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PHYSIOLOGICAL STUDIES OF SOYBEAN SEEDS UNDER TROPICAL STORAGE CONDITIONS

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ABSTRACT: The Physiological changes such as Standard germination, Field emergence, Length of Seedling and Electrical conductivity 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. The maximum value of seed germination, field emergence and seedling length were observed in JS-335 variety, followed by AMS-99-33, TAMS-38 and TAMS-98-21 at the end of 540 days of storage. Among the storage containers, the seeds stored in Polyethylene bag recorded the highest values of three parameters followed by Cloth bag and Jute bag. The electrical conductivity of seed leachate was negatively associated with the other seed quality parameters. It was higher in the variety TAMS-98-21 (2.288 mmoh/cm) as compared to TAMS-38, AMS-99-33 and JS-335 as 2.217 mmoh/cm, 2.126 mmoh/cm and 1.945 mmoh/cm respectively after storage of 540 days in Jute bag. The seeds stored in Polyethylene bag showed minimum variation in electrical conductivity as compared to Cloth and Jute bag.

KEYWORDS: Soybean, Stoarge containers, physiological studies, Standard germination, Field emergence, Length of Seedling, Electrical conductivity.

I. 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). However, seed is not dried to relatively safe moisture content after harvest; its storability will be reduced (Gadewar *et. al.*, 2009).

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 months, 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). The oil seeds are poor storer and loose its viability very fast in adverse conditions of temperature and humidity.

Tame and Elam, (2015) studied the effects of storage materials and environmental conditions on germination of soybean with five storage materials bottle, polythene bag, polythene sack, clay pot and tin. They observed the variation among soybean varieties in storage in respect to germination and bottle and polythene bag showed better result with higher germination percentage during storage. *Slavica et. al., (2011)* observed better

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germinability of Sunflower seeds stored in polythene bags as compared to the seeds stored in cloth bags throughout the storage period. *Gregori et. al., (2013)* while working with cereal seeds observed that field emergence were lower than laboratory germination. The laboratory test performed in wheat (20 %) oat (15 %), barley (14 %) and rye (17 %) showed higher germination than field emergence.

Jensen, (2002) studied intensively the moderating effect of soil and climatic factors on seedling stands and observed that the field emergence is always lower than laboratory germination and much evidences indicates that seed kinds and lots differ widely in their ability to germinate in unfavourable conditions in the seed bed. *Salgado et. al. (2011)* observed that in cloth bags, viability in terms of germination was up to only 10 months. Seeds stored in polythene bags maintained 72 per cent germination up to 24 months, whereas seeds stored in paper bags retained viability above minimum seed certification standard (MSCS) up to one year in sunflower.

Filho, (2016) studied the effect of drying temperatures and storage of seeds on the growth of soybean seedlings and observed that the increase in the temperature of drying air affects the physiological quality of soybean seeds, and this effect is accentuated over time, especially on length of seedlings. *Edje and Burris, (1970)* working with soybean found that the seedling length also decreased with deterioration, but the hupocotylye length was increased by aging up to 16 days.

Verma and Gupta, (1975) reported that the measurements of electrical conductivity in leachate were found to be an estimation of soybean seed deterioration during storage. Electrolytes in leachate increased with increase in storage period. *Bhanumurthy and Gupta, (1981)* reported that electrical conductivity of leachate showed a negative correlation with germinability and seedling vigour. *Gidrol et. al., (1988)* reported that electrolytes leakage may results from membrane degradation in seeds. Literature reviews reveals that very less work on the physiological studies has been carried out with account of soybean seed varieties and different storage containers which farmers frequently use.

II. 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.

The standard germination test was carried out by ISTA rules with the help of moist towel paper. The field emergence test was carried out with the help of Complete Randomized Design (CRD). The length of Seedling was calculated by the sum of root and shoot measured in centimeter. Electrical conductivity measurements were done with the help of conductivity meter.

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.

III. RESULTS:

(a) Standard germination (%)

The effect of container and storage period on standard 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 Standard Germination (%) of soybean seeds during storage.

VxCxT	V1			V2			V3			V4		
	C1	C2	C3	C1	C2	C3	C1	C2	C3	C1	C2	C3
T1	97.67	97.67	97.67	93.67	93.67	93.67	86.33	86.33	86.33	82.33	82.33	82.33

T2	93.67	89.33	81.67	89.33	83.67	71.33	81.67	73.67	68.33	69.33	63.00	58.00
T3	84.67	74.67	69.00	81.67	70.00	64.67	76.33	65.33	59.33	63.33	52.33	48.00
T4	80.00	70.00	60.00	72.00	64.67	44.33	66.33	51.00	39.67	46.33	34.33	30.00
T5	68.33	58.00	48.33	54.67	49.67	34.33	43.00	37.33	29.67	31.67	28.67	19.67
T6	54.67	47.67	38.67	44.00	35.00	27.67	29.00	20.00	13.33	15.00	11.00	9.67
T7	46.33	41.67	30.00	38.67	27.67	20.00	19.33	12.00	9.33	8.33	5.67	4.00
Mean	**75.05**	**68.43**	**60.76**	**67.71**	**60.62**	**50.86**	**57.43**	**49.38**	**43.71**	**45.19**	**39.62**	**35.95**
SE (m)	**1.124**											
CD(P=5%)	**3.138**											

In variety JS-335 (V1), the standard germination significantly decreased with increase in storage period. However the rate of loss in standard germination varied with the type of container used. Seeds stored in Polyethylene bag (C1) showed significantly higher standard germination (46.33 %) as compared to those stored in Cloth bag (C2) (41.67 %) and Jute bag (C3) (30.00 %) up to 540 days (T7) days of the storage. Among the containers Polyethylene bag (C1) showed significantly higher standard germination (75.05 %) as compared to Cloth bag (C2) (68.43 %) and Jute bag (C3) (60.76 %) throughout the storage period.

(b) Field emergence (%)

The effect of container and storage period on field emergence 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 Field Emergence (%) of soybean seeds during storage.

VxCxT	**V1**			**V2**			**V3**			**V4**		
	C1	**C2**	**C3**	**C1**	**C2**	**C3**	**C1**	**C2**	**C3**	**C1**	**C2**	**C3**
T1	92.67	92.67	92.67	89.67	89.67	89.67	81.67	81.67	81.67	78.67	78.67	78.67
T2	87.67	81.67	77.33	83.00	79.00	70.00	76.33	71.67	57.33	63.67	57.67	49.67
T3	82.33	69.33	60.67	78.67	67.33	56.33	69.00	61.33	42.67	54.67	45.33	31.33
T4	76.67	61.67	49.33	69.67	53.33	40.67	57.33	46.67	30.67	35.67	31.67	22.67
T5	64.67	53.33	38.67	52.00	42.67	33.00	38.67	28.00	21.33	24.67	17.33	14.33
T6	51.67	41.67	27.33	40.67	31.00	19.67	27.67	14.67	9.33	11.33	8.67	6.33
T7	42.33	33.00	22.00	31.67	21.67	11.67	17.00	8.33	6.00	7.00	3.67	2.00
Mean	**71.14**	**61.91**	**52.57**	**63.62**	**54.95**	**45.86**	**52.52**	**44.62**	**35.57**	**39.38**	**34.72**	**29.29**
SE (m)	**1.187**											
CD(P=5%)	**3.316**											

In variety JS-335 (V1), the field emergence significantly decreased with increase in storage period. However, the rate of loss in field emergence varied with the type of container used. Seeds stored in Polyethylene bag (C1) showed significantly higher field emergence (42.33 %) as compared to those stored in Cloth bag (C2) (33.00%) and Jute bag (C3) (22.00%) up to 540 days (T7) days of the storage. Among the containers Polyethylene bag (C1) showed significantly higher field emergence (71.14%) as compared to Cloth bag (C2) (61.91%) and Jute bag (C3) (52.57%) throughout the storage period.

(c) Length of Seedling (cm)

The effect of container and storage period on Length of Seedling 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 Length of Seedling (cm) of soybean seeds during storage.

VxCxT	**V1**			**V2**			**V3**			**V4**		
	C1	**C2**	**C3**	**C1**	**C2**	**C3**	**C1**	**C2**	**C3**	**C1**	**C2**	**C3**
T1	34.50	34.50	34.50	32.10	32.10	32.10	30.40	30.40	30.40	29.60	29.60	29.60
T2	33.30	32.20	31.80	30.50	28.90	28.20	28.60	27.60	25.90	27.80	26.50	25.60
T3	31.80	30.50	29.20	28.20	24.40	23.60	26.30	24.80	22.20	23.30	22.30	21.90
T4	30.57	29.87	23.57	25.87	22.27	19.97	23.07	21.37	20.90	20.97	20.07	20.40
T5	27.77	26.27	20.27	22.67	19.47	16.17	20.27	18.17	16.90	18.77	16.37	15.90
T6	24.47	22.70	18.20	20.80	18.40	14.90	18.20	15.40	13.70	15.70	13.20	12.80
T7	20.33	20.13	13.03	18.43	15.63	12.73	15.53	14.53	12.10	13.43	11.63	10.20

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Mean	**28.96**	**28.02**	**24.37**	**25.51**	**23.02**	**21.10**	**23.20**	**21.75**	**20.30**	**21.37**	**19.95**	**19.49**
SE (m)	**1.091**											
CD(P=5%)	**NS**											

*NS- Non Significant

In variety JS-335 (V1), the length of seedling significantly decreased with increase in storage period. However the rate of decrease in length of seedling varied with the type of container used. Seeds stored in Polyethylene bag (C1) showed significantly higher length of seedling (20.33 cm) as compared to those stored in Cloth bag (C2) (20.13 cm) and Jute bag (C3) (13.03 cm) up to 540 days (T7) days of the storage. Among the containers Polyethylene bag (C1) showed significantly higher length of seedling (28.96 cm) as compared to Cloth bag (C2) (28.02 cm) and Jute bag (C3) (24.37 cm) throughout the storage period.

(d) Electrical conductivity (mmhos/cm)

The effect of container and storage period on Electrical Conductivity in all four varieties V1, V2, V3 and V4 is presented in **Table 4.**

Table 4: Effect of Varieties (V), Storage Containers (C) and Storage Periods (T) and three factor interaction on Electrical Conductivity (mmhos/cm) of soybean seeds during storage.

VxCxT	**V1**			**V2**			**V3**			**V4**		
	C1	**C2**	**C3**	**C1**	**C2**	**C3**	**C1**	**C2**	**C3**	**C1**	**C2**	**C3**
T1	0.120	0.120	0.120	0.170	0.170	0.170	0.189	0.189	0.189	0.238	0.238	0.238
T2	0.172	0.223	0.227	0.181	0.241	0.281	0.197	0.285	0.301	0.276	0.298	0.398
T3	0.240	0.432	0.445	0.249	0.544	0.601	0.275	0.662	0.781	0.291	0.670	0.856
T4	0.387	0.527	0.706	0.401	0.643	0.836	0.571	0.739	0.889	0.623	0.789	0.916
T5	0.530	0.831	0.817	0.570	0.949	1.201	0.633	0.993	1.287	0.734	1.109	1.302
T6	0.732	1.150	1.292	0.951	1.312	1.471	0.997	1.422	1.512	1.147	1.562	1.581
T7	1.135	1.881	1.945	1.154	1.990	2.126	1.178	2.189	2.217	1.199	2.198	2.288
Mean	**0.474**	**0.738**	**0.793**	**0.525**	**0.836**	**0.955**	**0.577**	**0.926**	**1.025**	**0.644**	**0.981**	**1.083**
SE (m)	**0.012**											
CD(P=5%)	**0.033**											

In variety JS-335 (V1), the electrical conductivity significantly increased with the increase in storage period. However, the rate of increase in electrical conductivity varied with the type of container used. Seeds stored in Polyethylene bag (C1) showed significantly lower electrical conductivity (1.135 mmhos/cm) as compared to those stored in Cloth bag (C2) (1.881 mmhos/cm) and Jute bag (C3) (1.945 mmhos/cm) up to 540 days (T7) days of the storage. Among the containers Polyethylene bag (C1) showed significantly lower electrical conductivity (0.474 mmhos/cm) as compared to Cloth bag (C2) (0.738 mmhos/cm) and Jute bag (C3) (0.793 mmhos/cm) throughout the storage period.

IV. DISCUSSION:

(a) Standard Germination (%)

A sharp decline in germination occurred in seeds of the four varieties of soybean stored in Cloth bag (C2) and Jute bag (C3) during storage. This might be due to moisture pervious nature of Cloth bag (C2) and Jute bag (C3), which absorbs more moisture necessary for biochemical activity and development of fungi during storage. The germination of seeds stored in Polyethylene bag (C1) declined at a very slow rate during storage. This may be due to impermeable membrane for water vapour and preventing fluctuations in seed moisture. The result suggest that seeds of soybean varieties stored in Polyethylene bag (C1) were liable to undergo the least amount of loss of germinability thereby retaining the initial germinability to a great extent, when stored specially under ambient conditions in warm and moderately humid tropical environment. The results are confirmatory with those of *Sing et. al.,(2016).* Varital differences for germination were significant in the soybean. The seeds of JS-335 (V1) of soybean exhibited significantly higher germination percentage than other varieties during storage. It could possible due to the superior genetic makeup of JS-335 (V1) variety of soybean. Genotypic differences in stored seeds are reported by *Tame and Elam, (2015).*

The results obtained from standard germination test (Polyethylene bag) have been illustrated graphically in **Figure 1**.

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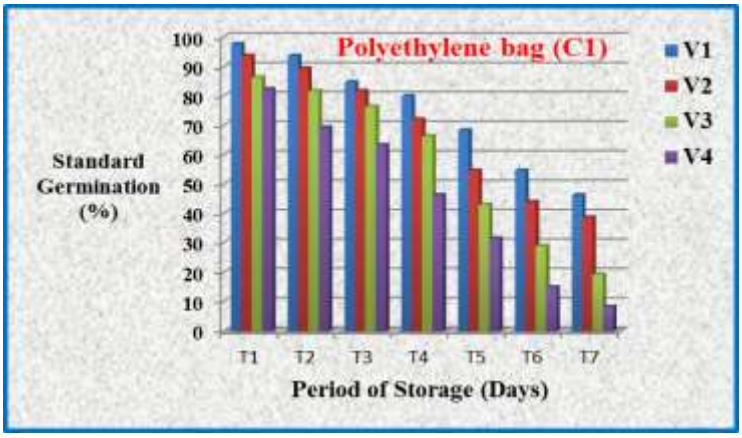

Figure 1: Effect of storage containers on Standard Germination (%) in Soybean seed varieties. Stored in Polyethylene bag (C1).

(b) Field Emergence (%)

The rate of decrease in field emergence percentage varied with the type of container used. The seeds stored in Cloth (C2) and Jute (C3) bags showed significantly lower percentage of field emergence than those of Polyethylene bag (C1). This reduction in germination may be due to unfavourable conditions of the field. *Monira et. al., (2012)* demonstrated that the emergence rate of seeds stored in Polyethylene bag was always significantly higher than those stored in moisture pervious bag. In the present investigation, field emergence percentage was found lower as compared to standard germination percentage because seeds sown in field were subjected to natural climate and weather. Similarly *Noori and Gowda, (2017) and Moshtaghi-Khavaran et. al., (2014)* observed that the standard germination percentage was higher than that of field emergence percentage supporting the view that the standard germination test are conducted under optimum conditions.

The results obtained from field emergence test (Polyethylene bag) have been illustrated graphically in **Figure 2**.

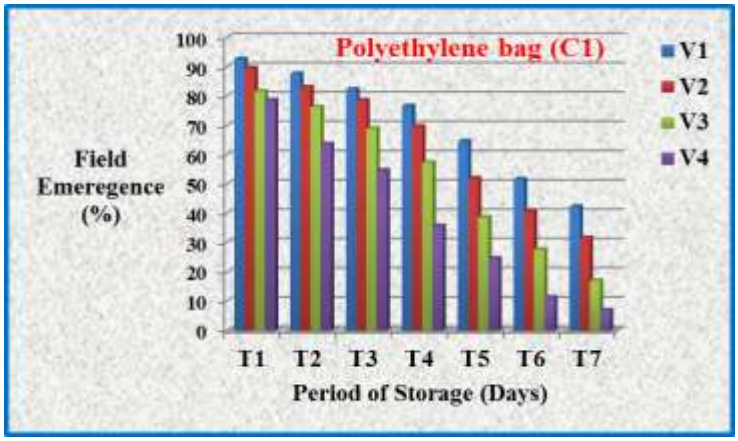

Figure 2: Effect of storage containers on Field Emergence (%) in Soybean seed varieties stored in Polyethylene bag (C1).

(c) Length of Seedling (cm)

The seed stored Cloth (C2) and Jute (C3) bags showed significant reduction in length of seedling, respectively during storage. The reduction in length of seedling with the advancement of storage was also reported by *Kandil et. al., (2013); Basso et. al., (2018); Meena et. al.,(2017)*; *Paul and Choudhury, (1991)*. The reason for length of seedling reduction may be assigned to the loss of vigour during storage. Similar findings have been reported by *Heydecker, (1972).* The seed stored in Polyethylene bag (C1) showed significantly longer length of seedling during storage. *Arulnandhy and Senanayake, (1988)* and *Vanangamudi, (1988)* reported that seeds stored in moisture vapour-proof container showed higher shoot and root length than those stored in moisture pervious container during storage.

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The results obtained from length of seedling (Polyethylene bag) have been illustrated graphically in **Figure 3**.

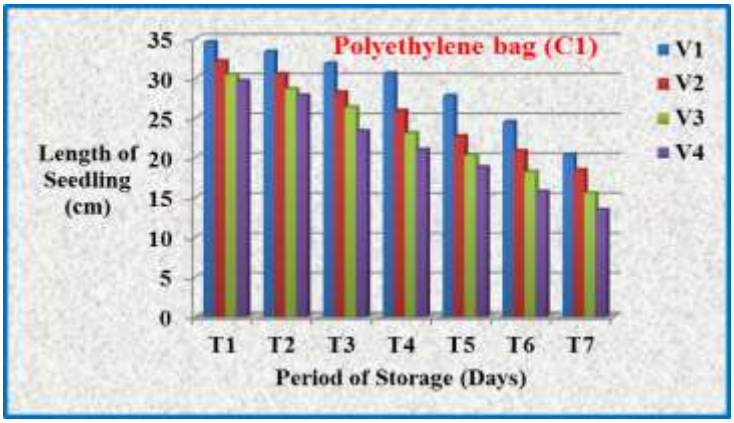

Figure 3: Effect of storage containers on Length of Seedling (cm) in Soybean seed varieties stored in Polyethylene bag (C1).

(d) Electrical Conductivity (mmhos/cm)

The electrical conductivity of seed leachate increased with increase in storage period in all four varieties of soybean. The seeds stored in Cloth (C2) and Jute (C3) bags, showed significantly higher values for electrical conductivity of seed leachate compared to those stored in Polyethylene bag (C1). This state of affair might be due to increase in permeability of seed coat which was more pronounced in Cloth (C2) and Jute (C3) bags respectively in prolonged storage. *Colete et. al., (2004); Panobianco and Vieira, (2007)* and *Salinas et. al., (2010)* reported that, the measurements of electrical conductivity in seed leachate were found to give an estimate of seed deterioration during storage. They also concluded that the electrolytes in seed leachate increased with increase in storage period. *Edje and Burris, (1971)* and *Vyas et. al., (1990)* reported varietal differences in electrical conductivity of seed leachate during storage.

The results obtained from measurement of electrical conductivity (Polyethylene bag) have been illustrated graphically in **Figure 4**.

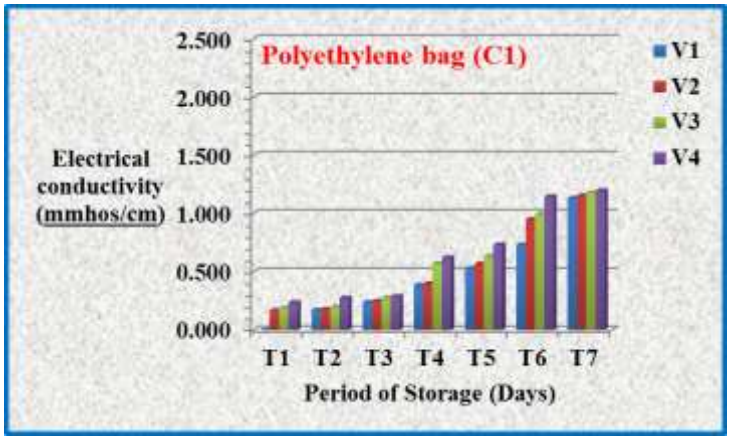

Figure 4: Effect of storage containers on Electrical Conductivity (mmoh/cm) in Soybean seed varieties stored in Polyethylene bag (C1).

IV. CONCLUSION:

The maximum value of seed germination, field emergence and seedling length were observed in JS-335 variety, followed by AMS-99-33, TAMS-38 and TAMS-98-21 at the end of 540 days of storage. Among the storage containers, the seeds stored in Polyethylene bag recorded the highest values of three parameters followed by Cloth bag and Jute bag. Also it is concluded that for the storage of soybean seeds in Polyethylene bag is superior as compared to Cloth and Jute bag. The order of superiority for maintaining the three physiological parameters discussed can be summarized as

,JS-335 > AMS-99-33 > TAMS-38 > TAMS-98-21

Polyethylene bag > Cloth Bag > Jute Bag

The electrical conductivity of seed leachate was negatively associated with the other seed quality parameters. It was higher in the variety TAMS-98-21 (2.288 mmoh/cm) as compared to TAMS-38, AMS-99-33 and JS-335 as 2.217 mmoh/cm, 2.126 mmoh/cm and 1.945 mmoh/cm respectively after storage of 540 days in Jute bag. The seeds stored in Polyethylene bag showed minimum variation in electrical conductivity as compared to Cloth and Jute bag.

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