Occurrence of Five Thrips Species on Flue-Cured Tobacco and Impact on Spotted Wilt Disease Incidence in Georgia

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ABSTRACT

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Thrips-vectored tomato spotted wilt tospovirus (TSWV) infection is a major constraint on tobacco production in Georgia. Flue-cured tobacco fields were surveyed throughout the season from 1989 to 1991 and 1996 to 1998 to determine spotted wilt disease incidence and seasonal abundance and species composition of thrips populations. Five species were commonly found that accounted for more than 95% of the 17,000 thrips collected, including *Frankliniella fusca*, *F. occidentalis*, *F. bispinosa*, *F. tritici*, and *Limothrips cerealium*. *F. fusca*, *F. occidentalis*, and *F. bispinosa* are vectors of TSWV. *F. fusca* was the most common foliage thrips collected during all years, except 1989, when *L. cerealium* was the most abundant species. During 1989 to 1991, 22 to 68% of the foliage and flower thrips identified were TSWV vector species. The 1996 to 1998 foliage collections had much higher percentages of vector species (95 to 97%). The 1996 flower samples also had a very high percentage of vector species (94%); however, the percentages were much lower in 1997 (3%) and 1998 (32%). A trend toward higher incidence of TSWV occurred during the last three seasons studied, when thrips vector species were more abundant.

Additional keywords: ELISA, tobacco thrips, virus detection, western flower thrips

Spotted wilt disease, caused by tomato spotted wilt tospovirus (TSWV), is an economically important problem on tobacco crops in Georgia. First reported in 1986 (5), disease incidence gradually has increased during recent years, with individual fields showing 80% disease incidence. Spotted wilt disease caused a 17.5% statewide loss in plant stands and \$12.7 million in losses to crops in 1997 (2).

TSWV is transmitted by several thrips species. The virus must be acquired by thrips larva in which it multiplies and survives through the larval developmental stages (9,14). Mature adults become viruliferous and remain so for life (14). Adults that feed on infected plants may ingest the virus but cannot transmit it due to the presence of a midgut barrier (14).

Forty-three thrips species have been found on flue-cured tobacco foliage and blooms in Georgia (6), of which three are reported vectors of TSWV: tobacco thrips, *Frankliniella fusca* (Hinds) (12); western flower thrips, *F. occidentalis* (Pergande) (11); and *F. bispinosa* (Morgan) (15). To effectively control these species and the virus they vector requires an understanding of their

seasonal abundance and the crop phenology that exists when damaging thrips populations occur. Although the seasonal dynamics of thrips species have been reported in peanut (3,8,13) and tomato (10), information is limited on the abundance of thrips on flue-cured tobacco, thrips species present, and incidence of TSWV vectors throughout the season.

Our study was conducted to determine the seasonal incidence of the common thrips species found on flue-cured tobacco, document the percentage of thrips capable of transmitting spotted wilt virus, and relate the incidence of TSWV to the abundance of known thrips vector species. Preliminary results were published previously (7).

MATERIALS AND METHODS

During 1989 to 1991 and 1996 to 1998, two flue-cured tobacco fields in Tift County, GA, were sampled for thrips every 7 to 10 days beginning just after transplanting in middle to late March and continuing until late June or early July. In 1989, 'NC 2326' tobacco was transplanted at both sites; in 1990, 'Coker 371 Gold' and 'McNair 944' were transplanted; and in 1991 and subsequent years, 'K326' was transplanted at both test sites. Test fields were located at the Coastal Plain Experiment Station and the Bowen Research Farm and ranged in size from 0.6 to 1.0 ha. Production practices were performed according to Georgia Cooperative Extension Service recommendations (4) and included a preplant incorporated tank mix of prebulate (Tillan) and

napropamide (Devrinol) for weed control, metalaxyl (Ridomil) for blue mold control, fenamiphos (Nemacur) for nematode suppression, and chlorpyrifos (Lorsban) for soil insect control. Fertilizer (6-6-18, N-P-K) was applied at a rate of 1,122 kg/ha in a split application. No foliar insecticides were applied at thrips collection sites, unless tobacco budworm (*Heliothis virescens* (Fabricius)) or hornworm (*Manduca sexta* (L.)) populations caused significant defoliation, in which case Dipel 2X or DF (*Bacillus thuringiensis*) was applied.

All foliage from 100 to 200 plants was examined visually for thrips at both sites early in the growing season during each year, when thrips populations were low. Later in the season (usually beginning during the middle of April), 20 to 30 plants were sampled at each site. As plants bloomed (beginning in May), all blooms on the terminal floral branch of 10 plants were observed for thrips. Each bloom initially was shaken over a white background, then torn open and shaken again. Bloom sampling continued until all plants were topped. All observed thrips were collected with a fine artist's brush and placed in a vial containing 70% ethyl alcohol, returned to the laboratory, and identified. During 1996, 1997, and 1998, on alternate collection dates, thrips were placed in phosphate-buffered saline containing 2% polyvinyl pyrrolidone and 0.02% sodium azide, identified, and assayed by enzyme-linked immunosorbent assay (ELISA) to determine the presence of non-structural (NS) TSWV proteins (1). The 1996 thrips samples were sorted by species, and 10 thrips were used per well in a microtiter plate, whereas thrips collected during 1997 and 1998 were individually processed. Thrips reared without access to TSWV served as negative controls. In composite thrips samples, a positive ELISA response indicated the thrips (or at least 1 of 10 thrips in 1996) was capable of transmitting TSWV (1).

All plants in each field were examined visually weekly for spotted wilt disease symptoms. Depending on the size of the plot (0.6 to 1 ha.), the number of plants examined for symptoms varied from 8,800 to 14,800. Foliar symptoms indicative of spotted wilt disease included necrotic lesions and veinal necrosis. Infected plants often were stunted and sometimes showed necrotic streaks on the stem (5). Infection at the seedling stage often resulted in plant death. Symptomatic plants were flagged and dated,

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Table 1. Number of each thrips tomato spotted wilt tospovirus (TSWV) vector species collected on flue-cured tobacco foliage and blooms in Georgia during 1989–1996

Year	<i>F. fusca</i>	<i>F. bispinosa</i>	<i>F. occidentalis</i>	Other ^a
No. of thrips collected on foliage				
1989 (21.9) ^b	79	14	2	337
1990 (64.7)	1,893	58	22	1,076
1991 (63.6)	680	29	1	407
1996 (96.7)	1,996	0	21	67
1997 (97.5)	756	9	0	19
1998 (94.7)	5,617	4	40	319
No. of thrips collected on blooms				
1989 (63.7)	0	176	15	109
1990 (57.5)	18	837	385	918
1991 (67.8)	3	713	8	343
1996 (94.4)	5	0	199	12
1997 (3.6)	2	6	2	279
1998 (47.2)	8	4	73	180

^a Other thrips species were primarily *F. tritici* and *L. cerealeum*, which are not vectors of TSWV. Thrips numbers reported for 1989 to 1991 are summarized from an earlier report (6).

^b Percentage of all thrips collected that were vector species of TSWV.

Fig. 1. Seasonal abundance of foliage thrips on flue-cured tobacco at the Coastal Plain Experiment Station, Tift County, GA.

Fig. 2. Seasonal abundance of foliage thrips on flue-cured tobacco at the Bowen Research Farm, Tift County, GA.

and the cumulative percentage of infected plants was determined. To confirm a diagnosis of TSWV, representative symptomatic plants were tested by ELISA with a commercial kit (Agdia, Elkhart, IN).

RESULTS AND DISCUSSION

More than 17,000 thrips specimens were identified on flue-cured tobacco during our 6-year study. *F. fusca* was the most common foliage thrips observed every year, except 1989, when *L. cerealeum* was the most abundant species. Interestingly, *L. cerealeum* was very common on tobacco foliage during 1989 to 1991, but very low numbers (less than 100 total) were observed during 1996 to 1998. Some *F. occidentalis* and *F. bispinosa* also were observed on tobacco foliage each year. During 1989 to 1991, these three *Frankliniella* spp. comprised 22, 65, and 64% of the total thrips complex counted on tobacco foliage (Table 1). During 1996 to 1998, the three TSWV vectors made up 95 to 97% of the total thrips population. The dramatic increase in the overall percentage of vector species in the population probably was due to a vast reduction in the numbers of *L. cerealeum* present during 1996 to 1998.

The percentage of vector species collected from tobacco blooms ranged from 3 to 94% during the 6 years of this study. Of the thrips complex from 1989 to 1991, 57 to 68% was made up of vector species, primarily high numbers of *F. bispinosa*. The high percentage of vector species in 1996 (94%) was due to the predominance of *F. occidentalis*, when no *F. bispinosa* were found. In 1997 and 1998, fewer *F. occidentalis* and *F. bispinosa* were found. Instead, *F. tritici*, which is not a vector, was much more abundant. Thus, a much lower percentage of the thrips complex was composed of vector species during these 2 years (Table 1).

ELISA indicated that none of the 100 *F. fusca* (10 sets of 10 thrips each) collected 2 weeks after transplant were positive for TSWV NS. At 4 weeks after transplant, 15 of 30 sets of 10 thrips (50%) tested positive, indicating at least 1 *F. fusca* in each set of 10 was transmitting TSWV, because ELISA is capable of detecting NS protein in a single adult insect (1,9). Even if only 1 thrips in each of the 15 positive samples was a vector, it would equate with 15 transmitters of 300 thrips tested or 5% of the population. In 1997 and 1998, 3.5 to 4.6% of the individual *F. fusca* tested were positive for TSWV NS, respectively. The seasonal dynamics of thrips transmitters in peanut fields showed that ≈8% of *F. fusca* were potential transmitters of TSWV (9).

Field population densities of thrips were low during the first 4 weeks after transplanting, after which they rapidly increased from late April to the middle of May at both the Coastal Plain Experiment Station (Fig. 1) and Bowen Research Farm (Fig. 2) locations. Peak populations occurred between

Fig. 3. Seasonal incidence of spotted wilt disease of symptomatic flue-cured tobacco plants.

3 and 24 May at both locations during all 6 years, after which populations rapidly dropped to low levels when tobacco began to flower. Peak populations ranged from 8.5 to 99.7 thrips per plant among years and between locations (99.7 at the Coastal Plain Experiment Station and 54.2 at the Bowen Farm).

The seasonal incidence of spotted wilt disease for each year of our study (average of both locations) is presented in Figure 3. Very few symptomatic plants were observed at either location until late April (5 to 6 weeks after transplanting), after which the cumulative percentage of infected plants steadily rose, peaking at 2.5, 13.6, and 4.2% during 1989, 1990, and 1991, respectively, and 8.4, 29.8, and 19.5% during 1996, 1997, and 1998, respectively. Only minor increases in the cumulative percentage of TSWV incidence were observed after 31 May, except in 1997, when incidence rose from 15% on 31 May to nearly 30% on 30 June. Average plant stand loss due to TSWV was 1 to 17.5% during 1988 to 1998; the highest loss (17.5%) was in 1997.

There has been a trend toward higher incidence of TSWV in flue-cured tobacco in Georgia. During this period of increased disease incidence, there has been a dramatic shift in the thrips species complex

composition, including a higher percentage of vector species. In particular, *F. fusca* has become the dominant species on tobacco foliage, while populations of *L. cerealeum* (a nonvector species) have declined. Knowing which vector species are present and the seasonal abundance of these pests will aid the development of effective strategies for managing spotted wilt disease in flue-cured tobacco.

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