https://doi.org/10.29321/MAJ.10.A02862

Madras agric. J. 67 (7): 453-461, July, 1980

Influence of Seed Size on Seed Quality of Sorghum*

A. SENTHILKUMAR KALINGARAYAR[1] and C. DHARMALINGAM[2]

Five seed size classes of sorghum CSH 5 hybrid and its parents, CS 3541, ms 2077 A and 2077 B were studied for the relative differences in seed quality. The 1000-seed weight, seed volume and specific gravity of seeds showed distinct and significant differences among seed sizes. The germination and field emergence potential of 10, 9 and 8 retained seeds were significantly higher than those from 7 and 5 retained seeds. The seedling vigour assessed by seedling growth measurements and dry matter estimation in plant parts and the vigour index values amply showed the superiority of the large and medium size seeds over the smaller ones. The study had revealed that the optimum sieve size is 8/64" round perforated metal sieve for processing the seed lots of sorghum CSH 5 hybrid and its parental lines.

A clear understanding of the relationship of seed size with the quality attributes assumes greater importance to determine the optimum seed size for a variety. The studies so far carried out based on seed size and/or seed weight have been reviewed by Black (1957), Hyoung *et al.* (1974) and Dhillon and Kler (1976). In all this investigations the nature of influence of seed size on one or several of the growth attributes and yield were never the same in different crops. In the present study five seed size classess of sorghum CSH 5 hybrid and its parents, CS 3541, ms 2077 A and 2077 B, were studied to bring out the relative differences in seed quality in respect to physical and physiological indices.

MATERIAL AND METHODS

The studies were carried out with hybrid seeds of Sorghum CSH 5 (V_1) and its parents, CS 3541 (restorer line) (V_2), 2077 B (maintainer line) (V_3) and ms 2077 A (female line) (V_4). The seeds were size graded with 10/64", (G_1), 9/64" (G_2), 8/64" (G_3), 7/64" (G_4) and 5/64" (G_5) round perforated metal sieves. The recovery of seeds in different size grades was recorded and expressed as percentage by weight.

The 1000 seed weight was determined by recording the mean weight of eight replications and expressed as g. The seed volume was measured by immersing 100 seeds in a known quantity of water in a measuring cylinder. The rise in water level was recorded and expressed as cc/100 seeds. Specific gravity of seeds was determined by using specific gravity bottle. Fifty seeds were used and the determination was made in duplicate.

The germination tests (ISTA, 1966) were conducted in paper towels (RT)

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* Part of M. Sc. (Ag) thesis submitted by the first author to the Tamil Nadu Agricultural University, Coimbatore.

1 and 2 Department of Seed Technology, Tamil Nadu Agricultural University, Coimbatore-641 003

using 4 x 100 seeds randomly counted and uniformly spaced on the germination paper and placed at 25°± 5°C in the germination room. Germination was evaluated after seven days and the normal seedlings were counted and expressed as germination percentage. The field emergence potential of seed was assessed by sowing 400 seeds in four rows of 100 each in raised beds and watered to maintain optimum soil moisture. The normal seedlings were counted on the 10th day and expressed as percentage. Ten seedlings were taken at random and the length of the root and shoot was measured separately in cm. The same seedlings were then dried at 80° C for 24 hours in a hot air oven. The root and shoot weights were recorded separately in mg and the total dry matter content was computed. The vigour index value was computed using germination percentage and total seedling length (Abdul-Baki and Anderson, 1973) and expressed as a number.

RESULTS AND DISCUSSION

The maximum recovery of seeds was recorded in 9 and 8 sieves (Table I). The largest and smallest seeds retained by 10 and 5 were 1.0 to 8.2 per cent in the farmer and 2.5 to 18.3 per cent in the latter. The smaller seeds retained by seven as more in V_3 followed by V_2.

TABLE I Seed recovery (%)

	V_1	V_2	V_3	V_4
10/64" (G_1)	8.2	1.8	1.0	1.3
9/64" (G_2)	42.0	30.4	6.1	44.5
8/64" (G_3)	37.7	39.3	40.1	43.2
7/64" (G_4)	9.2	21.2	34.5	8.5
5/64" (G_5)	2.9	7.3	18.3	2.5

The 1000 seed weight recorded in respect to seed sizes, varieties and the interaction between them were highly significant (Table II a). G_1 was superior to other grades followed by G_2, G_3, G_4 and G_5. Among varieties, V_2 was superior to V_4 while V_1 and V_3 were on par with V_4. The 1000 seed weight showed a close positive association with the seed size classes both in the hybrid and its parents. The increase in seed weight as influenced by seed size was reported in sorghum (Hyoung *et al.*, 1974).

The graded seeds exhibited obvious differences in their seed volume and specific gravity (Table II b). Among varieties the differences within the same grade was, however, negligible. The seed volume and specific gravity were found to be corollary of seed size. Selection of seeds for higher seed weight resulted in increased seed size and density.

The germination potential of seeds showed significant differences between seed sizes, varieties and their interactions (Table III a). The mean germination percentages recorded for G_1 was 92, for G_2 91 and for G_3 86. These were on a par and superior to G_4 (75) and G_5 (56). The germination percentage was observed in CSH 5, 2077 A and 2077 B (r = 0.7985**, 0.9252** and 0.9150**, respectively).

The significant reduction in the germination capacity of small seeds, 5 and 7 retained, as compared with the larger and medium grades, could be due to the inclusion of higher proportion of shrivelled and immature seeds resulting from incomplete seed development (Crocker and Barton, 1953). The differential behaviour of the hybrid and its parental lines in this respect was more pronounced with smaller seeds than with the larger or medium grades. Except the last grade, the other seed size grades of the restorer line had apparently higher potential for germination. But the female parent revealed superiority only with the top two grades. The hybrid and maintainer line showed superiority with top three grades in their germination potential.

The field emergence potential of seeds revealed highly significant differences between seed sizes, varieties and their interactions (Table III b). The mean field emergence percentages of G_2 was 82, G_1, 79 and G_3 79. Although on par, they were superior to G_4, (60) and G_5 (44). The varieties V_2 and V_1 were on par in their field emergence potential and superior to V_3 and V_4. The interaction brought out the superiority of the top three grades in all the varieties. A significant correlation between seed size and field emergence was obtained (r = 0.5669**, 0.5549**, 0.8811** and 0.7863**, respectively for V_1, V_2, V_3, and V_4). Hyoung *et al.* (1974) showed that germination and plant stand were not related to seed size in sorghum.

The results pertaining to root length of seedlings from the standard germination test showed significant differences among seed sizes within a variety and among varieties (Table IV a) The differences in mean root lengths recorded in the seedlings from G_5 and G_1 seeds were respectively 5.8 and 13.4 in V_1, 7.1 and 13.5 in V_2, 6.8 and 11.4 in V_3 and 4.6 and 13.0 cm in V_4. The mean root length of seedlings obtained from G_1 seeds was 13.8 cm, followed by G_2, (11.7), G_3 (10.1), G_4 (8.3) and G_5 (6.2). Regarding the varieties, V_2 showed higher potential over others while V_1, V_4 and V_3 were almost similar in respect to their root length. The interaction brought out that the seedlings produced from the first three grades of seeds had higher root length both in the hybrid and its parents than those from the last two grades. A positive relationship was seen between seed size and the root length of the seedlings (r = 09411 **, 0.8088 **, 0.9309 ** and 0.8476 **, respectively for V_1, V_2, V_3 and V_4.)

The mean shoot length of 19.9 and 19.3 cm recorded in respect of G_1 and G_2, while on par, were superior to those of other grades (Table IV b). The interaction between them revealed the superiority of the top three grades for producing seedlings with higher shoot length both in the hybrid and its parents. Seed size and shoot length were also positively related (r = 0.8854 **, 0.8739 **, 0.8088 ** and 0.8531 ** for V_1, V_2 V_3 and V_4 respectively). The vigour index scored on the basis of total seedling length and germination percentage also depicted the higher vigour potential of the seedlings obtained from the first three grades of seeds in all the varieties. The interactions between varieties and grades and the significant correlations observed between them, amply demonstrated the superiority of these grades. A linear relationship between seed size and seedling growth was reported by Whalley *et al*, (1966) in grass species. The relative increase in root length and shoot length of seedlings during early stages of germination would predict their subsequent growth performances.

The root weight of seedlings from different seed sizes showed marked differences both in the hybrid as well as in the parental lines (Table V a). The differences in mean values for the seedlings from the last and top grade seeds were 13.0 and 62.0 mg for V_1, 16.1 and 89.1 mg for V_2, 15.0 and 55.0 mg for V_3 and 11.0 and 51.0 mg for V_4. These differences were highly significant and G_1 was superior to other grades. Among varieties V_2 was superior to V_1 V_2 and V_4. The interaction between varieties and seed sizes brought out the higher potential of the top two grades in all the verieties. A close association between seed size and root weight of seedlings seen (r = 0.9491 **, 0.9817 **, 0.8025 ** and 0.81948 *, respectively, for V_1, V_2, V_3 and V_4).

The differences in shoot weight of seedlings observed among grades, varieties and their interactions were highly

TABLE II a – 1000-Seed Weight (g)

	V1	V2	V3	V4	Mean	CD (P = 0.05)
G1	32.36	32.86	28.23	28.29	30.445	Grades — 1.614 **
G2	24.56	26.27	22.52	22.28	23.908	Varieties — 1.801 **
G3	15.04	17.38	15.21	15.33	15.740	Grades X Varieties — 3.617 **
G4	10.00	10.82	9.75	9.21	9.945	
G5	5.96	8.02	5.77	5.29	6.260	
Mean	17.584	8.02	19.070	16.02		

TABLE II b — Seed volume and Specific gravity

	Seed volume cc.				Sp. gravity			
	V1	V2	V3	V4	V1	V2	V3	T4
G1	2.8	2.8	2.3	2.4	1.105	1.121	1.154	1.207
G2	2.0	2.3	1.9	1.8	0.971	0.825	0.986	1.032
G3	1.4	1.6	1.4	1.3	0.749	0.725	0.821	0.888
G4	1.0	1.0	1.0	0.9	0.732	0.716	0.805	0.871
G5	0.6	0.8	0.4	0.4	0.530	0.668	0.691	0.649

TABLE III a Standard germination (%)

	V1	V2	v3	V4	Mean	C.D. (P = 0.05)
G1	86 (68.03)	92 (73.57)	95 (77.08)	94 (75.82)	92 (73.63)	Grades = 3.59**
G2	87 (68.87)	94 (75.82)	91 (72.54)	91 (72.54)	91 (72.44)	Varieties = 3.21**
G3	83 (65.65)	97 (80.02)	80 (63.44)	85 (67.21)	86 (69.08)	Grades x varieties = 7.18 **
G4	69 (56.17)	93 (74.64)	71 (57.42)	66 (54.33)	75 (60.64)	
G5	53 (46.72)	73 (58.63)	50 (45.00)	47 (43.28)	56 (48.41)	
Mean	76 (61.09)	90 (72.54)	77 (63.09)	77 (62.64)		

significant (Table V b). The mean shoot weight (95.6 mg) recorded for the seedlings raised from G_1 seeds was significantly higher than that obtained with G_2, G_3, G_4 and G_5 seeds. Among the varieties, V_2 and V_4 were on par but superior to V_3 and V_1. The interaction studied highlighted the superiority of G_1 and G_2 seeds for producing seedlings with higher shoot weight.

The relationship between seed size and the shoot weight of seedlings was positive (r = 0.9198 **, 0.9844 **, 0.9262 ** and 0.8921 ** for V_1, V_2, V_3 and V_4, respectively).

As regards the total dry matter content, significant differences were noticed among seed sizes, varieties and their interactions (Table VI a). The mean value recorded for the seedlings

TABLE III b Field emergence (%)

	V1	V2	V3	V4	Mean	C. D. (P = 0.05)
G1	82 (64.90)	79 (62.72)	77 (61.34)	79 (62.72)	79 (62.92)	Grades 3.93 **
G2	75 (60.00)	84 (66.42)	82 (64.90)	86 (68.03)	82 (64.84)	Varieties 3.52 **
G3	86 (68.03)	79 (62.72)	79 (62.72)	71 (57.42)	79 (62.72)	Gradesx varieties 7.86 **
G4	65 (53.73)	74 (59.34)	50 (45.00)	50 (45.00)	60 (50.77)	
G5	55 (47.87)	47 (43.28)	40 (39.23)	33 (35.06)	44 (41.36)	
Mean	73 (58.91)	73 (58.90)	68 (54.64)	64 (53.65)		

TABLE IV a Root length (cm.)

	V1	V2	V3	V4	Mean	CD (P = 0.05)
G1	13.4	13.5	11.4	13.0	12.83	Grades = 0.844 **
G2	12.6	13.4	10.2	10.8	11.75	Varieties = 0.755 **
G3	10.2	12.6	8.4	9.4	10.15	Varieties × Grades = 1.688 **
G4	7.7	9.9	8.1	7.6	8.33	
G5	5.8	7.1	6.8	4.6	6.08	
Mean	9.94	11.30	8.98	9.08		

** Values in parantheses are the respective are sin transformation of the germination percentage and the Corresponding C. D. Values (arc-sin) are also given in paranthieses.

TABLE IV b Shoot length (cm)

	V1	V2	V3	V4	Mean	CD (P = 0.05)
G1	21.1	15.8	21.0	21.7	19.90	Crades = 1.148 **
G2	20.3	15.4	19.9	21.7	19.33	Varieties = 1.026 **
G3	18.8	14.9	17.1	19.9	17.67	Varieties × Grades = 2.995 **
G4	14.6	11.7	15.2	18.0	14.88	
G5	12.5	9.0	14.9	11.6	12.00	
Mean	17.46	13.36	17.62	18.58		

TABLE V a Root weight (mg/10 seedlings)

	V1	V2	V3	V4	Mean	CD (P = 0.05)
G1	62	89	55	51	64.25	Gredes = 4.154 **
G2	49	61	44	40	46.50	Varieties = 3.715 **
G3	28	48	20	33	32.25	Varieties × Grades = 8.308 **
G4	22	28	23	33	26.50	
G5	13	16	15	11	13.75	
Mean	34.80	48.40	31.40	33.60		

TABLE V b Shoot Weight (mg/10 seedlings)

	V1	V2	V3	V4	Mean	CD (P = 0.05)
G1	186	135	110	96	131.75	
G2	185	134	101	181	137.75	Grades = 7.581 **
G3	95	113	92	108	102.03	Varieties = 7.049 **
G4	68	77	67	72	71.00	Varieties × Grades = 15.763 **
C5	34	71	29	29	40.75	
Mean	113.6	106.0	79.8	87.2		

TABLE VI a Total dry matter production (m_/10 seedlings)

	V1	V2	V3	V4	Mean	CD (P = 0.05)
G1	146	208	138	147	159.75	Grades = 7.901 **
G2	120	150	124	134	132.00	Varieties = 7.067 **
G3	89	113	58	94	88.50	Varieties × grades = 15.802 **
G4	59	68	68	89	71.00	
G5	28	38	36	30	33.00	
Mean	88.40	115.40	84.80	98.80		

TABLE VI b Vigour index (Germination % × Total seedling length, cm)

	V1	V2	V3	V4	Mean	CD (P = 0.05)
G1	2959	2690	3057	3242	2987.0	Grades = 193 **
G2	2861	2740	2735	2955	2822.8	Varieties × Grades = 387 **
G3	2404	2693	2039	2480	2404.0	
G4	1523	2006	1754	1672	1738.9	
G5	956	1175	1078	753	990.5	
Mean	2140.6	2260.8	2132.6	2220.4		

raised from G_1 was 159.7 mg and this was superior to the other treatments. Among the varieties the seedlings from V_2 had higher dry matter content than those of other varieties. The interaction also brought out the greater potential of larger seeds compared to smaller seeds.

The dry matter production of the plant parts viz., root, shoot and the sum depended on the rapidity with which the seedlings wore able to grow and reach the autotrophic stage. The variation in these parameters observed with the graded seeds in a standard germination test were all found to be highly significant. The proportionate decrease in the root, shoot and total dry matter content of seedlings with decraase in seed size have been reported by Boyd *et al.*, (1971) in barley and Ries and Everson (1973) in wheat Results obtained in this study with these parameters as well as with the vigour index value established the superiority of 10, 9 and 8 retained seeds over the smaller ones.

The results had amply revealed the necessity of grading the seed lots of sorghum to secure good seeds of uniform size and vigour which would result in good germination and vigorous plants. Considering seed recovery and quality, 8/64" round perforated metal sieve is found to be optimum for processing the seed lots of CSH 5 hybrid and its parents, CS 3541, ms 2077A and 2077B.

REFERENCES

ABDUL-BAKI, A.A. and J.D. ANDERSON 1973. Vigour determination in soybean seed by multiple criteria. *Crop. Sci.* **13** : 630—33.

BLACK, J.N. 1957. The early vegetative growth of three strains of subterranean clover (*Trifolium subterraneum* L.) in relation to seed size. *Aust. J. agric. Res.* **8** : 1—14.

BOYD, W.J.R., A.G. Gordon and L.T. LACROIX. 1971. Seed size, germination resistance and seedling vigour in barley. *Can. J. Pl. Sci.* **51** : 93—99.

DHILLON, G. S. and R. S. KLER 1976. Crop. production in ralation to seed size. *Seed Res.* **4** : 143—55.

HYOUNG, W. S., A. J. CASADAY and R. L. VANDERLIP, 1974. Influence of sorghum seed weight on the performance of the resulting crop. *Crop. Sci.* **14** : 835—36.

International rules for seed testing 1966. *Proc int. Seed Test. Assoc.* **31**.

RIES, S. K. and E. H. EVERSON, 1973. Protein content and seed size relationship with seedling vigour of wheat cultivars. *Agron. J.* **65** : 884—87.

WHALLEY, R. D. B., C. M. Mc. KELL and L. R. GREEN, 1966. Seedling vigour and the early non-photosynthetic stage of seedling growth in grasses. *Crop. Sci.* **6** : 147.