Breeding Value of Host Plant Thrips Resistance for Reduced-Input Cotton Systems

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Introduction

- Thrips (Thysanoptera: Thripidae) management is an important component of cotton (*Gossypium hirsutum* L.) production systems on the Texas High Plains.
- Significant delays in crop maturity under heavy thrips pressure.
  - *Reduced cotton fiber quality and yield potential in severe scenarios.*
- Thrips management has become more complicated with the loss of synthetic aldicarb as an insecticide.
- Host plant resistance can be a valuable tool for mitigating thrips injury to cotton seedlings, especially in reduced-input and organic production systems.
- Plant breeders need a better understanding of genetic nature of thrips resistance and its utility in cultivar development
- **Objectives: Determine breeding value of thrips resistance in cotton through segregation analyses and heritability and gain from selection evaluations.**

Materials and Methods

- **Location:** Texas A&M AgriLife Research and Extension Center at Lubbock and Halfway, 2011-2014.
- **Evaluations Conducted:**
  - F_2 segregation analyses
  - Broad-sense heritability evaluations
  - Gain from selection evaluations
- **Segregation Analyses:** An interspecific F_2 population was evaluated in a greenhouse trial under elevated thrips pressure in 2011. Population was derived from *G. hirsutum* x *G. barbadense* cross ('CA 2266' x 'TX 110'). A field trial was also conducted in 2012 on another interspecific family ('07-7-1407CT' x 'Cobalt'). Individual plants were phenotyped at 4-5 true leaves using a visual thrips damage scale (1 = plant necrosis; 9 = no damage). Chi-square analyses were conducted to determine genetic segregation ratios.
- **Heritability Evaluations:** Five separate interspecific families were grown in a greenhouse evaluation under elevated thrips pressure. Parents and F_2 individuals were grown and phenotyped for visual thrips damage at 4-5 true leaves. Broad-sense heritability (H^2) estimates were conducted using variance components for each family. These evaluations were repeated at the field level in 2014, but abandoned due to severe glyphosate injury from non-target drift.
- **Gain From Selection Evaluation:** F_3 progeny from the aforementioned F_2 07-7-1407CT x Cobalt population in 2012 were planted in progeny rows in 2013. Individual plants from each row were phenotyped for visual thrips injury at 4-5 true leaves and means were calculated for each F_3 row. Actual gain from selection (G_s) was determined by selecting the top 1%, 5%, and 10% resistant F_2 individuals and subtracting their mean performance as rows in the F_3 from the overall F_3 population mean. G_s is expressed as a percentage of the overall F_3 population mean (Frey and Horner, 1955).

Results

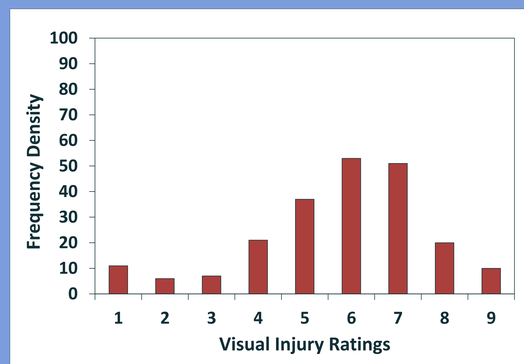


Fig. 1. Frequency density histogram of visual thrips injury ratings for an F_2 population derived from a CA 2266 x TX 110 cross – Lubbock, TX, 2011.

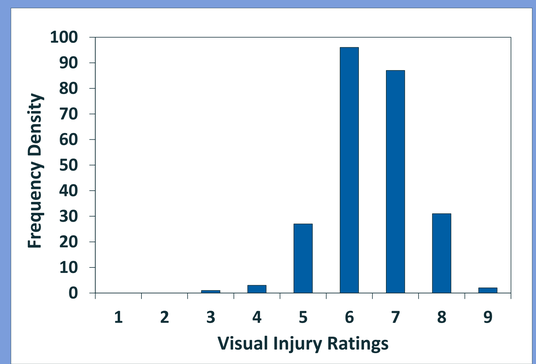


Fig. 2. Frequency density histogram of visual thrips injury ratings for a field F_2 population derived from a 07-7-1407CT x Cobalt cross – Lubbock, TX, 2012.

Table 1. Chi-square analyses of individual plant phenotypes against expected ratios in two interspecific F_2 populations – Lubbock, Texas, 2011-2012.

Family	Phenotypic Ratio	Observed			Expected			χ^2	*P*
		Tol	Inter	Susc	Tol	Inter	Susc		
CA 2266 x TX 110	3:1	81	---	24	164	---	54	58.70	< 0.05
(N = 218)	1:2:1	81	113	24	54	110	54	30.10	< 0.05
07-7-1407CT x Cobalt	3:1	33	---	1	185	---	62	138.01	< 0.05
(N = 247)	1:2:1	33	213	1	62	123	62	184.89	< 0.05

Table 2. Broad-sense heritability (H^2) estimates for resistance to thrips injury in five F_2 interspecific families – Lubbock, TX, 2013.

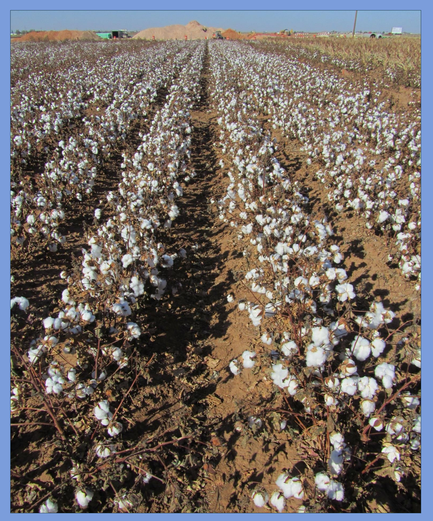
Family	H^2		
	Test 1	Test 2	Mean
	----------%----------		
CA 2266 x TX 110	36	45	41
CA 3027 x TX 110	71	29	50
07-7-519CT x Cobalt	66	60	63
07-7-1001CT x Cobalt	69	---	69
07-7-1407CT x Cobalt	78	56	67

Based on visual thrips injury ratings conducted at 4-5 true leaves.

Table 3. Thrips injury means for selected F_2, F_3 progeny, and F_3 base populations and actual gain from selection (G_s) – Lubbock, TX, 2012-2013.

Selection Intensity	Selected F_2 Mean	F_3 Progeny Mean	F_3 Pop. Mean	G_s
				---%---
1%	5.1	5.5	3.6	51
5%	4.6	4.4	3.6	22
10%	4.5	3.9	3.6	9

Based on visual thrips injury ratings conducted at 4-5 true leaves.



Discussion and Conclusions

- Non-discrete phenotypes for thrips resistance – **continuous phenotypic distribution suggests quantitative inheritance**
  - *Did not fit known single- or two-gene phenotypic ratios (partial data shown)*
- **Thrips resistance has a moderately high heritability in the broad sense (35-77%), but varies by family.**
- Phenotypic gain per cycle of selection ranged 9-51%, as selection intensity increased.
- Other field evaluations of advanced breeding lines have shown a 37% improvement in resistance to thrips feeding over a commercial standard (data not shown).
- **Significant genetic improvement can be achieved through visual selection, depending on selection intensity in a given cycle.**
- More research needed to elucidate value of resistant germplasm in reduced-input and organic production systems.
- *Frey, K.J. and T. Horner. 1955. Comparison of actual and predicted gains in barley selection experiments. Agron. J. 47:186-188.*