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Physio-biochemical changes associated with seed ageing in soybean [*Glycine max* (L.) Merrill]

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Abstract

The laboratory experiments were comprised of 20 genotypes with five different seed coat colours (Black, Brown, Variegated, Green and Yellow) and seeds were stored for 10 months in polythene bags to evaluate the physiological and biochemical changes during storage. The results revealed that black coloured genotypes showed resistant for seed ageing followed by brown coloured genotypes. Yellow coloured genotypes are susceptible for seed ageing followed by green coloured genotypes. Among the genotypes, PB-5 offered highest germination (97.67%), mean seedling dry weight (56.02 mg). EC 76756 recorded highest mean seedling length (42.63 cm) and lower activity of TSS (93.43 to 118.69 (µg/ml of seed leachates). Minimum electrical conductivity was found in black coloured seeds (0.477 to 0.587 dS cm^{-1}) from initial to 10^{th} month of storage. And minimal seed germination, mean seedling length, seedling dry weight (90%, 30.48 cm, 47.54 mg respectively) and maximum EC (0.867 to 1.434 dS cm^{-1}) and TSS (135.56 to 179.87 µg/ml of seed leachates) were found in 115-B genotype.

Keywords: Seed ageing, seed germination, mean seedling length, mean seedling dry weight, total soluble sugars, electrical conductivity

Introduction

Soybean (*Glycine max* L. Merril) is the world's most important seed legume, which contributes about 25 per cent of the global edible oil, which is two-third of the world's protein concentrate for livestock feeding (Agarwal *et al.*, 2013) [1]. It has earned epithets like ''Cow of the field'' or ''Gold from soil'', "poor man's food" and "wonder crop". Owing to its amino acids composition like glycine, tryptophan and lysine, the protein of soybean is called a complete protein. It has around 40 per cent protein and 20 per cent oil in it. The plant has been classified as an oilseed rather than pulse by an UN Food and Agricultural Organization and known as Golden bean of 20^{th} century.

It is originated in Eastern Asia or China. The cultivated soybean (*Glycine max* L. Merril) is a member of Leguminacae and sub family Papilionaceae with twenty chromosome pair (2n = 40). Cultivated soybean is believed to have derived from a wild progenitor *Glycine ussuriensi.*

Soybean tops in world production of both oilseeds and edible oil production. It is globally grown over an area of 107.21mha with a production of 251mt and productivity of 2447 kg per ha (Anon., 2016) [2, 3]. In India soybean is grown over an area of 11.67 m ha with a production of 8.59 mt and productivity of 737 kg per ha (Anon., 2016) [2, 3]. The major soybean producing states are Madhya Pradesh (831 kg per ha), Maharashtra (557 kg per ha), Rajasthan (829 kg per ha), Karnataka (558 kg per ha) and Andhra Pradesh (1000 kg per ha).

Soybean seed has been identified as poor storer, because of delicate (thin) seed coat and vulnerable position of embryo. Among oilseed crops, soybean is the most extensively studied crop with respect to ageing. Soybean oil with approximately 60 per cent of polyunsaturated fatty acids (PUFA) content is liable to rapid degradation making it a poor storer. The intrinsic factors that are believed to be closely associated with the seed ageing are loss of membrane integrity, alteration of chemical composition, changes in enzyme activities, depletion of food reserves and chromosomal aberrations. Soybean seeds, rich in both fatty acids and proteins are very much prone ageing.

With these facts a comprehensive study was conducted to evaluate and asses the physiological and biochemical changes occurring during seed ageing in soybean genotypes.

Material and Methods
The material for the present study comprised of 20 soybean (*Glycine max* (L.) Merrill) genotypes by taking seed coat colour as main criteria.
A laboratory experiment was conducted to evaluate the physiological and biochemical changes occurring during seed ageing. This experiment was under taken in Department of Seed Science and Technology, GKVK, UAS, Bangalore, by using freshly harvested seeds which were cleaned and dried to safe moisture level. The genotypes were stored in polythene bags for 10 months and observations were recorded.

Seed germination (%)
The laboratory germination test was conducted as per the ISTA (Anon., 2010) [2, 3] using between paper methods of germination. Fifty seeds in eight replications were allowed to germinate at temperature of 25 °C up to 8 days. The germination counts were recorded on 5th and 8th day and per cent germination was expressed on normal seedling basis.

Mean seedling length (cm)
On eighth day of germination test, ten normal seedlings were taken random from four replications of each treatment and measured from the tip of primary root to the tip of apical shoot. The average of ten seedlings from each replication was calculated and expressed as mean seedling length in centimeters.

Mean seedling dry weight (mg)
Ten normal seedlings used for measuring shoot and root length were taken in a butter paper and dried in hot air oven, maintained at 75 ˚C temperatures for 24 hours. Then the seedlings were removed and allowed to cool in desiccators for 45 minutes before weighing on an electrical balance. The average was calculated and expressed as seedling dry weight in milligram (mg).

Electrical conductivity (dScm^{-1})
Electrical conductivity was measured according to procedure described by Presley, 1958. Four replications of five grams of seeds from each treatment were taken. Then the seeds were soaked in 25 ml of distilled water and incubated at constant temperature of 25 ± 1 ˚C for 24 hours. The electrical conductivity of the seed leachate was measured by the digital conductivity meter and expressed in dS cm^{-1}.

Total soluble sugars (µg/ml of seed leachate)
The total soluble sugar content of seed samples was estimated by phenol sulphuric acid method according to Dubois *et al.* (1951) [5]. The procedure followed is given below:

1. Preparation of reagents
a. Seed leachate
b. Phenol (5%) (Five gram of analytical grade phenol was dissolved in distill water to make 100 ml.)
c. Sulphuric acid (96%)
d. Standard glucose solution: 100 mg of glucose was dissolved in 100 ml water. One ml of this solution was diluted to 10 ml with water to get working standard containing 10-100 µg/ml.

2. Estimation of total soluble sugars
The required quantity (0.1 ml) of seed leachate was diluted to 1 ml with distilled water. One ml of 5 per cent phenol and 5 ml of 96 per cent H_2SO_4 were added. Sulphuric acid was added in such a way that it hits the reactants surface directly. The mixture was allowed to cool for 45 minutes at room temperature. After cooling to room temperature, the absorbance was read at 490 nm against the reagent blank. A standard curve was constructed with glucose as a standard with the concentration of 10 to 100 µg. The standard curve was used to estimate the total soluble sugars of the sample and the results are expressed in µg/ml of seed leachate.

Results and Discussion
The results revealed that, the seed ageing had significant effects on seed quality parameters of soybean genotypes. Among the 20 genotypes used for the study, the genotypes with black (EC-76756, EC-57042, IC-501268, TR-5, PB-5) and brown (DS-72-244) coloured seed coat showed a highest resistance against the seed deterioration changes compared with variegated, green and yellow coloured genotypes. The genotypes having black coloured seed coat (Table 1) were found to be highly resistant against deterioration and genotypes with yellow coloured were found susceptible for deterioration changes.

Table 1: Genotypes of different testa colour

Testa colour of genotypes				
Brown	**Variegated**	**Green**	**Black**	**Yellow**
DS-72244	RSC 1071	JS - 90 41	EC-57042, TR-5, IC-501268, EC-76756, PB-5.	JS - 335, JS - 9560, NRC 86, 115- B, DSB-21, RKS 45, NRC 37, RKS 24, JS - 2034, JS - 2069, AGS 29, JS - 2029

Physiological characteristics
The initial germination was above 90 per cent for almost all genotypes (Table 2). However, after 10th month of ageing the seed germination of the black and brown coloured genotypes was reduced by 17 to 23. In the initial month storage, highest seed germination was found in PB-5 (97.67%) and minimal seed germination was found in 115- B (90%). After 10 months of storage, EC-76756 showed highest (80.33%) germination and 115-B showed minimal (58.67%) seed germination. The highest percentage reduction in germination was noticed in RKS 24 (34.99%) followed by 11 5-B (34.78%) and the minimum percentage reduction in germination was noticed EC76756 (17.47%).

Table 2: Performance of soybean genotypes during storage on seed germination (%)

Seed germination (%)									
Period of storage (December, 2018 to October, 2019)									
Genotypes	**Initial**	**1**	**3**	**5**	**7**	**8**	**9**	**10**	**Percent reduction**
Black colour genotypes									
EC76756	97.33	97.67	96.67	92.00	88.67	85.33	82.33	80.33	17.47
PB - 5	97.67	97.00	96.00	91.33	88.00	84.67	81.00	79.67	18.42
IC - 501268	96.00	95.00	94.33	90.33	83.67	82.00	80.67	72.33	24.69
TR 5	95.00	94.33	93.33	89.33	82.00	80.00	77.33	73.33	22.84

EC 57042	97.00	96.33	95.67	91.00	84.67	82.67	80.00	74.33	23.40
Yellow colour genotypes									
NRC86	91.33	90.67	89.33	81.00	72.33	70.33	66.33	60.67	33.52
115 - B	90.00	89.33	88.00	78.67	69.67	66.00	61.67	58.67	34.78
DSB - 21	92.33	91.67	90.67	85.67	78.00	76.33	70.00	67.00	27.41
RKS 45	92.67	92.00	91.33	87.00	78.67	76.67	71.33	68.33	26.32
NRC 37	93.67	93.00	92.33	87.67	80.00	77.33	72.00	65.67	29.88
JS - 9560	92.33	91.67	90.33	84.33	76.33	75.67	71.67	66.33	28.17
RKS 24	90.33	90.00	88.00	79.00	70.33	67.00	62.67	58.67	34.99
JS - 2069	90.33	90.00	88.33	80.00	74.33	69.33	63.33	59.33	34.33
JS - 335	94.67	90.00	88.67	85.67	80.67	77.33	74.00	69.00	27.14
JS - 2029	91.33	91.00	88.77	80.67	72.00	70.00	64.67	60.33	33.95
JS - 20 34	91.67	91.00	89.33	82.33	73.00	71.67	67.33	58.33	33.42
AGS 29	91.67	91.33	90.00	83.67	74.33	73.00	68.00	60.33	34.24
Brown colour genotypes									
DSB72244	95.67	95.00	94.33	89.67	82.33	81.67	79.00	72.67	26.12
Green colour genotypes									
JS - 90 41	94.33	93.67	92.67	88.00	81.00	78.67	73.67	69.67	26.09
Variegated colour genotypes									
RSC 10 71	94.67	94.00	93.33	89.00	81.67	79.33	75.00	70.00	26.08
Mean	93.33	92.75	91.56	85.53	77.91	75.76	71.45	63.40	
S.Em. ±	1.54	1.05	1.83	0.56	0.70	0.71	0.47	0.45	
C.D. (P = 0.01)	5.08	3.25	6.09	1.69	2.16	2.29	1.31	1.51	
CV (%)	2.85	1.97	4.04	1.13	1.55	1.61	1.08	1.08	

EC 76756 (Black coloured testa) have showed maximal mean seedling length (42.63 cm) followed by PB-5 (41.00 cm) and minimal mean seedling length was recorded by 115-B (30.48 cm) followed by RKS24 (30.67 cm) in the initial period. After 10th of storage, maximal mean seedling length was observed in EC76756 (23.00 cm) and minimal was seen in 11 5-B (9.63 cm) and depicted in table 3.

Table 3: Performance of soybean genotypes during storage on mean seedling length (cm)

Mean seedling length (cm)									
Period of storage (December, 2018 to October, 2019)									
Genotypes	**Initial**	**1**	**3**	**5**	**7**	**8**	**9**	**10**	**Percent reduction**
Black colour genotypes									
EC76756	42.63	40.33	37.00	33.54	29.47	27.00	25.33	23.00	46.05
PB - 5	41.00	39.67	36.11	31.65	27.65	25.70	22.63	20.33	50.41
IC - 501268	39.00	37.33	33.36	29.62	25.69	23.33	21.00	19.54	49.89
TR 5	38.08	36.00	31.36	27.36	25.03	23.00	21.48	19.40	49.05
EC 57042	39.22	38.00	34.53	30.59	26.56	24.44	21.04	19.48	50.33
Yellow colour genotypes									
NRC86	32.00	30.00	25.47	21.32	17.67	15.06	13.00	10.67	66.66
115-B	30.48	27.54	23.00	19.00	15.03	13.13	11.11	9.63	68.41
DSB - 21	34.45	32.22	28.64	24.04	19.07	16.58	14.40	12.36	64.12
RKS 45	35.00	33.00	29.00	24.33	19.58	17.21	15.34	13.00	62.86
NRC 37	35.33	33.45	29.62	25.80	21.09	19.04	16.59	14.59	58.70
JS - 9560	33.58	32.00	28.00	23.39	19.03	16.57	14.07	12.00	64.26
RKS24	30.67	28.00	23.81	19.65	15.26	13.33	11.32	9.66	68.50
JS - 2069	31.00	28.65	24.00	19.95	15.88	13.25	11.55	9.83	68.29
JS - 335	31.56	29.00	24.21	20.33	16.28	14.07	12.15	10.21	67.65
JS - 2029	31.87	29.52	25.00	20.91	16.83	14.44	12.74	10.62	66.68
JS - 20 34	32.33	30.66	26.62	22.04	18.63	15.69	13.44	11.01	65.94
AGS 29	33.00	31.33	27.43	23.01	19.00	16.03	13.81	11.83	64.19
Brown colour genotypes									
DSB72244	38.45	36.67	32.34	28.51	24.14	22.22	20.66	18.00	53.19
Green colour genotypes									
JS - 90 41	36.48	34.12	30.76	26.00	21.58	19.77	17.26	15.00	58.88
Variegated colour genotypes									
RSC 10 71	37.33	35.25	31.21	26.94	22.66	20.94	18.40	15.48	58.53
Mean	35.17	33.13	29.07	24.89	20.70	18.44	16.26	14.13	
S.Em. ±	0.31	0.78	0.24	0.19	0.30	0.16	0.24	0.39	
C.D.(P = 0.01)	1.09	2.39	0.82	0.63	0.94	0.51	0.81	1.18	
CV (%)	1.53	4.08	1.43	1.32	2.49	1.49	2.54	4.74	

The least mean seedling dry weight was observed in 11 5-B (47.54 mg) followed by RKS 24 (47.67 mg). Whereas the highest mean seedling dry weight showed by PB-5 (56.02 mg) followed by EC76756 (54.23 mg) in the initial month of storage. The highest percentage reduction was seen in yellow coloured genotypes and minimal was seen in black and brown coloured genotypes and depicted in table 4.

Table 4: Performance of soybean genotypes during storage on mean seedling dry weight (mg)

Mean seedling dry weight (mg)									
Period of storage (December, 2018 to October, 2019)									
Genotypes	**Initial**	**1**	**3**	**5**	**7**	**8**	**9**	**10**	**Percent reduction**
Black colour genotypes									
EC76756	54.23	53.49	51.33	49.00	47.73	45.11	42.20	42.00	22.55
PB -5	56.02	54.67	53.07	51.33	49.25	47.12	45.53	44.33	20.86
IC - 501268	52.84	51.56	50.28	47.99	45.33	43.51	40.81	40.48	23.39
TR 5	51.75	50.58	48.12	46.21	44.77	43.67	42.87	40.07	22.57
EC 57042	52.94	51.65	50.33	48.13	46.00	44.44	41.11	40.88	22.78
Yellow colour genotypes									
NRC86	48.06	44.45	42.45	39.33	38.44	34.03	32.40	31.40	34.67
115 - B	47.54	45.51	41.47	37.03	35.13	33.09	32.12	30.13	36.62
DSB - 21	48.36	46.12	44.00	42.25	39.67	36.00	34.39	33.99	29.71
RKS 45	48.48	47.16	45.67	42.53	40.47	36.97	34.56	33.67	30.55
NRC 37	48.52	46.68	45.00	42.67	41.00	38.63	35.55	35.55	26.73
JS - 9560	49.32	47.77	44.40	41.33	38.59	35.80	33.74	33.33	32.42
RKS24	47.67	45.56	41.67	37.17	35.33	30.73	30.32	30.00	37.07
JS - 2069	47.78	46.59	42.67	37.33	35.29	33.11	32.43	31.00	35.12
JS - 335	47.81	44.27	41.09	37.67	35.70	33.33	32.27	31.10	34.95
JS - 2029	47.96	43.22	41.14	38.00	36.47	33.67	32.20	31.33	34.67
JS - 20 34	46.11	44.41	41.44	39.67	37.63	35.40	32.47	31.90	30.82
AGS 29	45.24	43.41	41.77	40.33	38.60	35.74	32.41	31.74	29.84
Brown colour genotypes									
DSB72244	51.81	50.60	48.33	45.81	43.67	41.77	39.93	39.03	24.67
Green colour genotypes									
JS - 90 41	47.04	46.36	44.00	43.07	41.67	38.90	36.82	35.22	25.13
Variegated colour genotypes									
RSC 10 71	49.62	48.41	46.33	44.74	42.63	40.04	38.17	36.17	27.11
Mean	49.45	47.62	45.12	42.43	40.52	37.80	35.55	34.18	
S.Em. ±	0.32	0.97	0.60	0.46	0.63	0.87	0.66	0.82	
C.D. (P = 0.01)	1.21	3.71	2.31	1.78	2.42	3.32	2.52	3.13	
CV (%)	1.11	3.52	2.32	1.90	2.71	3.98	3.21	3.85	

Higher electrical leachates was found in yellow seeded genotype, 115-B (0.867 to 1.434 dS cm^{-1}) followed by RKS 45 (0.700 to 1.097 dSm^{-1}). The gradual increase in electrical conductivity was highest in yellow coloured genotypes followed by green (0.551 to 0.902 ds cm^{-1}), variegated (0.530 to 0.853 dS cm^{-1}) and brown (0.519 to 0.837 dSm^{-1}). Whereas, least electrical leachates found in black coloured genotypes (0.477 to 0.587 dS cm^{-1}) and depicted in table 5.

Table 5: Performance of soybean genotypes during storage on electrical conductivity (dS cm^{-1}) of seed leachate

Electrical conductivity (dS cm^{-1}) of seed leachate									
Period of storage (December, 2018 to October, 2019)									
Genotypes	**Initial**	**1**	**3**	**5**	**7**	**8**	**9**	**10**	**Percent increase**
Black colour genotypes									
EC76756	0.477	0.481	0.498	0.521	0.546	0.565	0.576	0.587	18.74
PB - 5	0.500	0.523	0.545	0.576	0.598	0.601	0.623	0.635	21.26
IC - 501268	0.513	0.542	0.564	0.587	0.602	0.634	0.640	0.657	21.92
TR 5	0.524	0.543	0.576	0.589	0.598	0.612	0.623	0.654	19.88
EC 57042	0.512	0.529	0.534	0.567	0.603	0.623	0.678	0.699	24.75
Yellow colour genotypes									
NRC86	0.762	0.779	0.826	0.871	0.935	0.966	1.004	1.241	38.59
115-B	0.867	0.893	0.918	0.955	1.003	1.212	1.243	1.434	39.54
DSB - 21	0.728	0.736	0.772	0.821	0.864	0.896	0.932	1.123	35.17
RKS 45	0.700	0.720	0.763	0.809	0.847	0.873	0.911	1.097	36.19
NRC 37	0.637	0.653	0.703	0.737	0.778	0.822	0.897	1.043	38.92
JS - 9560	0.755	0.769	0.794	0.837	0.878	0.915	0.957	1.213	37.75
RKS24	0.853	0.877	0.902	0.945	0.997	1.154	1.178	1.321	35.42
JS - 2069	0.819	0.835	0.873	0.911	0.989	1.066	1.121	1.432	42.80
JS - 335	0.800	0.822	0.858	0.907	0.966	1.029	1.098	1.333	39.98
JS - 2029	0.779	0.796	0.841	0.888	0.958	0.993	1.056	1.231	36.71
JS - 20 34	0.755	0.764	0.808	0.862	0.926	0.958	0.999	1.247	39.45
AGS 29	0.731	0.749	0.803	0.858	0.902	0.927	0.978	1.211	39.63
Brown colour genotypes									
DSB72244	0.519	0.555	0.597	0.642	0.709	0.745	0.801	0.837	37.99
Green colour genotypes									
JS - 90 41	0.551	0.573	0.616	0.682	0.733	0.805	0.888	0.902	38.91
Variegated colour genotypes									

RSC 10 71	0.530	0.567	0.614	0.673	0.724	0.792	0.836	0.853	37.86
Mean	0.666	0.687	0.729	0.775	0.829	0.886	0.935	0.982	
S.Em. ±	0.010	0.013	0.012	0.014	0.013	0.024	0.013	0.023	
C.D.(P = 0.01)	0.039	0.052	0.038	0.044	0.042	0.082	0.042	0.070	
CV (%)	2.71	3.45	2.99	3.16	1.31	4.72	2.53	4.19	

An increase in electrolyte leachates from seeds was associated with a decrease in seed membrane integrity and it is more pronounced in large seeds (Vyas *et al.*, 1990) [12]. In the present study increase in electrolyte leakage was observed with decrease in germination over the period of storage in all the genotypes which is in confirmation with the earlier reports of Nutile, (1964) [9], Powell and Matthews, (1977) [10], Halder (1981) [7]. The increase in the amount of electrolytes is found to be proportional to the seed longevity.

Higher activity of TSS found in yellow coloured genotype, 115-B (135.56 to 179.87 (µg/ml of seed leachates) and lower activity of TSS recorded in EC76756 (93.43 to 118.69 (µg/ml of seed leachates) from initial month of seed storage to 10th month of seed storage. Over all black seeded genotypes registered resistant slight increase in values of TSS followed by brown and variegated coloured genotypes. Whereas, yellow seeded genotypes showed a higher activity of TSS after 10th month of seed storage followed by green coloured genotypes. The maximum percentage increase was found in yellow coloured genotypes and minimum was found in black coloured genotypes.

These may be due to least membrane integrity of yellow seeded genotypes and their higher permeability results in maximum leach of soluble sugars compare to black seeded genotypes. The similar results of increased in total soluble sugar content upon ageing were revealed by Bhanuprakash, *et al.* (2006) [4] and these results clearly demonstrate that the aged seeds lost integrity of cell membranes.

Table 6: Performance of soybean genotypes during storage on total soluble sugar (µg/ml of seed leachates)

Total soluble sugar (µg/ml of seed leachates)									
Period of storage (December, 2018 to October, 2019)									
Genotypes	**Initial**	**1**	**3**	**5**	**7**	**8**	**9**	**10**	**Percent increase**
Black colour genotypes									
EC76756	93.43	95.21	101.47	104.40	108.84	111.25	115.50	118.69	21.28
PB - 5	95.34	97.77	103.30	105.54	109.33	112.40	117.10	122.25	22.01
IC - 501268	97.03	101.40	104.39	110.89	113.13	115.69	119.62	124.37	21.98
TR 5	100.20	104.67	107.36	113.93	116.18	119.44	122.33	126.55	20.82
EC 57042	96.78	98.02	101.14	106.26	109.69	112.62	118.28	123.04	21.34
Yellow colour genotypes									
NRC86	123.47	125.63	131.85	139.62	143.88	146.33	149.22	158.45	22.08
115 - B	135.56	138.04	143.33	151.66	154.99	158.17	163.29	179.87	24.63
DSB - 21	117.98	120.25	124.44	129.02	132.69	135.84	139.33	154.65	23.71
RKS 45	112.34	115.60	119.52	126.69	129.49	133.59	136.17	147.43	23.80
NRC 37	110.03	113.77	117.11	123.55	126.46	128.58	132.18	154.32	28.70
JS - 9560	118.21	121.73	127.28	132.36	135.36	138.28	143.21	156.43	24.43
RKS24	132.92	135.39	139.51	147.14	150.59	154.38	157.30	176.98	24.90
JS - 2069	131.23	133.70	138.25	142.03	147.00	151.22	154.07	187.65	30.07
JS - 335	127.00	129.43	133.25	141.77	145.29	149.10	152.70	187.34	32.21
JS - 2029	124.30	126.16	132.44	140.29	144.03	148.88	151.47	163.43	23.94
JS - 20 34	119.33	123.03	130.05	138.62	141.03	144.70	146.14	167.89	28.92
AGS 29	115.27	122.08	129.88	136.62	139.06	142.54	145.03	153.67	24.99
Brown colour genotypes									
DSB72244	97.57	103.23	105.44	111.70	113.88	117.32	120.47	125.48	22.24
Green colour genotypes									
JS - 90 41	107.37	110.81	114.06	118.40	121.29	125.65	128.75	143.32	25.08
Variegated colour genotypes									
RSC 10 71	105.43	108.89	111.03	117.28	120.76	123.33	127.76	145.23	27.40
Mean	113.04	116.24	120.76	126.89	130.15	133.47	137.00	140.77	
S.Em. ±	1.72	2.01	2.16	1.91	2.90	2.02	1.89	1.78	
C.D. (P = 0.01)	6.17	6.71	6.26	5.79	9.11	6.73	5.69	5.81	
CV (%)	2.64	3.00	3.10	2.61	3.87	2.62	2.40	2.29	

These may be due to differences existing among varieties, it can be noticed that performances of genotypes also influenced the biochemical changes in seeds during deterioration. The above obtained results are similar with the results of Sital *et al.*, 2008 [11]. Seed susceptibility to oxidative changes differed, depending on seed fatty acid composition and lipid peroxidation can be considered as one of the indicators of individual soybean genotype susceptibility to oxidative stress (Sital *et al.*, 2008) [11]. Based on the above discussion it is concluded that, among the 20 soybean genotypes used for the study, were classified in to three vigour levels based on the assessment of their physiological and biochemical changes during seed deterioration. The genotypes with Black and brown coloured seed coat are grouped as high viogour seeds, green and variegated coloured genotypes as medium vigour and yellow coloured seeds as low vigour.

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