YIELD LOSS TO COTTON CULTIVARS DUE TO RENIFORM AND ROOT-KNOT NEMATODE AND THE ADDED BENEFIT OF VELUM TOTAL

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Abstract

Nematodes were estimated to cause a 4.3% loss in U.S. cotton production during the 2016 growing season. This is estimated to be a loss of 672,900 bales of cotton. The majority of this damage was a result of the reniform (*Rotylenchulus reniformis*) and root-knot (*Meloidogyne incognita*) nematodes. Because of this, it is vital to understand how these nematodes affect different cotton cultivars and the benefits of applying a nematicide such as Velum Total. Tests were conducted at two Alabama locations, one infested with the reniform nematode and one with root-knot nematode. At each location, ten cotton cultivars were planted with and without the addition of Velum Total into neighboring fields, one of which was naturally infested with the nematode and one that was not infested. Reniform nematode testing showed a yield reduction of 59% (2,091 lb/A seed cotton) when cotton was planted in the nematode infested field without the application of Velum Total. When Velum Total was applied a 93% reduction in reniform nematode was observed which increased yield by 1,355 lb/A seed cotton but was still reduced by 21% (736 lb/A seed cotton) compared to the yields of the non-infested field. Minor damage was observed from the root-knot nematode testing at this location this season, however, Velum Total still provided a yield bump of 127 pounds of seed cotton when it was applied in the root-knot infested field.

Introduction

During the 2016 cotton production season nematodes caused large amounts of crop damage which was estimated to be a 4.3% loss of cotton production across the cotton belt (Lawrence et al. 2018). The two major nematodes responsible for the majority of this damage were the *Rotylenchulus reniformis* (reniform nematode) and *Meloidogyne incognita* (root-knot nematode). Reniform nematodes are semi-endoparasitic plant pathogens that have a wide host range that includes more than 314 plant species (Wang, 2013). In the U.S. the nematode is very damaging to cotton and was estimated to be responsible for 1.4% production loss of the cotton crop in 2016 which amounts to 205,300 bales of cotton (Lawrence et al. 2018). Symptoms of reniform nematode damage on cotton include yield loss, stunting of plants which may give a wave-like appearance to the field, reduction in feeder roots, and interveinal chlorosis. The nematode is well suited to the tropical and warm temperate regions of the world such as the southeast and mid-south regions of the U.S. cotton belt. These nematodes can be commonly found in heavy soil textures with a high clay or silt content, such as the soils common in north Alabama.

Root-knot nematodes are a sedentary endoparasitic nematode and much like the reniform nematode, they have a very extensive host range that includes cotton. Across the U.S. cotton belt the root-knot nematode was estimated in 2016 to cause yield losses of 2.2% or 414,700 bales of cotton. Symptoms of root-knot nematode damage on cotton include stunting, chlorosis, and reduced yield. However, the most common and well-known symptom of root-knot nematode damage is the knots or galls that form on the plant roots. Unlike the reniform nematode, root-knot nematodes are better suited to coarsely textured soils that have a high concentration of sand such as the soils that are commonly found in south Alabama. Management strategies for both reniform and root-knot nematodes include crop rotation, use of nematicides, and varieties with resistance to root-knot nematodes. This study looks at numerous cotton cultivars as well as the application of Velum Total (fluopyram + imidacloprid) in both the presence and absence of the nematodes to evaluate the nematode damage caused to each cultivar as well as the benefit of applying a nematicide such as Velum Total.

Materials and Methods

Reniform testing was conducted in the heavier clay soils of north Alabama and the root-knot test was conducted in south Alabama where the soil was much sandier. Tests were conducted in the same fashion at both locations. One

nematode infested field and a neighboring non-infested field were planted with the same ten cotton cultivars. All the tests were arranged in a randomized complete block design with 5 replications. Each plot consisted of four rows that were 25 feet long with a 36-inch row spacing. The right two rows in each plot were treated with Velum Total and the left two rows were left untreated. Velum Total (Bayer Crop Science) was applied as an in-furrow spray at a rate of 14 oz/A at planting. Nematode population density (eggs/g of root) was collected 44 days after planting by digging four plants at random from each plot. Extraction of nematode eggs from roots was accomplished by shaking the roots in 6% NaOCl for 4 minutes and collecting the eggs on a 25µm sieve. All data for these tests were analyzed with SAS 9.4 using PROC GLIMMIX and LS-means were compared using Turkey-Kramer's method ($P \leq 0.1$)

Reniform nematode testing was conducted at Auburn University's Tennessee Valley Research and Extension Center (TVREC) near Belle Mina, AL. The fields at this location contain a Decatur silt loam soil type (24% sand, 49% silt, and 28% clay). The ten cotton cultivars used for this testing were Deltapine 1646 B2XF, 1522 B2XF, 1614 B2XF, PhytoGen 487 WRF, 444 WRF, 333 WRF, 490 W3FE, Stoneville 6182 GLT, 4848 GLT, and Croplan Genetics 3885 B2XF. This test was planted in a reniform infested field and a non-infested field on May 9th and cotton was mechanically harvested on November 10th.

Root-knot nematode testing was conducted at the Auburn University Gulf Coast Research and Extension Center (GCREC) near Fairhope, AL. This field location contains a Malbis sandy loam (59% sand, 31% silt, and 10% clay) soil type. The ten cotton cultivars used during this testing were Deltapine 1646 B2XF, 1747NR B2XF, 1639 B2XF, PhytoGen 444 WRF, 450 W3FE, 490 W3FE, Stoneville 5020 GLT, 6182 GLT, 5115 GLT, and Croplan Genetics 3885 B2XF. This test was planted in a root-knot infested field and a non-infested field on May 16th and mechanically harvested on October 10th.

Results and Discussion

At TVREC, reniform nematode pressure was very high during the 2017 production year with the highest recorded population density greater than 4,800 reniform eggs/g of root, and this population was sufficient to cause significant damage to the cotton yield (Table 1). A yield loss of 2,091 pounds of seed cotton (59%) was recorded in the reniform infested field when no nematicide was applied. However, the application of Velum Total was very effective at lowering the reniform population density. Across all varieties, an average of a 92.6% reduction in the number of reniform eggs/g of root was recorded when Velum Total was applied. Associated with this reduction in nematode numbers was an increase in the yield over the plots where no nematicide was added. On average the yields were increased by 1,345 pounds of seed cotton over plots were Velum Total was not applied. However, this higher yield was still reduced from the yields that were obtained in the non-infested field. The highest yielding cultivars in this test were Deltapine 1522 B2XF and PhytoGen 444 WRF that had significantly higher yields than ($P \leq 0.1$) Deltapine 1646 B2XF.

The root-knot test at the GCREC resulted in no significant yield difference being observed between the root-knot infested and not-infested field (Table 2). The application of Velum Total was observed to significantly ($P \leq 0.1$) reduce the number of root-knot eggs/g of root by an average of 52%. As a result of this decrease in nematode numbers, when Velum Total was applied, yield was increased by an average of 127 pounds of seed cotton over the plots that were untreated in the root-knot infested field. No significant difference was observed with the addition of Velum Total when no root-knot was present in the field. The highest yielding varieties were Deltapine 1646 B2XF and Stoneville 5115 GLT which both had significantly higher ($P \leq 0.1$) yields than Deltapine 1747NR B2XF, PhytoGen 444 WRF, 490 W3FE, and Stoneville 5020 GLT.

Table 1. Average number of reniform nematodes eggs/g of root and seed cotton yield for cotton cultivar testing at Auburn University's Tennessee Valley Research and Extension Center in 2017.

Source of Variation (F-value)	Reniform eggs/g of root[z]	Seed Cotton Yield (lb/A)	
Cotton Variety	0.73[y]	1.47	
Nematicide	130.46****	54.24****	
Nematode	-	85.82****	
Variety x Nematicide	0.69	0.48	
Variety x Nematode	-	1.54	
Nematicide x Nematode	-	41.53****	
Variety x Nematicide x Nematode	-	0.21	
Nematicide LS-means		Nematode	No Reniform
Untreated control	4510 a[x]	1445 b	3536 a
Velum Total[w]	333 b	2800 a	3625 a
Nematode LS-means			
Reniform infested field	- -	2114 b	
Non-infested field	- -	3580 a	
Cotton Variety LS-means			
Deltapine 1646 B2XF	3443 a	2628 c	
Deltapine 1522 B2XF	1760 a	3124 a	
Deltapine 1614 B2XF	1869 a	2930 abc	
PhytoGen 487 WRF	1312 a	2943 abc	
PhytoGen 444 WRF	2615 a	3091 ab	
PhytoGen 333 WRF	2307 a	2761 abc	
PhytoGen 490 W3FE	1806 a	2655 bc	
Stoneville 6182 GLT	2875 a	2893 abc	
Stoneville 4848 GLT	1408 a	2634 bc	
Croplan Genetics 3885 B2XF	4823 a	2846 abc	

[z] Data for reniform eggs/gram of root was only collected from the nematode infested field and not the control field.

[y] Significance at the 0.1, 0.05, 0.01, and 0.001 level is indicated by *, **, ***, and **** respectively

[x] Values present are LS-means separated using the Tukey-Kramer method at $P \leq 0.1$. Values in the same column followed by the same letter do not differ significantly.

[w] Velum total was applied at the time of planting as an in-furrow spray at a rate of 14 oz/A.

Table 2: Average number of root-knot nematode eggs/g of root and seed cotton yield for cotton cultivar testing at Auburn University's Gulf Coast Research and Extension Center in 2017.

Source of Variation (F-value)	Root-knot eggs/g of root[z]	Seed Cotton Yield (lb/A)	
Cotton Variety	1.35[y]	4.47****	
Nematicide	1.97	8.03***	
Nematode	-	0.47	
Variety x Nematicide	0.75	0.83	
Variety x Nematode	-	1.48	
Nematicide x Nematode	-	10.04***	
Variety x Nematicide x Nematode	-	1.03	
Nematicide LS-means		Nematode	No Root-knot
Untreated control	443 a[x]	3719 b	3786 a
Velum Total[w]	212 b	3846 a	3764 a
Nematode LS-means			
Root-knot infested field	- -	3916 a	
Non-infested field	- -	3775 a	
Cotton Variety LS-means			
Deltapine 1646 B2XF	521 a	4118 a	
Deltapine 1747NR B2XF	167 a	3399 d	
Deltapine 1639 B2XF	218 a	3950 abc	
PhytoGen 444 WRF	355 a	3730 c	
PhytoGen 450 W3FE	590 a	3816 abc	
PhytoGen 490 W3FE	345 a	3658 cd	
Stoneville 5020 GLT	606 a	3771 bc	
Stoneville 6182 GLT	104 a	3833 abc	
Stoneville 5115 GLT	271 a	4122 a	
Croplan Genetics 3885 B2XF	100 a	4060 ab	

[z] Data for root-knot eggs/gram of root was only collected from the nematode infested field and not the control field.
[y] Significance at the 0.1, 0.05, 0.01, and 0.001 level is indicated by *, **, ***, and **** respectively
[x] Values present are LS-means separated using the Tukey-Kramer method at $P \leq 0.1$. Values in the same column followed by the same letter do not differ significantly.
[w] Velum total was applied at the time of planting as an in-furrow spray at a rate of 14 oz/A.

Summary

During this testing, large yield losses were observed in the presence of reniform nematode that amounted to a 59% loss of cotton yield. Unexpectedly, a similar crop loss was not recorded for the root-knot nematode testing that was conducted in south Alabama. Only a loss of about 2% was recorded in the nematode infested field and when Velum Total was applied, the yield was increased over the non-infested field. The location of this root-knot test had unusually large amounts of rain throughout the 2017 growing season. The rainfall total was 50.41 inches from the time of planting until harvest, which was a drastic increase over the recorded 12.56 inches in the same time period of the 2016 growing season. Despite these environmental conditions, an increase ($P \leq 0.1$) in yield was recorded in both tests when Velum Total was applied to the nematode infested field. This increase amounted to 1,355 pounds of seed cotton in the reniform testing and 127 pounds in the root-knot test.

References

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