COTTON CROPPING FREQUENCY AND VARIETY SELECTION IMPACT ON TARGET SPOT, COTTON ROOT KNOT, AND YIELD

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Abstract

Impact of cotton cropping frequency, variety on target spot severity, and cotton root knot nematode (*Meloidogyne incognita* Race 3) was evaluated in an ongoing rotation study at the Wiregrass Research and Extension Center in Headland, AL. In 2014, cropping frequency treatments included 1) continuous cotton (28 years); 2) two consecutive years of cotton following one year of peanut; 3) one year out with cotton following peanut; and 4) two year out rotation with cotton following two years of peanut. Cotton varieties included Phytogen 499, Phytogen 427, Deltapine 1050, and Deltapine 1454NR. A factorial arranged in split plot with cotton cropping frequency as the main plot and cotton variety as the split plot treatment was used. Target spot ratings were recorded on 1 August, 20 August, 2 September, 15 September, and 25 September. Areas under disease progress curve (AUDPC) values were calculated from the leaf spot data recorded over the study period. Cotton cropping frequency and variety impacted target spot intensity at the latter three rating dates and AUDPC values. A significant cropping frequency × variety interaction noted at the 2 September and 25 September rating dates showed that the impact of cropping frequency on target spot differed by variety. At the final rating date, defoliation levels for Phytogen 427 but not the other varieties were affected by cropping frequency. While Phytogen 499 suffered the heaviest defoliation, the least damage was noted on Deltapine 1454NR. Season-long, similar defoliation levels were recorded for the continuous cotton and two years of cotton following one year of peanut. The one and two year out cropping patterns had similarly lower AUDPC values compared with the latter cropping pattern. Yield data will be presented.

Introduction

Crop rotation is a useful tool for managing the cotton root knot nematode (*Meloidogyne incognita* race 3) in cotton (Kirkpatrick and Rothrock, 2001) buy its' utilization is restricted because widely planted rotation partners such as corn and soybean are good *M. incognita* race 3 hosts (Davis and Timper, 2000; Kirkpatrick and Sassar, 1984; Kirkpatrick and Rothrock, 2001). In contrast, peanut, which is a non-host for *M. incognita* race 3, is an excellent rotation partner with cotton (Kirkpatrick and Sassar, 1984) is not cropping option for most lower and mid-South cotton producers. Johnson et al. (1998) reported yield gains of 26% for cotton cropped after one year of peanut on a *M. incognita* race 3-infested site. Similar yield gains for cotton in one- or two-year out rotations with peanut on an *M. incognita* race 3-infested site were also observed in Alabama (Campbell *et al.*, 2007).

Cotton varieties with a high level of cotton root knot nematode resistance as well as yield potential equal to commercial varieties have until recently with the release of Phytogen 427 and Deltapine 1454NR, not been available (Thomas and Kirkpatrick, 2001). The above Deltapine and Phytogen cotton varieties possess a high level of resistance to the cotton root knot nematode. Performance of these newly released varieties under heavy root knot nematode pressure has yet to be evaluated by university personnel.

Target spot, which was first reported Mississippi cotton by Jones (1961), has emerged in recent years as a widespread and sometimes destructive disease in Alabama (Conner *et al.,* 2013) and Georgia (Fulmer *et al.,* 2012) cotton. Additional field crop hosts for the target spot causal fungus *Corynespora cassiicola* include soybean and sesame (Jones, 1961; Stone and Jones, 1960). Recovery of *C. cassiicola* from overwintering sesame stems collected from the soil surface suggests that cotton cropping frequency and possibly tillage practices could significantly impact disease development on subsequent cotton crops and highest target spot severity may be anticipated in strip-till, continuous cotton (Stone and Jones, 1960).

Cotton varieties differ considerably in their reaction to target spot. When compared with the majority of commercial cotton varieties such Deltapine 1050, Deltapine 1137, Deltapine 1252, and Fibermax 1944, Phytogen 499 has proven most sensitive to target spot-induced leaf spotting and defoliation (Hagan *et al.*, 2013; Hagan, 2014). While significant yield losses attributed to target spot have been documented for Phytogen 499, yield response of this variety has often been competitive with most other commercial cotton varieties, while other varieties suffering significantly less target spot-incited defoliation have sometimes posted lower yields (Hagan *et al.*, 2013; Hagan, 2014).

The objective of this study was to assess the impact of cotton cropping frequency with peanut on target spot severity, cotton root knot populations, and yield of selected cotton root knot and target spot susceptible and resistant cotton varieties.

Material and Methods

Crop production - Plots were prepared for planting with a KMC strip till rig. On 21 May, Phytogen 499 WFR, Phytogen 427 WFR, Deltapine 1050 B2RF, and Deltapine 1454NR B2RF cotton varieties were sown at 2 seed/row foot in a Dothan sandy loam soil (OM<1%) with an established population of *Meloidogyne incognita* race 3 population in plots previously cropped to cotton at the Wiregrass Research and Extension Center in Headland, AL. Recommendations of the Alabama Cooperative Extension System for fertility, along with weed, and insect control were followed. The study area was irrigated as needed. The experimental design was a factorial arranged in a split-plot with cotton cropping sequence as the whole plot and cotton variety as the split plot treatment. Individual split-plots consisted of two 40-foot rows spaced 3 feet apart. Each twelve-row plot included two outside border rows. Four replications of treatments were included. Cotton was mechanically harvested on 3 Nov.

Disease assessment – Target spot was assessed on 7 Aug, 20 Aug, 2 Sep, 15 Sep, and 25 Sep using a 1 to 10 leaf spot scoring system where 1 = no disease, 2 = very few lesions in canopy, 3 = few lesions noticed in lower and upper canopy, 4 = some lesions seen and ≤ 10% defoliation, 5 = lesions noticeable and ≤ 25% defoliation, 6 = lesions numerous and ≤ 50% defoliation, 7 = lesions very numerous and ≤ 75% defoliation, 8 = numerous lesions on few remaining leaves and ≤ 90% defoliation, 9 = very few remaining leaves covered with lesions and ≤ 95% defoliation, and 10 = plants defoliated (Chiteka, *et al.*, 1988). Defoliation values were calculated using the formula [% Defoliation = 100/ (1+e (- (disease score-6.0672)/0.7975)] (Liu *et al.*, 2012). Areas under disease progress curve (AUDPC) values were calculated from the defoliation data recorded at each rating date. Soil samples for a nematode assay taken on 5 Nov from each variety subplot were processed using the sugar flotation method. Significance of interactions was determined using PROC GLIMMIX procedure in SAS. Statistical analysis on target spot defoliation was done on rank transformations, which were back transformed for presentation. Means were separated using Fisher's protected least significant difference (LSD) test ($P \leq 0.05$).

Results

Since the cropping frequency × variety interaction for target spot season-long AUDPC defoliation values and yield were not significant, data was pooled across cropping sequences and cotton varieties (Table 1). Target spot AUDPC values significantly differed by cotton cropping frequency (Table 1). Higher defoliation AUDPC values were recorded for the peanut - cotton – cotton than the one-year out (cotton – peanut – cotton) and two-year out (peanut – peanut – cotton) rotations. The AUDPC values for continuous cotton (cotton – cotton – cotton) rotation were similar to the peanut - cotton – cotton and above two-year out rotations but were higher than the one-year out cotton – peanut – cotton rotation.

Phytogen 499 had the highest and Deltapine 1454NR had the lowest AUDPC defoliation values. Similar season-long defoliation levels recorded for Phytogen 427 and Deltapine 1050 were intermediate between the above varieties. Despite cropping frequency related differences in AUDPC defoliation values, cropping frequency did not have the expected impact on cotton yield (Table 1). Highest yields were noted for the peanut - cotton – cotton rotation. Similar lower yields were recorded for the continuous cotton, 1- and 2-year out rotations. Phytogen 499 and Deltapine 1454NR produced the highest seed cotton yields than Deltapine 1050 and Phytogen 427 with the latter variety having the lowest yields.

Table 1. Influence of cropping frequency and variety selection on target spot-incited defoliation and yield of four cotton varieties in 2014.

Split plot analysis (F)	Target spot Intensity[z]	Target spot AUDPC[y]	Seed cotton yield[x] lb/A
Cotton cropping frequency	3.63*[w]	5.64*	4.28*
Cotton variety	48.83***	32.69***	13.23***
Cropping frequency x variety	2.99**	1.85	0.61
Cropping frequency			
Cotton-Cotton-Cotton (Continuous Cotton)	--	218 ab[x]	4307 b
Peanut-Cotton-Cotton	--	290 a	4683 a
Cotton-Peanut-Cotton (1 year out)	--	118 c	4216 b
Peanut-Peanut-Cotton (2 year out)	--	178 bc	4335 b
Cotton variety			
Phytogen 499	--	343 a	4591 a
Deltapine 1050	--	161 b	4367 b
Phytogen 427	--	163 b	3994 c
Deltapine 1454NR	--	75 c	4591 a

[z]Target spot intensity was rated using a leaf spot scoring system (1 to 10 scale) on 18 Sep and converted to % defoliation values.
[y]AUDPC = area under the disease progress curve.
[x]Seed cotton yield = total weight of seed + lint.
[w]Significance of *F* values at the 0.05, 0.01, and 0.001 levels is indicated by *, **, or ***, respectively.
[x]Means in each column followed by the same letter are not significantly different according to Fisher's protected least significant difference (LSD) test ($P \leq 0.05$).

Leaf spotting was first observed on all varieties on 20 Aug followed by minimal premature defoliation on 2 Sep (Fig. 1). Higher defoliation levels were noted o Phytogen 499 on the 15 Sep and 25 Sep rating dates. Final defoliation levels for the remaining varieties did not greatly differ until the final rating date.

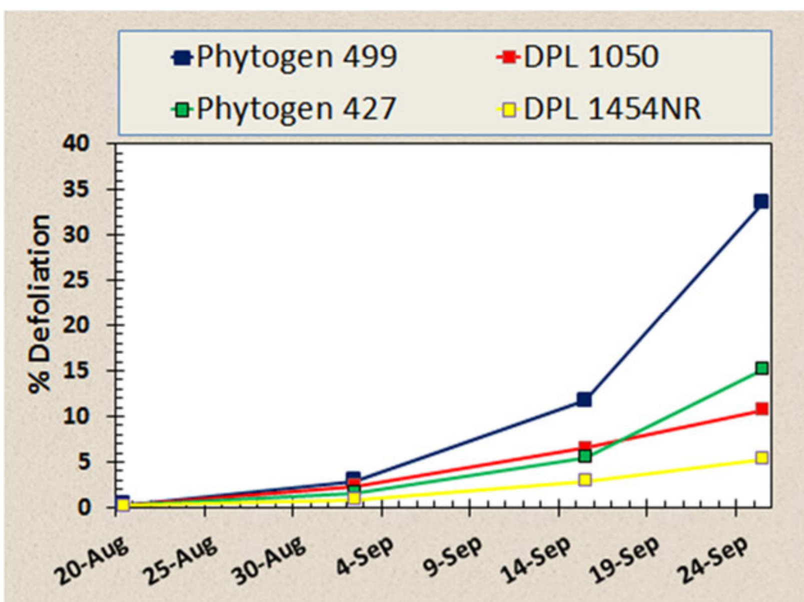

Figure 1. Target spot defoliation on four cotton varieties over time in 2014.

As indicated by a significant cropping frequency × variety interaction, the impact of cropping frequency on target spot defoliation differed by variety (Table 1). Cropping frequency impacted defoliation on Phytogen 427 but not on Phytogen 499, Deltapine 1050, and Deltapine 1454NR, where similar defoliation levels were seen regardless of cotton cropping frequency (Fig. 1). For Phytogen 427, defoliation levels were higher for the peanut-cotton-cotton than for the other rotations, which were similarly low. With one exception with Phytogen 427, highest defoliation levels were recorded for Phytogen 499. Target spot-incited defoliation levels were usually lower for Deltapine 1454NR than Phytogen 427 and Deltapine 1050, which often had similar target spot defoliation ratings.

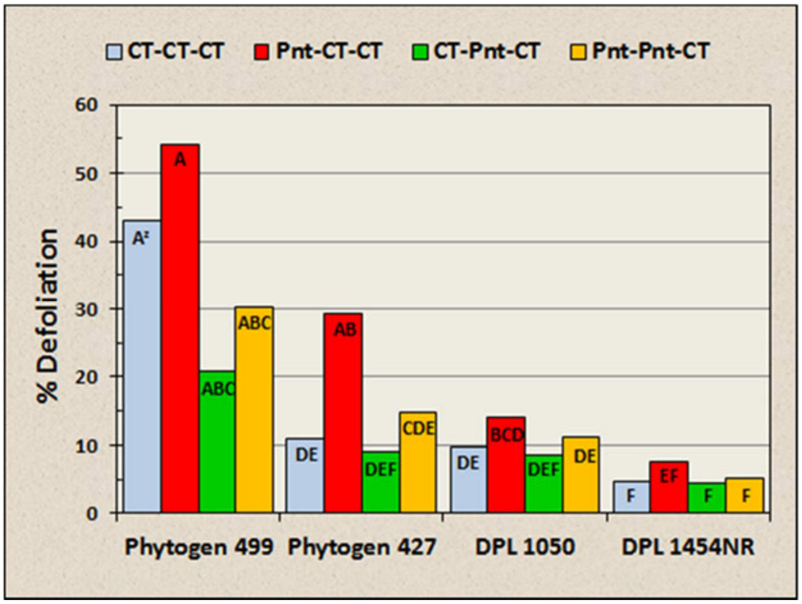

Figure 2. Interaction of cropping frequency and variety selection on target spot-incited defoliation on four cotton varieties. [z]Means followed by the same letter are not significantly different ($P \leq 0.05$).

Summary

The relationship between cotton cropping frequency and target spot is weak. Delayed disease development, possibly due to the mid-May planting date, probably contributed to relatively low final defoliation levels in all cotton varieties, particularly on Phytogen 427, Deltapine 1050, and Deltapine 1454NR, which were insufficient to cause sizable yield losses (Hagan, 2014).

Final defoliation levels on three of four varieties were not influenced by cotton cropping frequency. On Phytogen 427, higher final defoliation levels were seen for the peanut – cotton - cotton cropping pattern than plots maintained in continuous cotton for 28 years along with a one or two year out cropping pattern. While final defoliation values were similar, lower target spot AUDPC values for the one- and two-year out rotations indicates that disease onset may be delayed in cotton cropped behind one or two years of peanut compared with the peanut – cotton – cotton rotation. Similar AUDPC defoliation values for the continuous cotton and 2 year-out cropping pattern, however, clouds the relationship between season-long target spot defoliation and cotton cropping frequency.

In contrast of Campbell *et al.* (2008) and Johnson *et al.* (1998), significant yield gains were not observed with cotton was cropped after one or two years of peanut. Here, seed cotton yields for the continuous cotton, one- and two-year out rotations was similar with the highest yields recorded for the peanut – cotton – cotton cropping pattern. Cotton root knot and target spot apparently had little if any impacts on seed cotton yield. Phytogen 499, which is susceptible to both cotton root knot and target spot, similar or higher yields than varieties that previously demonstrated resistance or tolerance, respectively, to one or both of these diseases. It must be also noted that target spot development was slow compared with situations where sizable yield losses were previously observed (Hagan (2014).

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