Cutting Costs for Germplasm Conservation

by

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Abstract

Seed banks are the most popular, efficient and effective measure for ex situ conservation of germplasm. For medium term storage, the germplasm is stored at 0 to 50C temperature and 15 to 20% humidity and for long term storage at -20 to -180C. Compared to conservation under natural cold dry conditions, storage in gene banks at low temperature and at low moisture regime is a reasonably costly affair. An attempt was made at Directorate of Wheat Research to observe the effects on viability of seeds stored under natural and controlled conditions. The germinability of accessions stored at Dalang Maidan, Lahaul Spiti (HP) in three types of packing materials namely, cloth bags, water proof paper bags and aluminium bags was tested for 8 consecutive years and compared with that conserved under medium range storage facility at Karnal. The waterproof aluminium bags used for storage under both conditions were found to be superior over the other two types of packing. The cost of conservation was higher at Karnal compared to storage under natural conditions at Dalang Maidan in Lahaul & Spiti due to fixed cost of establishing module plus variable cost for maintenance of module, power supply and power back up, etc.

Key Words: conservation, germplasm, germination, cost effective, gene bank

Introduction

Genetic resources have received due attention, in the sense of their collection, characterization, conservation, evaluation and utilization in consequence to grave warnings from the scientific community about genetic erosion of the total germplasm. The diversity in genetic resources is shrinking due to commercialization of agriculture, the area development projects and other related activities. The biodiversity need to be conserved for two reasons: to save from unforeseen disasters and extinction and to ensure its availability for future. In case of wheat, the erosion has been felt ever since the 19th century (Strampelli 1932; Porceddu et al. 1988). Both in situ and ex situ means are used for conservation of biodiversity.

Ex situ conservation of plants involves three methods namely, field gene banks, seed banks and in vitro storage. Of these, seed banks are the most efficient and effective method of conservation for orthodox seed. It is an effective and compact method of storage. The seeds are placed in packets and stored in medium term storage facilities (maintained at 00C to 50C temp. and 15% to 20% relative humidity) as active collections. Most of the material is also kept in long-term storage facilities (held at colder temperatures, -20 to -180C). Most seed samples are expected to remain viable for 20 to 30 years in medium term storage and for up to 100 years in long term storage depending upon the species, the initial seed quality and specificity of storage environment and general state of infrastructure (Koo et al. 2002).

World wide, the number of gene banks and the amount of seed stored in them has increased substantially over the past few decades. Germplasm conservation in gene banks involves costs. Maintaining storage areas for conservation in gene banks at low temperature and at low relative humidity is a reasonably costly affair, which include labour, buildings, equipments, electricity supply, power back up, their maintenance and other operational costs (Pardey et al. 2001). According to Koo et al. (2003), the cost for conserving and distributing the genetic material held in CGIAR gene banks is US $ 5.7 million per year while to provide these gene bank services to all future generations may cost US $ 149 million. During the period 2002-06, CGIAR centres spent an average of US $46,000,000 (12% of annual research investment) on germplasm collection (including conservation, characterization and evaluation) (Annonymous 2007). Conserving germplasm is a very long term, if not in perpetuity, proposition and the mismatch between annual funding support for this conservation effort and its very long term nature and intent is a serious concern. Seeds gene banks in developing countries often have a hard time fulfilling their mandate to conserve plant genetic resources for future use. Lack of funds, equipment malfunction and unreliable power all conspire to make it very difficult for gene bank curators to manage their collections. Low-input methods for seed storage do exist but have not been well documented or scientifically assessed for their impact on seed longevity, because mostly these activities take place at farmer's house or at a community level. Low cost alternative for drying seeds is to use salt to sun dried samples and alternative to refrigeration is provided by passive cooling by evaporation, heat-exchange or insulation, etc.(http://www.bioversityinternational.org). Other cost saving storage alternatives have not been reported so far.

At Directorate of Wheat Research (DWR), Karnal, we are conserving wheat germplasm in medium term storage facilities where temperature is maintained at 4 ± 10C temperature and the relative humidity at 23% in moisture proof aluminium packets. Before storage, the seed moisture content is reduced to 9 – 10%. As an alternative, one set of germplasm is stored under cold dry natural conditions at Regional Station, Dalang Maidan, Lahaul Spiti (HP). The station is situated at an altitude of 10,000 ft above sea level (Fig. 1), where the average maximum temperature remains around 150C during summers and up to –220C during winters. The annual temperature, rainfall and snowfall are given in table 1. At this station, the germplasm is stored in a room using three types of packing materials; (i) cloth bags, (ii) water proof paper bags and (iii) water proof aluminium bags. The infrastructure requirements at Dalang Maidan include one room, few racks, etc. Presently, 7691 accessions comprising of T. aestivum, T. dicoccum, T. durum and Triticale are conserved at Dalang Maidan and 10339 accessions are conserved in long term storage facility at DWR, Karnal.

These accessions were evaluated for their germination percentage from 1999 to 2006. Based on the germination data, this study reports here the effectiveness and economical efficiency of conservation under natural conditions vis-à-vis medium term storage in gene bank.

Of the 7691 accessions conserved under natural conditions at Dalang Maidan in Lahaul Spiti (HP) since 1998, twenty-nine belonging to three species, namely T. aestivum, T. dicoccum and T. durum were randomly selected. These were evaluated for their germination percentage from 1999 to 2006. Twenty-five seeds of each accession from each packing were germinated on moist filter paper in petri dishes. The experiment was laid out in completely randomized block design (CRD) with four replications under laboratory conditions at DWR, Karnal during November every year. These accessions from Karnal gene bank were evaluated once during 2006 after 8 years of conservation. The data on germination percentage was recorded and analyzed following the design of experiment.

The analysis revealed significant differences over different years and accessions stored under natural conditions at Dalang Maidan, Lahaul & Spiti location. The average germination decreased marginally from 97.7 % in 1999 to 88.0% in 2006. However, the germination percentage under medium storage facility for 8 years was 100% irrespective of the accessions investigated. The type of packing used for storage had influenced the germination pattern. The difference was statistically significant for seeds stored in different packing materials. Germination percentage for cloth bags and aluminium packing and cloth bags and waterproof paper bags was significantly different for all the years. However, the difference in germination between water proof paper bags and aluminium packing was non-significant initially for 5 years (1999 to 2003) but was significant thereafter (Table 2). The average germination was recorded the least (90%) in cloth bags followed by water proof paper bags (93 %) and maximum in water proof aluminium bags (95%). Over the years the decline in germination percentage was from 96 to 82% in cloth bags, from 98 to 88% in water proof paper bags and from 99 to 94% in water proof aluminium bags (Fig. 1).

The non-significant differences in germination of seed stored in aluminium packing for 8 years (1999 to 2006) indicated that the aluminium is a better storage packing material than waterproof paper bags and cloth bags. Location wise also, aluminium packing did not differ. The cost of conservation was higher at Karnal compared to storage under natural conditions at Dalang Maidan in Lahaul Spiti due to fixed cost of establishing module plus variable cost for maintenance of module, power supply and power back up, etc. Simply holding a seed sample in gene bank for one year (without any special treatment) costs less than US $ 1.50/accession/year. These storage costs include mainly of the costs of electricity, annualized capital cost of storage facility with small expense for its maintenance (Koo et al. 2003). The CIMMYT estimate revealed that for each existing accession of wheat, which does not require regeneration, US $ 0.37 and 0.48 are spent for medium and long range storage respectively. In case of regeneration, the conservation cost is estimated to be US $ 4.47 and the cost of addition of a new accession is around US $ 8.21 (Koo et al. 2002). Although we have not worked out the actual cost at DWR, but under Indian situations, National Bureau of Plant Genetic Resources, New Delhi has worked out the costs for storing rice germplasm, which is also a self pollinated crop. An expenditure of US $ 1.8/accession/year is incurred for the same (Saxena et al. 2003). The costs for acquisition, evaluation and characterization will remain same under both conditions; the storage costs are reduced drastically at high altitude dry cold areas where costs of equipments, electricity and power back up, etc. are not required.

Therefore, it may be concluded that waterproof aluminium bags can serve the purpose of medium term germplasm storage under cold dry conditions at high altitudes. However, for long term storage, the results need to be validated. For this the material should be checked for loss of viability in the years to come from time to time and compared with those stored in gene bank.

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Table 1. Average temperature, rainfall and snowfall at Dalang Maidan, Lahaul Spiti (HP)*

Month	Temperature (0C)	Rainfall (mm)	Snowfall (cm)
January	-22	0	14
February	-18	0	111
March	-4	3	96
April	3	6	26
May	8	55	2
June	12	0	0
July	14	6	0
August	15	34	0
September	10	11	0
October	6	0	0
November	0	0	19
December	-5	0	10

* Source: Data recorded at DC Office, Keylong (located near Dalang Maidan at similar height).

Table 2. Average germination percentage of accessions stored under natural conditions at Lahaul using three packings.

Year	Cloth bags	Water proof paper bags	Water proof aluminium bags	CD at 5%

1999	96.2	97.7	98.8	2.354
2000	92.5	95.6	95.3	2.227
2001	94.1	96.0	96.7	2.307
2002	90.9	94.4	94.8	2.350
2003	87.3	92.3	91.4	2.556
2004	87.6	91.1	93.8	2.395
2005	86.1	89.8	95.0	2.421
2006	82.1	87.6	94.3	2.544

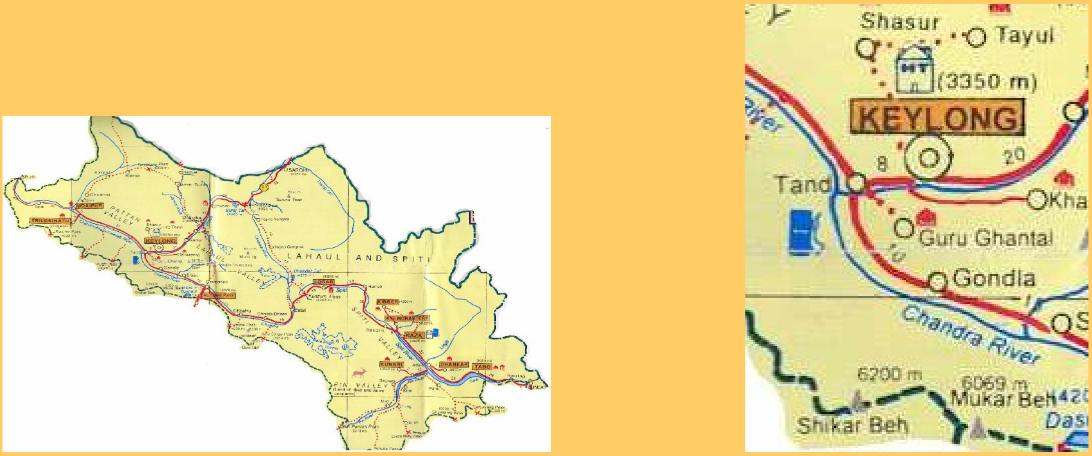

Fig. 1. (a) Map of Lahaul Spiti (HP) (b) Location of Dalang Maidan

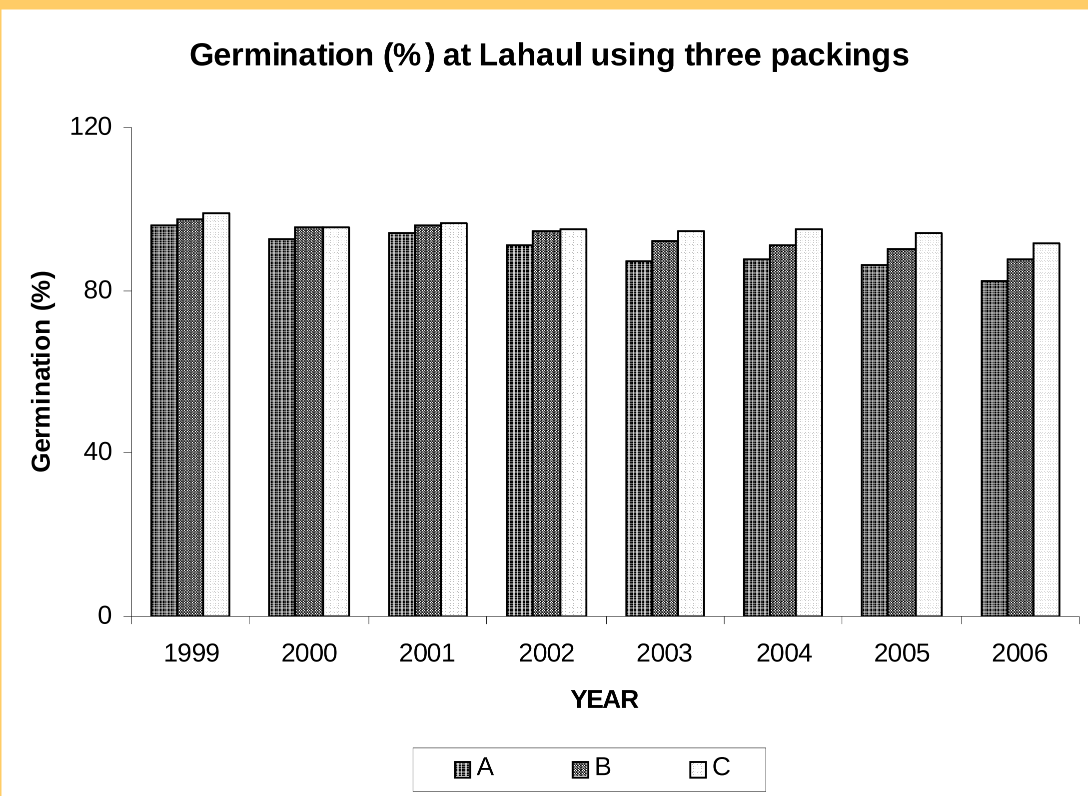

Fig.2. Germination %age of Triticum accessions stored in three types of packings under natural conditions at Dalang Maidan for 8 years

(A= cloth bags, B= water proof paper bags and C= water proof aluminium bags)