

# Effect of packaging materials and storage duration on seed germination of maize inbred

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**Abstract:** The germination percent of inbred IGI 1103 affected significantly with storage duration. The rate of seed deterioration was higher in ambient conditions compare to cold storage because of uncontrolled environmental conditions. Seed packaging materials also significantly affected seed deterioration. Among two types of packaging materials, aluminium foil bag ( $P_2$ ) was found superior for maintaining viability. Cloth bag ( $P_1$ ) is not safe for maize inbred line seed storage for longer time. From the result of present study, it was concluded that maize inbred IGI 1103 kept in aluminium bag in cold storage for longer period minimize the deterioration effect on seed germination status.

**Keywords:** Inbred · Storage · Packing materials · Environment · Germination

## Introduction

Seeds are required to be kept in safe storage since they are harvested in the proceeding season and usually used for sowing in the subsequent season often after a time gap of six months or longer. Even if properly dried after harvest, exposure to moist and humid conditions during storage causes the kernel to absorb water from the surroundings (Devereau *et al.*, 2002), leading to increased maize moisture contents, which results in enhanced deterioration. It is also stated that seed vigour decreases with increasing water content especially in high

temperature environments and high air humidity. Inbreds have less vigour when compared to maize hybrid seed and are more susceptible to drying temperatures, in the form of cobs, compared to commercial hybrids, requiring moderate drying regimes (Moldovan *et al.*, 2015). However, it varies among genotypes/maize parental lines. Poor seed storability is a major problem in maize. The longevity of seed in storage is influenced by the initial seed quality as well as conditions of storage (Oyekale, 2012). Storage of seed beyond optimum storage period might result in reduced germination potential, seedling establishment and final seed production. The hygroscopic nature of maize seed sometimes makes them unsafe for storage in an open container (Adetumbi *et al.*, 2009). In addition, the seed must be packaged using moisture vapour proof containers like polythene bags, aluminium foil bag, gunny bag lined with polythene with or without desiccating agent to properly maintain the quality of seed for a longer period (Singh and Singh, 1992).

## Materials and methods

The experiment was carried out at the Department of Seed Science and Technology, Anand Agricultural University, Anand during the year 2020-21. The seeds of a male inbred line (IGI 1103) were obtained from Main Maize Research Station, AAU, Godhra. The seeds used for this experiment were already stored for 7 months under ambient condition in cloth bag before conducting this research. The seeds of inbred line IGI 1103 were packed in two packaging containers *viz.*, cloth bag ( $P_1$ ) and aluminum foil bag ( $P_2$ ). The packed seeds were stored in 4°C (Cold) ( $E_2$ ) and ambient storage (Room temperature) conditions ( $E_1$ ), for three different durations *viz.*, 6 months ( $D_1$ ), 9 months ( $D_2$ ) and 12 months ( $D_3$ ).

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Germination percentage was determined by following the between paper towel method as prescribed under ISTA rules. Four replications of 100 seeds each were kept for germination in rolled towels in a germinator maintained at 25°C and 95 per cent relative humidity. Final count was taken on 7<sup>th</sup> day. The germination was calculated based on normal seedlings counted on the final day and expressed in per cent.

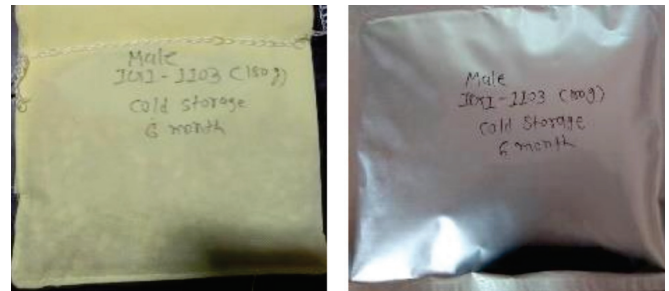
## Results and discussion

The inbred line was influenced by packaging materials, storage duration and environmental condition and their interaction was found significant (Table 1 & Plate 1&2).

### Effect of packaging materials

The effect of packaging materials on germination was significant over different storage durations at 6, 9 and 12

months of storage. The line IGI 1103 seed stored in aluminum foil bag (P<sub>2</sub>) recorded significantly higher germination (70.17) due to its moisture and vapor impervious nature. The seeds stored in the cloth bag (P<sub>1</sub>) recorded the lowest germination percent (62.78) and recorded fast reduction due to its moisture pervious nature. This higher moisture in the seed may be the main reason of quick quality deterioration in the seeds of cloth bag.



P<sub>1</sub> (cloth bag)

P<sub>2</sub> (aluminum foil bag)

**Plate 1.** Packing material used in experiment

**Table 1.** Effect of packaging materials, storage duration and environmental condition on germination percentage of maize (*Zea mays* L.) IGI 1103 inbred

Particulars	Storage Duration (Months)			Mean
	D1	D2	D3	
Interaction P×D				P
Packaging materials	P1	92.67	70.00	25.67
	P2	93.33	77.00	40.17
Interaction EXD				E
Environmental conditions	E1	91.67	67.67	19.50
	E2	94.33	79.33	46.33
Interaction PXEXD				PXE
E1	P1	91.33	61.33	14.67
	P2	94.00	78.67	36.67
E2	P1	92.00	74.00	24.33
	P2	94.67	80.00	56.00
Duration mean		93.00	73.50	32.92
Overall mean				66.47
Comparing mean		S.Em.(±)		CD@ 5%
Packaging material (P)		0.96		2.18
Duration (D)		1.18		3.45
Interaction PXD		1.67		4.88
Environmental condition (E)		0.96		2.82
Interaction PXE		1.37		NS
Interaction EXD		1.67		2.82
Interaction PXEXD		2.36		6.91
CV (%)				6.16

Storage period

D1: 6 months

D2: 9 months D3: 12 months

NS: Non-significant

Environmental condition

E1: Ambient condition

E2: Cold Storage

Packaging materials

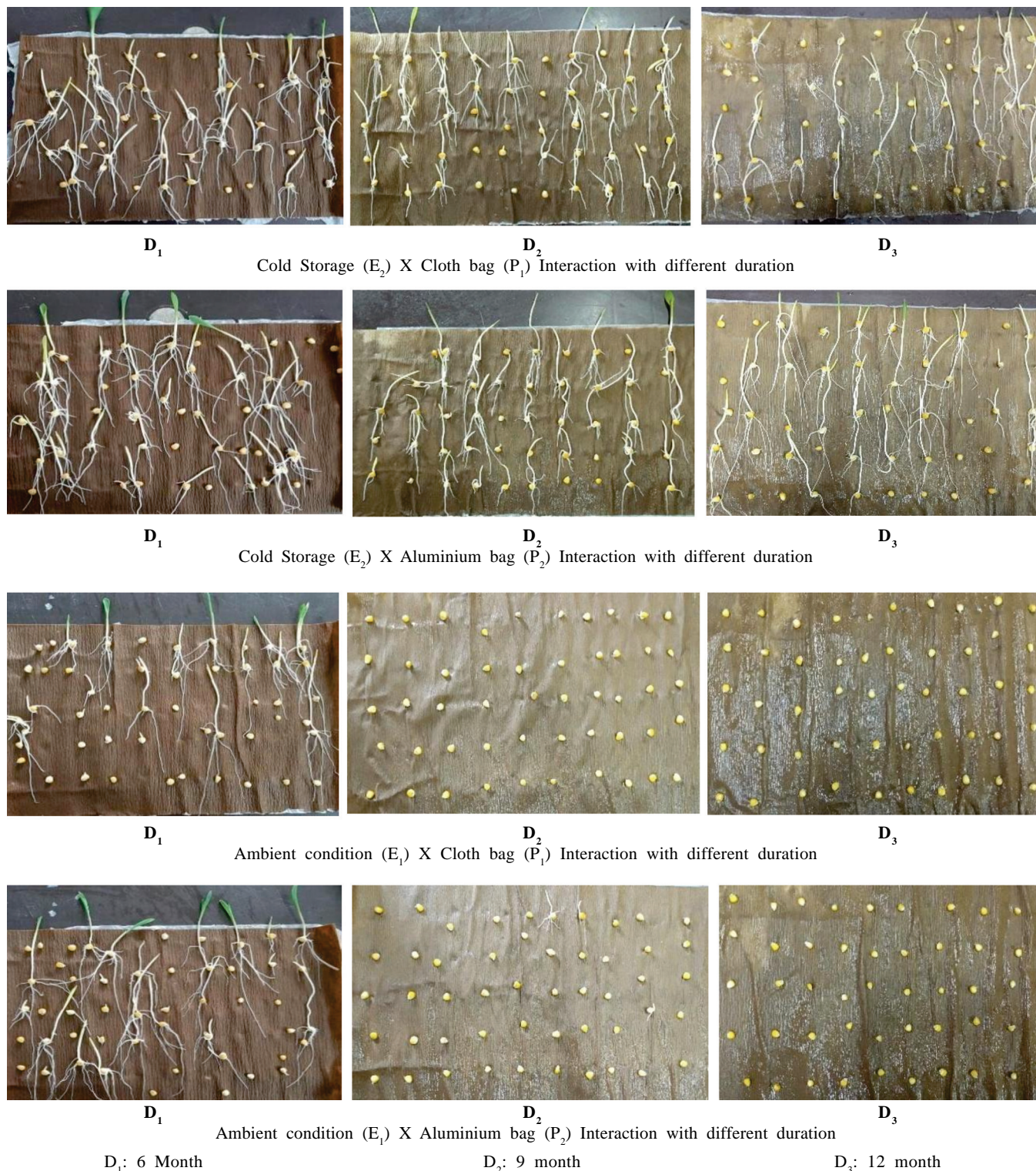
P1: Cloth bag

P2: Aluminium foil bag

*Effect of storage duration*

In maize parental line IGI1103, seed germination potential decreased as per progressive storage duration. Significantly the highest germination percent (93.00) was

recorded at 6 months ( $D_1$ ) storage duration and reduced to (73.50) at 9 months ( $D_2$ ) of storage. The seed germination of stored inbred line IGI1103 seed of maize maintained has germination percent as per Indian minimum seed certification standard (IMSCS) at very initial 6 months



**Plate 2.** Effect of packaging materials, storage duration and environmental condition on germination percentage of maize (*Zea mays* L.) IGI 1103 Inbred line

(D<sub>1</sub>) of storage duration irrespective of packaging materials. At the end of 12 months (D<sub>3</sub>) of storage significantly the lowest germination per cent (32.92) recorded.

#### *Effect of environmental condition*

The observation on germination indicated that the germination of maize inbred line IGI 1103 seeds was significantly influenced by different environmental conditions. Higher germination percentage (73.33) was recorded in (E<sub>2</sub>) cold storage (4°C) condition compare to (E<sub>1</sub>) ambient condition (59.61). The probable reason for high rate of reduction in germination in ambient condition was high temperatures during storage enhance seed deterioration for fast metabolic activities under moist condition (McDonald, 1999).

#### *Interaction effect of packaging materials and storage duration*

The significant difference was observed due to interaction effect of packaging materials and storage duration in germination percentage of maize inbred line IGI1103 seeds. A significantly higher germination percentage (93.33) was recorded by the seeds stored in Aluminum foil bags for six months (P<sub>2</sub>D<sub>1</sub>). At the end of twelve months, seeds stored in cloth bags (P<sub>1</sub>D<sub>3</sub>) showed lower germination percentage (25.86). The maize seed is hygroscopic and absorbs moisture from surrounding environment and rapidly loose viability. This may be the reason for lower viability in cloth bag.

#### *Interaction effect of packaging materials and environmental condition*

The observation on germination in maize inbred line IGI 1103 seeds indicated that the interaction effect of packaging materials and environmental condition found non-significant. Seeds stored in aluminum foil bag in cold storage (P<sub>2</sub>E<sub>2</sub>) recorded higher germination percentage (76.89) whereas; seeds stored in cloth bag in ambient condition (P<sub>1</sub>E<sub>1</sub>) recorded numerically the lowest germination percentage (55.78).

#### *Interaction effect of storage duration and environmental condition*

Germination percentage was greatly influenced by different combination on storage duration and environmental

condition and also found significant differences observed in this study. Significantly the higher germination per cent (94.33) was maintained by the maize inbred line IGI 1103 seeds stored in cold storage for six months (D<sub>1</sub>E<sub>2</sub>) and decrease as storage duration increases. At the end of twelve months, seeds stored in ambient condition (D<sub>3</sub>E<sub>1</sub>) showed maximum deterioration and recorded lower germination percentage (19.50). Compared to ambient condition at the end of storage duration, cold condition maintained higher germination percentage.

#### *Interaction effect of packaging materials, storage duration and environmental condition*

Data pertaining to germination percentage of maize inbred line IGI1103 seeds showed significantly influenced of combine effect of packaging materials, storage duration and environmental condition on germination percentage and the differences were also found significant. Numerically higher germination (94.67) was recorded by the seeds stored under cold storage up to six months in aluminium foil bags (P<sub>2</sub>D<sub>1</sub>E<sub>2</sub>) followed by ambient condition in aluminium foil bags for same duration (92.00).

The decrease in the germination percentage over the storage duration might be attributed to deterioration due to fluctuating temperature, moisture content and relative humidity as influenced by packaging materials. Cloth bags having porous nature and reacts with change in atmospheric condition. Aluminum foil bags sustain viability for longer storage duration because of its impervious nature so protected the seeds from surrounding environmental factors. The results are in concurrence with the earlier finding of Owolade *et al.* (2011) in sorghum, Rajasekaran (2004) in brinjal hybrid and Patil and Gouda (2007) in rice hybrid seeds.

At the initial stage of storage, germination percentage of seeds was higher because of initial vigorous nature of seeds and it decrease further increase in storage period. As reported by Walter *et al.* (2005) the length of storage time is strongly influenced by environmental and genetic factors such as storage temperature and seed moisture content. When seeds deteriorate during storage, they lose vigour, become more sensitive to stress during germination and ultimately become unable to germinate. These findings were also reported by Rajjou and Debeaujon (2008) and Borza *et al.* (2017) in maize.

Storage of seeds under low temperatures or cold storage (4°C) can extend the lifetime use of maize seeds. Under ambient condition high temperatures accelerated respiration quickly so that faster the changes in food reserves in the seeds that have an impact on the decrease in germination percentage and vigour of the seeds. The rate of seed deterioration enhances with increased moisture levels. Seed moisture content fluctuates with long-term changes in atmospheric humidity. Low temperature and air humidity limit the increase of seed moisture content and the rate of respiration of the seeds during the storage period. These results conform with a finding of Wang *et al.* (2018), Gupta (2010) in rice and Timoteo and Marcos (2013) in corn genotype. Germination per cent, viability, vigour and other seeds quality parameters significantly reduced with natural ageing. The seed germination of stored IGI1103 inbred line seed of maize maintained its germination percent above Indian Minimum Seed Certification Standard (IMSCS) at very initial 13 months of storage duration irrespective of packaging materials. Maize inbred lines seeds are packaged in aluminium foil bags and kept in a cold environment (4°C) for long periods without affecting the germination of the seeds.

## Conclusion

The rate of seed deterioration was higher in ambient conditions compared to low temperatures or cold storage (4°C) which can extend the life span of maize inbred seeds. The seed germination percentage of the stored maize inbred line (IGI1103) was maintained above the Indian Minimum Seed Certification Standard for an initial 13 months of storage duration in cold storage irrespective of packaging materials. Seed packaging materials also significantly affected seed deterioration. Among the two types of packaging materials, aluminium foil bag was found superior for maintaining the seed viability of maize inbred.

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