

Effect of seed moisture and storage containers on seed longevity of forage sorghum*

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The multi-cut forage sorghum 'SSG 59-3' (Sudan grass) variety released in 1977 is suitable for all the forage sorghum areas and widely sought for cultivation. This variety is very popular due to its profuse tillering habit, quick regeneration and better palatability characters. Its seeds are small, flat, pointed, shiny and less hard structure. The annual seed requirement of this variety is very high and thus studies on better maintenance of seed viability are necessary to meet the regular demand. The most important factors that determine the longevity of seeds are moisture content, type of container and the storage environment. Storing the seed in cold storage for longer periods in huge quantities is an expensive proposition. Further, the availability of controlled seed storage facilities in India is scanty. Therefore, the present study was conducted to identify suitable seed moisture level and storage containers for storing seeds of 'SSG 59-3' under ambient conditions (temperature 10–45°C and relative humidity 25–90%) and meeting the minimum certification standards of seed germination.

Fresh seeds of 'SSG 59-3' with initial moisture content of 12% and germination of around 95% were used for the experiment. The experiment was conducted in 2 sets namely moisture level and the other storage containers. Seeds with 3 different moisture levels (6, 8, and 10%) were obtained by drying in a hot air oven (40±1°C). The seeds so obtained were treated with Thiram @ 2 g/kg seed and stored under room temperature in different sealed moisture proof containers, viz rigid plastic bottle (C1), 1 000 gauze polyethylene bag (C2), 700 gauze polythene bag (C3), 400 gauze polythene bag (C4) and cloth bag (C5 or control). Five sub-samples of 1 kg each from each treatment of moisture level were drawn and each treatment was replicated 4 times. After initial sampling of 200 g seeds the polyethylene bags filled with seeds were sealed with heat sealer immediately to make them vapour impermeable, and all the containers

were kept in a wire meshed almirah in a masonry building with cemented walls, floor and roof. Similarly, subsequent sampling was done at 12, 18 and 24 months after initial sampling. Observations on seed quality parameters, viz seed germination (%), field emergence (%), seedling dry weight (mg) and seedling vigour index were recorded on each sample.

The germination test was conducted in paper towels or roll towels as per ISTA (1999) rules. The seeds were germinated at 25±5°C and 90±3% relative humidity in a germinator. The germination counts were made after 9 days and the seedlings were evaluated. The percentage germination was calculated based on the number of normal seedlings produced/100 seeds. Ten normal seedlings were selected at random from the standard germination test. The root length was measured from the collar region to the tip of the primary root and shoot length from the collar region to the tip of the leaf. The measurement of length of root and shoot was carried out individually in all the 10 normal seedlings selected at random and expressed in centimetres. The dry matter production was calculated by drying the 10 normal seedlings selected from each replication in a hot air oven maintained at 80°C for 24 hr. On completion of drying, they were immediately transferred to a desiccator for half an hour for cooling, weighed and expressed in milligrams. The mean dry weight of normal seedling was computed and reported. 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.

At each interval of seed storage study, 50 seeds/replication from each of the treatments were sown in cement pot (45 cm diameter) filled with pot mixture. Pots were watered as and when required. After 10 days, the seedlings with leaves above the soil surface were considered as emerged. The field emergence data were collected from each replication and expressed as percentage.

The treatments were replicated 4 times and the data was transformed to arc sine values, wherever necessary and ANOVA was performed in randomized complete block

*Short note

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design (Gomez and Gomez 1978). Data on seed germination, root length, shoot length, seedling dry weight, vigour index and field emergence were analyzed statistically, using a statistical software package (Statistix, version 8.1).

Seed quality parameters in stored seed of the forage sorghum ‘SSG 59–3’ variety improved with lowering of seed moisture levels during storage. The seed quality parameters, viz field emergence, seedling dry weight, and vigour index reduced significantly from 12 to 24 month of storage under different seed moisture levels (Table 1). Up to 12 months of storage, there was no significant reduction in germination percentage under different moisture levels. The seeds stored at 6% moisture maintained 90% germination, 74% field emergence and the vigour index of 1278 even after 24 months of storage as against 76, 57% and 716, respectively with the seeds stored at 10% moisture content in different moisture proof containers. The seeds with 8% moisture content retained their germination (86%) and vigour (1111) well

above the minimum certification standard (75%). The seeds stored with 10% moisture level showed germination percentage (76) almost equal to certification standard (75%) however recorded low vigour index (716) after 24 months of storage. Percentage change in germination was minimum (–8.5) after 24 months of storage when seed moisture level during storage was less (6%), and maximum (–20.5) when seed moisture level was more (10%) (Fig 1). The findings are in agreement with observations made by Barton (1961) that the moisture content of seed is of utmost importance as seed deterioration is directly proportional to seed moisture. Nagarajan and Karivaratharaju (1976) reported existence of significant negative correlation between seed moisture content and viability. They noted significant reduction in viability of seeds of sorghum, pearl millet and maize, when stored in moisture-pervious containers mainly due to increase in moisture content in seed during storage.

Storage containers had variable effects on seed quality.

Table 1 Seed quality parameters of forage sorghum variety ‘SSG 59–3’ at different intervals of storage as influenced by various seed moisture levels

Seed moisture	Germination (%)*				Field emergence (%)*				Seedling dry weight (mg)				Seedling vigour index			
	Initial	12 M	18 M	24 M	Initial	12 M	18 M	24 M	Initial	12 M	18 M	24 M	Initial	12 M	18 M	24 M
6% (M1)	95 (77.9)	93 (74.8)	93 (74.6)	90 (71.3)	91 (72.8)	84 (66.3)	81 (64.3)	74 (59.1)	17.4	17.2	17.2	14.3	1 658	1 594	1 595	1 278
8% (M2)	98 (77.7)	93 (74.2)	91 (72.6)	86 (68.2)	92 (73.0)	83 (65.6)	80 (63.1)	67 (54.9)	18.6	15.4	17.3	12.9	1 771	1 421	1 572	1 111
10% (M3)	94 (76.1)	93 (74.2)	86 (67.9)	76 (60.4)	91 (72.4)	80 (63.6)	69 (55.8)	57 (49.0)	16.9	14.3	13.2	9.5	1 588	1 324	1 134	716
SEm±	0.83	0.64	0.41	0.63	0.57	0.54	0.67	0.63	0.5	0.5	0.4	0.4	51.6	45.8	33.9	38.1
CD (P=0.05)	NS	NS	1.18	1.81	NS	1.56	1.94	1.83	NS	1.4	1.1	1.2	NS	131.7	97.6	110

* Figures in parentheses are arcsine root transformed values of percentage

Table 2 Seed quality parameters of forage sorghum variety ‘SSG 59–3’ at different intervals of storage in various types of containers

Seed moisture	Germination (%)*				Field emergence (%)*				Seedling dry weight (mg)				Seedling vigour index			
	Initial	12 M	18 M	24 M	Initial	12 M	18 M	24 M	Initial	12 M	18 M	24 M	Initial	12 M	18 M	24 M
Rigid plastic container (C1)	95 (76.5)	93 (75.2)	91 (73.0)	86 (68.0)	91 (72.8)	83 (65.3)	78 (62.1)	55.8 (68)	18.0	17.1	17.0	13.4	1 701	1 595	1 554	1 157
1000 gauze polyethylene bag (C2)	95 (77.2)	93 (74.6)	91 (72.9)	86 (68.0)	92 (73.5)	83 (65.7)	77 (61.8)	66 (54.3)	18.1	16.3	16.5	12.3	1 713	1 509	1 502	1 054
700 gauze polyethylene bag (C3)	96 (78.2)	92 (73.7)	90 (71.1)	84 (66.5)	92 (72.5)	83 (65.9)	76 (60.4)	65 (53.9)	17.6	14.6	15.5	12	1 681	1 345	1 395	1 018
400 gauze polyethylene bag (C4)	76.9 (95)	74 (92)	69.7 (88)	64.0 (81)	72.4 (92)	63.9 (80)	60.1 (75)	53.4 (64)	16.8	14.5	14.5	11.2	1 592	1 337	1 284	910
Cloth bag (C5, control)	75.8 (94)	68.0 (86)	61.9 (78)	52.7 (63)	71.9 (90)	61.7 (77)	47.6 (54)	32.3 (29)	18.3	15.1	8.3	8.0	1 714	1 300	645	506
SEm±	0.96	0.74	0.47	0.73	0.66	0.63	0.78	0.73	0.6	0.5	0.4	0.5	59.6	52.9	39.2	44.0
CD (P=0.05)	NS	NS	1.36	2.09	NS	NS	NS	NS	NS	1.6	1.2	1.4	NS	152	113	126

* Figures in parentheses are original values and without parentheses are arcsine root transformed values of percentage

Influence of rigid plastic container and 1000 gauze polyethylene bag were similar on most of the seed quality parameters at the end of 24 months storage period, indicating their similar effectiveness (Table 2). With the reduction in thickness of polyethylene film from 700 to 400 gauze, the seed germination, seedling dry weight and vigour index declined from 18th month onwards (Table 2). The control (seeds stored in cloth bag) showed 78% germination after 18 months of storage but seedling vigour index was very low (645). After 24 months, the seed quality in control container further deteriorated to 63% germination and vigour index to 506. Percentage change in the seed quality parameters were less in seeds stored for 24 months in rigid plastic containers than on cloth bag (Fig 1). Krishnaswamy (1952) reported that sorghum seeds dried and sealed in glass bottles retained their viability longer than seeds stored in gunny bags. The periodical fluctuations in the moisture content of paddy seeds stored in moisture proof sealed containers were not comparable to those stored in jute bags and bamboo baskets (Saibabu *et al.* 1983). Therefore, seeds stored in cloth bag were not comparable with those stored in polyethylene bag. Seed moisture content depends on the relative humidity and air temperature. Whenever, the vapour pressure within the seed is greater than that of the surrounding air, vapor will move out of the seed and *vice-versa*. When seeds are stored in air tight moisture proof containers like plastic bottles and 1000 gauze thick polyethylene bags, the 2 vapour pressures will be in state of

equilibrium and there will be no movement of vapour, at this point the moisture content in seed is equilibrium with the air within the sealed container. Therefore, it is desirable to store the seed in moisture proof containers at low seed moisture levels to avoid harmful interactions within the sealed atmosphere.

It is clear from the present study that simply sealing seeds in air proof and moisture proof containers is not a satisfactory packaging procedure for safe long term storage but needs careful drying to moisture levels that are safe for the high temperatures under which the seeds may be exposed. Adequate drying before sealing is essential for safe storage of seeds in air tight, moisture proof containers, especially for seed stored at warm temperatures in tropical conditions. Sealed storage cannot be directly compared with open storage, because in sealed containers oxygen concentration in the atmosphere decreases and the carbon dioxide concentration increases with time (Harrington 1963) where as in open storage the composition of the atmosphere remains constant.

Safe storage conditions for a short-term period, ie from harvest to the next planting season (1–9 months) are those in which the seed equilibrium moisture is lower than 14% for cereal seeds and 11% for oils seeds (Harrington 1972) or more properly ranges from 12 to 13% and from 8 to 9.5% respectively (Delouche *et al.* 1973). Therefore, proper control of the seed moisture content and seed storage conditions becomes essential for the maintenance of seed viability and vigour, especially in tropical regions. Sorghum seeds during the second year of storage retained significantly higher germination when sealed under a partial vacuum (Bass 1963). The most important factors that determine the longevity of seeds are the seed moisture, type of container and storage environment.

The controlled seed storage facilities in India are scanty and storing of seed in larger quantities for longer periods under ambient conditions is prevalent. From the above results, it is clear that by reducing seed moisture to 8% and by storing the seeds of ‘SSG 59–3’ forage sorghum either in rigid plastic container or 1000 gauze polyethylene bag, the vigour and viability can be maintained safely even up to 2 years of storage under ambient conditions.

SUMMARY

The multi-cut forage ‘SSG 59–3’ sorghum (Sudan grass) variety is widely cultivated in all forage sorghum areas of India. Large quantity of good quality seeds is needed to meet annual seed requirement of this variety. Investigation was carried out to understand the influence of low seed moisture content and storage containers on the seed quality parameters, viz seed germination, field emergence, seedling dry weight and seedling vigour index, in storage up to 2 years under ambient conditions. The seeds of ‘SSG 59–3’ could be stored safely at 8% moisture, either in rigid plastic container or in

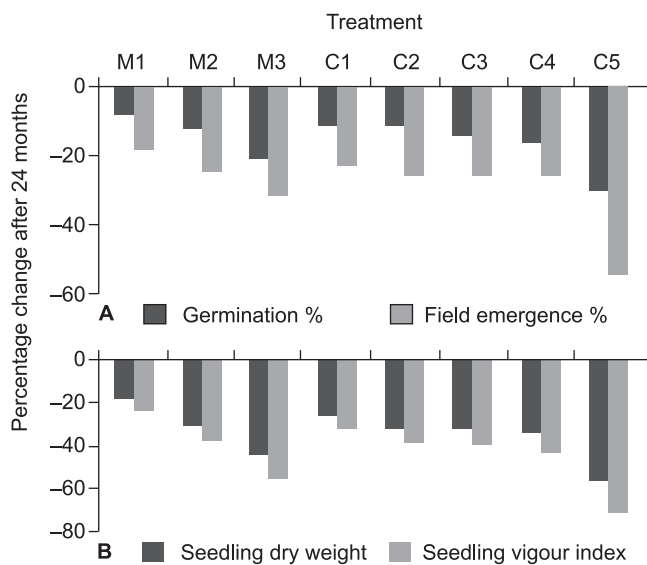


Fig 1 Influence of seed moisture level (M1= 6%, M2= 8% and M3=10%) and storage containers (C1= rigid plastic container, C2= 1000 gauze polythene bag, C3= 700 gauze polythene bag, C4= 400 gauze polythene bag, and C5= cloth bag or control) on seed quality parameters in forage sorghum SSG 59–3 after 24 months of storage. (A) Germination (%) and field emergence (%) and (B) seedling dry weight (mg) and seedling vigour index.

1000 gauge polythene container up to 2 years under ambient conditions, without significant loss in seed vigour and viability.

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