

Evaluation of Groundnut Core Collection to Identify Sources of Tolerance to Low Temperature at Germination

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Groundnut (*Arachis hypogaea* L.) is an important oilseed crop cultivated in about 96 countries of the world. In the year 2000, it was cultivated on 23.84 million hectares with 34.52 million tonnes output of groundnut in shell. *Arachis hypogaea* is divided into two subspecies, *fastigiata* and *hypogaea*. The subspecies *fastigiata* is subdivided into four botanical varieties, *fastigiata*, *peruviana*, *aequatoriana*, and *vulgaris* and subspecies *hypogaea* into two botanical varieties, *hypogaea* and *hirsuta*. The crop is grown under wide range of climatic conditions, from warm tropical to humid temperate, although all the production environments can be characterized by a warm, frost-free period of at least 90 days (Bunting *et al.* 1985). During this growing season, mean temperatures generally range from 24 to 33°C (Saxena *et al.* 1983), with temperature optima for growth and dry matter production generally considered to lie within a similar range (Ketring *et al.* 1982; Ketring, 1984). The base temperature (T_b), the temperature at or below which the rate of progress towards a phenological event is zero, for groundnut is considered to be 10°C. Bell *et al.* (1991) estimated mean T_b for 16 cultivars for germination to be 13.3°C. In some countries in Asia and North America, the temperatures at planting time are low resulting in delayed and poor germination/plant stand in groundnut and consequently poor yield and economic loss to the farmers. The objective of the study was to determine genetic variation and identify sources for low temperature (12°C) tolerance at germination in the core collection of groundnut.

The core collection of groundnut, consisting 1704 accessions (Upadhyaya *et al.* 2001), was screened for low temperature tolerance at germination under laboratory conditions. The core collection consisted of 584 (34.3%) accessions belonging to variety *vulgaris*, 299 (17.5%) to *fastigiata*, 27 (1.6%) to *peruviana*, 6 (0.4%) *aequatoriana*, 784 (46.0%) *hypogaea*, and 4 (0.2%) *hirsuta*. Gangapuri (*fastigiata*), ICGS 44 (*vulgaris*), ICGS 76 (*hypogaea*), and M 13 (*hypogaea*) were used as control cultivars. Twenty-five seeds of each accession

grown in 1999-2000 post-rainy season were treated with Captan, n-[(trichloromethyl) thio]-4-cyclohexene-1,2-dicarboximide, at 2 g/kg seed before test. The seeds of *hypogaea* and *hirsuta* botanical varieties were also treated with ethrel (2-chloroethylphosphonic acid) before testing to overcome the possible effects of seed dormancy. Each accession was replicated twice. Rolled paper towel test (Ellis *et al.* 1985) was used for germination in an incubator at 12°C day/night temperature. Sufficient quantity of distilled water was added to the tray so as to keep 3-4 cm of rolls in the water. The number of germinating seeds was recorded at 10 days after incubation for *fastigiata*, *vulgaris*, *aequatoriana*, and *peruviana* types. In the case of *hypogaea* and *hirsuta*, very few seeds germinated at 10 days and germination was, hence, recorded at 15 days after incubation. The percentage germination was calculated and data analysed using completely randomized design. The accessions which showed 80% or more germination were considered as having tolerance for low temperature at germination. Among the tolerant accessions, land races were selected as they have the original variation and used to estimate diversity. The land races were grown in 1999 rainy and 1999-2000 post-rainy seasons on ridges in one row plot of 4 m length, in an augmented design. The distance between ridges was 60 cm and between plants 10 cm. The data on 12 morphological descriptors traits, and 15 quantitative traits each in 1999 rainy and 1999-2000 post-rainy season and oil and protein contents in the 1999-2000 post-rainy season were used to assess the diversity among them. The data on morphological descriptors, growth habit, stem colour and hair, leaf colour and hair, flower, flower streak, and peg colour were recorded on plot basis. Pod beak, constriction, and reticulation was recorded on 10 mature pods and primary seed colour on 10 sound mature seeds. The data on quantitative traits, days to 50% flowering and plot yield were recorded on plot basis, and primary branches, plant height, leaflet length and width on five randomly selected competitive plants. The number of seeds/pod, pod length

Table 1. Performance of selected low temperature tolerant land races in the 1999-2000 post-rainy season, ICRISAT Centre, Patancheru, India

Landrace	Botanical variety*	Country of origin	Germination** (%)	Pod yield (t ha ⁻¹)	Shelling percentage	100-seed weight (g)	Oil (%)	Protein (%)
ICG 12553	AEQ	Ecuador	90 (72) ⁺	1.19	68	52	50	24
ICG 8570	FST	Argentina	92 (74)	1.54	79	46	45	28
ICG 4788	FST	Benin	82 (66)	1.39	79	54	48	24
ICG 12743	FST	Bolivia	92 (74)	1.84	67	53	50	25
ICG 14130	FST	Brazil	94 (76)	1.78	73	38	49	24
ICG 115	FST	India	86 (69)	1.67	68	38	46	26
ICG 7884	FST	Israel	96 (79)	1.56	71	57	51	22
ICG 7929	FST	Paraguay	94 (76)	1.29	77	43	49	23
ICG 7352	FST	Peru	94 (76)	1.17	71	52	43	28
ICG 1966	FST	Venezuela	96 (79)	1.35	75	40	45	27
ICG 10092	FST	Zimbabwe	88 (71)	1.64	75	53	48	28
ICG 13539	HYP	Togo	98 (84)	1.71	80	66	51	23
ICG 8797	HYP	Zambia	94 (76)	1.97	76	81	48	24
ICG 2708	HYP	Australia	92 (74)	1.68	74	58	50	22
ICG 4331	HYP	India	96 (82)	1.95	77	53	47	25
ICG 11631	HYP	India	84 (67)	1.84	72	54	51	19
ICG 9515	HYP	Mozambique	96 (82)	2.16	76	55	49	25
ICG 2773	HYP	Tanzania	92 (74)	1.64	76	53	48	19
ICG 10567	PRU	Peru	92 (74)	1.33	70	53	50	24
ICG 10945	PRU	Peru	88 (70)	2.08	67	57	50	24
ICG 11088	PRU	Peru	92 (74)	1.83	66	54	48	22
ICG 11911	VUL	Mali	94 (80)	1.26	74	54	52	19
ICG 11579	VUL	Sri Lanka	85 (67)	1.39	72	49	51	23
ICG 1899	VUL	Uganda	92 (74)	1.27	67	43	44	28
Control								
Gangapuri	FST	India	84 (66)	0.85	73	46	47	24
ICGS 44	VUL	India	43 (37)	1.47	77	58	49	23
ICGS 76	HYP	India	50 (45)	1.71	76	62	49	22
M 13	HYP	India	50 (45)	1.54	69	63	50	23
SE _±			±15.09 (11.41)	±0.295	±2.96	±5.44	±0.93	±1.16
Trial mean			47 (42)	1.39	74	57	49	23
CV(%)			32.1 (27.0)	26.7	5.0	11.9	2.4	6.3

* AEQ, *aequatoriana*, FST, *fastigiata*, HYP, *hypogaea*, PRU, *peruviana*, and VUL, *vulgaris*

** Germination test was carried out in laboratory and germination was recorded 15 days after incubation in *hypogaea* and 10 days in all other botanical varieties

* Figures in brackets are arc sine transformed values

and width were recorded on 10 mature pods and shelling percentage on 200 g pods. The 100 randomly selected mature seeds were taken to record seed weight which were later on used to determine oil and protein contents. Seed length and width was recorded on 10 mature seeds.

A phenotypic distance matrix was created by calculating the differences between each pair of entries

for each characteristic. The diversity index was calculated by averaging all the differences in the phenotypic values for each trait divided by the respective range (Johns *et al.* 1997). Hierarchical cluster analysis was performed following Ward (1963) by Statistica software.

In 480 accessions, germination ranged from 0 to 10%, in 331 from 21 to 40%, in 254 from 41 to 60%,

in 296 from 61 to 80%, and in 343 from 81 to 100% compared to 43% in ICGS 44, 84% in Gangapuri, and 50% in both ICGS 76 and M 13. The 343 accessions with 81-100% germination consisted of 25 cultivars, 93 breeding lines, 164 land races, and 61 others. Botanically, they represented, 4 *aequatorina*, 97 *fastigiata*, 11 *peruviana*, 20 *vulgaris*, and 211 *hypogaea*. This indicated that tolerance to low temperature is not restricted to any particular group of botanical variety nor it is confined to any geographical region as botanical varieties have evolved from different regions.

The low temperature tolerant landraces differed for various agronomic traits and showed a wide range of variability for traits of economic importance like, yield (0.38- 2.31 t/ha), shelling percentage (55-80), 100-seed weight (24-81 g), and oil (43-54%) and protein (16-30%) contents. Several land races showed an excellent combination of pod yield, shelling percentage, 100-seed weight, and oil and protein contents. The data on selected tolerant land races from the five botanical varieties is given in Table 1. Broad sense heritability for tolerance to low temperature at germination was estimated to be 88%. These land races need to be further evaluated for germination at lower temperature in laboratory and for agronomic traits in replicated field trials.

The cluster analysis using diversity index delineated 164 tolerant landraces and control cultivar Gangapuri, which is a land race from Khargone, Madhya Pradesh in India, into seven clusters. The number of land races varied from five in Cluster 1 to 44 in Cluster 3. There was no pattern of clustering on the basis of botanical varieties in most of the clusters. The mean phenotypic diversity index of the 165 tolerant landraces was 0.222. The minimum diversity index (0.051) was observed

between ICG 4235 (*hypogaea* from India) and ICG 4389 (*hypogaea* from India) to 0.519 between ICG 1710 (*peruviana* from Peru) and ICG 9037 (*hypogaea* from Cote d'Ivoire). Selected diverse lines can be identified for use in the improvement program to develop high yielding low temperature tolerant cultivars and to broaden the crop genetic base.

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