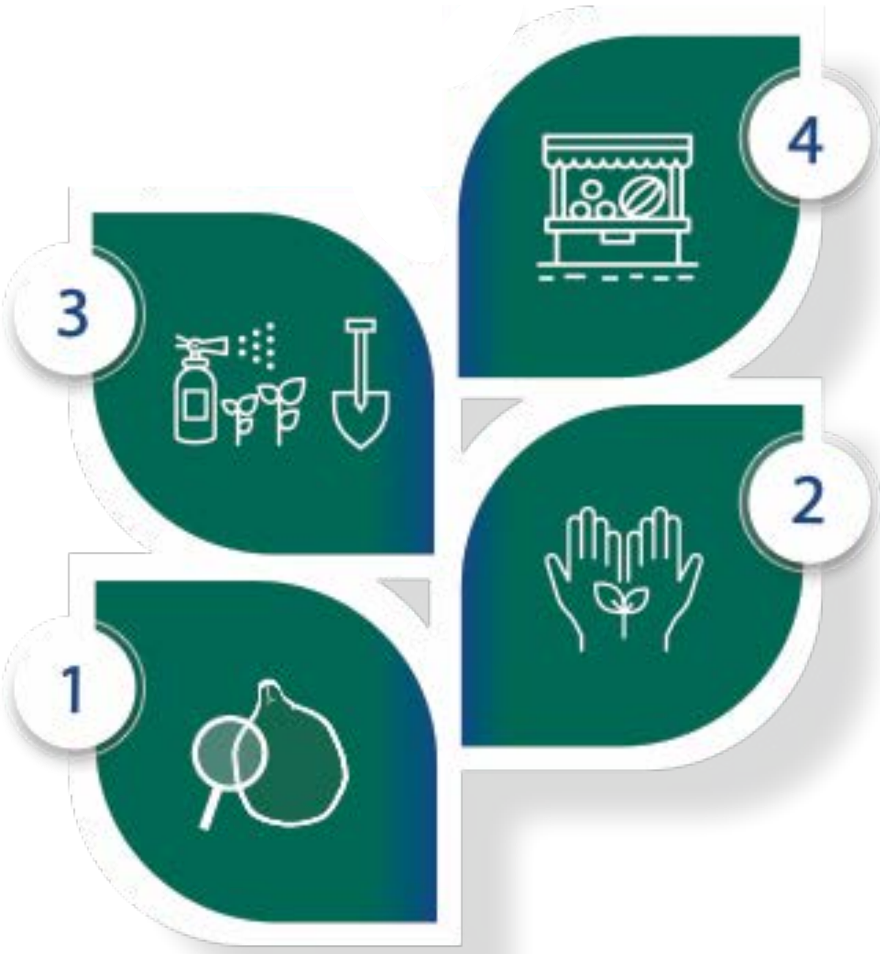
	Southern Root-Knot Nematode	Peanut Root-Knot Nematode	Javanese Root-Knot Nematode	Stubby-Root Nematode	Sting Nematode
Cash Crops					
Broccoli	Varies	Host	Host	Unknown	Unknown
Cabbage	Varies	Host	Varies	Host	Host
Cauliflower	Varies	Host	Varies	Unknown	Host
Corn	Host	Varies	Host	Host	Host
Soybean	Varies	Host	Host	Host	Host
Sweet potato	Varies	Host	Host	Unknown	Unknown
Tomato	Varies	Varies	Varies	Host	Host
Watermelon	Host	Host	Host	Unknown	Poor/nonhost
Cover Crops					
Sorghum-sudangrass	Poor/nonhost	Poor/nonhost	Poor/nonhost	Host	Host
Sunn hemp	Poor/nonhost	Poor/nonhost	Poor/nonhost	Unknown	Poor/nonhost
Cowpea	Varies	Varies	Varies	Varies	Host
Velvet bean	Poor/nonhost	Poor/nonhost	Poor/nonhost	Host	Poor/nonhost
Hairy indigo	Poor/nonhost	Poor/nonhost	Poor/nonhost	Unknown	Poor/nonhost
Jointvetch	Poor/nonhost	Poor/nonhost	Poor/nonhost	Host	Unknown

Host status of selected cash and summer cover crops for common plant-parasitic nematodes in potato-growing regions of Florida.

Objective 4

Assess the costs and returns of rotations, cover crops, and nematicides for the management of GRKN on sweet potato, cucumber, watermelon, and tomato crops

- Perform assessment of economic risk to vegetable growers
- Estimate costs and returns for management strategies
- Assess economic impact of quarantine measures



Objective 5

Develop print and web-based materials to disseminate suggested management/ containment strategies for GRKN

- Translate findings into user-friendly solutions for stakeholders
- Disseminate through extension publications and communication during grower meetings and field days

Please complete the survey

Expected Outcomes

1. Enhance knowledge of distribution and diversity of GRKN
2. Identify previously unknown sources of resistance
3. Increase availability of cultivars and germplasm resistant to GRKN
4. Disseminate management techniques via workshops, meetings, web-based materials

USDA Agricultural Research Service

UF University of Florida

NC State University

University of Georgia

Clemson University

USDA

United States Department of Agriculture
National Institute of Food and Agriculture

https://newsstand.clemson.edu/mediarelations/clemson-researchers-armed-to-combat-guava-root-knot-nematodes/