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EFFECT OF SEED FORTIFICATION TREATMENTS AND CONTAINERS ON THE STORABILITY OF SESAME CV TMV 3

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Abstract

They study was undertaken to monitor the viability of various fortified seeds of sesame seeds stored under different containers in the Department of Genetics and Plant Breeding, Annamalai University, Annamalai Nagar. Genetically pure seeds of sesame cv. TMV 3 were obtained from the Oilseed Research Station, Thindivanam. The bulk seeds were graded for uniformity using appropriate round perforated metal sieves of sizes of 5/64" size sieve and were imposed with various fortification pre-storage seed treatments *i.e.,* GA_3 @ 100 ppm, IAA @ 100 ppm, $MnSo_4$ @ 0.5 %, $FeSo_4$ @ 0.5 %, Pungam (*Pongamia pinnata*) leaf extract @ 2 %, Prosopis (*Prosopis juliflora*) leaf extract @ 2 %, Arappu (*Albizia amara*) leaf extract @ 2 % and Tamarind (*Tamarindus indica*) leaf extract @ 2 %. The treated seeds were dried under shade and in drying chamber to reach required moisture content for storage. The treated seeds along with control were stored in cloth bag and 700 gauge polythene bag under ambient condition of Annamalai nagar for a period of 10 months and were evaluated for seed quality characters viz germination percent, root length, shoot length, dry matter production, Vigour index, electrical conductivity and oil content at bimonthly intervals. The study clearly revealed the sesame seeds fortified with prosopis leaf extract @ 2 % and stored in 700 gauge polythene bag maintained its germination for minimum seed certification standard till the end of the storage period in sesame cv TMV 3. This type of storage treatment registered higher germination percentage, seedling length, dry matter production, vigour index and oil content with low electrical conductivity when compared to other treatments and control.

Key words : Sesame, Fortification, Seed storage.

Introduction

Sesame or gingelly (*Sesamum indicum* L.) commonly known as til (Hindi) is an ancient oilseed crop grown in India, and perhaps the oldest oilseed crop in the world. The crop is now grown in a wide range of environments, extending from semi-arid tropics and subtropics to temperate regions. Consequently, the crop has a large diversity in cultivars and cultural systems. India is the largest producer of sesame in the world. It also ranks first in the world in terms of sesame-growing area (24%) (Sathiya Narayanan and Prakash, 2015). In general, average productivity of sesame continues to be lower than expected from agricultural technology for the last 10 years, mainly due to its cultivation on marginal lands, under poor management and without inputs except seed. The major constraint responsible for lower yield are inappropriate production technologies. Good seed treatment helps in getting good germination, plant establishment, and crop protection in early stage of crop growth. Seed storage helps in enhancing the longevity of the seed for sowing in the following season. Seed treatment and storage are two important aspects of agriculture. Seeds are required to be kept in safe storage since they are harvested in the preceding season and usually used for sowing in the subsequent season often after a time gap of six months or longer. Seed deterioration is an inexorable and an irreversible process. During the aging process, seeds lose their vigor, ability to germinate and ultimately become less viable (Chakrabarti *et al.*, 2005). Losses in seed quality occur during field weathering, harvesting and storage. Several intrinsic and extrinsic factors influence the viability of seeds during

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Table 1: Effect of treatment, period of storage and containers on seed Germination (%) of sesame cv. TMV 3.

Containers	Treatments	P_0	P_2	P_4	P_6	P_8	P_{10}	MEAN
C_1	T_0	92 (73.59)	88 (76.74)	80 (63.44)	78 (62.03)	64 (53.13)	52 (46.14)	75 (61.34)
	T_1	90 (71.58)	85 (67.22)	81 (64.16)	76 (60.67)	72 (58.05)	58 (45.00)	77 (61.11)
	T_2	92 (73.59)	87 (68.87)	82 (64.90)	76 (60.67)	70 (56.79)	57 (49.02)	77 (62.31)
	T_3	89 (70.64)	84 (66.43)	78 (62.03)	73 (58.69)	68 (55.55)	55 (47.87)	74 (60.20)
	T_4	91 (72.56)	85 (67.22)	80 (63.44)	76 (60.67)	69 (56.17)	56 (48.44)	76 (61.41)
	T_5	90 (71.58)	84 (66.43)	79 (62.73)	75 (60.00)	72 (58.05)	61 (51.35)	77 (61.39)
	T_6	94 (75.85)	89 (70.64)	84 (66.43)	81 (64.14)	78 (62.03)	68 (55.55)	82 (65.78)
	T_7	93 (74.68)	88 (69.74)	83 (65.65)	79 (62.73)	75 (60.00)	66 (54.33)	81 (64.52)
	T_8	91 (72.56)	87 (68.87)	84 (66.43)	79 (62.73)	74 (59.34)	64 (53.13)	79 (63.84)
	MEAN	**91 (72.96)**	**86 (68.35)**	**81 (64.35)**	**77 (61.37)**	**72 (57.68)**	**68 (50.09)**	**78 (62.47)**
C_2	T_0	91 (72.56)	86 (68.87)	81 (66.43)	75 (62.73)	69 (59.34)	60 (53.13)	77 (63.84)
	T_1	92 (72.56)	88 (68.03)	85 (64.14)	81 (60.00)	78 (56.17)	70 (50.77)	82 (61.95)
	T_2	91 (73.59)	87 (69.74)	84 (67.22)	82 (64.16)	77 (62.03)	68 (56.79)	81 (65.59)
	T_3	90 (72.56)	86 (68.87)	81 (66.43)	78 (64.90)	74 (61.34)	64 (55.55)	79 (64.94)
	T_4	93 (71.58)	89 (68.03)	85 (64.16)	81 (62.03)	75 (59.34)	66 (53.13)	81 (63.04)
	T_5	93 (74.68)	90 (70.64)	86 (67.22)	84 (64.14)	82 (60.00)	72 (54.33)	84 (65.17)
	T_6	95 (74.68)	93 (71.58)	93 (68.03)	91 (66.43)	89 (64.90)	82 (58.05)	90 (67.18)
	T_7	94 (77.12)	91 (74.68)	89 (74.68)	88 (72.56)	87 (70.64)	79 (64.90)	88 (72.43)
	T_8	94 (75.85)	92 (72.56)	90 (70.64)	88 (69.74)	86 (68.87)	78 (62.73)	88 (70.06)
	MEAN	**92 (73.91)**	**89 (70.33)**	**86 (67.66)**	**83 (65.19)**	**79 (62.51)**	**77 (56.60)**	**82 (66.03)**
Treatment mean	T_0	91 (73.07)	87 (69.31)	80 (64.93)	76 (62.38)	66 (56.24)	56 (49.64)	76 (62.59)
	T_1	91 (72.07)	86 (67.63)	83 (64.16)	78 (60.33)	75 (57.11)	64 (47.88)	79 (61.53)
	T_2	91 (73.59)	87 (69.31)	83 (66.06)	79 (62.41)	73 (59.41)	67 (52.90)	80 (63.95)
	T_3	89 (71.60)	85 (67.65)	79 (64.23)	75 (61.80)	71 (58.45)	59 (51.71)	76 (62.57)
	T_4	92 (72.07)	87 (67.63)	82 (63.80)	78 (61.35)	72 (57.75)	61 (50.79)	79 (62.23)
	T_5	91 (73.13)	87 (68.53)	82 (64.97)	79 (62.08)	77 (59.03)	66 (52.84)	80 (63.43)
	T_6	94 (75.27)	91 (71.11)	88 (67.23)	86 (65.29)	83 (63.46)	75 (56.80)	86 (66.53)
	T_7	93 (75.90)	89 (72.21)	86 (70.17)	83 (67.64)	81 (65.32)	72 (59.61)	84 (68.48)
	T_8	92 (74.20)	89 (70.71)	87 (68.53)	83 (66.23)	80 (64.11)	71 (57.93)	83 (66.95)
	MEAN	**91 (73.43)**	**88 (69.34)**	**83 (66.01)**	**79 (63.28)**	**75 (60.10)**	**65 (53.14)**	**80 (64.25)**

Figures in parenthesis are Arcsine Transformed value

	C	T	P	C × T	T × P	C × P	C × P × T
CD P = 0.05	0.219	0.467	0.379	0.657	1.137	0.536	1.169

storage. Among intrinsic and extrinsic factors, seed moisture content, relative humidity, temperature of storage, pests and diseases and oxygen availability are more important. With these in background, studies have been undertaken in sesame cv TMV 3 seeds to study the influence of seed fortification treatment and containers on seed storage.

Materials and Methods

The present study was carried using genetically pure seeds of sesame cv. TMV 3 obtained from obtained from Regional Research Station, Thindivanam, TNAU, Tamilnadu. The experiments were conducted at the Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University, Annamalai Nagar (11°24'N latitude and 79°44'E longitude with an altitude of +5.79 mts above mean sea level). The bulk seeds were first dried to below 12% moisture content, cleaned, then graded with suitable sieves and imposed for following priming treatments *viz.,* GA_3 @ 100 ppm, IAA @ 100 ppm, $MnSO_4$ @ 0.5 %, $FeSo_4$ @ 0.5 %, Pungam (*Pongamia pinnata*) leaf extract @ 2 %, Prosopis (*Prosopis juliflora*) leaf extract @ 2 %, Arappu (*Albizia amara*) leaf extract @ 2 % and Tamarind (*Tamarindus indica*) leaf extract @ 2 %. After the treated seeds were removed from the solutions, rinsed in water, shade and sun dried at room temperature to bring back to its original moisture content. The treated seeds along with control (T_0) were stored in cloth bag (C_1) and 700 gauge polythene bag (C_2) under ambient condition at Annamalai

Table 2: Effect of treatment, period of storage and containers on seed Root length(cm) of sesame cv. TMV 3.

Containers	Treatments	P_0	P_2	P_4	P_6	P_8	P_{10}	MEAN
C_1	T_0	8.9	8.5	7.9	7.6	7.5	7.4	7.9
	T_1	9.0	8.8	8.3	8.2	8.0	7.9	8.3
	T_2	9.2	8.9	8.5	8.3	8.0	7.9	8.4
	T_3	9.1	8.8	8.3	8.1	7.9	7.7	8.3
	T_4	9.2	8.7	8.2	7.6	7.2	6.8	7.9
	T_5	9.3	8.9	8.5	8.3	8.1	8.0	8.5
	T_6	10.0	9.2	9.0	8.7	8.5	8.0	8.9
	T_7	9.8	9.4	9.0	8.3	8.1	7.9	8.7
	T_8	9.5	9.1	8.7	8.4	8.2	8.1	8.6
	MEAN	9.3	8.9	8.5	8.2	8.0	7.8	8.5
C_2	T_0	9.1	8.6	8.4	8.2	8.0	7.8	8.3
	T_1	9.7	9.1	8.5	8.3	8.2	8.1	8.6
	T_2	9.6	9.2	8.7	8.2	8.1	8.0	8.6
	T_3	9.2	8.9	8.4	8.3	8.0	7.8	8.4
	T_4	9.4	8.7	8.4	8.3	8.1	7.9	8.4
	T_5	9.9	9.2	8.8	8.5	8.3	8.2	8.8
	T_6	10.5	10.1	9.5	9.4	9.2	8.9	9.6
	T_7	10.1	9.8	9.2	8.8	8.6	8.5	9.1
	T_8	10.0	9.7	9.3	8.6	8.5	8.3	9.0
	MEAN	9.7	9.2	8.8	8.5	8.3	8.1	8.8
Treatment mean	T_0	9.0	8.5	8.1	7.9	7.7	7.6	8.2
	T_1	9.3	8.9	8.4	8.2	8.1	8.0	8.5
	T_2	9.4	9.0	8.6	8.2	8.0	7.9	8.5
	T_3	9.1	8.8	8.3	8.2	7.9	7.7	8.4
	T_4	9.3	8.7	8.3	7.9	7.6	7.3	8.1
	T_5	9.6	9.0	8.6	8.4	8.2	8.1	8.7
	T_6	10.2	9.6	9.2	9.0	8.9	8.4	9.2
	T_7	9.9	9.6	9.1	8.5	8.3	8.2	9.0
	T_8	9.7	9.4	9.0	8.5	8.3	8.2	8.8
	MEAN	9.5	9.1	8.6	8.3	8.1	7.9	8.6

	C	T	P	C × T	T × P	C × P	C × P × T
CD P = 0.05	0.029	0.063	0.070	0.089	0.210	0.099	0.297

nagar for a period of 10 months. The experiment was formulated adopting FCRD with three replications and evaluated for its seed quality parameters once in two months viz., germination percentage (ISTA, 1999), shoot length (ISTA, 1999), root length (ISTA, 1999), drymatter production (ISTA, 1999), vigour index (Abdul-Baki and Anderson, 1973), electrical conductivity (Priestley and Leopold, 1983) and oil content (AOAC, 1960). under laboratory condition. The data were statistically analyzed as per the method of Panse and Sukhatme (1985).

Results and Discussion

Seed is a living hygroscopic material with a very complex and heterogeneous composition. It should be maintained well from harvest to next sowing season without appreciable loss in vigour and viability. Seed quality maintenance especially under storage conditions is important. The germination potential is the basic requirement for seed. The viability and vigour are the two important facts of seed quality and they go hand in hand while judging the quality of seeds. Germination is the last measure of quality to decline as the seed deteriorates during storage. In the present study, the germination percentage decreased with increase in the storage period *viz*. 91 to 65 per cent Table 1. The study highlighted that sesame seeds fortified with prosopis leaf

Table 3: Effect of treatment, period of storage and containers on seed shoot length(cm) of sesame cv. TMV 3.

Containers	Treatments	P_0	P_2	P_4	P_6	P_8	P_{10}	MEAN
C_1	T_0	6.9	6.2	5.6	4.3	3.5	3.4	4.9
	T_1	7.4	6.9	6.2	5.5	4.3	3.7	5.6
	T_2	7.3	6.8	6.0	5.2	4.5	3.6	5.5
	T_3	7.0	6.5	5.9	5.1	4.6	3.5	5.4
	T_4	7.1	6.8	6.2	5.2	4.5	3.6	5.6
	T_5	7.6	7.1	6.6	5.5	4.9	3.7	5.9
	T_6	7.9	6.9	5.9	5.4	4.5	4.2	5.8
	T_7	7.8	6.6	5.9	5.0	4.5	4.0	5.6
	T_8	7.7	6.3	6.1	5.1	4.1	3.9	5.5
	MEAN	7.4	6.7	6.0	5.1	4.3	3.7	5.6
C_2	T_0	7.4	7.0	6.3	5.2	4.6	3.6	5.6
	T_1	7.8	7.2	6.8	6.0	5.5	3.9	6.2
	T_2	7.7	7.2	6.4	5.9	4.3	3.8	5.8
	T_3	7.5	7.0	6.3	5.8	4.5	3.6	5.7
	T_4	7.6	7.2	6.5	5.7	4.0	3.8	5.8
	T_5	8.0	7.4	6.4	5.5	4.6	4.1	6.0
	T_6	8.3	7.5	7.2	6.2	5.4	4.5	6.5
	T_7	8.2	7.4	6.8	6.0	5.1	4.3	6.3
	T_8	8.1	7.2	6.4	5.8	5.0	4.2	6.0
	MEAN	7.8	7.2	6.5	5.7	4.7	3.9	6.0
Treatment mean	T_0	7.1	6.6	5.9	4.7	4.0	3.5	5.3
	T_1	7.6	7.0	6.5	5.7	4.9	3.8	5.9
	T_2	7.5	7.0	6.2	5.5	4.4	3.7	5.7
	T_3	7.2	6.7	6.1	5.4	4.5	3.5	5.6
	T_4	7.3	7.0	6.3	5.4	4.2	3.7	5.6
	T_5	7.8	7.2	6.5	5.5	4.7	3.9	5.9
	T_6	8.1	7.2	6.4	5.8	4.9	4.3	6.2
	T_7	8.0	7.0	6.3	5.5	4.8	4.1	5.9
	T_8	7.9	6.7	6.2	5.4	4.5	4.0	5.8
	MEAN	7.6	7.0	6.3	5.5	4.6	3.8	5.8

	C	T	P	C × T	T × P	C× P	C × P × T
CD P = 0.05	0.043	0.091	0.100	0.129	0.302	0.142	0.427

extract @ 2 % and stored in 700 gauge polythene bag maintained their germination for minimum seed certification purpose till the end of the storage period. Where the actual germination percent recorded after storage was 84 per cent. Cloth bag being a pervious container, moisture exchange took place until it reached the equilibrium with the storage environment on the other hand, the 700 gauge polythene bag acted as a moisture resistant container resulting in minimum fluctuation in moisture. Agrawal (1988) reported that the seeds in moisture resistant container experienced relatively low fluctuation as compared to seeds stored in moisture pervious containers. This might have explained why the seeds stored in 700 gauge polythene bag performed better than that in cloth bag.

Seed deterioration as evident from loss of viability is associated with decreased growth of root and shoot (Abdall and Roberts, 1969). The root length could be considered as a good criterion for assessing seed vigour (Woodstock, 1969). In the present study, the root and shoot length of the seedling showed significant reduction over periods of storage, irrespective of the treatment, container and crops. The sesame seeds fortified with prosopis leaf extract @ 2 % and stored in 700 gauge polythene bag produced lengthier seedlings compared to those stored in cloth bag. At the end of the storage period the above treatment were superior in producing lengthier

Table 4: Effect of treatment, period of storage and containers on seed Dry matter production (mg. seedlings^{-10}) of sesame cv. TMV 3.

Containers	Treatments	P_0	P_2	P_4	P_6	P_8	P_{10}	MEAN
C_1	T_0	2.500	2.061	1.421	1.216	1.121	1.096	1.569
	T_1	2.709	2.327	1.726	1.513	1.426	1.321	1.837
	T_2	2.653	2.214	1.696	1.496	1.321	1.291	1.777
	T_3	2.605	2.184	1.612	1.442	1.275	1.114	1.705
	T_4	2.631	2.213	1.743	1.521	1.321	1.104	1.755
	T_5	2.762	2.421	1.984	1.683	1.549	1.392	1.965
	T_6	2.912	2.713	2.384	1.985	1.832	1.793	2.269
	T_7	2.887	2.801	2.531	1.834	1.726	1.624	2.233
	T_8	2.811	2.957	2.719	1.747	1.593	1.432	2.209
	MEAN	2.171	2.432	1.979	1.604	1.462	1.351	1.924
C_2	T_0	2.700	2.435	1.857	1.489	1.248	1.015	1.790
	T_1	2.852	2.458	2.103	1.873	1.602	1.496	2.064
	T_2	2.843	2.685	2.204	1.687	1.483	1.324	2.037
	T_3	2.807	2.758	2.183	1.753	1.304	1.269	2.012
	T_4	2.821	2.605	2.098	1.825	1.458	1.292	2.016
	T_5	2.861	2.585	2.245	1.944	1.632	1.526	2.132
	T_6	3.050	2.904	2.694	2.058	1.903	1.827	2.406
	T_7	2.872	2.607	2.432	2.142	1.821	1.714	2.264
	T_8	2.870	2.563	2.274	1.975	1.734	1.699	2.185
	MEAN	2.285	2.622	2.232	1.860	1.576	1.462	2.101
Treatment mean	T_0	2.600	2.248	1.639	1.352	1.184	1.055	1.679
	T_1	2.780	2.392	1.914	1.693	1.514	1.408	1.950
	T_2	2.748	2.449	1.950	1.591	1.402	1.307	1.908
	T_3	2.706	2.471	1.897	1.597	1.289	1.191	1.858
	T_4	2.726	2.409	1.920	1.673	1.389	1.198	1.886
	T_5	2.811	2.503	2.114	1.813	1.590	1.459	2.048
	T_6	2.981	2.808	2.539	2.021	1.867	1.810	2.337
	T_7	2.879	2.714	2.581	1.988	1.773	1.669	2.267
	T_8	2.840	2.760	2.496	1.861	1.663	1.565	2.197
	MEAN	2.785	2.528	2.117	1.732	1.519	1.407	2.015

	C	T	P	C × T	T × P	C× P	C × P × T
CD P = 0.05	0.021	0.046	0.050	0.065	0.152	0.071	1.215

seedlings than the untreated ones. It produces 8.9 cm root and 4.5 cm shoot (Table 2 and 3).

The vigour estimations based on physiological manifestations such as seedling length, dry matter accumulation and the vigour index arrived at from germination percentage with the respective seedling length had clearly brought out the importance of such estimations for determining the vigour of seeds in storage. The vigour index, which is the totality of germination and seedling growth, has been regarded as a good index to measure the vigour of seeds (Murugan, 1981). In the present study, the dry matter production and vigour index decreased with increase in the storage period irrespective of treatments and containers. The decrease was low in sesame seeds fortified with prosopis leaf extract @ 2 % and stored in 700 gauge polythene bag treatment. At the end of the storage period the above treatment recorded high dry matter (1.827 g) and high vigour index (1098) (Table 4 and 5).

Electrical conductivity was increased with increase in the storage period. The increase was from 0.090 to 0. 208 dSm^{-1} and the oil content decreased with increased storage period *i.e.*, 47.8 % to 40.8 %. The sesame seeds fortified with prosopis leaf extract @ 2 % and stored in 700 gauge polythene bag recorded relatively low electrical conductivity and high oil content compared to the

Table 5: Effect of treatment, period of storage and containers on seed vigour index of sesame cv. TMV 3.

Containers	Treatments	P_0	P_2	P_4	P_6	P_8	P_{10}	MEAN
C_1	T_0	1453	1293	1080	928	704	561	1003
	T_1	1476	1334	1174	1041	885	672	1097
	T_2	1518	1365	1189	1026	875	655	1104
	T_3	1432	1285	1107	963	850	616	1042
	T_4	1483	1317	1152	972	807	582	1052
	T_5	1521	1344	1192	1035	936	713	1123
	T_6	1682	1432	1251	1142	1014	829	1125
	T_7	1636	1408	1236	1050	945	785	1177
	T_8	1565	1340	1243	1066	910	768	1148
	MEAN	1529	1346	1180	1025	881	687	1108
C_2	T_0	1501	1341	1190	1005	869	684	1098
	T_1	1610	1434	1300	1158	1068	840	1235
	T_2	1574	1426	1268	1156	954	802	1197
	T_3	1503	1367	1190	1099	925	729	1135
	T_4	1581	1415	1266	1134	907	772	1179
	T_5	1664	1494	1307	1176	1057	885	1264
	T_6	1786	1636	1553	1419	1299	1098	1465
	T_7	1720	1565	1453	1302	1191	1011	1369
	T_8	1701	1554	1413	1267	1161	975	1345
	MEAN	1626	1470	1323	1190	1048	866	1254
Treatment mean	T_0	1477	1317	1080	928	786	622	1050
	T_1	1543	1384	1237	1099	976	756	1166
	T_2	1521	1395	1228	1091	914	728	1150
	T_3	1467	1326	1148	1031	887	672	1088
	T_4	1532	1366	1209	1053	857	677	1115
	T_5	1592	1419	1249	1105	996	799	1193
	T_6	1734	1534	1402	1280	1156	963	1345
	T_7	1678	4486	1344	1176	1068	898	1275
	T_8	1633	1447	1328	1166	1035	871	1246
	MEAN	1578	1408	1253	1107	964	766	1181

	C	T	P	C× T	T × P	C× P	C × P × T
CD P = 0.05	5.926	12.472	13.921	17.808	41.664	19.687	59.063

untreated ones. At the end of the storage period the above treatment recorded low electrical conductivity (0.129 dsm^{-1}) and high oil content (44.1 %) (Table 6 and 7). Similar results were reported by Srimathi *et al.,* 2007 and Kamaraj and Padmavathi, 2012, Sathiya Narayanan *et al.,* 2015 in green gram.

This could be due to the modification of physiological and biochemical nature of the seeds so as to get the characters that were favorable for drought resistance (Henckel, 1964). The percentage of germination is an excellent indicator for survival and growth potential of seed. The *Prosopis* leaf extract (2%) hardened seeds would become physiologically advanced by carrying out some of the initial steps of germination and the subsequent improvement in germinability of these 2%*, Prosopis* leaf extract hardened seeds could be due to fact that such advanced step in the germination process which on further placement for germination, remember the stage of initial imbibition step and continue from that stage for further growth and development. The first step of germination is formation of GA_3 and hydrolytic enzyme that aid in translocation of food material in simpler form to the germinating radical (Copeland, 1995). The reason for the higher germination of *Prosopis* leaf extract seed caused by due to the presence of greater hydration of colloids, higher viscosity and elasticity of protoplasm, increase in

Table 6: Effect of treatment, period of storage and containers on seed Electrical conductivity (dSm^{-1}) of sesame cv. TMV 3.

Containers	Treatments	P_0	P_2	P_4	P_6	P_8	P_{10}	MEAN
C_1	T_0	0.099	0.214	0.258	0.298	0.399	0.399	0.277
	T_1	0.091	0.134	0.176	0.192	0.201	0.231	0.170
	T_2	0.093	0.156	1.094	0.212	0.218	0.241	0.502
	T_3	0.098	0.194	0.236	0.279	0.312	0.352	0.245
	T_4	0.095	0.172	0.192	0.218	0.289	0.314	0.213
	T_5	0.090	0.121	0.156	0.179	0.199	0.215	0.160
	T_6	0.086	0.098	0.106	0.120	0.129	0.133	0.112
	T_7	0.089	0.101	0.111	0.131	0.176	0.196	0.134
	T_8	0.088	0.118	0.146	0.169	0.189	0.209	0.153
	MEAN	0.092	0.145	0.275	0.310	0.234	0.254	0.218
C_2	T_0	0.090	0.154	0.162	0.166	0.174	0.181	0.154
	T_1	0.091	0.129	0.139	0.149	0.158	0.162	0.138
	T_2	0.094	0.131	0.142	0.153	0.159	0.165	0.140
	T_3	0.097	0.151	0.159	0.162	0.169	0.173	0.151
	T_4	0.095	0.141	0.152	0.159	0.160	0.169	0.146
	T_5	0.089	0.126	0.131	0.142	0.150	0.182	0.136
	T_6	0.081	0.092	0.102	0.109	0.116	0.129	0.104
	T_7	0.084	0.096	0.109	0.121	0.329	0.141	0.146
	T_8	0.086	0.101	0.112	0.129	0.141	0.153	0.120
	MEAN	0.089	0.124	0.134	0.143	0.172	0.161	0.137
Treatment mean	T_0	0.094	0.184	0.210	0.232	0.286	0.290	0.216
	T_1	0.091	0.131	0.157	0.170	0.179	0.179	0.154
	T_2	0.093	0.143	0.618	0.682	0.188	0.188	0.321
	T_3	0.097	0.172	0.197	0.220	0.240	0.240	0.198
	T_4	0.095	0.156	0.172	0.188	0.224	0.224	0.179
	T_5	0.089	0.123	0.143	0.160	0.174	0.174	0.148
	T_6	0.083	0.095	0.104	0.114	0.122	0.131	0.108
	T_7	0.086	0.098	0.110	0.126	0.252	0.252	0.140
	T_8	0.087	0.109	0.129	0.149	0.165	0.165	0.136
	MEAN	0.090	0.134	0.204	0.227	0.203	0.208	0.178

	C	T	P	C × T	T × P	C × P	C × P × T
CD P = 0.05	0.007	0.016	0.018	0.023	0.056	0.026	0.079

bound water content, lower water deficit, more efficient root system (May *et al.,* 1962) and increased metabolic activities of seed that hastened by the hardening treatment also observed improvement in root and shoot growth seedling due to the earliness of germination and seedling growth in hardened seed. The increase in dry weight was claimed to be due to enhanced lipid utilization through glyoxalate cycle, a primitive pathway leading to faster growth and development of seedling to reach autotrophic stage well in advance of others and enabling them to produce relatively more quantity of dry matter. Ultimately its leads to cause for the hike in vigour index by hardening treatment. The study clearly revealed the sesame seeds fortified with prosopis leaf extract @ 2 % and stored in 700 gauge polythene bag maintained its germination for minimum seed certification standard till the end of the storage period in sesame cv TMV 3

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Table 7: Effect of treatment, period of storage and containers on seed Oil content (%) of sesame cv. TMV 3.

Containers	Treatments	P_0	P_2	P_4	P_6	P_8	P_{10}	MEAN
	T_0	46.7 (43.10)	45.8 (42.59)	43.2 (41.09)	41.6 (40.16)	39.1 (38.70)	37.0 (37.46)	42.2 (40.52)
	T_1	47.6 (43.62)	45.3 (42.30)	44.7 (41.95)	42.5 (40.68)	41.1 (39.87)	40.2 (39.34)	43.5 (41.29)
	T_2	47.2 (43.39)	45.6 (42.47)	43.5 (41.26)	42.1 (40.45)	40.1 (39.29)	39.3 (38.82)	42.9 (40.95)
	T_3	46.9 (43.22)	44.4 (41.78)	42.6 (40.74)	40.6 (39.58)	38.9 (38.58)	37.6 (37.82)	41.8 (40.29)
C_1	T_4	47.0 (43.28)	45.9 (42.64)	43.7 (41.38)	41.5 (40.10)	39.1 (38.70)	38.2 (38.17)	42.5 (40.71)
	T_5	48.0 (43.85)	46.1 (42.76)	44.3 (41.72)	43.8 (41.43)	42.5 (41.26)	41.1 (39.87)	44.3 (41.82)
	T_6	48.9 (44.37)	47.3 (43.45)	45.5 (42.41)	44.7 (41.95)	43.4 (41.78)	42.8 (40.86)	45.4 (42.47)
	T_7	48.7 (44.25)	47.0 (43.28)	45.3 (42.30)	44.2 (41.67)	42.6 (40.74)	42.1 (40.33)	44.9 (42.11)
	T_8	48.5 (44.14)	48.0 (43.85)	46.1 (42.76)	44.6 (41.90)	42.2 (40.50)	41.9 (40.33)	45.2 (42.25)
	MEAN	47.2 (43.69)	46.1 (42.79)	44.3 (41.73)	42.8 (40.88)	41.0 (39.94)	40.0 (39.24)	43.6 (41.38)
	T_0	47.0 (43.28)	45.6 (42.47)	44.7 (41.95)	42.9 (40.91)	40.3 (39.40)	39.1 (38.70)	43.2 (41.12)
	T_1	47.8 (43.74)	46.1 (42.76)	44.3 (41.72)	43.2 (41.09)	42.1 (40.45)	41.8 (40..28)	44.2 (41.67)
C_2	T_2	47.7 (43.68)	45.3 (42.30)	44.9 (42.07)	43.6 (41.32)	42.6 (40.75)	41.2 (39.93)	44.2 (41.67)
	T_3	47.3 (43.45)	46.4 (42.93)	45.7 (42.53)	43.1 (41.03)	41.6 (40.16)	40.1 (39.29)	44.0 (41.56)
	T_4	47.5 (43.56)	45.9 (42.64)	44.4 (41.78)	42.5 (40.68)	41.3 (39.99)	40.7 (39.64)	43.7 (41.38)
	T_5	48.0 (43.85)	47.6 (43.62)	45.8 (42.59)	44.2 (41.67)	43.7 (41.38)	42.1 (40.45)	45.2 (42.26)
	T_6	49.1 (44.48)	48.6 (44.19)	47.2 (43.39)	46.9 (43.22)	45.4 (42.36)	44.1 (41.61)	46.8 (43.21)
C_2	T_7	48.7 (44.25)	47.9 (43.79)	45.2 (42.64)	44.6 (41.90)	44.1 (41.61)	43.8 (41.43)	45.7 (42.54)
	T_8	48.3 (44.02)	47.5 (43.56)	46.8 (43.16)	44.7 (41.95)	43.3 (41.15)	42.5 (40.68)	45.5 (42.42)
	MEAN	47.9 (43.81)	46.7 (43.14)	45.4 (42.38)	43.9 (41.53)	42.7 (40.80)	41.7 (40.22)	44.7 (41.98)
	T_0	46.8 (43.19)	45.7 (42.53)	43.9 (41.52)	42.2 (40.54)	39.7 (39.05)	38.0 (38.08)	42.7 (40.82)
	T_1	47.7 (43.68)	45.7 (42.53)	44.5 (41.84)	42.8 (40.88)	41.6 (40.16)	41.0 (39.81)	43.8 (41.48)
	T_2	47.4 (43.53)	45.4 (42.39)	44.2 (41.66)	42.8 (40.88)	41.3 (40.01)	40.2 (39.37)	43.5 (41.31)
	T_3	47.1 (43.33)	45.4 (42.36)	44.1 (41.63)	41.8 (40.30)	40.2 (39.37)	38.8 (38.55)	42.9 (40.92)
Treatment mean	T_4	47.2 (43.42)	45.9 (42.64)	44.0 (41.58)	42.0 (40.39)	40.2 (39.34)	39.4 (38.90)	43.1 (41.05)
	T_5	48.0	46.8	45.0	44.0	43.1	41.6	44.7

Table 3 continue......

Table 3 continue......

Containers	Treatments	P_0	P_2	P_4	P_6	P_8	P_{10}	MEAN
		(43.85)	(43.19)	(42.15)	(41.55)	(41.32)	(40.16)	(42.04)
	T_6	49.0 (44.42)	47.9 (43.82)	46.3 (42.90)	45.8 (42.59)	44.4 (42.07)	43.4 (41.23)	46.1 (42.84)
	T_7	48.7 (44.25)	47.4 (43.53)	45.2 (42.27)	44.4 (41.78)	43.3 (41.17)	42.9 (40.94)	45.3 (42.33)
	T_8	48.4 (44.08)	47.7 (43.71)	46.4 (42.96)	44.6 (41.92)	42.7 (40.83)	42.2 (40.51)	45.3 (42.33)
	MEAN	47.8 (43.75)	46.4 (42.97)	44.8 (42.06)	43.4 (41.20)	41.8 (40.37)	40.8 (39.73)	44.2 (41.68)

Figures in parenthesis are Arcsine Transformed value

	C	T	P	C × T	T × P	C × P	C × P × T
CD P = 0.05	0.219	0.467	0.379	0.657	1.137	0.536	1.169

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