Influence of Planting Date on Yield and Spotted Wilt of Runner Market Type Peanut

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ABSTRACT

Date of planting and cultivar resistance are two primary control measures for spotted wilt of peanut. Current recommendations for the southeastern USA consider risk of spotted wilt to be high if planted prior to 1 May, moderate if planted 1 May to 10 May, least if planted 11 May to 25 May, and moderate to high if planted after 25 May. We evaluated the spotted wilt and pod yield reaction of ten peanut cultivars when planted in late April, mid-May and early June during 1998, 1999, and 2000 near Marianna, Florida. Average pod yield of all genotypes was greater when planted in mid-May compared to either April or June ($P>F<0.05$). In six of ten genotypes, spotted wilt ratings were greater in April plantings and least in June plantings ($P>F<0.05$). However, in 'Florunner', a very susceptible genotype, spotted wilt was greatest in June plantings and least in April plantings. In 1998 and 2000, when spotted wilt incidence was relatively low, pod yield was greatest in May plantings but spotted wilt was generally consistent across planting dates. In 1999, when spotted wilt was measurably worse than in 1998 or 2000, June plantings produced the highest pod yield and had the least spotted wilt in comparison to April and May plantings, indicating that severe spotted wilt can override the biological pod yield advantage of May plantings. Regression analysis showed that pod yield decreased by 590 kg/ha ($P>F<0.001$) for every one point increase in spotted wilt ratings and that this loss rate was consistent for all genotypes (non-significant spotted wilt rating x genotype interaction), suggesting that spotted wilt has the same effect on pod yield of resistance and susceptible genotypes. Pod yield decrease rates were not consistent among planting dates (spotted wilt rating x planting date interaction, $P>F<0.001$). The rate of pod yield decrease for each point increase in spotted wilt rating was greater in April plantings (840 kg/ha per point), intermediate in May plantings (590 kg/ha per point), and least in June plantings (379 kg/ha per point). This supports the conclusion that risk of loses from spotted wilt was least in June plantings, but tells only part of the story since pod yields were greatest in May plantings in two out of three years. Since we are unable to predict spotted wilt prior to planting, planting the most resistant cultivars in mid-May appears to provide the best opportunity for maximizing yield over time.

Key Words: tomato spotted wilt, peanut, yield, planting date.

Introduction

Spotted wilt of peanut is caused by Tomato Spotted Wilt Tospovirus (TSWV). The disease has caused a dramatic shift in cultivars, planting date, and other cultural practices of peanut in the southeastern United States since the mid 1990's. For 20 years prior to the spotted wilt epidemic, Florunner was the dominant cultivar (Gorbet, 1999). Georgia Green has moderate resistance to spotted wilt and because of that, became the dominant cultivar in the late 1990's (Gorbet, 1999). Additionally, the date of planting in the southeast shifted from what was considered the optimum window of early April to early May (Henning *et al.*, 1982; Sturkie and Buchanan, 1973) to mid to late May. The recommendation for early April to early May planting seems to have been based mostly on research conducted without irrigation and in the absence of spotted wilt since the dates of the reports are mostly in the 1940's (Sturkie and Buchanan, 1973.) Results from research with non-irrigated virginia-type peanut in Virginia also showed that in years with inadequate rainfall, earlier planting results in the highest pod yield (Mozingo *et al.*, 1991). Under irrigation in North Carolina, spotted wilt incidence was least when peanut was planted in late May rather than early May (Hurt *et al.*, 2005). Of the two cultivars used in the study, the susceptible Perry (Isleib *et al.*, 2003) responded more to planting date that the less susceptible NC-V 11 (Wynne *et al.*, 1991). Research in Georgia under irrigation showed higher pod yield of peanut planted in mid-May rather than April or June (McKeown *et al.*, 2001). Spotted wilt was usually more prevalent in April and June

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Table 1. Number of days elapsed from planting to digging peanuts of differing maturity planted sequentially on about 27-day intervals near Marianna, Florida during 1998, 1999, and 2000.

	Planting Date								
	1998			1999			2000		
Maturity Class	Apr 17	May 13	Jun 9	Apr 14	May 10	Jun 7	Apr 18	May 12	Jun 8
	Days elapsed from planting to digging								
Early	133	128	125	131	129	130	129	128	123
Medium	143	138	130	138	140	130	136	139	130
Late	154	150	154	149	150	151	150	149	144

plantings than in May plantings in their study. The increase in pod yield in May plantings compared to April and June plantings was attributed to a lower incidence of spotted wilt in the May planting.

There are limited publications detailing the effect of planting date on recently released cultivars that have better resistance to spotted wilt. The objective of this study was to determine the effect of planting date on pod yield and spotted wilt of new cultivars and breeding lines.

Materials and Methods

Planting date tests were conducted at the North Florida Research and Education Center near Marianna, Florida during 1998, 1999, and 2000. The soil type was a Chipola loamy sand (Loamy, kaolinitic, thermic Arenic Kanhapludults). Plots consisted of two 6.1 m long rows spaced 91 cm apart. Cultural practices were common to all years and included overhead irrigation, conventional tillage with moldboard plowing in the spring, standard recommendations for weed and insect control as well as a full season fungicide program. In-furrow insecticides were not applied. The seeding density was 13 seeds/meter in 1998 and 1999 and 16 seeds/meter in 2000.

Ten peanut genotypes were tested over the three year period in three planting dates, mid-April, mid-May and early June (Table 1). The genotypes were Florida MDR98 (Gorbet and Shokes, 2002), Georgia Green (Branch, 1996), SunOleic 97R (Gorbet and Knauft, 2000), Andru 93 (Gorbet and Knauft, 1995), Florunner (Norden *et al.*, 1969), Hull (Gorbet, 2003b), Carver (Gorbet, 2003a), and three University of Florida breeding lines 86x13A-4-2-3-2-b3-B, UF99621, and 88x1B-OLBC1-6-1-3-1-b2-B (Andersen and Gorbet, 2002). The experimental design was a randomized complete block with treatments replicated three times. The peanut genotypes can be placed into three maturity groups and differ in their susceptibility to spotted wilt. The cultivars Andru 93, SunOleic 97R, and Florunner are susceptible; UF99621 and 88x1B-OLBC1-6-1-3-1-b2-B are moderately susceptible; Georgia Green and 86x13A-4-2-3-2-b3-B are moderately resistant; Hull, Carver and Florida MDR-98 show the most resistance. The genotypes Andru 93, UF99621, and 88x1B-OLBC1-6-1-3-1-b2-B are early maturing (125–130 days); Georgia Green, SunOleic 97R, Carver, and Florunner are medium maturing (133–138 days); Florida MDR-98, 86x13A-4-2-3-2-b3-B, and Hull are late maturing (145–150 days). Genotypes were dug and harvested based on their relative maturity (Table 1).

Prior to digging, symptoms of spotted wilt were rated on a plot basis on a 1 to 10 scale where 1= no disease and 10= all plants severely diseased. Pod yield was determined by threshing all plants in a plot with a stationary thresher and weighing the pods after the seeds had dried to 9–10% moisture. Pod yield per plot was converted to kg/ha.

Pod yield and spotted wilt data were analyzed using the GLM procedure of SAS partitioning variance by year, replication, planting date, genotype, and all two-way interactions between year, plant date, and genotype (SAS Institute, 2000). Trend contrasts were constructed for each genotype to test linear and quadratic functions in pod yield and spotted wilt attributable to planting date (Steel and Torrie, 1980). The linear contrast tested the difference between the April and June planting dates and the quadratic contrast tested the difference between the May planting date and both the April and June planting dates (Saville and Wood, 1991). The Duncan's multiple range test was used to test potential differences in severity of spotted wilt among years.

A regression analysis was conducted to test pod yield loss rate differences between genotypes and planting dates using the REG procedure of SAS (SAS Institute, 2000). In the first model, pod yield was the dependent variable with spotted wilt rating, planting date, and the interaction between spotted wilt rating and planting date as independent

Table 2. Planting date effects on peanut pod yield and spotted wilt near Marianna, Florida.

Year	Planting Date	Pod Yield	Spotted Wilt
		kg/ha	1-10[a]
1998	17-Apr	4059	4.3
	13-May	5094	3.9
	9-Jun	3915	3.8
Linear[b] p-value		0.1948	0.0007
Quadratic[c] p-value		<0.0001	0.2316
1999	14-Apr	1044	6.6
	10-May	2243	5.4
	7-Jun	3128	4.1
Linear p-value		<0.0001	<0.0001
Quadratic p-value		0.1011	1.0
2000	18-Apr	4008	4.5
	12-May	4437	4.4
	8-Jun	3432	4.8
Linear p-value		<0.0001	0.0647
Quadratic p-value		<0.0001	0.0975
Overall	Mid-April	3073	5.1
	Mid-May	3993	4.4
	Early-June	3564	4.1
Linear p-value		<0.0001	<0.0001
Quadratic p-value		<0.0001	0.1309

[a]Spotted wilt was rated on a plot basis on a 1 to 10 with 1 meaning no disease and 10 meaning all plants severely stunted.

[b]Linear contrast tested the difference between April and June planting dates.

[c]Quadratic contrast tested the difference between the May planting date and the combination of the April and June planting dates.

variables. In the second model, pod yield was the dependent variable with spotted wilt rating, genotype, and the interaction between spotted wilt and genotype as independent variables.

Results and Discussion

Analysis of variance showed that pod yield and spotted wilt ratings were affected by planting date ($P>F<0.0001$), genotype ($P>F<0.0001$, year ($P>F<0.0001$), year x planting date interaction ($P>F<0.0001$) and year x genotype interaction ($P>F<0.0001$). Pod yield was not affected by the planting date x genotype interaction unlike spotted wilt ($P>F<0.0001$). Because of treatment interactions with years, a subsequent analysis was performed for each year so that individual year effects could be interpreted (Table 2; Figures 1 & 2).

Spotted wilt incidence was higher in 1999 than in 1998 or 2000 (Table 2). Ratings averaged 5.4 in 1999, 4.4 in 2000, and 3.8 in 1998 (LSD for Duncan's Multiple Range Test for 3 means = 0.25). Pod yield in 1999 was 2140 kg/ha, lower than that in 1998 (4450 kg/ha) and 2000 (4040 kg/ha) (Duncan's Multiple Range Test for 3 means = 135 kg/ha).

When averaged over all cultivars, pod yield was greatest in the May plantings and least in the June and April plantings in 1998 and 2000 (quadratic contrast $P>F<0.001$) (Table 2). However, in 1999 pod yield was least in April plantings, intermediate in May plantings, and greatest in June plantings (linear contrast $P>F<0.001$).

In 1999, pod yield was greatest in June plantings, intermediate in May plantings, and least in April plantings for all nine genotypes tested that year (linear contrast $P>F<0.05$) (Figure 1). In contrast, eight of nine genotypes had more spotted wilt in April or May plantings than in June plantings (linear or linear and quadratic contrast $P>F<0.05$) (Figure 2). In 1999, the increase in pod yield from April to June plantings seems to correspond to the decrease in spotted wilt from April to June. Severe spotted wilt in 1999 shows the importance of cultivar resistance because the pod yield of resistant cultivars such as Florida MDR 98 and Hull planted in May, 1999 were at least equal to pod yields of Georgia Green and other susceptible genotypes planted in June, 1999 (Figure 1).

Spotted wilt incidence was lower in 1998 and 2000 compared to 1999, and the majority of genotypes (9 of 10 in 1998 and 6 of 10 in 2000) had higher yield in May plantings (quadratic contrast, or linear and quadratic contrast $P>F<0.05$) (Figure 1). Planting date had little effect on spotted wilt ratings in 1998 and 2000 with only three of ten genotypes showing more spotted wilt in April versus June in 1998 and two of ten showing more disease in June versus April in 2000 (Figure 2). Interestingly, SunOleic 97R, the most susceptible genotype planted in 1999 had similar spotted wilt ratings in each planting date. In fact, spotted wilt ratings for SunOleic 97R did not vary by planting date any of the three years.

When planting date affected the spotted wilt ratings of a particular cultivar, the ratings were almost always highest in April plantings and least in June plantings. Often the spotted wilt ratings in May and June were similar. These two statements apply to all cultivars except Florunner and Hull in 2000.

Results from regression analysis showed that pod yield decreased by 590 kg/ha ($P>F<0.001$) for every one point increase in spotted wilt ratings and that the loss rate was consistent for all genotypes. This suggests that spotted wilt has the same effect on pod yield of resistance and susceptible genotypes even though pod yield potential of different genotypes may vary. In contrast, pod yield decrease

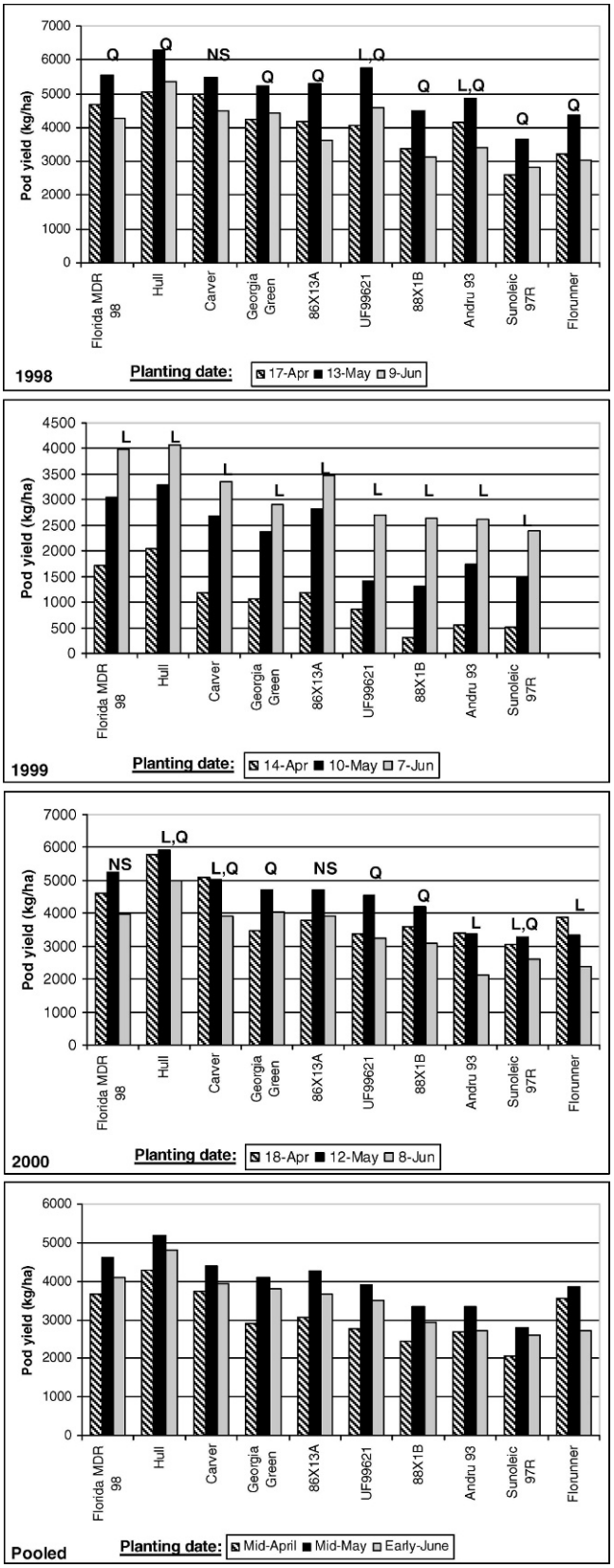

Fig. 1. Pod yield of ten peanut varieties planted on about 27 day intervals near Marianna, Florida during 1998, 1999, 2000, and combined over years. (L=linear contrast significant at P>F<0.05; Q=quadratic contrast significant at P>F<0.05; NS=non significant)

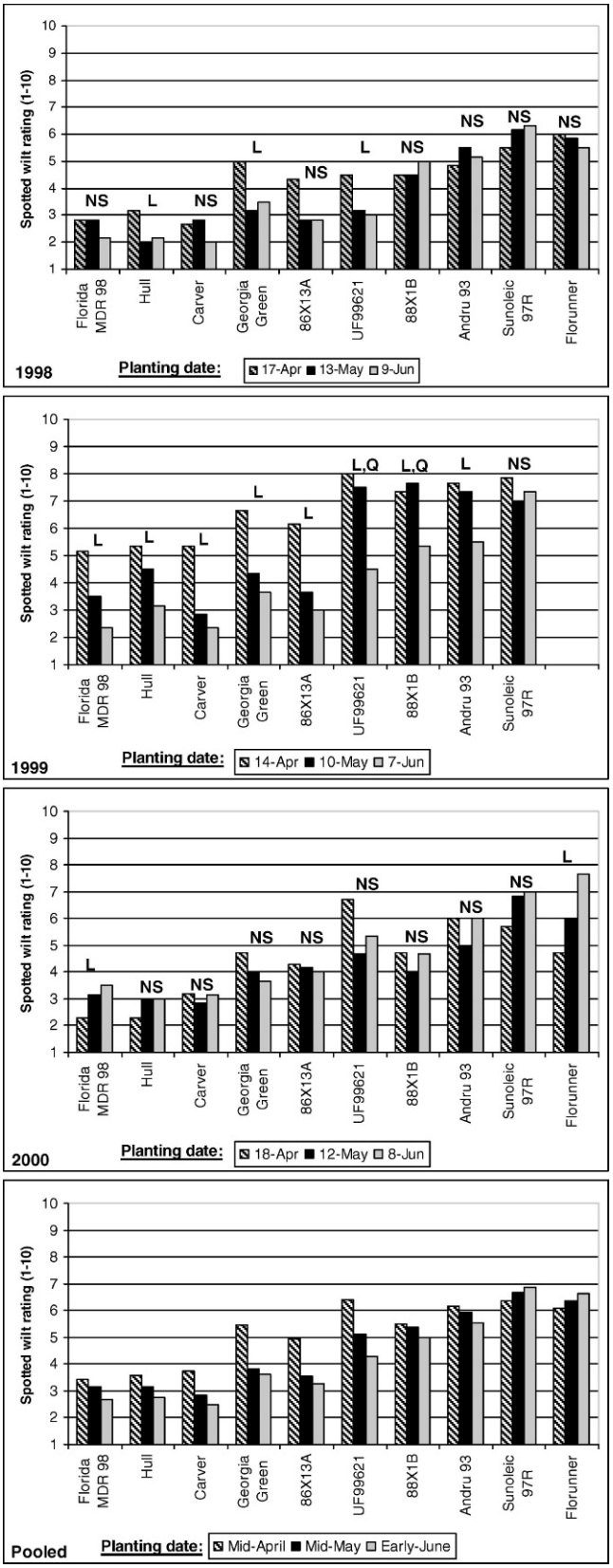

Fig. 2. Spotted wilt (caused by Tomato Spotted Wilt Tospovirus) ratings of ten peanut varieties planted on about 27 day intervals near Marianna, Florida during 1998, 1999, 2000, and combined over years. (L=linear contrast significant at P>F<0.05; Q=quadratic contrast significant at P>F<0.05; NS=non significant)

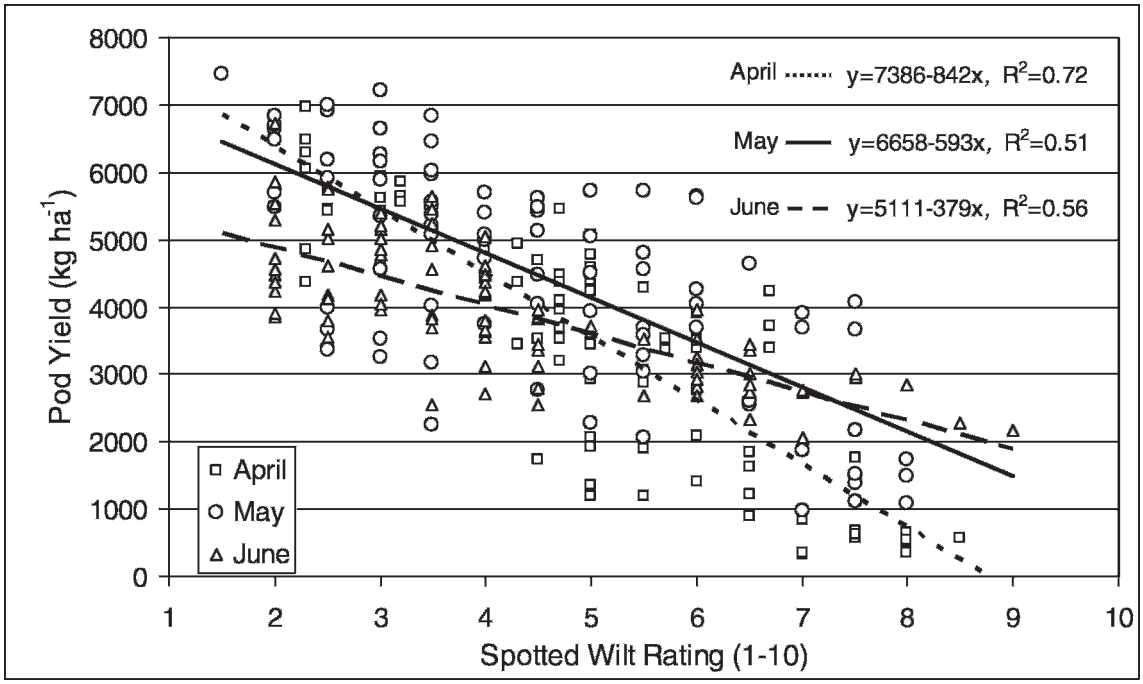

Fig. 3. Regression of pod yield on spotted wilt disease ratings from three planting dates (mid-April, mid-May, and early June) in 1998, 1999, and 2000 near Marianna, Florida.

rates were not consistent among planting dates. The rate of pod yield decrease for each point increase in spotted wilt rating was greater in April plantings (840 kg/ha per point), intermediate in May plantings (590 kg/ha per point), and least in June plantings (380 kg/ha per point) (Figure 3). This supports the conclusion that risk of loses from spotted wilt were least in June plantings. However, spotted wilt incidence was generally greater in April plantings and least in June plantings and pod yield was greatest in May plantings for all cultivars in two of three years and in the combined analysis. This indicates that in years when spotted wilt pressure is low such as in 1998 and 2000, mid-May planting would give the greatest pod yields, but in years such as 1999, when spotted wilt was severe, June plantings would produce the greatest pod yields. Averaged over 1998, 1999 and 2000, the greatest pod yield for all cultivars occurred in mid-May plantings. Since we are unable to predict spotted wilt severity in an upcoming year, mid-May plantings of the most resistant cultivars will minimize risks and most likely provide the highest pod yield.

Conclusions

Previous research with non-irrigated peanut in the southeast prior to spotted wilt showed that pod yield increased with plantings as early as the average date of the last frost (Sturkie and Buchanan, 1973). In contrast, pod yield of the genotypes in the present study were maximized in the mid-May planting under irrigation. For instance, when differences in spotted wilt between planting dates were observed in 2000 in only two out of ten genotypes, pod yield of seven of the eight remaining genotypes was either greatest in May plantings, or similar in April and May plantings. A similar trend was apparent in 1998 (Figure. 1).

Current cooperative extension recommendations advise farmers to plant within the middle two weeks of May to reduce the risk of spotted wilt (Culbreath *et al.*, 2003, Brown, *et al.*, 2007). This is based on observations of greater spotted wilt in April plantings and June plantings, although the effects of June planting on spotted wilt are less consistent than the responses in April and May. In the three years of the present study, spotted wilt was lower in June plantings compared to April plantings in 6 out of 10 genotypes tested (Figure 2). Even though spotted wilt was lowest in June plantings, pod yields tended to be greater in May plantings compared to April and June in all genotypes (Figure 1). The recommendation of mid-May planting to reduce risk of losses from spotted wilt may be based as much on biological pod yield potential under irrigation as on avoidance of spotted wilt. Otherwise, June plantings would give the least risk of spotted wilt and correspondingly, maximum yield.

Spotted wilt reduced pod yield of susceptible and resistant genotypes equally (no interaction between genotype and spotted wilt rating), but susceptible genotypes generally had greater overall spotted wilt ratings and lower overall pod yield at the same planting date compared to resistant genotypes. As was the case in April and May plantings in 1999, severe spotted wilt can cause significant pod yield losses in even the most resistant genotypes. Because spotted wilt epidemics cannot be predicted, our results suggest that, under irrigation, farmers should be able to maximize pod yield and minimize risk of loses from spotted wilt by planting the most resistant genotypes in mid-May.

Literature Cited

Andersen, P.C. and D.W. Gorbet. 2002. Influence of year and planting date on fatty acid chemistry of high oleic acid and normal peanut genotypes. J. Agric. Food Chem. 50:1298-1305.

Branch, W.D. 1996. Registration of 'Georgia Green' peanut. Crop Sci. 36(3):806.

Culbreath, A.K., J.W. Todd, and S.L. Brown. 2003. Epidemiology and management of tomato spotted wilt in peanut. In: Annual review of phytopathology. 41: 53-75.

Brown, S., J. Todd, A. Culbreath, J. Beasley, B. Kemerait, E. Prostko, T. Brenneman, N. Smith, D. Gorbet, B. Tillman, R. Weeks, and A. Hagan. 2007. Minimizing Diseases of Peanut in the Southeastern United States: The 2007 Version of the University of Georgia's Peanut Disease Risk Index. The University of Georgia, College of Agricultural and Environmental Sciences.

Gorbet, D.W. 1999. University of Florida Peanut Breeding Program. Proceedings of the Soil and Crop Sciences Society of Florida, 58:2-7.

Gorbet, D.W. and D.A. Knauft. 2000. Registration of 'SunOleic 97R' peanut. Crop Sci. July/Aug 2000. v. 40(4):1190-1191.

Gorbet, D.W. and D.A. Knauft. 1995. Registration of 'Andru 93' peanut. Crop Sci. Sept/Oct 1995. v. 35(5):1507.

Gorbet, D.W. and F.M. Shokes. 2002. Registration of 'Florida MDR 98' peanut. Crop Sci. Nov/Dec 2002. v. 42(6):2207-2208.

Gorbet, D.W. 2003a. Carver- A New Medium Maturity Peanut Cultivar. Marianna NFREC Research Report 03-5.

Gorbet, D.W. 2003b. Hull- A New Multiple Disease Resistant High Oleic Peanut Variety. Marianna NFREC Research Report 03-6.

Henning, R.J., A.H. Allison, and L.D. Tripp. 1982. Cultural Practices, pp. 123-138. *In:* Peanut Science and Technology, H.E. Pattee and C.T. Young (eds.), American Peanut Research and Education Society, Inc. Yoakum, TX.

Isleib, T.G., P.W. Rice, R.W. Mozingo, II., J.E. Bailey, R.W. Mozingo, and H.E. Pattee. 2003. Registration of 'Perry' Peanut. Crop Sci. 43:739-740.

Hurt, C.A., R.L. Brandenburg, D.L. Jordan, G.G. Kennedy, and J.E. Bailey. 2005. Management of Spotted Wilt Vectored by Frankliniella fusca (Thysanoptera: Thripidae) in Virginia Market-Type Peanut. J. Econ. Entomol. 98(5):1435-1440 (2005).

Norden, A.J., R.W. Lipscomb, and W.A. Carver. 1969. Registration of 'Florunner' Peanuts. Crop Sci. 9(6):850.

McKeown, S.P., J.W. Todd, A.K. Culbreath, D.W. Gorbet, and J.R. Weeks. 2001. Planting date effects on tomato spotted wilt in resistant and susceptible peanut cultivars. Phytopathology 91:S60.

Mozingo, R.W., T.A. Coffelt, and F.S. Wright. 1991. The influence of planting and digging dates on yield, value, and grade of four virginia-type peanut cultivars. Peanut Sci. 18:55-62.

SAS Institute. Statistical Analysis Software for Windows. Version 8.1. 1999–2000. SAS Institute, Cary, NC.

Saville, D.J. and G.R. Wood. 1991. Polynomial Contrasts. *In* Statistical Methods: The Geometric Approach, pages 224-270. Springer- Verlag, New York.

Steel, R.D.G. and J.H. Torrie. 1980. Analysis of Variance III: Factorial Experiments. *In:* Principles and Procedures of Statistics, A Biometrical Approach, Second Edition, pages 336-372. McGraw-Hill Publishing Company, New York.

Sturkie, D.G. and G.A. Buchanan. 1973. Cultural Practices, pp. 299-326. *In* Peanuts: Culture and Uses. American Peanut Research and Education Association, Stillwater, OK.

Wynne, J.C., T.A. Coffelt, R.W. Mozingo, and W.F. Anderson. 1991. Registration of 'NC-V11' peanut. Crop Sci. 31:484-485.