EVALUATING GENETIC RESISTANCE AND NEMATICIDES FOR RENIFORM NEMATODE MANAGEMENT IN COTTON

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Abstract

Reniform nematode, *Rotylenchulus reniformis*, is an increasingly detrimental cotton pest throughout the United States cotton belt. Field research was conducted at Damon, College Station, and Wall, TX in 2019 and 2020, and at Lubbock, TX in 2020, to assess efficacy of genetic resistance and nematicides to reduce negative impacts of reniform nematodes on cotton production. One trial compared genetic resistance among root-knot resistant (RKN), reniform resistant (REN), and nematode-susceptible varieties (SUS) with and without an in-furrow nematicide (fluopyram + prothioconazole). The second trial compared nematicides: in-furrow aldicarb (15G), in-furrow fluopyram + prothioconazole, foliar-applied oxamyl, and practical combinations of these products. At Damon in 2019, PX3D43 W3FE (REN) was among the top yielding but was similar to the (SUS). PX3D43 W3FE resulted in 25.5% greater yields compared to all other varieties in the remaining two locations ($p < 0.0001$). In 2020, the REN varieties were among the greatest yielding in the genetics study ($p < 0.0001$). Additionally, the addition of fluopyram + prothioconazole reduced yields by 6.4% across locations ($p = 0.009$). Nematicide treatments did not affect yield at Damon 2019 ($p > 0.05$). Applications of aldicarb 15G and aldicarb 15G + oxamyl, increased yields by 183 kg ha^{-1} compared to the untreated check among all other site-years ($p = 0.007$). These findings indicate that genetic resistance to reniform nematodes confers a greater and more consistent yield benefit than root-knot nematode resistance or nematicides in reniform nematode infested cotton fields.

Introduction

As reniform nematodes have spread throughout the southern United States, the severity of their impact on cotton yields has become more apparent. A range of nematicides and treatments have been used against this pest, and new genetic resistance to reniform nematodes is being integrated into modern cotton varieties. The efficacies of these management tools and their interactions have not been adequately assessed to inform grower decisions. Field research is underway to evaluate genetic resistance and nematicides to determine which management options offer the greatest efficacy against reniform nematodes.

Methods

Two field trials were conducted over two years in four locations with known reniform nematode infestations: Damon, College Station, and Wall, Texas in 2019 and 2020, and Lubbock in 2020 only. Treatments in the genetics study included six or eight varieties per location, depending on the year (Table 1). In 2019 at Damon PHY440 W3FE was planted as the susceptible check. This variety was later realized to have root-knot nematode resistance, so PHY340 W3FE was used as the susceptible variety in all other site-years. Due to this inconsistency, findings from Damon 2019 are analyzed separately. Varieties were chosen for varying degrees of nematode resistance including root-knot

nematode resistance (RKN), reniform nematode resistance (REN), and nematode susceptible varieties (SUS). In the genetics study fluopyram + prothioconazole at 994 mL ha^{-1} was applied as a split-plot treatment in-furrow at planting compared to an untreated check. Six chemical treatments consisted of different combinations of in-furrow aldicarb (15G) (5.6 kg ha^{-1}), and fluopyram + prothioconazole (994 mL ha^{-1}) both at planting, foliar broadcasted oxamyl (1108 mL ha^{-1}) 30 and 45 days post planting, and an untreated check (Table 2). All treatments were arranged in a randomized complete block design with four replications.

Table 1. Cotton varieties tested

Nematode Resistance	2019	2020
SUS	PHY340 W2FE	PHY340 W2FE
RKN	PHY440 W3FE	-
RKN	PHY480 W3FE	PHY480 W3FE
RKN	DG3651 B2XF	DG3651 B2XF
RKN	DP1747 NR B2XF	DP1747 NR B2XF
RKN	DP18R628	DP18R628
REN	PX3D43 W3FE	PX3D43 W3FE
REN	-	PX3D32 W3FE
REN	-	DP19R24 NR B3XF

Table 2. Chemical treatments

Treatment	Rate
aldicarb 15G	5.6 kg ha^{-1}
[fluopyram + prothioconazole]	994 mL ha^{-1}
oxamyl	1108 mL ha^{-1}
[fluopyram + prothioconazole] + oxamyl	
aldicarb 15G + oxamyl	
untreated check	

Results and Discussion

Genetic Resistance

Cotton lint yields were affected by variety (p = 0.0001) in Damon 2019, but not by chemical treatment or the interaction of chemical treatment and variety (p > 0.05). PX3D43 W3FE (REN) yielded greater than DP1747 NR B2XF (RKN) and DG3651 B2XF (RKN) but was not different from the other varieties. Among the other two locations in 2019, lint yields were influenced by both location (p < 0.0001) variety (p < 0.0001), and the location by variety interaction (p = 0.008). Yields at College Station ($\bar{x}$ = 1561 kg ha^{-1}) were higher than yields at Wall ($\bar{x}$ = 161 kg ha^{-1}), and PX3D43 W3FE (REN) yielded greater (25.5%) than all other varieties. The rank of non-reniform resistant varieties was different within locations (Table 3); however the REN resistant variety yielded greater than the susceptible check within each location. In 2020 yields were affected by location (p < 0.0001), variety (p < 0.0001), and chemical treatments (p = 0.001) (Table 4). PX3D43 W3FE (REN) and PX3D32 W3FE (REN) yielded greater than all other treatments. DP19R24 NR B3XF (REN) also yielded more than all SUS and RKN varieties. Yields at Wall ($\bar{x}$ = 2537 kg ha^{-1}) were higher than yields at all other locations ($\bar{x}$ = 1006 kg ha^{-1}). The addition of fluopyram + prothioconazole reduced yields by 6.4% across locations. The interactions of location by variety as well as location by chemical treatments also influenced yield (p < 0.0001 and p = 0.009, respectively). PX3D43 W3FE (REN) and PX3D32 W3FE (REN) were among the highest yielding at all locations but were not different from the SUS variety at Damon and College Station (Table 4). Treatments of fluopyram + prothioconazole reduced yields by 9.3% in Wall but did not affect yields at other locations. The consistent yield benefit observed among REN varieties, and the lack of differences between RKN and SUS varieties support that the efficacy of nematode resistance in cotton is species-dependent, and REN varieties are best suited to mitigate yield losses from reniform nematodes. The yield reduction associated with application of fluopyram + prothioconazole may indicate potential phytotoxicity of some in-furrow nematicides. This effect was largely influenced by the Wall site in 2020, where a heavy rainfall event occurred immediately after planting, potentially moving a greater concentration of the product into contact or close proximity with the seed as it imbibed and germinated. Differences in stand establishment and plant height were not observed

due to this treatment; therefore, yield impacts were presumably due to some other physiological effect that was not measured.

Chemical Management

Cotton yields were not influenced by variety, chemical treatments, or the interaction of chemical treatments and variety at Damon 2019 ($p > 0.05$). Variety and chemical treatments influenced cotton yields in all other site-years combined ($p = 0.03$ and $p = 0.003$, respectively). PHY340 W2FE (SUS) ($\bar{x}$ = 1434 kg ha^{-1}) yielded greater than PHY480 W3FE (RKN) ($\bar{x}$ = 1365 kg ha^{-1}). Application of aldicarb (15G) and aldicarb (15G) + oxamyl increased yield ($\bar{x}$ = 1472 kg ha^{-1}) by 183 kg ha^{-1} compared to the untreated check ($\bar{x}$ = 1314 kg ha^{-1}) ($p = 0.007$). The cost, safety, and ecological implications of aldicarb application should be considered in an assessment of risk vs. benefit relative to newly available management alternatives (genetic resistance).

Table 3. Lint yield relative to cotton variety at three reniform nematode infested sites in 2019.

Variety	College Station	Wall	Damon†
		kg ha $^{-1}$	
PX3D43 W3FE	2026 a§	445 a	1340 a
DP1747 NR B2XF	1924 ab	103 b	1005 bc
DP18R628	1852 a-c	209 ab	1111 ab
PHY480 W3FE	1711 b-d	126 b	1210 ab
PHY340W2FE	1673 cd	154 b	-
DG3651 B2XF	1588 d	93 b	807 c
PHY440 W3FE	1475 d	154 b	1172 ab

† Damon analyzed separately due to different variety treatments.
§ Within columns, means with the same letter are not significantly different (α = 0.05) according to Tukey's HSD.

Table 4. Variety influence on cotton lint yield across four reniform nematode infested sites (variety main effect) and within each location (variety × location interaction) in 2020.

Variety	Main Effect (All Locations)	Location			
		College Station	Wall	Damon	Lubbock
			kg ha $^{-1}$		
PX3D32 W3FE	1664 a§	1153 a	3316 a	1164 a	1021 a
PX3D43 W3FE	1634 a	1148 a	3176 a	1290 a	1120 ab
DP19R24 NR B3XF	1433 b	1198 a	2670 b	1060 ab	802 bc
PHY480 W3FE	1210 c	856 ab	2289 bc	1060 ab	682 bc
PHY340 W2FE	1233 c	943 a	2241 c	999 ab	600 c
DP1747 NR B2XF	1110 c	916 ab	2032 c	896 ab	522 c
DP18R628	957 d	955 a	1435 d	969 ab	401 c
DG3651 B2XF	772 d	557 b	1364 d	701 b	423 c

§ Within columns, means with the same letter are not significantly different (α = 0.05) according to Tukey's HSD.

Summary

Overall, REN varieties were consistent in mitigating yield loss and outperformed SUS and RKN varieties in reniform nematode infested fields. Among nematicide treatments, aldicarb 15G and aldicarb 15G + oxamyl improved cotton yield, although greater yield benefit was observed due to genetic resistance in these trials. In addition to the greater yield impact, use of genetic resistance requires fewer inputs of producers throughout the growing season compared to chemical treatments.

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