FIELD EVALUATION OF THRIPS RESISTANCE IN GLANDLESS AND GLANDED COTTON

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Abstract

Glandless cotton can be grown for glandless cottonseed free of toxic gossypol to be used as food and feed for ruminant animals. However, one of the most important limiting factors preventing its commercial production is its heavier insect damage than conventional glanded cotton. Thrips is the one of the most important insect pests in early growing season that may cause yield losses. In this study, 28, 29, 26, and 3 glandless cotton lines were compared with glanded control Acala 1517-08 and other lines in four replicated field tests each containing 32 genotypes, respectively. In the same field, 28 glanded commercial cultivars and 78 glanded breeding lines were compared with glanded 1517-08 and Acala 1517-99 in three other tests of 32 genotypes each. The experimental layouts allowed a comprehensive comparative analysis of thrips resistance within and between glandless cotton and glanded cotton. Overall, glandless cotton had lower field damages by thrips than glanded cotton, indicating that the glandless trait may serve as a genetic factor for suppressing thrips damage. As compared with Acala 1517-08 which represented one of the most thrips resistant genotypes among glandled cotton including commercial cultivars and breeding lines tested, glandless GLS and many selections from glandless germplasm were more resistant, while some were similar to Acala 1517-08, indicating that genetic factors other than the glandless trait also affect thrips resistance in cotton. The estimates for broad-sense heritability in thrips resistance were moderate, indicating that thrip resistance can be selected in breeding. Through a cross between Acala 1517-08 and Acala GLS, the thrips resistance has been transferred to many glandless lines.

Introduction

Glands containing toxic gossypol and terpenoid aldehydes are distributed in most tissues and organs of cotton (*Gossypium* spp.), which play an important role in the survival of cotton during the co-evolution between cotton and its insect pests. Glandless cotton that is devoid of gossypol can produce glandless seeds for human food and ruminant animal feed. The glandless mutant is conditioned by two recessive alleles, gl_2 and gl_3 (McMichael, 1960). Since the 1960s, extensive activities in breeding for glandless cotton had been conducted, resulting in release of numerous improved glandless germplasm. However, there was no commercial scale glandless cotton production in the U.S., and only intermittent breeding activities occurred until the late 1990s. One of the most important limiting factors preventing the commercial production of glandless cotton is its heavier insect damage than conventional glandless cotton.

Thrips is one of the most important insect pests in early growing season of cotton production. Even though cotton can suffer early season damage by thrips in growth and leaf area (Lei and Wilson, 2004; Sadras, and Wilson, 1998), damaged plants can recover well and yield may not be affected. High population thrips may significantly reduce cotton yields and earliness if untreated (Durant, 1982). But thrips controls are solely dependent on insecticide applications in many areas. To date, no commercial cotton cultivars have resistance to thrips (Cook et al., 2011). However, Genetic variation in thrips resistance exists among cotton species and genotypes within cultivated species (Ballard, 1951; Hawkins et al., 1965). Many lines in *G. arboretum* and *G. barbadense* are more resistant than Upland cotton (Stanton et al., 1992; Zhang et al., 2013). Under the intense thrip (*Frankliniella* spp.) pressure, breeding lines Arkot 8710, Arkot 8717, 8918, Arkot 9103, and Arkot 9111 were more resistant to thrips and had higher yield than ST 474 (Bourland and Benson, 2002a,b,c; Bourland and Jones, 2005). 'Tamcot Pyramid' and 'Tamcot Sphinx' had certain levels of thrips resistance (El-Zik and Thaxton, 1996; Thaxton and El-Zik, 2004). Cotton morphological traits may respond to thrips damage differently. For example, Chen and Chu (2006) found that cotton with Okra-leaf supported larger populations of western flower thrips, *F. occidentalis* (Pergande) as compared with normal-leaf cotton. Using reduction in leaf area as measurement for thrips resistance, Quisenberry and Rummel (1979) found that Pilose (H2) was highly resistant to thrips, while other morphological traits including glandless (gl2gl3) did not provide the plant with resistance. Glandless cotton was reported to be more susceptible to thrips in China (Fang et al., 1995).

Based on a general observation in a replicated test in 2012 where no apparent higher thrips damage was noticed in glandless cotton, this study was conducted to evaluate both glandless and glanded cotton for thrips resistance under the natural field infestation conditions.

Materials and Methods

A total of seven replicated field tests (13 Trial S, U, W, K, X, HQ and NV) were performed in Las Cruces, NM in 2013. All the tests were arranged using a randomized complete block design with 3 replications. The plot size was 1-row × 40 ft except for 2-rows × 40 ft for Trial HQ and NV. In Trial S, U and W, each contained 32 entries including 30 glandless genotypes, the glandless control Acala GLS (Dobbs and Oakley, 2000) the glanded control Acala 1517-08 (Zhang et al., 2011). The glandless germplasm lines were selections from obsolete germplasm released by other programs (e.g., Owen and Gannaway, 1995) and new glandless breeding lines developed from a cross between Acala 1517-08 and glandless Acala (Zhang et al., 2014). In Trial X, three glandless cotton (Acala GLS, STV GL and JACO), three Pima lines (11Q1286, 11Q1293 and PHY 76) and 24 glanded lines developed from New Mexico State University were compared with glanded Acala 1517-08 and PHY 375 WRF. In Trial K, 30 more new breeding lines developed from New Mexico State University were compared with Acala 1517-99 (Cantrell et al., 2000) and Acala 1517-08. In Trial HQ, 20 commercial transgenic cultivars from seed companies and 20 advanced breeding lines from the U.S. public breeding programs were compared with Acala 1517-99 and Acala 1517-08. In Trial NV, 12 commercial transgenic cultivars, three conventional (i.e., non-transgenic) cultivars and 15 conventional breeding lines were compared with Acala 1517-99 and Acala 1517-08. Five commercial cultivars were tested in both Trial HQ and NV.

Seeds were planted on May 8, 2013 at a seeding rate of 10 seed m-1 using a 4-row plot planter. Crop managements followed local recommendations except that no seed treatment and no insecticides were applied. On June 12, plots were screened for thrips damage based on a rating scale of 0 to 7 (Zhang et al. 2013):

0	no symptom
1	very light symptom, very small mottled dots on leaves
2	light symptom, small mottled appearance of leaf, no wrinkled leaf
3	moderate symptom, malformation and tearing of leaf
4	severe symptom, injury of apical meristem
5	very severe symptom, death of apical meristem, and severely wrinkled leaf
6	nearly dead, death of apical meristem, and defoliation
7	a dead plant

An analysis of variance was performed for each test and the least significant difference (LSD) was used to compare entry means with the controls. Segregation in glandless trait was observed in several lines and new breeding lines, but data from these entries were still included in the statistical analysis.

Results and Analysis

Analysis of variance

Of the seven replicated field tests (Table 1), five showed significant genotypic variation at the 0.01 level and one at the 0.10 level except for Trial X in which the variation in genotype was insignificant. Therefore, further analysis was performed (Table 2 to 8).

Table 1. Analysis of variance of thrips resistance in seven replicated trials, Las Cruces, NM, June 2013.

Trial	Source	df	MS	F	F0.10	F0.05	F0.01
S	Block	2	0.22				
	Genotype	31	0.68	4.68	1.47	1.64	2
	Error	62	0.15				
U	Block	2	0.41				
	Genotype	31	0.51	2.22	1.47	1.64	2
	Error	62	0.23				
W	Block	2	0.00				
	Genotype	31	0.54	1.56	1.47	1.64	2
	Error	62	0.34				
K	Block	2	2.80				
	Genotype	31	0.62	2.22	1.47	1.64	2
	Error	62	0.28				
X	Block	2	0.32				
	Genotype	31	0.92	1.21	1.47	1.64	2
	Error	62	0.76				
HW	Block	2	1.79				
	Genotype	31	0.63	2.01	1.47	1.64	2
	Error	62	0.31				
NV	Block	2	0.24				
	Genotype	31	0.89	4.34	1.47	1.64	2
	Error	62	0.20				

Comparison between glandless and glanded cotton

The results are shown Table 2 to 4. The thrips ratings ranged from 0.83 to 3 in Trial S in which the glandless control Acala GLS had lower rating than the glanded control Acala 1517-08, which almost reached the level of significance. Except for one selection (12G1009-1) that almost had significantly lower rating than Acala GLS, none had significant lower thrips damage. Three glandless selections and one glanded selection had significantly higher thrips damage than Acala GLS, one of which (from TX-8702 gl) incurred significantly higher damage than Acala 1517-08. Eight other lines had similar ratings to Acala 1517-08 or higher ratings. Interestingly, two selections (one glandless-12G1021-1 and another glanded-12G1021-7) from SA2455 had similar ratings, while the two glandless selections-12G1014-1 and 12G1014-2 had significantly lower ratings than the glanded- 12G1014-3 from the same source 10NM11-7.

In Trial U (Table 3), the thrips ratings ranged from 1 for Acala GLS and three other selections to 2.33 for 12G3001-2. Similarly to Trial S, Acala GLS had significantly lower thrips damage than Acala 1517-08, and the selection (12G2014-2) from SA2454 also had the lowest thrips damage. While 21 lines had similar ratings to Acala GLS, other 10 lines had significantly higher thrips damage, four of which were selections from SA1531. As compared with the glanded control Acala 1517-08, 13 glandless lines had significantly lower thrips ratings. Interestingly, the glandless selection 12G1031-1 had significantly lower rating than the glanded 12G1031-2 from the same source 10NM11-6. On the contrary, the glandless selection 12G3002-2 had significantly higher rating than the glanded 12G3001-1 and glandless 12G3002-3 from the same source 10NM11-17.

Notably, except for five selections, all others were derived from a cross between Acala 1517-08 and Acala GLS (i.e., with 10NM11 identifications). 19 selections had similar thrip resistance to the more resistant parent Acala GLS, while six had similar thrip ratings to the more susceptible parent Acala 1517-08.

The results for glandless selections from introduced exotic lines and Acala GLS are shown Table 4. The thrips ratings ranged from 1.17 for Acala GLS and a selection from French 86-1 to 3 for YL 7570. The six selections from Acala GLS had relatively higher ratings than Acala GLS, but the differences were insignificant. As compared to Acala GLS, 9 lines including two glanded genotypes (Acala 1517-08 and a selection from Acala 1517-99) had significantly higher ratings, but none had significantly higher ratings than Acala 1517-08 except for glandless YL 7570.

Table 2. Field evaluation of thrips resistance in glandless cotton, 13 Trial S, Las Cruces, NM, June 2013

Selection	Source	Rating
12G1027-1	Acala G8160	1.00
12G1027-2	Acala G8160	1.00
12G1012-1	Lambright GL-5	1.50
12G1017-1	TX-8702 gl	3.00
12G1006-1	TX-8703 gl	2.00
12G1006-2	TX-8703 gl	1.50
12G1006-3	TX-8703 gl	1.83
12G1010-1	TX-8704 gl	1.33
12G1010-2	TX-8704 gl	1.33
12G1007-1	TX-8705 gl	2.33
12G1007-2	TX-8705 gl	1.83
12G1007-3	TX-8705 gl	1.83
12G1032-1	SA2454	1.33
12G1021-1	SA2455	1.33
12G1021-7*	SA2455	1.00
12G1024-1	10NM11-2	1.50
12G1016-1	10NM11-4	1.00
12G1009-1	10NM11-5	0.83
12G1014-1	10NM11-7	1.00
12G1014-2	10NM11-7	1.00
12G1014-3*	10NM11-7	1.67
12G1003-1	10NM11-8	1.83
12G1030-1	10NM11-10	1.00
12G1001-1	10NM11-11	1.83
12G1001-2	10NM11-11	1.33
12G1001-3	10NM11-11	1.00
12G1029-1	10NM11-14	1.83
12G1026-1	10NM11-15	1.17
12G1013-1	10NM11-16	1.17
12G1004-1*	10NM11-18	2.00
Acala GLS	Acala GLS	1.33
Acala 1517-08*	Acala 1517-08	1.83
CV(%)		25.76
LSD0.05		0.62

*glanded

Table 3. Field evaluation of thrips resistance in glandless cotton, 13 Trial U, Las Cruces, NM, June 2013.

Selection	Source	Rating
12G2026-1	Lambright GL-5	2.17
12G2026-2	Lambright GL-5	2.17
12G3003-1	Lambright GL-5	2.00
12G3003-2	Lambright GL-5	1.83
12G2014-2	SA2454	1.00
12G2031-1*	10NM11-6	2.17
12G2031-2	10NM11-6	1.17
12G3005-1	10NM11-7	1.00
12G3005-2	10NM11-7	1.17
12G3005-3	10NM11-7	1.33
12G3005-4	10NM11-7	1.33
12G3005-5	10NM11-7	1.17
12G3005-6	10NM11-7	1.33
12G2030-1	10NM11-8	1.17
12G2024-1	10NM11-11	1.00
12G2024-2	10NM11-11	1.17
12G2023-1	10NM11-14	1.17
12G2023-4	10NM11-14	1.67
12G2025-1	10NM11-15	1.50
12G2025-2	10NM11-15	1.50
12G2025-3	10NM11-15	1.50
12G2025-4	10NM11-15	1.00
12G2025-6	10NM11-15	2.17
12G3001-1*	10NM11-17	1.67
12G3001-2	10NM11-17	2.33
12G3001-3	10NM11-17	1.33
12G2033-1	10NM11-18	1.17
12G2033-2	10NM11-18	1.50
12G2033-3	10NM11-18	1.83
12G3001-5	10NM11-27	1.50
Acala GLS	Acala GLS	1.00
Acala 1517-08	Acala 1517-08	1.83
CV		32.00
LSD0.05		0.78

*glanded.

Table 4. Field evaluation of thrips resistance in glandless cotton, 13 Trial W, Las Cruces, NM, June 2013.

Selection	Source	Rating
12G3030-3	10NM11-11	1.33
12G3033-1	10NM11-11	1.67
12Y1002-1	YL 7570	3.00
12Y1004-1	YL 7895	1.50
12Y1005-1	YL 9587	1.33
12Y1012-1	US F-12	1.33
12Y1013-1	8619-7 W-81	2.00
12Y1015-1	G8160	1.83
12Y1017-1	Gregg 45M	2.50
12Y1018-1	Acala 63-74	2.00
12Y1019-1	Acala 63-75	1.33
12Y1034-1	ISA BC1	2.17
12Y1026-1	ISA BC2	1.33
12Y1027-1	ISA BC3	1.67
12Y1033-1	Boy	1.83
12Y1035-1	GP 205	2.50
12Y1037-1	French 86-1	1.17
12Y1039-1	Acala 63-75	1.67
12Y1040-1	Acala GLS	1.33
12Y1042-1	Acala GLS	1.67
12Y1045-1	AcalaGLS	1.50
12Y1048-1	Acala GLS	1.50
12Y1048-2	Acala GLS	1.50
12Y1050-1	Acala GLS	1.67
12Y1058-1*	1517-99	1.67
12Y1058-2*	1517-99	1.83
12Y1058-3*	1517-99	2.33
12Y1058-4*	1517-99	1.67
Acala 1517-99	Acala 1517-99	1.50
JACO	JACO	2.00
Acala GLS	Acala GLS	1.17
Acala 1517-08	Acala 1517-08	2.00
CV		33.82
LSD0.05		0.96

*glanded.

A further comparison between glandless and glanded cotton was conducted (Table 5). Even though that the ANOVA showed insignificance for genotypes, the three glandless lines (Acala GLS, STV GL and JACO) had lower thrips ratings than most of the glanded lines, and the three Pima lines (PHY 76, 11Q1286 and 11Q1293) also had lower ratings.

Table 5. Field evaluation of thrips resistance in glanded and glandless cotton, 13 Trial K, Las Cruces, NM, June 2013.

Line	Entry	Rating
11Q1739-1	NM01	2.83
11Q1735-4	NM02	2.50
11Q1739-9	NM03	3.00
12G1001	NM04	2.67
12G1027	NM05	2.00
12H1006	NM06	2.50
12K1006	NM07	2.33
12W1090	NM08	2.33
12W1523	NM09	2.83
12W1525	NM10	3.17
12W2209	NM11	2.33
12W2220	NM12	2.17
12W2223	NM13	3.50
12W2226	NM14	2.50
12W2225	NM15	2.83
11Q1293	NM16	1.67
11Q1286	NM17	2.00
11Q1656	NM18	3.17
11Q1420	NM19	2.67
11Q197	NM20	1.83
11Q1572	NM21	1.67
11Q1455	NM22	2.00
11Q1295	NM23	1.67
11Q1475	NM24	1.50
11Q1467	NM25	2.00
12H1001	NM26	1.67
PHY 375 WRF	NM32	2.67
Pima Phy 76	NM27	1.50
STV GL*	NM29	2.00
JACO*	NM30	1.33
Acala GLS*	NM28	2.00
Acala 1517-08	NM31	2.00
CV		38.19
LSD0.05		1.42

*glandless.

Glanded cotton

Thrips damages were evaluated for new glanded lines developed from the New Mexico State University (Table 6). Once again, Acala 1517-08 had the lowest rating (1.67), and three other lines also had the same rating. 12W2336 had the highest rating, and it, together with 9 other lines had significantly higher thrips damage than Acala 1517-08.

Table 6. Field evaluation of thrips resistance in glanded cotton, 13 Trial X, Las Cruces, NM, June 2013.

Line	Entry	Rating
12W1778	13PYT31	2.33
12W1972	13PYT32	1.67
12W2055	13PYT33	2.67
12W2057	13PYT34	2.00
12W2063	13PYT35	2.17
12W2064	13PYT36	2.33
12W2109	13PYT37	1.67
12W2119	13PYT38	1.83
12W2137	13PYT39	2.33
12W2144	13PYT40	2.00
12W2166	13PYT41	3.17
12W2257	13PYT42	2.33
12W2259	13PYT43	2.33
12W2274	13PYT44	1.83
12W2275	13PYT45	2.67
12W2313	13PYT46	2.33
12W2323	13PYT47	2.50
12W2324	13PYT48	3.00
12W2325	13PYT49	3.00
12W2326	13PYT50	2.00
12W2327	13PYT51	1.83
12W2336	13PYT52	3.17
12W2339	13PYT53	1.67
12W2340	13PYT54	1.83
12W2337	13PYT55	2.67
12W2339	13PYT56	2.33
12W2387	13PYT57	2.00
12W2393	13PYT58	2.00
12W2404	13PYT59	3.00
12W2417	13PYT60	2.17
Acala 1517-99	CK1	2.33
Acala 1517-08	CK2	1.67
CV		23.16
LSD0.05		0.86

Commercial cultivars from major U.S. seed companies and advanced breeding lines from other breeding programs were further screened for thrips resistance (Table 7 and 8). As compared with Acala 1517-08 which had the lowest thrips ratings in the two tests (Trial HQ and NV), none had lower ratings; 18 lines had significantly higher ratings in Trial HQ and 12 had significantly higher ratings in Trial NV. The results further confirmed that Acala 1517-08 does carry certain level of thrips resistance. Notably, the lines (LA 17, LA 35RS, LA 1110017 and LA Blend) developed from Louisiana had similar thrips ratings.

The consistency in thrips evaluation can be gauged from the same genotypes tested in the same test or different tests. First, Acala 1517-08 was consistently rated lower in thrips damage in all the tests. Second, PHY 375 WRF was evaluated twice in Trial HQ, and both entries had significantly higher thrips ratings than Acala 1517-08. Similar results were obtained for the two entries of FM 9058 F in the same test. DP 1321 B2RF, FM 1944 GLB2, FM 2484 B2F, PHY 339 WRF, and PHY 375 WRF were tested in both Trial HQ and NV. All of them had higher thrips ratings than Acala 1517-08, three of which were significantly higher in both tests. PHY 375 WRF also was tested in Trial X and it also had high thrips ratings.

Table 7. Field evaluation of thrips resistance in glanded cotton, 13 Trial HQ, Las Cruces, NM, June 2013.

Genotype	Entry	Rating
Ark 0517	HQ05	3.83
Ark 0606	HQ03	3.00
Ark 0614	HQ04	2.50
DC F6 Bulk	HQ19	2.50
DP 0912 B2RF	NV02	2.33
DP 1050 B2RF	HQ07	3.00
DP 1219 B2RF	HQ08	2.33
DP 1321 B2RF	HQ06	2.33
DP 161 B2RF	WV01	2.83
FM 1944 GLB2	HQ12	2.50
FM 2484 B2F	HQ14	2.67
FM 8270 GLB2	HQ15	2.00
FM 9058 F	NV03	2.50
FM 9058 F*	HQ02	2.17
FM 9170 B2F	WV02	2.00
LA 17	HQ16	2.17
LA 35RS	HQ17	1.83
MD 10-6	HQ18	2.67
NGX 3306 B2RF	HQ20	3.00
NM 1301	RB28	2.67
NM 1302	RB29	3.50
NM 1303	RB31	2.83
PHY 339 WRF	HQ09	2.33
PHY 375 WRF	NV01	2.50
PHY 375 WRF*	HQ01	2.67
PHY 725 RF	NV04	2.33
PHY 755 WRF	WV03	2.83
PX 3122-40 WRF	HQ10	2.00
PX 4444-13 WRF	HQ11	2.17
ST 6448 GLB2	HQ13	2.67
Acala 1517-99	RB30	2.17
Acala 1517-08	CK	1.67
CV		22.15
LSD0.05		0.91

*tested twice under two different entry identifications.

Table 8. Field evaluation of thrips resistance in glanded cotton, 13 Trial NV, Las Cruces, NM, June 2013.

Cultivar	Entry	Rating
0043-28 -1	ML10	2.00
0043-28 -11	ML11	2.50
0043-28 Blend	ML12	2.33
Ark 0409-3	ML1	3.17
Ark 0409-7	ML2	3.17
Ark Blend	ML3	3.00
DP 1044 B2RF	NV1	2.50
DP 1321 B2RF	NV2	2.17
DP 393	ML16	2.17
FM 1944 GLB2	NV12	2.50
FM 2484 B2F	NV10	2.33
FM 2989 GLB2	NV11	1.83
FM 958	ML17	2.00
LA 1110004	ML7	nt
LA 1110017	ML8	1.83
LA Blend	ML9	1.83
NG 1511 B2RF	NV3	1.83
NG 4010 B2RF	NV5	2.33
NG 5315 B2RF	NV4	2.00
NM 12H1014	ML13	2.17
NM 12H2031	ML14	2.17
NM Blend	ML15	2.33
PD 05069	ML4	2.00
PD 05070	ML5	2.33
PD Blend	ML6	2.33
PHY 339 WRF	NV6	2.17
PHY 367 WRF	NV7	2.50
PHY 375 WRF	NV8	1.83
PHY 499 WRF	NV9	2.17
SG 105	ML18	1.67
Acala 1517-99	NV14	2.17
Acala 1517-08	NV13	1.67
CV		20.98
LSD0.05		0.74

nt, not tested.

Estimate of broad-sense heritability for thrips resistance

Based on the ANOVA results, broad-sense heritability for thrips resistance in six of the seven tests were estimated (Table 9). The estimates ranged from 0.36 to 0.79 with a mean of 0.59, indicating that 60% of the phenotypic variation in thrips resistance is determined by genetic factors. However, it should be noted that, coefficients of variation for the thrips rating were high, ranging from 21 to 38%. Similar results were reported by Zhang et al. (2013).

Table 9. Estimate of broad-sense heritability (H) for thrips resistance, Las Cruces, NM, June 2013.

Trial	Exp. design	H
S	RCBD, 32 lines, 3 reps, 1-row plot	0.79
U	RCBD, 32 lines, 3 reps, 1-row plot	0.55
W	RCBD, 32 lines, 3 reps, 1-row plot	0.36
K	RCBD, 32 lines, 3 reps, 1-row plot	0.55
X	RCBD, 32 lines, 3 reps, 1-row plot	0.18*
HQ	RCBD, 32 lines, 3 reps, 2-row plot	0.50
NV	RCBD, 32 lines, 3 reps, 2-row plot	0.77

*, not significant.

Summary

In this study, 28, 29, 26, and 3 glandless cotton lines were compared with glanded control Acala 1517-08 in Trial S, U, W and X (each containing 32 genotypes), respectively. Three, 2, 5 and 28 glanded genotypes in the respective tests were included for a comparative analysis. In the same field, 28 glanded commercial cultivars and 78 glandedbreeding lines were compared with glanded 1517-08 and Acala 1517-99 in Trial X, K, HQ and NV each containing 32 genotypes. The experimental layouts allowed a comprehensive comparative analysis of thrips resistance within and between glandless cotton and glanded cotton.

Our results showed that genetic variation existed within glandless cotton in all the three trials. Although most glandless lines had thrips resistance similar to the glandless control Acala GLS, some had higher ratings, similar to or higher (although insignificant) than the glanded control Acala 1517-08. Specifically, selections from TX-8702 gl, TX-8703 gl, TX-8705 gl (all in Trial S), and Lambright GL-5 (in Trial U) had higher ratings, while these from TX-8704 gl, SA2455, Acala G8160 (all in Trial S) and SA2454 (in Trial S and U) had lower ratings. Therefore, except for the glandless trait, other genetic factors affect thrips resistance.

Similarly, genetic variation in thrips resistance exists in glanded cotton (Trial K, HQ and NV) in that many new breeding lines and commercial cultivars had significantly higher thrips ratings than Acala 1517-08 and were therefore more susceptible to thrips. In fact, Acala 1517-08 represents the most thrips resistant genotypes among the glanded lines and cultivars tested.

In Trial S, U, W, and X that had both glandless and glanded lines, the mean thrips ratings for the two groups were 1.46 vs. 1.63, 1.45 vs. 1.89, 1.71 vs. 1.83 and 1.78 vs. 2.33. The glandless group had lower ratings in each trial. As a comparison, the means for glanded genotypes in Trial K, HQ and NV were 2.28, 2.52, and 2.23, respectively. Overall, the thrips damage was lower in glandless cotton than in glanded cotton. This is consistent with the difference between glandless selection(s) and a glanded selection in two F4 progeny 10NM11-6 (Trial U) and 10NM11-7 (Trial S). However, a glanded selection from 10NM11-17 had higher rating than one glandless one and was similar to another from the same progeny. A glanded selection from SA2455 also had similar rating to a glandless selection in the same source. The results confirm that glandless cotton is not more susceptible than glanded cotton if not more resistant.

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