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Plant Pathology
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TITLE: Spotted Wilt Resistance Mechanisms and Effects of Thrips Aggregation

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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 three field tests in Frio County: destructive sampling for plant mapping of 10 varieties at Phillips Farm; Advanced Lines Test (20 entries) at Phillips and Advanced Lines Test (20 entries) at Wilmeth Farm. Plots were photographed from above and from near horizontal positions in attempts to quantify canopy color and shape. Early season photographs most closely matched past TSWV data for susceptible checks.

Computer analysis of hue, saturation, and intensity from digital photographs did not consistently rank susceptible checks differently than resistant entries. Early season data (July) were most promising. Visual ratings appear to be superior to analysis of digital photos for ranking entries for spotted wilt susceptibility (data reported in TPPB report, 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' 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 to continue validation of our hypothesis using a somewhat different genotype entries. 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, quinary). Digital photographs were taken from near-horizontal angles against a grid board. Contrast was enhanced with with software to estimate height (outline) of canopy across 37 inches of the grid. Data analyzed is planned with linear regression (PC SAS, Cary, NC) to estimate model fit, slope, and intercept.

Canopy color was evaluated visually. Relative hue and saturation were estimated separately. Hue and saturation were analyzed separately and as a sum and a product. Color digital photographs without flash were evaluated for hue, saturation, and intensity using Assess Image Analysis Software (APS Press, St. Paul, IN). The HIS model of color encapsulates information about a color in terms that are more familiar to humans than RGB or CMYK models. Each color is described by three numbers, each on a 0 to 255 scale: hue (H), saturation (S), and intensity (I). For hue, the number for red < yellow < green < blue < violet. Hue = tint; what color is it? Similarly, Saturation = shade or how faded or rich and vibrant is the color? Intensity (or value) = tone; how light or dark, how much light is reflected from the image? (Fooley and Van Dam, 1990; http://en.wikipedia.org/wiki/HSV_color_space). Intensity as used by Assess is comparable to converting the image to black and white and measuring the relative whiteness or blackness of the monochrome image.

Assess evaluated relative hue as: reds 56 to 60, yellows 97 to 102, greens 117 to 158, blues 210 to 224, violets 239 to 242 (Figure 2).

RESULTS AND DISCUSSION: Spotted wilt was near zero at both sites in 2007. 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). Near-horizontal digital color photographs of the plots were enhanced with computer software for canopy shape (outline) (data analysis pending). Visual and computer 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 (Fig. 1). Hue values peaked in August, but saturation values remained fairly constant from July to September. Data for

Advanced lines tests at Phillips and Dilley are not presented.

Intensity was sometimes significantly different among replications, suggesting that images became somewhat washed out as light changed due to scattered clouds, and as sun angle and intensity progressed from morning to mid-day. The human eye is apparently able to compensate for changing light conditions better than our camera equipment.

Plant mapping data have been digitized, but analysis has not been completed. Lack of spotted wilt ratings in 2007 do not allow us to compare disease with various stem measurements.

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 (high I).

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 the previous three 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 if low or absent.

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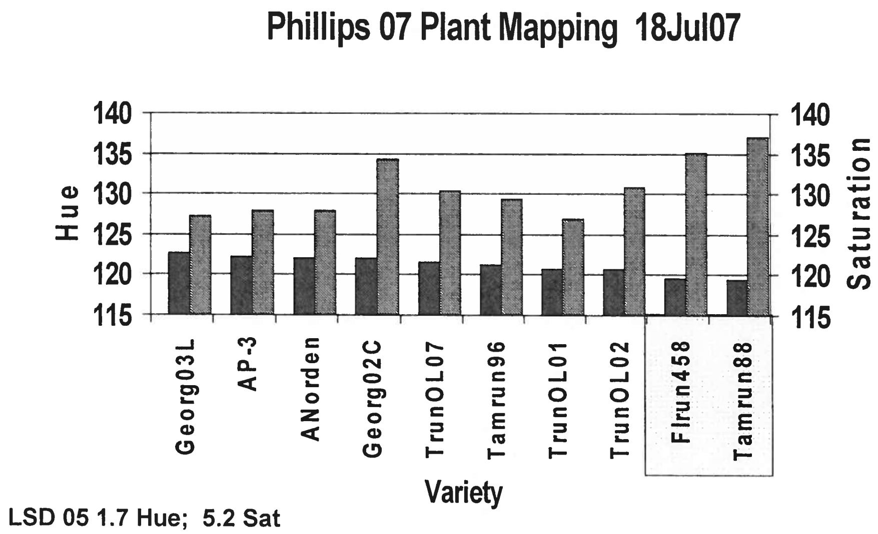
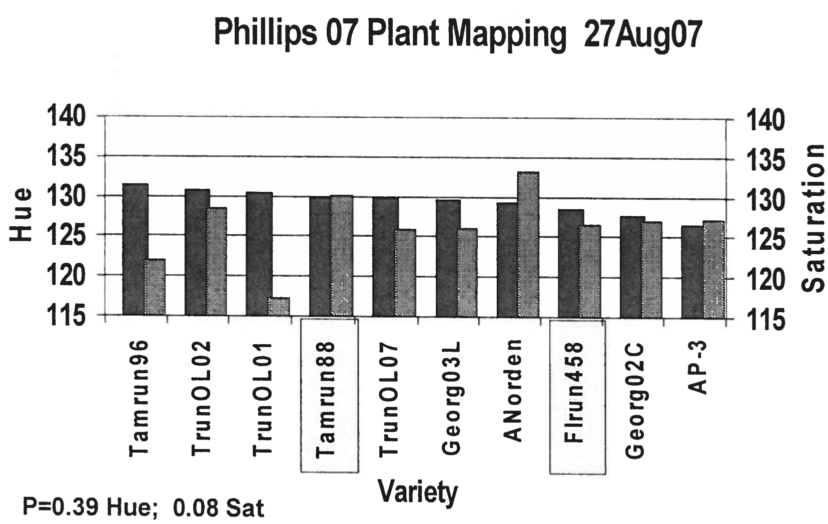
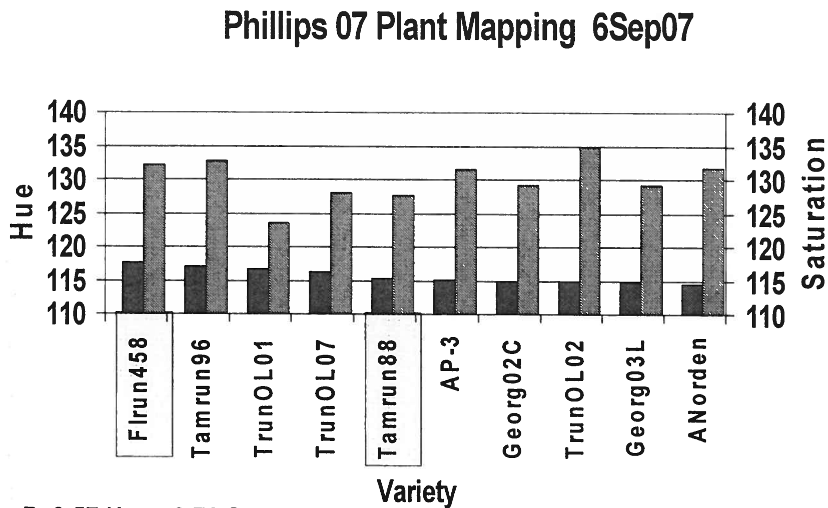
Figure 1. Hue (dark bars) and saturation (light bars) of 10 varieties at Phillips Farm, Frio, Co. in 2007 from color digital photographs analyzed by Assess Software. July18 data ranked TSWV susceptible checks FlavorRunner458 and Tamrun88 together (yellow boxes), but this changed as the season progressed (27Aug, 6Sep).







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