YIELD BENEFITS OF NEMATICIDE APPLICATIONS ACROSS MULTIPLE COTTON CULTIVARS IN ROOT-KNOT AND RENIFORM NEMATODE INFESTED FIELDS

Will Groover
D. Dyer
K. S. Lawrence
Auburn University
Auburn, Alabama

Abstract

In 2018, an estimated 204,700 bales of the total cotton crop in the United States was lost due to the reniform nematode *(Rotylenchulus reniformis)*, and an estimated 485,300 bales of cotton were lost to the root-knot nematode (*Meloidogyne* spp.). With large losses reported to both reniform and root-knot nematodes in cotton year after year, two studies were conducted in order to investigate yield losses to reniform and root-knot nematodes over multiple cotton cultivars currently available on the market during the 2019 growing season. In the root-knot nematode infested field, AgLogic 15G (Aldicarb) was evaluated as an in-furrow granular application at planting. In the reniform nematode infested field, COPeO Prime (Fluopyram) and NemaStrike (Tioxazafen) were evaluated as seed treatments. Plant parameters analyzed for both trials included plant stand, plant height, shoot fresh weight, root fresh weight, and nematode eggs per gram of root. In the root-knot nematode trial, AgLogic 15G significantly reduced average eggs per gram of root across all varieties by 90% (398 eggs/g root to 38 eggs/g root). In the reniform nematode trial, COPeO Prime significantly reduced eggs per gram of root by 79% (6782 eggs/g root to 1372 eggs/g root), and NemaStrike eggs per gram of root were 35% higher compared to the untreated plots (6782 to 9195 eggs/g root). AgLogic 15G did not significantly increase seed cotton yield in the root-knot nematode trial, with only a 2% yield increase by AgLogic (2511 lb./A) compared to the untreated plots (2478 lb./A). In the reniform nematode trial, neither nematicide significantly increased seed cotton yield compared to the untreated control (2312 lb./A), with NemaStrike increasing yield by 1% (2334 lb./A) and COPeO Prime increasing yield by 14% (2636 lb./A). Overall, 2019 was a favorable year for both root-knot and reniform nematodes to develop and significantly impact cotton production in Alabama.

Introduction

Plant-parasitic nematodes are one of the most damaging pests of cotton throughout the cotton belt in the United States. Two prime examples that cause consistent yield losses are the southern root-knot nematode (*Meloidogyne incognita*), and the reniform nematode (*Rotylenchulus reniformis*). Over the past ten years, the cotton production industry has averaged an estimated 2.63% of the cotton crop to the root-knot nematode, and 1.62% to the reniform nematode per year (Lawrence et al. 2019). The root-knot nematode is an endoparastic sedentary nematode, and the reniform nematode is a semi-endoparasitic sedentary nematode. Both of these nematodes have a worldwide distribution throughout most sub-tropic and tropic geographic regions and can feed on the important agronomic crop of cotton. While both of these are a major pest of cotton, they prefer slightly different soil types. The root-knot nematode prefers a lighter soil type than the reniform nematode. Soil percentages with a high sand concentration are more favorable for root-knot nematode feeding, and soils with a high concentration of clay and silt are more favorable for reniform nematode reproduction. Feeding on cotton by both of these nematodes can lead to a wide array of symptoms, including stunting and wilting of the plant, a reduction of feeder roots, and interveinal chlorosis on the foliage. Traditionally, nematode management consists of a combined implementation of a crop rotation, nematicide applications, and using resistant cultivars when available. For root-knot nematodes, there are cotton cultivars commercially available with resistance, but there are none available for reniform nematode management. A common crop rotation for root-knot nematode and reniform involves following a cotton crop with a non-host such as corn, sorghum, or peanut. Currently, chemical nematicides are the most common form of nematode management. Thus, two trials were conducted for this study. The first evaluated the nematicide AgLogic 15G (Aldicarb) along with multiple cotton cultivars for its efficacy in root-knot nematode management, and the second evaluated NemaStrike (Tioxazafen) and COPeO Prime (Fluopyram) along with multiple cotton cultivars for their efficacy in reniform nematode management.

Materials and Methods

Data collection for both trials took place during the 2019 growing season. For the root-knot nematode trial, seven commonly grown upland cotton cultivars were evaluated for their performance in the presence of root-knot nematode.

AgLogic 15G (Aldicarb, 5 lb./A) was added as a granular at planting for the evaluation of the added yield benefit as well as the ability to decrease root-knot nematode egg proliferation. In the reniform nematode trial, six upland cotton cultivars were evaluated for their performance in the presence and absence of the reniform nematode. Nemastrike (Tioxazafen, 1.0 mg a.i./seed) and COPeO Prime (Fluopyram, 0.3 mg a.i./seed) were added as a seed treatment for evaluation of the added yield benefit and ability to decrease reniform egg proliferation. The root-knot nematode trial was planted on May 17, 2019 and harvested on October 25, 2019 at the Plant Breeding Unit in Tallassee, AL. The field is classified as a Kalmia loamy sand (80% sand, 10% silt, 10% clay), and has a natural infestation of the root-knot nematode. The reniform nematode trial was planted on April 30, 2019 and harvested on October 2, 2019 at the Tennessee Valley Research and Extension Center near Belle Mina, AL. Two adjacent fields were used for the research: one field that does not contain a reniform population, and one that has been artificially inoculated since 2007. Both fields are a Decatur silt loam (24% sand, 49% silt, 28% clay). Lateral irrigation was used at both field locations as needed to maintain water. Both tests were arranged in a RCBD with five replications. The root-knot nematode trial was four row plots: two rows with no nematicide, two rows with AgLogic. The reniform nematode trial was six row plots: two rows with no nematicide, two with Nemastrike, and two with COPeO Prime. Rows were 25-feet long with 40-inch row spacing and a 20-foot wide alley separating each replication. Four plants were randomly selected per plot for root-knot and reniform nematode egg numbers per gram of root at 41 days after planting (DAP) in the root-knot trial and 37 DAP in the reniform trial. Eggs per gram of root was calculated by taking the ratio of root fresh weight and the total eggs per plot. Yields were mechanically harvested at 162 DAP for the root-knot nematode trial and 155 DAP for the reniform nematode trial, with yield being reported as seed cotton. Data analysis occurred by ANOVA using Proc Glimmix via SAS 9.4 (SAS Institute, Inc., Cary, NC), and means were separated using Tukey Kramer's HSD test at the $\alpha \leq 0.05$ level.

Results and Discussion

Root-knot nematode population density was not high in this trial for the 2019 growing season, with nematode presence not being a significant factor on yield (Table 1). However, root-knot nematode eggs per gram of root were significantly reduced in the AgLogic treated plots compared to the untreated plots, with an average reduction of around 90% (Table 1). This was only a 2% yield reduction when comparing seed cotton yield of the untreated plots to the AgLogic plots. All yields were statistically similar when separated by variety, but some numerical differences were observed. Deltapine 1646 B2XF and Stoneville 5471 GLT had a 2 and 3% increase in yield with the addition of AgLogic, respectively (Table 2). Phytogen 330 WRF had the largest increase in yield with the addition of AgLogic, increasing from 1897 lb./A seed cotton to 2773 lb./A seed cotton, a 46% increase in yield (Table 2).

Reniform nematode population density was very high during the 2019 growing season, and nematode presence was a significant factor on yield (Table 3). On average, there was a 52% reduction in yield from the non-reniform infested field to the reniform infested field (Table 4). The addition of COPeO Prime in the reniform infested field significantly reduced reniform eggs per gram of root by an average of 80%, leading to an average increase of 261 lb./A seed cotton (14%). Nemastrike did not significantly lower reniform eggs per gram of root, and increased seed cotton yield by an average of 55 lb./A (1%) (Table 5). There were no significant differences in seed cotton yield among variety and nematicide combinations for the non-reniform field, but significant differences did occur in the reniform infested field (Table 6). Deltapine 1725 B2XF (2759 lb./A) with no nematicide was the highest yielding treatment in the reniform field and was significantly higher than three other treatments ($P \leq 0.05$).

Table 1. Average number of root-knot nematode eggs/g of root and seed cotton yields in the root-knot infested field at Auburn University's Plant Breeding Unit for the 2019 growing season in Tallassee, AL.

Nematicide	Eggs/g root	lb./A
No Nematicide	38 b[z]	2478
AgLogic 15G	398 a	2511
P-value ($P \leq 0.05$)	**0.0256**	0.9054

[z] Values present are LS-means separated by using Tukey-Kramer method at $P \leq 0.05$, and values followed by different letters differ significantly.

Table 2. Cotton cultivar seed cotton yields in the root-knot nematode field at Tallassee, AL.

	No AgLogic	AgLogic
Cotton Variety	LB/A	LB/A
Deltapine 1646 B2XF	2816[z]	2846
Deltapine 1725 B2XF	2817	2708
Deltapine 1747NR B2XF	2430	2076
Phytogen 330 WRF	1897	2773
Phytogen 350 WRF	2439	2236
Stoneville 6182 GLT	2333	2265
Stoneville 5471 GLT	2614	2672
P-value ($P \leq 0.05$)	0.9472	0.8833

[z] Values present are LS-means separated using Tukey-Kramer method at $P \leq 0.05$, and values followed by different letters differ significantly.

Table 3. Source of variation for seed cotton yield and eggs/g root at Auburn University's Tennessee Valley Research and Extension Center in Belle Mina, AL.

	Seed cotton yield (lb./A)		Eggs/g root	
Source of Variation	F Statistic	P-value	F statistic	P-Value
Nematode	1366.88	**<0.0001**[z]	-	-
Nematicide	0.50	0.6088	5.46	**0.0063**
Variety	11.99	**<0.0001**	0.59	0.7045
Nematode x Nematicide	2.77	0.0658	-	-
Nematode x Variety	2.62	**0.0268**	-	-
Nematicide x Variety	0.95	0.4913	0.73	0.6946
Nematode x Nematicide x Variety	0.96	0.9579	-	-

[z] Significance present at the $P \leq 0.05$ level.

Table 4. Average seed cotton yields in the non-reniform and reniform fields for the 2019 growing season in Belle Mina, AL.

Field Location	lb./A
Non-Reniform Field	4819 a[z]
Reniform Field	2309 b

[z] Values present are LS-means separated using Tukey-Kramer method at $P \leq 0.05$, and values followed by different letters differ significantly.

Table 5. Average reniform eggs/g root and seed cotton yields in the reniform field in Belle Mina, AL.

Nematicide Treatment	Eggs/g root	lb./A
No Nematicide	5932 a[z]	2204
Nemastrike	6652 a	2259
COPeO	1141 b	2465

[z] Values present are LS-means separated using Tukey-Kramer method at $P \leq 0.05$, and values followed by different letters differ significantly.

Table 6. Cotton variety seed cotton yields in the non-reniform and reniform fields in Belle Mina, AL.

	Non-Reniform Field	Reniform Field
Cotton Variety + Nematicide	lb./A	lb./A
Deltapine 1646 B2XF	5010	2424 abc [z]
Deltapine 1646 B2XF + Nemasrike	5087	2702 ab
Deltapine 1646 B2XF + COPeO	4935	2628 abc
Deltapine 1725 B2XF	4850	2759 a
Deltapine 1725 B2XF + Nemastrike	4797	2414 abc
Deltapine 1725 B2XF + COPeO	4354	2601 abc
Deltapine 1747 B2XF	4556	1635 c
Deltapine 1747 B2XF + Nemastrike	4436	1963 abc
Deltapine 1747 B2XF + COPeO	4711	2302 abc
Phytogen 330 WRF	4494	1629 c
Phytogen 330 WRF + Nemastrike	4430	1748 bc
Phytogen 330 WRF + COPeO	4389	2255 abc
Phytogen 350 WRF	5363	2449 abc
Phytogen 350 WRF + Nemastrike	5274	2263 abc
Phytogen 350 WRF + COPeO	5320	2531 abc
Stoneville 5471 GLT	5012	2326 abc
Stoneville 5471 GLT + Nemastrike	4880	2463 abc
Stoneville 5471 GLT + COPeO	4845	2472 abc

[z] Values present are LS-means separated using Tukey-Kramer method at $P \leq 0.05$, and values followed by different letters differ significantly.

Summary

In summary, AgLogic 15G as a granular at 5 lb./A had a significant impact on root-knot nematode eggs per gram of root (90% reduction), and COPeO Prime at 0.3 mg a.i./seed had a significant impact on reniform nematode eggs per gram of root (80% reduction). While AgLogic 15G only increased average yield by 2% in the 2019 root-knot nematode trial, average population density was low across the entire trial regardless of nematicide application, so impact by the root-knot nematode in this trial was minimal. COPeO led to a 261 lb./A increase in seed cotton in the reniform infested field, which is approximately a 12% increase. However, the most striking results of the reniform trial are the differences observed between the non-reniform field and the reniform infested field. Reniform reduced yield on average by 52% in 2019, and all varieties and nematicide combinations saw a decrease in yield going from the non-reniform field to the reniform field. While it is apparent that cotton fields with a heavily infested reniform population density will never reach yield levels possible in a non-reniform infested field, using a seed treatment nematicide can help boost yields and limit impact of the reniform nematode.

Reference

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