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Study on effect of storage conditions and storage periods on germination in mungbean germplasm

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Abstract
Effect of different storage conditions (10 ºc, 15 ºc and 25 ºc) and different storage periods (12, 24 and 36 months) on seed germination in 5 different mungbean germplasm lines collected from different locations of Kashmir valley was determined. Multivariate ANOVA revealed significant ($P < 0.0001$) effect of storage period on seed germination. Seed germination percentage significantly ($P < 0.01$) varied between 80% (SKUA-WMB-7) and 90% (SKUA-WMB-25) during initial testing. Data were recorded comparatively over different storage periods. In addition, above 80% seed germination in almost all germplasm lines even after 36 months of storage suggests 10 ºc as the most appropriate storage condition for long-term storage of mungbean.

Keywords: Germination, storage, condition, mungbean, viability

Introduction
Among pulse crops, mungbean (*Vigna radiata* L.) is one of the grain legumes under family of Leguminosae. Mungbean (*Vigna radiata* L.) also known as greengram, stands third after chickpea and pigeonpea among pulses. It is grown in about 4.5 million hectares with the total production of 2.5 million tonnes with a productivity of 548 kg/ha and contributing 10% to the total pulse production [1]. Mungbean seed contains a significant amount of protein(25.67%) fat(1-3%), carbohydrates (5.4%), fibers (3.5-4.5%) and ash (4.5-5.5%) with very low amount of flatulence effects [2, 3]. Mungbean protein is highly and easily digestible than other legumes as it has less sulphur containing amino acid with evenless methionine than lysine. If pulses can be properly stored they will remain in edible condition for several years. However, pulses suffer much greater damage from insects and microorganisms therefore are more difficult to store than cereals. This will result in quantitative as well as qualitative reduction of the nutritive value due to vitamin loss and protein quality deterioration. Insect-damaged grains show higher milling losses due to more breakage and powdering during milling. Pulses are also susceptible to infestation, both in field and storage, by weevils, which are prolific, breed rapidly, and cause serious deterioration in the nutritive value and the damage ranges from 30–70%. Higher humidity is conducive to more rapid proliferation of all species. As at 30 °C and 70% relative humidity (RH), some insects like bruchids take only few weeks to develop. Storage of seeds as *ex situ* germplasm is an essential step for long-term conservation of plant genetic resources. Maintaining seed viability for longer period is very essential to preserve the genetic integrity in stored samples. Room temperature storage is regarded as an inappropriate storage condition that often results in low seed germination, seed deterioration and loss of viability [4, 5]. Several factors *viz*., temperature, moisture, relative humidity and nature of seeds influence the seed longevity during storage [7, 8, 9. 10]. For seed longevity and quality conservation of products, degradation processes must be slowed down. Principal factors *viz*., time, temperature, humidity, moisture, oxygen content and light have tremendous effect on degradation of grains during storage; these factors may cause severe loss to the seed viability during other phases of the post-harvest storage.
It has been observed that there is a close relationship between the loss of seed viability during storage and the accumulation of genetic damage in the surviving seeds [11, 12]. Seed moisture content, temperature, and storage periods are among the main factors affecting above relationship [13]. Slight increase in temperature and moisture may promote fungal growth [9] and insect development in seeds [14].

Most important factors like temperature, humidity and moisture and their interaction are the determining factors in accelerating or delaying the complex phenomena of the biochemical transformation for grain degradation. Furthermore, these have a direct influence on development of insects and microorganisms (moulds, yeasts and bacteria), germination of grains in offseason. So, it is said that higher the value of these three factors, more rapidly the grain deteriorates. Seeds should be dried properly before storage otherwise high moisture content may cause reduction of seed viability by promoting fungal growth. Such deterioration could further result in decline of seed germination capacity [15]. Proper storage conditions, however, may effectively retain substantial viability in seeds over a considerable storage period. Decreasing seed viability process cannot be stopped, but might be slow down for longer shelf life. There occur some biochemical changes during seed storage and the rate of chemical change is influenced by two factors, internal and external factors. The internal factor is related to the seed characteristic that influence germination process (genetic trait called physiological decline). The external factor is related to seed packaging, storage temperature and humidity, called physical factors [16].

To minimize the occurence of chemical change in seed, it must be stored properly for optimal viability. Change of relatively high protein and fat content in seed, increase in moisture, temperature and humidity of the storage environment will cause decrease in the quality of mungbean seeds and it is a gradual and cumulative process of deterioration in viability and cannot be reversed due to physiological and biochemical changes [17, 18].

2. Materials and Methods

During year 2018, five (5) different mungbean germplasm were collected from 5 different locations of Kashmir valley. Collected seed were sown for seed multiplication. After harvesting seed were brought to the laboratory, cleaned thoroughly and dried in room temperature for 15 days. And then were tested for viability at three storage conditions over time.

2. a. Location and duration: The research work was performed at the laboratory of Division of Genetics and Plant Breeding, FoA, SKUAST-Kashmir, Wadura Sopore.

2. b. Storage condition: The daily weather data on temperature (maximum, minimum and mean) and relative humidity during the experimentation was recorded from the meteorological division of Agronomy, FoA, SKUAST-Kashmir, Wadura Sopore.

2. c. Seed moisture: Seed moisture content was determined by oven drying (60 ^{o}c; 48 hrs). Seed viability test were conducted by using 2, 3, 5, triphenyl tetrazolium chloride solution. For each germplasm, immediately after room drying, seeds were tested for their initial germination potential. The remaining seeds from each genotype were stored in different experimental conditions, *viz*., at temperature (10 ^{o}c, 15 ^{o}c and at 25 ^{o}c. The seeds were periodically tested for their germination viability. For each germination test, seeds were first disinfected with sodium hypochlorite solution (4% w/v available chlorine) or 70% ethanol for 5 sec. to reduce the incidence of disease. Disinfected seeds were washed thoroughly with double distilled water (DDW) and soaked in DDW for 24 hours. The soaked seeds were placed in Petri-plates lined with single layer filter paper saturated with DDW. 10 seeds from each genotype were used and kept in petri-plates then placed in a seed germination chamber. The seeds were kept moist (using DDW) and checked every day. Visible protrusion of the radical was the criterion to score seed germination. The germinated seeds were counted and removed. Seeds were observed daily until constant reading obtained.

3. Results

Mungbean (*Vigna radiata* L.) germplasm lines differed significantly for various seeds characteristics. Multivariate ANOVA revealed significant effect of germplasm lines from different storage periods and their interaction on seed germination percentage and germination time. An average of 12 days was required for the completion of seed germination in almost all of the germplasm lines for all the storage periods (Figure 1).

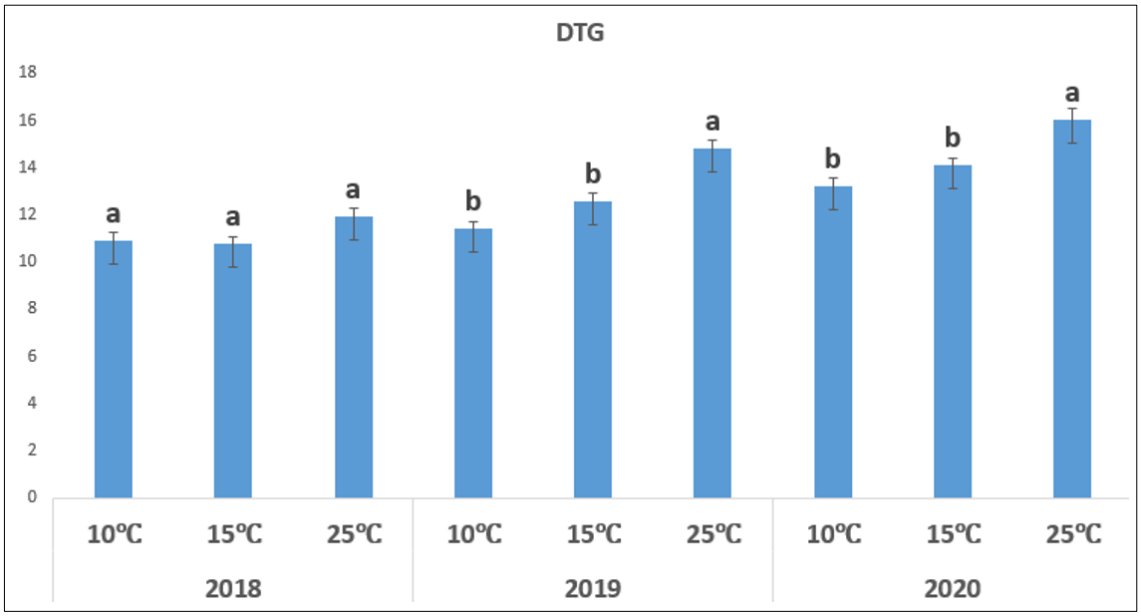

Fig 1: Figure indicates effect of storage period on days to germination

For the seeds stored at 10 °c, 90% germplasm lines recorded over 90% seed germination after 12 months; 80% germplasm lines recorded over 85% germination after 24 months; 75% germplasm lines recorded over 80% germination after 36 months of storage (Figures 2). For the seeds stored at 15 °c, 90% germplasm lines recorded over 80% seed germination after 12 months; 70% germplasm lines recorded over 60% germination after 24 months and 65% germplasm lines recorded over 50% germination after 36 months of storage (Figures 2). The seeds stored at 25 °c, resulted in above 70% seed germination in 90% germplasm lines after 12 months. Here, the percent seed germination ranged between 70% (SKUA-WMB-9) and 73% (SKUA-WMB-25) after 12 months; 70% germplasm lines recorded above 50% germination after 24 months, and the seed germination recorded below 50% in 90% of germplasm lines after 36 months of the storage (Figures 2).

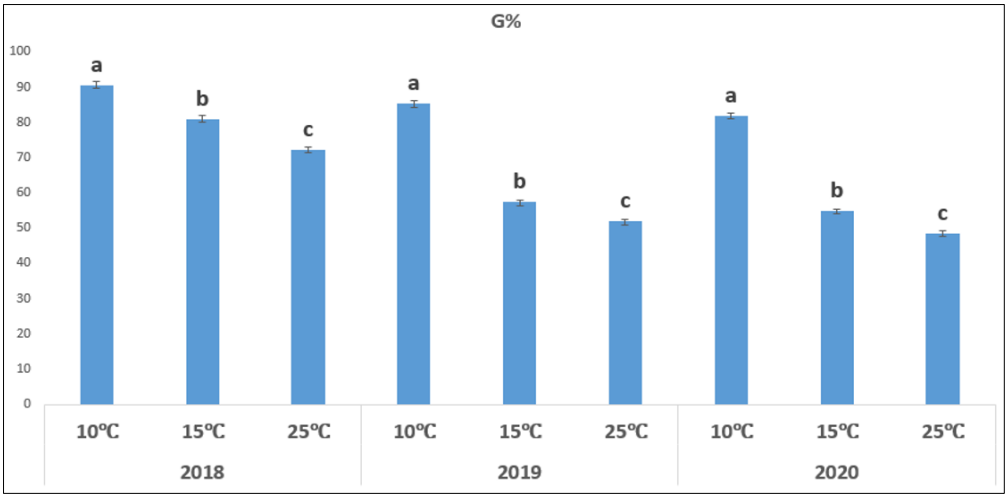

Fig 2: Figure indicates effect of storage period on germination percentage

At the initial test, seed germination percentage significantly ranged from 80% (SKUA-WMB-7) to 90% (SKUA-WMB-25). SKUA-WMB-25 recorded highest and local land race recorded the lowest germination at all storage periods, respectively; (Figure 3(a, b)).

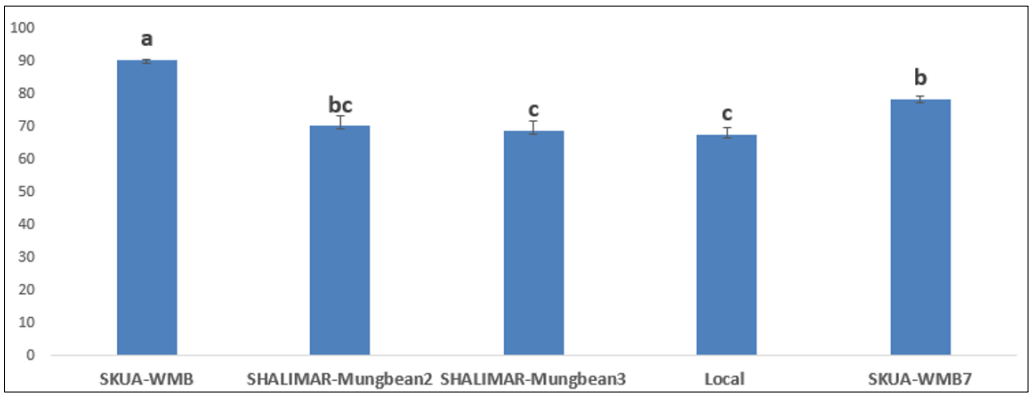

Fig 3(a): Figure indicates overall germination percentage of germplasm lines at all storage periods

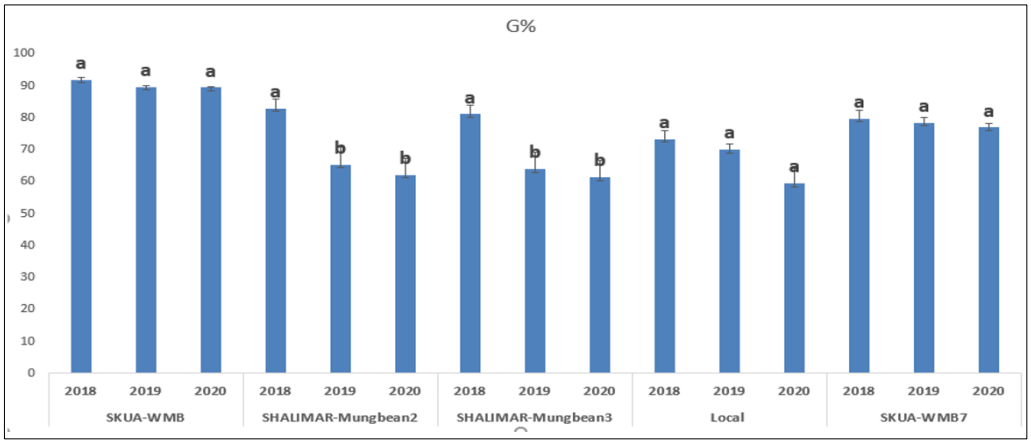

Fig 3(b): Figure indicates germination percentage of germplasm lines in 3 years at 3 different storage conditions.

Collectively, significant reduction in germination percentage was observed with the increasing storage duration compared to initial test in almost all germplasm lines of mungbean. Cumulatively for all the germplasm lines, seeds stored at 10 ºc showed significantly higher germination percentage than at 15 ºc and 25 ºc. The rate of fall in germination percentage was higher at room temperature followed by 15 ºc and then at 10 ºc stored seeds (fig. 4). This indicates that seed loses its viability completely by approximately after 36 months of storage at room temperature however at 15 ºc and 10 ºc temperature the rate of fall of seed viability is low.

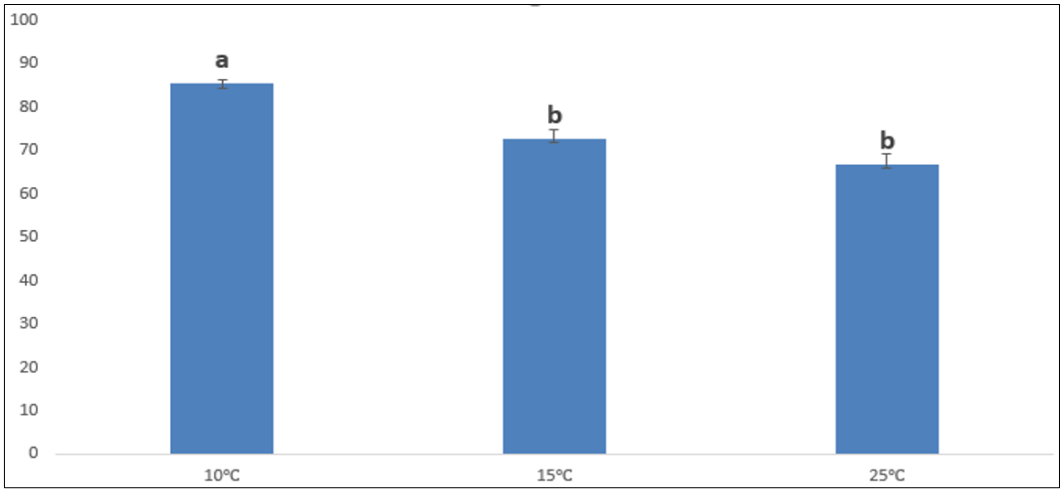

Fig 4: Figure depicts seed storage at 10 ºc shows higher germination percentage than at15 ºc and 25 ºc.

4. Discussion

The present study indicates, with increase in storage period the germination percent and/or seed viability gradually declines. 12 month storage did not show much variation in percent germination among the storage conditions suggesting the suitability of all three conditions for short-term storage, which is often practiced in almost all the locations in Kashmir valley. For 10 ºc storage, all the germplasm lines showed higher percent germination after 12 months, comparing to 15 ºc storage and 25 ºc. In general, above 60%, 70%, and 80% germination is observed after 12-month storage at 25 ºc, 15 ºc, and 10 ºc, respectively, suggests that up to 12 months, the seed storage at room temperature can also be opted provided due care be taken in respect of moisture content level prior to storage. After 24 months, there is abrupt fall in the percent seed germination below 60% in 80% germplasm lines indicates the room temperature as inappropriate condition of storing seeds for longer period in mungbean. Seed storage at 15 ºc for 24 and 36 months of storage resulted in decrease in the seed germination (below 60%) for all germplasm lines, which suggests this as unsuitable condition for the long-term seed storage. Comparatively, the seeds stored at 10 ^{0}c resulted in higher percent germination than the seeds stored at 15 ºc, and 25 ºc on subsequent testing. For all three storage conditions, progressive and significant reductions in percent seed germination were observed with increasing duration of the storage. On an average basis, loss of seed viability was much faster at room temperature followed by 15 ^{0}c stored seeds, but gradual at 10 ºc suggesting it as the most appropriate condition for the long-term storage. Our present finding suggests that storing seeds of mungbean at 15 ºc can be a second option after 10 ºc; however, here the seeds lose their viability early compared to 10 ºc. Many studies reported that the seed storage at 10 ºc was effective for germination after 6 months [8] to 12 months [19]. Seed moisture content is adjusted as per the relative humidity of the surrounding air which changes with the air temperature and seeds differ in the way they adjust their moisture content to humidity. After drying seeds retain 8% to 10% moisture content shows viability for longer period of time. This is supported by the study which stated that 9% to 12% seed moisture is desirable to increase the grain storage life [20]. It has been observed in our earlier study that with 9% to 12% seed moisture content, seeds showed 90% germination during initial testing and above 60% seed germination in majority of germplasm lines up to 24 months of storage [21].

5. Conclusion

The present study stressed on the high seed germination potential as well as variability in seed germination in five (5) germplasm lines of mungbean collected from different areas of Kashmir valley. The study indicated that the storage at 10 ºc temperature can retain seed viability for the longer period than other storage conditions and suggests it as the best/effective storage condition for the seeds of mungbean. However, 15 ºc and the room temperature (25 ºc) storage conditions can be opted for short-term storage up to one and half year (18 months). It concludes convincingly that the storage condition highly affects the seed germination percentage, which declines with increasing storage duration irrespective of storage condition.

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