RELATIVE REPRODUCTION OF SOUTHERN ROOT-KNOT NEMATODE ON ROOT-KNOT SUSCEPTIBLE AND RESISTANT COTTON VARIETIES

M. T. Plumblee
J. D. Mueller
Clemson University, Edisto REC
Blackville, South Carolina

Abstract

Levels of reproduction and galling caused by Southern root-knot nematode (SRK; *Meloidogyne incognita*) were compared on 6 recently released cotton varieties that were reported to exhibit some level of resistance to SRK to levels of reproduction and galling on a susceptible, high-yielding variety (DP 1646 B2XF). Stoneville variety was ST5600 B2XF. Other Deltapine lines included DP 1747NR B2XF and DP 1840 B2XF. Phytogen lines include PHY 350 W3FE, PHY 430 W3FE, and PHY 480 W3FE. Each variety was planted with and without 0.56 kg a.i./ha of aldicarb applied in-furrow at plant. The Deltapine varieties were either treated with the seed treatment "Nemastrike" and nontreated. The Stoneville variety was treated and nontreated with "COPeO + Aeris", and the Phytogen lines were all treated with *Burkholderia* spp. strain A396. Plots consisted of 4 rows on 96-cm centers, 73-m long, with each variety x seed treatment x aldicarb treatment replicated 3 times in an RCB with paired plots. Nematode samples were collected at 6 weeks-after-planting (WAP) and at harvest. Cotton roots were collected at 6 WAP and rated from 0 to 5 for galling where 0 = no galling and 5 = roots 100% galled. Data were subjected to ANOVA using PROC GLIMMIX and means separated using multiple pairwise t-tests.

At 6 WAP aldicarb significantly reduced recovery of SRK from soil from 250 to 70/100 cm^3 soil. Seed treatment had no effect on recovery of SRK from soil at 6 WAP. Recovery of SRK from soil was highest for DP1646 (325/100 cm^3 soil) and less than 33% of that for DP 1747, ST 5600, PHY 1840, and PHY 480. Recovery from PHY 350 and PHY 430 plots were intermediate between those two groups. Galling at 6-WAP followed an almost identical pattern. Aldicarb treatment significantly reduced galling from an index of 1.7 to 1.1. Seed treatment had no significant effect on galling. Galling on DP 1646 was at 2.5 which was significantly higher than galling on PHY 480, DP 1747 and ST 5600 which were all below 1.0. Galling indices for the other 3 varieties were intermediate, ranging from 1.5 to 1.9.

At harvest recovery of SRK did not differ in aldicarb treated (120/100 cm^3) vs. nontreated (125/100 cm^3) plots. Highest recovery of SRK was from soil in plots planted to PHY 430 (370/100 cm^3) compared to recovery from plots planted to PHY 480 and ST 5600 (approximately 30/100 cm^3 soil). Recovery of SRK from soil of plots planted to DP 1747 (70/100cm^3 soil) and PHY 350 (65/100 cm^3 soil) which in turn was lower than the intermediate values for DP 1646 (160/100 cm^3 soil) and DP 1840 (155/100 cm^3 soil). Yields are not reported due to extensive stand losses in one block.

The three varieties reported to be resistant to SRK (DP 1747, ST 5600 & PHY 480) performed very much as expected with lower levels of galling at 6-WAP than the susceptible standard variety (DP 1646). These varieties also supported lower levels of reproduction, as measured by recovery of SRK larvae from soil at 6-WAP and at harvest. These reductions should benefit growers by reducing the need for in-furrow or nematicidal seed treatments in cotton in the following year. More definitive work is needed to assess the yield levels of these varieties in the presence of varying levels of SRK.

Introduction

Southern root-knot nematode causes significant yield losses in cotton throughout the southern and southeastern United States. Yield losses across the cotton belt average more than 5% in most years (Lawrence et al., 2018). Yield losses in individual fields can exceed 25% and dead plants may be observed, especially where Fusarium wilt or other diseases are present. Management of SRK has been primarily using rotations with peanut or application of preplant or at-plant nematicides (Koenning et al., 2004). Nematicide applications are cost prohibitive in many cases ranging from $44 to $89 per hectare for the 1.36 and 2.72 kg rates of AgLogic 15GG to $148+ for a 28.06 L per hectare rate of Telone II. If cotton or an SRK susceptible crop has been grown for more than 2 years SRK levels in a cotton field may be high enough that even high levels of a nematicide provide only partial control. Rotations with nonhosts such as peanut every third year can keep SRK at manageable levels, however many growers have only SRK-susceptible crops such as soybean and corn in their rotations.

Recently several seed companies have introduced new varieties that they report to be highly resistant to SRK. The availability of agronomically adapted, high-yielding lines with high levels of resistance to SRK could conceivably allow growers to produce a cotton crop in SRK-resistant fields without the use of nematicides (Starr et al., 2007).

Materials & Methods

Cotton Cultivars

Seven cotton cultivars were chosen for this study based on their susceptibility to Southern root-knot nematode. Susceptible cultivars included Deltapine 1646 B2XF, Phytogen 430 W3FE, and Deltapine 1840 B2XF. Resistant cultivars used were Deltapine 1747NR B2XF, Phytogen 350 W3FE, Phytogen 480 W3FE and Stoneville 5600 B2XF.

Nematicide Treatments

Seed obtained had been treated with a variety of nematicidal seed treatments depending upon their company of origin. Nematicidal seed treatments included commercially treated BST 100 (*Burkholderia* spp. strain A396) for all Phytogen seed. Two versions of Stoneville 5600 were used; nontreated and commercially treated with COPeO + Aeris. Two versions of each of the Deltapine lines were used; nontreated and commercially treated with Nemastrike.

All varieties, either nontreated or treated with a nematicidal seed treatment were also either nontreated or treated with 5.6 kg per hectare AgLogic 15GG applied in-furrow at-planting.

Field Experiments

This experiment consisted of 1 field plot located at the Edisto REC near Blackville, South Carolina. Soil type in field was a Norfolk loamy sand. Seven cotton cultivars were planted on May 21, 2019 using conventional tillage with in-row subsoiling. Each plot consisted of four-rows 73-m long on 96-cm row spacings. Varieties were evaluated to assess if the levels of resistance present in the varieties was capable of suppressing infection and reproduction by Southern root-knot nematodes early in the growing season and at harvest. All treatments were replicated 3 times. Nematode density in each plot was determined at 5-weeks-after planting and at harvest from soil, and from roots at 5-weeks-after planting. Galling was determined at 5-weeks-after planting.

Nematode Data Collection

Population densities of SRK were determined at planting, 6-weeks-after planting and at harvest. At planting samples consisted of a random collection of 12 cores within each block. At 6-weeks-after planting and at harvest eight 2.54-cm diam. by 25-cm deep soil cores were collected from each plot. Samples were submitted to the Clemson University Nematode Assay Laboratory where vermiform nematodes were extracted using a combination of wet sieving and centrifugal flotation (Jenkins, 1964). Vermiform nematodes were identified to genera based on nematode morphology. At six-weeks-after planting 10 plants were excavated at random from the middle two rows of each plot. Each root system was rated on a scale from 0 to 5 where 0=no galling and 5 = 100% of root surface galled (Barker et al., 1986). After rating for galling each root system was cut into 5.0-cm long pieces and nematodes extracted using a modified mist chamber (Barker et al., 1986). Vermiform nematodes were collected, identified to genera using nematode morphology, and results expressed as “nematodes per gram dry weight of root”.

Statistics

Data were subjected to analysis of variance using PROC GLIMMIX in SAS v. 9.4. All means were separated using multiple pairwise t-tests at alpha = 0.05. Fixed effects consisted of variety, seed treatment, and aldicarb. Random effects consisted of replication.

Results and Discussion

At-Planting

Mean nematode densities at planting across all plots were 17 Southern root-knot, 17 ring, and 33 lesion nematodes per 100 cm^3 soil.

Six-Weeks-After Planting

Mean levels of SRK across all cultivars and seed treatments without AgLogic 15GG were 250 per 100 cm^3 soil compared to 70 per 100 cm^3 soil for AgLogic 15GG-treated plots. In comparison, mean levels of SRK across all Deltapine varieties and Stoneville 5600 were 160 J2 per 100 cm^3 soil for both the nontreated and seed nematicide-

treated seed. A similar pattern existed for recovery of SRK from roots. Treatment with AgLogic 15GG significantly reduced recovery of SRK per gram dry weight of root from 380 to 140 J2 per 100 cm^3 soil. Recovery of SRK was not affected by nematicidal seed treatments.

Recovery from soil was greatest for DP 1646, intermediate for PHY 350 and PHY 430 and lower for DP 1840, DP 1747, ST 5600 and PHY 480 (Figure 1). Recovery from the DP 1840, DP 1747, ST 5600 and PHY 480 was lower than from the AgLogic 15GG-treated plots (Figure 1). Recovery of SRK was greater from roots of DP 1646 than from all other cultivars except Phytogen 350.

Levels of galling were lower for AgLogic 15GG treated (galling index of 1.1) than nontreated (1.8) plots. Nematicidal seed treatments had no effect on mean levels of galling across all cultivars compared to nontreated plots. Levels of galling were lower for PHY 480, ST 5600, and DP 1747 compared to the susceptible DP 1646 (Figure 2).

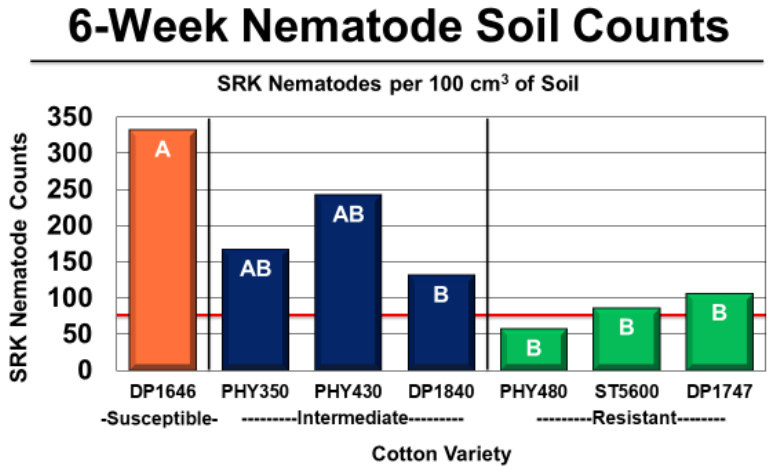

Figure 1. 6-week SRK nematode counts by cotton variety. Red line indicates SRK counts when treated with AgLogic 15GG. Bars with the same capital letters are not significantly different at alpha = 0.05.

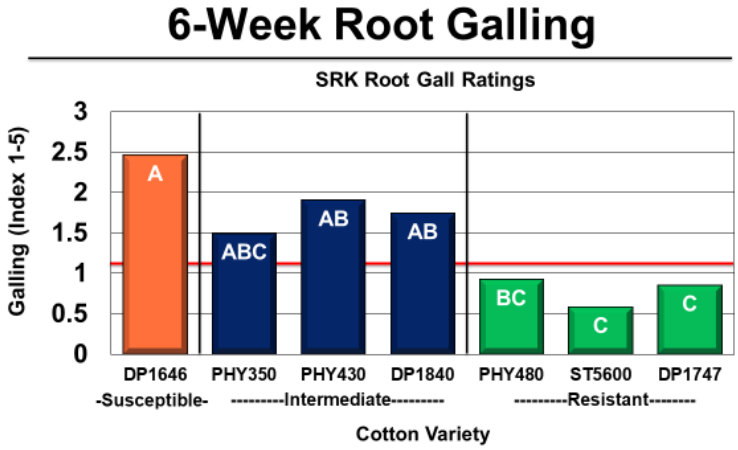

Figure 2. 6-week root gall ratings by cotton variety. Red line indicates average galling when treated with AgLogic 15GG. Bars with the same capital letters are not significantly different at alpha = 0.05.

Harvest

Treatment with AgLogic 15GG had no effect on mean recovery across cultivars of SRK from soil. Recovery from soil was greater for Phytogen 430 than for other cultivars. Recovery was lowest for Phytogen 480 and ST 5600, followed by PHY 350 and DP 1747, with intermediate levels of recovery from DP 1646 and DP 1840 (Figure 3).

Summary

AgLogic 15GG worked well providing nematode control on all varieties up to 6-weeks after planting. Nematicidal seed treatments did not provide adequate levels of nematode control.

Levels of resistance present in Deltapine 1747NR, Phytogen 350, Phytogen 480, and Stoneville 5600 reduced recovery of Southern root-knot nematode J2's from soil and roots, as well as galling indices at 6-weeks after planting. DP 1840 and DP 1646 supported intermediate levels of recovery of J2's from soil and roots, and galling indices. Phytogen 430 and DP 1646 supported the highest levels of recovery of J2's from soil and roots as well as galling indices.

The SRK-resistant varieties had lower SRK densities in soil at harvest than the susceptible lines. Levels of recovery of SRK from Phytogen 430, DP 1646 and DP 1840 all had more than double the recommended damage threshold of 75 SRK/100 cm^3 soil. Recovery from Phytogen 430 was more than 4x the recommended damage threshold of 75/100 cm^3 soil. These low levels of recovery at harvest support the idea that these resistant varieties can be used in a rotation to help lower levels of SRK present in a field and prevent yield losses due to SRK on subsequent crops.

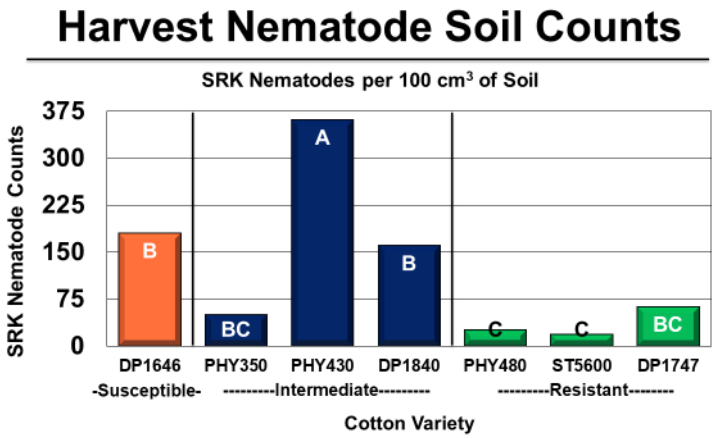

Figure 3. Harvest SRK nematode soil counts by cotton variety. Bars with the same capital letters are not significantly different at alpha = 0.05.

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References

Barker, K. R. 1986. Determining nematode population responses to control agents. Pp. 283-296 *In* Methods for evaluating pesticides for control of plant pathogens. K. D. Hickey, ed. A.P.S. Press, St. Paul, MN.

Jenkins, W. R. 1964. A rapid centrifugal-flotation technique for separating nematodes from soil. Plant Dis. Rep. 48:692.

Koenning, S. R., T. L. Kirkpatrick, J. L. Starr, J. A. Wrather, N. A. Walker, N. A., and J. D. Mueller. 2004. Plant-parasitic nematodes attacking cotton in the U.S.: Old and emerging problems. Plant Disease 88:100-113.

Lawrence, K., Hagan, A., Norton, R., Hu, J., Faske, T., Hutmacher, R., Muller, J., Small, I., Grabau, Z., Kemerait, R., Overstreet, C., Price, P., Lawrence, G., Allen, T., Atwell, S., Idowu, J., Bowman, R., Goodson, J., Kelly, H., Woodward, J., Wheeler, T. A., and Mehl, H. 2018. Cotton disease loss estimates committee report, 2017. Proceedings of the Beltwide Cotton Conferences; New Orleans, LA. National Cotton Council, Cordova. Pp. 161-163.

Starr, J. L., Koenning, S. R., T. L. Kirkpatrick, A. F. Robinson, P. A. Roberts, and R. L. Nichols. 2007. The future of nematode management in cotton. J. Nematology 39:283-294.