Effect of Thrips Infestation on the Development of Cotton Seedling Diseases

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ABSTRACT

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The effect of thrips infestation on the development of cotton seedling diseases was evaluated in field plots in 1986, 1987, and 1989. The insecticide disulfoton was applied to obtain different levels of thrips infestation. When thrips were present, stands were reduced 47 and 53% less in insecticide-treated plots than in control plots in 1986 and 1989, respectively. The application of insecticide also resulted in lower disease indices. Thrips infestation was positively correlated with stand reduction ($r = 0.85$ in 1986 and 0.53 in 1989) and disease index ($r = 0.64$ in 1986 and 0.59 in 1989). In 1987, when thrips were not present, stand reduction, disease index, and plant height did not differ significantly among treatments.

The seedling disease complex of cotton (*Gossypium hirsutum* L.) is the single most important disease of cotton. Losses due to seedling diseases in Louisiana in 1988 were estimated at 27,205 bales, or 2.5% of the cotton crop (1). *Rhizoctonia solani* Kühn, *Thielaviopsis basicola* (Berk. & Br.) Ferr., *Pythium ultimum* Trow, and *Fusarium* spp. are the major fungi associated with seedling diseases (6,8,9).

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Seedling diseases are enhanced by environmental conditions or cultural practices that retard seed germination and seedling growth (6,9). Such practices include planting poor-quality seeds and planting in cold, wet soils or in soils containing high concentrations of herbicides and insecticides (8–10). Insect damage and nematode infection also reduce seedling growth, predisposing the affected plants to seedling disease (9).

Aphids and thrips are recognized pests of seedling cotton. In Louisiana, thrips are the most common early-season pest. Four species of thrips are commonly found on cotton in Louisiana: *Frankliniella fusca* (Hinds), *F. tritici* (Fitch), *Sericothrips variabilis* (Beach), and *Thrips tabaci* (Lind.). Uncontrolled thrips infestations can reduce seedling height and weight (4), leaf area (7), and yields (2,3,10) and delay maturity (10). The first true leaves of cotton seedlings infested with thrips are smaller than normal and appear crinkled as they expand. With severe infestations, the terminal buds may be killed, resulting in a loss of apical dominance.

Thrips damage may also increase the severity of seedling diseases of cotton. Plants from plots treated for thrips control had less sore shin than plants not treated for thrips control (5). The objective of this study was to evaluate the relationship between thrips infestation and seedling mortality.

MATERIALS AND METHODS

Experiments were conducted on a Norwood very fine sandy loam at the Red River Research Station in Bossier City, LA, during 1986–1989. No testing was done in 1988 because drought conditions inhibited seed germination and stand establishment. Experiments were designed in a randomized complete block with four replications. Plots were eight 64-m rows planted on 102-cm centers. Anhydrous ammonia at 67 kg of N per hectare was applied on 19, 21, and 4 March in 1986, 1987, and 1989, respectively. Seed of cultivar Deltapine 41 commercially treated with captan and carboxin was used throughout the study.

Different levels of thrips infestation were obtained by application of the insecticide disulfoton (Di-Syston 15G; Mobay Chemical Corp., Kansas City, MO) at 1.12 kg a.i./ha alone or in combination with the fungicide 10% pentachloronitrobenzene plus 2.5% etridiazole (Terraclor Super X; Uniroyal Chemical Co., Middlebury, CT) at 1.4 kg a.i./ha. A fungicide treatment and untreated control plots were also included in the tests. Pesticides were applied in the planting furrow with a four-row planter equipped with granular applicators.

To evaluate seedling disease, plant populations were quantified and a root-hypocotyl disease index (RHDI) was assessed on surviving seedlings. Surviving seedlings were counted in the two center rows of each plot 2 and 6 wk after planting. Percentage stand reduction after emergence was calculated as follows: [(2-wk count − 6-wk count)/2-wk count] × 100. Counts from the two center rows were averaged and used in all analyses. Percentage stand reduction during the 2- to 6-wk period of plant growth was used to estimate the effects of thrips infestation on seedling disease because thrips are most damaging during this period. Seedlings are just beginning to emerge 2 wk after planting, so thrips at that time have not yet infested the seedlings. At 6 wk after planting, protected plants begin to grow rapidly and are less susceptible to thrips damage.

RHDI and plant height were recorded 4 wk after planting. Twenty randomly selected seedlings were removed from the soil, washed under tap water to remove any adhering soil, and evaluated for root and hypocotyl necrosis. RHDI was assessed on a scale of 0–4, where 0 = no necrosis, 1 = less than 33% necrosis on the roots and/or hypocotyl, 2 = 33–66% necrosis, 3= 67–100% necrosis, and 4 = dead taproot with adventitious lateral roots developing above the dead area.

To identify causal agents, isolations were made from 4-wk-old cotton seedlings. Seedlings were removed from the field and washed under tap water to remove any adhering soil. Necrotic root and hypocotyl tissue was excised from the seedling, submerged in 70% ethanol for 30 sec, and surface-disinfested in 0.5% (w/v) NaOCl for 3 min. Tissue samples were plated on potato-carrot agar acidified to pH 4.0 with lactic acid. Plates were incubated in the dark at 24 C for 7 days.

Thrips were counted 4 wk after planting. In 1986 and 1987, 10 plants from each plot were shaken over a box covered with an 18×16 mesh wire screen containing an aluminum plate coated with Tangle-Trap adhesive (Tanglefoot Co., Grand Rapids, MI). Thrips collected on the plates were examined under a binocular microscope and counted. In 1989, a plant washing technique was used to collect thrips. Ten plants per plot were randomly selected and placed in a quart jar. The jar was filled with 500 ml of water, 100 ml of 5.25% sodium hypochlorite, and 1 ml of liquid detergent and shaken vigorously. The contents of the jar were then poured into a 30-mesh sieve placed over a 200-mesh sieve and washed under tap water. Any material retained on the 200-mesh sieve was then washed into a Buchner funnel lined with no. 8 filter paper. The material retained on the filter paper after aspiration was inspected under a binocular microscope, and thrips were counted.

Percentage stand reduction, numbers of thrips, plant heights, and RHDI were analyzed by analysis of variance using orthogonal contrasts. Treatment means were separated by Duncan's multiple range test. The relationships among the four variables were determined by Pearson correlation analysis.

RESULTS AND DISCUSSION

As determined by the contrast between the untreated control and the in-furrow treatments (Table 1), the treatments significantly affected percentage stand reduction, thrips infestation, and RHDI in 1986 and 1989 and had no effect on these parameters in 1987. The effect of the insecticide treatments on these three parameters differed from that of the fungicide alone, and the effect of the combination of the insecticide with the fungicide did not differ from that of the insecticide alone (Table 1). Plant height was not affected by treatment contrasts except the insecticide versus fungicide contrast in 1986.

Thrips populations were high in 1986

Table 1. Mean squares[a] of orthogonal contrasts comparing the effects of in-furrow treatments on stand reduction, thrips, root-hypocotyl disease index (RHDI), and height of cotton seedlings

Contrast[b]	Stand reduction[c] (%) 1986	1987	1989	Thrips[d] (no.) 1986	1989	RHDI[e] 1986	1987	1989	Plant height (cm) 1986	1987	1989
Untreated vs. others	614**	10	446**	1,704**	2,479**	2.30**	0.02	2.34**	590	6	28
Insecticide vs. fungicide	4,262*	3	305*	4,817**	2,166**	3.05**	0.00	1.87**	881*	12	174
Insecticide plus fungicide vs. insecticide alone	27	4	2	8	18	1.09	0.05	0.00	391	4	6

[a] One asterisk indicates significance at $P = 0.05$; two asterisks indicate significance at $P = 0.01$.
[b] Fungicide = 10% pentachloronitrobenzene plus 2.5% etridiazole (Terraclor Super X at 1.4 kg a.i./ha); insecticide = disulfoton (Di-Syston 15G at 1.12 kg a.i./ha).
[c] Reduction in plant population between 2 and 6 wk after planting, calculated as [(2-wk count − 6-wk count)/2-wk count] × 100.
[d] No thrips were collected in 1987.
[e] On a scale of 0–4, where 0 = no necrosis, 1 = less than 33% necrosis, 2 = 33–66% necrosis, 3 = 67–100% necrosis, and 4 = dead taproot with proliferation of adventitious lateral roots above the dead area.

Table 2. Effect of in-furrow treatments on root-hypocotyl disease index (RHDI), plant height, thrips, and stand reduction of cotton seedlings

Treatment[v]	RHDI[w,x] 1986	1987	1989	Plant height (cm)[x] 1986	1987	1989	Thrips[x,y] 1986	1989	Stand reduction (%)[x,z] 1986	1987	1989
Untreated	3.3 a	0.3 a	2.0 a	64.9 b	17.2 a	86.8 a	57 a	57 a	55 b	12 a	32 a
Fungicide	3.1 a	0.2 a	2.0 a	66.9 b	17.2 a	84.4 a	61 a	47 a	67 a	10 a	27 a
Insecticide	1.7 c	0.3 a	0.8 b	92.0 a	18.7 a	91.6 a	18 b	17 b	29 c	11 a	15 b
Insecticide plus fungicide	2.4 b	0.1 a	0.8 b	78.0 ab	20.1 a	93.4 a	20 b	20 b	25 c	9 a	16 b

[v] Fungicide = 10% pentachloronitrobenzene plus 2.5% etridiazole (Terraclor Super X at 1.4 kg a.i./ha); insecticide = disulfoton (Di-Syston 15G at 1.12 kg a.i./ha).
[w] On a scale of 0–4, where 0 = no necrosis, 1 = less than 33% necrosis, 2 = 33–66% necrosis, 3 = 67–100% necrosis, and 4 = dead taproot with proliferation of adventitious lateral roots above the dead area.
[x] Means within a column followed by the same letter do not differ significantly at $P = 0.05$ according to Duncan's multiple range test.
[y] Number per 10 plants. No thrips were collected in 1987.
[z] Reduction in plant population between 2 and 6 wk after planting, calculated as [(2-wk count − 6-wk count)/2-wk count] × 100.

Table 3. Correlation coefficients[a] for the relationships among thrips,[b] plant height (PH), stand reduction (SR),[c] and root-hypocotyl disease index (RHDI)[d] of cotton seedlings

	1986			1987		1989		
Variable	RHDI	PH (cm)	Thrips	RHDI	PH (cm)	RHDI	PH (cm)	Thrips
SR (%)	0.75**	−0.60*	0.85**	−0.41	−0.11	0.77**	−0.33	0.53*
RHDI		−0.89**	0.64**		−0.52*		−0.48	0.59*
PH (cm)			−0.45					−0.17

[a] One asterisk indicates significance at $P = 0.05$; two asterisks indicate significance at $P = 0.01$.
[b] Number per 10 plants. No thrips were collected in 1987.
[c] Reduction in plant population between 2 and 6 wk after planting, calculated as [(2-wk count − 6-wk count)/2-wk count] × 100.
[d] On a scale of 0–4, where 0 = no necrosis, 1 = less than 33% necrosis, 2 = 33–66% necrosis, 3 = 67–100% necrosis, and 4 = dead taproot with proliferation of adventitious lateral roots above the dead area.

and 1989 (Table 2). Plots treated with disulfoton alone or in combination with the fungicide had significantly lower thrips populations than plots not treated with the insecticide. No thrips were detected in any of the plots in 1987.

In 1986 and 1989, seedling diseases were severe, as indicated by percentage stand reduction and RHDI, and these variables differed significantly among treatments (Table 2). Plots in which thrips were managed with insecticides had significantly lower percentage stand reduction and RHDI than plots where thrips were not controlled (Table 2). Even in the presence of a fungicide, RHDI and percentage stand reductions were higher when thrips were not controlled. Because of warm, dry conditions in 1987, the severity of seedling diseases was low, and stand reduction and RHDI did not differ significantly among the treatments.

Percentage stand reduction and RHDI were positively correlated with thrips infestation in 1986 and 1989 (Table 3). Because no thrips were detected in 1987, correlations between thrips and percentage stand reduction were not examined. Percentage stand reduction and RHDI were also positively correlated in 1986 and 1989 (Table 3).

Of the isolates obtained from diseased cotton seedlings, 42% were *Fusarium* spp. and 45% were *Rhizoctonia* spp. The frequency of isolation of these fungi did not differ over the 3 yr.

In 1986, plants collected from plots treated with insecticide were significantly taller than those from untreated plots or plots treated with fungicide alone (Table 2). Reduced plant height is a common effect of thrips infestation on seedling cotton (4). In 1987 and 1989, plant height did not differ significantly among treatments (Table 2). It is not surprising that heights were not different in 1987, because no thrips were present. In 1989, although plant heights were not different, plants were visibly damaged by thrips (i.e., leaves were ragged and crinkled). Apparently, the terminal bud was not damaged enough to cause a reduction in plant height. Cotton genotypes with pubescent leaves have a high degree of resistance to thrips injury (7). However, because the same cultivar was used throughout this study and because plant height was reduced in 1986, we can conclude that the lack of reduction in plant height in 1989 was not a cultivar response.

Although plant height differed significantly among treatments in 1986, it was not correlated with thrips infestation (Table 3). Plant height was negatively correlated with RHDI in 1986 and 1987 but not in 1989 (Table 3). Apparently, the level of seedling infection (i.e., RHDI) influenced plant height, and that effect was greater than the effect of thrips infestation.

The results of contrast and correlation analyses indicated that in this study, thrips infestation increased the severity of seedling disease, as determined by stand reduction and RHDI. It has been theorized that the reduced leaf area caused by thrips infestation reduces photosynthetic activity and the translocation of nutrients to the roots and thus renders seedlings more susceptible to seedling diseases (5). Although this study did not examine the mechanism by which thrips increase the severity of seedling disease, it does show that thrips provide a stress that increases seedling disease. Even in the presence of a fungicide, seedling disease was more severe on plants infested with thrips, which demonstrates the importance of thrips in the etiology of seedling diseases of cotton.

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