Effect of Cultivar and Plant Population on Spotted Wilt in Virginia Market-Type Peanut

C.A. Hurt[1]*, R.L. Brandenburg[1], D.L. Jordan[2], G.G. Kennedy[1], and J.E. Bailey[3]

ABSTRACT

Field experiments were conducted in North Carolina during 2001 and 2002 to evaluate the impact of cultivar and plant population on the incidence of symptoms of tomato spotted wilt virus, which is transmitted primarily by tobacco thrips [*Frankliniella fusca* (Hinds) (Thysanoptera: Thripidae)]. Treatments included the virginia market-type cultivars Gregory, NC-V 11, and Perry seeded at in-row plant populations of 7, 13, and 17 plants/m. In these experiments, there was a consistent trend for increased foliar injury from thrips as plant population decreased. Less thrips feeding injury was noted for Gregory and Perry than for NC-V 11. Incidence of visual symptoms of spotted wilt (SW) was recorded from mid-June through mid-September. A plant condition rating was recorded late in the season. Consistent with the results for thrips-induced injury, the percentage of plants infected with SW and the plant condition rating increased as plant population decreased. Gregory had the lowest SW incidence, while NC-V 11 was intermediate between Gregory and the most susceptible Perry. Establishing higher plant densities and planting Gregory rather than NC-V 11 or Perry reduced SW incidence and plant condition rating. Gregory had consistently the highest %ELK (extra large kernels) and %FP (fancy pods) across treatments and locations whereas no definitive trend in market grade characteristics were noted among treatments. In some cases, Perry had a higher incidence of SW, but still had higher pod yields than NC-V 11 with a lower incidence of SW. However, in most cases pod yield correlated with plant condition ratings, and as thrips injury increased, pod yield decreased.

[1]Former Grad. Res. Asst., Prof., and Prof., respectively, Dept. of Entomology, Box 7613, North Carolina State Univ., Raleigh, NC 27695-7613. Current address of Christie Hurt: USDA-APHIS, 1730 Varsity Drive, Suite 300, Raleigh, NC 27606.

[2]Assoc. Prof., Dept. of Crop Sci., Box 7620, North Carolina State Univ., Raleigh, NC 27695-7620.

[3]Prof., Dept. of Plant Pathology, Box 7616, North Carolina State Univ., Raleigh, NC 27695-7616.

*Corresponding author (email: Christie.A.Hurt@aphis.usda.gov).

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Tomato spotted wilt virus (TSWV), a *Tospovirus*, has recently become one of the most devastating pathogens of peanut (*Arachis hypogaea* L.) in North Carolina (Cochran *et al.*, 2003) causing a disease known as spotted wilt (SW). In peanut-producing areas of North Carolina, *Frankliniella fusca* (Hinds), the tobacco thrips, is the most prevalent TSWV-vector species, accounting for about 95% of the vector thrips individuals in NC fields (Barbour and Brandenburg, 1994; Cho *et al.*, 1995; Eckel *et al.*, 1996; Mound, 1996). *Frankliniella occidentalis* (Pergande), the Western flower thrips, is also present at lower levels (Barbour and Brandenburg, 1994; Cho *et al.*, 1995; Eckel *et al.*, 1996). Although the economic threshold for leaf injury by thrips is 25% and is frequently exceeded (Brandenburg, 2003), the concern for feeding injury to foliage has become secondary to the greater economic risk of thrips-transmitted TSWV.

In North Carolina, numerous weed species are competent sources of virus inoculum (Ullman *et al.*, 1993; Groves *et al.*, 2002). After overwintering on susceptible weed hosts primarily as brachypterous females (Chamberlin *et al.*, 1992; Cho *et al.*, 1995; Brown *et al.*, 1996), thrips begin dispersing to new hosts in late March and early April (Groves *et al.*, 2003). In North Carolina, movement of thrips vectors among weed hosts in late winter and spring results in spread of TSWV among weed hosts and an increase in source of TSWV prior to peak flights of tobacco thrips, which typically occur in mid- to late-May (Eckel *et al.*, 1996; Groves *et al.*, 2002, 2003). Thrips moving into the field during the spring are mostly from nearby sources, and these populations of thrips provide the primary source of inoculum (Todd *et al.*, 1990; Chamberlin *et al.*, 1992; Camann *et al.*, 1995; Brown *et al.*, 1996; Groves *et al.*, 2003). Thrips may also migrate into fields on wind currents (Todd *et al.*, 1990; Mound, 1996). Groves *et al.* (2003) documented that spread of TSWV in North Carolina was concentrated during two periods. The greatest amount of spread occurred from April through June and coincided with peak flights of *F. fusca*. A second period of spread occurs in Oct. and early Nov. and coincides with peak dispersal of *F. fusca* from summer host plants to winter annual and perennial weeds.

When a peanut plant is infected with TSWV, oil content of seeds can be reduced in infected plants (Ali and Rao, 1982) and yield loss may occur (Pappu *et al.*, 1999). Yield loss is due to both decreased weight of seeds and overall lower seed production in infected plants (Culbreath *et al.*, 1992).

Management practices that reduce incidence of SW include increasing the plant population, planting TSWV field-resistant cultivars, seeding peanut in twin row planting patterns (rows spaced approximately 18 cm apart on centers spaced 91 to 100 cm apart), altering planting dates, and applying phorate insecticide in-furrow (Brown *et al.*, 2003). Differences exist in production systems for runner and virginia market-type peanuts (Jordan *et al.*, 2000). Runner market-type peanuts dominate in southeastern and southwestern production regions of the U.S. while most virginia market-type peanut production is in the Virginia-Carolina production region. The effect of cultivar and plant population on incidence of SW in virginia-type peanut production in the Virginia-Carolina production region needs to be addressed.

Decreased SW and increased pod yield are often associated with increased plant populations (Wehtje *et al.*, 1994). Higher plant populations may result in a greater number of healthy plants, which can compensate for diseased and dead plants within rows (Brown *et al.*, 2003). Gorbet and Shokes (1993) found a positive relationship between within-row plant spacing and SW incidence. The higher seeding rate needed to establish an elevated plant population increases production costs; these added costs must be offset by increases in yield and quality in order to justify the use of higher plant populations. In North Carolina, in-row plant populations of 17 seeds/m are currently recommended for SW suppression (Hurt *et al.*, 2003).

Cultivar selection is extremely important in managing SW in peanut (Brown *et al.*, 2003; Hurt *et al.*, 2003). The cultivar Gregory has the best field resistance to TSWV of the commercially available virginia-type cultivars (Jordan, 2003a). The cultivar NC-V 11 has moderate field resistance to SW (Jordan *et al.*, 1999), although results are sometimes inconsistent (Culbreath *et al.*, 2000). The cultivar Perry is considered to be susceptible to TSWV (Brown *et al.*, 2003; Jordan, 2003a).

Peanut planted in twin rows spaced 17 cm apart with 91 cm centers frequently have higher yields and improved market grade characteristics when compared with peanut planted in single rows (Culbreath *et al.*, 1999; Baldwin and Williams, 2002). Levels of SW in fields planted to twin rows are also reduced (Brown *et al.*, 1996), which may be due in part to the earlier canopy cover that may impact the migrating thrips (Culbreath *et al.*, 1999). There is a need for research on virginia-type cultivars planted in single and twin rows to find cultural controls for reducing SW.

No single production or pest management practice always provides high levels of SW control in peanut. Several methods must be incorporated into a management program to reasonably suppress this virus (Brown *et al.*, 1996; Culbreath *et al.*, 1999). Preventative methods are necessary to minimize the impact of TSWV on peanut because no "rescue" or curative control options are available (Brown *et al.*, 2003; Hurt *et al.*, 2003). Additionally, management of TSWV in peanut is extremely challenging due to the extensive host ranges of the virus and the thrips vectors. When used together, several cultural and chemical controls can be additive. While a combination of production and pest management practices has been successful in reducing the impact of TSWV on peanut in the southeastern and southwestern U.S., a combination of practices that is effective in the Virginia-Carolina peanut producing region has not been clearly identified. The objectives of this research were to determine the impact of plant population and cultivar selection on virginia market-type peanut grown in North Carolina.

Materials and Methods

Experiments in 2001 were conducted in North Carolina on commercial farms located near Williamston and Tarboro. In 2002, experiments were conducted at the Upper Coastal Plain Res. Sta. located near Rocky Mount and in two separate fields at the Peanut Belt Res. Sta. located near Lewiston-Woodville. Soil at Williamston, Tarboro, and Lewiston-Woodville site 1 was a Norfolk sandy loam (fine-loamy, siliceous, thermic Aquic Paleudalts). Soil at Lewiston-Woodville site 2 and Rocky Mount was a Goldsboro sandy loam (fine-loamy, siliceous, thermic Aquic Paleudalts). Conventional raised beds with plots two rows (91-cm spacing) × 12 m long were planted 1 May 2001 at Tarboro and on 4 May 2001 at Williamston. Planting was on 10 May 2002 at Rocky Mount, and on 3 and 8 May 2002 at Lewiston-Woodville site 1 and Lewiston-Woodville site 2, respectively. Only the Lewiston-Woodville sites 1 and 2 were irrigated on a regular schedule.

The experimental design was a randomized complete block with treatments replicated four times. Data for thrips injury, SW incidence based on actual plant counts, visual estimates of plant condition rating, pod yield, and market grade characteristics were subjected to analyses of variance (GLM Procedure) for a five (experiment) × three (plant population) × three (cultivar) factorial arrangement of treatments (SAS Institute, Cary, NC). Means of significant main effects and interactions were separated using Fisher's Protected LSD Test at $P \leq 0.05$ (Steel *et al.*, 1997).

Treatments in all experiments consisted of three plant populations (in-row densities of 7, 13, or 17 plants/m) in all combinations with three cultivars (Gregory, NC-V 11, or Perry). Single rows spaced 91 cm apart were established for in-row plant populations of 7 and 13 plants/m using a vacuum planter. Twin rows were spaced 18 cm apart on 91 cm centers to establish the in-row population of 17 plants/m (sum of both twin rows). Seeds were placed 5 to 8 cm deep depending on soil moisture. Aldicarb {*0*-[(methylamino)carbony]oxime} (Bayer Crop Science, Research Triangle Park, NC) was applied to all plots at 7.9 kg ai/ha in-furrow at planting as a granular formulation for each row in both planting patterns. Gregory, NC-V 11, and Perry offered various levels of field resistance to TSWV (Shew, 2003) and pod characteristics (Jordan, 2003a). All other production and pest management practices were held constant at all test sites (Brandenburg, 2003; Jordan, 2003a,b; Shew, 2003). Thrips injury was recorded 33 d after planting. The most recently emerged leaves on 25 plants per plot were examined for signs of thrips feeding. Leaves were scored as injured when one or more leaflets had evidence of scarring due to thrips feeding. The percentage of leaflets with feeding injury was then calculated.

Foliar symptoms scouted included ring spotting, stunted growth, wilting or twisting of petioles, and general chlorosis or bronzing (Shew, 2003). Plants were scouted monthly in 2001 and weekly in 2002. Symptomatic plants were marked with a survey flag when any symptoms were noted. Foliar samples from at least three leaflets from symptomatic plants were tested for presence of TSWV using an ImmunoStrip (STX 39300, ACC 00936) assay (Agdia, Elkhart, IN) within 2 wk prior to inversion of peanut plants.

Percent disease (SW incidence) was derived from the number of symptomatic plants out of the total number from the estimated stand count within an experiment. Within 1 wk prior to plant inversion, plant condition ratings were taken. The ratings were comprised of visual estimates of percent SW severity in the peanut canopy were recorded using a scale of 0 = no symptoms to 100 = all plants in a plot exhibiting symptoms.

Peanut plants were inverted on 1 Oct. 2001 at Williamston and Tarboro, 1 Oct. 2002 at Lewiston-Woodville sites 1 and 2, and 3 Oct. 2002 at Rocky Mount. Peanut stand was estimated the day of inversion by counting taproots in each plot in the first replication. Plants that were necrotic, but still identifiable, were included in the stand count; however, plants that died early in the season were not accounted for in this experiment.

Plants were allowed to air dry for approximately 1 wk after vine inversion. On 8 and 9 Oct. 2001, pods were harvested using conventional harvesting equipment at Tarboro and Williamston, respectively. On 10 Oct. 2002 Rocky Mount was harvested; Lewiston-Woodville sites 1 and 2 were harvested 8 Oct. 2002. Market grade characteristics were determined by collecting a 1 kg sample of pods from each plot at harvest. Percentages of total sound mature kernels (%TSMK), extra large kernels (%ELK), and fancy pods (%FP) were determined using Cooperative Grading Serv. criteria for quota peanut (Peanut Loan Schedule, 1997-2001, USDA-FSA-101-3).

Results and Discussion

Thrips Injury. The interaction of experiment × plant population was significant ($P \leq 0.05$) for thrips injury 33 d after planting (Table 1). With the exception of Lewiston-

Table 1. Analyses of variance (MS values) for percentage of plants with thrips injury, spotted wilt (SW) incidence, plant condition rating, pod yield, and the percentages of total sound mature kernels (%TSMK), extra large kernels (%ELK), and fancy pods (%FP).

Treatment factor	Degrees of freedom	Thrips injury	SW incidence	Plant condition rating	Pod yield	TSMK	ELK	FP
		%	%	%	kg/ha	%	%	%
Experiment (Exp)	4	2399.4***	3616.2***	1214.7***	6401459	51.02	663.1***	635.7***
Rep	3							
Error (Exp × Rep)	12							
Cultivar (Cul)	2	9625.5***	916.3*	1856.4	31687803*	1.49	668.8**	1222.4**
Population (Pop)	2	1490.7	4119.1**	792.3**	21381877	2.87	9.4	15.3
Cul × Pop	4	958.3**	94.9	57.1	8445108	11.90	8.3	33.4
Exp × Cul	8	504.6*	126.9**	458.8***	7190808	5.46	93.4**	166.7***
Exp × Pop	8	515.5*	340.1***	73.2	11129823	16.01**	38.0	51.6
Exp × Cul × Pop	16	160.1	38.6	57.0	8019575	6.47	11.2	19.4
Error	120							
Coefficient of Variation (%)	–	51.2	30.9	77.9	57.5	2.9	10.9	8.6

*,**,*** = levels of probability at $P \leq 0.05$, 0.01, 0.001, respectively.

Woodville site 1, the highest percentage of leaflets injured by thrips generally occurred at the lowest in-row plant population of 7 plants/row m, with decreasing levels of injury as the in-row population increased to 13 and 17 plants/m (Table 2). The most dramatic example of this trend was at Williamston where the mean values were 55, 44, and 32% injured leaflets with in-row populations of 7, 13, and 17 plants/m, respectively (Table 2). All in-row plant populations for Lewiston-Woodville site 2, Rocky Mount, and Tarboro had very similar injuries at the 7, 13, and 17 plants/m, respectively (Table 2). For these three experiments, the in-row plant population of 7 plants/m had higher thrips injury, while 13 and 17 plants/m were not significantly different. This is in agreement with previous findings from Brown *et al.* (1996) who presumed that lower in-row plant populations often attract thrips and increase SW.

Results differed at Lewiston-Woodville site 1, where the ratings were 21, 33, and 30% for in-row populations of 7, 13, and 17 plants/m, respectively (Table 2). Lewiston-Woodville site 2 was surrounded by other peanuts, potatoes (*Solanum tuberosum* L.), and a tree border with weed undergrowth, while Lewiston-Woodville site 1 was in the middle of the research station and surrounded by corn (*Zea mays* L.) and cotton (*Gossypium hirsutum* L). The differences in crop borders may have delayed thrips movement into Lewiston-Woodville site 1 when the effect of the canopy was lessened.

The interaction of experiment × cultivar was significant ($P \leq 0.05$) for thrips injury at 33 d after planting (Table 1). The highest percentage of thrips injury was always noted on NC-V 11 and these differences were significant at all but one site (Table 3). Thrips injury on Gregory and Perry was not different at most locations (Table 3). At Williamston, Gregory had higher percentages of thrips injury than Perry (Table 3). At Lewiston-Woodville site 1, Gregory was not different from either NC-V 11 or Perry (Table 3). Gregory and Perry had lower thrips injury than NC-V 11 at Lewiston-Woodville site 2, Tarboro, and Rocky Mount.

Table 2. Interaction of experiment and in-row plant population on thrips injury, spotted wilt (SW) incidence, and percentage of total sound mature kernels (%TSMK) in five NC Coastal Plain fields.[a]

In-row plant population[b]	Williamston	Lewiston-Woodville-1	Lewiston-Woodville-2	Tarboro	Rocky Mount
plants/m	%				
			Thrips injury[c]		
7	55 a	21 b	33 a	29 a	33 a
13	44 b	33 a	24 b	21 b	24 b
17	32 c	30 a	21 b	19 b	21 b
			SW incidence[d]		
7	31 a	15 a	26 a	51 a	14 a
13	22 b	12 a	14 b	33 b	7 b
17	9 c	7 b	13 b	19 c	6 b
			%TSMK		
7	73 b	75 a	72 b	76 a	71 a
13	73 b	74 a	74 b	75 ab	70 a
17	76 a	72 b	76 a	73 b	70 a

[a]Means for each parameter within an experiment followed by the same letter are not significantly different according to Fisher's Protected LSD test at $P \leq 0.05$. Data are pooled over cultivars.

[b]In-row plant populations of 7 and 13 plants/m were established in single row planting patterns spaced 91 cm apart. In-row plant populations of 17 plants/row m were established in the twin row planting pattern.

[c]Thrips injury recorded 33 d after planting as a percent.

[d]Final SW incidence (late May through late Sept.) as the percentage of total plants at harvest exhibiting SW symptoms at some point throughout the growing season.

Table 3. Interaction of experiment and cultivar on thrips injury, spotted wilt (SW) incidence, plant condition rating, the percentage of extra large kernels (%ELK), and the percentage of fancy pods (%FP) in five NC Coastal Plain fields.[a]

Cultivar	Williamston	Lewiston-Woodville-1	Lewiston-Woodville-2	Tarboro	Rocky Mount
	%				
			Thrips injury[b]		
Gregory	41 b	30 ab	17 b	15 b	17 b
NC-V 11	66 a	37 a	41 a	36 a	41 a
Perry	34 c	18 b	21 b	18 b	21 b
			SW incidence[c]		
7Gregory	13 b	9 a	14 b	29 b	6 b
NC-V 11	23 a	12 a	20 a	32 b	9 ab
Perry	26 a	13 a	19 a	43 a	13 a
			Plant condition rating[d]		
Gregory	1 b	3 b	5 b	2 b	8 a
NC-V 11	3 b	11 a	26 a	4 b	7 a
Perry	9 a	14 a	28 a	22 a	6 a
			%ELK		
Gregory	45 a	57 a	57 a	58 a	43 a
NC-V 11	29 b	45 b	44 b	44 b	46 a
Perry	31 b	48 b	48 b	47 b	40 a
			%FP		
Gregory	79 a	85 a	89 a	83 a	81 a
NC-V 11	60 b	67 b	70 b	70 b	86 a
Perry	58 b	70 b	72 b	73 b	83 a

[a]Means for each parameter within an experiment followed by the same letter are not significantly different according to Fisher's Protected LSD test at $P \leq 0.05$. Data are pooled over in-row plant populations.

[b]Thrips injury recorded 33 d after planting as a percentage.

[c]Final SW incidence (late May through late Sept.) as the percentage of total plants at harvest exhibiting SW symptoms at some point throughout the growing season.

[d]Plant condition rating measured in late Sept. using a scale of 0 to 100%, where 0 = no symptoms of SW and 100 = the entire peanut canopy expressing symptoms of SW.

The interaction of cultivar × plant population was significant for thrips injury, but interaction of experiments × cultivar × plant population was not significant (Table 1). NC-V 11 and Perry both had the highest percentage of thrips injury on the lowest in-row plant population of 7 plants/row m (Table 4). This is consistent with the findings that more thrips injury occurs on lower plant populations (Gorbet and Shokes, 1993). Occurrence of thrips injury was different between 13 or 17 plants/m (41 or 40% for NC-V 11, 16 or 14% for Perry) and 7 plants/m for NC-V 11 and Perry (52 and 32%, respectively) (Table 4). For Gregory, the highest percentage of thrips injury (31%) was noted at 13 plants/m, which was different from both 7 and 17 plants/m (20% for both) (Table 4).

Table 4. Interaction of cultivar and in-row plant popultion on thrips injury in five NC Coastal Plain fields.[a]

Cultivar	In-row plant population (plants/m)[b] 7	13	17
	% Thrips injury[c]		
Gregory	20 c	31 b	20 c
NC-V 11	52 a	41 b	40 b
Perry	32 b	16 c	14 c

[a]Means followed by the same letter are not significantly different according to Fisher's Protected LSD test at $P \leq 0.05$. Data are pooled over experiments.

[b]In-row plant populations of 7 and 13 plants/m were established in single row planting patterns spaced 91 cm apart. In-row plant populations of 17 plants/m were established in the twin row planting pattern.

[c]Thrips injury recorded 33 d after planting as a percent.

SW Incidence. Testing of leaflets from symptomatic plants with the ImmunoStrip assay showed that more than 98% of the samples were infected with TSWV. Leaflets from asymptomatic plants were positive 25% of the time. The significant interaction of experiment by plant population revealed similar trends across the five experiments for the percentage of plants symptomatic for TSWV (Table 1). In four out of five experiments, the in-row plant population of 7 plants/m had the greatest SW incidence (Table 2). As reported by Gorbet and Shokes (1993) and Brown *et al.* (1996), a low plant population often results in higher SW incidence. In Williamston and Tarboro, the in-row plant population of 17 plants/m had a lower incidence of SW than other populations. The greatest range of values for percent infection was at Tarboro. Fifty-one, 33, and 19% of plants were infected with respective in-row populations of 7, 13, and 17 plants/m. These data suggest that establishing a higher plant population is more critical where incidence of SW is high than where incidence of TSWV is typically low (Black *et al.,* 2001). Differences in SW at the in-row plant population of 17 plants/m could be the result of using the twin-row planting pattern, the increased plant population, or a combination of the two factors. Regardless of the plant condition rating, the greatest incidence SW was noted at the in-row plant population of 7 plants/m.

The interaction of experiment by cultivar was significant for SW incidence (Table 1). Consistent with other research (Shew, 2003), Perry often ranked higher for SW incidence than Gregory or NC-V 11 (Table 3); but Perry was significantly greater than the other cultivars only at Tarboro. At Tarboro, SW incidence for NC-V 11 and Gregory were not significantly different, and both had lower SW incidence than Perry (Table 3). In all other experiments, the percentage of NC-V 11 plants showing symptoms of SW was not different from Perry. Gregory had a lower SW incidence than did NC-V 11 and Perry in all experiments except for Lewiston-Woodville site 1, which had no significant differences among cultivars. All experiments followed the trend of the lowest SW incidence with Gregory, then NC-V 11, and the highest SW incidence with Perry. Even though NC-V 11 had the most thrips injury, Perry had the highest overall SW incidence. Higher thrips feeding injury does not always lead to higher SW incidence (Broadbent and Allen, 1995). In general, Gregory had the lowest injury from thrips feeding and the lowest SW incidence. Gregory is considered to be one of the most field-resistant virginia-type cultivars of peanut to TSWV (Shew, 2003). There was no significant difference for the percentage of plants with SW symptoms in the interaction of cultivar × plant population (Table 1). Plant population affected SW independently of cultivar.

Plant Condition Rating. The interaction of experiment × cultivar was significant for the percentage of peanut plants expressing symptoms of TSWV infection (plant condition rating) (Table 1). In four of five experiments, Perry had the highest rating of damage for the plant condition rating, and SW incidence was higher than Gregory and NC-V 11 at Williamston and Tarboro (Table 3). At Lewiston-Woodville sites 1 and 2, plant condition ratings were lower for Gregory than for NC-V 11 or Perry. While NC-V 11 had higher thrips injury, Perry had the highest incidence of SW and highest plant condition rating in most experiments. The SW incidence was not significantly different among cultivars at Lewiston-Woodville site 1, although the plant condition rating for Gregory was less than other cultivars. This implies that there were nearly as many infected plants in all three cultivars, but Gregory did not express the severity of infection as much as NC-V 11 or Perry.

The main effect of plant population was significant for the SW plant condition ratings and there were no population interactions with cultivar or test (Table 1). The mean values across cultivars and tests for in-row populations of 7, 13, and 17 plants/m were 14, 9, and 7%, respectively. This trend is similar to that of SW incidence, with the increasing plant population having a decreasing percent SW incidence. Results for SW plant condition ratings were more consistent than SW incidence (actual number of infected plants) (Table 1). The percent plants with SW symptoms was not the same across experiments and the relative effect on the severity of disease expression in the peanut canopy is similar. This corresponds with the findings of Brown *et al.* (1996).

Yield Parameters. The main effect of cultivar resulted in pod yield differences (Table 1). The pooled pod yields for Gregory, NC-V 11, and Perry were 6240, 4770, and 4930 kg/ha, respectively. Gregory had the lowest thrips injury and the lowest incidence of SW across all experiments, which could have led to the higher pod yield. The interaction of experiment × plant population was significant for the %TSMK (Table 1). There were no differences in %TSMK at Rocky Mount regardless of plant population (Table 2). At Williamston and Lewiston-Woodville site 2, the %TSMK was higher when in-row plant population was 17 plants/m than 13 and 7 plants/m (Table 2). Lewiston-Woodville site 1 had a lower %TSMK for the high in-row plant population than for the middle and low in-row populations (Table 2). At Tarboro, %TSMK was similar when the plant population was 13 or 17 plants/row m. Additionally, while %TSMK was similar at plant populations of 13 and 17 plants/row m, %TSMK for the highest plant population exceeded that of the lowest plant population. There were no differences for the main effect of cultivar for %TSMK, with all values equaling 73%.

The interaction of experiment × cultivar was significant for the %ELK (Table 1). For all experiments except Rocky Mount, the %ELK was higher for Gregory than for NC-V 11 or Perry (Table 3). At Rocky Mount, there were no differences in %ELK for any cultivar. Gregory is a large-seeded virginia market-type cultivar that generally produces a higher %ELK than NC-V 11 or Perry (Jordan, 2003a). Because Lewiston-Woodville sites 1 and 2 were irrigated regularly, whereas those at Rocky Mount were not, drought may have contributed to lower %ELK by preventing Gregory from reaching its full potential during 2002. NC-V 11, which has smaller seeds than Gregory or Perry, would have been affected less by dry weather. The main effect of plant population was not significant for %ELK with a range of 45 to 46%.

The interaction of experiment × cultivar was significant for the %FP. In all experiments except for Rocky Mount, Gregory had a higher %FP than both NC-V 11 and Perry (Table 3). At Rocky Mount, there were no significant differences between cultivars for %FP. This corresponds with the drier conditions at Rocky Mount and Gregory having a larger seed than both NC-V 11 and Perry.

Correlation Between Parameters. Using the Pearson correlation coefficient ($N = 180$), the relationship between the following pairs of data were examined: SW incidence and plant condition rating (0.388, $P \leq 0.0001$); SW incidence and thrips injury (0.126, $P = 0.0920$); SW incidence and pod yield (-0.083, $P = 0.2695$); and plant condition rating and pod yield (-0.170, $P = 0.0222$) (Steel *et al.*, 1997). None of the pairs had a high r-value, indicating that there is not a strong relationship between any two parameters. The highest r-value was the correlation of SW incidence to plant condition rating, which indicates that the number of plants infected is predictable by taking a visual estimate of the percent of the peanut canopy expressing symptoms of SW. Culbreath *et al.* (1997) found similar results. There was no correlation between SW incidence and the amount of thrips injury to leaflets, suggesting that there was not a strong relationship between thrips feeding injury and the incidence of SW. Also, there was not a correlation between the pod yield and SW incidence for this test.

There was a negative correlation of plant condition rating and pod yield with the r-value of -0.170. From the results of this test, the plant condition rating may be more appropriate for estimating pod yield loss in peanut, which is in agreement with Culbreath *et al.* (1997, 2000). Practitioners most likely will use plant condition ratings rather than actual plant counts to document incidence of SW because of time constraints.

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