The Impact of Tillage Practices on Thrips Injury of Peanut in North Carolina and Virginia[1]

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ABSTRACT

Reduced tillage peanut production is gaining popularity and the impact of this practice on insect pests is not well understood. This study monitored thrips (*Frankliniella fusca* Hinds) damage and abundance on peanut (*Arachis hypogaea* L.) in North Carolina and Virginia on peanuts grown under different tillage regimes from 1986-92. A general trend for less thrips damage in reduced tillage plots was consistent in all years except 1992 in North Carolina. In many instances, damage to plants in reduced tillage peanuts was significantly less than in a conventionally tilled system. The implications for future pest management strategies involving reduced pesticide use as well as research needs to meet these goals are discussed.

Key Words: *Arachis hypogaea* L., conservation tillage, cultural practices, *Frankliniella fusca,* minimum till, no-till, tobacco thrips.

Using cultural practices for insect management in field crops is common in agriculture and recently a component of integrated pest management (IPM) programs (Johansen, 1985). In the Southeastern United States, several cultural practices strategies are commonly employed in IPM programs for peanuts. Crop rotation is an effective and widely practiced tool for disease suppression in peanuts (Henning *et al.*, 1982). In peanuts cultural practices also have been used to a lesser degree for insect management. Delayed planting of peanuts is used for reducing populations of early season thrips (*Frankliniella fusca* Hinds and *F. occidentalis* Perg.) in Georgia, Alabama, and Texas (Weeks and Hagan, 1992), and crop rotation has been used to minimize potential damage from wireworms (Womack *et al.*, 1981).

The cultural practice of tillage is used commonly in many crops for pest management (Johansen, 1985). Reduced tillage has become popular in many crops as a means of saving time and money. In addition, reduced tillage is necessary for compliance with soil conservation requirements in fields classified as erodible. For these reasons, interest in the use of reduced tillage in peanut production has increased in the Southeastern United States. Recent developments in foreign trade agreements and in legislation for peanut price support have directly affected the economics of growing peanuts and consequently renewed interest in reducing peanut production costs. The impact of reduced tillage on insect pest populations is variable depending on the crop and cropping system. Because tillage can affect pest survival, the ability of an insect to find a host, and predator and

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parasite abundance (Johnson *et al.*, 1984), it is important to determine the impact of any changes in peanut production practices on common pest species. Preliminary studies on tillage and cover crop effects have demonstrated a significant negative impact on mid-season pests such as southern corn rootworm, *Diabrotica undecimpunctata howardi* Barber (Coleoptera: Chrysomelidae) (Brust, 1990). This effect appears to be manifested through a synergistic association between predators and weed-crop root associations.

The impact of changes in tillage practices on peanut insect pests has not been well documented. This study focused on monitoring the impact of reduced tillage compared with conventional tilled peanuts on an early season pest tobacco thrips (*F. fusca*).

Materials and Methods

In 4 yr (1986, 1987, 1991 and 1992), a total of seven test sites were evaluated. Tillage practices and pest evaluations varied at each specific site. Basic agronomic practices followed those recommended by the North Carolina Coop. Ext. Serv. (Sullivan *et al.*, 1995) and the Virginia Coop. Ext. Serv. (Swann *et al.*, 1995) in the respective states. A cover crop (usually wheat) was present in all tests at the time of field preparation and planting. Prior to planting (either the day before or the day of) the reduced tillage plots were treated with paraquat or glyphosate to kill existing vegetation. Tillage and reduced tillage techniques are listed under specific studies. Treatments in all North Carolina studies were arranged in a randomized complete block design and data were subjected to analysis of variance using General Linear Model procedures. Means were compared using Duncan's New Multiple Range Test (SAS, 1985). All North Carolina thrips count data were square root transformed (X + 0.5) and percent injury data were arcsin transformed before analysis, but actual means are presented.

1986

A section of a field in Northampton Co., NC with a cover crop of winter wheat was divided into eight equal plots approximately 12 rows wide (0.91-m centers) by 107 m long. On 2 May, four of the strips were thoroughly disked (at least three times) for the conventional tillage treatment. Each plot was further subdivided into two six-row subplots with and without an at-plant, in-furrow insecticide (phorate at 1.12 kg ai/ha). On the same day, peanuts (cv. Florigiant at 95 kg seed/ha) were planted using a two-row planter into a sandy soil, with pH of 5.9 and 0.3% organic matter. At planting soil temperature was 24C. On 30 May and 12 June, thrips feeding damage was assessed by randomly selecting 25 leaflets from each subplot and recording the simple presence or absence of thrips damage on each leaflet.

1987

In Northampton Co., NC a field with a cover crop of oats was divided into 16 plots four rows wide (0.91-m centers) by 30.5 m long. The soil was sandy with 0.4% organic matter and a pH of 5.9. Eight of the 16 strips were thoroughly disked on 7 May for conventional tillage treatments prior to planting. Peanuts (cv. NC 7 at 135 kg seed/ha) were planted on 7 May, at which time the soil temperature was 17C. Four tilled plots and four no-tilled plots were treated with disulfoton 15G at 1.12 kg ai/ha and the remaining four plots in each tillage regime did not receive any insecticide at planting. Thrips damage was assessed (as above) from 25 leaflets randomly sampled per plot on 28 May and 4, 10, and 18 June.

1991

Two sites were used for evaluating tillage effects in 1991. Site 1 was in Chowan Co., NC and evaluated six different tillage regimes in plots 16 rows wide (0.91-m centers) by 24.4 m long. The field had a winter wheat cover crop. The six tillage treatments were (a) moldboard plow, then disk (MP+D); (b) moldboard plow, disk, then subsoil rip (MP+D+R); (c) disk (D); (d) no-till into residue with fluted coulters (NT+FC); (e) no-till with subsoil rip (NT+R); and (f) no-till with 0.46 m wide roto-till (strip till) over the seed bed (NT+RT). Peanuts (NC 7) were planted on 3 May. All tillage occurred during the 3 d preceding planting and no insecticides were applied.

Site 2 was in Northampton Co., NC and was planted on 30 April immediately following tillage practices. All treatments were the same as the Chowan Co. test except for a D+RB treatment consisting of disking, then bedding was added in place of the no-till plus roto-tilled plots as a standard. All plots in Northampton Co. were treated in-furrow with 1.12 kg ai/ha of aldicarb 15G at planting.

Both sites were sampled on 23 May and 5 June for thrips damage by randomly collecting 25 leaflets per plot. On 5 June, five unopened leaflets per plot were collected at random and placed in vials of alcohol for each plot. These leaflets and alcohol were examined later in the laboratory under a dissecting scope and the number of thrips recorded.

1992

Two sites were again used in North Carolina. Site 1 in Chowan Co. had a cover crop of winter wheat and utilized the seven tillage techniques described for the 1991 tests. Immediately after tillage was complete, NC 7 peanuts were planted on 30 April in 0.97-m rows in plots eight rows wide by 32 m long. All treatments were replicated five times. No at-plant insecticide was used. Site 2 was in Bertie Co. at the North Carolina Dept. of Agric. Peanut Belt Sta. in Lewiston, NC. Plots were 12 rows wide (0.91-m centers) by 18.3 m long and replicated four times. Cultivar NC 10C peanuts were planted on 15 May following tillage the previous day. Five treatments were used in Bertie Co. including (a) no-till with fluted coulters on the planter (NT+FC); (b) no-till with subsoil rip (NT+R); (c) moldboard plow, disk, bedding, then roto-till (strip till) over bed (MP+D+RB+RT); (d) moldboard plow, disk, subsoil rip, bedding, then roto-till (stip till) (MP+D+R+RB+RT); and (e) moldboard plow, disk, then roto-till, and aldicarb 15G at 1.12 kg ai/ha at plant and chlorpyrifos 15G at 2.24 kg ai/ha at pegging insecticide treatments (MP+D+RT+I).

The Chowan Co. site was sampled for thrips damage on 28 May, and 4 and 11 June by examining 25 newly opened leaflets per plot and recording any leaflet that was damaged. On 4 June, 10 unopened leaflets per plot were placed in vials of alcohol. These were later examined for the total number of thrips. The Bertie Co. site was sampled on 11 and 18 June by examining 25 newly opened leaflets. In addition, 10 unopened leaflets were collected and placed in vials with alcohol on 11 June for subsequent thrips counts under a dissecting microscope.

A third study site was established at the Virginia Polytechnic Inst. and State Univ. Tidewater Agric. Res. and Ext. Center in Suffolk, VA to evaluate the effects of tillage on thrips and on insecticide efficacy in different tillage systems. The study site had a wheat cover crop that was killed with paraquat herbicide and cut so that plant stubble was about 30 cm tall. Cultivar NC 9 peanut was planted on 13 May and, except for tillage practices, management was according to standards for Virginia (Swann *et al.*, 1995). Full or conventional tillage consisted of moldboard plowing, disking two times, and land conditioning plots just prior to planting. Minimum tillage consisted of planting directly into dead and standing wheat stubble. A randomized split plot design was used with tillage as the main effect and four insecticide treatments (aldicarb, chlorpyrifos, aldicarb plus chlorpyrifos, and an untreated control) as subplots within each tillage practice. Tillage plots were eight rows wide (0.91-m row centers) by 15.2 m long and insecticide treatments were applied to two rows. Aldicarb was applied at 1.12 kg ai/ha in the seed furrow at planting and chlorpyrifos at 2.24 kg ai/ha. Alidicarb 15G was applied into the seed furrow at planting. Chlorpyrifos 15G was applied over the row as a 36-cm band at pegging time (1 July) with no soil incorporation.

Tobacco thrips injury to plants was rated by visual inspection of plants in both rows of each plot (30.4 m of row per plot) using a scale where 0 = no injury; 1 = 10% leaves injured; 2 = 20% leaves injured; 3 = 30% leaves injured; 4 = 40% leaves injured; 5 = ≥ 50% leaves injured + ≤ 5% terminal buds injured; 6 = 50% leaves injured + ≤ 25% terminal buds injured; 7 = 50% leaves injured + ≤ 50% terminal buds injured; 8 = 50% leaves injured + ≤ 75% terminal buds injured; 9 = 50% leaves injured + ≤ 90% terminal buds injured; 10 = dead plants. Visual ratings were taken on 8, 15, 22, and 29 June. Peanuts from all plants (30.4 m of row per plot) were harvested on 12 Oct. by digging and combining with commercial field equipment. Analysis of variance and LSD procedures ($P = 0.05$) were conducted on thrips plant injury ratings (by sample date) and peanut yield.

Results and Discussion

1986

Percentage of thrips-damaged leaflets was significantly lower ($P \leq 0.05$) in insecticide-treated peanuts in the no-till plots (6.75%) as compared to conventional tilled plots (9.5%) on 30 May, but not on 12 June. There was no difference in thrips damage on peanuts for either date in the tillage treatments where no insecticide was used.

1987

Thrips damage was not reduced by insecticide use in either the conventional or no-till planting methods (Table 1). Comparison of no-till planted peanuts with conventional planted peanuts in the insecticide-treated plots showed a reduction in thrips damage only on the first sampling date. Comparisons of tillage effects when no insecticide was used showed less thrips damage on the second and fourth sampling dates.

1991

Northampton Co., NC (Insecticide Used). At the first sampling date, there were no differences in thrips damage; however, by the second sampling date, there was a general trend toward less damage in peanuts planted in reduced tillage (Table 2). Peanuts planted in no-till had less damage than the plants in tilled systems with the exception of the treatment using moldboard plow plus disking and the treatment of planting on raised beds after disking. These trends toward less damage in the peanuts planted no-till are reflected in the actual thrips numbers.

Chowan Co., NC (No Insecticide Used). The impact of tillage was most evident in this study (Table 3). No differences in thrips damage were revealed on the first sampling date. At the second sampling date, the peanuts planted in no-till (with the exception of the no-till + roto-till over the bed treatment) had less damage and fewer thrips than plants in the tilled systems. Even among no-till treatments, peanuts planted under the least amount of soil disturbance (no-till planter with fluted coulter) had significantly less thrips damage than treatments that involved more soil and crop residue disturbance. The number of thrips found in 10 unopened leaflets was significantly less in the no-till planted peanuts.

1992

Bertie Co., NC. The differences in peanut leaflet damage between tillage regimes were inconsistent and there were no differences in the number of thrips per 10 leaflets, although there was a trend for fewer thrips on peanuts in no-till plots (Table 4). High insect pressure

Table 1. Mean thrips plant injury in minimum and conventional tillage peanuts treated with an insecticide (disulfoton 1.12 kg ai/ha) at planting, Northampton Co., NC, 1987.

	Insecticide	Thrips-damaged leaflets			
Tillage practice	Y/N	28 May	4 June	10 June	18 June
		%			
No-till	Y	12 b[a]	29 ab	27 b	37 ab
No-till	N	19 ab	18 b	40 ab	36 b
Conventional	Y	25 a	45 ab	41 ab	51 ab
Conventional	N	34 a	50 a	62 a	55 a

[a]Means followed by the same letter are not significantly different within columns (DNMRT; $P = 0.05$).

Table 2. Mean thrips plant injury in minimum and conventional tillage peanuts treated with an insecticide (aldicarb 1.12 kg ai/ha) at planting, Northampton Co., NC, 1991.

	Leaflet damage[a]		Thrips/10 leaflet
Tillage practice[b]	23 May	5 June	5 June
	%		no.
MP + D	32 a	31 ab	5.5 b
MP + D + R	33 a	45 a	15.0 a
D	35 a	44 a	8.25 bc
NT + FC	18 a	15 b	3.75 c
NT + R	16 a	19 b	3.5 c
D + RB	41 a	31 ab	9.5 ab

[a]Means followed by the same letter are not significantly different within columns (DNMRT; $P = 0.05$).

[b]Moldboard plow, plus disk (MP+D), moldboard plow, plus disk, plus subsoil rip (MP+D+R); disk (D); no-till into dead residue with fluted coulters (NT+FC); no-till with subsoil rip (NT+R); disk plus raised bed (D+RB).

Table 3. Mean thrips plant injury and abundance in minimum and conventional tillage peanuts, Chowan Co., NC, 1991.

Tillage practice[b]	Leaflet damage[a]		Thrips/10 leaflets
	23 May	5 June	5 June
	- - - - - % - - - - -		no.
MP + D	66 a	92 ab	38.00 a
MP + D + R	75 a	97 a	37.75 a
D	80 a	93 ab	38.25 a
NT + FC	62 a	34 d	12.25 b
NT + R	66 a	50 c	12.50 b
NT + RT	70 a	78 b	10.50 b

[a]Means followed by the same letter are not significantly different within columns (DNMRT; P = 0.05).

[b]Moldboard plow, plus disk (MP+D); moldboard plow, plus disk, plus subsoil rip (MP+D+R); disk (D), no-till into dead residue with fluted coulters (NT+FC), no-till with subsoil rip (NT+R); no-till with 0.40 m wide roto-till over the seed bed (NT+RT).

Table 4. Mean thrips plant injury and abundance in minimum and conventional tillage peanuts, Bertie Co., NC, 1992.

Tillage practice[b]	Leaflet damage[a]		Thrips/10 leaflets
	11 June	18 June	11 June
	- - - - - % - - - - -		no.
NT + FC	48.0 a	67.0 ab	88.00 a
NT + R	75.0 b	83.0 ab	109.75 a
MP + D +RB + RT	56.0 ab	76.0 ab	119.75 a
MP + D + R +RB + RT	66.0 ab	85.0 b	116.00 a
MP + D + RT + I	62.0 ab	63.0 a	99.25 a

[a]Means followed by the same letter are not significantly different within columns (DNMRT; P = 0.05).

[b]No-till into dead residue with fluted coulters (NT+FC); no-till with subsoil rip (NT+R), moldboard plow, plus disk, plus raised bed, plus rototill (MP+D+RB+RT); moldboard plow, plus disk, plus subsoil rip, plus raised bed, plus rototill (MP+D+R+RB+RT); moldboard plow, plus disk plus rototill plus insecticide (MP+D+RT+I).

may have overwhelmed the effects of varying tillage systems on peanut leaf damage.

Chowan Co., NC. Similar findings in Chowan Co. as Bertie Co. indicated that tillage effects may not be consistent from year to year as observed in previous years (Table 5). The insect pressure was moderate, yet damage was not consistently reduced in no-till plots and there were no significant differences in the number of thrips found per leaflet.

Suffolk, VA. Results of this trial showed that both tillage and insecticide treatment significantly affected thrips plant injury (Table 6). Thrips injury was significantly higher in conventionally tilled plots on three of four sample dates. Insecticide reduced injury significantly, regardless of tillage system and insecticide-by-tillage interaction was always significant ($P \leq 0.0001$). Peanut yields were not affected by insecticide treatment,

Table 5. Mean thrips plant injury and abundance in minimum and conventional tillage peanuts, Chowan Co., NC, 1992.

Tillage practice[b]	Leaflet damage[a]			Thrips/10 leaflets
	28 May	4 June	11 June	4 June
	- - - - - - - - % - - - - - - - -			no.
NT + FC	31.2 c	15.2 a	46.4 a	37.0 a
NT + R	23.2 c	15.2 a	48.8 a	45.8 a
NT + RT	9.6 ab	12.8 a	53.6 ab	28.6 a
D	19.2 bc	9.6 a	67.2 b	43.0 a
MP + D	8.8 a	9.6 a	52.0 ab	43.0 a
MP + D + R	10.4 ab	8.0 a	48.0 a	34.6 a
D + RB	28.0 c	11.2 a	57.6 ab	50.4 a

[a]Means followed by the same letter are not significantly different within columns (DNMRT; P = 0.05).

[b]No-till into dead residue with fluted coulters (NT+FC); no till plus rip (NT+R), no-till plus 0.40-m wide rototill over seed bed (NT+RT), disk only (D); moldboard plow plus disk (MP+D); moldboard plow plus disk plus rip (MP+D+R); disk plus raised seed bed (D+RB).

Table 6. Mean thrips plant injury ratings, percentage peanut pod injury and yield in minimum, and conventional tillage peanuts treated with selected insecticides, Tidewater Agric. Res. and Ext. Center Res. Farm, Suffolk, VA, 1992.

Tillage practice	Thrips injury rating[a]				Yield[b]
	8 June	15 June	22 June	29 June	
					kg/ha
Minimum till	1.1 b	1.5 a	2.0 b	1.7 b	2527 b
Conventional till	1.5 a	1.6 a	3.3 a	3.5 a	2764 a
LSD (P = 0.05)	0.2	0.2	0.2	0.2	123

[a]Thrips injury to plants rated on a 0-10 scale, 0 = no thrips injured leaves and 10 = 100% thrips injured leaves. Means followed by the same letter are not significantly different within columns (LSD; P = 0.05).

[b]Yield based on weight of peanut with moisture content of 7%.

but tillage type, pooled over all insecticide treatments, did affect yields ($P \leq 0.0001$). Peanuts planted in the conventional full tillage system achieved significantly higher yields, 237 kg/ha greater, than plants growing in the reduced tillage environment.

Less thrips damage on peanuts grown in minimum tilled plots (1986, 1987, 1991 in NC, and 1992 in VA) indicates that reducing tillage in peanut production could be useful as a cultural pest management strategy. Using this strategy for pest management would be an added incentive for growers to adopt a technique that saves fuel, time, and reduces soil erosion. Results from North Carolina in 1992, as well as the reduced yields observed in the Virginia trial, however, indicated that this practice does not always reduce pressure from thrips early in the season, and may have agronomic disadvantages. Reduced tillage did not increase thrips problems early in the season and should not be discouraged based on that premise, and current agronomic studies are showing more favorable yields. In North Carolina, inconsistent trends observed in 1992 would indicate a better understanding of the biological mechanisms affected by tillage—such as ovipositional preferences, predation, host finding, etc. (Johnson *et al.*, 1984; Brust, 1990; Brust and House, 1990)—is critical to facilitate effective insect management in reduced tillage peanut production. Our current understanding of thrips dispersal and their movement early in the season indicates that cultural practices that effect host finding may play a significant role in the level of early season damage (Barbour and Brandenburg, 1994). These studies indicate that tillage can have a significant effect on thrips abundance and injury in peanut fields. Additional research is needed to determine if this effect is sufficient to be useful in pest management programs as well as the effects of tillage on other peanut insect pests and tomato spotted wilt virus.

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