

**ROOT-KNOT NEMATODE SCREEN OF
150 TEXAS RACE STOCK ACCESSIONS**

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Abstract

The southern root-knot nematode, *Meloidogyne incognita* race 3 (Kofoid & White) is a widespread pathogen of Upland cotton (*Gossypium hirsutum* L.) in the United States. Progress in the development of productive cultivars in root-knot infested soils is dependent upon the identification of germplasm sources containing genes conferring resistance and/or tolerance this pest. The objective of this research was to screen 150 accessions from the Texas Race Stock collection previously uncharacterized for their reaction to the root-knot nematode. This was done in a sick plot nursery by rating the degree of galling present. Of the 150 accessions evaluated, 146 were rated at maturity using an indexed scoring system ranging from 0 (no galling present) to 5 (severe galling). The range of galling scores was from 1.7 – 5.0 with a mean of 3.75. The average gall score of the resistant check, Stoneville LA887, was 2.04. Twenty-four accessions had galling index scores of less than 3 with two having index scores less than the resistant check. A total of 15 percent of the accessions flowered during the traditional growing season at the Red River Research Station. Two of the flowering accessions had galling scores not significantly different from the resistant check. These are from Thailand and India, countries outside the center of diversity for Upland cotton, indicating that useful diversity can arise outside of germplasm centers.

Introduction

The southern root-knot nematode, *Meloidogyne incognita* race 3 (Kofoid & White) Chitford, is one of the most prevalent nematode pests of Upland cotton (*Gossypium hirsutum* L.) in the United States. Typically recognized by the presence of root galls, which the pest induces, it can negatively influence yield by affecting water and nutrient transport in plants (Orr and Robinson, 1984) and by increasing the incidence and severity of the fungus *Fusarium oxysporum* f. sp. *vas infectum* (Atk.) Sund. & Hans., the causal organism of fusarium wilt in cotton (Martin et. al., 1956).

While numerous control options for the root-knot nematode exist, including cultural and chemical methods, host plant resistance is available and has been used successfully in a few cases (e.g. Stoneville LA887, Paymaster 1560, and CPCSD Acala Nem-X). Several breeding lines (e.g. Auburn 623 RNR, M-315 RNR, Auburn 634 RNR, LA RN1032, LA 434-RKR) with resistance or tolerance to the root-knot nematode have also been developed (Jones et. al. 1988; Shepard, 1974; Shepard et. al. 1996). Most of these resistant germplasm lines derive their resistance from a wild *G. hirsutum* accession from Mexico, Wild Mexican Jack Jones and/or the obsolete Fusarium-wilt resistant cultivar Cleve-wilt 6-8.

The development of either root-knot resistant varieties or germplasm, however, begins with the identification of desirable variation. Several studies have looked for resistance in commercial cultivars, e.g. Robinson et. al. (1999) but most are highly suitable hosts except for the 3 varieties mentioned above. Screenings of the wild accessions of cotton for desirable

root-knot nematode resistance have also been conducted. One of the most extensive was conducted by Shepherd (1983) who found 18 resistant accessions after evaluating 471 photoperiodic primitive cottons. McCarty et. al. (1998) evaluated 79 primitive accessions of cotton that had been converted to day neutrality. All accessions were either as susceptible as the susceptible check or only moderately resistant. Given the general consensus that Mexico and Central America are the likely center of origin of *G. hirsutum*, Robinson and Percival (1997) evaluated 46 *G. hirsutum* accessions from several southern states of Mexico. They reported that 5 of these had resistance equal to Cleve-wilt 6-8 but not as good as Auburn 623 RNR. Similar to Shepard's (1983) results, these 5 accessions were from Mexico. Given the relative paucity of germplasm accessions that are resistant to root-knot nematode, the objective of this research was to evaluate previously untested accessions of the Texas Race Stock Collection for their degree of root galling as induced by *M. incognita*.

Materials and Methods

A total of 150 accessions from the Texas Race Stock were requested from the Cotton Crop Germplasm Research Unit (College Station, TX). These are listed in Table 1. Seed were planted, along with a resistant commercial cultivar check, Stoneville LA887, on June 1, 2000 at the LSU Agricultural Center Red River Research Station in Bossier City, LA. Design was a RCB with 2 replications. The single row plots were 6m long, spaced 1.02m apart, and with an intrarow seed spacing of 15cm. Plots of the resistant check were planted every 10 rows. The field was a root-knot nematode sick plot nursery developed by growing a highly root-knot susceptible kenaf variety the previous year. Standard cultural and pest management procedures, as per Louisiana Cooperative Extension Service recommendations, were followed except that no nematicides were used.

Root-knot gall ratings were taken on two dates, November 17 for replication 1 and December 5 for replication 2. Ten plants per row were evaluated where possible. Visual assessment of the degree of galling was taken using a 0-5 scale with 0 = no galls present, 1 = 1-2 galls present, 2 = 3-5 galls present, 3 = 6-20 galls present, 4 = 21-40 galls present, and 5 = more than 40 galls present. Data were analyzed according to a randomized complete block design using PC-SAS 8.1 (SAS Institute, Cary, NC) and means were separated using the Waller-Duncan K-ratio t Test.

Boll samples were collected from mature bolls on December 6 in replication 2. Seedcotton was ginned on a 10-saw laboratory gin and lint percentage determined by dividing lint weight by seedcotton weight.

Discussion

Of the 150 Texas Race Stock (TX) accessions planted, 146 germinated. Mean root-knot nematode galling scores for these accessions and the resistant check are given in Table 1. The average gall score of all TX accessions was 3.75 compared to the average gall score of 2.04 for the resistant check, Stoneville LA887. The distribution of gall scores is given in Table 2.

The analysis of variance for root-knot galling scores is given in Table 3 and indicated a significant difference between the accessions. Ten TX accessions (TX-1028, TX-1483, TX-1437, TX-1355, TX-2311, TX-2324, TX-695, TX-2362, TX-1585, and TX-1240) had gall scores not significantly different than the resistant check. Two of these, TX-1028 and TX-1483 had average gall scores lower than the resistant check. Notably, these accessions are from geographically diverse regions, a contrast with the results of Shepherd (1983) and Robinson and Percival (1997).

Of the 146 TX accessions that germinated and grew during the normal cotton production season for Bossier City, LA, 15 percent were non-photoperiodic and went on to produce flowers and bolls with mature seed.

Several of these accessions were as resistant as the resistant check to the root-knot nematode as measured by their degree of root galling. (Table 4). Country of origin and lint percentages for these 22 accessions is given in Table 4.

Phenotypically, the 146 Texas Race Stock accessions were a diverse group for plant height, stem pubescence, leaf pubescence, leaf shape and size, and general plant architecture (data not presented). Of the non-photoperiodic accessions, three stand out as being potentially useful, TX-2311, TX-2362, and TX-1585 (TX-2324 is excluded since it is hirsute). All are close fruiting, of medium height, and nectaried.

Summary

The Texas Race Stock collection is a potentially valuable source of new germplasm for use in cotton improvement. Of 150 accessions tested from this collection for root-knot nematode resistance, 146 germinated and were evaluated for galling severity. Ten accessions were found to have galling scores statistically equivalent to the resistant check, Stoneville LA887. A majority of the accessions were photoperiodic but three nonphotoperiodic accessions, TX-2311, TX-2362 and TX-1585 were found to be as resistant as the resistant check.

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Table 1. Root-knot gall scores of 150 Texas Race Stock Accessions.

Country	TX	Rep 1	Rep 2	Average
Afghanistan	1305	2.8	3.0	2.9
Antigua & Barbuda	1837	3.9	4.6	4.3
Australia	2315	2.8	4.6	3.7
Bahamas	804	3.6	3.0	3.3
	806	3.4	3.7	3.6
Barbados	1876	1.8	4.7	3.3
	1877	4.3	2.1	3.2
Belize	765	4.0	5.0	4.5
	782	1.9	4.8	3.4
	785	5.0	5.0	5.0
	791	4.3	4.1	4.2
	1442	2.0	5.0	3.5
Brazil	1028	1.6	1.8	1.7
	1142	2.9	4.8	3.9
	1145	3.4	5.0	4.2
	2420	4.5	4.5	4.5
	2437	4.6	2.8	3.7
China (PRC)	2067	3.3	4.8	4.1
	2308	2.5	3.3	2.9
Columbia	1020	4.0	3.0	3.5
	1058	3.5	2.5	3.0
	1062	3.0	3.8	3.4
	1064	2.8	2.8	2.8
	1068	4.4	4.9	4.7
Costa Rica	1375	1.7	4.9	3.3
	2116	2.7	3.4	3.1
Cuba	801	4.8	4.7	4.8
	803	4.3	3.8	4.1
	902	3.9	4.5	4.2
Dominican Republic	1555	4.9	4.5	4.7
	1374	4.3	3.2	3.8
	911	2.5	3.5	3.0
	1260	2.9	4.4	3.7
	1573	2.9	4.8	3.9
	1579	4.3	5.0	4.7
	1825	4.3	4.9	4.6
El Salvador	380	4.9	4.2	4.6
	390	4.9	4.6	4.8
Ethiopia	1150	3.5	4.3	3.9
France (FWI)	1613	4.2	4.5	4.4
	1629	3.1	4.0	3.6
	1803	3.0	3.8	3.4
	1839	4.5	2.9	3.7
	1842	4.3	3.9	4.1
Ghana	1259	3.1	4.8	4.0
Grenada	853	3.3	2.7	3.0
	856	4.3	4.9	4.6
	907	4.4	3.5	4.0
Guatemala	81	1.7	5.0	3.4
	86	1.4	4.2	2.8
	145	4.7	4.8	4.8
	163	3.2	4.8	4.0
	166	4.8	3.4	4.1
	168	2.6	4.2	3.4
	179	4.5	4.3	4.4
	185	3.1	4.6	3.9
	210	3.0	4.7	3.9
Haiti	1581	3.0	4.4	3.7
	1585	3.3	1.7	2.5
	1588	4.7	3.7	4.2
	1593	1.9	4.3	3.1
	1601	3.5	5.0	4.3
Honduras	695	2.4	2.2	2.3

	699	3.5	4.2	3.9	United States	1136	2.4	3.3	2.9
	706	3.7	3.4	3.6		1240	1.2	3.9	2.6
	708	4.8	4.9	4.9		1277	2.1	4.5	3.3
	1050	2.4	4.4	3.4		1353	2.8	5.0	3.9
India	1258	3.4	5.0	4.2		1355	2.4	2.1	2.3
	1304	5.0	5.0	5.0		2295	4.3	4.2	4.2
	2324	2.0	2.6	2.3	U.S. Virgin Islands	986	4.4	3.0	3.7
Iran	1437	1.7	2.7	2.2		1237	3.7	4.3	4.0
Iraq	1215	0.9	5.0	3.0	Unknown	1030	3.3	5.0	4.2
Ivory Coast	1326	3.4	4.2	3.8		1033	3.1	3.0	3.1
Jamaica	2222	2.2	4.5	3.4	Uzbekistan	2391	2.2	3.7	3.0
	2230	2.8	5.0	3.9		2392	5.0	5.0	5.0
	2231	3.9	4.3	4.1	Venezuela	1076	3.0	3.8	3.4
	2237	3.0	4.6	3.8		1085	4.0	4.7	4.4
Mali	1463	3.1	4.0	3.6		1242	3.2	3.8	3.5
Malta	2410	3.1	2.4	2.8		1288	2.1	4.5	3.3
Mexico	46	5.0	3.9	4.5		1483	1.6	2.4	2.0
	51	4.7	4.5	4.6		1511	4.5	2.7	3.6
	128	4.4	4.8	4.6	Zambia	2350	4.9	5.0	5.0
	143	3.2	5.0	4.1	Resistant check	LA887	1.8	2.2	2.0
	161	4.8	5.0	4.9					
	172	4.4	4.2	4.3					
	189	4.9	2.4	3.7					
	192	3.7	3.2	3.5					
	252	5.0	5.0	5.0					
	256	4.5	4.9	4.7					
Netherlands (NA)	2205	3.7	4.6	4.1					
	2207	3.9	4.3	4.1					
	2218	3.8	4.8	4.3					
Nicaragua	1376	3.7	3.0	3.4					
	1385	4.4	3.5	4.0					
	1389	2.3	3.7	3.0					
	1429	2.7	3.5	3.1					
Nigeria	1424	4.7	4.8	4.8					
Panama	1314	3.8	4.6	4.2					
	1315	3.5	n.d.	3.5					
Paraguay	2354	2.4	4.3	3.4					
	2357	2.8	4.3	3.6					
	2362	2.2	2.6	2.4					
	2365	3.4	3.9	3.7					
	2368	4.3	4.2	4.3					
	2373	3.8	4.9	4.4					
Portugal	867	1.7	4.1	2.9					
Russia	2318	4.8	4.8	4.8					
	2320	3.6	3.6	3.6					
Saint Lucia	1296	4.3	5.0	4.7					
St. Chris & Nevis	1373	2.9	4.3	3.6					
	1838	n.d.	3.5	3.5					
St. Vincent & Grenadine	1866	4.6	4.9	4.8					
Sudan	680	4.8	4.1	4.5					
Surinam	1034	4.4	5.0	4.7					
Thailand	2311	3.6	0.9	2.3					
	2313	5.0	4.8	4.9					
Trinidad & Tobago	2122	5.0	5.0	5.0					
	2130	2.3	3.2	2.8					
	2133	4.3	2.4	3.4					
	2171	2.0	3.5	2.8					
	2185	2.8	2.7	2.8					
U.K. (BWI)	994	4.8	1.6	3.2					
	2288	4.1	2.8	3.5					
U.K. Virgin Islands	1367	3.1	3.4	3.3					
	1369	2.1	3.3	2.7					
	1370	4.7	4.5	4.6					
	1371	4.6	5.0	4.8					

Table 2. Rook-knot gall score distribution.

Gall score	Number of accessions
0-1	0
1-2	1
2-3	23
3-4	64
4-5	58
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Avg. gall score all TX accessions	3.54
Stoneville LA887 gall score	2.04
(resistant check)	

Table 3. Analysis of variance of 146 Texas Race Stock accessions and resistant check for galling index as induced by the root-knot nematode.

Source	Df	Mean Square	F
Model	147	19.259	20.45***
Accession	146	18.365	19.50***
Rep	1	193.023	204.94***
Error	3115	0.942	

*** P<0.001.

Table 4. Gall scores and lint percentages of non-photoperiodic TX accessions evaluated for root-knot nematode resistance.

Accession	Country	Gall Score	Lint%
LA887	United States	2.04	40.80
TX-2311	Thailand	2.25	32.69
TX-2324	India	2.30	34.36
TX-2362	Paraguay	2.40	32.43
TX-1585	Haiti	2.50	30.03
TX-2410	Malta	2.75	26.41
TX-2308	China (PRC)	2.90	31.35
TX-1305	Afghanistan	2.90	33.95
TX-1215	Iraq	2.95	29.77
TX-2391	Uzbekistan	2.95	33.57
TX-2354	Paraguay	3.35	40.30
TX-2357	Paraguay	3.55	36.90
TX-2320	Russia	3.60	26.45
TX-2365	Paraguay	3.65	39.09
TX-2315	Australia	3.70	34.81
TX-1326	Ivory Coast	3.80	38.07
TX-2368	Paraguay	4.25	38.72
TX-2373	Paraguay	4.35	38.02
TX-380	El Salvador	4.55	13.03
TX-2318	Russia	4.78	28.81
TX-2313	Thailand	4.90	16.34
TX-1304	India	5.00	34.25
TX-2392	Uzbekistan	5.00	35.49