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Study of some physiological properties of soybean seeds in four different varieties of soybean seeds in three different storage containers

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Abstract
The Physiological changes such as speed of germination; seedling dry weight and moisture content are occurred in seeds during storage. Literature reported that these changes mainly depend upon the type of storage containers, variety of the seeds used and storage conditions. In the present study three different bags Polythene bag (C1), Cloth bag (C2) and Jute bag (C3) of dimensions 20 cm x 30 cm were used for the storage of soybean seed of four different varieties JS-335 (V1), AMS-99-33 (V2), TAMS-38 (V3) and TAMS-98-21 (V4) under ambient temperature and relative humidity for a period of 18 months. The seeds from each container were removed after 3 months (90 days) and examined for different physiological observations. Maximum speed of germination (20.33) was observed in JS-335 variety, followed by AMS-99-33, TAMS-38 and TAMS-98-21 as 18.67, 14.67 and 13.67 respectively at the end of 540 days of storage. Among the storage containers the seeds stored in Polyethylene bag recorded the highest value of speed of germination followed by Cloth bag at the end of storage and seeds stored in Jute bag recorded lowest value of speed of germination in the variety TAMS-98-21. Thus, JS-335 variety showed least effect on speed of germination during storage as compared to AMS-99-33, TAMS-38 and TAMS-98-21. Maximum seedling dry weight (0.98 gm) was observed in JS-335 variety, followed by AMS-99-33, TAMS-38 and TAMS-98-21 as 0.91 gm, 0.81 gm and 0.74 gm respectively at the end of 540 days of storage. The corresponding moisture content values of soybean varieties JS-335, AMS-99-33, TAMS-38 and TAMS-98-21 when stored in Polyethylene, Cloth and Jute bags were different. Variety JS-335 seeds recorded lower moisture content (9.1 %) as compared to AMS-99-33, TAMS-38 and TAMS-98-21.

Keywords: soybean, Stoarge containers, physiological studies, speed of germination, seedling dry weight, moisture content

1. Introduction
An important aspect in any agricultural improvement programme is the maintenance of quality in the storage of seeds. High temperature and high humidity conditions which are the common ambient feature of subtropical and tropical areas, induced deterioration of seed quality. Although several reviews are available on the loss of seed viability during storage and its assessment has been standardized. Soybean; the raw materials for vegetable oils, occupy a significant place in India's national economy. India is the world's biggest oilseed growing country and, paradoxically, the world's biggest important of edible oils as well, the main reason for this can be traced to low productivity per hector. In Vidarbha region of Maharashtra State, soybean crop are harvested in October-November. The seeds of soybean crops are stored for 7-8 months prior to sowing. Through sun drying after harvest, followed by storage, has been found to reduce the problem of loss of viability. Even keeping the seeds under ambient conditions in ordinary gunny bags, would result in significant loss of viability (Charjan and Tarar; 1992) [10]. However, seed is not dried to relatively safe moisture content after harvest; its storability will be reduced (Gadewar *et al*., 2009) [18].
The demand for seed is fluctuating and very often there are large surplus stock of seed which need to be preserved till the time of next sowing. Such left-over seed experience in the hot and humid mansoon month, would significantly decline germinability. By the time of next sowing in June-July, the loss in vigour and viability of carry over seeds, may adversely affect field emergence and productivity (Basu, *et al*.; 1978, Charjan and Tarar; 1992, and Abdullah M. Alhamdan *et al*.; 2011) [8, 11]. The oil seeds are poor storer and loose its viability very fast in adverse conditions of temperature and humidity.

2. Material and Methods
Seeds of the following kinds and varieties i.e.JS-335, AMS-99-33, TAMS-38 and TAMS-98-21, (Denoted by V1, V2, V3 and V4 respectively) were obtained from "All India Co-ordinate Oil Seed project, College of Agriculture, Nagpur.
The seed samples were packed in the respective containers Polyethylene bag 700 gauge (moisture vapour proof), Cloth bag (moisture pervious) and Jute bag (moisture pervious). Polyethylene bag, Cloth bag and Jute bag, are denotes by C1, C2 and C3 respectively. All the three bags will be of 20 cm x 30 cm. The respective containers were then stored in wire mesh almirah in mesonary building having cemented walls, roof and floor under ambient temperature and relative humidity for a period of 18 months. Portion of the seeds from each container were removed after 3 months (90 days) and examined for Physiological observations.
0 Days, 90 Days, 180 Days, 270 Days, 360 Days, 450 Days, and 540 Days intervals are denoted by T1, T2, T3, T4, T5, T6 and T7 respectively.

Statistical analysis
The data obtained from the experiments were statistically analyzed by using factorial CRD. (Complete Randomized

Design), Using Web Portal of CCS Hariyana Agricultural University, Hisar: http://14.139.232.166/opstat/default.asp. The critical differences between the parameters like Soybean seed Varieties, containers and storage period were worked out at five per cent significance.

3. Liturature Survey

Ray *et al*., (2015) [39] studied the effects of temperature stress on Soybean seeds and reported that he soybean seeds exhibited gradual reduction in speed of germination in all the treatments temperatures of 40°C, 50°C, and 60°C for extended periods of 3, 5, and 7 days. Khaliliaqdam *et al*., (2012) [27] found that decrease in soybean seed lot vigour led to a significant reduction in field emergence in nine of the seed lots mainly due to poor germination rate. Low seed vigour caused delay in germination and subsequent reduction in speed of germination. Yaja *et al*., (2005) [56] studied soybean seed quality in relation to seed moisture Content and storage temperature and revealed that a moisture content of 65% and a temperature of 28°C were most favourable conditions for highest speed of germination. Adam *et al*., (2018) [2] studied germination performance and vigour of pepper seeds stored in different environmental conditions at different storage periods and stated that speed of germination is more superior to standard germination as a measure of vigour. Bahry *et al*., (2017) [6] reported that the speed of germination test results in most correctly distinguished vigour levels among the seed lots and closely correlated with yield in soybean seeds.

Jaiswal *et al*., (2018) studied on packaging materials, storage duration on seed viability and seed health in soybean (*Glycine max* L.) seeds and recorded higher seedling dry weight seeds stored in vacuum polythene bag compared to Non-vacuum polythene bag, and Cloth bag after 6 months of storage. Meena *et al*. (2017) [30] studied influence of vacuum packaging and storage conditions on the seed quality of cotton (Gossypium spp.) for storage period of 18 months and reported that maximum seedling dry weight with vacuum containers and least with aluminium and cloth bags. Ali *et al*. (2014) [3] showed that seedling dry matter decreased initial seed moisture content irrespective of storage containers used. Highest seedling dry matter of soybean seed was in polythene bag at 8% initial moisture content as compared to those stored in cloth bag at 12% initial moisture.

Khan *et al*., (2018) [28] observed the correlation between container and seed moisture level, the highest germination and lowest seed-borne fungal infection was recorded in seeds stored in aluminum foil bag with 7% moisture content. Maina *et al*., (2017) found that seeds stored in clay pots, brown paper bags, plastic transparent jars and freezer had higher seed quality than those stored in polythene bags. Rani *et al*., (2013) [38] suggested that the seeds at higher moisture contents (16, 18, and 20%) must be dried to lower levels before 8, 5, and 3 weeks, respectively for prolonged storage. Verma and. Verma, (2014) [51] observed that cloth bag is not perfect for soybean seed storage for long time as compared to tin container and polyethylene bag; because the rate of moisture absorbance was higher in bag than in container and polythene bag.

Results and Discussion

a. We *Speed of Germination*

The effect of container and storage period on speed of germination in all four varieties V1, V2, V3 and V4 is presented in Table 1.

Table 1: Effect of Varieties (V), Storage Containers (C) and Storage Periods (T) and three factor interaction on Speed of Germination of soybean seeds during storage.

VxCxT	V1			V2			V3			V4		
	C1	C2	C3	C1	C2	C3	C1	C2	C3	C1	C2	C3
T1	44.33	44.33	44.33	44.00	44.00	44.00	43.00	43.00	43.00	41.00	41.00	41.00
T2	44.00	44.00	43.33	43.33	42.33	41.33	42.33	41.67	40.67	38.67	37.67	36.33
T3	42.00	42.00	41.00	40.33	39.00	36.67	38.33	37.67	37.00	34.33	31.33	28.33
T4	40.33	36.33	34.33	39.67	34.00	34.00	35.33	30.00	27.67	30.67	27.67	22.67
T5	37.33	28.67	26.67	36.33	23.33	21.67	30.00	21.67	19.33	23.00	18.33	15.67
T6	25.33	21.67	18.67	23.67	18.00	16.33	20.33	15.67	13.67	17.33	14.67	10.00
T7	20.33	15.67	10.67	18.67	12.00	8.67	14.67	9.67	7.67	13.67	8.33	1.67
Mean	36.24	33.24	31.29	35.14	30.38	28.95	32.00	28.48	27.00	28.38	25.57	22.24
SE (m)	1.008											
CD (P=5%)	NS											

*NS- Non-Significant

In all four varieties, the speed of germination significantly decreased with increase in storage period. However the rate of decrease in speed of germination varied with the type of container used. Seeds stored in Polyethylene bag (C1) showed significantly higher speed of germination (20.33) as compared to those stored in Cloth bag (C2) (15.67) and Jute bag (C3) (10.67) up to 540 days (T7) days of the storage. Among the containers, Polyethylene bag (C1) showed significantly higher speed of germination (36.24) as compared to Cloth bag (C2) (33.24) and Jute bag (C3) (31.29) throughout the storage period.

b. *Seedling Dry Weight (gm)*

The effect of container and storage period on Seedling dry weight in all four varieties V1, V2, V3 and V4 is presented in Table 2.

Table 2: Effect of Varieties (V), Storage Containers (C) and Storage Periods (T) and three factor interaction on Seedling dry weight (gm) of soybean seeds during storage

VxCxT	V1			V2			V3			V4		
	C1	C2	C3	C1	C2	C3	C1	C2	C3	C1	C2	C3
T1	1.70	1.70	1.70	1.65	1.65	1.65	1.59	1.59	1.59	1.49	1.49	1.49

T2	1.61	1.57	1.53	1.56	1.51	1.49	1.42	1.38	1.27	1.38	1.32	1.22
T3	1.52	1.43	1.40	1.41	1.37	1.31	1.35	1.25	1.18	1.29	1.19	1.13
T4	1.42	1.30	1.28	1.27	1.21	1.18	1.19	1.12	1.09	1.12	1.02	1.00
T5	1.25	1.20	1.15	1.17	1.04	0.97	1.08	1.00	0.95	0.97	0.91	0.86
T6	1.12	1.08	1.03	1.06	1.01	0.91	0.94	0.88	0.80	0.86	0.81	0.76
T7	0.98	0.94	0.89	0.91	0.87	0.81	0.81	0.74	0.70	0.74	0.69	0.68
Mean	1.37	1.32	1.28	1.29	1.24	1.19	1.20	1.14	1.08	1.12	1.06	1.02
SE (m)	0.017											
CD (P=5%)	NS											

*NS- Non-Significant

In variety JS-335 (V1), the seedling dry weight significantly decreased with increase in storage period. However, the rate of decrease in seedling dry weight varied with the type of container used. Seeds stored in Polyethylene bag (C1) showed significantly higher seedling dry weight (0.98 gm) as compared to those stored in Cloth bag (C2) (0.94 gm) and Jute bag (C3) (0.89 gm) up to 540 days (T7) days of the storage. Among the containers, Polyethylene bag (C1) showed significantly higher seedling dry weight (1.37 gm) as compared to Cloth bag (C2) (1.32 gm) and Jute bag (C3) (1.28 gm) throughout the storage period.

c. *Moisture Content (%)*

The effect of container and storage period on Moisture Content in all four varieties V1, V2, V3 and V4 is presented in Table 3.

Table 3: Effect of Varieties (V), Storage Containers (C) and Storage Periods (T) and three factor interaction on Moisture Content (%) of soybean seeds during storage.

VxCxT	V1			V2			V3			V4		
	C1	C2	C3	C1	C2	C3	C1	C2	C3	C1	C2	C3
T1	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
T2	9.0	8.9	9.0	9.1	8.8	9.2	9.0	9.0	9.1	9.1	8.9	9.2
T3	9.2	10.8	11.2	9.1	11.0	11.4	9.2	10.8	11.4	9.0	11.1	11.5
T4	9.1	10.2	10.4	9.0	10.4	10.5	9.1	10.1	10.6	9.0	10.3	10.6
T5	9.0	10.1	10.2	9.0	10.2	9.9	9.1	10.2	10.4	9.0	10.3	9.8
T6	9.0	9.3	9.4	9.0	9.5	9.5	9.0	9.6	9.8	9.0	9.4	9.6
T7	9.1	11.2	11.6	9.1	11.4	11.8	9.2	11.1	11.7	9.1	11.3	11.9
Mean	9.1	9.9	10.1	9.0	10.0	10.2	9.1	10.0	10.3	9.0	10.0	10.2
SE (m)	0.193											
CD (P=5%)	NS											

*NS-Non Significant

In variety JS-335 (V1), Polyethylene bag (C1), Cloth bag (C2) and Jute bag (C3) showed fluctuations in moisture content of seeds during storage according to temperature and relative humidity of the atmosphere. A significant minimum fluctuation of moisture content was observed in Polyethylene bag (C1). Seed stored in Polyethylene bag (C1) showed significantly lower moisture content (9.0 %) as compared to those stored in Cloth bag (C2) (11.2 %) and Jute bag (C3) (11.6 %) up to 540 days (T7) days of the storage. Among the containers Polyethylene bag (C1) showed significantly lower mean moisture content (9.1 %) as compared to Cloth bag (C2) (9.9 %) and Jute bag (C3) (10.1 %) throughout the stoarage period.

4. Discussion

a. *Speed of Germination*

The values for speed of germination decreased with advancement of storage period in all four varieties. The seeds stored in Cloth (C2) and Jute (C3) bags showed significantly lower value for speed of germination respectively (Figure 5.13 and Figure 5.14). It was comparatively more in Polyethylene bag (C1). It seems that Cloth (C2) and Jute (C3) bags, the seed vigour decreases proportionately. The efficiency of this test decreased directly with the increase in seed deterioration during storage as reported by Shelar et al., (2008) [44]. The seeds stored in Cloth (C2) and Jute (C3) bags deteriorated more rapidly due to moisture pervious nature (Jyoti1 and Malik, 2013; Vithal et al., 1989) [24, 53].

In the present investigation seed stored in Polyethylene bag (C1) exhibited significantly higher values for speed of germination. The reason for this may be traced to higher vigour of seeds than those stored in Cloth (C2) and Jute (C3) bags respectively. Kandil et al., 2013 [25] reported that higher speed of germination is on account of greater seed vigour.

Varietal differences were noted regarding speed of germination. The seeds of variety JS-335 (V1) showed significantly higher values for speed of germination than other varieties under study during storage. This difference at varietal level might be due to the superior genetic make-up (Lambat *et al*., 2017) [29] of JS-335 (V1) as compared to AMS-99-33 (V2), TAMS-38 (V3) and TAMS-98-21.

The results obtained from speed of germination study for Polyethylene bag have been illustrated graphically in Figure 1.

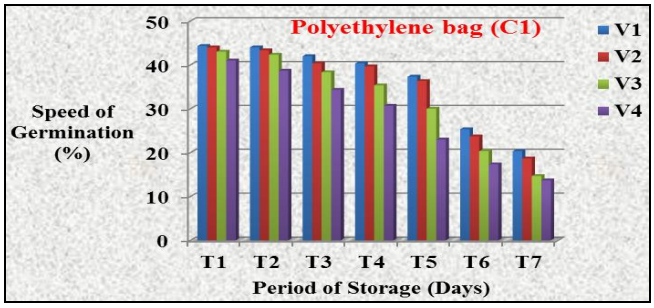

Fig 1: Effect of storage containers on Speed of Germination in Soybean seed varieties. Stored in Polyethylene bag (C1).

b. *Seedling dry weight*

The rate in the present investigation, seedling dry weight decreased with corresponding increase in storage period. The seeds stored in Cloth (C2) and Jute (C3) bags, showed significant reduction in seedling dry weight compared to those stored in Polyethylene bag (C1)

Rezapour *et al*., (2013) [40]; Egli, (1975) [15] found that prolonged period of storage decreased dry matter of seedling. Progressive reduction in seedling dry matter was due to decrease in viability (Hussaini *et al*., 1988) [22] and Vigour (Karuna and Aswathaiah, 1989) [26].

The seeds stored in Polyethylene bag (C1) showed significantly higher seedling dry weight during storage. Arulunandhy and Senanayake, (1988) [5] recorded that seeds

stored in moisture vapour-proof container showed higher seedling dry weight than moisture pervious container.

Varietal differences were noted regarding seedling dry weight. The seeds of variety JS-335 (V1) showed significantly higher values for seedling dry weight than other varieties under study during storage. This difference at varietal level might be due to the superior genetic make-up of JS-335 (V1) as compared to AMS-99-33 (V2), TAMS-38 (V3) and TAMS-98-21. Arulunandhy and Senanayake, (1988) [5] reported varietal differences in seedling dry weight during storage.

The results obtained from Seedling dry weight for Polyethylene bag have been illustrated graphically in Figure 2.

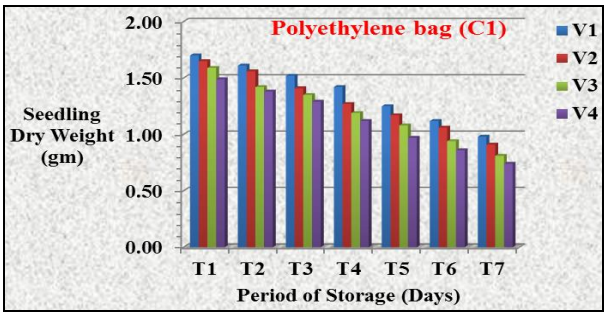

Fig 2: Effect of storage containers on Seedling dry weight in Soybean seed varieties stored in Polyethylene bag (C1).

c. *Moisture content*

The In the present investigation, the moisture content of the seeds does not adopt any trend either of decrease or rise continuously with the increase of storage period in all four varieties of soybean. The moisture content of seeds increased or decreased according to the atmospheric relative humidity and temperature. The moisture content of seeds was directly related to the relative humidity of the atmosphere (Delouche *et al*., 1973).

It was also found that when seeds were stored in Cloth (C2) and Jute (C3) bags, it showed higher moisture content than those stored in Polyethylene bags (C1). The least amount of moisture increase was found in seeds stored in Polyethylene bag (C1) during storage. This increase in moisture content of seeds stored in Cloth (C2) and Jute (C3) bags may be due to moisture pervious nature. While in Polyethylene bag it is primarily due to resistance to moisture penetration. Nahar *et al*. (2009) [33] investigated that, Cloth and Jute sacks offer no resistance to moisture penetration. The moisture content of seeds stored in open weave, cotton or Jute sacks will eventually reach a value which is in equilibrium with the atmospheric relative humidity in the store. Ali *et al*., (2014) [3] reported that seed stored in Polyethylene packets is considered to be the best because humidity cannot pass through it.

In the present investigation, the corresponding moisture content values of soybean varieties JS-335 (V1), AMS-99-33 (V2), TAMS-38 (V3) and TAMS-98-21 (V4) when stored in Polyethylene (C1), Cloth (C2) and Jute (C3) bags were different. The seeds of soybean varieties absorb more moisture comparatively. This may be due to bulk protein constitution of soybean seeds. The present findings are in agreement with those of Snow, (1944) [47] and Allerup, (1958) [4].

Wang et al., (2010) [55] reported high moisture holding capacity of proteineous legume seeds. Significant varietal differences in soybean crop were not found in regard to moisture content of seeds during storage.

The results obtained from determination of moisture content have been illustrated graphically in Figure 3.

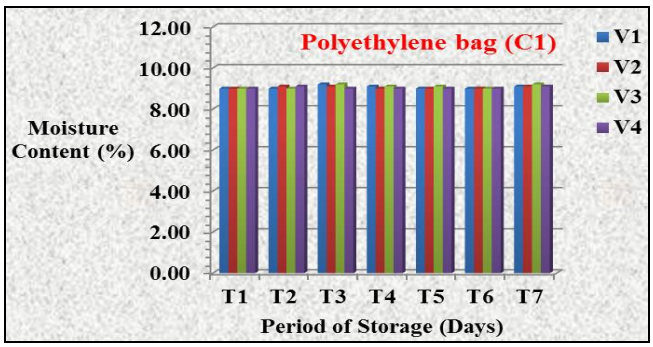

Fig 3: Effect of storage containers on moisture content in Soybean seed varieties stored in Polyethylene bag (C1).

5. Conclusions and Future Work

In it The Maximum speed of germination (20.33) was observed in JS-335 variety, followed by AMS-99-33, TAMS-38 and TAMS-98-21 as 18.67, 14.67 and 13.67 respectively at the end of 540 days of storage. Among the storage containers the seeds stored in Polyethylene bag recorded the highest value of speed of germination followed by Cloth bag at the end of storage and seeds stored in Jute bag recorded lowest value of speed of germination in the variety TAMS-98-21. Thus, JS-335 variety showed least effect on speed of germination during storage as compared to AMS-99-33, TAMS-38 and TAMS-98-21.

Maximum seedling dry weight (0.98 gm) was observed in JS-335 variety, followed by AMS-99-33, TAMS-38 and TAMS-98-21 as 0.91 gm, 0.81 gm and 0.74 gm respectively at the end of 540 days of storage. Among the storage containers the seeds stored in Polyethylene bag recorded the highest value of seedling dry weight followed by Cloth bag at the end of storage and seeds stored in Jute bag recorded lowest value seedling dry weight in the variety TAMS-98-21. Thus, JS-335 variety showed least variation in seedling dry weight during storage as compared to AMS-99-33, TAMS-38 and TAMS-98-21. Hence, it is concluded that for the storage of soybean seeds, Polyethylene bag is superior as compared to Cloth and Jute bag.

The corresponding moisture content values of soybean varieties JS-335, AMS-99-33, TAMS-38 and TAMS-98-21 when stored in Polyethylene, Cloth and Jute bags were different. Variety JS-335 seeds recorded lower moisture content (9.1 %) as compared to AMS-99-33, TAMS-38 and TAMS-98-21.

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