NEMATICIDE ENHANCEMENTS OF RENIFORM RESISTANT COTTON GENOTYPES

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Abstract

In previous studies, LONREN derived resistant genotypes used in field trials displayed severe stunting and reduced plant growth when introduced to high populations of reniform nematodes. The hypothesis of this study was that applying nematicides will reduce nematode pressure at the seedling stage and allow LONREN derived reniform resistant lines to reach a point where they can withstand the damage caused by the nematodes. Results show that reniform populations in all resistant lines treated with nematicides were reduced at 36 days after planting (DAP). By harvest all resistant lines supported lower population levels than the susceptible lines. Less stunting of LONREN derived genotypes was evident when plant heights were taken at 45 and 79 (DAP), when comparing the nematicide treatments to the untreated control. Seed cotton yields were enhanced in LONREN resistant genotypes that had been treated with nematicides compared to the untreated controls.

Introduction

The reniform nematode (*Rotylenchulus reniformis*) is considered the most damaging pests to cotton grown in Alabama and causes significant yield losses in many southeastern states of the United States. Resistant cultivars to this pathogen have not been available to growers and research efforts are looking into wild cotton relatives to establish a source. In April of 2007, the United States Department of Agriculture (USDA) Texas AgriLife, and Cotton Incorporated released two germplasm lines LONREN-1 and LONREN-2 (Starr et al., 2007). LONREN derived breeding lines have shown the potential to reduce reniform nematode populations in previous greenhouse and field trials (Bell *et al*., 2009; Weaver *et al*. 2011). The LONREN derived lines have also had superb fiber quality in previous field trials (Bell *et al.,* 2009; Weaver *et al*., 2011). It was later reported that LONREN lines were introduced to high levels of reniform populations, early season stunting occurred indicating that these lines were intolerant to the initial attack from the reniform nematode (Nichols *et al*., 2010, Sikkens *et al*., 2011). The BARBREN germplasm line (BARBREN-713) has been released to cotton breeders to use in crosses with upland cotton as well. In 2012, Sikkens *et al*. reported that this line did not display any intolerant responses to the reniform nematode, supported lower populations of reniform than susceptible lines, and had comparable yields. The BARBREN-713 germplasm line may be a very good alternative source for reniform resistance but due to the novelty of this genetic materials response to reniform nematodes more evaluations are needed.

The hypothesis of this study is that nematicides will suppress nematode pressure in the cotton seedling stage, reducing the amount of damage to the root system and allow our resistant lines to grow to a point to withstand the hypersensitive reaction of the plant. The three primary objectives of this study were to: 1.) Evaluate reniform nematode populations on LONREN derived genotypes with and without nematicides 2.) Evaluate the effects that applying nematicides have on early seedling stunting of LONREN genotypes, and 3.) Evaluate yield performances influenced by nematicides. The BARBREN germplasm line BARBREN-713 was also included in this study to give more insight on the response to reniform nematodes of this genetic material.

Material and Methods

Eight different genotypes were evaluated in an 8x4 factorial design in a reniform infested field at the Tennessee Valley Research and Experiment Center (TVREC). The genotypes entered in this study were the germplasm line LONREN-1, three resistant genotypes A107, A122, and B219 that were derived from the cross LONREN-1 x FM966, the resistant BARBREN germplasm line BARBREN-713, the susceptible genotype B211, and the conventional cultivar Deltatpine (DP) 393. The resistant lines that were selected for this study have shown the capacity to reduce reniform populations in previous field trial screenings and also display high levels of resistant in

previous greenhouse screenings. Four levels of nematicides were applied to each of the eight genotypes. These four levels consisted of 1.) an untreated control; 2.)Avicta (abamectin) applied at 0.15 mg ai/seed combined with Aeris (thiodicarb) at 0.375 mg ai/seed 3.) Temik 15G (aldicarb) applied in furrow at 5 lbs/A; 4.) and the concomitant treatment of the abamectin (0.15 mg ai/seed) and thiodicarb (0.375 mg ai/seed) seed treatment plus Temik 15G applied in furrow at 5 lbs./A. The eight genotypes were arranged in four row plots of 25 feet in length with each row being treated with the levels of nematicides independently. Reniform populations were evaluated at 36 days after planting (DAP) and at harvest. Plant heights were recorded at 45 and 79 DAP to evaluate early season stunting. Seed cotton yields were recorded at the end of the season to determine if nematicides had any influence on yield production. All data were analyzed in SAS 9.2 using the Glimmix procedure. The LSMEANS were separated by Dunnett's P values ($P \leq 0.10$).

Results and Discussion

Genotype entries that had been treated with nematicides compared to the untreated control supported fewer reniform populations, had an increase in plant heights, and an increase in seed cotton yields. At 36 DAP reniform populations per 150 cm^3 of soil had a trend of decreasing populations where nematicides were applied, across all treatments. There were significant reductions ($P< 0.10$) of populations in the Avicta/Aeris + Temik combination treatment on the LONREN derived resistant line A107 and the susceptible entry B211(Table 1) compared to the untreated controls. Reniform populations were similar between resistant and susceptible lines at 36 DAP. At the harvest sampling period (170 DAP) no effects ($P< 0.10$) of the nematicide treatment remained evident (Table 1). However, the overall average of reniform populations per 150 cm^3 of soil in the susceptible lines had increased to two times the amount of the LONREN derived resistant lines and two and a half time the amount found in BARBREN-713 (Table 1). Significant increases ($P< 0.10$) in plant heights were evident at 45 DAP in the LONREN derived resistant line B103, and in LONREN-1, when the seed treatments were applied (Table 2). The Temik and the Avicta/Aeris + Temik combination treatments both provided significant increases ($P< 0.10$) in plant heights in all the resistant and susceptible genotypes (Table 2). The plant heights of the LONREN derived genotypes at 45 DAP were comparable to the susceptible lines in the plots that had been treated with Temik, indicating that the amount of early season stunting had been reduced in the LONREN derived lines. At 79 DAP the Temik or Avicta/Aeris + Temik treatments provided significant increases ($P< 0.10$) in plant heights in the LONREN derived resistant lines A107, A122, B103, and B219, and the susceptible entry B211 (Table 2). By mid-season not as many effects of the nematicide were evident in plant heights recorded at 79 DAP. However, many of the LONREN lines that were treated with aldicarb were still comparable to the susceptible lines (Table 2). BARBREN-713 had the highest plant heights recorded at 79 DAP indicating that this entry had limited intolerance to the reniform nematodes (Table 2). At harvest, there was an overall trend of increasing seed cotton yields as influenced by the different nematicide levels. Significant increases ($P< 0.10$) were evident in the LONREN derived genotypes A107, B103, and LONREN-1 when either treated with Temik alone or Avicta/Aeris + Temik (Table 3). These increases were comparable to the commercial cultivar DP393 (Table 3). The germplasm line BARBREN-713 was the overall highest yielding genotype in this field trial, regardless of the nematicide treatment (Table 3).

Table 1: Reniform populations in response to resistant and susceptible genotypes as affected by nematicides at 36 DAP and at harvest (P< 0.10).

***Rotylenchulus reniformis* vermiform life stages per 150 cm^3**						
			36 DAP*		Harvest	
				Dunnett's *P vs.*		Dunnett's *P vs.*
Group	Genotype	Treatment	*R. reniformis*	Control	*R. reniformis*	Control
Resistant	A107	Control	8891		5052	
		Seed Trt	8714	0.748	8729	0.314
		Temik	7099	0.302	5469	0.908
		Temik + ST	6381	0.096	5624	0.776
	A122	Control	6968		7385	
		Seed Trt	6141	0.343	9857	0.246
		Temik	5145	0.881	8003	0.770
		Temik + ST	5832	0.677	6211	0.671
	B103	Control	6698		1684	
		Seed Trt	7408	0.919	2101	0.966
		Temik	6721	0.933	2549	0.001
		Temik + ST	5786	0.716	1808	0.999
	B219	Control	8104		4280	
		Seed Trt	6450	0.428	6520	0.668
		Temik	5091	0.156	6026	0.446
		Temik + ST	5662	0.351	3538	0.830
	LONREN-1	Control	8567		5979	
		Seed Trt	8335	0.389	4867	0.809
		Temik	7725	0.439	6010	0.415
		Temik + ST	8629	0.483	6026	0.617
	BARBREN-713	Control	5485		2704	
		Seed Trt	3808	0.786	3306	0.822
		Temik	5114	0.605	3770	0.966
		Temik + ST	5809	0.661	2858	0.852
Susceptible	DP393	Control	8003		10846	
		Seed Trt	6311	0.241	12159	0.430
		Temik	5732	0.121	11448	0.693
		Temik + ST	7115	0.438	12530	0.649
	B211	Control	8181		7648	
		Seed Trt	5238	0.055	8374	0.342
		Temik	5539	0.091	9007	0.269
		Temik + ST	6033	0.221	10398	0.055

*DAP=days after planting.

Table 2: Effects of nematicide treatments on early season stunting of LONREN derived genotypes as indicated by plant heights at 45 and 79 DAP (P< 0.10).

Plant Heights (PH)						
			45 DAP		79 DAP	
Group	Genotype	Treatment	PH (cm)	Dunnett's *P vs.* Control	PH (cm)	Dunnett's *P vs.* Control
Resistant	A107	Control	12.97		50.63	
		Seed Trt	14.09	0.174	52.00	0.671
		Temik	15.75	0.001	56.00	0.064
		Temik + ST	16.75	0.001	56.75	0.111
	A122	Control	14.34		59.00	
		Seed Trt	15.31	0.404	60.38	0.710
		Temik	17.71	0.005	64.13	0.190
		Temik + ST	16.78	0.015	65.63	0.075
	B103	Control	8.50		28.50	
		Seed Trt	10.19	0.039	30.88	0.682
		Temik	11.59	0.003	37.88	0.022
		Temik + ST	12.13	0.001	37.75	0.032
	B219	Control	13.25		46.88	
		Seed Trt	14.16	0.157	48.88	0.464
		Temik	15.47	0.010	56.25	0.001
		Temik + ST	15.22	0.010	52.88	0.009
	LONREN-1	Control	12.12		48.25	
		Seed Trt	13.94	0.049	54.13	0.019
		Temik	14.06	0.016	50.13	0.111
		Temik + ST	16.59	0.001	60.13	0.765
	BARBREN-713	Control	16.13		73.38	
		Seed Trt	17.00	0.402	70.75	0.404
		Temik	18.66	0.001	71.63	0.911
		Temik + ST	18.00	0.012	70.63	0.524
Susceptible	DP393	Control	13.76		52.38	
		Seed Trt	14.19	0.275	50.75	0.580
		Temik	17.72	0.001	61.25	0.003
		Temik + ST	16.09	0.015	55.50	0.402
	B211	Control	13.69		45.63	
		Seed Trt	14.38	0.547	51.00	0.100
		Temik	15.63	0.035	53.38	0.005
		Temik + ST	16.56	0.001	53.13	0.040

Table 3: Effects of nematicides on seed cotton yields of LONREN derived genotypes (P< 0.10).

Seed Cotton Yields				
			Seed Cotton	
				Dunnett's *P vs.*
Group	Genotype	Treatment	lbs/A	Control
Resistant	A107	Control	1878.13	
		Seed Trt	2048.02	0.314
		Aldicarb	2540.94	0.001
		Aldicarb + ST	2522.65	0.002
	A122	Control	2281.15	
		Seed Trt	2352.76	0.819
		Aldicarb	2555.06	0.548
		Aldicarb + ST	2671.62	0.192
	B103	Control	1252.96	
		Seed Trt	1507.52	0.304
		Aldicarb	1717.66	0.118
		Aldicarb + ST	1889.63	0.044
	B219	Control	2000.97	
		Seed Trt	1984.25	0.675
		Aldicarb	2426.99	0.147
		Aldicarb + ST	2219.47	0.524
	LONREN-1	Control	2120.68	
		Seed Trt	2562.37	0.153
		Aldicarb	2340.74	0.372
		Aldicarb + ST	2814.32	0.044
	BARBREN-713	Control	3231.46	
		Seed Trt	3201.66	0.835
		Aldicarb	3689.88	0.014
		Aldicarb + ST	3542.47	0.196
Susceptible	DP393	Control	2424.90	
		Seed Trt	2422.81	0.842
		Aldicarb	2871.82	0.172
		Aldicarb + ST	2808.57	0.147
	B211	Control	1921.00	
		Seed Trt	2293.70	0.098
		Aldicarb	2448.94	0.038
		Aldicarb + ST	2615.17	0.001

Conclusions

The primary goal of this study was to investigate if applying nematicides provided protection to LONREN derived resistant genotypes that are damaged when planted in fields with high levels of reniform nematodes. The results of this study indicate that applying Temik 15G with and without Avicta and Aeris at planting suppressed nematode pressure in the seedling stage and provided protection to cotton seedlings. The subsequent response from this suppression of nematode pressure at planting was a reduction in early season stunting of LONREN derived genotypes. However, Temik 15G reduced early season stunting more so than the seed treatment combination of Avicta and Aeris. Temik 15G provided significant increases in seed cotton yields in three of the LONREN derived genotypes in this study and in some cases these yields were comparable to the commercial cultivar DP393. Applying a 5 pound rate of aldicarb at planting for nematode control has been the industry standard for many years. Currently the use of aldicarb is in a phase out process and is expected to be completely off the market by 2018. The future practicality of the LONREN source of resistance is dependent on initial reniform populations in which this genetic material is introduced to. Other management practices that reduce initial populations such as non-host crop rotations or fumigant nematicide applications such as 1,3-Dichloropropene applied at planting could be considered.

The germplasm line BARBREN-713 was also included in this experiment to compare a new source of reniform resistant to the LONREN derived genotypes. In this study there was no evidence of any intolerant responses to the reniform nematode. This line performed well with or without nematicide treatments and produced the highest seed cotton yields out of all the genotypes, resistant or susceptible, in this experiment. Reniform populations at harvest were 69% lower for the BARBREN-713 line than the susceptible entries. The results of this study confirm earlier findings that the BARBREN source of resistance could be of high interest in future reniform resistant research.

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