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Original Research Article

Effect of Genotypes and Containers on Physiological and Biochemical Changes during Storage of Soybean seed (*Glycine max* L. Merrill)

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A B S T R A C T

The goal of the study was to determine the effect of genotypes and storage containers on the quality of Soybean seed. The experiment was conducted at Vasanthrao Naik Marathwada Krishi Vidyapeeth. The Genotypes like MAUS-71, MAUS-81, MAUS-158, MAUS-162 were used for the study likewise cloth bag, gunny bag and high density polyethylene bag were used as containers for storage. The seeds were stored during July 2016 to April 2017 at optimum room temperature and relative humidity for the storage period. The monthly observations for different seed quality parameters were taken during storage. The physiological and biochemical components like germination percentage, root-shoot length of seedling, seedling vigour index, dry matter content of seedlings, viability by TZ test, protein content and oil content were found to be decreased. Whereas moisture content of seeds and electrical conductivity increased during storage, as the storage period advances irrespective of the varieties and storage containers. The results revealed that the variety MAUS-158 and MAUS-162 followed by MAUS-71 were found to be the most ideal for storability than the variety MAUS-81. It was also noticed that the storage of seed in High density Poly Ethylene bag had significantly increased the storability of soybean seed over the seed stored in gunny bag and cloth bags.

Keywords

Soybean seed, Storage containers, Genotypes

Introduction

Soybean (*Glycine max* L. Merrill) is an important legume and oil seed crop in the world and is soybean belongs to family leguminoceae, sub family papillonaceae and genus *Glycine*. It is belonging to the origin South East Asia and extensively cultivated in China. Nutritional value of soybean lies in its protein (40%-42%) and oil ranges (18%-22%) and is free from cholesterol making it highly desirable in the human diet. It has biological value as meat and protein and rich amino acids like lysine and tryptophan are present. It contains 60% poly unsaturated fatty acid and calorific value of 452 calories per 100 gm. In Maharashtra soybean cultivated in an area of 35.809 lakh hectares with production of 39.455 lakh and productivity of 1102kg/ha (Research Review Report on Soybean-2016-17).

Seeds of soybean deteriorate faster than those most of other crops (Priestley *et al.*, 1985) especially under tropical conditions (Delouche *et al.*, 1973). Two main factors which appear to contribute to the low stability of soybean seed. One is relatively short intrinsic longevity of soybean seeds as indicated by the low KE (Elis *et al.*, 1982).

The second factor is highly permeable seed coat because of which soybean seed imbibes moisture easily and thus tends to more susceptible to weathering in the field (Burchett *et al.*, 1985 and Tekrony *et al.*, 1980) as well as to humid tropical environments under open storage conditions.

Besides poor storability, mechanical damage is one more factor strongly responsible for seed quality deterioration especially by small farmers in developing countries which has been overshadowed by more important problems such as storage deterioration, insect infestation and diseases (Wilson and Mc Donald Jr., 1992).

Poor storage conditions greatly affect seed vigor (Heydecker, 1979); reduce respiration and seedling size. It has been reported that the extent of seed losses due to damage of seed ranges from 10-30% (Copeland, 1972). With invisible damage seed could lake vigour resulting in reduced yield.

Materials and Methods

The study was carried out at the Department of Agriculture Botany, VNMKV, Parbhani during July 2016 to April 2017. Seeds were kept in three containers such as HDPE bag, gunny bag and cloth bag to take monthly observations. During the storage period seed samples were taken every 30 days from the containers for determination of changes in seed quality parameters.

Germination percent

Three replications of hundred seeds of each variety different treatment combination were germinated using rolled paper method a 25±2ºC in seed germinator for 8 days (ISTA, 1985). The germination percent were recorded on the basis of normal seedling (Krishnamurthy and sheshu, 1990).

$$\text{Germination\%} = \frac{\text{Number of seeds germinated}}{\text{Number of seeds tested}} \times 100$$

Root-shoot length

Ten normal seedlings from each of the replication of germination test were selected randomly and root-shoot length is recorded in centimeter.

The average of ten normal seedlings were calculated and recorded.

Dry matter content

To evaluate the dry matter content, ten normal seedlings were oven dried at 50ºC for 24 hours and dry matter weight (g) will be recorded.

Seedling vigour index

The vigour index of the seed was assessed by

Dry weight accumulation (g/10seedling)

Vigor index was calculated as

Vigour index = Average seedling length (root+shoot) cm × average germination percent (Abdul Baki and Anderson, 1973).

Moisture content

Moisture percentage was determined by hot air oven method by grinding the seed in grinding mill and dried at 103^0c for 17 hours in hot air oven. The percentage of moisture content is calculated on weight basis.

$$MC\% = \frac{W_1 - W_2}{W_1} \times 100$$

Whereas,

W_1 = fresh weight of seed sample (g)
W_2 = dry weight of seed sample (g)

Electrical conductivity

Three replications of each 50 seeds were randomly counted from each treatment and soaked in 75 ml of distilled water at 25^0C for 24 hours. The solution and seeds were gently swirled for 10 to 15 seconds prior to evaluation. Evaluate the sample by using electrical conductivity meter having cell constant one and expressed as ohms/cm/g. (Loeffer *et al.,* 1988).

Viability by tetrazolium test

Three replications each of 50 seeds will be soaked in distilled water for four hours. Then seeds were continuously decorticated taking care not to injure the embryo or the endosperm after which they would place in 0.5% aqueous tetrazolium (2, 3-5 triphenyl tetrazolim chloride) solution in petridishes covered with black paper at 35ºc for two and half hours. During this period, seeds were stained red in various patterns. Viable and non- viable seed categories were identified on the basis of distributions of stain.

Protein content

$$N\% = \frac{(\text{ml of HCL} - \text{ml blank}) \times \text{Normality of } 0.014 \times 0.25}{\text{Weight of sample (mg) taken for distillation} \times \text{Aliquot taken}}$$

Protein % = %N × 5.71

Oil Content (percent)

Oil content of seed was estimated from the seeds by using NMR (Nuclear Magnetic Resonance technique (Alexander *et al.,* 1967).

Results and Discussion

Physiological parameters

Seed germination (%)

The data pertaining to the effect of varieties, storage containers and two factor interactions of different treatments on soybean seed during storage have been presented in Table 1.

The germination percentage of soybean varieties influenced significantly due to different storage containers during storage.

It was also noticed that the germination percentage decreased with the advancement of storage period irrespective of different varieties. The germination percentage of soybean influenced significantly due to different storage containers during storage.

The soybean variety MAUS-162 fallowed by MAUS-158 and MAUS-71 had significantly higher germination than MAUS-81 during all the period of storage.

The germination of soybean seed stored in high density polyethylene bags was significantly higher than the germination of soybean seed stored in gunny bag and cloth bags during all the period of storage irrespective of varieties. The germination was maintained above seed certification standard in soybean varieties MAUS-162, MAUS-158, MAUS-71 and MAUS-81 upto 300, 270, 270,150 respectively. The germination above seed certification standard was maintained upto 270, 210,150 days in seed stored in high density polyethylene bag, gunny bag and cloth bag respectively irrespective of varieties.

Two factor interaction

V×C – The effect of V×C interaction on germination of soybean seed during storage was significant during all the period of storage except 30, 60 and 180 days of storage. The V_4C_3 and V_2C_1 interactions recorded the significantly higher and lower germination percentage respectively.

Root shoot length

The data pertaining to the effect of varieties, storage containers and two factor interactions of different treatments on root shoot length of seedlings of soybean varieties during storage have been presented in Table 2.

The root shoot length of seedlings of different varieties, stored in different containers was significantly influenced during storage.

The root shoot length was decreased with advancement of storage period irrespective of varieties and treatments. The RS length of seedling of soybean MAUS -162 fallowed by MAUS 158 and MAUS-71 higher than the RS length of MAUS-81 during all the period of storage except at harvest irrespective of treatments.

The RS length of seedling stored in High density polyethylene had significantly higher than the RS length of seedling of seed stored in gunny bags and cloth bag during all he periods of storage irrespective of varieties.

Two factor interaction

V×C –The effect was significant during all the periods of storage except at 60 days, 90 days and 300 days after storage. The numerically higher and lower RS length was recorded in V_4C_3 and V_2C_1 interaction respective

Seedling Vigour Index

The data pertaining to the effect of varieties, storage containers and two factor interactions of different treatments on seedling vigour index of soybean varieties during storage have been presented in Table 3.

The vigour index of soybean seedling of different varieties stored in different containers was significantly influenced during storage the seedling vigour index was decreased with advancement of storage period irrespective of varieties and treatments. The seedling vigour index of soybean MAUS -162 fallowed by MAUS 158 and MAUS-71 higher than the seedling vigour index of MAUS-81 during all the period of storage. The seedling vigour index of the soybean seed stored in High density polyethylene was significantly higher than the seed stored in gunny bags and cloth bag during all he periods of storage irrespective of varieties.

Two factor interaction

V×C – The effect was significant during all the periods of storage except at harvest, at 90, 180 and 330 days after storage. The numerically higher and lower seedling vigour index was recorded in V_4C_3 and V_2C_1 interaction respectively.

Dry matter content

The data pertaining to the effect of varieties, storage containers and two factor interactions of different treatments on seedling vigour index of soybean varieties during storage have been presented in Table 4.

The dry matter content of soybean seedling of different varieties stored in different containers was significantly influenced during storage. The seedling dry matter content was decreased with advancement of storage period irrespective of varieties and treatments. The dry matter content of seedling of soybean MAUS -162 fallowed by MAUS 158 and MAUS-71 higher dry matter content of MAUS-81 during all the period of storage. The dry mater content of the soybean seed stored in High density polyethylene was significantly higher than the seed stored in gunny bags and cloth bag during all the periods of storage irrespective of varieties.

Two factor interaction

V×C – The effect was non-significant during all the periods of storage except at 30,300 days after storage.

Moisture content

The data pertaining to the effect of varieties, storage containers and two factor interactions of different treatments on moisture content of soybean seed during storage have been presented in Table 5.

The moisture content of soybean seed of different varieties stored in different containers was significantly influenced during storage. The seed moisture content was decreased with advancement of storage period irrespective of varieties and treatments. The moisture content was significantly higher in MAUS -162 fallowed by MAUS-158, MAUS-71 and significantly lower in MAUS-81 during all the period of storage. The moisture content of the soybean seed stored in High density polyethylene was significantly higher than the seed stored in gunny bags and cloth bag during all the periods of storage irrespective of varieties.

Two factor interaction

V×C - The effect was significant during all the periods of storage except at 60, 90, 300, 330 days

Biochemical parameters

Viability by TZ test

The data pertaining to the effect of varieties, storage containers and two factor interactions on viability tested by soybean seed during storage have been presented in Table 6.

The viability of soybean seed of different varieties stored in different containers was significantly influenced during storage. It was also noticed that the viability decreased with advancement of storage period irrespective of treatments. The viability of seed was significantly higher in MAUS -162 fallowed by MAUS 158, MAUS-71 and significantly lower in MAUS-81 during all the period of storage.

The viability of the soybean seed stored in High density polyethylene was significantly higher than the seed stored in gunny bags and cloth bag during all the periods of storage irrespective of varieties.

Two factor interaction

V×C - The interaction effect was non-significant during all the period of storage except at harvest, at 60, 90 days.

Electrical conductivity (μScm^{-1})

The data pertaining to the effect of varieties, storage containers and two factor interactions on electrical conductivity of soybean seed during storage have been presented in Table 7.

Table.1 Effect of varieties, storage containers and two factor interaction on germination percentage of soybean seeds during storage

Treatment	At Harvest	30 DAS	60 DAS	90 DAS	120 DAS	150 DAS	180 DAS	210 DAS	270 DAS	300 DAS	330 DAS
Variety (V)											
V_1 - MAUS-71	85.66	85.57	84.22	83.22	81.55	80.88	77.44	75.32	73.33	64.55	55.88
V_2 - MAUS-81	82.22	82.22	79.88	76.22	75.33	73.55	68.66	62.20	49.77	49.55	35.11
V_3 - MAUS-158	87.22	86.66	83.66	83.55	82.55	80.77	79.00	76.35	76.33	67.66	52.66
V_4 - MAUS-162	87.77	87.55	86.44	84.22	82.66	81.66	80.22	78.40	76.33	74.22	68.00
SE	0.262	0.412	0.356	0.2611	0.242	0.243	0.313	0.313	0.596	1.186	1.231
CD at 5%	0.767	1.206	1.042	0.764	0.709	0.714	0.917	0.917	1.746	3.475	3.605
Storage container (c)											
C1 – Cloth bag	84.41	84.25	82.66	80.41	78.83	77.50	67.00	63.10	66.83	52.58	42.91
C2 – Gunny bag	86.50	85.50	83.91	81.66	80.83	79.16	75.50	72.30	68.25	61.25	47.75
C3 – HDPE	86.41	86.75	84.00	83.41	81.91	81.00	80.50	78.40	72.08	65.16	51.58
SE	0.227	0.356	0.356	0.226	0.209	0.211	0.271	0.20	0.516	1.027	1.06
CD at 5%	0.664	1.044	1.042	0.662	0.614	0.618	0.794	0.65	1.512	3.00	3.122
Two factor interaction											
V_1C_1	85.66	85.00	83.33	83.00	81.66	81.00	74.66	74.30	74.66	58.66	43.00
V_1C_2	86.66	86.00	84.66	82.67	81.00	79.33	76.66	76.20	77.33	65.00	54.66
V_1C_3	85.66	85.33	84.66	84.00	83.00	82.33	81.00	80.32	80.00	70.00	40.00
V_2C_1	81.66	80.33	79.66	75.00	74.66	72.00	42.33	47.33	41.70	40.67	30.33
V_2C_2	82.00	83.00	78.66	75.67	74.66	73.33	64.33	62.40	50.00	45.00	29.66
V_2C_3	83.33	83.00	81.33	78.00	76.66	75.33	75.33	73.70	52.00	46.33	37.00
V_3C_1	87.00	85.33	84.33	82.33	81.33	79.66	75.33	72.55	72.66	61.66	44.66
V_3C_2	89.67	87.000	85.00	83.00	82.66	80.33	79.33	78.40	78.33	71.00	57.33
V_3C_3	86.67	86.33	86.00	85.67	83.66	82.33	82.33	80.22	78.00	70.33	66.00
V_4C_1	85.33	84.33	83.33	81.33	78.66	77.33	75.66	73.55	72.66	72.66	65.33
V_4C_2	89.33	88.33	87.33	85.33	85.00	83.66	81.66	80.70	78.00	74.00	69.33
V_4C_3	90.67	88.66	88.00	86.00	84.33	84.00	83.33	81.44	78.33	76.00	69.33
SE	0.454	0.713	0.616	0.452	0.419	0.424	0.342	0.342	1.033	2.05	2.13
CD At 5%	1.329	NS	NS	1.324	1.228	1.237	1.532	NS	3.123	6.01	6.24

Note i) Kharif 2016 seed produce was used upto 210 DAS observation

ii) Kharif 2015 seed produce used at 270, 300 and 330 DAS for observation during 2015-16.

Table.2 Effect of varieties, storage containers two factor interaction on root shoot length (cm) of soybean seedlings during storage

Treatment	At Harvest	30 DAS	60 DAS	90 DAS	120 DAS	150 DAS	180 DAS	210 DAS	270 DAS	300 DAS	330 DAS
Variety (V)											
V_1 - MAUS-71	28.78	28.00	26.21	25.12	24.15	23.27	21.71	21.30	20.13	19.31	18.20
V_2 - MAUS-81	22.27	21.35	20.63	20.28	19.56	18.91	18.07	17.90	17.52	16.93	15.75
V_3 - MAUS-158	28.68	28.05	26.52	25.34	24.42	14.18	22.05	21.90	21.12	19.22	17.72
V_4 - MAUS-162	29.86	28.92	28.50	27.86	26.74	24.52	23.12	22.70	21.05	19.46	18.44
SE	0.198	0.675	0.132	0.058	0.229	0.231	0.208	0.17	0.138	0.131	0.217
CD at 5%	0.580	1.977	0.387	0.144	0.670	0.677	0.610	0.52	0.454	0.386	0.636
Storage container (c)											
C1 – Cloth bag	26.64	24.00	25.07	23.558	23.20	21.46	19.69	19.30	18.86	17.642	16.35
C2 – Gunny bag	26.03	25.65	24.45	24.17	23.75	22.78	21.36	21.05	19.61	18.43	17.43
C3 – HDPE	28.79	26.55	26.42	25.40	24.77	23.92	22.66	22.62	21.39	20.12	18.80
SE	0.171	0.584	0.114	0.125	0.229	0.200	0.208	0.14	0.119	0.114	0.188
CD at 5%	0.502	1.712	0.387	0.366	0.670	0.586	0.610	0.45	0.350	0.334	0.550
Two factor interaction											
V_1C_1	28.30	27.00	26.00	24.63	24.50	23.16	21.10	20.80	19.56	18.40	17.23
V_1C_2	28.73	28.00	26.00	25.23	24.33	23.32	20.18	20.06	19.00	18.20	17.46
V_1C_3	29.33	29.00	26.64	25.63	23.50	23.43	20.16	19.96	21.83	21.33	19.90
V_2C_1	21.73	20.96	20.00	18.40	18.63	17.40	16.33	15.40	16.73	16.50	15.53
V_2C_2	21.73	21.33	20.56	19.50	19.40	18.23	17.73	16.30	17.56	16.96	14.83
V_2C_3	23.36	22.66	21.33	20.08	19.83	17.40	20.16	19.12	18.26	17.33	16.90
V_3C_1	28.50	27.83	25.35	24.16	24.10	21.10	20.50	20.10	19.66	18.06	16.50
V_3C_2	27.16	26.73	26.16	25.36	24.76	22.40	22.16	21.78	20.73	19.83	19.93
V_3C_3	31.40	29.16	27.50	26.50	25.43	24.83	23.50	22.80	22.96	20.50	18.90
V_4C_1	28.93	28.20	28.03	27.16	25.43	25.33	20.83	20.40	19.50	17.60	16.16
V_4C_2	29.3	28.20	27.50	27.73	26.50	22.90	23.70	22.75	21.16	18.73	17.50
V_4C_3	31.06	30.23	25.36	28.70	27.33	24.83	24.83	23.40	22.96	21.33	19.50
SE	0.343	1.169	0.229	0.250	0.396	0.400	0.361	0.27	0.239	0.228	0.376
CD At 5%	1.005	3.425	NS	NS	1.161	1.173	1.057	0.700	NS	1.101	1.081

Note
i) Kharif 2016 seed produce was used upto 210 DAS observation
ii) Kharif 2015 seed produce used at 270, 300 and 330 DAS for observation during 2015-16.

Table.3 Effect of varieties, storage containers and two factor interaction on seedling vigour index of soybean seedlings during storage

Treatment	At Harvest	30 DAS	60 DAS	90 DAS	120 DAS	150 DAS	180 DAS	210 DAS	270 DAS	300 DAS	330 DAS
Variety (V)											
V_1 - MAUS71	2478	2402.1	2210.3	2017.0	1926.3	1887.1	1684.1	1630.2	1538.1	1252.0	830.8
V_2 - MAUS81	1823	1772.6	1657.6	1529.4	1477.7	1375.5	1212.5	1460.3	867.2	439.6	346.3
V_3 -MAUS158	2568	2455.6	2317.8	1954.5	2039.8	1835.5	1737.6	1625.4	1670.0	1286.8	948.2
V_4 - MAUS162	2698	2596.4	2478.5	2314.3	2024.8	1998.3	1860.5	1720.2	1615.8	1408.0	1215.0
SE	35.17	41.73	16.72	17.79	17.22	53.98	14.95	20.33	18.54	40.02	93.82
CD at 5%	103.0	122.2	48.97	52.10	50.43	158.09	43.67	62.14	54.31	117.2	281.46
Storage container (c)											
C1 – Cloth bag	2302	2190.9	2058	1852.2	1749.4	1628.3	1409.8	1370.2	1278.3	936.8	676.9
C2 – Gunny bag	2364	2285.9	2132	1962.2	1902.5	1784.0	1641.5	1540.7	1431.0	1071.9	873.1
C3 – HDPE	2506	2443.2	2307	2047.0	1949.3	1911.8	1819.7	1758.3	1559.1	1281.2	880.3
SE	17.59	24.96	14.48	15.40	14.91	46.75	12.91	17.20	16.06	34.66	11.58
CD at 5%	51.51	70.56	42.41	45.12	43.67	136.91	43.67	52.70	47.03	105.50	33.91
Two factor interaction											
V_1C_1	2430.1	2295.7	2184.5	1951.7	1856.4	1851.7	1575.6	1404.2	1411.3	1069.8	741.30
V_1C_2	2445.7	2436.0	2167.0	2033.0	1942.7	1879.8	1702.1	1620.1	1469.7	1176.5	955.20
V_1C_3	2558.6	2474.5	2279.4	2069.0	1979.7	1929.7	1774.7	1645.5	1733.3	1509.7	796.00
V_2C_1	1775.1	1657.6	1593.3	1455.3	1380.0	1253.0	978.3	870.2	773.3	286.0	361.67
V_2C_2	1782.1	1771.0	1644.1	1510.3	1462.3	1337.2	1140.8	1020.4	878.7	403.2	487.20
V_2C_3	1913.8	1889.3	1735.3	1622.7	1589.5	1536.3	1519.0	1410.1	949.6	629.6	490.2
V_3C_1	2479.5	2432.0	2158.7	1828.7	1990.0	1637.5	1509.3	1402.5	1481.5	1112.7	748.0
V_3C_2	2508.2	2346.7	2243.4	1970.9	2071.3	1828.7	1787.7	1604.7	1737.4	1329.4	303.6
V_3C_3	2716.8	2588.0	2551.5	2063.8	2058.2	2047.7	1915.8	1840.1	1790.9	1418.3	306.0
V_4C_1	2526.6	2378.2	2298.7	21733	1771.0	1771.0	1576.7	1427.4	1447.0	1278.8	305.67
V_4C_2	2721.3	2590.0	2473.3	2337.3	2133.7	2090.2	1935.4	1802.3	1638.0	1378.3	321.33
V_4C_3	2836.1	2821.0	2663.6	2432.3	2169.8	2133.7	2069.5	1970.2	1762.5	1567.0	337.5
SE	35.17	41.73	28.96	30.81	29.82	93.50	25.83	22.70	32.12	69.31	23.16
CD At 5%	NS	122.22	84.82	NS	87.34	273.81	NS	NS	94.07	203.00	NS

Note

i) Kharif 2016 seed produce was used upto 210 DAS observation

ii) Kharif produce 2015 seed produce used at 270, 300 and 330 DAS for observation during 2015-16

Table.4 Effect of varieties, storage containers, two factor interaction on dry matter content of soybean seedlings during storage

Treatment	At Harvest	30 DAS	60 DAS	90 DAS	120 DAS	150 DAS	180 DAS	210 DAS	270 DAS	300 DAS	330 DAS
Variety (V)											
V_1 - MAUS71	1.04	0.64	0.62	0.61	0.56	0.55	0.51	0.46	0.40	0.38	0.33
V_2 - MAUS81	0.98	0.51	0.50	0.60	0.43	0.41	0.38	0.35	0.37	0.31	0.25
V_3 -MAUS158	1.07	0.67	0.66	0.64	0.58	0.55	0.53	0.48	0.50	0.40	0.39
V_4 - MAUS162	1.10	0.97	0.85	0.85	0.72	0.67	0.63	0.56	0.49	0.44	0.33
SE	0.02	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
CD at 5%	0.06	0.02	0.02	0.02	0.02	0.18	0.15	0.02	0.03	0.03	0.03
Storage container (c)											
C1 – Cloth bag	1.04	0.65	0.61	0.60	0.54	0.51	0.50	0.40	0.39	0.33	0.27
C2 – Gunny bag	1.04	0.71	0.67	0.66	0.57	0.54	0.52	0.48	0.44	0.40	0.33
C3 – HDPE	1.06	0.74	0.69	0.68	0.61	0.57	0.54	0.50	0.48	0.42	0.38
SE	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01
CD at 5%	0.05	0.02	0.03	0.18	0.02	0.03	0.03	0.02	0.02	0.03	0.03
Two factor interaction											
V_1C_1	1.00	0.64	0.62	0.62	0.55	0.52	0.50	0.42	0.37	0.36	0.30
V_1C_2	1.06	0.68	0.67	0.68	0.57	0.56	0.52	0.45	0.41	0.38	0.33
V_1C_3	1.07	0.70	0.69	0.69	0.64	0.57	0.53	0.50	0.43	0.40	0.38
V_2C_1	0.96	0.48	0.47	0.42	0.39	0.37	0.34	0.30	0.33	0.30	0.21
V_2C_2	1.00	0.52	0.51	0.45	0.43	0.41	0.39	0.36	0.37	0.31	0.24
V_2C_3	0.98	0.55	0.52	0.51	0.49	0.45	0.42	0.38	0.40	0.33	0.29
V_3C_1	1.10	0.62	0.55	0.55	0.53	0.54	0.50	0.42	0.47	0.38	0.29
V_3C_2	1.09	0.65	0.65	0.65	0.57	0.55	0.54	0.50	0.51	0.47	0.43
V_3C_3	1.04	0.66	0.66	0.66	0.58	0.57	0.55	0.51	0.52	0.48	0.46
V_4C_1	1.12	0.88	0.82	0.82	0.70	0.64	0.59	0.54	0.41	0.29	0.28
V_4C_2	1.07	0.99	0.85	0.85	0.71	0.67	0.63	0.60	0.50	0.44	0.32
V_4C_3	1.11	1.10	0.88	0.88	0.74	0.69	0.67	0.61	0.57	0.48	0.39
SE	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.019	0.02	0.02
CD At 5%	NS	0.04	NS	NS	NS	NS	NS	NS	NS	0.06	NS

Note

i) Kharif 2016 seed produce was used upto 210 DAS observation

ii) Kharif 2015 seed produce used at 270, 300 and 330 DAS for observation during 2015-16.

Table.5 Effect of varieties, storage containers and two factor interaction on moisture content of soybean seeds during storage

Treatment	At Harvest	30 DAS	60 DAS	90 DAS	120 DAS	150 DAS	180 DAS	210 DAS	270 DAS	300 DAS	330 DAS
Variety (V)											
V_1 - MAUS71	11.6	10.6	10.0	9.71	9.16	8.43	7.78	7.28	8.10	8.38	8.76
V_2 - MAUS81	11.8	11.0	10.4	9.88	9.40	8.51	7.92	7.52	8.51	8.73	8.88
V_3 - MAUS158	11.5	10.8	10.1	9.86	9.20	8.47	7.78	7.30	8.28	8.58	8.92
V_4 - MAUS162	11.6	10.7	10.0	9.57	9.22	8.32	7.80	7.22	8.20	8.65	8.86
SE	0.148	0.011	0.067	0.061	0.053	0.063	0.080	0.030	0.066	0.053	0.057
CD at 5%	0.324	0.045	0.186	0.181	0.157	0.185	0.236	0.090	0.194	0.55	0.167
Storage container (c)											
C1 – Cloth bag	11.6	10.9	10.3	9.85	9.30	8.60	7.98	7.78	8.30	8.69	8.97
C2 – Gunny bag	11.7	10.8	10.0	9.73	9.26	8.42	7.85	7.35	8.31	8.56	8.87
C3 – HDPE	11.6	10.6	10.0	9.69	9.10	8.27	7.64	7.15	8.20	8.51	8.73
SE	0.128	0.134	0.084	0.053	0.046	0.054	0.069	0.022	0.057	0.046	0.049
CD at 5%	0.305	0.394	0.248	0.156	0.136	0.160	0.204	0.040	0.168	0.135	0.144
Two factor interaction											
V_1C_1	11.6	10.7	10.23	9.76	9.26	8.50	7.90	7.80	8.10	8.60	8.96
V_1C_2	11.7	10.7	10.00	9.70	9.16	8.43	7.76	7.70	8.13	8.30	8.73
V_1C_3	11.6	10.4	9.90	9.66	9.10	8.36	7.70	7.65	8.13	8.53	8.83
V_2C_1	11.9	11.3	10.86	10.03	9.50	8.73	7.93	7.75	8.46	8.76	9.03
V_2C_2	11.7	11.1	10.26	9.83	9.33	8.46	7.90	7.80	8.60	8.73	8.96
V_2C_3	11.8	10.8	10.16	9.80	9.36	8.33	7.70	7.40	8.46	8.70	8.66
V_3C_1	11.5	10.7	10.16	9.90	9.13	8.60	8.13	8.01	8.36	8.66	9.00
V_3C_2	11.5	10.7	10.13	9.86	9.30	8.53	8.00	7.97	8.33	8.53	8.93
V_3C_3	11.8	10.9	10.03	9.833	9.16	8.30	7.63	7.30	8.16	8.56	8.83
V_4C_1	11.7	10.9	10.23	9.73	9.30	8.60	7.96	7.82	8.26	8.73	8.90
V_4C_2	11.7	10.7	9.93	9.56	9.26	8.26	7.73	7.50	8.20	8.70	8.86
V_4C_3	11.3	10.2	9.90	9.433	9.06	8.10	7.53	7.42	8.06	8.26	8.60
SE	0.25	0.029	0.016	0.107	0.093	0.109	0.139	0.011	0.115	0.122	0.098
CD At 5%	NS	0.078	NS	NS	0.27	0.320	0.409	0.035	NS	NS	NS

Note
i) Kharif 2016 seed produce was used upto 210 DAS observation
ii) Kharif 2015 seed produce used at 270, 300 and 330 DAS for observation during 2015-16

Table.6 Effect of varieties, storage containers and two factor interaction on viability by TZ test of soybean seeds during storage

Treatment	At Harvest	30 DAS	60 DAS	90 DAS	120 DAS	150 DAS	180 DAS	210 DAS	270 DAS	300 DAS	330 DAS
Variety (V)											
V_1 - MAUS71	95.33	93.11	90.66	89.55	86.33	83.00	81.66	79.63	74.55	73.33	71.11
V_2 - MAUS81	91.00	90.33	89.55	85.22	81.77	79.22	77.11	74.92	73.77	71.33	67.44
V_3 - MAUS158	92.88	93.55	92.88	90.44	86.00	83.00	80.22	76.1	74.66	73.00	70.00
V_4 - MAUS162	94.66	93.66	93.44	91.11	87.55	84.22	82.66	80.96	79.44	76.11	72.00
SE	0.297	0.382	0.271	0.239	0.136	0.309	0.337	0.255	0.274	0.252	0.309
CD at 5%	0.870	1.119	0.795	0.700	1.061	0.905	0.987	0.765	0.804	0.739	0.905
Storage container (c)											
C1 – Cloth bag	93.16	93.00	91.41	88.83	84.41	81.91	79.66	76.12	74.91	72.75	69.08
C2 – Gunny bag	91.08	93.08	91.50	89.16	85.08	82.16	79.83	78.35	77.08	73.5	69.58
C3 – HDPE	94.33	93.75	92.00	89.25	86.00	83.00	81.75	78.99	77.08	74.83	71.00
SE	0.257	0.331	0.235	0.207	0.313	0.267	0.291	0.258	0.237	0.218	0.267
CD at 5%	0.753	1.939	0.688	0.606	0.919	0.784	0.854	0.774	0.696	0.640	0.784
Two factor interaction											
V_1C_1	95.33	95.00	90.33	88.00	84.33	82.66	80.33	79.33	78.66	75.66	70.00
V_1C_2	95.33	90.33	90.00	89.00	85.00	83.00	82.33	81.84	79.33	76.33	72.66
V_1C_3	95.66	94.66	91.33	90.66	89.66	86.33	85.33	83.45	80.66	77.00	73.66
V_2C_1	91.33	90.66	88.66	84.66	80.33	77.66	76.66	74.31	71.33	71.33	68.00
V_2C_2	91.66	90.33	89.33	85.00	83.66	80.66	77.00	76.11	74.66	71.33	65.66
V_2C_3	90.66	90.33	89.66	86.00	81.33	79.33	77.66	77.09	75.33	71.33	68.66
V_3C_1	94.66	94.66	92.66	90.33	88.00	85.00	81.66	77.92	73.00	71.66	70.00
V_3C_2	92.33	92.33	92.00	90.66	86.00	81.66	78.66	78.49	76.00	73.33	69.33
V_3C_3	93.66	93.66	92.00	90.33	87.00	82.33	80.33	78.95	75.00	74.00	70.66
V_4C_1	95.33	94.66	94.00	92.33	85.00	83.33	80.00	77.91	76.66	72.33	68.33
V_4C_2	93.66	93.00	93.00	91.00	85.66	84.00	81.33	79.86	78.33	73.00	70.66
V_4C_3	95.00	93.33	93.333	90.00	86.00	82.33	83.66	81.52	77.33	74.00	71.00
SE	0.514	0.662	0.470	0.414	0.627	0.535	0.583	0.498	0.475	0.437	0.537
CD At 5%	1.508	NS	1.377	1.213	NS	NS	NS	NS	NS	NS	NS

Note

i) Kharif 2016 seed produce was used upto 210 DAS observation

ii) Kharif 2015 used seed for 270, 300 and 330 DAS for observation during 2015-16

Table.7 Effect of varieties, storage containers and two factor interaction on electrical conductivity of soybean seedlings during storage

Treatment	At Harvest	30 DAS	60 DAS	90 DAS	120 DAS	150 DAS	180 DAS	210 DAS	270 DAS	300 DAS	330 DAS
Variety (V)											
V_1 - MAUS71	0.55	0.67	0.81	0.88	1.04	1.42	1.90	1.95	2.02	2.15	2.18
V_2 - MAUS81	0.60	0.74	0.93	1.00	1.17	1.62	2.19	2.21	2.25	2.31	2.39
V_3 - MAUS158	0.56	0.64	0.77	0.85	1.02	1.37	1.70	1.85	2.07	2.14	2.16
V_4 -MAUS162	0.61	0.71	0.89	0.98	1.07	1.56	1.94	1.98	2.06	2.17	2.22
SE	0.03	0.01	0.01	0.02	0.03	0.04	0.13	0.10	0.02	0.03	0.06
CD at 5%	0.09	0.05	0.45	0.06	0.10	0.12	0.39	0.30	0.19	0.09	0.17
Storage container (c)											
C1 – Cloth bag	0.60	0.74	0.90	0.97	1.14	1.56	2.00	2.06	2.14	2.21	2.26
C2 – Gunny bag	0.57	0.66	0.86	0.93	1.07	1.48	1.93	1.98	2.12	2.19	2.22
C3 – HDPE	0.57	0.66	0.80	0.88	1.02	1.44	1.85	1.90	2.07	2.18	2.21
SE	0.02	0.01	0.01	0.02	0.02	0.03	0.06	0.04	0.03	0.02	0.03
CD at 5%	0.07	0.04	0.03	0.06	0.08	0.10	0.19	0.12	0.11	0.08	0.10
Two factor interaction											
V_1C_1	0.61	0.70	0.88	0.96	1.14	1.46	1.92	1.94	1.98	2.17	2.20
V_1C_2	0.56	0.66	0.85	0.89	1.01	1.41	1.91	1.98	2.06	2.15	2.18
V_1C_3	0.49	0.66	0.71	0.80	0.98	1.39	1.87	1.92	2.03	2.14	2.17
V_2C_1	0.55	0.82	0.98	1.01	1.18	1.67	2.21	2.26	2.35	2.32	2.44
V_2C_2	0.55	0.69	0.94	1.00	1.18	1.61	2.19	2.22	2.32	2.29	2.37
V_2C_3	0.58	0.69	0.88	1.01	1.16	1.60	2.16	2.20	2.22	2.33	2.35
V_3C_1	0.58	.0.67	0.81	0.87	1.09	1.44	1.86	1.91	2.11	2.18	2.15
V_3C_2	0.57	0.63	0.77	0.86	1.04	1.36	1.72	1.85	2.06	2.15	2.17
V_3C_3	0.65	0.63	0.74	0.82	0.93	1.32	1.51	1.65	2.04	2.09	2.15
V_4C_1	0.66	0.78	0.92	1.06	1.14	1.67	2.01	2.05	2.13	2.19	2.27
V_4C_2	0.60	0.68	0.89	0.98	1.05	1.55	1.92	1.99	2.05	2.17	2.19
V_4C_3	0.57	0.68	0.87	0.91	1.02	1.45	1.88	1.93	2.01	2.14	2.19
SE	0.053	0.030	0.026	0.047	0.059	0.074	0.136	0.110	0.066	0.057	0.061
CD At 5%	0.157	0.088	NS	NS	0.174	0.219	0.399	0.332	0.193	NS	NS

Note

i) Kharif 2016 seed produce was used upto 210 DAS observation

ii) Kharif 2015 used seed produce at 270, 300 and 330 DAS for observation during 2015-16.

Table.8 Effect of Varieties, Storage containers and two factor interaction on Protein Content of soybean seeds during storage

Treatment	At Harvest	30 DAS	60 DAS	90 DAS	120 DAS	150 DAS	180 DAS	210 DAS	270 DAS	300 DAS	330 DAS
Variety (V)											
V_1 - MAUS71	41.66	41.61	41.57	41.46	41.30	41.09	40.88	40.10	38.76	38.60	38.49
V_2 - MAUS81	41.41	41.39	41.38	41.38	41.21	41.01	40.81	40.01	38.71	38.43	38.34
V_3 - MAUS158	42.38	42.34	42.13	42.22	42.04	41.95	41.83	41.12	38.97	38.69	38.57
V_4 -MAUS162	41.92	41.90	41.84	41.84	41.59	41.38	41.14	40.90	38.85	38.62	38.43
SE	0.045	0.055	0.069	0.066	0.065	0.144	0.016	0.011	0.066	0.026	0.024
CD at 5%	0.132	0.163	0.202	0.193	0.191	0.424	0.047	0.030	0.194	0.077	0.726
Storage container (c)											
C1 – Cloth bag	41.78	41.76	41.72	41.70	41.52	41.15	41.13	40.90	38.67	38.46	38.33
C2 – Gunny bag	41.82	41.82	41.81	41.75	41.50	41.29	41.22	41.01	38.84	38.55	38.45
C3 – HDPE	41.90	41.87	41.64	41.70	41.59	41.45	41.32	41.15	38.95	38.73	38.60
SE	0.039	0.027	0.059	0.057	0.0565	0.072	0.014	0.010	0.057	0.022	0.021
CD at 5%	0.114	0.094	0.175	0.167	0.165	0.212	0.041	0.031	0.168	0.067	0.062
Two factor interaction											
V_1C_1	41.58	41.57	41.55	41.44	41.26	41.05	40.79	40.68	38.62	38.57	38.48
V_1C_2	41.62	41.62	41.57	41.45	41.33	41.07	40.86	40.78	38.80	38.71	38.56
V_1C_3	41.79	41.63	41.58	41.50	41.32	41.14	41.00	40.70	39.13	38.81	38.67
V_2C_1	41.42	41.32	41.25	41.25	41.12	40.92	40.70	40.30	38.67	38.32	38.26
V_2C_2	41.49	41.44	41.43	41.39	41.24	40.99	40.80	40.41	38.65	38.33	38.30
V_2C_3	41.48	41.46	41.41	41.41	41.27	41.12	40.93	40.80	38.83	38.63	38.46
V_3C_1	42.34	42.29	42.28	42.28	42.12	41.90	41.76	41.68	38.75	38.45	38.33
V_3C_2	42.36	42.33	42.32	42.32	41.81	41.97	41.89	41.10	39.16	38.58	38.50
V_3C_3	42.40	42.43	42.18	42.06	41.73	41.99	41.86	41.15	39.00	38.77	38.65
V_4C_1	41.90	41.88	41.81	41.81	41.57	41.40	41.29	41.00	38.66	38.54	38.23
V_4C_2	41.92	41.87	41.86	41.86	41.61	41.36	41.13	40.81	38.77	38.60	38.45
V_4C_3	41.93	41.96	41.84	41.84	41.58	41.55	41.51	40.98	38.86	38.72	38.61
SE	0.078	0.055	0.119	0.114	0.113	0.144	0.028	0.040	0.115	0.045	0.042
CD At 5%	0.229	0.165	NS	0.335	0.331	NS	0.082	NS	NS	NS	NS

Note

i) Kharif 2016 seed produce was used upto 210 DAS observation

ii) Kharif 2015 seed produce used at 270, 300 and 330 DAS for observation during 2015-16.

Table.9 Effect of Varieties, Storage containers and two factor interaction on Oil Content (NMR Method) of Soybean seeds during storage

Treatment	At Harvest	30 DAS	60 DAS	90 DAS	120 DAS	150 DAS	180 DAS	210 DAS	270 DAS	300 DAS	330 DAS
Variety (V)											
V_1 - MAUS71	20.18	20.10	20.05	19.99	19.99	19.91	19.82	19.79	19.66	19.56	19.43
V_2 - MAUS81	19.90	19.90	19.88	19.83	19.80	19.79	19.74	19.70	19.53	19.48	19.08
V_3 - MAUS158	20.18	20.13	20.13	20.08	19.98	19.92	19.85	19.80	19.79	19.67	19.50
V_4 -MAUS162	20.12	20.06	20.03	19.96	19.90	19.84	19.74	19.72	19.71	19.57	19.14
SE	0.015	0.017	0.065	0.018	0.016	0.011	0.009	0.003	0.023	0.047	0.054
CD at 5%	0.044	0.050	0.193	0.055	0.047	0.033	0.026	0.012	0.069	0.137	0.159
Storage container (c)											
C1 – Cloth bag	20.07	20.01	19.95	19.93	19.88	19.81	19.71	19.68	19.45	19.28	19.12
C2 – Gunny bag	20.06	20.00	20.00	19.98	19.89	19.85	19.80	19.76	19.65	19.54	19.35
C3 – HDPE	20.12	20.09	20.04	20.01	19.96	19.93	19.85	19.81	19.75	19.67	19.39
SE	1.319	0.014	0.057	0.016	0.014	0.009	0.000	0.001	0.020	0.040	0.047
CD at 5%	0.013	0.043	0.167	0.047	0.041	0.028	0.023	0.012	0.060	0.119	0.137
Two factor interaction											
V_1C_1	20.19	20.10	19.98	19.91	19.86	19.75	19.58	19.50	19.33	19.38	19.36
V_1C_2	20.18	20.14	20.04	19.97	19.91	19.89	19.82	19.78	19.46	19.34	19.30
V_1C_3	20.17	20.20	20.14	20.13	20.03	19.95	19.90	19.85	19.78	19.68	19.61
V_2C_1	19.92	19.90	19.88	19.83	19.79	19.77	19.72	19.68	19.63	19.63	18.95
V_2C_2	19.89	19.90	19.88	19.83	19.79	19.78	19.75	19.72	19.68	19.50	19.28
V_2C_3	19.89	19.90	19.87	19.84	19.81	19.83	19.76	19.70	19.66	19.59	19.18
V_3C_1	20.27	20.08	20.12	20.04	19.96	19.79	19.78	19.72	19.76	19.55	19.35
V_3C_2	20.12	20.17	20.14	20.08	19.90	19.89	19.83	19.80	19.78	19.72	19.58
V_3C_3	20.14	20.19	20.15	20.10	20.10	20.08	19.95	19.90	19.84	19.74	19.57
V_4C_1	20.07	20.00	19.99	19.93	19.87	19.81	19.61	19.56	19.87	19.05	18.80
V_4C_2	20.11	20.17	20.07	19.96	19.90	19.84	19.82	19.78	19.69	19.60	19.22
V_4C_3	20.19	20.05	19.99	19.99	19.92	19.86	19.80	19.76	19.71	19.67	19.22
SE	0.026	0.014	0.114	0.032	0.0283	0.019	0.0158	0.012	0.041	0.081	0.094
CD At 5%	NS	NS	0.334	NS	0.083	NS	NS	0.036	0.120	0.238	0.275

Note

i) Kharif 2016 seed produce was used upto 210 DAS observation

ii) Kharif 2015 seed produce used at 270, 300 and 330 DAS for observation during 2015-16.

The electrical conductivity of soybean seed of different varieties stored in different containers was significantly influenced during storage. It was also noticed that the EC increased with advancement of storage period irrespective of treatments.

The EC of seed was significantly higher in MAUS -162 fallowed by MAUS 158, MAUS-71 and significantly lower in MAUS-81 during all the period of storage. The viability of the soybean seed stored in High density polyethylene was significantly higher than the seed stored in gunny bags and cloth bag during all the periods of storage irrespective of varieties.

Two factor interaction

V×C - The interaction effect was significant during all the period of storage except at 60, 90, 300 days.

Protein content (%)

The data pertaining to the effect of varieties, storage containers and two factor interactions of different treatments on protein content of soybean seed during storage have been presented in Table 8.

The protein content of soybean seed significantly influenced by different varieties stored in different containers was significantly influenced during storage. The protein content was decreased with advancement of storage period irrespective of varieties and treatments.

The protein content was significantly higher in MAUS -162 fallowed by MAUS 158, MAUS-71 and significantly lower in MAUS-81 during all the period of storage. The protein content of the soybean seed stored in High density polyethylene was significantly higher than the seed stored in gunny bags and cloth bag during all the periods of storage irrespective of varieties.

Two factor interaction

V×C - The effect was significant during all the periods of storage except at 60, 150, 270, 300, 330 days.

Oil content

The data pertaining to the effect of varieties, storage containers and two factor interactions of different treatments on oil content of soybean seed during storage have been presented in Table 9.

The oil content of soybean seed significantly influenced by different varieties stored in different containers was significantly influenced during storage. The protein content was decreased with advancement of storage period irrespective of varieties and treatments.

The oil content was significantly higher in MAUS -162 fallowed by MAUS 158, MAUS-71 and significantly lower in MAUS-81 during all the period of storage. The oil content of the soybean seed stored in High density polyethylene was significantly higher than the seed stored in gunny bags and cloth bag during all the periods of storage irrespective of varieties.

Two factor interaction

V×C - The interaction effect was non-significant during all the periods of storage except at 60, 120, 270, 300, 330 days. The significantly higher and lower oil content of soybean seed was recorded in V_4C_3 and V_2C_3 interaction respectively.

The variety MAUS-162 fallowed by MAUS-158 and MAUS-71 was found to be

better stored than the MAUS 81, irrespective of treatments.

The germination, RS length, vigour index, dry matter content, viability as tested by TZ test, protein and oil content were found to be decreased, whereas, the moisture content and electrical conductivity increased during all the periods of storage as storage period advances irrespective of varieties and storage containers.

The seeds stored in High Density Polyethene bag fallowed by gunny bag was found to be better storability by 90 days and 60 days respectively than the seed stored in cloth bag irrespective of varieties.

From the above statements we may conclude that cloth bag is not safe for soybean seed storage for long time than in HDPE bag and gunny bag. Because the rate of moisture absorbance was higher in cloth bag than HDPE bag and gunny bag.

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