

## Variation in seed quality of sorghum cultivars available in market

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**ABSTRACT** In order to know the variation in seed quality among the varieties and hybrids (public, private sector) of sorghum collected from different market outlets. A total of 52 lots (38 cultivars) were evaluated for seed germination and seedling vigour. The values ranged significantly from 1.67 g (KDSH 302) to 4.60 g (MRS 4649) for hundred seed weight; 55% (CSH 16) to 97% (CSH 14) for seed germination; 9.2 cm (CSH 16) to 16.93cm (JKSH 434) for root length; 11.15cm (MSH 51) to 20.95cm (Sudhama 333) for shoot length; 10.21 mg (KDSH 302) to 28.22 mg (MRS 4649) for seedling dry weight and 728 (KDSH 302) to 2196 (JKSH 22) for seedling vigour index traits. Whereas, CSH 16, JKSH 474, NSH 36, KDSH 302, CSH 9, NSH 18, MDSH 262, VJH 540, MSH 51 and 'Local farm market (Udaipur)' showed low values of germination ranging from 55 to 75% (lesser than minimum seed certification standard) which is the alarming and needs attention for searching the causes and solutions. The differences for these seed quality traits within the cultivar were also observed due to different market sources as found in 11 cultivars. Farmers become aware of vigour differences when the germination test fails as measure of quality for expensive seeds. The study highlights the importance of seed vigour and suggests the supply of standard quality seed by seed industry which is essential to realize the performance of cultivars on farmer field.

**Keywords:** Sorghum cultivars, market sources, seed germination, seedling vigour, field emergence

Sorghum [*Sorghum bicolor* L. (Moench)] is one of the main staple food across the semi-arid tropics. In India, the genetic improvement in plant type, productivity and resistance to various biotic stresses in systematically planned manner by both public and private sectors has resulted in the development and release of different sorghum hybrids and varieties. These improved cultivars made major contribution to increase the productivity of sorghum in India. However, their continuing contribution will depend on adequate supply of high quality seed to the farmers by the seed industry. Seeds often faces the problems of quick loss in seed germination and vigour of some sorghum genotypes and their susceptibility to various stress factors. Cultivars with high seedling vigour are advantageous for crop stand establishment in dry land cropping system [1]. The transfer of the seed from the producer to the farmer (*i.e.*, the marketing of the seed) is a vital link in the seed industry. Marketing may

be relatively simple process in which the farmer purchases directly from the seed producer/dealer. Although the facts seen obvious, farmer must be impressed with the importance of the quality seed as a key input in modern agriculture. Keeping this in view, the purpose of this study was to understand the variation in a set of 52 entries (38 sorghum cultivars) procured from different seed market sources and to know the association among the traits of seedling vigour.

### MATERIALS AND METHODS

A total of 52 lots (38 sorghum cultivars) collected at different market outlets were evaluated for seed germination and seedling vigour at Directorate of Sorghum Research, Hyderabad (Table 1). The seed samples were tested for hundred seed weight, germination, root length, shoot length, seedling dry weight, seedling vigour and field emergence. All the entries were evaluated in four replications for traits related to seedling vigour (germination,

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root and shoot length, seedling dry matter) and then an index on seedling vigour was calculated. Seeds were surface sterilized with 0.6% sodium hypochlorite and rinsed several times with distilled water before using them for the experiment. The germination test was conducted in paper towels or roll towels as per International Seed Testing Association [2] rules. The seeds were germinated at  $25\pm 5^{\circ}\text{C}$  and  $90\pm 3\%$  relative humidity in a germinator. The percentage germination was calculated based on the number of normal seedlings produced per hundred seeds. Ten normal seedlings were selected at random from the standard germination test, and the root length was measured from collar region to the tip of the primary root and shoot length from collar region to the tip of the leaf. The dry matter production was calculated by drying the ten normal seedlings selected from each replication in a hot air oven maintained at  $80^{\circ}\text{C}$  for 24 hours. On completion of drying, they were transferred immediately to a desiccator for half an hour for cooling, weighted and expressed in milligrams (mg). The vigour index was calculated by multiplying the mean germination percentage by the dry matter production of single seedling and expressed to the nearest whole number. Fifty seeds per replication from each of the cultivar were sown in cement pot (45 cm diameter) filled with pot mixture. The seedlings with leaves above the soil surface were considered as emerged after ten days. The field emergence data were collected from four replications and expressed as percentage. The data on seed germination, root length, shoot length, seedling dry weight, vigour index and field emergence were analyzed statistically in randomized complete block design using a statistical software package (Statistix, version 8.1).

## RESULTS AND DISCUSSION

Significant differences were observed among the 52 lots of 38 cultivars of sorghum for

hundred seed weight, germination, root length, shoot length, seedling dry weight and vigour index values (Table 1). The variations for seed quality within cultivar due to market source were found with 11 cultivars (Table 1) and (Fig. 1 & 2). The high and low performed cultivars for seed vigour among 52 entries were identified, based on mean performance for seed quality traits (Table 1). Among the 52 lots, the values ranged from 1.67g (KDSH 302) to 4.60 g (MRS 4649) for hundred seed weight, 55% (CSH 16) to 97% (CSH 14) for seed germination, 9.2 cm (CSH 16) to 16.93 cm (JKSH 434) for root length, 11.15 cm (MSH 51) to 20.95 cm (Sudhama 333) for shoot length, 10.21mg (KDSH 302) to 28.22 mg (MRS 4649) for seedling dry weight and 728 (KDSH 302) to 2196 (JKSH 22) for seedling vigour index traits (Table 1). These results are in agreement with the report of Cisse and Ejeta [3] in sorghum with highly significant differences for visual seedling vigour, seed germination, field emergence, seedling height and shoot dry weight. Simple plant characteristics such as kernel weight, percentage germination, and seedling weight and height have been identified as good indicators of seedling vigor [4-5]. Seed vigour and germination are the two important indicators of seed quality of seed lots for uniform emergence and stand establishment in the field. Estimates of vigour gives assurance about the reliability of emergence which is especially important for costly seed of new improved cultivars in less than ideal sowing conditions and for situations where crop performance is determined by rapid and even emergence. In the present study, the cultivars JKSH 22, MRS 4649, CSH 14, NSH 18, MSH 51, NJH 21 (Neha), NJH 40 (Ratna), Super 7707 and JKSH 434 showed high values of seedling vigour index ranging from 1950 to 2196 (Table 1). Whereas, the cultivars KDSH 302, Local farm market, CSH 16, JKSH 474, MP Chari, SPV 1616, MDSH 262, MFSH 4, SSG 17 (Fodder Lakshya) and MJ 4334 showed low values of seedling

Table 1. Seed quality standards of 38 sorghum cultivars (public &amp; private) procured from different market sources

S. No.	Source	Variety	Hundred seed weight (g)	Germination (%)*	Shoot Length (cm)	Root Length (cm)	Seedling Dry Weight (g)	Seedling Vigour Index	Field emergence (%)*
1	A	CSH 9	3.60	73 (59.29)	13.68	11.03	22.15	1638	72 (58.38)
	B	CSH 9	3.92	84 (66.64)	16.28	14.90	22.67	1892	75 (60.55)
2		CSH 14	3.36	96 (79.90)	17.78	14.30	22.07	2105	87 (68.96)
3	A	CSH 16	3.16	84 (66.78)	14.00	9.20	20.25	1703	79 (62.80)
	B	CSH 16	2.96	55 (48.32)	14.40	11.13	21.79	1217	54 (47.59)
4		CSH 23	3.27	85 (67.79)	14.53	11.23	21.58	1839	83 (65.77)
5		SPV 1616	2.62	82 (65.12)	13.75	12.98	17.30	1415	78 (62.37)
6	A	JKSH 22	3.79	87 (69.51)	16.98	11.00	20.66	1805	80 (63.46)
	B	JKSH 22	3.80	89 (71.14)	16.90	12.50	24.54	2197	82 (64.92)
7		JKSH 434	4.16	80 (63.56)	16.75	16.93	24.50	1962	78 (62.07)
8		JKSH 474	3.11	66 (54.80)	14.05	10.80	18.45	1225	66 (54.51)
9	A	MSH 51	3.64	75 (60.29)	11.15	12.03	26.91	2016	72 (58.41)
	B	MSH 51	3.53	84 (66.75)	12.75	11.30	20.97	1760	80 (63.95)
	C	MSH 51	3.57	80 (63.45)	15.15	13.30	21.14	1691	76 (60.85)
	D	MSH 51	3.50	82 (65.26)	14.08	14.45	22.11	1802	78 (62.46)
10		MFSH 4	2.75	85 (67.79)	18.60	12.28	17.71	1518	75 (60.45)
11		MDSH 262	3.20	74 (59.72)	17.25	13.98	19.65	1463	67 (55.30)
12	A	VJH 540	3.40	75 (60.03)	12.90	11.80	21.72	1616	71 (57.91)
	B	VJH 540	3.51	84 (66.69)	14.55	13.08	21.95	1844	79 (63.14)
13		VJH 550	2.80	90 (72.23)	15.25	10.93	17.41	1575	87 (69.38)
14		NSH 9 (Bhakti)	3.41	82 (65.49)	13.35	9.80	22.20	1825	79 (63.19)
15	A	NSH 18	3.73	74 (59.61)	13.53	11.95	22.78	1691	72 (58.07)
	B	NSH 18	3.58	92 (74.12)	17.58	13.05	21.89	2017	85 (67.48)
16	A	NSH 27	3.08	83 (65.94)	15.43	12.30	19.10	1596	79 (63.34)
	B	NSH 27	2.99	84 (66.49)	17.45	11.88	21.47	1804	79 (62.84)

Table 1 Contd...

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S. No.	Source	Variety	Hundred seed weight (g)	Germination (%)*	Shoot Length (cm)	Root Length (cm)	Seedling Dry Weight (g)	Seedling Vigour Index	Field emergence (%)*
17		NSH 36	3.29	70 (57.19)	12.83	11.90	23.08	1626	66 (54.36)
		NJH -21 (Neha)	3.66	87 (69.18)	15.98	11.33	22.81	1985	82 (65.56)
18	A	NJH 40 (Ratna)	3.87	79 (63.16)	13.45	13.78	24.87	1976	77 (61.57)
	B	NJH 40 (Ratna)	3.67	82 (65.15)	17.20	14.20	23.80	1950	79 (62.81)
19	A	Shubam 511	3.53	89 (70.85)	16.43	12.18	21.59	1921	82 (64.95)
	B	Subham 511	3.59	89 (71.75)	19.10	12.83	21.22	1904	84 (67.18)
20	A	Sudhama 333	3.54	80 (64.03)	20.95	14.10	20.34	1640	73 (58.93)
	B	Sudhama 333	3.55	83 (65.72)	17.88	14.03	21.07	1745	77 (61.88)
21		Sudhama 1179 (KDSH)	3.45	85 (67.94)	16.60	14.33	19.73	1693	81 (64.83)
22	A	SSG 17 (Fodder)	3.12	78 (62.12)	16.55	11.75	19.68	1533	70 (57.19)
	B	SSG 17 (Fodder)	3.14	81 (64.40)	17.45	13.40	19.91	1619	77 (61.57)
23		MP Chari (Fodder)	1.87	91 (72.68)	15.75	11.30	13.55	1234	84 (66.56)
24		Manisha 96	3.42	82 (64.98)	14.68	11.93	21.78	1788	74 (59.88)
25		Lakshmi 369	3.39	78 (62.44)	12.25	11.00	21.39	1667	75 (60.38)
26		504 Bioseeds	3.52	85 (67.89)	14.60	13.43	21.89	1876	79 (62.80)
27		MJ 4334	3.19	80 (63.49)	15.20	11.00	19.53	1535	75 (60.52)
28		MRS 4649	4.60	77 (61.70)	17.70	12.48	28.22	2178	71 (57.65)
29		8340 (Hybrid)	2.96	90 (71.55)	20.25	9.50	17.40	1558	87 (68.94)
30		Karamveer Hybrid	3.70	83 (66.37)	18.38	13.33	21.17	1772	80 (63.68)
31		DS White	2.66	93 (75.66)	20.05	14.05	17.21	1592	89 (71.43)
32		Local Farm Market (Udaipur)	1.70	75 (60.53)	17.75	14.40	11.02	833	74 (59.45)
33		Amarnath 2000	3.51	83 (65.62)	15.13	13.48	20.37	1684	74 (59.56)
34		Super 7707	3.56	89 (71.40)	16.43	14.60	21.96	1967	83 (66.12)
35		S 201	3.47	80 (64.09)	17.63	11.78	19.05	1538	80 (63.48)

\*Figures in parentheses are arcsine root transformed values of percentage

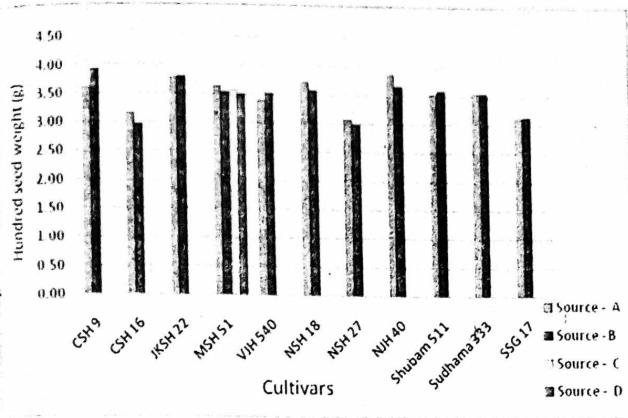


Fig. 1. Variation in hundred seed weight (g) of sorghum cultivars procured from different market sources

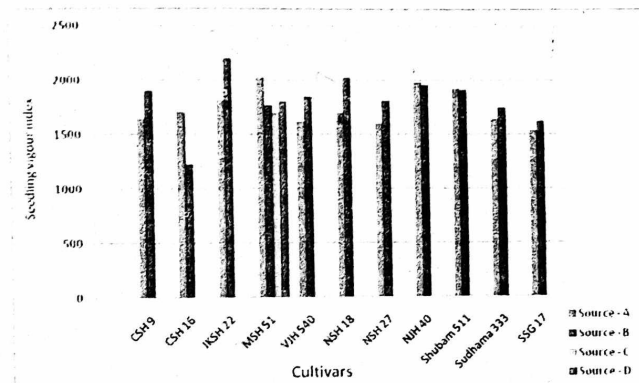


Fig. 2. Variation in seedling vigour of sorghum cultivars procured from different market sources

vigour index ranging from 728 to 1535. The cultivars CSH 14, DS White, NSH 18, MP Chari (Fodder), HT-JH-3201, VJH 550, Subham 511, 8340 (Hybrid), Super 7707 and JKSH 22 showed high germination values ranging from 89 to 97% (Table 1). The minimum certification standard for seed germination of sorghum is 75% [6]. In the present study, CHS 16, JKSH 474, NSH 36, KDSH 302, CSH 9, NSH 18, MDSH 262, VJH 540, MSH 51 and Local farm market (Udaipur) showed low values of germination (lesser than minimum seed certification standard) ranging from 55-75% (Table 1) which is the alarming status of seed quality and needs attention for searching the causes and solutions. The results also

indicated the variation within the cultivar procured from two different market sources for hundred seed weight and seedling vigour as prominently exhibited by the popular public bred hybrids CSH 9 and CSH 16 (Fig. 1 & 2). These observations indicate how the seed quality of the same variety/hybrid vary before reaching the end user *i.e.*, farmer. The reasons for this kind of variation in seed quality of cultivars available in market may be due to varied seed production systems, processing and storage operations followed by seed companies/units. The poor emergence can result from sowing low vigour seeds, even though the germination in the laboratory is perfectly acceptable. Thus seed vigour is not equivalent of seed germination. So, seed vigour indicates the ability of seed/seed lot to germinate and establish seedlings even under sub optimal or poor field conditions. As a result, seed lots of genotype with similar germination percentages may differ significantly in terms of their vigour levels. Differences in vigour are only revealed in practice when germination tests sometimes may fail to indicate emergence differences in the field. Sorghum cultivars with high seedling vigour are advantageous for crop stand establishment in dry land cropping system. The results are in accordance with the earlier reports on oats [7], sorghum [8] and wheat seeds [9].

The pooled correlations among seed quality traits of 52 lots of 38 sorghum cultivars indicated significantly positive association of hundred seed weight with seedling dry weight and vigour index, whereas seedling vigour showed positive association with all the other traits and significantly with germination and seedling dry weight (Table 2). Similar relation between seedling traits was reported by Cisse and Ejeta [3]. The present study clearly showed the variation for seed vigour traits among 38 sorghum cultivars (hybrids/varieties) and also within the cultivar sold at different market outlets.

Table 2. Pooled correlations among seed quality traits of 52 lots of 38 sorghum cultivars

	100 Seed weight	Germination (%)	Field Emergence (%)	Seedling vigour index	Seedling dry weight	Root length
Germination (%)	0.043					
Field emergence (%)	0.020	0.777**				
Seedling vigour index	0.742**	0.523*	0.378			
Seedling dry weight	0.835**	-0.029	-0.053	0.825**		
Root length	0.140	0.116	0.019	0.107	0.037	
Shoot length	0.013	0.366	0.282	0.085	-0.145	0.263

\*P and \*\*P indicate correlation co-efficient @ significant at 5% and 1% level of significance

Seedling vigor in sorghum was assessed by direct measurement of seedling dry weight, which was highly correlated to leaf area, leaf number, and plant height [10]. Comparing hybrid corn seed lots produced by different growers, Fleming [11] found economically significant differences in yield between lots with the same level of germination. Farmers become aware of vigour differences when the germination test fails as measure of quality for expensive seeds. For example  $F_1$  hybrid, and when their production system demands not just a stand adequate for yield but a near complete and even establishment to give uniform produce. But as seed prices increase through the greater use of certified seed of new cultivars that have been bought in rather than farm saved there will be a desire to increase the efficiency with which seed achieves an acceptable stand. Under these circumstances, high vigour seed will be in demand as a means of reducing sowing rates

whilst still maintaining adequate stands for yield. When farmer wishes to buy improved seed, he may find it is available from several market sources. It is important that the information on seed vigour also be readily available to him for judging the quality of seed. Production of commercial seed is a specialized operation that calls for a higher level of competence. Producers of the commercial seed are specialists in that business and are expected to produce a reliable, high quality seed. Supply of standard quality seed along with genetic purity is essential in order to realize the performance of cultivars on farm. The seed industry should adopt standard seed production technology, processing and storage operations specific to each cultivar in order to ensure uniform seed vigour and field establishment among different seed lots of same cultivar. In addition, present seed inspection and certification system needs to be reoriented/

strengthened for effective implementation of 'testing for seed vigour' and rejection of inferior seed lots before reaching the market outlets.

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