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Screening Groundnut Breeding Lines for Resistance to Aphids, Aphis craccivora Koch

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Aphis craccivora Koch is a major pest of groundnut (*Arachis hypogaea L.*) causing yield losses by feeding on phloem sap and through transmission of virus diseases (Padgham et al. 1990, Feakin 1973). It is a vector of at least seven viruses that attack groundnuts, the most important ofwhich are groundnut rosette virus (GRV) in Africa and peanut stripe virus in Asia.

Host-plant resistance to *A. craccivora* in groundnut is recognized as the most effective, economic and sustainable method of limiting both the spread of the aphid and the viruses (Padgham et al. 1990). Evans (1954) demonstrated that host-plant resistance restricted the spread of GRV in Tanzania and subsequent studies confirmed this in Malawi (ICR1SAT 1988). Amin (1985) suggested that resistance mechanisms in groundnut could deter colonization by immigrant alatae and could also reduce their fecundity. Screening of germplasm from various regions by ICRISAT has led to the identification of aphid-resistant groundnut genotypes (ICRISAT 1988). Through the global groundnut breeding activities of the ICRISAT Chitedze Research Station near Lilongwe, Malawi, breeding lines and elite groundnut varieties were screened for aphid resistance after demonstrating field resistance to rosette virus infections during the 1998/99 cropping season.

Thirty-seven breeding populations (F_6) were compared to four standard controls (CG7, a rosette-susceptible but high-yielding medium-duration groundnut variety released in Malawi, Zambia, and Uganda; JL 24, a rosette-susceptible short-duration groundnut variety originating from India and released in Malawi and Zambia; ICG 12991, a short-duration rosette-resistant variety at final evaluation; and EC 36892, a medium-duration groundnut aphid resistant variety from ICRISAT Genetic Resources Unit) in a screenhouse experiment.

The F_6 populations were selected from four crossing combinations. The variety EC 36892 was the female parent and the source of resistance to A. craccivora. The male parents and the progenies expressed host-plant resistance to rosette virus under high disease pressure conditions in Malawi. The objective of the crosses was to combine rosette virus resistance with resistance to the vector (*A. craccivora*). The details of pedigrees are presented in Table 1.

Table 1. Pedigree of the groundnut varieties derived from crosses involving a female aphid-resistant parent and rosette virus-resistant male parents.

	Pedigree	
Identity	Female	Male
ICGX-SM 94101	EC36892	ICG 6428
ICGX-SM 94104	EC36892	ICGV-SM 90704
ICGX-SM 94108	EC36892	ICG 7457
ICGX-SM 94110	EC36892	ICG 9540

In the screenhouse, three seeds of each genotype were sown in plastic pots (13 cm top diameter, 13 cm high) containing a local Alfisol. There were ten replicates in a randomized complete block design. The soil in the pots was constantly kept moist. Six days after sowing (DAS) the seedlings were inspected and thinned to one per pot. Eight days after sowing, single first instar aphid nymphs from a culture maintained on a susceptible groundnut variety, Malimba, were introduced onto the tender leaf of each seedling. After confirming that each nymph was moving about on the area of placement, each pot was covered by a crisp bag and secured in place. Aphids were left to move freely along plants and feed. Daily observations were maintained on the development of nymphs to adults and reproductive life. New first instar nymphs were observed on some of the lines six days after first instar infestation (DAFI) on plants. The adults were left to reproduce for five days after which the first colony count was made (10 DAFI) on each plant. The plants were secured in place for the colonies to develop further for another five days and care was taken to avoid disturbance. A second colony count was made at 15 DAFI to get an overview of any further population growth over time.

The results indicated that first instar aphid nymphs established on all genotypes tested (Table 2). The rate of nymphal growth and time taken to produce new offspring nymphs varied between genotypes. There were highly significant differences ($P<0.001$) of offspring population counts between the 41 genotypes at the two counting dates. Among the genotypes selected from previous field trials, aphid fecundity at 10 and 15 DAFI showed that ICG 12991 had the lowest rate of nymph development, low fecundity, and relatively smaller-sized aphids compared with EC 36892, CG 7, and JL 24.

The aphid population counts on eight breeding lines among the F_6 populations and the controls are shown in Table 2. The results indicated that the genotypes tested showed varying degrees of resistance to A. craccivora by reduced aphid growth and fecundity. The level of resistance in ICG 12991 was significantly higher ($P<0.001$) than the other control varieties. JL 24 was most susceptible, with all its plants supporting the highest aphid reproductive rate compared with the other genotypes. Among the breeding populations, the majority showed higher levels of resistance compared with EC 36892 at both 10 DAFI and 15 DAFI.

Although screening was only conducted during the first month of groundnut plant establishment (up to 30 DAS), this period covers most of the stage when groundnut plants are vulnerable to rosette virus infections in the field. If the aphids land on the plant and delay in maturity which leads to low offspring populations, it would imply that there could probably be delayed disease spread to other plants. It is also probable that there are various factors in the plants which deter the aphids from settling and developing normally. These preliminary results, therefore, support the suggestion by Amin (1985) and Kimmins (F M Kimmins, NRI/University of Greenwich, Chatham, Kent, UK, personal communication, 1999) that resistance mechanisms in groundnut could deter colonization and reduce fecundity. Field experiments to further assess the populations under natural/artificial aphid populations and screenhouse trials to establish the mechanisms of resistance in these genotypes should be considered as a priority area for immediate research work.

Table. 2 Mean aphid population counts on F_6 groundnut lines and controls.

Identity	Count at 10 DAFI[1]	Count at 15 DAFI
ICGX-SM 94101/P1	14.3[2]	92.7[2]
ICGX-SM94101/P7	19.7	49.4
ICGX-SM 94104/P5	19.5	72.2
ICGX-SM 94104/P10	18.6	93.0
ICGX-SM 94108/P1	15.0	46.1
ICGX-SM 94108/P3	18.2	69.9
ICGX-SM 94109/P2	20.3	43.0
ICGX-SM 94109/P3	16.8	66.1
Control		
JL24	42.8	265.6
EC 36892	29.2	209.2
CG7	32.0	294.7
ICG 12991	9.0	14.8
Mean	25.2	105.7
SE	±4.26	±22.01
LSD (P = 0.05)	11.85	61.28

1. DAFI = Days after first instar infestation.
2. Mean of 10 replications.

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Evaluation of Advanced Breeding Genotypes of Groundnut for Resistance to Major Foliar Fungal Diseases

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Early leafspot (*Cercospora arachidicola*), late leafspot (Phaeoisariopsis personata), and rust (*Puccinia arachidis*) are important foliar diseases of groundnut (*Arachis hypogaea L.*) causing severe damage to the crop (McDonald et al. 1985, Kokalis-Burelle et al. 1997). These foliar diseases both reduce the yield and render the fodder unsuitable as animal feed by causing deterioration in quality of the plant biomass. Control of these diseases through application of fungicides not only increases the cost of cultivation, but also leads to environmental and health hazards. Therefore, the development of resistant cultivars is one of the best alternatives to reduce the incidence of these diseases. Attempts have been made at the National Research Centre for Groundnut (NRCG) to develop such cultivars/genotypes with the major emphasis on foliar disease resistance. Materials developed in this breeding program have been evaluated for their resistance to early and late leafspots, and rust.

The trial included 29 promising advanced breeding Virginia genotypes *(A. hypogaea* subsp *hypogaea* var *hypogaea*) along with two control varieties. It was laid out in a randomized complete block design with three replications during the rainy seasons of 1996 and 1997 at the NRCG, Junagadh, Gujarat. The plots were of 5 rows, each of 5 m length, with interrow spacing of 60 cm and plant-to-plant distance of 10 cm. The recommended agronomic practices were followed. Disease severity of early leafspot (ELS), late leafspot (LLS) and rust were recorded by adopting a modified 1-9 scale under field conditions (Subrahmanyam et al. 1995).

The genotypes PBS 20026, PBS 21063, PBS 22028, CS 19 (TMV 2 x *A. chacoense*), and Code 7 (J11 x *A. cardenasii*) were consistently resistant or moderately resistant to ELS during both the seasons (Table 1). Genotypes PBS 20026, PBS 21063, PBS 23007, and CS 19 recorded scores from 2.7 to 5.0 during both seasons, and were, therefore, categorized as resistant/moderately resistant to LLS. Four genotypes, PBS 20026, PBS 21063, PBS 23007, and CS 19 showed consistently moderate resistance to ELS, LLS, and rust. The genotype PBS 21063 was also equivalent to the best control, ICGS 44, for pod yield. The cultivar PBS 23007 also combined a high level of resistance to all three diseases and good yield level. High yield potential and a high degree of resistance do not generally go together (Nigam et al. 1991). Lower dry matter partitioning in rust- and LLS-resistant genotypes have been reported by Williams et al. (1984). Hence, a good strategy for resistance breeding would be the development of genotypes with high yield potential and a moderate level of resistance. Some of the resistant genotypes reported in this paper may be recommended for testing their performance under different agroclimatic conditions and/or further use as donor parents in breeding programs.

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