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Conservation tillage and thiamethoxam seed treatments as tools to reduce thrips densities and disease in cotton and peanut

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ABSTRACT

Damage to seedling cotton as a result of feeding by adult and immature thrips can result in stunted growth and reduced plant stand. Transmission of Tomato spotted wilt virus by thrips in peanut can result in reduced yield and plant stand. The objectives of this research were to examine the effects of planting cotton and peanut into conventionally (no soil residue) tilled plots or planting into reduced tillage plots including rolled rye and standing rye (cotton only) tillage in conjunction with thiamethoxam seed treatments on seedling thrips counts, thrips associated injury in cotton, Tomato spotted wilt virus incidence in peanut, and yield for both crops. Conservation tillage practices consistently reduced adult and immature thrips populations in cotton. Standing rye residues suppressed thrips similarly to rolled rye, but yielded less lint in one of the two years. Thiamethoxam seed treatment effects were inconsistent, although general numerical trends suggest that this practice can suppress immature thrips for up to three weeks in cotton. Thiamethoxam seed treatment either had no effect or significantly improved cotton lint yield depending on year. Conservation tillage was also effective at reducing immature thrips in peanut. Incidence of Tomato spotted wilt virus in peanut was decreased in conservation tilled plots in 2013, but was slightly greater in 2014. Similarly, effects of tillage on peanut yield were significant but inconsistent between years. Thiamethoxam seed treatments did not consistently reduce thrips in peanut nor did it improve yield in either year. These data demonstrate conservation tillage and thiamethoxam seed treatments are generally effective practices for reducing thrips densities; however, effects on yield and disease transmission were inconsistent.

1. Introduction

Thrips (Thysanoptera: Thripidae) are pests of seedling cotton (*Gossypium hirsutum* L.) and peanut (*Arachis hypogaea* L.) in the southeastern US. Seedling cotton and peanut are rapidly infested by thrips as they disperse from senescing winter hosts in the spring and can reach economically damaging levels if left untreated (Gaines, 1934; Northfield et al., 2008; Cook et al., 2011). Adult and immature thrips damage cotton by rupturing cells and sucking out the fluids, and symptoms of thrips injury include silvering, malformation of leaves, and damage to terminal buds. In cotton, thrips feeding damage can result in loss of apical dominance, excessive vegetative branching (Gaines, 1934) and delayed maturity (Cook et al., 2011). The primary thrips found in cotton in the southeast is the tobacco thrips *Frankliniella fusca* (Hinds), though lower numbers of eastern flower thrips *Frankliniella tritici* (Fitch) and western flower thrips *Frankliniella occidentalis* (Pergande) also occur in cotton (Cook et al., 2003). Injury symptoms are similar in peanut (Lynch et al., 1984), but the primary economic concern is the transmission of Tomato spotted wilt virus (TSWV) from infected winter hosts (Groves et al., 2003; Camann et al., 1995) to the peanut crop (Hurt et al., 2005). TSWV causes concentric ringspots, chlorosis patterns, and deformation on the foliage and stunting resulting in reduced yield (Culbreath et al., 2003; Culbreath and Srinivasan, 2011). TSWV is transmitted by thrips in a persistent and propagative manner; *F. fusca* and *F. occidentalis* are the primary vectors for spotted wilt transmission in the southeastern US. Chamberlin et al. (1992) observed that while *F. occidentalis* was more abundant in the spring on overwintering hosts in Georgia, *F. fusca* was the predominant species found on peanut.

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In cotton, thrips can be suppressed for approximately two to three weeks with systemic neonicotinoid seed treatments (i.e. thiamethoxam, imidacloprid, or clothianidin), or with foliar application of acephate at 1–2 true leaves (Greenberg et al., 2009). Although natural enemies such as *Orius insidiosis* (Say) are effective predators of thrips under field conditions (Funderburk et al., 2000), predator populations are generally not sufficient in seedling cotton to control thrips (Greenberg et al., 2009). Georgia Cooperative Extension recommends that a foliar application will be necessary any time cotton is planted on conventional tillage prior to 10 May (Collins et al., 2014).

In peanut, thrips management through the use of systemic and non-systemic insecticides, while effective in reducing thrips infestations, has not been shown to significantly improve yield (Morgan et al., 1970; Tappan and Gorbet, 1981; Lynch et al., 1984). Currently, the organophosphate insecticide phorate is the only insecticide that has consistently provided suppression of TSWV (Culbreath et al., 2003; Culbreath and Srinivasan, 2011). Primary methods for managing thrips and TSWV in peanut are delayed planting and disease resistant cultivars (Culbreath et al., 2003; Hurt et al., 2005; Reitz et al., 2011).

Conservation tillage, a method of soil cultivation that leaves residues on the soil surface, can improve soil organic matter, reduce erosion and reduce leaching of nutrients (Blevins et al., 1983; Liu and Duffy, 1996; Nyakatawa et al., 2001). Increased ground cover from winter cover crops in conservation tillage systems has been shown to reduce thrips densities and feeding damage in cotton, and thrips densities and TSWV incidence in peanut (Johnson et al., 2001; Bauer and Roof, 2004; Olson et al., 2006; Toews et al., 2010). Previous studies show that conservation tillage with a rye (*Secale cereale* L.) winter cover crop can reduce soil compaction and increase seed cotton yield compared with conventional tillage (Bauer and Busscher, 1996; Raper et al., 2000). Tubbs and Gallaher (2005) demonstrated equivocal yield between conventional and conservation tillage with effective weed management. The objectives of this study were to examine the effects of planting cotton and peanut into conventionally tilled plots or into reduced tillage plots with rolled rye or standing rye (cotton only) residue in conjunction with thiamethoxam seed treatments on seedling thrips counts, thrips associated injury in cotton, TSWV incidence in peanut, and yield for both crops.

2. Materials and methods

Experiments were conducted in 2013 and 2014 at the Coastal Plain Experiment Station, Tift County, Georgia (31.52385 °N, 83.548025 °W) on an irrigated field of Tifton loamy sand (fine-loamy, kaolinitic, thermic Plinthic Kandiudults). The experiment was designed as a two way factorial with factors consisting of two seed treatments and two or three tillage types in peanut and cotton respectively. For cotton, manufacturer applied seed treatments included base fungicide (mefenoxam, fludioxonil, myclobutanil, pyraclostrobin and trifloxystrobin) only, and base fungicide + thiamethoxam (Cruiser® 5FS, Syngenta Crop Protection LLC, Greensboro, NC). For peanut, seed treatments consisted of base fungicide (fludioxonil and mefenoxam) only and base fungicide + thiamethoxam (CruiserMaxx® Peanuts, Syngenta Crop Protection LLC, Greensboro, NC), made by the seed distributor. Tillage components differed between peanut and cotton plots. Tillage for peanut plots consisted of conventional tillage or strip tillage into rolled rye. In cotton, tillage consisted of conventional tillage, strip tillage into rolled rye, and strip tillage into standing rye. Both cotton and peanut plots measured 3.7 m wide by 12.2 m long with a 91.4 cm row spacing. Plots for both cotton and peanut were arranged in a split plot randomized block design with 4 replicates.

2.1. Cover crop establishment and seedbed preparation

Rye (cv. 'Wrens Abruzzi') was the cover crop used for both cotton and peanut trials. Prior to cover crop establishment, all plots were disc harrowed and then smoothed with a field conditioner. Cover crops were planted in November of 2013 and 2014 with a Tye Pasture Pleaser no-till grain drill (AGCO Corporation, Duluth, GA) at the recommended rates of 101 kg of seed per ha with a 17.8 cm row spacing. At least two weeks before planting, rolled rye cover crops for cotton and peanut were terminated with glyphosate (1.610 L per ha) and Valor (0.146 L per ha) on 10 April 2013, and 22 April 2014. After rye termination, strip tillage 4 row (3.7 m) plots were tilled with a two-row strip till rig (Rip/Strip Generation II; Kelly Manufacturing Co., Tifton, GA) equipped with an in-row subsoiler adjusted to a depth of 40.6 cm. All conventional-tillage plots were cultivated (Field Cultivator-Four Bar; Kelly Manufacturing Co., Tifton, GA), followed by a rip and bed pass (Rip & Bed-Generation II; Kelly Manufacturing Co., Tifton, GA) with the subsoiler adjusted to a depth of 40.6 cm.

2.2. Cotton and peanut establishment and management

The same four-row vacuum planter (model 1700 Rigid Integral, Deere and Co., Moline, IL) equipped with row cleaners was used to sow both conventional and strip tilled plots. Cotton was planted on 6 May 2013 and 5 May 2014. Peanut was planted on 6 May 2013 and 29 April 2014. Cotton plots were planted with the cultivar 'DP174RF' (Deltapine, Monsanto Co., St. Louis, MO), while peanut plots were planted with 'Georgia-06G' (Reg. no. CV-094, PI 644220). Supplemental overhead irrigation was provided and each crop was managed following standard agronomic practices recommended for cotton and peanut production in Georgia. No additional insecticide applications were made in peanut, but cotton was treated with a tank mix of 280 g/ha dicrotophos (Bidrin 8, Amvac Chemical Corp, Los Angeles, CA) and 70 g/ha bifenthrin (Bifen 2 Ag Gold, Direct Ag Source, Eldoa, IA) every two weeks during the bloom cycle to prevent stinkbug damage from confounding yield.

2.3. Thrips sampling

Thrips counts in cotton were estimated at 16, 23 and 30 days after planting by randomly selecting five plants from across the entire plot. Cotton was sampled by gently pulling plants from the soil and immediately inverting them into a 0.47 L glass jar filled with 100 ml of 70% ethyl alcohol. Thrips were dislodged from the cotton by vigorously shaking the plants in the alcohol. Plants were then discarded and the jars containing dislodged thrips were sealed. Thrips counts in peanut were determined 23, 30, and 37 days after planting by taking five plant terminals per plot and immediately placing them in a 20 ml vial filled with 10 ml of 70% ethyl alcohol. Jars or vials containing alcohol and thrips were transported to the laboratory where they were sieved through a fine-mesh sieve (125 μm openings) and transferred to 20 ml vials. Thrips were enumerated on a ruled petri dish under a compound dissecting microscope (60X). Adult thrips collected from cotton were identified to species, while all immatures were simply enumerated.

2.4. Plant height and leaf count

Cotton plots were assessed at 16, 23, and 30 days after planting for plant height and number of true leaves. Plant height was assessed by measuring 5 plants randomly selected from each plot from the ground to the terminal. The number of true leaves expanded to a size greater than 2 cm at their widest point was