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Research Note

Standardization of duration for accelerated ageing in barnyard millet cv. CO2 and MDU 1

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Abstract
The study was carried out to identify the pattern of seed deterioration in barnyard millet. Physiological quality parameters were evaluated to predict their storability through accelerated ageing at 40 ± 1° C and 100 % RH for 12 days. Based on the physiological quality parameters the duration of ageing required to reach a germination percentage around 75% (IMSCS) was identified as nine days for CO 2 and eight days for MDU 1.

Key words
Ageing, Germination, Deterioration, Seed quality

Minor millets are claimed to be the future foods for better health and nutrition security.Small millets are also rich in dietary fiber, have low glycemic index and are valued for their preventive and curative health properties (Varma and Patel, 2013; Yenagi and Mannurmath, 2013). They are also known for their water stress tolerance, which makes them suitable for rainfed agricultural systems threatened by climate change.

Barnyard millet *(Echinochloa frumentacaea* L.*)* also known as sawa millet, is commonly grown in India, Nigeria, Niger, China, BurkinaFaso, Mali, Sudan, Uganda, Chad and Ethiopia. It is an important small millet crop well adapted to low and moderate rainfall areas (500-700 mm) due to its early maturity character. It is an excellent source of dietary fibre (13 g/100 g) with good amounts of soluble (4.66 g/100 g) and insoluble (8.18 g/100 g) fractions and fair source of highly digestible (81.13 g/100 g digestibility) protein (Hadimani & Malleshi, 1993; Veena *et al.*, 2005). The lesser carbohydrate content which is slowly digestible (25.88 g/100 g digestibility) (Veena *et al.*, 2005) further increases its potential for development of functional foods.

In India, the crop is confined to states like Tamil Nadu, Andhra Pradesh, Karnataka and Uttar Pradesh. In Tamil Nadu, it is cultivated in dry lands and hilly areas of Ramanathapuram, Madurai, Salem, Namakkal, Vilupuram, Dindugal, Coimbatore and Erode districts (Channappagoudar *et al.*, 2008). The area under barnyard millet in India is about 1.95 lakh hectares and production of 1.67 million tonnes with the productivity of 8.57 q/ha. (RashmiYadav and Vijaya Kumar Yadav, 2011).The grain is highly nutritious in comparison with other millets. It is a fair source of protein which is highly digestible and is an excellent source of dietary fibre with good amounts of soluble and insoluble fractions. The carbohydrate content is low and slowly digestible which makes the barnyard millet a nature's gift for the modern mankind who is engaged in sedentary activities. The grains of barnyard millet are low in phytic acid and rich in iron and calcium (Sampath *et al*., 1990).

Seed ageing is known to cause appreciable changes in viability, producing large number of changes in qualitative and quantitative characters and can be used on large scale with simple equipment for inducing variability (Purkar *et al*., 1980 in peas). Ageing can also be due to alter cell membrane permeability as a consequence of lipid peroxidation leading to poly unsaturated fatty acids present in the membrane or reserve lipids, nucleic acids and proteins (Simon, 1974; Saha *et al*.,1990; Beckman and Ames, 1997) and works of (Pammenter *et al*., 1974) and (Pallavi *et al*. 2003). The knowledge on the pattern of seed deterioration is important to use its potential to judge seed vigour. In accerlerated ageing test, the seeds were incubated for a short period under high humidity and temperature as developed by Delouche and Baskin (1973) is used for predicting the storability of seed. Santipracha *et al*., (1997) recorded that the response to the accelerated ageing test is different among the cultivar. With this background, studies were

undertaken by employing the accelerated ageing technique to identify the pattern of seed deterioration in barnyard millet.

One month old seeds of barnyard millet CO 2 and MDU 1 retained by 14 ×14' and 12×12' round perforated sieves respectively were packed in perforated blotter paper cover in duplicate and subjected to accelerated ageing in an ageing chamber maintained at 100 percent RH and a constant temperature of 40 ± 1° C in a desiccators with frequent stirring (Delouche and Baskin, 1973) for a period of 15 days. The aged seeds were shade dried for 48 h and evaluated for the physiological quality parameters.

Germination test was carried out in quadruplicate using 100 seeds each with 4 sub replicates of 25 seeds, were carried out in roll paper towel method (ISTA., 1999), in a germination room maintained at 25 ± 1°C and RH 96 ± 2 % with diffused light during the day. On seventh day of germination test, number of normal seedlings were counted and the average was expressed as percent.

During germination test period, observations were made daily from second to seventh day. The emergence of the seedlings with the plumule was taken as the criterion for germination.
From the mean per cent germination on each counting date, the rate of germination was calculated employing the formula suggested by Maguire (1962).

Rate of germination =

$$\frac{X1}{Y1} + \frac{x_2 - x_1}{y_2} + \ldots + \frac{x_n - (X_n\text{-}1}{Y_n}$$

where,

X_n = Percentage germination n^{th} count

Y_n = Number of days from sowing to n^{th} count

Root length of all the normal seedlings from the germination test was measured from collar region to the root tip and the mean was expressed in cm.
Shoot length of all normal seedlings from the germination test was measured from collar region to the shoot apex and the mean was expressed in cm.

The normal seedlings used for growth measurements were placed in paper cover and dried under shade for 24 h and then in a hot air oven maintained at 80°C for 16 h and the weight was recorded using and electronic balance. The mean weight was expressed in g. 10 seedlings$^{-1.}$

Seedling vigour index was computed by adopting the following formula as suggested by (Abdul-Baki and Anderson, 1973), and was expressed in whole number.
Vigour index = Germination percentage x Total seedling length in centimetre

The data collected from various experiments were analysed statistically adopting the procedure described by Panse and Sukhatme (1985). AGRES package was used for finding critical differences (CD) values.

Accelerated seed ageing techniques is a widely used tool to test the seed quality and storage potential. The deterioration of seed is highly influenced by genetic factors (Varghese and Rai, 2005). The non-aged seeds of CO 2 and MDU 1 recorded maximum germination of (94%) and (95%) respectively. Aged seeds observed a reduction for physiological quality parameters *viz*, germination (%), root length (cm), shoot length (cm), dry matter production (g/10 seedlings) and vigour index in both varieties. The reduction was faster after two days in CO2 and after four days in MDU 1. At the end of 12 days, the germination has been (55%), root length (6.90 cm), shoot length (5.21cm), dry matter production (16.1 g/10 seedlings) and vigour index (1123) in CO 2 variety (Table 1).
In case of MDU1 variety the initial germination of control seeds was 95%. After 12 days the germination was reduced to 63%. The root length and shoot length declined from 12.90 to 6.50cm and 12.00 to 6.11 cm respectively and the dry matter production from 19.4g to 14.1g. The vigour index from 2698 to 1211. The rate of reduction was slower when compared to CO 2 variety (Table 2). The progressive decline in viability potential recorded during accelerated aging could be ascribed to the physiological aging process which leads to the destruction of inhibitory compounds and essential bio molecules present in the embryonic axis. This process might have been accelerated by the interaction effect of increased seed moisture, temperature and depletion of food reserves leading to adverse effect on germination and seedling vigour.
Tirusenduraselvi *et al*. (2013) observed a gradual decrease in germination, root length, shoot length and free radical scavenging activity in maize inbreeds. The similar results were also obtained by (Vanitha., 2005) in blackgram, maize and

sunflower, Vanniarajan *et al*. (2004) in blackgram and Sujatha *et al*. (2012) in pulses.

It could be concluded that based on the physiological quality parameters the duration of ageing required to reach a germination percentage around 75% (Indian Minimum Seed Certification Standards) was identified as ten days for CO 2 and nine days for MDU 1.

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Table 1. Accelerated ageing period for barnyard millet CO 2

Ageing (days)	Germination (%)	Root length (cm)	Shoot length (cm)	Dry matter production (g 10 seedlings^{-1})	Vigour index
Control	94(75.823)	15.10	9.80	23.0	2376
1	97(80.028)	15.90	9.92	23.8	2490
2	96(78.465)	15.72	9.85	23.2	2415
3	93(74.660)	14.34	8.00	20.7	2245
4	90(71.567)	14.02	7.32	20.5	2018
5	85(67.215)	13.75	7.11	20.3	1987
6	85(67.215)	13.10	6.50	20.0	1945
7	81(64.159)	12.50	6.25	19.6	1910
8	79(62.727)	11.00	6.00	19.4	1850
9	75(60.001)	10.78	5.89	18.4	1790
10	73(58.695)	9.43	5.50	18.1	1523
11	65(53.730)	7.51	5.35	17.9	1490
12	55(47.870)	6.90	5.21	16.1	1123
Mean	**82.15**	**12.31**	**7.13**	**20.07**	**1935.53**
SEd	**1.70**	**0.23**	**0.13**	**0.41**	**49.67**
CD (P=0.05)	**3.52****	**0.48****	**0.27****	**0.84****	**102.51****

Figures in parentheses are arc sine transformations
**** indicates significance of value at P=0.01**

Table 2. Accelerated ageing period for barnyard millet MDU 1

Ageing (days)	Germination (%)	Root length (cm)	Shoot length (cm)	Dry matter production (g 10 seedlings^{-1})	Vigour index
Control	95(77.081)	12.90	12.00	19.4	2698
1	98(81.872)	14.15	13.45	21.5	2875
2	98(81.872)	13.78	13.10	20.5	2709
3	94(75.823)	12.21	11.32	19.0	2612
4	90(71.567)	11.10	10.21	18.2	2578
5	85(67.215)	10.32	9.43	17.2	2510
6	83(65.651)	10.01	9.20	16.9	2432
7	80(63.436)	9.34	8.50	16.0	2390
8	74(59.344)	8.33	7.55	15.5	1810
9	69(56.168)	8.10	7.40	15.0	1509
10	67(54.940)	7.55	6.50	14.9	1300
11	65(53.730)	7.00	6.32	14.5	1255
12	63(52.536)	6.50	6.11	14.1	1211
Mean	**81.61**	**10.09**	**9.31**	**17.13**	**2145.30**
SEd	**2.06**	**0.21**	**0.14**	**0.32**	**44.69**
CD (P=0.05)	**4.25****	**0.44****	**0.30****	**0.67****	**92.24****

Figures in parentheses are arc sine transformations
**** indicates significance of value at P=0.01**