



Standardization of Seed Grading Sieve Sizes for Maximum Seed Recovery and Quality in Clusterbean (*Cyamopsis tetragonoloba*) and Dhaincha (*Sesbania aculeata*)

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ABSTRACT

Background: High quality seed is a basic requirement for achieving optimum crop establishment, productivity and economic returns. Seed processing plays a crucial role in improving seed quality by removing inert matter, broken seeds and other impurities, consequently enhancing physical purity, uniformity, germination and planting value. Seed grading is an essential operation for removing impurities and undersized seeds, which are generally associated with lower physiological quality and vigour and helps maximize the recovery of pure seed fractions while ensuring that the processed seed meets the prescribed quality standards. The continuous development and release of new crop varieties necessitates periodic standardization of grading sieves to accommodate difference in seed size and shape. Considerable variation in seed size has been observed among newly released and older varieties. Optimization of sieve dimensions can improve processing efficiency, enhance physical purity and reduce seed losses, thereby increasing the availability of quality seed to farmers.

Methods: Unprocessed seed lots of clusterbean varieties HG 365 and HG 2-20 and dhaincha variety DH 1 were procured from the breeder seed store of the Department of Seed Science and Technology. Seed samples were graded using a Sieve Shaker (Model SB5W). For clusterbean, sieves of 1.60, 1.70, 1.80, 1.90, 2.00, 2.10 and 2.20 mm (slotted) were used, whereas for dhaincha, sieves of 1.50, 1.60, 1.70, 1.80, 1.90, 2.00, 2.10 and 2.20 mm (slotted) were tested. A 250 g unprocessed seed sample was sieve for 3-5 minutes at a shaking frequency of 25-30 strokes per minute. Seeds retained on each sieve were collected separately and evaluated for seed recovery and quality parameters such as seed recovery (%), seed dimensions (length and breadth in mm), first count germination (%), final germination (%), physical purity (%), 1000 seed weight (g) and moisture content (%). The sieve that retained the maximum quantity of seeds with seed quality parameters (above IMSCS) was identified as the optimum sieve size for that particular variety.

Result: In clusterbean varieties HG 365 and HG 2-20, the 2.00 mm slotted sieve recorded maximum seed recovery of 97.26% and 90.34% with germination (76.67% and 81.33%) and physical purity (98.78% and 99.38%) respectively, above IMSCS standards. In dhaincha variety DH 1, the 1.50 mm slotted sieve recorded maximum seed recovery (89.02%) with germination (75.67%) and physical purity (98.17%) above IMSCS. Although smaller sieve sizes increased the seed recovery percentage but reduced seed quality, whereas larger sieves improved seed quality but lower seed recovery. The study concludes that 2.00 mm slotted sieve is most suitable for processing clusterbean varieties HG 365 and HG 2-20 and 1.50 mm slotted sieve is optimum for dhaincha variety DH 1. Using these variety specific sieve sizes can enhance seed processing efficiency, maximize seed recovery and improve the economics of seed production programmes.

Key words: *Cyamopsis tetragonoloba*, Recovery, Seed germination, Seed processing, *Sesbania aculeata*, Sieve size.

INTRODUCTION

Clusterbean (*Cyamopsis tetragonoloba* L.), commonly known as guar, is an economically important drought hardy legume cultivated mostly in arid and semi-arid regions (Kumar, 2005). The crop is well adapted to drought prone environments due to its low water requirement and capacity for biological nitrogen fixation, which contributes to soil fertility enhancement and sustainability of rainfed production systems. Clusterbean believed to have originated in Africa, now is widely cultivated in the Indian subcontinent, where it provides a source of vegetable, fodder, green manure and industrial raw material.

India is the largest producer of clusterbean, contributing about 80-85% of world production, mainly

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cultivated in Rajasthan, Haryana, Gujarat and Punjab. The crop has gained substantial commercial importance because of guar gum, a galactomannan polysaccharide extracted from the seed endosperm. Guar gum is widely utilized in food, pharmaceutical, textile, paper, cosmetic, mining and petroleum industries because of its thickening, stabilizing and emulsifying properties (Bhatt *et al.*, 2016). Thereby, increasing industrial demand has enhanced the strategic and economic significance of clusterbean cultivation.

Dhaincha (*Sesbania aculeata*), belonging to Fabaceae family is a fast growing leguminous species, widely recognized for its role in sustainable agriculture. The crop possesses excellent adaptability to saline, alkaline, waterlogged and other marginal soils, making it suitable for cultivation under diverse agro-ecological conditions. Dhaincha enhances soil fertility through symbiotic nitrogen fixation and improves soil health, supporting environmentally sustainable crop production systems. *Sesbania bispinosa* and *Sesbania aculeata* are the most widely cultivated species across Asia, Africa, Australia and Central America. In India, dhaincha is commonly grown in rice-based cropping systems in Uttar Pradesh, Haryana, Punjab, Rajasthan, Bihar, West Bengal andhra Pradesh, Tamil Nadu and Odisha. The crop is recognized as one of the most effective green manure species because of its rapid biomass accumulation and high nitrogen fixation potential. Under favourable conditions, dhaincha can produce 22.3t ha⁻¹ of green biomass which supplies 47.85 kg N ha⁻¹ under sodic soil condition (Ramesh and Rathika, 2017). Use of its biomass enhances soil organic carbon content, nutrients availability, microbial activity and physical properties of soil. In addition to green manuring, dhaincha is used for fodder, fiber, fuel-wood production and reclamation of salt affected soils, emphasizing its importance in climate resilient agriculture (Chanda *et al.*, 2021; Masilamani *et al.*, 2024).

High quality seed is a basic requirement for achieving optimum crop establishment, productivity and economic returns. Seed processing plays a crucial role in improving seed quality by removing inert matter, broken seeds and other impurities, consequently enhancing physical purity, uniformity, germination and planting value. The effectiveness of seed processing mainly depends on the selection of appropriate grading sieves, which grade seeds based on size and shape characteristics (Agrawal, 1996).

According to Indian Minimum Seed Certification Standards, a minimum physical purity of 98% is recommended for certified seed of clusterbean and dhaincha. For the grading of clusterbean varieties, a bottom sieve size of 1.80 mm (slotted) is currently recommended; however, no standard bottom sieve size has yet been standardized for dhaincha seed grading (Anonymous, 2013). However, seed lots obtained after threshing usually fail to meet these standards and therefore require cleaning and grading operations. Due to substantial variation in

seed dimension among crops and varieties, the efficiency of grading is profoundly influenced by the sieve size used during processing. Improper sieve size selection may either enable the retention of impurities or result in the rejection of sound seeds, resulting in both seed quality and seed recovery.

Seed size is closely related with seed vigour, as larger and fully developed (sound) seeds generally possess greater food reserves and produce more vigorous seedlings than small or shriveled seeds. According to Ambika *et al.* (2014), the effect of seed size is very much evident on seed vigour and seed germination among various crops. Large seeds have better vigour and field performance than small seeds. During processing, substantial proportion of usable seed may be discarded along with undersized fractions if inappropriate grading sieves are used. Therefore, selection of suitable sieve sizes is essential for maximizing seed recovery without compromising quality standards. Because varietal differences in seed morphology influence grading efficiency, a single sieve size may not be equally suitable for all the varieties of a crop. Seed grading is carried out to remove impurities and undersized seeds, which are usually considered to be underdeveloped, from seed lots in order to maximize the recovery of pure seed fractions that meet the prescribed standards. This process contributes to improved seed quality by ensuring uniform germination and enhancing the planting value of the seed lot (Suma *et al.*, 2014).

The continuous development and release of new crop varieties necessitate periodic standardization of grading sieves to accommodate difference in seed size and shape. Considerable variation in seed size has been observed among newly released and older varieties. Therefore, to ensure the production of high quality seed and compliance with the physical purity standards prescribed under IMSCS, it is essential to standardize the grading sieve size for seed processing.

In seed processing plants, cleaner-cum-graders use top and bottom screens for separation, with bottom sieves requiring varietal specific adjustments for efficient grading. Optimization of sieve dimensions can improve processing efficiency, enhance physical purity and reduce seed losses, thereby increasing the availability of quality seed to farmers. Therefore, the present investigation was undertaken to standardize grading sieve sizes for efficient seed processing of clusterbean and dhaincha to maximize seed recovery while maintaining prescribed seed quality standards, thereby improving the overall efficiency and economics of seed processing.

MATERIALS AND METHODS

Unprocessed seed lots of clusterbean varieties HG 365 and HG 2-20 and dhaincha variety DH 1 were procured from the breeder seed store of the Department of Seed Science and Technology. Seed samples were graded using a Sieve Shaker (Model SB5W) (Fig 1A). For clusterbean, sieves

of 1.60, 1.70, 1.80, 1.90, 2.00, 2.10 and 2.20 mm (slotted) were used, whereas for dhaincha, sieves of 1.50, 1.60, 1.70, 1.80, 1.90, 2.00, 2.10 and 2.20 mm (slotted) were tested (Fig 1B). A 250 g unprocessed seed sample was sieved for 3-5 minutes at a shaking frequency of 25-30 strokes per minute. Seeds retained on each sieve were collected separately and evaluated for seed recovery and quality parameters. The grading screen retaining the maximum quantity of seed while maintaining superior seed quality standards was considered as the optimum sieve size.

Seeds retained on each sieve were evaluated for important seed quality parameters such as seed recovery (%), seed dimensions (length and breadth in mm), first count germination (%), final germination (%), physical purity (%), 1000 seed weight (g) and moisture content (%). The sieve that retained the maximum seed recovery with seed quality parameters (above IMSCS) was identified as the optimum sieve size for that particular variety. Seed size (length and Breadth) of the varieties were measured by digital vernier caliper (Fig 1C). The seeds retained on each sieve were weighed and the seed recovery was expressed in percentage using the following formula:

Seed recovery (%) =

$$\frac{\text{Weight of the seed retained on the sieve}}{\text{Total weight of the seed}} \times 100$$

For estimation of physical purity, the working sample was separated into purity components viz., pure seeds, weed seeds, seeds of other crops and inert matter. The physical purity percentage was then calculated using the following formula:

Physical purity (%) =

$$\frac{\text{Weight of pure seed}}{\text{Total weight of working sample}} \times 100$$

A total of 100 seeds received from each sieve, with three replications, were placed between adequately

moistened germination papers and incubated in a seed germinator at 25°C for both clusterbean and dhaincha. First count in clusterbean and dhaincha was taken on 5th day while the final germination count was recorded on 14th day in clusterbean and on 7th day in dhaincha. Only normal seedlings were considered for calculating germination percentage, following the guidelines of the International Seed Testing Association (ISTA, 2019). For 1000 seed weight determination, 1000 seeds retained on each sieve size were counted and weighed in triplicate using an electronic balance and the average seed weight was expressed in grams. Seed moisture content was determined using the hot air oven method. The weight of the empty container with its lid was recorded as M_1 . The seed samples were ground (coarse grinding), mixed thoroughly and 4-5 g of the sample was placed in the container (M_2). The oven was pre-heated to 130±1°C and the sample was dried for one hour. After drying, the lid was immediately placed on the container, which was then cooled in a desiccator for 30 to 45 minutes before being weighed again (M_3). Seed moisture content was calculated to one decimal place using the formula:

$$\text{SMC (\%)} = \frac{M_2 - M_3}{M_2 - M_1} \times 100$$

Where,

M_1 = Weight of the empty container with lid.

M_2 = Weight of container with lid and sample before drying.

M_3 = Weight of container with lid and sample after drying and cooling.

The collected data were statistically analyzed using a factorial completely randomized design (CRD), as per outlined (Panse and Sukhatme, 1985). Mean values were calculated across replications and the critical difference (CD) at the 5% significance level was determined using the online statistical tool OPSTAT (Sheoran, 2010).

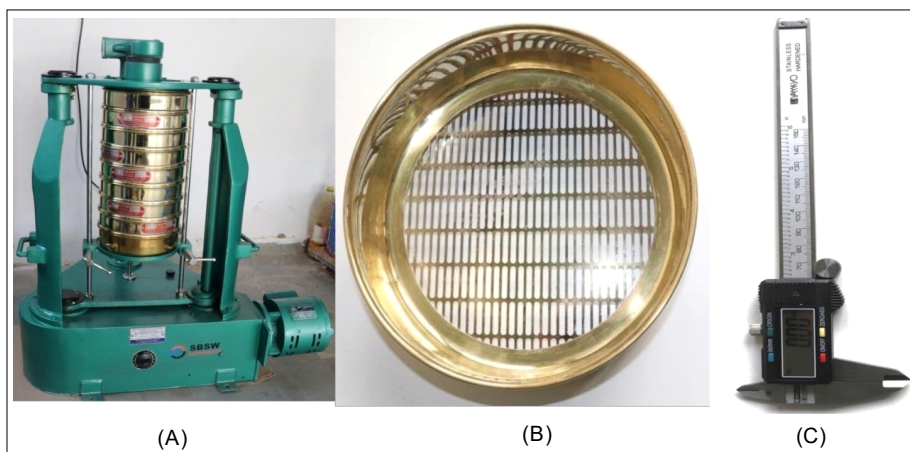


Fig 1: A) Sieve Shaker (Model no. SB5W); B) Sieve and C) Digital Vernier caliper.

RESULTS AND DISCUSSION

Effect of sieve size on seed recovery and seed quality parameters of clusterbean

The results revealed that sieve size significantly influenced seed recovery and seed quality parameters in clusterbean variety HG 365 (Table 1). Seed recovery increased significantly with decreasing sieve size, ranging from 85.70% in the 2.20 mm sieve to 99.30% in the 1.60 mm sieve. However, the improvement in recovery was accompanied by a decline in seed quality attributes. The largest seeds retained on the 2.20 mm sieve exhibited maximum seed length (4.09 mm), breadth (2.67 mm), first count (47.33%), germination (87.67%), physical purity (99.67%) and 1000 seed weight (27.45 g). A progressive reduction in these parameters was observed with decreasing sieve size, indicating that smaller sieves retained relatively undersized and less vigorous seeds. Although the 1.60 to 1.90 mm sieves recorded higher seed recovery (98.61-99.30%), germination declined below the minimum IMSCS standard of 75%, thus making them unsuitable for certified seed processing. The 2.00 mm sieve provided an optimum balance between seed recovery (97.26%) and seed quality, recording 76.67% germination and 98.78% physical purity, both meeting IMSCS requirements. Moisture content remained statistically non-significant across sieve sizes. Therefore, the 2.00 mm

slotted sieve was found to be most suitable for processing clusterbean variety HG 365.

A similar trend was observed in clusterbean variety HG 2-20 (Table 2). Seed recovery increased significantly as sieve size decreased, varying from 72.45% in the 2.20 mm sieve to 97.89% in the 1.60 mm sieve. The seeds retained on larger sieves were comparatively bolder and possessed superior quality characteristics. Maximum seed length (4.13 mm), breadth (2.80 mm), first count (48.00%), germination (88.33%), physical purity (100%) and 1000-seed weight (30.25 g) were recorded in the 2.20 mm sieve. Reduction in sieve size resulted in a gradual decline in all quality parameters. Although smaller sieves increased seed recovery, germination dropped below the IMSCS standard at sieve sizes smaller than 2.00 mm. The 2.00 mm sieve recorded 90.34% seed recovery along with 81.33% germination and 99.38% physical purity, thereby fulfilling certification standards while minimizing seed loss during processing. Moisture content was not significantly affected by sieve size. Hence, the 2.00 mm slotted sieve was identified as the optimum grading screen for clusterbean variety HG 2-20.

Effect of sieve size on seed recovery and seed quality parameters of *Sesbania aculeata*

Significant differences among sieve sizes were also observed for seed recovery and quality parameters in

Table 1: Effect of sieve sizes on seed recovery and seed quality parameter during processing of clusterbean variety HG 365.

Sieve sizes (s) (mm)	Recovery (%)	Length (mm)	Breadth (mm)	First count (%)	Germination (%)	Physical purity (%)	1000 seed weight (g)	Moisture content (%)
2.2	85.70	4.09	2.67	47.33	87.67	99.67	27.45	7.90
2.1	86.43	3.85	2.47	41.00	81.00	99.33	24.03	7.80
2.0	97.26	3.84	2.29	37.00	76.67	98.78	22.70	7.83
1.9	98.61	3.81	2.16	31.00	71.00	97.98	22.44	7.90
1.8	98.69	3.58	2.07	16.00	57.00	97.01	21.29	7.90
1.7	98.91	3.21	1.88	7.00	47.00	92.24	20.88	7.83
1.6	99.30	3.03	1.86	3.33	42.00	88.46	18.47	7.93
SE _{mt}	0.029	0.003	0.004	0.917	1.148	0.317	0.051	0.072
C.D. (P=0.05)	0.088	0.010	0.012	2.809	3.515	0.972	0.157	N.S.

s- Slotted.

Table 2: Effect of sieve sizes on seed recovery and seed quality parameter during processing of clusterbean variety HG 2-20.

Sieve sizes (s) (mm)	Recovery (%)	Length (mm)	Breadth (mm)	First count (%)	Germination (%)	Physical purity (%)	1000 seed weight (g)	Moisture content (%)
2.2	72.45	4.13	2.80	48.00	88.33	100.00	30.25	7.47
2.1	73.17	3.88	2.65	45.33	85.33	99.33	25.37	7.30
2.0	90.34	3.82	2.42	40.67	81.33	99.38	23.40	7.43
1.9	95.58	3.76	2.15	34.00	75.00	97.92	19.19	7.43
1.8	95.89	3.40	1.97	29.33	69.67	97.88	19.06	7.50
1.7	96.35	3.34	1.95	24.33	65.67	97.22	13.88	7.40
1.6	97.89	3.01	1.58	19.00	59.67	95.78	13.16	7.50
SE _{mt}	0.092	0.011	0.006	0.701	1.00	0.248	0.015	0.044
C.D. (P=0.05)	0.280	0.032	0.018	2.148	3.063	0.758	0.047	N.S.

s- Slotted.

dhaincha variety DH 1 (Table 3). Seed recovery increased significantly with decreasing sieve size, from only 3.76% in the 2.20 mm sieve to 89.02% in the 1.50 mm sieve. Seeds retained on larger sieves were larger in size and possessed superior physiological quality. The highest first count (46.00%), germination (87.00%), physical purity (100%) and 1000 seed weight (20.06 g) were recorded in the 2.20 mm sieve.

However, the very low recovery obtained with larger sieve sizes makes them uneconomic for commercial seed processing. As sieve size decreased, seed recovery improved substantially, although seed quality parameters showed a gradual decline. The 1.50 mm sieve retained the maximum quantity of seed (89.02%) while maintaining germination (75.67%) and physical purity (98.17%) above IMSCS standards. Moisture content remained unaffected by grading treatments. Therefore, the 1.50 mm slotted sieve was found to be the most suitable sieve size for processing dhaincha variety DH 1. Overall, the results indicate a clear inverse relationship between seed recovery and seed quality. Larger sieves retained bolder seeds with superior vigour, germination and seed weight but resulted in lower recovery, whereas smaller sieves improved recovery by retaining a greater proportion of seed, including undersized seeds. Consequently, varietal standardization of grading screens is essential to achieve an optimum balance between seed recovery and seed quality. Based on IMSCS standards and processing efficiency, the 2.00 mm slotted sieve was found optimum for clusterbean varieties HG 365 and HG 2-20, whereas the 1.50 mm slotted sieve was most suitable for dhaincha variety DH 1.

The sieve size of 2.7 mm was found optimum for grading black gram varieties ADT 6 and VBN 10 seeds, instead of the currently recommended 2.8 mm sieve while for varieties VBN 8 and VBN 11, a 3.0 mm sieve was found optimum (Ramanadane and Gnanasekar, 2025). In green gram (Kumar *et al.*, 2014) and in red gram (Ganiger *et al.*, 2016) also supported the results and recommended different sieve sizes for different varieties for better seed recovery with seed quality parameters above IMSCS.

To obtain the maximum quantity of quality seeds in Amaranthus CO 2, the seeds should be graded using a mechanical seed shaker for 5 minutes with a sieve size of BSS 22 × 22 (Pavithra *et al.*, 2021).

Sieve size of 2.2 mm (round) screen aperture was found to be the optimal size for seed processing of the sunhemp local variety, as it resulted in higher seed recovery without compromising seed quality parameters (Thimmanna *et al.*, 2013). Similarly a study was conducted to standardize sieve sizes for dhaincha (*Sesbania aculeata*) seed grading and found 2.00 mm sieve was most suitable for grading the seeds (Raghuraman *et al.*, 2024). However, in the present study, a 1.50 mm sieve size was found to be optimum for grading the DH-1 variety. This variation in the optimum sieve size may be attributed to differences in varietal characteristics, particularly seed size, seed shape and test weight among the genotypes used for grading. For wheat seed grading, 2.75 mm sieve resulted in maximum seed recovery having physical purity and germination percentage in both AAIW6 and AAIW9 wheat genotypes (Rai *et al.*, 2025). Similarly, a study was carried out to standardize screen size for grading French bean varieties such as Arka Komal and Burpee Stringless. They found that replacing the currently recommended 4.75 mm (slotted) screen with a 4.50 mm (slotted) screen for Arka Komal could save 17-18% more quality seeds. However, for Burpee Stringless, the existing 4.75 mm (slotted) screen was found to be suitable for continued use (Vishwanath *et al.*, 2025).

It can therefore be said from the present study that seed grading is an exercise which requires a balance between seed recovery and seed quality where larger sieve sizes retained mostly bold, heavy and vigorous seeds at the expense of low recovery levels. Smaller sieve sizes on the other hand increased recovery levels by retaining a higher percentage of seeds from the seed lot, some of which were undersized and low vigor. Thus, the ideal grading screen will be one which ensures the maximum level of recovery of seed while at the same time meeting the minimum required seed quality standards. From the

Table 3: Effect of sieve sizes on seed recovery and seed quality parameter during processing of Dhaincha variety DH 1.

Sieve sizes (s) (mm)	Recovery (%)	Length (mm)	Breadth (mm)	First count (%)	Germination (%)	Physical purity (%)	1000 seed weight (g)	Moisture content (%)
2.2	3.76	4.14	2.39	46.00	87.00	100.00	20.06	8.07
2.1	4.26	4.16	2.41	41.67	84.00	99.67	19.27	8.03
2.0	37.21	3.76	2.14	38.67	82.33	99.82	17.85	7.93
1.9	54.15	3.71	2.10	36.00	81.00	99.36	17.22	8.03
1.8	55.22	3.69	2.13	33.00	80.00	99.09	16.96	7.93
1.7	58.96	3.64	2.17	30.67	78.33	98.84	15.89	8.10
1.6	71.98	3.38	1.86	29.00	77.00	98.28	15.07	8.03
1.5	89.02	2.77	1.69	27.33	75.67	98.17	13.96	8.07
SE _{mt}	0.082	0.005	0.043	0.799	0.677	0.120	0.009	0.059
C.D. (P=0.05)	0.249	0.014	0.131	2.417	2.047	0.364	0.027	N.S.

s- slotted.

findings, it emerges that 2.00 mm slotted sieve is the best sieve for clusterbean varieties HG 365 and HG 2-20 whereas 1.50 mm slotted sieve is the optimum for dhaincha variety DH 1.

CONCLUSION

The study highlights the necessity of varietal standardization of grading sieves to achieve an optimum balance between seed recovery and seed quality. Adoption of a 2.00 mm slotted sieve for clusterbean varieties HG 365 and HG 2-20 and a 1.50 mm slotted sieve for dhaincha variety DH 1 can improve seed processing efficiency, reduce processing losses, maximize the availability of quality seed and enhance the economic viability of seed production programmes.

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Conflict of interest

The authors declare no conflict of interest. This research received no external funding. The study was conducted independently and no funding or sponsorship influenced the study design, data collection, analysis, manuscript preparation or the decision to publish.

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