EVALUATION OF ROOT-KNOT AND RENIFORM NEMATODE RESISTANT COTTON CULTIVARS WITH SUPPLEMENTAL CORTEVA AGRISCIENCE NEMATICIDES

A. Kate Turner
K.S. Lawrence
Auburn University
Auburn, AL
J. Richburg
Corteva Agriscience
Headland, AL

Abstract

A Phytogen cotton cultivar with resistance to the root-knot nematode (*Meloidogyne incognita*) became available to growers beginning in 2020, and the resistant reniform nematode (*Rotylenchulus reniformis*) cultivar is expected to be available to growers in 2021. The objectives of this study were: 1) to determine the benefit of a root-knot resistance variety PHY 360 W3FE and the reniform resistant variety PHY 332 W3FE in nematode infested fields, and 2) to determine the benefit of the addition of the nematicides fluazaindolizine and oxamyl. Field trials were established in nematode infested fields and arranged as a RCBD with five replications and the tests were repeated for a total of 4 trials. To reduce root-knot and reniform nematode population levels, a fluazaindolizine (Reklemel^{TM}) and Vydate (oxamyl) mixture was applied at planting as an in-furrow spray. Field trials indicated that both root knot and reniform eggs per gram of root were significantly ($P > 0.05$) lower on the resistant cotton cultivars at 45 days after planting. Root-knot population density was reduced 84% by the PHY 360 W3FE compared to PHY 340 W3FE and reniform population density was reduced 78% by the PHY 332 W3FE variety compared to PHY 340 W3FE. The addition of a nematicide to both susceptible and resistant varieties further reduced nematode egg numbers.

Introduction

Upland cotton, *Gossypium hirsutum*, is one of the most prominent crops grown in the Mid-South region of the United States. Recent studies show that *Meloidogyne incognita* and *Rotylenchulus reniformis* cause the greatest damage to upland cotton, *G. hirsutum*, production because both pathogens reduce the cotton plant's ability to make cotton lint (Khanal et al., 2018). Important parasites like root-knot and reniform nematodes can accumulate in infected fields, resulting in at least 40-50% yield decrease. Plant-parasitic nematodes cause worldwide yield loss to agricultural crops of about 12.3% which is estimated at $157 billion dollars (Singh et al., 2015). Root-knot nematode is a sedentary endoparasitic nematode that feeds on plant roots and has a host range that exceeds more than 3000 plant species including important agronomic crops like cotton (Abad et al., 2003). Reniform nematode is a sedentary semi-endoparastic nematode that has a wide host range that also includes agronomic crops such as cotton and soybean. Both nematodes have a worldwide distribution throughout most sub-tropic and tropic geographic regions. However, root-knot nematode prefers soil percentages with a high sand content, and reniform nematode favors soils with a high content of clay and silt.

Symptoms of these nematodes feeding on cotton plants include stunting and wilting of the plant, a reduction of feeder roots, and interveinal chlorosis on the foliage. Traditionally, nematode management consists of combined practices of crop rotation, nematicide applications, and using resistant cultivars when available. For root-knot nematodes, there are cotton cultivars commercially available with resistance such as PHY 360 W3FE, but there is only one resistant cotton cultivar, PHY 332 W3FE, for reniform nematode that just became available. Currently, chemical nematicides are the most common form of nematode management. Therefore, two trials were conducted for this study. The first evaluated three rates of the nematicides Vydate and Reklemel^{TM} along with a nematode susceptible cotton cultivar, PHY 340 W3FE, with a nematode resistant cotton cultivar, PHY 360 W3FE, for their efficacy in root-knot nematode management, and the second evaluated three rates of the nematicides Vydate and Reklemel^{TM} along with a nematode susceptible cotton cultivar, PHY 340 W3FE, with a nematode resistant cotton cultivar, PHY 332 W3FE, for their efficacy in reniform nematode management.

Methods and Materials

Data collected for this research during the 2020 growing season. The root-knot trial was planted May 7, 2020 and harvested on October 7, 2020 at the Plant Breeding Unit in Tallassee, AL. The field has a natural infestation of root-knot nematode, and the soil type is classified as a Kalmia loamy sand (80% sand, 10% silt, 10% clay). For the root-knot trial, two upland cotton cultivars PHY 340 W3FE and PHY 360 W3FE were evaluated for their performance in the presence of *M. incognita*. Reklemel (low, medium, and high) and Vydate (low, medium, and high) were added as in-furrow treatments with three different rates for evaluation of the added yield benefit and ability to decrease root-knot egg density. The reniform trial was planted May 5, 2020 and harvested October 21, 2020 at the Tennessee Valley Research and Extension Center near Belle Mina, AL. The reniform field has a soil type classified as Decatur silt loam (24% sand, 49% silt, 28% clay). This field was originally inoculated in 1997 and has had supplemental inoculum added to maintain reniform nematode above detection levels. For the reniform trial, two upland cotton cultivars PHY 340 W3FE and PHY 332 W3FE were evaluated for their performance in the presence of *R. reniformis*. Reklemel (low, medium, high) and Vydate (low, medium, high) were added as in-furrow treatments with three different rates for evaluation of the added yield benefit and ability to decrease reniform egg density. Lateral irrigation was used throughout the growing season at both field locations as needed to maintain water supply. Both tests were arranged in a Randomized Complete Block Design with five replications. Plots were set up with two, 25 foot long rows with 36 inch row spacing. A 20-foot wide alley separated every replication. Four plants were randomly selected per plot for root-knot and reniform nematode egg numbers per gram of root at 32 days after planting (DAP) in the root-knot trial and 43 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 153 DAP for the root-knot nematode trial and 169 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 $\alpha \leq 0.1$ level.

Results and Discussion

Both root-knot and reniform nematode field trials produced positive yield returns for all treatments. The root-knot field trials showed the addition of the nematicides reduced root-knot nematode eggs/g of root 90 % for cultivar PHY 340 W3FE and 88 % for cultivar PHY 360 W3FE (Table 1). Stand was statistically similar across all treatments as well as plant biomass. The highest yielding treatment was PHY 360 W3FE + Reklemel + Vydate high + TRiO, with seed cotton yields increased by 898 lb/A over the PHY 340 W3FE + TRiO lowest yielding treatment (Table 2). The control, PHY 340 W3FE, yielded 2541 lb/A compared to 2913 lb/A for PHY 360 W3FE. The addition of a nematicide improved seed cotton yield by 52 lb/A for PHY 340 W3FE and 148 lb/A for PHY 360 W3FE.

Reniform nematode disease pressure was high in 2020. Stand was significantly different between PHY 332 W3FE + TRiO and treatments with PHY 340 W3FE + Reklemel + Vydate +TRiO (Table 3). Treatment PHY 332 W3FE + Reklemel +Vydate mid statistically had the highest plant biomass when compared back to the control. PHY 340 W3FE + TRiO and the control had the highest reniform eggs/g of root. The addition of the nematicides reduced reniform nematode eggs/g of root 80 % for PHY 340 W3FE and 83 % for PHY 332 W3FE. The highest seed cotton yields in this test were recorded on PHY 332 W3FE + Reklemel + Vydate med + TRiO, with yields increased by 2484 lb/A over the lowest yielding treatment, the control PHY 340 W3FE (Table 2). PHY 340 W3FE yielded 1653 lb/A compared to 3346 lb/A for PHY 332 W3FE. The addition of a nematicide improved seed cotton yield by 1162 lb/A for PHY 340 W3FE and 791 lb/A for PHY 332 W3FE.

Table 1. Cultivar and nematicide effects on root-knot eggs per gram of root, stand counts, and plant biomass at Plant Breeding Unit in 2020.

Treatments	Root-knot eggs/ g of root[a]	Stand[b]	Biomass[x]
PHY 340 W3FE	1448 a[z]	66 a	4.47 a
PHY 340 W3FE + Reklemel + Vydate low	42 bc	61 a	5.00 a
PHY 340 W3FE + Reklemel + Vydate mid	220 bc	64 a	5.13 a
PHY 340 W3FE + Reklemel + Vydate high	64 bc	57 a	5.22 a
PHY 340 W3FE + SAT TRiO	599 b	46 a	4.14 a
PHY 340 W3FE + Reklemel + Vydate low +TRiO'	3 c	45 a	4.31 a
PHY 340 W3FE + Reklemel + Vydate mid + TRiO	18 c	47 a	4.49 a
PHY 340 W3FE + Reklemel + Vydate high + TRiO	113 bc	49 a	5.04 a
PHY 3XD32	256 bc	58 a	3.89 a
PHY 360W3FE + Reklemel + Vydate low	32 c	65 a	4.93 a
PHY 360W3FE + Reklemel +Vydate mid	17 c	64 a	5.47 a
PHY 360W3FE + Reklemel + Vydate high	10 c	63 a	5.18 a
PHY 360W3FE + SAT TRiO	102 bc	64 a	4.74 a
PHY 360W3FE + Reklemel + Vydate low +TRiO	6 c	62 a	4.88 a
PHY 360W3FE+ Reklemel + Vydate mid + TRiO	38 bc	64 a	4.87 a
PHY 360W3FE + Reklemel + Vydate high + TRiO	19 c	56 a	5.30 a

[a] Total number of eggs extracted from the roots of four plants.
[b] Stand was the number of seedlings in 25 feet of row
[x] Total weight of plant measured in grams.
'TRiO is an addition seed treatment with a biological agent
[z] Means followed by the same letter do not significantly differ by Tukey-Kramer's method ($P \leq 0.1$).

Table 2. Cultivar and nematicide effects on seed and lint cotton yields in the presence of root-knot at Plant Breeding Unit in 2020.

Treatments	Seed Yield (lb/A)	Lint Yield (lb/A)
PHY 340 W3FE	2541 ab[z]	1206 ab
PHY 340 W3FE + Reklemel + Vydate low	2593 ab	1232 ab
PHY 340 W3FE + Reklemel + Vydate mid	2352 ab	1114 ab
PHY 340 W3FE + Reklemel + Vydate high	2462 ab	1207 ab
PHY 340 W3FE + SAT TRiO	2163 b	1028 ab
PHY 340 W3FE + Reklemel + Vydate low +TRiO	2404 ab	1141 ab
PHY 340 W3FE + Reklemel + Vydate mid + TRiO	2427 ab	1153 ab
PHY 340 W3FE + Reklemel + Vydate high + TRiO	2358 ab	1176 ab
PHY 3XD32	2912 ab	1334 ab
PHY 360W3FE + Reklemel + Vydate low	2843 ab	1302 ab
PHY 360W3FE + Reklemel +Vydate mid	2631 ab	1205 ab
PHY 360W3FE + Reklemel + Vydate high	3020 a	1402 a
PHY 360W3FE + SAT TRiO	3028 a	1387 a
PHY 360W3FE + Reklemel + Vydate low +TRiO	2947 ab	1350 ab
PHY 360W3FE+ Reklemel + Vydate mid + TRiO	2747 ab	1258 ab
PHY 360W3FE + Reklemel + Vydate high + TRiO	3060 a	1402 a

[z] Means followed by the same letter do not significantly differ by Tukey-Kramer's method ($P \leq 0.1$)

Table 3. Cultivar and nematicide effects on reniform eggs per gram of root, stand counts, and plant biomass at Tennessee Valley Research Extension Center in 2020.

Treatments	Reniform eggs/ g of root[a]	Stand[b]	Biomass[x]
PHY 340 W3FE	12438 a	52 abc	11.63 e
PHY 340 W3FE + Reklemel + Vydate low	195 b	44 a-d	18.44 a-e
PHY 340 W3FE + Reklemel + Vydate mid	550 b	47 a-d	20.58 a-e
PHY 340 W3FE + Reklemel + Vydate high	407 b	45 a-d	15.52 b-e
PHY 340 W3FE + SAT TRiO	15684 a	36 cd	13.64 de
PHY 340 W3FE + Reklemel + Vydate low +TRiO	109 b	33 d	15.15 cde
PHY 340 W3FE + Reklemel + Vydate mid + TRiO	342 b	36 cd	19.70 a-e
PHY 340 W3FE + Reklemel + Vydate high + TRiO	217 b	39 bcd	18.30 a-e
PHY 332 W3FE	3388 b	50 abc	17.00 b-e
PHY 332 W3FE + Reklemel + Vydate low	349 b	50 abc	20.14 a-e
PHY 332 W3FE + Reklemel +Vydate mid	713 b	54 ab	26.84 a
PHY 332 W3FE + Reklemel + Vydate high	115 b	49 a-d	20.74 a-d
PHY 332 W3FE + SAT TRiO	2778 b	58 a	22.53 a-d
PHY 332 W3FE + Reklemel + Vydate low +TRiO	114 b	48 a-d	20.20 a-e
PHY 332 W3FE + Reklemel + Vydate mid + TRiO	120 b	55 ab	24.21 ab
PHY 332 W3FE + Reklemel + Vydate high + TRiO	51 b	47 a-d	22.92 abc

[a] Total number of eggs extracted from the roots of four plants.
[b] Stand was the number of seedlings in 25 feet of row
[x] Total weight of plant measured in grams.
‘TRiO is an addition seed treatment with a biological agent
[z] Means followed by the same letter do not significantly differ by Tukey-Kramer’s method ($P \leq 0.1$).

Table 4. Cultivar and nematicide effects on seed and lint cotton yields in the presence of reniform at Tennessee Valley Research Extension Center in 2020.

Treatments	Seed Yield (lb/A)	Lint Yield (lb/A)
PHY 340 W3FE	1653.06 e	759 e
PHY 340 W3FE + Reklemel + Vydate low	2808.22 d	1290 bc
PHY 340 W3FE + Reklemel + Vydate mid	2816.84 d	1293 bc
PHY 340 W3FE + Reklemel + Vydate high	2778.96 d	1276 bc
PHY 340 W3FE + SAT TRiO	1709.22 e	784 de
PHY 340 W3FE + Reklemel + Vydate low +TRiO	2632.15 d	1209 cd
PHY 340 W3FE + Reklemel + Vydate mid + TRiO	2750.48 d	1262 c
PHY 340 W3FE + Reklemel + Vydate high + TRiO	2814.49 d	1291 bc
PHY 3XD32	3345.57 c	1542 abc
PHY 3XD32 + Reklemel + Vydate low	3903.03 ab	1799 a
PHY 3XD32 + Reklemel +Vydate mid	3948.22 ab	1820 a
PHY 3XD32 + Reklemel + Vydate high	3685.16 bc	1699 ab
PHY 3XD32 + SAT TRiO	4124.03 a	1901 a
PHY 3XD32 + Reklemel + Vydate low +TRiO	3908.78 ab	1802 a
PHY 3XD32 + Reklemel + Vydate mid + TRiO	4137.35 a	1907 a
PHY 3XD32 + Reklemel + Vydate high + TRiO	3896.50 ab	1796 a

[z]Means followed by the same letter do not significantly differ by Tukey-Kramer’s method ($P \leq 0.1$).

Summary

In summary, the addition of Reklemel and Vydate significantly reduced root-knot and reniform nematode population density. The use of resistant cultivars PHY 360 and PHY 332 further reduced root-knot and reniform nematode population density an average of 82%. Lint yields improved with the resistant cultivars PHY 360 and PHY 332 by an average of 10% and 51% respectively. Even though it is apparent that cotton fields with heavily infested root-knot and reniform population density will never reach maximum yield potential, using nematode resistant cultivars, PHY 360 and PHY 332, and Reklemel and Vydate helped increase yields and minimize impact of root-knot and reniform nematodes.

Reference

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