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Standardization of screen aperture size for grading of Sunn hemp

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Abstract
An experiment was conducted to standardize the sieve size for seed grading in Sunn hemp during *Kharif* 2019-20 and 2020-21. The Sunn hemp local variety was processed using S_1 - 1.4 mm (S), S_2 - 1.6 mm (S), S_3 - 1.8 mm (S), S_4 - 2.0 mm (S) and S_5 - 2.2 mm (S) of slotted perforated metal sieves with CRD design. The study revealed that larger sized seeds are obtained from 2.0 mm and 2.2 mm sieves which recorded maximum seed quality parameters. Seed recovery percentage in 1.4 mm sieve was higher than other sieves and also quality of seeds obtained in 2.2 mm sieve was higher than the Minimum Seed Certification Standards. The graded seeds obtained from the sieve 2.0 mm recorded the highest recovery (92.99%), physical purity (98.18%), pure live seed (81.17%), test weight (40.40 g), seed germination (82.68%), total seedling length (25.4 cm), seedling dry weight (19.0 mg), seedling vigour index-I (2101) and seedling vigour index-II (1573) in pooled mean data of both years. Hence, grading of Sunn hemp seeds with 2.0 mm sieve is more effective and economical than 2.2 mm sieve. Using the sieve of 2.0 mm (S), higher seed recovery, germination and physical purity percentage above acceptable limits of Indian Minimum Seed Certification standard (IMSCS) can be obtained.

Keywords: Sunn hemp, sieve and grading

Introduction
Green manuring is a time-honored farming practice for preserving soil fertility. The green revolution, on the other hand, has expanded the use of chemical fertilizers while marginalizing the usage of green manures in intensive cropping systems. This can be seen in the shrinking area beneath green manure crops over time. In India, green manure crops are reported to cover 1.23 million hectares (Anon., 2015) [3]. The use of organic manures including green manure crops, declined substantially. Inorganic fertilizers are becoming more expensive recently besides sustainability of soil productivity is in vogue. Green manure crops are low cost and effective technology in minimizing the cost of fertilizers and safeguarding soil health and productivity.

Sunn hemp (*Crotalaria juncea*) is one of the most important green manure crops which is grown all over India. Sunn hemp, a member of the legume family (*Fabaceae*), has great potential as an annually renewable, multi-purpose fiber crop. Green manuring with Sunn hemp improves the soil fertility by addition of large quantities of organic matter besides nitrogen to the soil. *Sunn hemp* can fix about 50-60 kg N/ha within 60-90 days of cultivation. It provides 60 kg N/ha to the soil when it is used as green manure.

In any crop's seed production programme, a shortage of good quality seeds can lead to poor germination and field emergence. Seed quality deterioration may be caused by inappropriate seed handling after harvest, which results in poor and erratic field emergence and failure of seedling establishment in the field, resulting in lower output (Ganiger *et al*., 2018) [9].

Any seed lot when harvested includes seeds of different sizes and densities. This variation is because of the differences between seeds harvested from different plants and partly due to differences among seeds borne at different times on the same plant. Seed size, to some extent is an inherited character; it is also influenced by mother plant nutrition, moisture availability to the developing seed and its position in the plant (Angadi and Kumar, 2016) [2]. Also seed development can be retarded by pest and disease and seeds borne on poorly developed plants will be smaller. Therefore, it is required to process the seeds to elevate its planting value.

The influence of seed size on seedling vigour and crop productivity has drawn the attention of researchers since long time. Dhilon and Kler (1976) [6] revealed that seedling vigour and yield of cereals and pulses were influenced by protein content which was high in small seeds.

Seed size influences on quality of reserve food material which is available for the emerging seedling. Small and shriveled seeds do not contain as much as stored food to give raise to vigorous plants as compared to the bold and plump ones. A large quantity of seed is lost during processing due to screen rejections as undersized seeds. To avoid this loss and to improve the availability of seed material without sacrificing the seed quality, it is necessary to find out the optimum screen size and screen types which can give higher seed recovery and quality.

With the brief background, the present investigation was undertaken to standardize the screen aperture size for grading of Sunn hemp.

Materials and Method

Freshly harvested bulk seed of Sunn hemp harvested from National Seed Project (Crops), Seed Block, UAS, Raichur were used for conducting the experiment. The seeds were dried under shade to bring down the initial seed moisture content to around 9 per cent. A laboratory experiments was conducted to standardize of the seed aperture size for grading of Sunn hemp seeds at Seed Quality Assurance and Research Laboratory, Seed Unit, University of Agricultural Sciences, Raichur during 2019-20 and 2020-21.The seeds were graded using five different sieve sizes.

The experiment was laid out in Complete Randomized Design with four repetitions to impose treatments i.e., S_1 - 1.4 mm (S), S_2 - 1.6 mm (S), S_3 - 1.8 mm (S), S_4 - 2.0 mm (S) and S_5 - 2.2 mm (S) screen aperture sizes. The seeds obtained from different sieves were assessed for various seed quality seed parameters.

Seed recovery

$$\text{Seed recovery (\%)} = \frac{\text{Total weight of graded seeds}}{\text{Total weight of bulk seeds}} \times 100$$

Physical purity

$$\text{Physical purity (\%)} = \frac{\text{Weight of pure seed fraction}}{\text{Weight of the components}} \times 100$$

$$\text{Pure live seed (\%)} = \frac{\text{Germination (\%)} \times \text{Physical purity (\%)}}{100}$$

Test weight

The mean weight of one thousand seeds was recorded as test weight and expressed in grams.

Germination (Anon., 2014)

$$\text{Germination (\%)} = \frac{\text{No. of normal seedlings}}{\text{Total no. of seeds}} \times 100$$

Total seedling length

Total seedling length was calculated by adding shoot and root length of ten normal seedlings which were randomly selected from each treatment on the day of final count and the average was expressed in cm.

Seedling dry weight

The ten seedlings were dried in a hot air oven maintained at $70 \pm 1\ ^0$C for 24 hours and cooled in a desiccator. The mean seedling dry weight was recorded and expressed in mg per seedling (Evans and Bhatt, 1977) [7].

Seedling vigour index-I and II: (Abdul Baki and Anderson (1973) [1]

SVI - I = Germination (%) x Mean seedling length (cm)

SVI - II = Germination (%) x Mean seedling dry weight (mg)

The statistical analysis and the interpretation of the experimental data was done by using Fischer method of Analysis of Variance technique as outlined by Gomez and Gomez (1984) [10]. The level of significance used in F test was 1 per cent for laboratory experiment.

Results and Discussion

Seed size exerted a significant influence on the seed recovery, test weight, physical purity, pure live seed, germination, total seedling length, seedling dry weight and seedling vigour index (Table 1, 2 and 3)

Table 1: Seed recovery, physical purity and pure live seed as influenced by different screen sizes in Sunn hemp

Treatments	Seed recovery (%)			Physical purity (%)			Pure live seed (%)		
	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled
S_1 (1.4 mm)	98.21	98.15	98.18	96.94	96.22	96.58	71.80	72.80	72.32
S_2 (1.6 mm)	98.01	97.82	97.91	97.14	97.08	97.11	76.03	76.23	76.16
S_3 (1.8 mm)	95.31	95.34	95.33	97.38	97.31	97.34	79.39	80.65	80.03
S_4 (2.0 mm)	93.53	92.44	92.99	98.10	98.27	98.18	80.64	81.87	81.17
S_5 (2.2 mm)	87.53	88.37	87.95	99.09	99.13	99.11	83.55	84.19	83.89
Mean	94.52	94.42	94.47	97.73	97.60	97.66	78.28	79.15	78.71
S.Em±	0.69	0.58	0.54	0.28	0.36	0.43	0.49	1.02	0.58
CD at 1%	2.88	2.41	2.27	1.19	3.50	0.99	2.06	3.55	2.42

Table 2: Test weight and germination as influenced by different screen sizes in Sunn hemp

Treatments	Test weight (g)			Germination (%)		
	2019	2020	Pooled	2019	2020	Pooled
S_1 (1.4 mm)	35.94	39.68	37.81	74.10	75.67	74.88
S_2 (1.6 mm)	37.31	40.57	38.94	78.33	78.52	78.42
S_3 (1.8 mm)	39.31	41.53	40.42	81.56	82.87	82.21
S_4 (2.0 mm)	41.08	39.72	40.40	82.04	83.31	82.68
S_5 (2.2 mm)	42.12	40.47	41.29	84.36	84.93	84.65
Mean	39.15	40.39	39.77	80.08	81.06	80.57

S.Em±	0.63	0.53	0.49	0.65	0.70	0.40
CD at 1%	2.63	2.22	2.02	2.70	2.90	1.65

Table 3: Total seedling length, seedling dry weight and seedling vigour index as influenced by different screen sizes in Sunn hemp

Treatments	Total seedling length (cm)			Seedling dry weight (mg)			Seedling vigour index-I			Seedling vigour index-II		
	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled
S_1 (1.4 mm)	19.0	19.1	19.5	15.0	16.1	15.6	1482	1445	1463	1111	1221	1166
S_2 (1.6 mm)	22.8	22.9	22.8	16.8	16.9	16.8	1774	1801	1788	1314	1328	1321
S_3 (1.8 mm)	23.4	23.4	23.4	17.3	17.5	17.4	1911	1939	1925	1408	1451	1429
S_4 (2.0 mm)	26.2	26.0	25.4	18.9	19.2	19.0	2033	2169	2101	1550	1596	1573
S_5 (2.2 mm)	29.2	28.0	28.4	19.1	19.8	19.4	2442	2371	2406	1607	1683	1645
Mean	24.1	23.9	23.9	17.4	17.9	17.7	1928	1945	1936	1398	1456	1427
S.Em±	0.3	0.3	0.2	0.3	0.2	0.2	31	22	22	22	30	23
CD at 5%	1.2	1.2	0.8	1.2	1.0	0.9	129	93	94	92	125	94

Seed recovery

Scrutiny of the data on seed recovery (%) presented in Table 1 shows that seed recovery (%) was significantly influenced by different screen size. The pooled mean data of two years indicated that, seeds retained on S_1 (1.4 mm slotted) showed maximum seed recovery of 98.18% followed by S_2 (1.6 mm slotted) (97.91%) and lowest was in S_5 (2.2 mm slotted) (87.95%). Similar trend was followed in 2019-20 and 2020-21.

Seed recovery was significantly affected by different sieve size with treatment S_1 (1.44 mm slotted) recorded significantly higher seed recovery because of less rejection due to retaining of seeds over the sieve, it was on par with S_2 (1.6 mm slotted) (Fig. 1). Whereas, S_5 (2.2 mm slotted) recorded lowest seed recovery due to higher rejection of seeds. The results are similar to that of Mathad *et al.* (2012) [18] and Vasudevan *et al.* (2012) [18] in eggplant, Lambat *et al.* (2017b) [17] in safflower, Shashidhar *et al.* (1988) [24] and Ramaiah *et al.* (1994) [21] in maize and Kanawade *et al.* (2000) [12] in sunflower. Similar results of less seed recovery with increase in sieve size were reported by Merwade (2000) [19] in chickpea.

Physical purity and pure live seed

The results on physical purity and pure live seed (%) exhibited a significant differences as influenced by different screen aperture sizes (Table 1). Seeds retained on S_5 (2.2 mm slotted) showed the highest physical purity (99.11%) and pure live seed (83.87%) followed by S_4 (2.0 mm slotted) (98.18 and 81.25%) and the lowest was in S_1 (1.4 mm slotted) (96.58 and 72.30%) in pooled mean data of two years. The similar trend was noticed in 2019-20 and 2020-21.

From the above results it is revealed that physical purity differed significantly due to the influence of different screen sizes and highest physical purity was recorded in seeds retained on S_5 (2.2 mm slotted) compared to other treatments (Fig. 1). This may be due to inert materials, low graded seeds are dropped through screens and retaining only good graded seeds. The results are parallel with the findings of Kausal *et al.* (1993) [13] in sorghum and green gram, Raghavendra Rao *et al.* (1993) [20] in sorghum and Shashidhar *et al.* (1988) [24] in maize and Verma and Ram (1989) [27] in soybean.

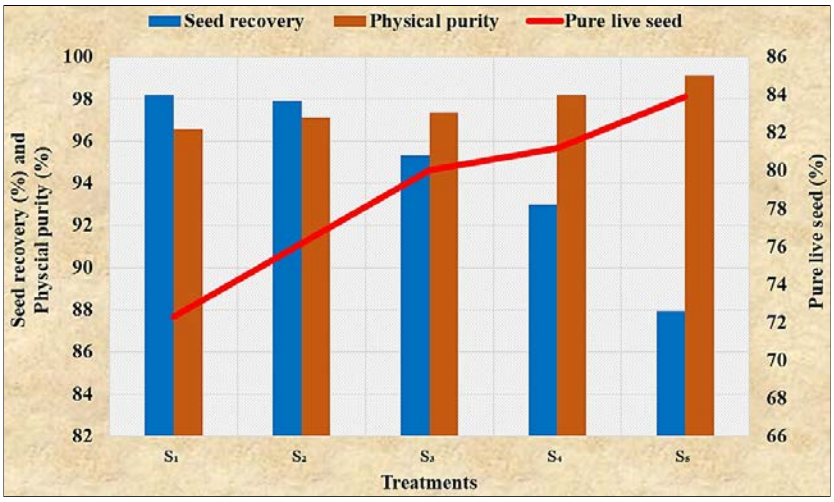

Fig 1: Seed recovery, physical purity and pure live seed as influenced by different screen sizes in sunn hemp.

Test weight and germination

Test weight (g) and germination (%) as influenced by different screen sizes was found to be differ significantly (Table 2 and Fig. 2). In pooled mean data of two years, highest test weight and germination (41.29 g and 84.64%) was recorded in seeds retained on S_5 (2.2 mm slotted) which was on par with S_4 (2.0 mm slotted) (40.40 g and 82.68%) and the lowest test weight was recorded in S_1 (1.4 mm slotted) (37.81 g and 74.88%), respectively. Similar trend was recorded in 2019-20 and 2020-21.

Because of the varying screen/sieve sizes, the test weight varied significant. This may be due to grading of seeds based on sieve sizes leading to increased test weight with increased sieve size which was reported in cluster bean by Renugadevi *et al.* (2009) [22]. Seed size and seed quality exerted a positive association in cluster bean. These results are in conformity with the findings of Anuradha *et al*. (2009) [5] in chickpea, Ganiger *et al*. (2016) [8] in greengram and Kausal *et al.* (2008) [14] in soybean. Seeds retained on 2.2 mm slotted sieve size gave higher germination (%). With decrease in sieve size a significant reduction in germination percentage was recorded. Superiority of big and medium size over small seeds with respect to germination percentage was observed in this study is in conformity with the earlier reports of Reshma *et al.* (2009) [23] in hedge lucerne. The higher potential of large and medium sized seeds might due to the initial capital and more amount of nutrients available for germination as stated by Ashby (1936). The enhanced activity of redox enzymes in the seeds, which aid in breakdown of complex food stores into simple soluble sugars, might contributed for higher germination (Gurbanov and Berth, 1970) [11] of bigger seeds.

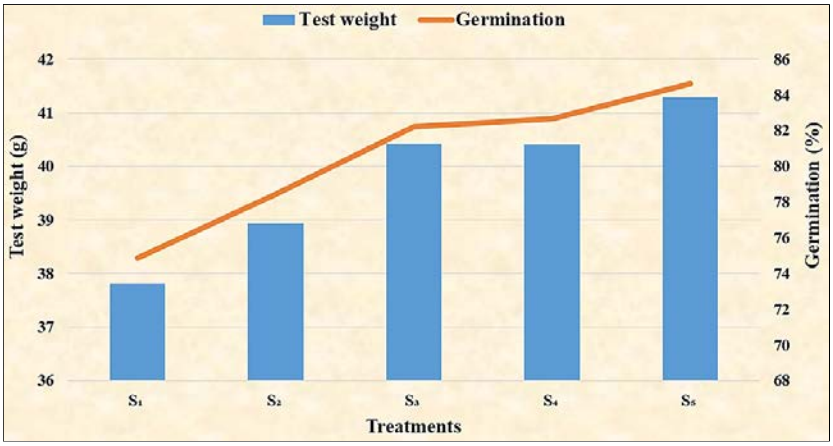

Fig 2: Test weight and germination as influenced by different screen sizes in sunn hemp.

Total seedling length and seedling dry weight

The data on total seedling length (cm) and seedling dry weight (mg) as influenced by different screen aperture sizes (Table 3). The total seedling length and seedling dry weight differed significantly among different screen sizes and maximum total seedling length and seedling dry weight (28.4 cm and 19.4 mg) was recorded in S_5 (2.2 mm slotted). Whereas the S_1 (1.4 mm slotted) recorded the lower shoot length (19.5 cm and 15.6 mg) in pooled data of two years, respectively.

The total seedling length and seedling dry weight was better in seeds retained on large screen size of 2.2 mm slotted (Fig. 3). This may be due to differences in seed sizes. Larger seeds contain more food reserve than small seeds, resulting in better supply of food to the embryo for a prolonged period of time, as well as higher mobilization efficiency of reserve food material during germination, resulting in more cells per cotyledon in the form of reserve food material, which might resulted in increased root, shoot, and total seedling length. This is in conformity with the findings of Kumar *et al.* (2014b) [16] in wheat and Kumar *et al*. (2014a) [15] in greengram. As there has been better seedling growth, which might have led to an increase in mean seedling dry weight and similar results were also documented by Sudeep Kumar *et al.* (2010) [25] in field bean.

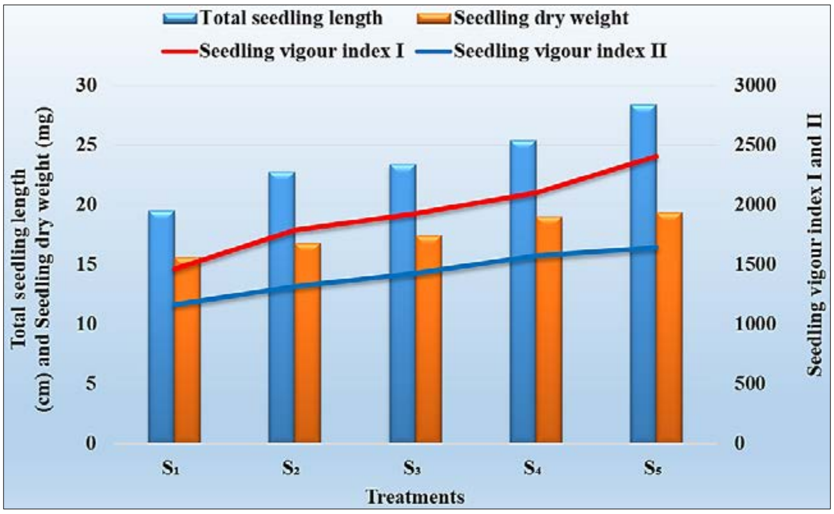

Fig 3: Total seedling length, Seedling dry weight and Seedling vigour index I and II as influenced by different screen sizes in sunn hemp.

Seedling vigour index I and II

Screen sizes influenced seedling vigour index I and II and significant difference was observed between the treatments. Significantly higher (2406 and 1644) seedling vigour index-I and II was recorded in S_5 (2.2 mm slotted). Whereas the S_1 (1.4 mm slotted) recorded least seedling vigour index-I and II (1462 and 1165) in pooled mean data of two years. Similar trend was observed in 2019-20 and 2020-21.

Conclusion

The study inferred that, a sieve size of 2.0 (S) mm registered seed recovery of (92.99%), physical purity (98.18%), germination (82.68%), test weight (40.40 g), pure live seed (81.17%), total seedling length (25.4 cm) and seedling vigour index-I and II (2101 and 1573) which is above the minimum seed certification standards. Hence the sunn hemp can be processed using 2.0 mm (S) grading sieve for better seed recovery and quality.

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