Understanding the effects of climate variability on Tomato Spotted Wilt Virus (TSWV) in peanut

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Introduction

Tomato spotted wilt virus (TSWV) (family *Bunyaviridae*) is an important plant virus that causes severe damage to peanut (*Arachis hypogaea* L.) production in southeastern region of the United States (Figure 1). Spotted wilt disease was first observed in peanut growing regions of the southeastern in 1986 and became endemic by the early 1990's. Serious economic losses have been recorded by Georgia's peanut growers in the last few years (Figure 2).

Fig. 1: Symptoms of spotted wilt disease showing reduced pods, chlorosis and concentric ringspots on leaves of peanuts in Georgia

TSWV related yield losses have been reported in crops including pepper, peanut, and tobacco, with total losses estimated at $100 million in 1996 (Bertrand 1997, Pappu 1997). In 2000, between 25 to 50% infection due to TSWV were reported in tomato, tobacco, and pepper fields in North Carolina (Groves et al. 2002).

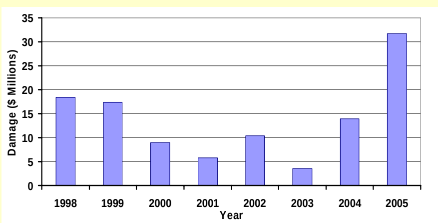


Fig. 2: Losses due to spotted wilt disease damage in Georgia peanut from 1998-2005

Western flower thrips and tobacco thrips are the major vectors of TSWV (Figure 3). Incidence and severity of tomato spotted wilt have been extremely variable in southeastern part of the US. The thrips populations are know to be sensitive to climatic variability and varying weather patterns. A spotted wilt risk index developed by scientists at the University of Georgia to assists growers with assessing the risk levels associated with production practices in order to avoid high-risk situations.

Objective

Climate variability and changing weather patterns could have significant impacts on the thrips population, volunteer plants and consequently on the severity of TSWV on peanut the southeast. The objective of this study was to examine the interactions between TSWV risk index and climate variability, and their effects on the tomato spotted wilt virus (TSWV) severity in peanut.

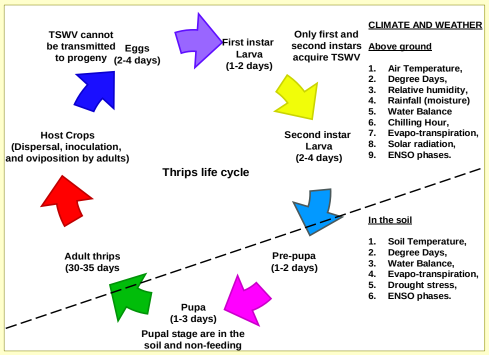


Fig. 3: A typical life cycle of thrips vector and environmental factors that might influence thrips population dynamics and spotted wilt severity in peanut.

Methods

This study was based on the on-farm surveys data conducted by scientists at the University of Georgia primarily for the development and validation of spotted wilt risk index (Brown, et al., 2005). Survey data used include for 1998, 1999, 2002, 2004 and 2005, with about 305 observations (Table 1).

Meteorological data were obtained from the Georgia Automated Environmental Monitoring Network based on nearest weather station to each field location.

Table 1: The La Niña and El-Niño episodes (blue and red colored respectively) are defined when the threshold is met for a minimum of 5 consecutive over-lapping seasons. Non colored represents the Neutral phase

ENSO	Year	SON	OND	NDJ	DJF	JFM	FMA
El-Niño	1997-8	2.4	2.5	2.5	2.4	2	1.4
La-Niña	1998-9	-1.1	-1.3	-1.5	-1.6	-1.2	-0.9
Neutral	2001-2	-0.1	-0.2	-0.2	-0.1	0.1	0.3
Neutral	2003-4	0.5	0.6	0.5	0.4	0.2	0.2
El-Niño	2004-5	0.9	0.9	0.8	0.6	0.5	0.3

Multiple regression analysis procedure was performed using square root transformed spotted wilt severity in SAS. Model selection criteria include;

- Akaike Information Criterion and Mallow's *CP* statistics,
- Coefficient of multiple determination (R^2),
- *F statistic*, and *t test* of estimated parameters $P \leq 0.05$

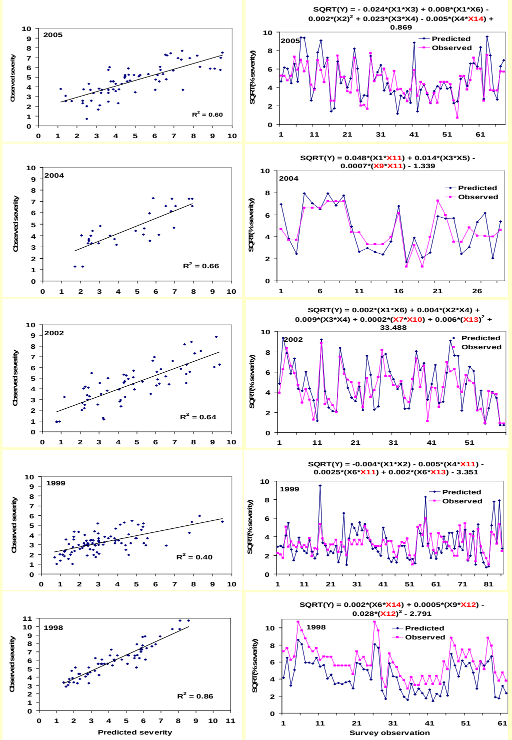
Code	Description of variable
X1	Variety index point
X2	Planting date index point
X3	Insecticide index point
X4	Row pattern index point
X5	Tillage index point
X6	Index total point
X7	Degree Day from January-1 until planting (56-84 °F)
X8	Degree Day from planting until flowering (56-84 °F)
X9	Degree Day from January-1 until flowering (56-84 °F)
X10	Total precipitation from January-1 until planting
X11	Total evapotranspiration from January-1 until planting
X12	Total water balance from January-1 until planting
X13	Average daily maximum temperature from March-1 until planting
X14	Average daily minimum temperature from March-1 until planting
X15	Average daily temperature from March-1 until planting

**Weather variables are represented with red; Y - SQRT (percent TSWV severity).*

Results

Best fitting model equation for TWSV severity in 1998, 1999, 2002, 2004 and 2005 explained approximately 86%, 40%, 64%, 66% and 60% respectively.

- Spotted wilt severity (%) was 13.8, 11.5, 28.2, 28.0, and 36.6 in 1998, 1999, 2002, 2004 and 2005 respectively
- Minimum temperature (X14) – had significant effects in 1998 (strong El-niño) and 2005 (mild El-niño).
- Water balance (X12) – had a significant effect in 1998.
- Maximum temperature (X13) – had significant effects in 1999 (La-Niña year) and 2002 (neutral year).
- Evapo-transpiration (X11) – had significant effects in 1999 and 2004 (neutral year).
- Degree day (X9) – had significant effects in 1998 and 2004.



Conclusion

The minimum daily temperature from March-1 until planting, had a significant effect on TSWV severity during the winter-spring El-niño year, while maximum daily temperature from March-1 until planting, had a significantly effect during the La-Niña and the neutral years. Further analysis and information from this study will facilitate the integration of localized weather and climate information into the existing TSWV risk index.

References

1. Bertrand, PF. 1997. 1996 Georgia Plant Disease Losses. *Univ. Ga. Coop. Ext. Serv.*, Athens, GA. **2**.Brown, SL, Culbreath, AK., Todd, JW., Gorbet, DW., Baldwin, JA., and Beasley, JP. 2005. Development of a Method of Risk Assessment to Facilitate Integrated Management of Spotted Wilt of Peanut. *Plant Disease* 89(4): 348-356., **3**. Pappu, HR. 1997. Management of emerging virus threats of crops: Impact of biotechnology in controlling tospoviruses. *Biotechnol. Dev. Monit.* 31:14-17., **4**. Groves, RL., Walgenbach, JF., Moyer, JW., and Kennedy, GG. 2002. The role of weed hosts and tobacco thrips, *Frankliniella fusca*, in the epidemiology of Tomato spotted wilt virus *Plant Dis.* 86:573-582.