IMPACT OF TRANSPLANTING DATE AND INSECTICIDE CONTROL PRACTICES ON THE INCIDENCE OF TOMATO SPOTTED WILT VIRUS AND INSECT PESTS IN FLUE-CURED TOBACCO

TOBACCO SCIENCE

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Field studies were conducted in Georgia on flue-cured tobacco, *Nicotiana tabacum* L., during 1991 and 1992 to evaluate the effects of transplanting date and six insecticide control practices on the abundance of thrips, primarily *Frankliniella fusca* (Hinds), and tobacco aphids, *Myzus nicotianae* Blackman. The effects on the incidence of spotted wilt, caused by thrips-vectored tomato spotted wilt virus, and on the yield and quality of cured tobacco also were examined. Thrips populations were higher on tobacco transplanted in late March or mid-April than on tobacco transplanted in late April in 1991, but no transplanting date effects were observed in 1992. Weekly foliar sprays of acephate with or without a transplant-water treatment of acephate were effective in reducing the seasonal population densities of thrips. There were, however, no differences in the incidence of spotted wilt among the six insecticide control practices used to manage thrips in 1991. Only weekly foliar sprays reduced the incidence of spotted wilt in 1992. Transplanting date had no consistent effect upon spotted wilt infection, with higher incidence of spotted wilt in the earlier plantings in 1991 and in the later plantings in 1992. Transplanting date did not affect the seasonal population densities of aphids either year. All of the thrips control practices reduced aphid populations. There was a higher yield of cured leaves in the early-transplanted tobacco, but there were no differences among the six insecticide control treatments. Neither transplanting date nor thrips control treatments affected tobacco quality. It appears that transplanting date and the use of certain transplant-water and foliar insecticide treatments to manage thrips populations are not effective, economical, or environmentally sound methods of reducing spotted wilt in flue-cured tobacco.

Additional key words: *Nicotiana tabacum*, *Frankliniella fusca*, *Myzus nicotianae*, virus vectors, cultural control, chemical control.

INTRODUCTION

Spotted wilt, caused by tomato spotted wilt virus, and the thrips that vector this disease have become areas of research interest in the production of flue-cured tobacco, *Nicotiana tabacum* L., in the United States (8). This virus is found on tobacco throughout Georgia and it accounts for stand losses of 6-8% annually (5). Spotted wilt is transmitted by the tobacco thrips, *Frankiniella fusca* (Hinds), and the western flower thrips, *F. occidentalis* (Pergande) (10,11). These thrips species are commonly collected on tobacco foliage and blooms throughout the growing season in Georgia (8).

The source of viruliferous thrips for spotted wilt infection in tobacco is not certain. However, *F. fusca* and *F. occidentalis* have been collected from 26 and 45 species of plants, respectively, during the winter and spring in Georgia (3). *F. fusca* also has been observed emerging from newly planted tobacco fields in North Carolina (2). The virus is acquired during feeding on infected plants by the larval stages of thrips, and it is transmitted to other host plants by adults (12). Post-harvest management (tillage and insecticide applications) was used to reduce volunteer weeds and thrips populations in peanuts, but this technique did not reduce spotted wilt incidence the following season (4). Certain transplant-water and foliar spray practices reduced thrips populations and incidence of spotted wilt in some tobacco trials; however, other chemical control practices increased vector movement so that disease incidence was greater (8). These conflicting data demonstrate that additional information is needed on the effects of chemical control on virus-vector relationships.

Transplanting date affects the seasonal populations of tobacco aphids, *Myzus nicotianae* Blackman, another economic

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Table 1. Effects of transplanting date and thrips treatments on the seasonal abundance of thrips and tobacco aphids and on the incidence of spotted wilt on flue-cured tobacco in Georgia, 1991.

Transplanting date	Treatments[a]	Mean Insects/plant		% incidence spotted wilt
		Thrips	Aphids	
27 March (TD 1)	Untreated (TRT 1)	3.0	1432.6	4.2
	Acephate 75S 1.7 TPW only (TRT 2)	2.1	308.5	4.8
	Acephate 75S 1.7 TPW + 0.84 F weekly (TRT 3)	1.4	0.3	2.7
	Acephate 75S 1.7 TPW + 0.84 F twice (TRT 4)	1.4	411.8	3.9
	Acephate 75S 0.84 F weekly (TRT 5)	0.8	0.7	3.0
	Acephate 75S 0.84 F twice (TRT 6)	1.0	158.1	3.9
10 April (TD 2)	Untreated	3.8	1637.3	2.8
	Acephate 75S 1.7 TPW only	1.8	769.3	4.6
	Acephate 75S 1.7 TPW + 0.84 F weekly	1.3	1.4	2.4
	Acephate 75S 1.7 TPW + 0.84 F twice	1.8	146.6	3.2
	Acephate 75S 0.84 F weekly	1.8	0.3	4.6
	Acephate 75S 0.84 F twice	1.5	603.8	4.8
24 April (TD 3)	Untreated	0.8	577.7	1.9
	Acephate 75S 1.7 TPW only	0.3	708.9	1.1
	Acephate 75S 1.7 TPW + 0.84 F weekly	0.3	0.5	1.3
	Acephate 75S 1.7 TPW + 0.84 F twice	0.6	241.1	1.4
	Acephate 75S 0.84 F weekly	1.2	0.3	3.2
	Acephate 75S 0.84 F twice	0.5	233.5	2.9
LSD for all dates (P = 0.05)		**1.1**	**440.2**	**NS**

Statistical Analyses

Transplanting date effects:	Thrips:	F = 13.47 with 2 and 45 df, P = 0.01.
	Aphids:	F = 1.46 with 2 and 45 df, P > 0.05.
	TSWV:	F = 4.73 with 2 and 45 df, P = 0.03.
Treatment effects:	Thrips:	F = 4.34 with 5 and 45 df, P = 0.01.
	Aphids:	F = 15.52 with 5 and 45 df, P = 0.01.
	TSWV:	F = 2.02 with 5 and 45 df, P > 0.05.

[a] Treatments either applied in transplant water (TPW), or foliar applied (F) weekly for 8 weeks or twice at 1 and 2 weeks after transplant; rates expressed as kg AI/ha.

tobacco pest (9,14). The effects of this cultural practice on thrips population densities and incidence of spotted wilt are not known. Therefore, this study was undertaken to examine the effects of transplanting date (early, middle, and late season) and spray control practices (transplant-water or foliar applications) on the seasonal abundance of thrips and tobacco aphids and the incidence of spotted wilt in flue-cured tobacco.

MATERIALS AND METHODS

Flue-cured tobacco (CV K-326) was transplanted early (27 March 1991 & 2 April 1992), middle (10 April 1991 & 15 April 1992), or late (24 April 1991 & 29 April 1992) in the season at the University of Georgia, Coastal Plain Experiment Station, Tifton, Ga. Individual plots (48 plants/plot) were 4 rows wide (1.1 m row spacing) by 6.1 m long, and they were arranged in a split plot design with four replications. Planting date was the main plot, and thrips management practice was the split plot.

The six management practices directed at controlling thrips as they move into the field were: 1) untreated control, 2) acephate 75S at 1.7 kg [AI]/ha in the transplant water (TPW), 3) acephate at 1.7 kg [AI]/ha TPW + weekly foliar sprays (F) at 0.84 kg [AI]/ha for 8 weeks in 1991 and 6 weeks in 1992, 4) acephate at 1.7 kg [AI]/ha TPW + 0.84 kg [AI]/ha twice at 1 and 2 weeks after transplanting, 5) acephate 0.84 kg [AI]/ha (F) weekly, and 6) acephate 0.84 kg [AI]/ha (F) twice. The TPW treatments were applied through the transplanter in 130 mL of water per plant. The foliar sprays were applied with a CO_2-powered backpack sprayer equipped with three TX-12 nozzles directed

Table 2. Effects of transplanting date and thrips control treatments on the abundance of thrips on flue-cured tobacco in Georgia, 1991.

Transplanting date	Treatments[a]	Number of thrips per three plants on each date					
		18 April	26 April	7 May	21 May	10 June	19 June
27 March (TD 1)	Untreated (TRT 1)	25.5	18.3	3.5	1.5	4.8	0.0
	Acephate 75S 1.7 TPW only (TRT 2)	7.2	13.7	13.5	1.5	2.4	0.0
	Acephate 75S 1.7 TPW + 0.84 F weekly (TRT 3)	5.1	3.2	12.0	0.9	2.4	0.9
	Acephate 75S 1.7 TPW + 0.84 F twice (TRT 4)	3.3	3.7	13.5	3.0	1.5	0.0
	Acephate 75S 0.84 F weekly (TRT 5)	3.9	2.2	5.4	6.6	0.9	1.5
	Acephate 75S 0.84 F twice (TRT 6)	6.3	4.1	9.9	3.9	1.5	0.0
10 April (TD 2)	Untreated	35.7	21.5	7.5	2.0	2.4	0.0
	Acephate 75S 1.7 TPW only	5.4	12.1	21.0	3.3	2.4	0.0
	Acephate 75S 1.7 TPW + 0.84 F weekly	1.8	4.5	11.4	0.6	0.9	3.9
	Acephate 75S 1.7 TPW + 0.84 F twice	4.2	5.1	28.5	3.9	4.5	0.0
	Acephate 75S 0.84 F weekly	18.3	5.3	6.0	2.4	3.0	9.0
	Acephate 75S 0.84 F twice	22.5	3.8	7.5	0.0	2.4	0.9
24 April (TD 3)	Untreated	---	1.3	7.5	0.9	3.0	0.0
	Acephate 75S 1.7 TPW only	---	0.3	0.9	1.5	2.4	0.0
	Acephate 75S 1.7 TPW + 0.84 F weekly	---	0.7	1.5	0.0	1.5	1.5
	Acephate 75S 1.7 TPW + 0.84 F twice	---	0.3	4.5	1.5	1.5	0.9
	Acephate 75S 0.84 F weekly	---	1.0	5.4	3.9	1.5	6.0
	Acephate 75S 0.84 F twice	---	0.9	3.0	0.6	3.0	0.0
LSD (P = 0.05)		**6.1**	**10.7**	**9.3**	**2.4**	**NS**	**3.3**
Statistical Analyses[b]							
Transplanting date (TD) effects		NS	*	*	*	NS	NS
Treatment (TRT) effects		*	**	**	*	NS	**
TD x TRT effects		NS	NS	*	NS	NS	NS

[a] Treatments either applied in transplant water (TPW), or foliar applied (F) weekly for 8 weeks or twice at 1 and 2 weeks after transplant; rates expressed as kg AI/ha.

[b] NS indicates no significant difference (P > 0.05) on that sampling date, * and ** indicate significant differences at P = 0.05 and P = 0.01, respectively.

over a single row. This sprayer setup delivered 115 L/ha at 276 KPa.

All plots were maintained as recommended by the Georgia Agricultural Extension Service guidelines (6), including a pre-plant incorporated tank mix of pebulate (Tillam®) 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 in the test site except acephate as described for specific treatments and *Bacillus thruingiensis* (Dipel®) for control of tobacco budworm, *Heliothis virescens* (F.), and tobacco hornworm, *Manduca sexta* L., larvae in mid-May and early June each year.

All plots were visually sampled for adult thrips and tobacco aphid populations every 1-2 weeks beginning in mid-April and continuing until mid-June. All live thrips and aphids on plants 2, 4, and 6 on the second row of each plot were recorded on each sampling date. Adult thrips also were collected from rows three and four on some dates for species identification. Because there are no keys available to identify immature thrips found on tobacco to species, they were discarded from the samples. Type specimens were placed in the insect museum at the Georgia Experiment Station in Griffin, Ga.

All plants in each plot were visually examined weekly for symptoms of spotted wilt. Symptomatic plants were flagged and dated, and the percentage of infected plants was determined for each treatment. To confirm diagnosis of spotted wilt, representative symptomatic plants were tested by an ELISA technique, using commercially available polyclonal antiserum to the common or "L strain" of tomato spotted wilt virus (Agdia, Inc., Elkart, Ind.) (4). Beginning in late June and

Table 3. Effects of transplanting date and thrips control treatments on the abundance of tobacco aphids on flue-cured tobacco in Georgia, 1991.

Transplanting date	Treatments[a]	Number of aphids per three plants on each date					
		18 April	26 April	7 May	21 May	10 June	19 June
27 March (TD 1)	Untreated (TRT 1)	7.2	15.0	38.7	203.1	19,950	5,555
	Acephate 75S 1.7 TPW only (TRT 2)	1.2	0.2	0.9	12.0	5,250	290
	Acephate 75S 1.7 TPW + 0.84 F weekly (TRT 3)	0.6	0.0	0.6	0.0	2	2
	Acephate 75S 1.7 TPW + 0.84 F twice (TRT 4)	0.9	0.0	2.4	16.8	5,848	1,545
	Acephate 75S 0.84 F weekly (TRT 5)	0.9	0.3	0.6	2.7	6	2
	Acephate 75S 0.84 F twice (TRT 6)	0.3	0.2	1.5	18.3	2,775	50
10 April (TD 2)	Untreated	0.6	3.5	10.8	9.3	11,259	18,188
	Acephate 75S 1.7 TPW only	0.0	0.3	1.5	0.9	2,310	12,021
	Acephate 75S 1.7 TPW + 0.84 F weekly	0.3	0.1	0.3	4.2	0	20
	Acephate 75S 1.7 TPW + 0.84 F twice	0.6	0.0	0.3	5.1	482	2,150
	Acephate 75S 0.84 F weekly	0.3	0.0	0.3	0.3	2	3
	Acephate 75S 0.84 F twice	0.3	0.3	0.0	2.4	699	10,167
24 April (TD 3)	Untreated	---	0.3	0.6	3.6	3,267	7,127
	Acephate 75S 1.7 TPW only	---	0.0	0.3	0.3	1,284	11,475
	Acephate 75S 1.7 TPW + 0.84 F weekly	---	0.1	0.6	0.3	0	8
	Acephate 75S 1.7 TPW + 0.84 F twice	---	0.0	0.3	0.3	209	4,131
	Acephate 75S 0.84 F weekly	---	0.0	0.3	1.5	0	3
	Acephate 75S 0.84 F twice	---	0.2	0.0	0.6	132	4,070
LSD (P = 0.05)		**2.1**	**3.2**	**5.7**	**18.8**	**602**	**5,267**
Statistical Analyses[b]							
Transplanting date (TD) effects		NS	NS	*	**	**	*
Treatment (TRT) effects		*	**	*	**	**	**
TD x TRT effects		NS	NS	NS	NS	NS	*

[a]Treatments either applied in transplant water (TPW), or foliar applied (F) weekly for 8 weeks or twice at 1 and 2 weeks after transplant; rates expressed as kg AI/ha.

[b]*NS indicates no significant difference (P > 0.05) on that sampling date, * and ** indicate significant differences at P = 0.05* and P = 0.01, respectively.

continuing until mid-July, 10 plants on row two of each plot were harvested (four primings) and cured. After curing, leaves were weighed and graded by USDA graders. Grade indices (from 1-99) were computed based on equivalent government grades being of equal value (1).

All data were analyzed by the GLM procedures of SAS (13). Thrips and aphid data were analyzed separately for each week and overall by combining all weeks. The incidence of spotted wilt and data for yield and quality were analyzed for overall effects. The weekly model contained effects due to transplanting date (TD), replicate (REP), treatment (TRT), TD x TRT, and TD x TRT x REP. The overall yearly analysis included TD, REP, TD x REP, TRT, TD x TRT, TD x TRT x REP (Error-b), week (WK), TD x WK, TRT x WK, TD x TRT x WK (Error-c). An LSD (P = 0.05) was computed to compare treatment means whenever significant treatment effects were detected.

RESULTS

1991

The seasonal mean population densities of thrips and aphids were significantly different among treatments in 1991 (**Table 1**). The TPW treatment followed by eight weekly foliar sprays (TRT 3) and the eight weekly sprays with no TPW treatment (TRT 5) were effective in reducing the seasonal populations of thrips. The only exception was TD 3 in which the thrips populations were not lower than those in the untreated plots. This was primarily due to overall low thrips counts on all TD 3 plots.

Treatments 3 and 5 also were very effective in controlling aphids throughout the season. In fact, all five of the control treatments were effective in reducing the seasonal population densities of aphids except the TD 3-TRT 2. There were more thrips throughout the season on tobacco from the two earlier transplanting dates than in the late-transplanted tobacco. On

Table 4. Effects of transplanting date and thrips treatments on the seasonal abundance of thrips and tobacco aphids and on the incidence of spotted wilt, yield and grade of flue-cured tobacco in Georgia, 1992.

Transplanting date	Treatments[a]	Mean insects/plant Thrips	Aphids	% incidence spotted wilt	Yield kg/plot	Grade index
2 April (TD 1)	Untreated (TRT 1)	5.8	21.3	1.8	3.37	43.7
	Acephate 75S 1.7 TPW only (TRT 2)	5.1	24.8	1.7	3.42	43.0
	Acephate 75S 1.7 TPW + 0.84 F weekly (TRT 3)	2.1	0.4	1.1	3.32	43.8
	Acephate 75S 1.7 TPW + 0.84 F twice (TRT 4)	6.5	2.1	1.1	3.38	40.0
	Acephate 75S 0.84 F weekly (TRT 5)	1.7	0.8	1.8	3.40	45.8
	Acephate 75S 0.84 F twice (TRT 6)	4.7	1.8	3.2	3.53	39.0
15 April (TD 2)	Untreated	3.6	1.7	4.4	3.20	42.2
	Acephate 75S 1.7 TPW only	6.7	4.9	5.8	3.19	45.0
	Acephate 75S 1.5 TPW + 0.84 F weekly	2.1	0.3	1.9	3.29	45.0
	Acephate 75S 1.7 TPW + 0.84 F twice	5.3	0.4	3.3	3.00	49.7
	Acephate 75S 0.84 F weekly	1.4	0.2	2.6	2.95	51.3
	Acephate 75S 0.84 F twice	5.4	1.7	7.6	3.23	43.2
29 April (TD 3)	Untreated	6.4	1.6	5.2	3.03	44.7
	Acephate 75S 1.7 TPW only	6.2	1.8	3.1	2.71	42.6
	Acephate 75S 1.7 TPW + 0.84 F weekly	2.5	0.3	2.0	3.09	48.5
	Acephate 75S 1.7 TPW + 0.84 F twice	4.8	0.4	3.1	2.89	49.1
	Acephate 75S 0.84 F weekly	1.9	0.4	1.8	3.07	43.5
	Acephate 75S 0.84 F twice	5.9	3.8	3.4	3.14	45.3
LSD for all dates (P = 0.05)		**2.9**	**4.8**	**2.3**	**NS**	**NS**

Statistical Analyses

Transplanting date effects:	Thrips:	F = 2.81 with 2 and 45 df, P > 0.05.
	Aphids:	F = 2.29 with 2 and 45 df, P > 0.05.
	TSWV:	F = 6.13 with 2 and 45 df, P = 0.01.
	Yield:	F = 5.66 with 2 and 45 df, P = 0.02.
	Grade:	F = 0.69 with 2 and 45 df, P > 0.05.
Treatment effects:	Thrips:	F = 16.26 with 5 and 45 df, P = 0.01.
	Aphids:	F = 2.44 with 5 and 45 df, P = 0.05.
	TSWV:	F = 2.43 with 5 and 45 df, P = 0.05.
	Yield:	F = 2.01 with 5 and 45 df, P > 0.05.
	Grade:	F = 1.99 with 5 and 45 df, P > 0.05.

[a] Treatments either applied in transplant water (TPW), or foliar applied (F) weekly for 6 weeks or twice at 1 and 2 weeks after transplanting; rates expressed as kg AI/ha.

the other hand, there were no differences in the seasonal mean aphid populations on tobacco among the three transplanting dates. No differences were detected in the incidence of spotted wilt among the treatments, although there was a significantly higher incidence in the first two transplantings than in the late-transplanted tobacco (**Table 1**). Yield and quality data were collected in 1991, but no results were reported due to a laboratory fire that destroyed the data records.

Thrips populations were higher during the early sampling dates, but remained relatively low throughout the remainder of the sampling period (**Table 2**). There were significant TD effects on 26 April, 7 May, and 21 May, with higher thrips populations in the early- and middle-transplanting dates than in the late-transplanted tobacco. There were significant treatment effects on every sampling date except 10 June. Populations were generally higher in the untreated and TPW-only treatments. However, on the mid-June sampling date there were higher thrips populations in the plots that received eight weekly foliar sprays than in the other treatments. This was possibly due to a reduction in predatory arthropods.

Aphid populations in the untreated plots increased steadily during the early part of the season and peaked on 10 June in the early-transplanted tobacco and on 19 June in the two later transplantings (**Table 3**). This is similar to

Table 5. Effects of transplanting date and thrips control treatments on the abundance of thrips on flue-cured tobacco in Georgia, 1992.

Transplanting date	Treatments[a]	Number of thrips per three plants on each date							
		14 April	23 April	8 May	18 May	25 May	1 June	11 June	24 June
2 April (TD 1)	Untreated (TRT 1)	0.8	0.7	5.0	36.5	46.8	37.8	11.0	0.0
	Acephate 75S 1.7 TPW only (TRT 2)	0.3	0.0	4.8	38.8	36.0	27.3	11.5	3.0
	Acephate 75S 1.7 TPW + 0.84 F weekly (TRT 3)	0.3	0.3	1.8	4.3	17.3	26.3	1.0	1.0
	Acephate 75S 1.7 TPW + 0.84 F twice (TRT 4)	0.3	0.3	2.5	32.0	73.0	37.8	10.0	0.0
	Acephate 75S 0.84 F weekly (TRT 5)	0.3	0.0	1.0	3.8	14.0	18.8	2.5	0.0
	Acephate 75S 0.84 F twice (TRT 6)	0.0	0.0	0.5	21.8	52.5	26.0	12.0	0.0
15 April (TD 2)	Acephate	---	1.0	0.8	10.3	29.3	22.3	8.0	3.0
	Acephate 75S 1.7 TPW only	---	0.0	0.4	10.8	58.5	52.0	16.5	1.5
	Acephate 75S 1.7 TPW + 0.84 F weekly	---	0.0	0.5	1.5	20.8	6.0	15.0	0.5
	Acephate 75S 1.7 TPW + 0.84 F twice	---	0.0	0.3	8.0	57.8	71.3	23.5	0.5
	Acephate 75S 0.84 F weekly	---	0.0	0.8	1.8	16.8	6.8	3.5	0.0
	Acephate 75S 0.84 F twice	---	0.3	0.0	6.8	45.3	48.8	12.5	0.5
29 April (TD 3)	Acephate	---	---	3.0	14.0	34.3	35.8	25.5	3.0
	Acephate 75S 1.7 TPW only	---	---	1.3	4.3	34.3	48.8	21.0	1.5
	Acephate 75S 1.7 TPW + 0.84 F weekly	---	---	0.5	0.5	8.8	26.2	9.0	0.0
	Acephate 75S 1.7 TPW + 0.84 F twice	---	---	0.3	3.8	30.3	36.7	15.0	0.0
	Acephate 75S 0.84 F weekly	---	---	0.0	3.0	11.5	11.0	8.0	1.0
	Acephate 75S 0.84 F twice	---	---	2.3	3.0	24.5	45.8	30.0	0.5
LSD for all dates (P = 0.05)		**NS**	**NS**	**2.8**	**10.8**	**24.4**	**37.5**	**10.1**	**NS**
Statistical Analyses[b]									
Transplant date (TD) effects		---	NS	*	**	*	NS	**	NS
Treatment (TRT) effects		N$	NS	*	*	*	*	**	NS
TD x TRT effects		---	NS	NS	NS	NS	*	NS	NS

[a] Treatments either applied in transplant water (TPW), or foliar applied (F) weekly for 6 weeks or twice at 1 and 2 weeks after transplanting; rates expressed as kg AI/ha.

[b] NS indicates no significant difference (P > 0.05) on that sampling date, * and ** indicate significant differences at P = 0.05 and P = 0.01, respectively.

previous reports (7). Plots sprayed eight times with foliar applications of acephate (TRT 3 & 5) had very low aphid population densities on all sampling dates. The other treatments (TRT 2, 4, & 6) were also initially effective in controlling aphids, but they began to fail by 10 June. The only exception to this trend was TD 1-TRT 2 (TPW only) that had greatly reduced aphid populations on 19 June, which may have been due to heavy lady beetle populations in two of the four replications.

1992

Results for 1992 were similar to 1991, although overall thrips populations were somewhat higher and aphid population densities were much lower in 1992 (**Table 4**). Transplanting date did not affect thrips or aphid populations, but treatment differences were highly significant for both pests. The six weekly foliar sprays of acephate (TRT 3 & 5) reduced seasonal thrips population densities. Low aphid populations were maintained throughout the season in the early-transplanted tobacco for TRT 3, 4, 5, & 6 (**Table 4**). The weekly acephate treatments reduced the incidence of spotted wilt in the middle- and late-transplanted tobacco, where spotted wilt incidence was higher and exceeded 5% in some of the treatments. There was a significantly higher yield of cured leaves in TD 1 than in TD 3, although there were no yield differences among the treatments. Neither transplanting date nor spray treatment affected tobacco quality.

During the early sampling dates there were higher thrips populations in the early-transplanted tobacco (**Table 5**). In late May, thrips population densities were relatively uniform across all three transplanting dates. By mid-June the middle- and late-transplanted tobacco had higher thrips populations. The treatments with weekly foliar sprays (TRT 3 & 5) had lower thrips densities on the five sampling dates that were significantly different (**Table 5**).

Table 6. Effects of transplanting date and thrips control treatments on the abundance of tobacco aphids on flue-cured tobacco in Georgia, 1992.

Transplanting date	Treatments[a]	Number of aphids per three plants on each date							
		14 April	23 April	8 May	18 May	25 May	1 June	11 June	24 June
2 April (TD 1)	Untreated (TRT 1)	2.3	1.7	2.5	44.5	58.0	26.0	175.0	201.5
	Acephate 75S 1.7 TPW only (TRT 2)	1.5	0.7	4.5	37.0	33.5	16.8	273.0	228.0
	Acephate 75S 1.7 TPW + 0.84 F weekly (TRT 3)	1.5	1.0	1.0	1.0	2.5	1.3	0.0	0.5
	Acephate 75S 1.7 TPW + 0.84 F twice (TRT 4)	1.0	1.3	1.8	15.0	26.3	0.5	4.1	0.0
	Acephate 75S 0.84 F weekly (TRT 5)	2.0	1.7	3.0	0.5	1.5	9.5	0.0	0.0
	Acephate 75S 0.84 F twice (TRT 6)	1.3	0.0	3.0	1.0	1.3	24.5	10.0	0.5
15 April (TD 2)	Acephate	---	1.0	0.0	1.0	1.0	2.0	6.0	23.0
	Acephate 75S 1.7 TPW only	---	1.3	1.0	0.5	0.8	2.0	45.5	51.5
	Acephate 75S 1.7 TPW + 0.84 F weekly	---	0.3	0.5	0.0	2.0	1.8	0.5	1.0
	Acephate 75S 1.7 TPW + 0.84 F twice	---	0.0	0.3	0.5	1.3	1.0	5.0	0.0
	Acephate 75S 0.84 F weekly	---	0.3	0.5	0.3	1.8	0.8	0.5	0.5
	Acephate 75S 0.84 F twice	---	0.3	1.0	0.8	0.3	1.3	31.5	1.0
29 April (TD 3)	Acephate	---	---	0.8	0.5	2.3	0.5	6.0	19.5
	Acephate 75S 1.7 TPW only	---	---	0.7	0.3	0.8	2.0	3.5	24.5
	Acephate 75S 1.7 TPW + 0.84 F weekly	---	---	1.5	0.3	2.0	1.4	0.5	0.5
	Acephate 75S 1.7 TPW + 0.84 F twice	---	---	0.8	0.0	0.5	1.7	4.0	1.0
	Acephate 75S 0.84 F weekly	---	---	2.0	1.8	0.5	1.0	1.0	0.5
	Acephate 75S 0.84 F twice	---	---	0.3	0.0	0.3	1.3	59.0	8.5
LSD for all dates (P = 0.05)		**NS**	**NS**	**NS**	**12.1**	**10.8**	**7.3**	**24.2**	**18.9**
Statistical Analyses[b]									
Transplant date (TD) effects		---	NS	*	**	**	*	**	**
Treatment (TRT) effects		NS	NS	NS	*	**	*	**	**
TD x TRT effects		---	NS	NS	NS	NS	*	NS	NS

[a] Treatments either applied in transplant water (TPW), or foliar applied (F) weekly for 6 weeks or twice at 1 and 2 weeks after transplanting; rates expressed as kg AI/ha.

[b] NS indicates no significant difference (P > 0.05) on that sampling date, * and ** indicate significant differences at P = 0.05 and P = 0.01, respectively.

Aphid populations remained low on all six treatments for all transplanting dates throughout the 1992 season (**Table 6**). There were, however, higher aphid densities in the early-transplanted tobacco on the last six sampling dates. All treatments that included acephate foliar sprays had lower aphid populations than the untreated or TPW-only treatment (**Table 6**).

DISCUSSION

The transplanting date for flue-cured tobacco in Georgia did not impact the seasonal abundance of thrips and aphids or the incidence of spotted wilt as much as anticipated. The early-transplanted tobacco did have higher thrips populations, primarily *F. fusca* but also some *Limothrips cerealium* (Haliday), during April and early May, but by mid-June thrips were more abundant in the late-transplanted tobacco. While there was higher incidence of spotted wilt in the early- and middle-transplanted tobacco in 1991, the middle- and late-transplanted tobacco had higher disease incidence in 1992.

Transplanting date did not affect seasonal population densities of aphids either year, although previous studies have reported higher peak aphid populations in early-transplanted tobacco in some years (7). A schedule of weekly foliar sprays of acephate was effective in reducing thrips populations and was also very effective in controlling aphids. However, this approach to thrips management is very costly, adversely affects beneficial arthropods, and could lead to environmental concerns. Furthermore, this extensive use of insecticide greatly enhances the possibility of insecticide resistance developing in these pests. Although fenamiphos was applied as a pre-plant treatment to suppress nematodes, this pesticide could have had some effect on early-season aphid and/or thrips populations in this study. These effects, if any, were probably minimal because the product was applied three weeks

before transplanting and live thrips and aphids were observed in all plots on the initial sampling date.

All of the insecticide treatments directed at controlling the thrips moving into the field, including the weekly foliar applications of acephate, had no effect on incidence of spotted wilt in 1991. Although the extensive control practices (i.e., weekly sprays) did reduce disease incidence in 1992, the yields and quality of flue-cured tobacco were not improved. Thus, it appears that neither the cultural practice of selecting transplanting date nor the use of insecticide treatments for reducing thrips populations is effective, nor are they economical or environmentally sound, in reducing the incidence of spotted wilt in flue-cured tobacco.

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