Genetic Resources and Enhancement

Groundnut Germplasm Seed Viability after Ten Years of Storage as Base Collection

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Long-term storage strategies for seed germplasm are needed to assure preservation of diminishing plant genetic resources. Monitoring the main factors causing genetic erosion in ex situ collections is strongly recommended to minimize the loss of genetic integrity. Seed deterioration is a continuous process, but for orthodox seeds such as groundnut (*Arachis hypogaea*) a combination of 3–7% seed moisture content and storage temperature below 0°C would permit long-term seed preservation (FAO and IPGRI 1994). The Rajendra S Paroda Genebank at ICRISAT, Patancheru, India conserves the global collection of groundnut germplasm consisting of 15,419 accessions assembled from 93 countries as active collection at +4°C and 30% relative humidity and as base collection at −18°C. Active collection is immediately available for multiplication and distribution while base collection at preferred seed moisture content and other storage facilities is for long-term storage for future use.

Different species and accessions within species may respond differently to storage conditions, resulting in a wide variance in the storability of individual accessions (Sikdar 1988). The determination of the maximum storage period for each accession in particular conditions of the genebank is of importance in designing management guidelines that minimize viability controls and seed multiplication of the samples. Genebank managers are responsible for providing conditions that will maintain the viability of each accession held within the genebank above a minimum value. Periodic testing of viability is crucial to operation of genebanks because it permits the control of genetic erosion during storage. The objectives of this study were to determine the changes in the viability of groundnut germplasm accessions stored at −18°C for 10 years and to determine the risk of viability decreasing below acceptable levels after 10 years of storage and to analyze the possible factors involved in the viability losses. In this work, seed viability of base collection of 990 groundnut accessions stored for 10 years was analyzed following a methodology recommended for germplasm conservation (FAO and IPGRI 1994).

Seed samples of 990 groundnut germplasm accessions regenerated at ICRISAT, Patancheru were dried to about 4% moisture content and maintained at −18°C in hermitically-sealed, laminated aluminum foil pouches to serve as base collection. For long-term storage, the seed is desiccated to a low level of moisture content in a seed drying cabinet at 15°C and 15% relative humidity. The seed moisture content was estimated using oven-drying method (ISTA 1985) on 30 randomly selected accessions before initial storage and during monitoring seed viability. The same seed samples of all accessions were used for monitoring viability after 10 years of storage. Seed viability was assessed by standard germination tests. Initial germination (G0) was determined before placing the samples in storage. Germination was monitored after 10 years of storage (G10). Germination tests were conducted in 1990 and 2001 following "between paper" method using standard towels (ISTA 1985). Two replications of 25 seeds were used for both initial and final germination testing to save the valuable seed material. Germination results are reported as percentage normal seedlings.

Changes in Seed Viability

The results revealed that groundnut germplasm accessions stored at −18°C with moisture content below 4% can also lose viability (Table 1). The minimum viability standard for conserving seeds as base collection was 85%. Viability was unaffected in 36.4% (360 accessions), improved (G10 over G0) in 20.2% (200 accessions), and decreased in 43.4% (430 accessions) of total collection monitored. The increase in germination during storage could be due to fresh seed dormancy, a common feature with groundnut germplasm, which was broken after a time of storage period (Ellis et al. 1993). This effect is more pronounced in *A. hypogaea* var *hypogaea* accessions (28%) compared to other botanical types. For reporting the potential viability in some of the accessions before storage, dormancy-breaking treatments are recommended.

The average initial viability of 990 accessions was 98.2%. Considerable variation occurred in the average viability for different botanical varieties of groundnut. The highest viability (99.2%) was recorded in *A. hypogaea* var *fastigiata* followed by 98.3% in *A. hypogaea* var *vulgaris* and 97.7% in *A. hypogaea* var *hypogaea*. The average initial viability was lowest (97.6%) for *A. hypogaea* var *peruviana* accessions. After 10 years of storage, the average viability of the total collection was 96.5%, a decrease of 1.7%. The reduction was lowest (1.0%) in *hypogaea* followed by 1.3% in *fastigiata*, and 2.1% in *vulgaris* accessions. The highest reduction in average viability (7.5%) was recorded in *peruviana* accessions. A germination level less than 85%, after 10 years of storage was observed in 46 accessions while it was less than 75% in 12 accessions. A deviation of 5% germination level between initial and final was considered as normal. Thus, over a period of 10 years as base collection, 787 accessions (79.5%) remained neutral, 35 accessions (3.5%) had improved viability and 168 accessions (17%) had viability losses. The highest gain was in 25 accessions (5.4%) of *hypogaea*, while the loss in viability was highest in 27 accessions (54.0%) belonging to *peruviana*.

It is necessary to investigate why some accessions possess low germinability after storage. One reason might be that they are sensitive with respect to the environment during reproduction as described in the genebank standards (FAO and IPGRI 1994). During storage, accessions with low viability lose their germinability much faster than accessions with high initial viability (Ellis 1982) and all accessions with low initial germinability need more frequent germination control. Passport data and taxonomical background of the accessions could be a possible source of information for ascertaining the possible losses in germination in addition to the regeneration and pre-storage conditions. No relationship was found between the passport traits and the loss in germination relating to donor, year of multiplication and the geographical distribution. However, significant ($P < 0.001$) differences in germination were related to the botanical variety. More significant losses were observed in *peruviana* group followed by *vulgaris*. This shows *hypogaea* and *fastigiata* accessions were more stable during storage compared to *peruviana* and *vulgaris*, which require frequent regeneration even when conserved under preferred conditions as base collection.

Table 1. Changes in germination in groundnut (*Arachis hypogaea*) accessions of different botanical varieties in the base collection at ICRISAT, Patancheru, India after 10 years of storage.

	No. of accessions											
Change in viability[1] (Range)	Entire collection		*hypogaea*		*fastigiata*		*aequatoriana*		*peruviana*		*vulgaris*	
16 to 20	1	(0.1)[2]	0	(0.0)	0	(0.0)	0	(0)	0	(0.0)	1	(0.3)
11 to 15	5	(0.5)	4	(0.9)	1	(0.6)	0	(0)	0	(0.0)	0	(0.0)
6 to 10	29	(2.9)	21	(4.6)	4	(2.3)	0	(0)	0	(0.0)	4	(1.3)
1 to 5	165	(16.7)	104	(22.6)	11	(6.3)	0	(0)	1	(2.0)	49	(16.2)
0	360	(36.4)	136	(29.5)	76	(43.2)	1	(100)	13	(26.0)	134	(44.4)
(–) 1 to (–) 5	262	(26.5)	131	(28.4)	65	(36.9)	0	(0)	9	(18.0)	57	(18.9)
(–) 6 to (–) 10	114	(11.5)	52	(11.3)	17	(9.7)	0	(0)	12	(24.0)	33	(10.9)
(–) 11 to (–) 15	31	(3.1)	10	(2.2)	2	(1.1)	0	(0)	7	(14.0)	12	(4.0)
(–) 16 to (–) 20	12	(1.2)	2	(0.4)	0	(0.0)	0	(0)	3	(6.0)	7	(2.3)
(–) 21 to (–) 25	6	(0.6)	0	(0.0)	0	(0.0)	0	(0)	3	(6.0)	3	(1.0)
(–) 26 to (–) 30	4	(0.4)	1	(0.2)	0	(0.0)	0	(0)	1	(2.0)	2	(0.7)
(–) 31 to (–) 35	1	(0.1)	0	(0.0)	0	(0.0)	0	(0)	1	(2.0)	0	(0.0)
Total	990	(100.0)	461	(46.6)	176	(17.8)	1	(0)	50	(5.1)	302	(30.5)
Gain in viability	35	3.5	25	5.4	5	2.8	0	0	0	0	5	1.7
Viability neutral	787	79.5	371	80.5	152	86.4	1	100	23	46	240	79.5
Loss in viability	168	17	65	14.1	19	10.8	0	0	27	54	57	18.8
Total	990	100	461	100	176	100	1	100	50	100	302	100

1. Each value refers to change in germination (G0 minus G10). G0 = Initial germination (%); and G10 = Germination (%) after 10 years.
2. Percentage of accessions is given in parentheses.

Regeneration Requirements

A level of viability less than 85% of initial viability was recommended for regeneration of base collection, as these standards are useful to ensure that the genetic integrity of the accessions is maintained (FAO and IPGRI 1994). The results obtained from the monitoring tests revealed that more than 97% of the accessions did not have significant decrease in germination after 10 years of storage and only 2.4% (24 accessions) would need regeneration. During storage, dormancy could be a common phenomenon in some accessions requiring special treatments at the time of germination testing.

This study revealed that taxonomical variation in groundnut had an impact on storage longevity suggesting suitable precautions during regeneration and pre-storage to secure high quality seeds for conservation of accessions belonging to *peruviana* group. Though the germplasm seeds are conserved under preferred conditions of international standards for present and future use, periodic monitoring of viability is vital for developing protocols for cost-effective regeneration intervals.

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Yield Potential of Some Spreading Type Local Groundnut Cultivars Under Late Rainy Conditions at Bijapur, India

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The area (0.43 million ha) and production (0.35 million t) of groundnut (*Arachis hypogaea*) is slowly declining in the northern dry zone of Karnataka, India and the groundnut farmers are switching to alternative oilseed crops. Under the prevailing circumstances such as erratic rains in the early rainy season and the lack of suitable groundnut genotypes, the crop is not bringing expected returns. Although most of the farmers have been growing many local spreading types continuously for a long time in this region, all these are not high yielding. There is a need to evaluate these genotypes during early rainy and late rainy seasons to assess the yield potentiality after preliminary screening. Thus, the performance of the cultivars can be evaluated in different climatic situations in different years.

The suitability of genetic architecture of some varieties to perform well in different seasons needs to be accounted statistically by assigning appropriate ranks, which might provide an opportunity to farmers to reconsider the best varieties available with them. Studies on water relations of groundnut by Sivakumar and Sarma (1986) have shown that the selection of appropriate varieties is feasible with a growing cycle that would match the probable stress periods and dependable rainfall periods. Moisture stress during early phase of the growth is favorable for optimum yield in groundnut (Anonymous 1995). Ramesh and Durgaprasad (1996) who screened many groundnut genotypes to identify good yielders despite mid (peg initiation to pod development) and late season drought (pod development to seed development) indicated that TG 26, ICGV 86347 and K-13G gave higher yield. Hence, there may be a possibility to isolate some of the groundnut genotypes that perform well under drought during both vegetative and reproductive phases. Analysis of long-term rainfall for Bijapur, Karnataka has indicated that water availability is relatively undependable during early part of the rainy season and more assured during later part of the rainy season (Kavi 1996). This may provide opportunities for some of the spreading groundnut genotypes to make better use of the season.

Preliminary investigations were carried out at the Regional Research Station, Bijapur during 1997 rainy season to evaluate 90 local spreading groundnut cultivars collected around Bijapur along with S 230 as check. Eight promising cultivars were selected. These were further evaluated during 1998 and 1999 early rainy seasons (June sowing) and 2000 and 2001 late rainy seasons (August sowing). The design of the experiment was randomized block design with four replications. The plot size was 5 m × 2.70 m with 45 cm inter-row and 15 cm intra-row spacing. Recommended agronomic practices for the region were followed. The pod yield was recorded plot-wise in each replication. Disease incidence of late leaf spot and rust was recorded as per modified 1–9 scale