141
TX-47
550

Plant Pathology
NPB 2008 Report Executive Summary

TITLE: Spotted Wilt Resistance Mechanisms and Effects on Thrips

PERSONNEL: Mark C. Black and Noel N. Troxclair, Texas AgriLife Extension Service, Uvalde; Michael R. Baring, Texas AgriLife Research, College Station; and Karl C. Steddom, Texas AgriLife Extension Service, Overton

EXECUTIVE SUMMARY: We continued to gather evidence that TSWV field resistance in runner peanut varieties involves plant canopy characteristics. We hypothesize that canopy traits affect vector thrips behavior.

Data were collected from one replicated field test in Frio County in 2008 including vegetative plant mapping of 10 entries at Phillips Farm and visual color ratings. In agreement with previous work in southwest Texas, field-resistant varieties tend to have less prominent mainstems (flatter canopy) and/or increased branching at mid-canopy height. On color continuums of hue from yellow-green-blue and saturation from faded to vibrant, TSWV field resistant varieties had more blue green canopy color (hue) and more vibrant color (saturation).

We are increasing our understanding of plant types that are highly vulnerable during spotted wilt epidemics and also plant types that hold up well to TSWV. This has potential for breeders to avoid advancing field-highly-susceptible breeding lines even in years with little spotted wilt pressure. The traits related to spotted wilt variety ratings do not indicate a simply inherited disease resistance. Canopy traits fall in the category of 'field resistance' that is apparently polygenically inherited. This type of 'field resistance' should be stable and additive with the low levels of 'true resistance' apparently available in some lines.

1411
TX-47
550
2008

final

Plant Pathology
NPB 08 Report, April 26, 2009

TITLE: Spotted Wilt Resistance Mechanisms and Effects on Thrips

PERSONNEL: Mark C. Black and Noel N. Troxclair, Texas AgriLife Extension Service, Uvalde; Michael R. Baring, Texas AgriLife Research, College Station; and Karl C. Steddom, Texas AgriLife Extension Service, Overton

SUMMARY: We continued to gather evidence that TSWV field resistance in runner peanut varieties involves plant canopy characteristics. We hypothesize that canopy traits affect vector thrips behavior. Data were collected from one replicated field test in Frio County including vegetative plant mapping of 10 entries at Phillips Farm and visual color ratings (data also reported in TPPB 08 report by M. Black).

We are increasing our understanding of plant types that are highly vulnerable during spotted wilt epidemics and also plant types that hold up well to TSWV. This has potential for selection even in years with little spotted wilt pressure. The traits related to spotted wilt variety ratings do not indicate a simply inherited disease resistance. Canopy traits fall in the category of 'field resistance' that is apparently polygenically inherited. This type of 'field resistance' should be stable and additive with the low levels of 'true resistance' apparently available in some lines.

INTRODUCTION: The peanut disease caused by thrips-vectored *Tomato spotted wilt virus* (TSWV) has been an important factor in southwest and central TX since the early 1980s and in the Southeast and Virginia-Carolina production areas of the U.S. since the 1990s. In every test with diverse peanut breeding lines and varieties, there have been significant differences in spotted wilt disease ratings by the end of the season. Some of the variation among lines/varieties is apparently due to canopy characteristics of field grown plants, or "field resistance." Our previous work suggests that relatively less prominent mainstems (flatter canopy) and increased branching at mid-canopy often occur in field-resistant varieties grown in southwest Texas. Our data suggests in part that among varieties, thrips numbers in main stem and lateral branches vary at certain times of the season. Field resistance is usually not detected under laboratory (growth chamber) conditions. Varieties with field resistance have performed well during mid- and late-season spotted wilt epidemics, but early season epidemics can cause significant yield loss. Ideally, "field resistance" will eventually be combined with "true resistance" (detectable in growth chamber tests).

Field screening for TSWV reactions among breeding lines is ongoing because plant breeders seek to maintain or improve multiple disease resistance and other desirable traits in future varieties. This work will lay the foundation for future crosses and selection efforts by identifying parental traits with resistance components to spotted wilt, other diseases, and stress. This work also will help explain benefits of increased seeding rate and twin-row planting patterns in managing spotted wilt because these management practices also affect canopy characteristics.

Our hypothesis for the canopy effect on spotted wilt is that thrips vectors are more dispersed throughout the canopy of field-resistant varieties and that vector efficiency increases with aggregation.

MATERIALS and METHODS: Ten peanut varieties with a range of TSWV field reactions were mapped for vegetative stem growth. The experimental design with two-row 13-ft plots was a randomized complete block with three replications. Whole plants were destructively sampled on three dates by removing a minimum of three plants in 1 row-ft from each of the two rows per plot (target was six plants per plot). The resulting gaps were measured after each sampling date to estimate stand (plants per row ft). Total number plants sampled and all branch lengths on the six largest plants were recorded (primary, secondary, tertiary, quaternary).

Canopy color was evaluated visually by relative hue and saturation. Hue and saturation were analyzed separately (data not presented) and as a sum and a product (data not presented). Hue = tint; what color is it? Similarly, Saturation = shade or how faded or rich and vibrant is the color?

RESULTS AND DISCUSSION: Spotted wilt was near zero at the test site in 2008. Early season visual evaluations of canopy color (hue and saturation) using four-category indices for hue and saturation again showed promise for identifying known spotted wilt-susceptible check varieties in a season with very low disease (data in TPPB report). Visual ratings characterized susceptible checks early in the season as being on the "yellow side" of green and a less vibrant color, and known resistant checks as being on the "blue side" of green and more vibrant color.

TSWV susceptible Tamrun88 canopy had less saturated green color than FlavorRunner458 on 3July, but similar canopy color on two later dates (Table 1). The most resistant cultivar, AP-3 had a different saturated bluer canopy color than both susceptible checks on 3July, but similar color on 22July and 18August. TSWV-resistant cultivars from SE states had similar or more saturated blue green color compared to TX TSWV-resistant cultivars on 3July and 22July. However, on 28August only Georgia02C among the four SE TSWV-resistant cultivars had significantly more saturated blue-green color than TSWV-susceptible FlavorRunner458. TX TSWV-resistant cultivars maintained relatively saturated blue-green canopy color throughout the season and all were significantly different from both susceptible checks on 18August. Based on deterioration of canopy color as the season progresses, SE breeding programs have perhaps released cultivars with greater TSWV resistance but with less adaptation to stresses in Frio County compared to cultivars developed in TX.

Vegetative growth was compared to historical TSWV ratings for these 10 entries. In general, TSWV-susceptible cultivars had more small-limb (higher order secondary, tertiary, quartenary) growth in August and September (Table 2). After mid-season, these actively growing branch tips may be favored feeding sites by thrips carrying TSWV.

Average secondary stem length (SStemL) was negatively correlated with TSWV susceptibility (Table 2B). In early season, cultivars with taller main stems vs. the first two secondary stem lengths were more susceptible based on positive correlations with disease for RMSSS2, RMSSS1_2, and RMSSS. This agreed with the 25Sep positive correlation of MSSS and disease. The ratio of average secondary stems length and average tertiary stems length was negatively correlated with spotted wilt on 25Sep, perhaps indicating that tertiary growth also decreased relative prominence of the main stem.

Regression equations that explained the most spotted wilt reactions mostly agreed with previously discussed individual parameter correlations. On 22Jul, main stem leaf number and more prominent main stems were positive factors, and secondary stem 2 length was a negative factor (Table 3). On 18Aug, secondary stem 5 length was a negative factor, as was main stem length ratio with average of secondary stems 1 and 2; the broader parameter of main stem ratio to all secondary stem lengths was positive. On 25Sep, main stem leaf number was a negative factor (opposite of 22Jul) and total number of secondary stems was a positive factor (similar to positive correlations with higher order secondary stem lengths discussed above).

Our hypothesis is that thrips vectors of TSWV respond to peanut canopy color in a way that influences spotted wilt epidemics. In general, highly susceptible varieties have canopies that are more yellow-green (lower H) and faded (lower S), while varieties with some resistance are more blue-green (higher H) and rich (higher S). Differences among H and S are most noticeable early in the day, and become less noticeable in the bright glare of mid-day sun.

Based on previous work, we do not anticipate identifying one or two easily measured traits related to spotted wilt reaction in the seedling stage that breeders could use for early screening in the greenhouse or winter nursery. The best disease correlations with vegetative growth traits varied somewhat among previous years of plant mapping, but these is commonality. We continue to gain understanding of plant types that are highly vulnerable and this can be used in years with little spotted wilt pressure.

The traits related to spotted wilt variety ratings explored in this report do not fit the classical definition of disease resistance. Rather, these canopy traits we identified fall in the category of 'field resistance' (some varieties/breeding lines have less disease in the field than would be expected based solely on laboratory tests). Fortunately, this type of 'field resistance' is stable to date, and even when epidemics occur, there should always be a similar rank of known susceptible and known resistant entries. The Georgia and Florida university breeding programs are using somewhat different genetics than Texas breeders for spotted wilt resistance, with the former apparently relying more on both dense-low spreading-highly branched canopy and some 'true resistance' to TSWV; those canopies are apparently more prone to southern blight, Sclerotinia blight, and heat stress. The Texas program apparently uses genetics for a less branched canopy that may have advantages for field resistance to southern blight, Sclerotinia blight, and summer stress.

Field testing and screening breeding lines at locations with risk of spotted wilt should continue. Work will continue on defining traits for use in field selections when disease intensity is low or absent.

ACKNOWLEDGMENTS: Texas Peanut Producers Board provided partial funding through National Peanut Board funds. We thank Alfred Sanchez, James 'Bud' Davis, Elisha Diaz, and Armando Pepi for technical assistance; Rosalinda Melchor for secretarial service; and Murray Phillips, Grayson Wilmeth, and Jaime Lopez for support and help with the field plots.

Table 1. Visual color ratings of peanut canopies (saturation plus hue) at Murray Phillips Farm in Frio County in 2008 in attempts to identify entries susceptible (Tamrun 88, FlavorRunner458) to spotted wilt disease in a season with near zero spotted wilt (caused by *Tomato Spotted wilt virus*) disease, with estimated historical spotted wilt reactions from TX and SE states arbitrarily assigned to entries (see s+h rank on 18Aug).

Entry	s+h3Jul	Entry	s+h22Jul	Entry	s+h18Aug	Historical spotted wilt reaction
Georg02C	5.3	Georg03L	4.7	TrunOL01	4.3	35
TrunOL07	4.7	Georg02C	4.3	TrunOL02	4.0	35
ANorden	4.3	Tamrun96	3.7	TrunOL07	4.0	25
Tamrun96	4.3	TrunOL07	3.7	Georg02C	4.0	15
Georg03L	4.3	ANorden	3.3	Tamrun96	3.7	40
TrunOL01	4.3	TrunOL02	3.3	Georg03L	3.3	15
TrunOL02	4.0	Tamrun88	3.0	ANorden	3.3	25
AP-3	4.0	TrunOL01	3.0	AP-3	2.7	10
Flrun458	2.7	AP-3	3.0	Flrun458	2.7	50
Tamrun88	2.0	Flrun458	2.3	Tamrun88	2.0	60
LSD.05	0.7		1.0		0.8	
p>f	0.0001		0.004		0.001	
CV%	11		17		14	
Average	4		3.4		3.4	

Table 2. Significant ($P \leq 0.05$) Pearson correlation coefficients (N=30) for historical spotted wilt disease ratings with selected peanut stem characteristics from three sampling dates for ten varieties at Phillips Farm in Frio County, TX, 2008.

Plant sample date	22Jul	18Aug	25Sep
A. Stem length[z]			
S1T2Q1		+.39*[y]	
S1T4Q1			+.46*
S1T6			+.37*
S1T7			+.39*
S2	-.40*		
S2T2Q1			+.49**[y]
S2T3Q1			+.40*
S2T3Q2		+.44*	+.38*
S2T3Q3		+.38*	
S2T4Q2		+.39*	
S3T4			+.50**
S3T6			+.42*
S4T2			+.42*
S4T2Q1		+.38*	
S5T1		+.50**	+.45*
S5T2		+.37*	+.43*
S6T2			+.47**
S6T3			+.42*
S8			+.38*
S11			+.45*
S12		+.42*	+.56**
S13		+.52**	+.47**
S14			+.51**
S15			+.40*
S16			+.42*

Plant sample date	22Jul	18Aug	25Sep
B. Calculated variables			
TtNoSSt		+.41*	+.51**
TtNoQSt			+.41*
TtNoStm			+.38*
SStemL			-.48**
RMSSS2	+.42*		
RMSSS1_2	+.37*		
RMSSS	+.54**		
MSSS			+.46*
RSSTS			-.37*

[y]Asterisks (one, two) indicate significance at $P \leq 0.05$ and $P \leq 0.01$, respectively.

[z]Stem length was an average of six plants per plot. Calculated variables were based on averages of previous variables for each plot. There were three replications, N=30. MS=main stem; S, SS and SSt=secondary stem; T= and TS=tertiary stem; Q= quaternary stem; Tt=total; R=ratio (of stems described); 1_2=1 and 2; 1_4=1, 2, 3, and 4; no number indicated an average of all SS on that date.

Table 3. Regression analysis of plant mapping data (three dates, destructive sampling) for 10 varieties at Phillips Farm in Frio County, TX, 2008 and predicted spotted wilt disease intensity.

Sample date	Best regression equation[z]	Model P > F	R^2
22Jul	SW = -175.0 + 13.7MSLvs – 5.0S2 + 64.4RMSSS + 0.6 SmMSS1_4	<0.0001	0.62
18Aug	SW = 34.1 – 1.1S5 – 68.9RMSSS12 + 94.9RMSSS	<0.001	0.53
25Sep	SW = 33.7 – 3.0MSLvs + 9.9TtNoSSt	<0.01	0.39

[z]Equations were estimated by PC-SAS Proc Regression using Stepwise option and minimum C(p) statistic. Six whole plants were collected from each plot on each date. Stem descriptions are:

SW = spotted wilt (% row ft with noteworthy symptoms)
Sm = sum
MS = average length of main (primary) stem 1 (cm)
S1 = average length of secondary stem 1 (cm)
S2 = average length of secondary stem 2 (cm)
S3 = average length of secondary stem 3 (cm)
S4 = average length of secondary stem 4 (cm)
S6 = average length of secondary stem 6 (cm)
SStmL = average total/plant secondary [arising from main(primary)] stem length (cm)
TStmL = average total/plant tertiary stem length
TtSStmL = average total/plant secondary stem lengths (cm)
TtTStmL = average total/plant tertiary (from secondary stems) stem lengths (cm)
TtQStmL = average total/plant quaternary (from tertiary stems) stem lengths (cm)
TtNoStm = average total number all stems/plant (cm)
TtNoTSt = average total number tertiary stems/plant (cm)
RMSSS12 = average ratio of main stem length to average of secondary stems 1 and 2
RMSSS1 = average ratio of main stem length to secondary stem 1 length
MSxxS1_4 = product of main stem length and the average length of secondary stems 1-4
MSSS = ratio of average main stem length/plot to average secondary stem length /plot.