

Research Project Report – 2018
Southern Region Small Fruit Consortium

PROJECT TITLE: Occurrence and distribution of plant-parasitic nematodes on muscadine grapes in Georgia and North Carolina.

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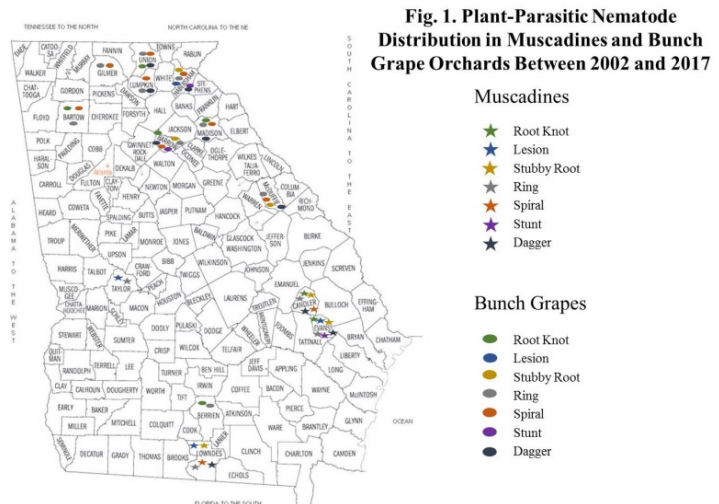
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Objective: To Study the occurrence and distribution of plant-parasitic nematodes on muscadine grapes in Georgia and North Carolina

Justification and Potential Benefits: Muscadine grape (*Vitis rotundifolia*) is native to the southeastern United States but among these states, Georgia and North Carolina are the largest producers of these economically important grapes, with over 1600 and 1300 planted acres and averages of \$2.7 and \$2.5 million farmgate values, respectively (USDA, 2015; Cline and Fisk, 2006; Georgia Crop Reporting Service, 2000). Muscadine grapes are valued for their fresh, sweet and unique flavor (Krewer and Myers, 2017), and in addition to fresh market sales, they are used for making juices, jams, pies, wines and nutraceuticals that have many health benefits. These grapes contain a very high level of resveratrols, phenols and antioxidants (Ector et al., 1996; Pastrana-Bonilla, et al., 2003; Percival et al., 2002) that are known to help in fighting cardiovascular diseases and cancer-causing agents (Olas and Wachowicz, 2005; Signorelli and Ghidoni, 2005). Although muscadine grapes are fairly resistant to different diseases and insect pests as compared to bunch grapes (*V. labrusca*, *V. vinifera*), they are attacked by a variety of diseases such as angular leaf spot (*Mycosphaerella angulata*), bitter rot (*Greeneria uvicola*, syn. *Melanconium fuligineum*), powdery mildew (*Uncinula necator*), ripe rot (*Glomerella cingulata*), macrophoma rot (*Botryosphaeria dothidea*), black rot (*Guignardia bidwellii* f. *muscadinii*), Pierce’s disease (*Xylella fastidiosa*) and crown gall (*Agrobacterium* sp.), and insect pests including aphids, leafhoppers, flea beetles, grape berry moth, grape weevil, stink bugs, green June beetle, grape root borer and Japanese beetle, all of which can cause serious damage to grape vines resulting in reduced grape yields (Cline, et al., 2010).

In addition to insect pests and diseases, plant-parasitic nematodes (PPNs) have become a significant factor affecting the health, quality, production, and maintenance of bunch grapes (*V. labrusca*, *V. vinifera*) in all the grape growing regions of the world (Raski, 1988). Major PPNs frequently found associated with bunch grapes include ring (*Mesocriconema* spp.), root-knot (*Meloidogyne* spp.), dagger (*Xiphinema* spp.) and lesion (*Pratylenchus* spp.) nematodes (Bird and Ransdell, 1985; Pinkerton et al., 1999). In Georgia, a limited survey of predominantly *V. vinifera* conducted during 2002 demonstrated that six PPNs, including root-knot (*Meloidogyne* spp.), stubby-root (*Trichodorus* spp.), ring (*Mesocriconema* spp.), stunt (*Tylenchorhynchus* spp.), spiral (*Helicotylenchus* spp.) and dagger (*Xiphinema* spp.) nematodes were associated with bunch grapes (Personal communication- Phil Brannen). The UGA Nematode Diagnostic Laboratory also processed soil samples from seven different bunch grape growers located in seven different counties for the presence of PPNs and confirmed the widespread occurrence and diverse distribution of these six PPN genera in Georgia bunch grape orchards (Fig. 1). However, virtually nothing is known about nematode populations in muscadine grapes and their potential for damage over time, especially in replant scenarios.

Over the last 15 years, only four soil samples from muscadine vineyards (four different Georgia counties) were processed by the UGA Nematode Diagnostic laboratory; ring nematodes were present in all samples; lesion,



stubby-root, spiral and dagger were present in 3 samples; root-knot nematodes were present in 2 samples; and stunt nematodes were found in only one sample (Fig. 1). This suggests that the PPNs could be important pests of muscadine grapes, but again, we have virtually no information available in the literature as to the occurrence and distribution of PPNs in muscadine grape orchards in Georgia or North Carolina. This information vacuum provided the impetus for conducting a preliminary PPN survey of muscadine grape vineyards during August and October 2018. This research would serve as the basis for developing future research on nematode management if necessary.

Methods: A systematic survey was conducted of PPNs infesting commercial muscadine grape vineyards in Georgia and North Carolina in August and October, 2018, respectively. Working in conjunction with Cooperative Extension agents in Georgia, 8 vineyards in 7 counties throughout Georgia were selected for the survey (Fig. 2). At each vineyard, 5 individual grapevines were randomly selected in a row for soil sampling, and 10 random soil cores (2-cores per grapevine) were collected from ~30 cm away from and around the trunk of each grape vine using a soil probe (15 cm deep X 2.5 cm wide). Soil cores from all 5 grapevines were mixed into one composite sample and 5 such composite samples were collected from each vineyard in each county. Each survey sample was placed in plastic bags and transported back to the Extension Nematology Laboratory (Athens, GA) in coolers. Plant-parasitic nematodes were then collected from a 100 cm³ soil sub-sample taken from each composite sample as described by Jenkins (1964). Nematodes from each sample were identified to their genus level and counted using an inverted compound microscope. Population densities of each nematode genus are expressed as nematodes/100 cm³ of soil. For presentation of the survey data, the frequency of occurrence for each genus detected was calculated the total number of samples in which the nematode genus was detected divided by the total number of samples collected (40 and 55 samples collected from Georgia and North Carolina, respectively), multiplied by 100 to convert to a percentage. An index of abundance was calculated for each genus as the sum of nematode densities per 100 cm³ soil divided by the total number of samples in which the nematode genus was detected. The maximum population density detected per 100 cm³ soil for each genus was also reported.

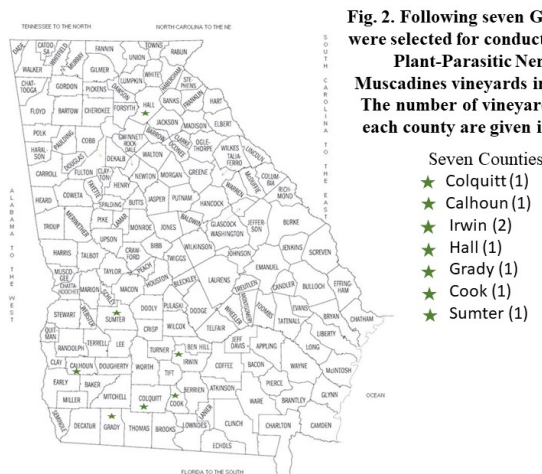


Figure 2. Nematode survey locations in seven Georgia counties including Colquitt, Calhoun, Cook, Grady, Hall, Irwin and Sumter.

A systematic survey was also conducted in North Carolina during October 2018 with similar sampling procedures, in which 11 vineyards were surveyed in 7 muscadine grape- producing counties for a total of 55 samples (Fig.3). The soil samples from North Carolina were also processed for PPN assays at the Extension Nematology Laboratory (Athens, GA) and collected PPNs were identified and counted, and data analyzed as described above.

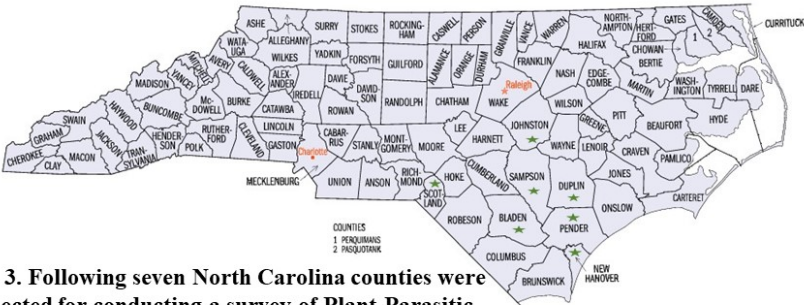


Fig. 3. Following seven North Carolina counties were selected for conducting a survey of Plant-Parasitic Nematode in Muscadines vineyards in October 2018. The number of vineyards sampled in each county are given in parenthesis

- Seven Counties
- ★ Bladen (3)
 - ★ Duplin (1)
 - ★ Johnston (1)
 - ★ Sampson (2)
 - ★ Scotland (1)
 - ★ New Hanover (1)
 - ★ Pender (2)

Figure 3. Nematode survey locations in seven North Carolina counties including Bladen, Duplin, Johnston, New Hanover, Pender, Sampson, and Scotland.

Results and Discussion

We found nine PPN genera including *Meloidogyne*, *Mesocriconema*, *Tylenchorhynchus*, *Helicotylenchus*, *Paratrichodorus*, *Pratylenchus*, *Hemicycliophora*, *Xiphinema* and *Scutellonema* were present in muscadine grape vineyards in 7 Georgia counties (Fig. 4). However, the frequency of occurrence of these PPN genera varied among the samples. For example, *Helicotylenchus* and *Mesocriconema* nematodes were present in the highest number of samples (93 and 65% of samples, respectively) followed by *Pratylenchus*, and *Xiphinema* genera in 33 and 28% of samples, respectively. The other genera including *Paratrichodorus*, *Meloidogyne*, *Tylenchorhynchus*, *Hemicycliophora* and *Scutellonema* nematodes were present only in less than 10% of soil samples (Table 1). Although the most frequently detected PPNs were *Helicotylenchus* (74/100 cm³ soil) and *Mesocriconema* (38/100 cm³ soil), their abundance was comparatively less than *Scutellonema* (351/100 cm³ soil) (Table 1). Although, the higher mean population density was recorded for *Scutellonema* (710/100 cm³ soil) than *Helicotylenchus* (450/100 cm³ soil), *Mesocriconema* (295/100 cm³ soil) and *Xiphinema* (29/100 cm³ soil) (Table 1), the genus *Scutellonema* was found associated with muscadine grapes in a vineyard located only in Grady County but not in other Georgia counties.

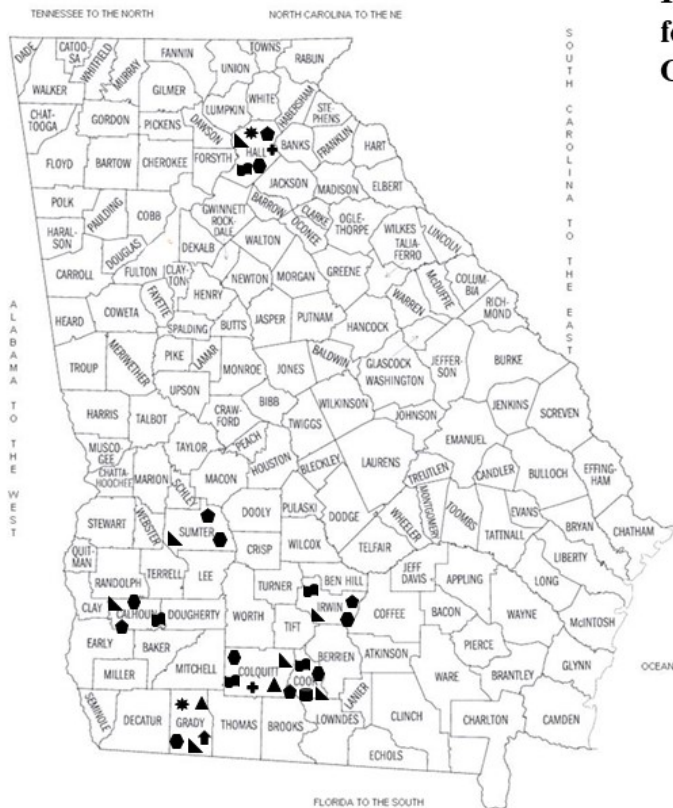


Fig. 4. Plant-Parasitic Nematodes found in Muscadines vineyards in Georgia (August 2018).

- ▲ *Helicotylenchus* sp. (Spiral)
- *Hemicycliophora* sp. (Sheath)
- * *Meloidogyne* sp. (Root Knot)
- ◈ *Mesocriconema* sp. (Ring)
- ▲ *Paratrichodorus* sp. (Stubby Root)
- ◆ *Pratylenchus* sp. (Lesion)
- ⊕ *Tylenchorhynchus* sp. (Stunt)
- ⚔ *Xiphinema* sp. (Dagger)
- ⬆ *Scutellonema* sp. (British Spiral)

Figure 4. Plant- parasitic nematode found in seven Georgia counties including Colquitt, Calhoun, Cook, Grady, Hall, Irwin and Sumter.

We also found that eight PPN genera including *Belonolaimus*, *Meloidogyne*, *Mesocriconema*, *Tylenchorhynchus*, *Helicotylenchus*, *Paratrichodorus*, *Pratylenchus* and *Xiphinema* were present in muscadine grape vineyards located in seven North Carolina counties (Fig. 5). Of these genera, only three genera including *Helicotylenchus*, *Xiphinema* and *Mesocriconema* nematodes were present in the highest number of samples (89, 80 and 76% of samples, respectively) followed by *Paratrichodorus* (18% samples) *Pratylenchus* (13% samples) and *Meloidogyne* (13% samples) nematodes (Table 2). Among the three most frequently occurring nematodes, *Mesocriconema* was the most abundant nematode genus, with mean soil population densities of 93 nematodes/100 cm³ soil (Table 2). Furthermore, the maximum mean population density was recorded for *Mesocriconema* (844/100 cm³ soil) followed by *Helicotylenchus* (190/100 cm³ soil) and *Tylenchorhynchus* (66/100 cm³ soil) (Table 2).

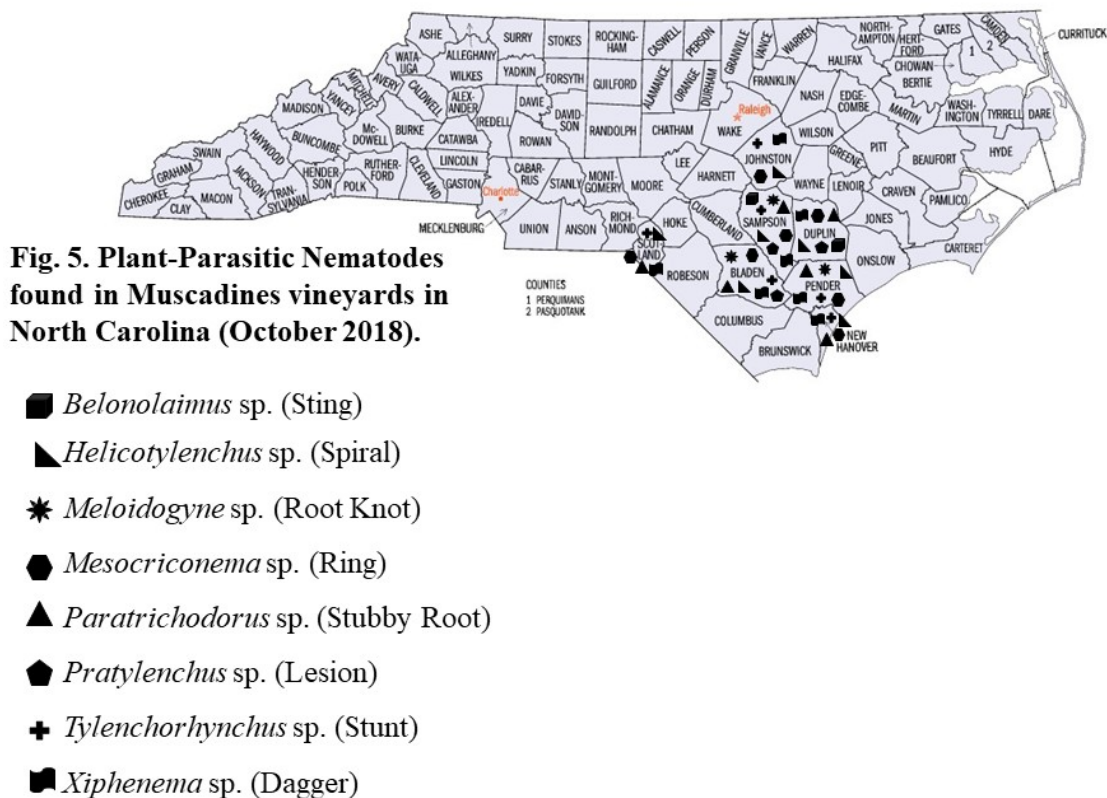


Figure 5. Plant- parasitic nematode found in seven North Carolina counties including Bladen, Duplin, Johnston, New Hanover, Pender, Sampson, and Scotland.

Although, seven PPN genera including *Meloidogyne*, *Mesocriconema*, *Tylenchorhynchus*, *Helicotylenchus*, *Paratrichodorus*, *Pratylenchus* and *Xiphenema* were common to both Georgia and North Carolina, their frequencies and population densities were lower in Georgia than in North Carolina (Tables 1 and 2). As dagger nematodes (*Xiphenema* spp.) were found at high and low frequencies in North Carolina and Georgia, respectively, it should be noted that these species are capable of transmitting plant viruses. The overall highest mean population densities were recorded for ring and spiral nematodes and lowest for other nematodes in both Georgia and North Carolina. However, damage threshold of all these PPNs on muscadine grapes is not known. Since muscadine grapes are grown over a period of many years, any nematodes that are present in the rhizosphere may be parasitic to grapes and therefore, their population will eventually increase to damaging levels and could become a limiting factor for the production of muscadine grapes in Georgia and North Carolina. Therefore, there is a need to study pathogenicity of PPNs, especially ring nematodes (*Mesocriconema* spp.), to muscadine grapes; some species of ring nematodes are known to cause disease to other small fruit crops such as blueberries (blueberry replant disease; Jagdale et al., 2013) and peaches (short-life of peach; Nyczepir, 1989). To our knowledge this is the first systemic survey that demonstrated the occurrence and distribution of different plant-parasitic nematodes on muscadine grapes in

Georgia and North Carolina. These results will be communicated to muscadine grape growers, extension specialists and agents through newsletters, extension publications, and other media outlets.

Impact Statement: Muscadines in Georgia and North Carolina were surveyed in 2018 for nematode species associated with established vineyards. Seven PPN genera including *Meloidogyne*, *Mesocriconema*, *Tylenchorhynchus*, *Helicotylenchus*, *Paratrichodorus*, *Pratylenchus* and *Xiphinema* were common to both Georgia and North Carolina. Muscadine grapes do not have established nematode thresholds, and it is not known whether these nematode species are negatively impacting mature grapes. Muscadines are generally assumed to be tolerant of nematodes, but this survey does raise additional questions for future research: (1) which if any nematodes are causing damage to muscadines, (2) are nematodes which are known vectors of grape viruses transmitting viruses in muscadines, (3) do muscadines suffer from a replant disorder, and are nematodes contributing to acute or chronic disorders of replanted muscadine vineyards, and (4) would fumigation benefit muscadine establishment and maintenance, especially in replant scenarios?

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Table 1. Survey of plant-parasitic nematodes in commercial vineyards in Georgia, August 2018.

Nematode species	Percent frequency ^a	Abundance ^b	Standard Deviation	Maximum density/ 100cm ³ soil ^c
British spiral (<i>Scutellonema</i> spp.)	8	351	123	710
Dagger (<i>Xiphenema</i> spp.)	28	5	5	29
Lesion (<i>Pratylenchus</i> spp.)	33	2	2	5
Ring (<i>Mesocriconema</i> spp.)	65	38	67	295
Root-knot (<i>Meloidogyne</i> spp.)	5	2	1	3
Sheath (<i>Hemicycliophora</i> spp.)	3	5	1	5
Spiral (<i>Helicotylenchus</i> spp.)	93	74	107	450
Stubby-root (<i>Paratrichodorus</i> spp.)	5	1	1	1
Stunt (<i>Tylenchorhynchus</i> spp.)	8	1	1	1

^aPercent of total samples with species present, N=40 samples.

^bSum of nematode densities per 100 cm³ soil divided by the total number of samples in which the nematode genus was detected.

^cMaximum count observed in the samples. Minimum was zero for all species.

Table 2. Survey of plant-parasitic nematodes in commercial vineyards in North Carolina, October 2018.

Nematode species	Percent frequency ^a	Abundance ^b	Standard Deviation	Maximum density/ 100 cm ³ soil ^c
Dagger (<i>Xiphenema</i> spp.)	80	4	4	17
Lesion (<i>Pratylenchus</i> spp.)	13	2	1	4
Ring (<i>Mesocriconema</i> spp.)	76	93	139	844
Root-knot (<i>Meloidogyne</i> spp.)	13	2	1	5
Spiral (<i>Helicotylenchus</i> spp.)	89	22	32	190
Sting (<i>Belonolaimus</i> spp.)	9	1	1	1
Stubby-root (<i>Paratrichodorus</i> spp.)	18	2	2	10
Stunt (<i>Tylenchorhynchus</i> spp.)	40	9	11	66

^aPercent of total samples with genus present, N=55 samples.

^bSum of nematode densities per 100 cm³ soil divided by the total number of samples in which the nematode genus was detected.

^cMaximum count observed in the samples. Minimum was zero for all species.

