Management of Seedling Diseases and the Root-Knot Nematode on Cotton with an Indian Mustard Winter Cover Crop

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RESEARCH PROBLEM

One of the limiting factors in cotton production is soilborne diseases. Disease management techniques for these pathogens include fungicide seed treatments and nematicides for seedling diseases and nematodes, respectively. Even with these chemical inputs, diseases continue to be important in limiting yields. Brassica green manure amendments have shown efficacy for disease management for a number of crops. Brassica winter cover crops would fit into an annual cropping sequence with cotton and could offer an alternative to traditional chemical control strategies. The objective of this study was to examine the efficacy of brassica amendments in cotton production systems using the Indian mustard cultivar Fumus.

BACKGROUND INFORMATION

One of the limiting factors in cotton production is soilborne diseases (Kirkpatrick and Rothrock, 2001). Seedling diseases, caused by Rhizoctonia solani, Pythium spp., Fusarium spp., and Thielaviopsis basicola, are important in cotton stand establishment every year. In addition to reducing stands and stand uniformity, seedling diseases may reduce plant vigor, delaying crop maturity and reducing yields. Pathogenic nematodes also reduce yields in infested fields. In Arkansas, the most important nematodes in cotton are Meloidogyne incognita and Rotylenchulus reniformis, the root knot and reniform nematodes, respectively. Disease management techniques for these pathogens include fungicide seed treatments for seedling diseases and nematicides for nematodes.

Brassica crop residues have shown efficacy for disease management for a number of crops. Brassica amendments have been effective in managing diseases on grape (Rahman and Somers, 2005), strawberries (Lazzeri et al., 2003), apple (Mazzola et al., 2007),

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wheat (Kirkegaard et al., 2000), soybean (Lodha et al., 2003), and potato (Snapp et al., 2007). Brassica tissues contain glucosinolates, which breakdown into isothiocyanates, nitriles, thiocyanates, and oxazolidinethiones which are thought to be involved in plant disease suppression (Bending and Lincoln, 1999; Morra and Kirkegaard, 2002). In the southeastern United States, brassica winter cover crops used for soil amendments would fit into an annual cropping sequence with cotton and could offer an alternative to traditional chemical control strategies.

The objective of this study was to examine the efficacy of brassica amendments in cotton production systems using the Indian mustard (Brassica juncea) cultivar Fumus, bred specifically for high levels of glucosinolates. Bates (2006) has shown previously that a brassica cover crop suppressed nematodes and seedling pathogens and improved cotton growth in a reniform nematode infested field.

**RESEARCH DESCRIPTION**

Field experiments were performed in a producer’s field with existing soilborne pathogen problems in the 2007 and 2008 cotton seasons in Ashley County. Treatments were the Indian mustard winter cover crop, winter fallow, and winter fallow fumigated with 1,3-dichloropropene (Telone II). Plots were approximately 70 meters long and 6 rows wide. The experiment had five and eight replications in 2007 and 2008, respectively, and were analyzed as randomized complete block designs.

Brassica seed was applied using hand-held spreaders into the cotton crop near the end of the growing season on 28 September 2006 and 28 September 2007 at a seeding rate of approximately 7 kg/ha. Seed was obtained from Australian Agricultural Commodities (Wee Waa, NSW, Australia). Above-ground biomass was determined by collecting and weighing biomass from an arbitrary 1-m square area in each plot at flowering, just prior to cover crop destruction. Standard herbicide practices were used to manage winter weeds, as well as the brassica crop. Residues were incorporated when beds were prepared. To avoid phytotoxicity to the cotton crop, the brassica crop was destroyed at least four weeks before planting cotton. Cotton was planted on 1 May 2007 and 10 May 2008.

Soils were sampled at the time of brassica crop termination, cotton planting, 21 days after planting (DAP), and cotton harvest. Soil samples were assayed for the populations of the seedling pathogens R. solani, Pythium spp., and T. basicola. For the planting and harvest sampling times, nematode populations were determined at the Arkansas Nematode Diagnostic Clinic, University of Arkansas Southwest Research and Extension Center in Hope, Ark.

At 21 DAP, stand counts were determined on 15.2-m sections of rows 3 and 4. At this time, 25 to 30 seedlings were collected from arbitrary 0.3-m sections from each plot. Seedlings were put on ice and then stored at 4°C prior to processing. Root discoloration and hypocotyl disease symptoms were recorded and the below-ground portions of the seedlings were excised and rinsed with tap water for 20 minutes, disinfested for 1.5 minutes in a 0.5% NaClO solution, and plated on water agar amended with rifampicin, ampicillin, and fenpropathrin (Danitol 2.4 EC, Valent USA Corp.) (WARad). Colonies growing from the seedlings were transferred to potato dextrose agar amended with the
same chemicals (PDArad) for identification. Seedlings were transferred to the selective medium TB-CEN (Specht and Griffin, 1985) modified with 60 mg/liter of Penicillin G and incubated for two weeks for assessment of colonization by *T. basicola*. For early-season seedlings and 6-week-old plants gall ratings were assessed for each plant. Twenty plants were collected for the 6-week sampling from each plot.

Prior to harvest, cotton plants were mapped by arbitrarily selecting a site in one of the two center rows and taking 8 or 10 consecutive plants from each plot on 1 October 2007 or 28 September 2008, respectively, using COTMAP (Bourland and Watson, 1990).

**RESULTS AND DISCUSSION**

At the Ashley County location in 2007, above-ground brassica biomass averaged 1.967 kg/m². In 2008, the brassica biomass was less than was recorded in 2007, 0.651 kg/m².

No differences were found among the treatments in stand or root discoloration in 2007 (Table 1). In 2008 there were no significant differences in stand (Table 1). However, root discoloration and hypocotyl lesions were reduced by both the Telone and Fumus treatments compared to the fallow treatment (Table 1). Gall rating were significantly lower for Fumus and Telone treatments than the fallow treatment in 2007 and 2008 (Table 1). *T. basicola* colonization of roots at the Ashley County location for the Telone and Fumus treatments were statistically lower than the fallow treatment in 2007 (data not shown). However, no significant differences were observed in *T. basicola* percent root colonization in 2008. Frequency of isolation of *R. solani* or *Pythium* spp. from seedlings was not significantly different among treatments (data not shown).

The cotton mapping and yield data at the Ashley County location in 2007 showed significant differences in total bolls produced and the seed cotton yield (Table 2). The Fumus and Telone treatments had more bolls per plant than the fallow treatment. Seed cotton yield for mapped plants for the Fumus treatment was significantly greater than both the fallow and Telone treatments. In 2008, harvest data was not statistically different among the treatments (Table ). In both years, plant height for Fumus and Telone were greater than the fallow treatment at $P = 0.10$.

*Pythium* and *T. basicola* populations were significantly reduced for the brassica and Telone treatments for some sampling times and years (data not shown). However, no statistical differences were found in *R solani* or *M. incognita* populations for any sampling time.

When grown as a winter crop and incorporated, the Indian mustard cultivar Fumus effectively reduced cotton seedling disease symptoms. Early-season galling was consistently reduced by the winter cover crop and Telone treatments. Soilborne pathogen population reductions were less consistent across the pathogen groups than disease suppression.

The brassica cover crop treatment resulted in higher cotton yields comparable to or greater than those associated with the Telone treatment. This data supports the results of Bates (2006) in a similar field study in Monroe County. In that study, yield increases were associated with *R. reniformis* population reductions. Yield increases
may be dependent upon establishing significant amounts of biomass, with disease being reduced and cotton growth improved in 2007 but not in 2008 in Ashley County. Other research has shown that rate of brassica application has an impact on disease suppression (Cochran, 2009; Snapp et al., 2007).

**PRACTICAL APPLICATION**

The Indian mustard cultivar Fumus is a promising new disease management strategy for cotton production systems. While disease suppression was not observed in all years, this strategy reduced seedling disease symptoms and galling and improved cotton yields. Telone and the brassica winter cover crop were found to have similar efficacy. Future studies should examine the method of planting the brassica crop to increase biomass production and evaluate different brassica crops. Large scale evaluations will be needed for evaluating the economic value of this cultural practice compared to chemical control practices. Brassica amendments appear to be a sustainable option for producers.

**LITERATURE CITED**


### Table 1. Seedling stands and disease symptoms.

<table>
<thead>
<tr>
<th>Year</th>
<th>Treatment</th>
<th>Stand ² (no./m of row)</th>
<th>Hypocotyl lesions ³</th>
<th>Root discoloration ⁴</th>
<th>Galling ⁵</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>Fallow</td>
<td>3.8 a</td>
<td>28.2 a</td>
<td>23.1 a</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fumus</td>
<td>3.9 a</td>
<td>31.1 a</td>
<td>13.6 b</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Telone II</td>
<td>3.9 a</td>
<td>30.1 a</td>
<td>7.3 b</td>
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<tr>
<td></td>
<td>P-value</td>
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<tr>
<td>2008</td>
<td>Fallow</td>
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<td>97.2 a</td>
<td>33.3 a</td>
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<tr>
<td></td>
<td>Fumus</td>
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<td>76.4 b</td>
<td>23.2 b</td>
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</tr>
<tr>
<td></td>
<td>Telone II</td>
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<td>81.5 b</td>
<td>21.4 b</td>
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<tr>
<td></td>
<td>P-value</td>
<td>0.3551</td>
<td>0.0088</td>
<td>0.0049</td>
<td>0.0058</td>
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</tbody>
</table>

² Means in a column and year followed by a common letter are not significantly different, protected LSD at P ≤ 0.05.
³ Percentage of plants with lesions, a rating of 3 or greater; 1 = healthy, 2 = discoloration, 3 = lesion, 4 = large or several lesions, 5 = girdling lesions.
⁴ Mid-percentile values of assigned discoloration ratings; 0 = 0%, 1 = 1 to 20%, 2 = 21 to 40%, 3 = 41 to 60%, 4 = 61 to 80%, 5 = 81 to 100% discoloration.
⁵ Mid-percentile values of assigned gall ratings; 0 = 0%, 1 = 1 to 10%, 2 = 11 to 25%, 3 = 26 to 50%, 4 = 51 to 75%, 5 = 76 to 100% galling.
Table 2. Cotton mapping data and seedcotton yield in 2007 and 2008.

<table>
<thead>
<tr>
<th>Year</th>
<th>Treatment</th>
<th>First fruiting node</th>
<th>Plant height (cm)</th>
<th>Bolls (no./plant)</th>
<th>Seed-cotton (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>Fallow</td>
<td>6.0 a</td>
<td>82.5 a</td>
<td>6.6 b</td>
<td>333.60 b</td>
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<tr>
<td></td>
<td>Fumus</td>
<td>5.0 a</td>
<td>92.8 a</td>
<td>12.3 a</td>
<td>683.80 a</td>
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<tr>
<td></td>
<td>Telone</td>
<td>5.1 a</td>
<td>94.9 a</td>
<td>10.0 a</td>
<td>418.00 b</td>
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<td></td>
<td>P-value</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>2008</td>
<td>Fallow</td>
<td>5.6 a</td>
<td>101.2 a</td>
<td>12.3 a</td>
<td>1108.20 a</td>
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<tr>
<td></td>
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<tr>
<td></td>
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<td>1061.45 a</td>
</tr>
<tr>
<td></td>
<td>P-value</td>
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<td>0.0690</td>
<td>0.6173</td>
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* Means in a column and year followed by a common letter are not significantly different, protected LSD at $P \leq 0.05$. 