Sources of Resistance to the Jassid (*Empoasca kerri* Pruthi), Thrips (*Frankliniella schultzei* (Trybom)) and Termites (*Odontotermes* sp.) in Groundnut (*Arachis hypogaea* L.)

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ABSTRACT

Field screening was carried out to identify sources of resistance to three groundnut pests. A total of 1,000 genotypes of groundnut were screened for resistance to the jassid (*Empoasca kerri* Pruthi), 2,700 for resistance to the thrips (*Frankliniella schultzei* (Trybom)), and 530 for resistance to pod scarifying termites (*Odontotermes* sp.). Genotypes with multiple resistance to these pests were identified from the 3 years field screening trials and some of them have been used in the breeding program at ICRISAT.

Key Words: Jassid, thrips, termites, groundnut, *Arachis hypogaea* L., multiple resistance.

Groundnut plants in India are attacked by over 70 species of insects. Those of economic importance include the jassid, *Empoasca kerri;* thrips, *Frankliniella schultzei;* and termites, *Odontotermes* sp. (1,2,3). Insecticides are routinely recommended for their control but, if genotypes resistant to these insects are found their use will reduce the dependence on insecticides. Although there are moderate levels of resistance to *Empoasca fabae* Harris and *Frankliniella fusca* Hinds (5,6,7,9,10), resistance to pod scarifying termites has not been recorded so far. However, resistance to southern corn rootworm *Diabrotica undecimpunctata howardi* Barber which damages the pods is known (6,7). This paper reports the results of field screening for resistance to *E. kerri, F. schultzei* and *Odontotermes* sp.

Materials and Methods

The plant material was obtained from the Genetic Resources Unit (GRU) of International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) which maintains a collection of groundnut germplasm from many countries. Most accessions were phenotypically uniform, but two accessions, ICRISAT Groundnut Germplasm (ICG) number 5043 and 5045 were supplied as mixtures with different testa colours. They were separated into tan (T) testa and deep purple (DP) testa types. No independent ICG numbers have been allotted to them by the GRU of ICRISAT.

All rainy season trials (June-October) were conducted under rainfed conditions. Postrainy season trials (December-April) were conducted under irrigation.

The genotypes were grouped into 3 growth habits - virginia runner (VR), virginia bunch (VB), and spanish bunch (SB). Commonly grown cultivars - TMV2, Robut 33-1 and M13 were used as checks for the SB, VB, and VR genotype groups, respectively.

Jassid screening:

One thousand genotypes were screened under moderate to heavy jassid infestation during the 1978,1981, and 1982 rainy seasons (June-October). In 1978, groundnut germplasm was sown in single 4 m rows which were replicated thrice. The accessions selected from the 1978 screening were sown in 12 m plots with 3 replications in 1981 and 1982 using cowpea plants (*Vigna unguiculata* cv C152) as an infestor crop. Row to row spacing was 0.75 m and plant to plant spacing was 0.15 m. One row of cowpea was sown alternating every four rows of groundnut. They were infested with laboratory-bred jassids, when the crop was 2 weeks old. In 1981, we distributed 5,000 jassids and in 1982, 10,000 jassids, throughout the field. Cowpea stems were cut in August and they were distributed evenly throughout the field. Jassids quickly infested the groundnut plants and ensured adequate screening.

Scoring was carried out in September because that is when jassids were most numerous. In the 1978 trial, we recorded the number of jassid nymphs on three young leaves of the main branch from each of five plants in a row. In the 1981 and 1982 trials, we also recorded the percentage of yellowed foliage in addition to the number of jassid nymphs on five plants.

Thrips screening:

Infestation by *F. schultzei* was high in both rainy and postrainy seasons, facilitating the screening of a larger number of germplasm lines (approximately 2,700) from 1978 to 1983.

Screening was carried out against *F. schultzei,* and not against *Scirtothrips dorsalis* Hood because the former is the major vector of bud necrosis disease caused by tomato spotted wilt virus (4,8). Feeding by *F. schultzei* adults and nymphs results in the development of distinct scars on the upper surface of young leaves. The peak infestations occur in August and September in the rainy season and January and February in the postrainy season. In the 1981 and 1981-82 postrainy season trials, the injury symptoms on the single most damaged leaflet/plant in ten randomly selected plants of each accession was rated on a 1-9 scale where 1 represents no injury, and 9 represents heavy scarring of the leaflet and distortion of margins (10,11). From 1981 to 1983, the percentage of leaflets showing thrips injury in five plants in a row was used as the criterion for measuring susceptibility (7).

Termites, *Odontotermes* sp. screening:

Five hundred and thirty lines was screened against pod scarifying termites in the 1981, 1982, and 1983 rainy seasons in a termite infested area. The termite infestation was initially uneven in this area, so a more uniform and dense infestation was induced by evenly distributing large numbers of winged adults collected from light traps during the onset of the monsoon rains. Subsequent cultivations were shallow and all operations were carried out in the afternoon to reduce the mortality of foraging termites which come above ground in the morning. During the hot summer months when food (grasses, weeds, etc.) became scarce, sawdust at the rate of 100 sacks/ha was spread over in the field to supplement the termites' food supply.

In the first week of July, the cultivars were sown in 12 m plots replicated thrice. The spacing between rows was 0.6 m and between plants 0.15 m. Termite damage (scarification) to the pod was pronounced on mature pods and severe on pods harvested about one month after the normal harvest period in October. Therefore, the crop was harvested in November. Pod damage was rated by two methods: percentage of shell area scarified, rated on a 1-9 scale where 1 represented no scarification, and 9 represented scarification of the entire shell and percentage of pods showing termite damage.

Results and Discussion

Jassids

The data refer only to most resistant cultivars. A complete list of the accessions screened can be obtained via the authors from the report of progress of work at ICRISAT. Jassid resistant cultivars (Table 1) can be grouped into 4 categories: (1) cultivars such as NC Ac 2214, NC Ac 2240 (DP) and NC Ac 2230 that showed high resistance to jassid infestation, (2) cultivars such as NC Ac 2242, NC Ac 2243 (DP), NC Ac 2232, NC Ac 2243 (T), NC Ac

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489, NC Ac 1705 and NC Ac 2462, M13 and Gujarat Narrow Leaf which were moderately jassid infested, ranging from 9-32 nymphs per 5 plants, but showed very low percentages of yellowed foliage indicating resistance to yellowing symptoms, (3) cultivars such as NC Ac 2666, NC Ac 1337, NC Ac 17888 and NC Ac 1741 that had an equivalent number of jassid nymphs as in (2) but a higher percentage of yellowed foilage, and (4) cultivars such as Robut 33-1 and TMV2 which showed susceptible reactions. Since percentage of yellowed foliage is an important criterion of resistance, only cultivars in the first two groups should be used in breeding programs.

Table 1. Sources of resistance to the jassid *Empoasca kerri*

Cultivars	1978 trial	1981 trial		1982 trial		
	No.of nymphs/ 5 plants	No.of nymphs/ 5 plants	Yellowing (%)	No.of nymphs/ 5 plants	Yellowing (%)	Level of resistance
NC Ac 2214	1	2	0.2 (2.0)	2	0.0 (0.6)	R
NC Ac 2232	2	1	0.0 (0.6)	17	0.1 (2.0)	R
NC Ac 2243 DP	4	2	0.1 (1.5)	9	0.7 (4.4)	R
NC Ac 2240 DP	2	2	0.7 (3.3)	4	2.0 (8.0)	R
NC Ac 2230	3	2	0.4 (3.1)	2	0.1 (1.2)	R
NC Ac 2242	3	1	0.2 (1.3)	17	0.2 (2.5)	R
Gujarat Narrow Leaf Mutant	NT	NT	NT	16	1.3 (4.8)	R
NC Ac 2243T	NT	1	0.2 (2.0)	20	0.0 (0.6)	R
NC Ac 2144	NT	10	1.7 (7.1)	34	3.5 (10.0)	MR
NC Ac 1705	NT	6	0.4 (3.4)	32	3.7 (11.0)	MR
NC Ac 489	8	5	1.0 (5.2)	33	11.7 (19.3)	MR
NC Ac 2666	7	9	1.5 (6.8)	42	9.0 (16.0)	MR
NC Ac 343	7	3	2.0 (7.6)	26	7.0 (13.3)	MR
NC Ac 2142	NT	9	2.3 (8.7)	48	5.0 (12.5)	MR
NC Ac 1337	9	9	2.7 (8.9)	39	11.7 (19.3)	MR
NC Ac 2700	8	8	4.0 (9.4)	58	16.0 (22.8)	MR
NC Ac 406	7	12	1.3 (5.2)	NT	NT	
NC Ac 17888	NT	6	3.3 (9.7)	32	8.0 (16.4)	MR
NC Ac 1741	NT	NT	NT	21	8.0 (16.0)	MR
NC Ac 785	NT	NT	NT	17	4.0 (10.9)	MR
M13 (RC)	9	9	10.0 (18.0)	15	8.0 (16.4)	MR
TMV2 (SC)	16	20	40.0 (39.1)	103	44.0 (41.2)	S
Robut 33-1 (SC)	12	14	35.0 (35.0)	34	33.3 (34.2)	S
Mean	6.8	6.6	(9.45)	28.5	(14.1)	
SE	±0.9	±1.8	±(2.5)	±7.5	±(3.1)	
CV %	27.7	47.0	(45.7)	45.7	(38.5)	

( ) = arcsine transformed values, RC = Resistant Check, SC = Susceptible Check.

R = Resistant, MR = Moderately resistant, S = Susceptible, NT = Not tested.

DP = Deep purple testa, T = Tan testa.

Thrips

Seven accessions consistently showed a low damage rating or a low percentage of damaged foilage by thrips, i.e. NC Ac 2242, NC Ac 2214, NC Ac 2243 (T and DP), NC Ac 2240 (DP), NC Ac 2232 and NC Ac 2230 had a consistently low rating for thrips damage (Table 2). Others, i.e. NC Ac 1741, NC Ac 2142, NC Ac 2144, NC Ac 343, NC Ac 1705, NC Ac 2154, NC Ac 2462 and NC Ac 2460 showed moderate levels of injury.

Termites

The most resistant accessions were NC Ac 2243 (T and DP), NC Ac 2240 (T and DP), and NC 343 (Table 3). Other accessions, i.e. NC Ac 10033, FESR 386, NC Ac 2142, NC Ac 17888, NC Ac 2242, NC Ac 2230, NC Ac 1705 and M13 also showed substantially lower damage than the standards (i.e. Robut 33-1 and TMV 2).

Table 4 summarizes the reaction of selected cultivars to all three pests, and gives additional data on growth habit, days to 50% flowering and yield potential. Even though most cultivars with high levels of resistance to more than one pest were poor yielders compared to standard cultivars, and therefore unsuitable for commercial cultivation, they are of potential use in a breeding program. Accessions NC Ac 343, NC Ac 17888, M13, NC Ac 10033, NC Ac 1113, and NC Ac 2462 were good yielders and had a moderate level of resistance to one or all pests. These could be suitable for commercial cultivation after further testing. The cultivar NC Ac 343 is unique in being resistant to thrips, jassids, pod scarifying termites, southern corn root worm, *Heliothis zea* Bodie and mites *Tetranychus urticae* Kock (7,8). It is also field-resistant to bud necrosis disease (ICRISAT Annual Report, 1984, p. 204) and has a high yield potential.

Table 2. Sources of resistance to thrips, *Frankliniella schultzei.*

Cultivar	% Damaged leaflets			Injury rating on 1-9 scale***		Level of resistance**
	1981	1981-82*	1982-83	1980-81*	1981	
NC Ac 2242	4.3 (12.0)	3.0	5.5 (13.5)	4.0	2.2	R
NC Ac 2214	5.7 (13.8)	2.1	4.9 (12.8)	2.9	2.3	R
NC Ac 2243 T**	5.4 (13.5)	2.1	4.9 (12.8)	2.9	1.9	R
NC Ac 2243 DP**	7.8 (16.1)	2.2	4.8 (12.7)	2.1	2.1	R
NC Ac 2240 T	8.2 (16.4)	9.0	4.0 (11.5)	5.4	2.4	MR
NC Ac 2240 DP	NT**	2.0	NT	NT	NT	R
NC Ac 2232	9.0 (17.1)	6.4	4.4 (12.6)	3.6	2.8	R
NC Ac 2230	7.0 (15.3)	5.3	5.8 (13.9)	3.6	2.3	R
NC Ac 1741	NT	NT	7.5 (15.8)	4.1	NT	MR
NC Ac 2142	8.3 (16.7)	4.8	8.2 (16.4)	3.1	3.2	MR
NC Ac 2144	8.5 (16.8)	7.2	5.8 (13.9)	3.0	2.9	MR
NC Ac 7481	NT	9.3	14.0 (21.9)	2.1	NT	MR
NC Ac 343	9.4 (18.0)	5.6	6.8 (15.1)	3.5	2.8	MR
NC Ac 1705	8.3 (16.6)	NT	5.4 (13.4)	5.5	2.4	MR
NC Ac 2154	NT	4.8	7.8 (16.0)	6.2	3.0	MR
NC Ac 2462	9.7 (17.9)	13.4	8.7 (17.1)	6.2	NT	MR
NC Ac 2460	NT	11.7	10.6 (19.0)	7.2	3.6	MR
M13 (RC)**	12.6 (20.6)	18.6	13.1 (21.1)	6.2	6.0	S
TMV2 (SC)**	26.5 (30.8)	18.8	17.1 (24.2)	7.8	5.8	S
Robut 33-1 (SC)	16.7 (24.0)	13.4	11.3 (19.6)	6.2	6.0	S
Mean	(17.7)		(15.9)		3.1	
SE	±(1.64)		±(1.21)		±0.41	
CV %	(16.02)		(13.16)		24.02	

( ) = arcsine transformed values

* = non replicated trials with 12 m plots

** = As in table 1.

*** = Injury rating on 1-9 scale, 1 = no injury and 9 = distortion of leaflets.

R = Resistant; MR = Moderately resistant; S = Susceptible

Table 3. Sources of resistance to termites *Odontotermes* sp. causing pod scarification.

Cultivar	Season 1981		1982		1983		
	Scarified pods (%)	Injury rating (1-9 scale)**	Scarified pods (%)	Injury rating (1-9 scale)	Scarified pods (%)	Injury rating (1-9 scale)	Level of resistance
NC Ac 2243 T*	2.4 (8.2)	2.8	0.5 (3.4)	4.7	0.0 (0.0)	1.0	R
NC Ac 2243 DP*	3.1 (10.0)	2.3	4.5 (10.8)	5.6	0.0 (0.0)	1.0	R
NC Ac 2240 DP	NT*	NT	5.7 (12.8)	5.8	0.0 (0.0)	1.0	R
NC Ac 2240T	4.9 (12.6)	4.7	0.6 (3.3)	4.1	2.3 (7.2)	1.7	R
NC Ac 2242	17.7 (24.4)	8.9	3.1 (8.7)	4.9	2.0 (4.7)	1.5	MR
NC Ac 10033	2.7 (9.1)	5.8	9.3 (17.6)	6.6	2.9 (9.0)	2.2	MR
FESR 386	5.7 (13.6)	6.3	7.9 (16.0)	7.6	0.7 (2.8)	1.1	MR
NC Ac 343	3.1 (9.7)	6.9	7.7 (15.2)	6.6	4.5 (11.3)	4.6	MR
RMP 40	5.0 (12.4)	7.0	19.5 (25.2)	7.1	0.8 (4.2)	2.3	MR
NC Ac 2142	13.0 (20.7)	7.8	NT	NT	5.1 (10.2)	2.6	MR
NC Ac 17888	9.7 (17.9)	8.0	13.1 (20.1)	7.7	2.0 (7.7)	1.9	MR
NC Ac 2230	8.8 (17.2)	7.8	15.6 (22.6)	6.2	3.6 (8.8)	2.1	MR
NC Ac 1705	12.9 (20.2)	8.0	13.3 (21.1)	6.9	7.3 (12.9)	2.1	MR
M13 (RC)*	8.1 (16.3)	8.8	18.9 (24.4)	7.6	5.5 (13.4)	6.9	MR
Robut 33-1(SC)*	29.5 (32.8)	8.4	44.4 (43.2)	6.9	19.3(24.2)	7.1	S
TMV2 (SC)	32.6 (34.7)	9.0	25.1 (29.8)	7.0	36.0(36.6)	7.4	S
Mean	(17.3)	6.7	(18.1)	6.4	(9.6)	2.9	
SE	± (2.77)	0.68	±(4.31)	0.96	±(3.80)		0.67
CV %	(27.42)	17.42	(41.01)	26.02	(68.87)		4.01

( ) = arcsine transformed values

* As in table 1.

** 1 = No injury, 9 = complete scarification of pod

R = Resistant; MR = Moderately resistant; S = Susceptible

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Table 4. Growth habit, days to flowering and pod yield potential of some selected insect resistant lines.

Cultivar	ICG No.	Resistance ** to			Growth habit	Days to 50% flowering	Pod Yield kg/ha*	
		Jassids	Thrips	Termite			1981	1982
NC Ac 2214	5040	R	R	S	VR	31	252	NT
NC Ac 2230	5041	R	R	MR	VR	29	415	359
NC Ac 2232	5042	R	R	S	VR	29	215	287
NC Ac 2243DP	5045	R	R	R	VR	31	83	252
NC Ac 2243T	5045	R	R	R	VR	31	133	339
NC Ac 2240DP	5043	R	R	R	VR	31	217	93
NC Ac 2240T	5043	R	MR	R	VR	31	NT	243
NC Ac 2242	5044	R	R	MR	VR	31	452	233
NC Ac 2144	2307	MR	MR	S	VB	31	270	450
NC Ac 1705	6764	MR	MR	MR	VB	28	548	363
NC Ac 489	273	MR	S	S	SB	26	819	224
NC Ac 2666	1660	MR	S	S	SB	21	519	241
NC Ac 343	2271	MR	MR	MR	VR	30	1407	1150
NC Ac 2142	2306	MR	MR	MR	VB	30	211	502
NC Ac 1337	398	S	S	S	SB	21	659	176
NC Ac 2700	318	MR	S	S	SB	21	748	320
NC Ac 406		MR	S	S	SB	21	833	NT
NC Ac 17888	6317	MR	S	MR	SB	29	1156	583
NC Ac 1741	5036	MR	MR	S	SB	30	348	617
Gujarat Narrow Leaf	2741	R	MR	S	SB	29	163	191
M13	156	MR	S	MR	VR	30	748	848
NC Ac 10033	5071	S	S	MR	SB	31	913	476
NC Ac 2462	2320	S	MR	S	SB	27	659	644
NC Ac 1113	5629	S	S	MR	SB	26	1041	1156
SE							±158.7	±148.8
CV %							28.5	33.6

* Row spacing 0.60 m, plant spacing 0.15 m, in low fertility area without fungicidal or insecticidal protection and irrigation.

** Resistance to jassid = % yellowed foliage, to thrips = % damaged leaflets and to termite = % scarified pods

VR = virginia runner, VB = virginia bunch, SB = spanish bunch

R = Resistant; MR = Moderately resistant; S = Susceptible

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The Presence of 5,7-Dihydroxyisoflavone in Peanuts by High Performance Liquid Chromatography Analyses

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ABSTRACT

The defatted flours of 43 colored and one white testa peanut (*Arachis hypogaea* L.) genotypes were analyzed for flavonoids. Flavonoids were extracted from the flours with aqueous methanol, hydrolyzed, and the resulting aglycones analyzed by high pressure liquid chromatography with a variable wavelenth detector. The UV spectrum and retention time coupled with those of standards allowed for the tentative identification of the principal flavonoid aglycone as 5,7-dihydroxyisoflavone (DHI).

Key Words: Isoflavones, cotyledons, genotypes, *Arachis hypogaea* L., analysis.

Flavonoids are a ubiquitous group of plant phenols. Their large number and variety of structure have made them ideal chemical markers (8). There is also much interest in their biological functions and physiological properties. In peanut (*Arachis hypogaea* L.) a dihydroquercetin glycoside was isolated (5,7) and, recently, its properties as an antioxidant were confirmed by Pratt and Miller (6). Turner, *et al.* (9) reported 5,7 dimethoxyisoflavone as a component of peanut cotyledons. An important property of this flavonoid was that it inhibited growth of *Aspergillus flavus* (Link) Fr., and *Trichoderma viride* Pers. ex. Fr. Gibbs (4).

Because of its activity against these fungi the confirmation of 5,7 dimethoxyisoflavone in experimental peanut varieties should be helpful in differentiation within similar genotypes. In our previous work with white testa peanuts, there were two unidentified flavonoids (isoflavones) (3). To see if either one was 5,7 dimethoxyisoflavone or 5,7 dihydroxyisoflavone, standards were synthesized and used for comparison. The availability of high performance liquid chromatography coupled with a variable wavelength (scanning) UV detector provided the quantitative flavonoid analyses on the small quantities of each experimental peanut genotype.

Material and Methods

Preparation of Flour Extracts. The available quantity of genotype varied from 5 to 10g. Deskinned peanuts were de-oiled with hexane (1:10/W:V) by homogenizing twice in a Waring blender at high speed for 2 min. The second extraction used half the amount of hexane used in the first extraction. The flour was filtered after each extraction. Flavonoids were then extracted from the homogenate flour by refluxing a solution of methanol/water: 80/20 (V/V) and the flour (3-7g) for 4 hours. The methanol was evaporated at room temperature, and the resulting aqueous solution was adjusted to pH≳3.5 with 2N HCl. Polyvinylpyrollidone (PVP) (1.0g) was added and the mixture stirred for 1 hour at room temperature. The mixture was filtered, then the PVP was washed with water (pH = 6.0). The PVP was washed on a filter with basic (pH = 8-10) methanol until the filtrate was no longer

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