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Effects of new field resistant cultivars and in-furrow applications of phorate insecticide on tomato spotted wilt of peanut

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A B S T R A C T

Field experiments were conducted at Tifton, Georgia from 2008 to 2014 to determine the effects of new peanut (*Arachis hypogaea*) cultivars and in-furrow applications of phorate insecticide on severity of tomato spotted wilt (TSW) caused by *Tomato spotted wilt virus*. Several cultivars, including Florida-07, Georgia-06G, Georgia-07W, Georgia Greener, and Tifguard, had final incidence of TSW that were less than that of Georgia Green. In-furrow applications of phorate insecticide reduced incidence of TSW in Georgia Green in three experiments in which that cultivar was included. In-furrow application of phorate insecticide reduced incidence of TSW in most cases where incidence in nontreated plots was 10% or higher. Cultivars Georganic, and Georgia-10T, had final incidence of TSW that was lower than that of Georgia-06G, or Florida-07 within nontreated plots across 2011–2012. Georgia-10T and Georgia-12Y had final incidence that was lower than that of Georgia-06G, Georgia-07W, Georgia-09B and Georgia Greener across insecticide treatments in 2013. In-furrow application of phorate increased yields across cultivars in 2008–2009, and increased yield of Georgia-09B in 2010. In most other cases, phorate had no significant effect on yield. With higher levels of field resistance in most of these cultivars, especially those such as Georgia-12Y, benefits from use of phorate insecticide for TSW suppression were small, and typically did not result in yield increase. Based on these results, several of these cultivars should allow greater flexibility for insecticide choice for thrips management without increasing the risk of losses to TSW.

1. Introduction

Management of tomato spotted wilt (TSW), caused by *Tomato spotted wilt virus* (TSWV), of peanut (*Arachis hypogaea* L.) in the southeastern United States is dependent upon integration of several factors that suppress epidemics of the disease (Brown et al., 2005; Culbreath and Srinivasan, 2011). The use of cultivars with field resistance is the single most important practice for management of TSW (Culbreath and Srinivasan, 2011). The cultivar Georgia Green (Branch, 1996) has a moderate level of stable general field resistance to TSWV (Branch and Culbreath, 2015; Culbreath et al., 1996) and was the predominant peanut cultivar grown in the southeastern U.S. from 1997 until 2007 (Culbreath and Srinivasan, 2011). Georgia Green was a critical component of the TSW management system, but the level of field resistance in Georgia Green is not sufficient to provide adequate control of TSW when the potential for development of epidemics is high. Thus, it was often desirable, if not essential, to use as many other suppressive factors as possible with that cultivar (Culbreath and Srinivasan, 2011).

Several new cultivars with higher levels of field resistance to TSWV than Georgia Green are now available (Culbreath and Srinivasan, 2011). Planting these cultivars has improved levels of control of TSW in general, and allowed more flexibility with other factors in the TSW management programs. Factors such as planting date (Culbreath et al., 2010), seeding rate (Culbreath et al., 2012, Culbreath et al., 2013; Tubbs et al., 2011), and row pattern (Culbreath et al., 2008; Tubbs et al., 2011) are much less critical for managing TSW than previously observed with Georgia Green.

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Similarly, these cultivars may allow more flexibility with insecticides used for control of thrips on the young plants. TSWV is transmitted by thrips, but use of most insecticides for control of tobacco thrips (*Frankliniella fusca* Hinds), the primary thrips species associated with direct damage and spread of TSWV in peanut in the southeastern U.S., generally has not resulted in reductions in incidence of TSW (Culbreath and Srinivasan, 2011; Culbreath et al., 2003). Phorate is the only insecticide that has provided suppression of TSW in peanut (Culbreath and Srinivasan, 2011; Culbreath et al., 2003; Todd et al., 2005), and has been an important component of an integrated management system for TSW in peanut. Culbreath et al. (2008) reported much lower incidence of TSW in new cultivars Florida-07 (Gorbet and Tillman, 2009) and Tifguard (Holbrook et al., 2008a) than in Georgia Green, regardless of whether they were treated with phorate. In most cases there was less response to phorate in those cultivars for suppressing TSW than in Georgia Green (Culbreath et al., 2008). However, yield increases in Florida-07 in two of three trials in response to phorate application were greater than would be expected considering the levels of TSW in both treatments (Culbreath et al., 2008). Responses of several other new cultivars to phorate have not been characterized. Therefore, the objective of this study was to determine the effects of in-furrow application of phorate insecticide on epidemics of TSW and on yield in new peanut cultivars available in the southeastern U.S.

2. Materials and methods

2.1. Experimental design

Field experiments were conducted at the Univ. of Georgia Coastal Plain Exp. Stn., Lang Farm, and Tifton GA in 2008–2014. Soil type in all fields was a Tifton sandy loam (fine-loamy, kaolinic, thermic Plinthic Kandiudult). The fields used in 2008–2012 and 2014 had been planted to cotton (*Gossypium hirsutum* L.) the preceding year, and the field used in 2013 had been planted to peanut the preceding year. Severe epidemics of TSW had occurred in peanut in these fields in previous years when peanut had been grown.

In all experiments, experimental design was a split-plot with four to five replications. Whole plot treatments consisted of: i) In-furrow application of phorate (Thimet 20 G, AMVAC Chemical Corporation, Los Angeles, CA) at 1.12 kg a.i./ha; and ii) Nontreated control. In all experiments, sub-plot treatments consisted of peanut genotypes. In 2008, 2009, and 2010, genotypes included cultivars Georgia Green, Tifguard, Georgia-06G (Branch, 2007a), Georgia Greener (Branch, 2007b), Georgia-07W (Branch and Brenneman, 2008), and Florida-07 and the released germplasm line TifGP-2 (tested previously as C724-19-25) (Holbrook et al., 2012, Holbrook et al., 2008b). In 2010, cultivars FloRun '107' (Tillman and Gorbet, 2015), and Georgia-09B (Branch, 2010) were added. In 2011, 2012, Georgia Green was omitted, and cultivars Georganic (Holbrook and Culbreath, 2008) and Georgia-10T (Branch and Culbreath, 2011) were added. In 2013, 2014, cultivars Georgia-11J (Branch, 2012) and Georgia-12Y (Branch, 2013) were included. Georganic and Georgia-10T were omitted in 2014. Planting dates were 28 April 2008, 28 April 2009, 29 April 2010, 27 April 2011, 30 April 2012, 6 May 2013, and 9 May 2014. Plots were 1.8 m wide and contained two single rows 91.4 cm apart. Plot length was 8.8 m in 2008, 7.9 m in 2009, 10.1 m in 2010 and 2011, 11.9 m in 2012, and 9.8 m in 2013 and 2014. Seeding rates were 14.8 seed/m of row in each of the two single rows.

2.2. Inoculum and thrips control

In all experiments, development of TSW epidemics was reliant upon infection via resident thrips vectors (*F. fusca* and *Frankliniella occidentalis* Pergande). Acephate (Orthene 75W, Valent U.S.A. Corporation, Walnut Creek, CA) 0.84 kg a.i./ha was applied to all plots 13–14 days after planting (DAP) in all experiments for early season control of thrips. This was done to reduce physical feeding damage by thrips larvae that might complicate early season evaluations for TSW. Such applications typically have had little effect on TSW incidence in Georgia (Todd et al., 2005). Fungicides were applied at approximately 14 day intervals, with initial applications approximately 30 days after planting, for control of fungal leaf spot diseases (*Cercospora arachidicola* S. Hori and *Cercosporidium personatum* (Berk. & M. A. Curtis) Deighton) and stem rot (*Sclerotium rolfsii* Sacc).

2.3. Disease assessment

Spotted wilt was evaluated for each plot at 64, 100, and 133 DAP in 2008; 70, 90, 107 and 127 DAP in 2009; 61, 104, and 125 DAP in 2010; 71, 104, 124, and 133 DAP in 2011; 84, 106, and 121 DAP in 2012; 92, 108, and 128 DAP in 2013; and 83 and 123 DAP in 2014. Incidence of TSW was determined by counting the number of 0.3-m portions of row containing severely stunted, chlorotic, wilted or dead plants for each plot and converting that number to a percentage of total row length (Culbreath et al., 1997). Area under the disease progress curve (AUDPC) for incidence of TSW was calculated for each plot as described by Shaner and Finney (1977). With low incidence of TSW in 2010 and 2014, AUDPC was not calculated, and only final incidence is reported.

2.4. Pod yield

All plots were inverted on 135 DAP in 2008, 140 DAP in 2009, and 132 DAP in 2010. Plots of all cultivars except Georganic and Georgia-10T were inverted 135 DAP in 2011 and 137 DAP in 2012. Plots of Georganic and Georgia-10T were inverted 153 DAP in 2011 and 148 DAP in 2012. Plots of Georgia-10T and Georgia-12Y were inverted 155 DAP in 2013; all other cultivars were inverted 127 DAP. In 2014, plots Georgia-12Y were inverted 151 DAP, and all other cultivars were inverted 137 DAP. Pods were harvested mechanically 5–10 days after plants were inverted, and were dried. Yields were adjusted to 10% wt/wt moisture.

2.5. Statistical analysis

Data were analyzed using SAS v.9.3 software (SAS Institute, Cary, NC). A mixed models procedure was used with maximum likelihood estimation of variance components (PROC MIXED). The Satterthwaite method was used for computing the denominator degrees of freedom ("ddfm = satterth" in the model statement). Analysis was made across years for trials conducted in 2008–2009, and 2011–2012, when the same genotypes were included in multiple years. Year and replication were considered random effects, and insecticide, cultivar and insecticide by cultivar interactions were considered fixed effects. Effects were considered significant when $P \leq 0.05$. Fisher's least significant difference (LSD) values were computed using standard errors and *t*-values of adjusted degrees of freedom.

3. Results

3.1. In-furrow insecticide experiments

Marginal chlorosis and necrosis on leaves of young plants were observed on all cultivars treated with phorate in all years. Severity of the phytotoxic effect was not assessed for each plot, but there