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Effect of seed coat colour on seed storability in sorghum genotypes (*Sorghum bicolor* (L.) Moench)

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Abstract

A laboratory experiment was conducted in the Department of Seed Science and Technology, UAS Raichur to study the effect of seed coat colour on seed storability in sorghum genotypes during 2021-2022. The study consists of 20 sorghum genotypes of different seed coat colour which were stored for ten months in cloth bag. Results revealed that, among different genotypes, black seed coat coloured genotype recorded significantly highest germination (80%), shoot length (17.60 cm), root length (8.20 cm), seedling vigour index-I (2064), seedling vigour index-II (11480), and lowest electrical conductivity (0.24 dSm^{-1}) at the end of ten months of storage period. Whereas lowest seed quality parameters were observed in white seed coat coloured genotype (69%, 5.70 cm, 3.00 cm, 600, 8625, 0.145 OD value, 10.5 mm, 0.39 dSm^{-1} respectively). Hence genotypes with dark seed coat colour are best in maintaining seed quality parameters and can be stored for longer period of time.

Keywords: Seed coat colour, longevity, sorghum, seed quality

Introduction

Sorghum [*Sorghum bicolor* (L.) Moench] is a tropical cereal C_4 grass plant belonging to Poaceae family. Sorghum is also called as camel crop due to its high tolerance to water and temperature stress and also high photosynthesis efficiency. It is an important grain and forage crop of semiarid regions due to its high adaptability and suitability to rain-fed low input agriculture (Anagholi *et al.*, 2000) [3]. It is one among the most efficient crops in conversion of solar energy and use of water and is known as a high-energy and drought tolerant crop that is environmentally friendly. Sorghum is the fifth most important cereal in the world followed by maize, rice, wheat and barley covering an area of about 41.97 million ha with production of 65.21 million metric tonnes and productivity of 1.45 metric tons per ha. India is a major sorghum growing country in the world, ranks third in acreage and seventh in production next to United States of America. It is cultivated in 4.24 million ha with an annual production of 4.78 million metric tons of grain with productivity of 1130 kg/ha (Anon., 2022 a) [5]. In India, it is cultivated in Maharashtra, Karnataka and Andhra Pradesh as a rainfed crop. In Karnataka, sorghum production is about 1.41 million ha with a production of 1.13 million metric tons and productivity of 974 kg/ha. Major sorghum growing districts of Karnataka are Kalaburgi, Raichur, Koppal, Belagavi and Vijayapur (Anon., 2022b) [5]. Seed coat is vital input in seed production and it attains their specific colour at physiological maturity. Seed coat colour is simple and excellent indicator of seed quality parameters. One of the unique features of sorghum seed is its variation in seed colour (Tiriyaki *et al.*, 2016). Differences in seed coat colour have been associated with differences in the composition of chemical compounds in the seed coats. Seed storage and retention of seed viability is an important post-harvest operation that decides the success of seeds in the next generation. Seed deterioration begins immediately after physiological maturity and is reflected in terms of loss in viability and vigour. Seed coat acts as a major defence against harmful environmental conditions and protect embryo from mechanical stress and from temperature and humidity fluctuation during storage. Seed coat is the main modulator of interaction between the internal structures and the external environment. It not only preserves integrity of seed parts but also protects the embryo from mechanical injuries and attacks of pest and diseases. So, seed coat is having the central role in seed longevity as it is the primary defence against adverse environmental condition.

Materials and Methods

A laboratory experiment was conducted in Department of Seed Science and Technology, College of Agriculture, Raichur during 2020-21, to know influence of seed coat colour on longevity of sorghum. The experiment was laid in a completely randomised design. There were 20 genotypes, white (G₁, G₂, G₃), pearly white (G₄, G₅), chalky white (G₆), whitish purple (G₇), purple (G₈), yellow (G₉), red (G₁₀, G₁₁), light red (G₁₂, G₁₃, G₁₄), light brown (G₁₅, G₁₆), dark brown (G₁₇, G₁₈), black (G₁₉, G₂₀). The seeds were harvested during February 2021. They were dried at 10 per cent moisture level and kept for storage under ambient condition in the month of August. These seeds were used for testing seed quality parameters.

Seed germination (%)

One hundred seeds from each replication were taken from each treatment. They were kept for germination as per ISTA (2025) [9] and number of germinated seed was counted as per the formula

$$\text{Seed Germination (\%)} = \frac{\text{Number of normal seedlings}}{\text{Total number of seeds}} \times 100$$

Shoot length (cm)

From the germination test, on 10th day, ten normal seedlings were selected randomly from each treatment and the shoot length was measured and was expressed in centimetre.

Root length (cm)

From the germination test, on 10th day, ten normal seedlings were selected randomly from each treatment and the root length was measured and was expressed in centimetre.

Seedling vigour index (SVI-I)

The seedling vigour index – I was calculated as per the method followed by Abdul-Baki and Anderson (1973) [1].

$$\text{SVI-I} = \text{Germination (\%)} \times \text{Seedling length (cm)}$$

Seedling vigour index (SVI-II)

The seedling vigour index-II was worked out by multiplying the per cent seed germination and mean seedling dry weight (Abdul-Baki and Anderson, 1973) [1].

$$\text{SVI-II} = \text{Germination (\%)} \times \text{Seedling dry weight (mg)}$$

Electrical conductivity (dSm⁻¹)

Seeds were soaked overnight by keeping in an incubator maintained at 25 °C ± 1 for twelve hours. The seed leachate was collected and measured in digital conductivity bridge with a cell constant 1.0 and the mean values were expressed in deci Siemens per meter (dSm⁻¹) as described by Milosevic *et al.*, 2010 [11].

Results and Discussion

Seed coat colour is unique genetic factor that varies with crop in most cases and sometimes with varieties. Seed coat colour has been coined as a factor of seed quality (Vakeswaran, 1998) [17]

and seed coat colour variation has been related to seed quality variations. Seed longevity is seed viability after seed dry storage (Rajjou and Debeaujon, 2008) [14]. Ageing of seed is well recognized cause of differences in seed quality in all species (Powell *et al.*, 1984) [13]. Seed deterioration and seed ageing are inexorable and irreversible process. In present investigation, the seed quality parameters declined with increase in storage period. Among the different seed coat colour sorghum genotypes, black seed coat colour genotype G₂₀ recorded significantly highest germination both at initial and at the end of ten months of storage (95.50% and 80.00% respectively). Whereas white seed coat colour genotype recorded lowest germination both at initial (84.53%) and at the end of the storage period (69.00%) (Table 1). This might be due to the presence of some various phenolic compounds in unpigmented seed that block the metabolism preparatory to germination and prevent the access of oxygen to embryo

The highest shoot (20.61 cm and 17.60 cm) and root length (12.13 cm and 8.20 cm) was noticed in black seed coat colour genotype, G₂₀ both at the beginning and at the end of the storage period respectively. While the lowest shoot (10.00 cm and 5.70 cm) root length (10.06 cm and 3.00 cm) (Table 2) was observed in white seed coat colour sorghum genotypes. The highest seedling length in pigmented seed might be because of its bolder size that may contain greater metabolites for resumption of embryonic growth and better accumulation of nutrients during germination. Similar results were also recorded by Anuradha *et al.* (2009) [6] in chickpea, Sinefu *et al.* (2011) [15] in bambara groundnut and Ibrahim in red clover.

As germination alone may not reveal the real potential of seed lots, so assessment of seedling vigour index is of prime importance. The highest seedling vigour index-I (3127 and 2064) and seedling vigour index-II (15805 and 11480) was noticed by black seed coat colour genotype G₂₀ both at initial and at the end of the storage period. Whereas white seed coat colour sorghum genotype recorded lowest vigour indices at initial and after ten months of storage [(1696 and 600) and (13305 and 8625) respectively] (Table 3). The highest seedling vigour index-I in black seed coat genotype might be due to highest seedling length, germination percentage and speed of germination. The findings are line with Abdullah *et al.* (1988) [2] in long bean, Mokashi (2017) [12] in cowpea.

Black seed coat colour genotype recorded significantly lowest electrical conductivity at the beginning and at the end of storage period (0.10 dSm⁻¹ and 0.24 dSm⁻¹) whereas white seed coat colour genotype recorded significantly highest electrical conductivity at initial and at the end of storage period (0.15 dSm⁻¹ and 0.39 dSm⁻¹) (Fig.1). The highest electrical conductivity in white or unpigmented genotypes was attributed to thinner seed coat leading to rapid water uptake into the outer cells of cotyledons that might disrupts the cell membranes and resulting in high solute leakage from the embryo. These observations are in accordance with Capeleti *et al.* (2005) [7] in soybean, Ibrahim in red clover, Mokashi (2017) [12] in cowpea and Kumar *et al.* (2020) [10] in soybean.

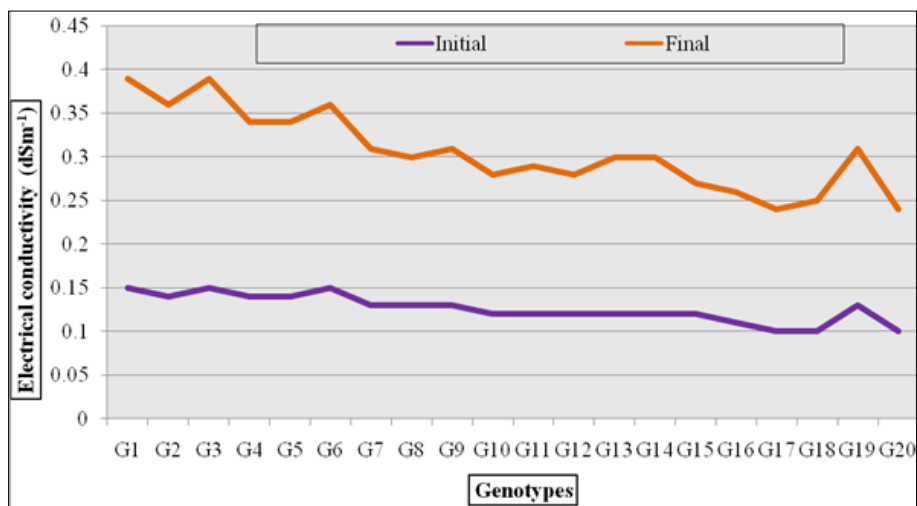


Fig 1: Influence of seed coat colour on electrical conductivity during storage in sorghum genotypes

Table 1: Effect of seed coat colour on seed germination (%) during storage in sorghum genotypes

Seed coat colour	Genotypes	Storage period					
		Initial (Aug)	2 (Sep)	4 (Nov)	6 (Jan)	8 (Mar)	10 (May)
White	G ₁ - IS37224	86.59	86.25	85.50	81.75	77.25	69.50
	G ₂ - M 35-1	87.85	87.25	86.25	82.00	78.75	69.75
	G ₃ - DJ6514	84.53	84.25	83.50	81.00	76.75	69.00
Pearly white	G ₄ - RSL46	88.92	88.75	87.50	83.75	79.00	71.50
	G ₅ - RSL54	88.25	88.00	87.25	82.50	78.75	70.75
Chalky white	G ₆ - RSL49	87.98	89.75	87.75	82.00	78.75	69.50
Whitish purple	G ₇ - IS3572	90.12	94.60	92.25	84.25	79.25	72.25
Purple	G ₈ - IS16310	90.75	89.75	88.00	84.29	79.50	72.25
Yellow	G ₉ - IS16006	90.82	90.50	89.50	84.75	79.75	72.50
Red	G ₁₀ - IS37247	93.45	93.00	92.00	86.25	82.25	75.50
	G ₁₁ - RSL69	92.75	92.50	90.50	86.00	82.00	74.50
Light red	G ₁₂ - RSL57	93.56	93.25	92.50	87.25	83.25	75.75
	G ₁₃ - IS37349	92.69	92.00	90.25	85.75	81.00	73.75
	G ₁₄ - IS37304	91.48	86.25	85.50	84.75	79.75	73.25
Light brown	G ₁₅ - IS37355	93.86	91.25	89.50	87.25	83.50	76.25
	G ₁₆ - IS6508	93.88	93.25	93.00	87.25	83.75	76.00
Dark brown	G ₁₇ - IS37225	94.86	93.50	93.00	88.25	84.75	78.25
	G ₁₈ - IS22436	94.76	95.00	94.50	88.28	84.25	77.00
Grey	G ₁₉ - IS2618	89.99	90.25	88.25	84.00	79.25	72.00
Black	G ₂₀ - IS25040	95.50	87.00	86.00	89.75	85.75	80.00
Mean		91.13	90.77	89.59	85.05	80.86	73.46
SEm±		1.42	1.45	1.49	1.55	1.58	1.76
CD @1%		4.01	4.10	4.21	4.39	4.49	4.98

Table 2: Effect of seed coat colour on shoot length and root length during storage in sorghum genotypes

Seed coat colour	Genotypes	Storage period											
		Shoot length (cm)						Root length (cm)					
		Initial (Aug)	2 (Sep)	4 (Nov)	6 (Jan)	8 (Mar)	10 (May)	Initial (Aug)	2 (Sep)	4 (Nov)	6 (Jan)	8 (Mar)	10 (May)
White	G ₁ - IS37224	11.79	11.70	7.80	7.20	6.40	6.00	10.14	9.60	7.20	5.30	3.50	3.10
	G ₂ - M 35-1	12.85	12.00	9.60	9.20	7.10	6.70	10.39	9.68	7.60	6.10	5.20	4.00
	G ₃ - DJ6514	10.00	9.50	7.50	7.00	6.10	5.70	10.06	9.35	6.80	4.81	3.40	3.00
Pearly white	G ₄ - RSL46	12.96	12.92	12.70	12.10	7.60	7.00	10.53	10.00	7.80	6.30	5.80	5.00
	G ₅ - RSL54	12.98	12.87	11.80	11.30	7.70	7.10	10.48	9.97	7.70	6.20	5.60	4.30
Chalky white	G ₆ - RSL49	12.10	11.98	8.80	8.40	6.90	6.40	10.20	9.62	7.60	5.70	5.00	3.90
Whitish purple	G ₇ - IS3572	13.87	13.42	11.60	11.30	8.40	8.10	10.64	10.51	7.89	6.80	5.90	5.62
Purple	G ₈ - IS16310	14.38	13.45	12.20	12.00	8.40	8.00	11.01	10.50	8.00	7.00	5.90	5.60
Yellow	G ₉ - IS16006	16.75	16.72	7.90	8.50	9.00	8.60	11.25	10.52	8.10	7.20	6.00	5.80
Red	G ₁₀ - IS37247	17.85	16.80	16.00	12.00	11.90	11.10	11.50	10.88	8.60	8.00	7.50	6.20
	G ₁₁ - RSL69	16.98	16.62	16.98	14.60	11.50	10.90	11.41	10.80	8.20	7.70	7.40	6.00
Light red	G ₁₂ - RSL57	18.20	17.80	18.20	15.10	12.20	11.40	11.51	10.95	8.70	8.00	7.50	6.60
	G ₁₃ - IS37349	16.63	16.61	16.63	11.40	11.10	10.40	11.38	10.79	7.86	7.67	7.23	5.90
	G ₁₄ - IS37304	18.50	18.30	16.70	12.20	10.80	10.10	11.32	10.73	8.10	7.50	7.10	5.80
Light brown	G ₁₅ - IS37355	18.92	18.85	17.50	14.30	12.50	11.70	11.60	10.98	8.70	8.00	7.80	7.10

	G ₁₆ -IS6508	19.08	19.02	17.80	15.80	12.50	12.00	11.61	11.00	8.80	8.10	7.80	7.60
Dark brown	G ₁₇ - IS37225	19.01	18.98	16.60	17.10	16.50	15.85	12.10	11.20	9.90	9.00	8.80	8.00
	G ₁₈ - IS22436	14.29	13.68	11.30	13.10	12.80	12.50	11.69	11.18	9.80	8.40	8.20	7.70
Grey	G ₁₉ - IS2618	20.61	20.20	18.90	11.00	8.00	7.20	10.63	10.38	7.80	6.30	5.80	5.10
Black	G ₂₀ - IS25040	18.50	18.30	16.70	18.50	18.00	17.60	12.13	11.60	9.90	9.10	9.00	8.20
Mean		15.76	15.43	13.26	12.11	10.27	9.72	11.08	10.51	8.25	7.16	6.53	5.73
SEm±		0.39	0.38	0.33	0.30	0.26	0.25	0.27	0.25	0.20	0.18	0.16	0.14
CD @1%		1.10	1.07	0.94	0.86	0.75	0.71	0.75	0.72	0.56	0.50	0.46	0.41

Table 3: Effect of seed coat colour on seedling vigour index-I and seedling vigour index-II during storage in sorghum genotypes

Seed coat colour	Genotypes	Storage period											
		Seedling vigour index-I						Seedling vigour index-II					
		Initial (Aug)	2 (Sep)	4 (Nov)	6 (Jan)	8 (Mar)	10 (May)	Initial (Aug)	2 (Sep)	4 (Nov)	6 (Jan)	8 (Mar)	10 (May)
White	G ₁ - IS37224	1899	1837	1283	1022	765	632	13759	13429	13064	11919	10753	8715
	G ₂ - M 35-1	2042	1892	1484	1255	969	746	14082	13777	13308	12169	11017	9061
	G ₃ - DJ6514	1696	1588	1194	957	729	600	13305	13118	12725	11648	10553	8625
Pearly white	G ₄ - RSL46	2089	2034	1794	1541	1059	858	14378	14085	13598	12496	11305	9467
	G ₅ - RSL54	2070	2010	1701	1444	1047	807	14235	13957	13515	12301	11151	9346
Chalky white	G ₆ - RSL49	2543	2465	1432	1331	1196	1044	14006	13703	13261	11997	11001	8847
Whitish purple	G ₇ - IS3572	1962	1939	1439	1156	937	716	14626	14306	13754	12629	11412	9754
Purple	G ₈ - IS16310	2304	2150	1778	1602	1137	983	14729	14386	13802	12635	11504	9768
Yellow	G ₉ - IS16006	2743	2574	2263	1725	1596	1306	14740	14453	14025	12772	11612	9817
Red	G ₁₀ - IS37247	2633	2536	2181	1918	1550	1259	15298	14954	14499	13188	12132	10646
	G ₁₁ - RSL69	2304	2150	1778	1602	1137	983	15155	14837	14245	13124	12070	10348
Light red	G ₁₂ - RSL57	2780	2681	2303	2015	1640	1364	15325	14995	14578	13410	12304	10734
	G ₁₃ - IS37349	2596	2521	2099	1635	1485	1202	15136	14757	14196	13068	11834	10192
	G ₁₄ - IS37304	2632	2412	1796	1670	1436	1165	14875	14627	14060	12916	11628	10109
Light brown	G ₁₅ - IS37355	2825	2672	2273	1946	1695	1434	15412	15004	14685	13550	12383	10843
	G ₁₆ -IS6508	2866	2784	2446	2085	1700	1490	15434	15138	14722	13559	12445	10830
Dark brown	G ₁₇ - IS37225	2958	2826	2576	2303	2144	1866	15671	15447	15035	13741	12619	11205
	G ₁₈ - IS22436	2909	2865	2495	1898	1769	1555	15616	15316	14649	13745	12528	11026
Grey	G ₁₉ - IS2618	2243	2171	1686	1453	1094	886	14569	14288	13654	12558	11396	9713
Black	G ₂₀ - IS25040	3127	2767	2477	2477	2315	2064	15805	15507	15122	14028	12777	11480
Mean		2456	2349	1925	1648	1370	1148	14808	14504	14025	12873	11721	10026
SEm±		59.91	57.20	47.40	41.27	35.19	29.85	354	347	336	308	281	241
CD @1%		169.90	162.21	134.41	117.04	99.78	84.66	1005	984	952	874	796	684

Conclusion

All the pigmented seeds recorded significantly higher seed quality attributes. Among the genotypes, black seed coat colour genotype G₂₀-IS25040 and the dark brown colour genotype G₁₇-IS37255 maintained its seed quality up to the ten months of storage which is above the Indian minimum seed certification standards. Hence these two genotypes were found to be superior in maintaining seed quality during storage.

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