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Standardization of Sieve Sizes for Maximum Seed Recovery with Better Quality in Wheat (*Triticum aestivum* L.) and Green gram (*Vigna radiata*)

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ABSTRACT: The present investigation was conducted to standardize appropriate sieve sizes for efficient seed processing in three wheat (*Triticum aestivum* L.) varieties (WH 1309, WH 1402 and DBW 303) and three green gram (*Vigna radiata* L.) varieties (MH 1762, MH 1142 and MH 421). Raw seed lots of each variety were processed using a Sieve Shaker (Model SB5W) fitted with slotted sieves of 1.60, 1.70, 1.80, 2.10, 2.30, 2.40 and 2.50 mm for wheat and 2.70, 2.80, 2.90, 3.00, 3.10, 3.20, 3.30 and 3.40 mm for green gram. Seeds retained on each sieve were evaluated for seed recovery and seed quality parameters. The results revealed that the 2.10 mm slotted sieve provided the highest seed recovery while maintaining seed quality parameters above the Indian Minimum Seed Certification Standards (IMSCS) for all three wheat varieties. Similarly, the 2.70 mm slotted sieve recorded the highest seed recovery with seed quality parameters meeting IMSCS requirements in all three green gram varieties. The findings indicate that a 2.10 mm slotted sieve is the most suitable for processing wheat varieties WH 1309, WH 1402 and DBW 303, whereas a 2.70 mm slotted sieve is optimum for processing green gram varieties MH 1762, MH 1142 and MH 421. Adoption of these standardized sieve sizes will enable higher seed recovery without compromising seed quality, thereby improving the efficiency of seed processing and facilitating the development of crop-specific seed grading standards.

Keywords: Seed processing, Recovery, Sieve size, *Triticum aestivum, Vigna radiata*

INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the most important staple food crops globally and plays a crucial role in ensuring food security, particularly in India. *Vigna radiata*, commonly known as mungbean or green gram, is a vital legume crop belonging to the family Fabaceae (Leguminosae). It is a short-duration crop (about 60–70 days) known for its high nutritional value, especially its rich content of protein (approximately 24%), carbohydrates, vitamins, and essential minerals. It plays a crucial role in vegetarian diets and serves as an excellent plant-based protein source. The crop is valued not only for its seeds, which are used in various culinary preparations (such as sprouts, soups and dal), but also for its role in sustainable agriculture due to its nitrogen-fixing ability, which improves soil fertility. Mungbean is typically grown during the kharif (monsoon) and summer seasons, depending on the region. It is well adapted to semi-arid conditions and can thrive in a wide range of soils, though well-drained loamy soils are ideal for optimal growth. With the continuous release and cultivation of a large number of wheat varieties, each exhibiting differences in seed shape, size, and test weight, the need for efficient seed processing practices has become increasingly significant. In seed production, especially when crops are harvested using combine harvesters or threshers, the resulting raw seed lots often contain considerable amounts of inert matter and do not meet the required physical purity standards. According to the Indian Minimum Seed Certification Standards [1], a minimum of 98% physical purity is mandated for most field crops. However, this level of purity is rarely achieved directly after mechanical threshing, necessitating further processing to clean and grade the seed. Seed processing is therefore an essential operation aimed at improving the quality of seeds by removing impurities and segregating seeds based on size, shape, and weight. Seed size impacts the quality of the reserve food material available for the emerging seedling. Small and shriveled seeds contain less stored food, resulting in less vigorous plants compared to bold and plump seeds. A significant amount of seed is lost during processing due to screen rejections of undersized seeds. To minimize this loss and enhance the availability of quality seed material, it is essential to determine the optimal screen size and screen types that can maximize both seed recovery and quality. A critical component of this process is seed grading, which involves the use of specific sieve sizes to separate out undersized seeds and foreign matter. Grading, which involves separating high-quality seeds from poor quality ones, is a fundamental post-harvest operation in seed crop production [1]. Given the varietal differences in seed morphology, using a standard sieve size across all varieties may result in either retention of impurities or loss of good quality seed along with reject material. Inappropriate sieve sizes can compromise seed recovery and seed quality, ultimately affecting the efficiency and economics of seed production. As per the Indian Minimum Seed Certification Standards (IMSCS), slotted sieves of 1.80, 2.10 mm and 2.30 mm are recommended for grading wheat varieties, while 2.80 mm and 3.20 mm sieves are advised for mungbean varieties. However, considerable variation in seed size has been observed between older and newly released wheat varieties. To ensure the production of high-quality seeds and to comply with the physical purity standards set by IMSCS, it becomes necessary to adjust sieve sizes during seed processing. Hence, this study was undertaken to identify the optimum sieve sizes required for efficient grading of wheat seed varieties. The objective was to improve seed recovery and physical quality by standardizing sieve sizes based on varietal seed characteristics, thereby enhancing the overall seed processing system for wheat.

MATERIAL AND METHODS

The experiment was carried out using raw seeds of three wheat varieties *viz.,* WH 1309, WH 1402 and DBW 303 and three green gram (mungbean) varieties *viz.,* MH 1762, MH 1142 and MH 421 with the objective of standardizing sieve sizes for efficient seed processing. The raw seed lots were processed using a Sieve Shaker (Model No. SB5W) operated for 5 minutes, with a tapping frequency of 170–180 taps per minute and a circulation shaking frequency of 350–360 shakes per minute (Figure 1). For wheat, a range of slotted sieve sizes (in mm) was used: the recommended sieves as per the Indian Minimum Seed Certification Standards (IMSCS) *i.e.,* 1.80, 2.10 and 2.30 mm; two sieves larger than the recommended size - 2.40 mm and 2.50 mm and two smaller sieve sizes-1.70 mm and 1.60 mm. Similarly, for green gram, the sieve sizes included the IMSCS-

Figure 1. Sieve Shaker (Model No. SB5W)

recommended 2.80 mm and 3.20 mm (slotted), two sieves above the recommended sizes-2.90 mm and 3.30 mm and one sieve below 2.70 mm. Seeds retained on each sieve were evaluated for key seed quality parameters, including 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 highest proportion of seeds while maintaining superior quality characteristics 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 (Figure 2). The seeds retained on each sieve were weighed, and the seed recovery was expressed as a percentage using the following formula:

$$\text{Seed recovery (\%)} = \frac{\text{Weight of the seed retained on the sieve}}{\text{Total weight of the seed}} \times 100$$

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:

$$\text{Physical purity (\%)} = \frac{\text{Weight of pure seed}}{\text{Total weight of working sample}} \times 100$$

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

Figure 2. Vernier Calipaer

germination papers and incubated in a seed germinator at 20°C for wheat and 25°C for mungbean. First count in wheat was recorded on 4th day while in green gram first count was taken on 5th day. The final germination count was recorded on the 8th day for wheat and the 7th day for green gram. Only normal seedlings were considered for calculating germination percentage, following the guidelines of the International Seed Testing Association [2]. For 1000 seed weight determination, 1000 seeds from 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 sample was ground (fine grinding for wheat and coarse grinding for green gram), 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 (SMC) was calculated to one decimal place using the formula:

$$SMC\ (\%) = [(M_2 - M_3) / (M_2 - M_1)] \times 100$$

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 [3]. Mean values were calculated across replications, and the critical difference (CD) at the 5% significance level was determined using the online statistical tool OPSTAT [4].

RESULTS AND DISCUSSION

The effect of different sieve sizes on seed recovery and seed quality parameters varied significantly among the wheat and green gram varieties studied. The data clearly highlight that sieve size plays a crucial role in optimizing both seed recovery and quality, influencing parameters such as seed size, purity, germination, vigour, and 1000-seed weight. Across all three wheat varieties (WH 1309, WH 1402 and DBW 303), larger sieve sizes (2.5 mm to 2.3 mm) retained bolder seeds, which were superior in physical and physiological quality but lower in recovery percentage. In contrast, smaller sieves (2.1 mm to 1.6 mm) resulted in higher recovery but lower seed quality. For WH 1309, maximum seed quality was observed with 2.5 mm sieve, with 94% germination, 99.67% physical purity, 41.73 g thousand seed weight, and 66% first count. However, seed recovery was lowest (43.63%) at this size. Conversely, the 1.6 mm sieve resulted in maximum recovery (97.74%) but had the lowest germination (88.67%), first count (57.0%), and thousand seed weight (21.05 g). In WH 1402, similar trends were evident. The 2.5 mm sieve provided 92% germination, 99.67% purity, and the highest thousand seed weight (48.71 g), though recovery was only 49.73%. Maximum recovery (92.07%) occurred at 1.6 mm, but seed quality dropped sharply (germination: 87.33%, thousand seed weight: 18.19 g). For DBW 303, the boldest seed fraction from the 2.5 mm sieve exhibited 96.67% germination, 99.67% purity, and 47.52 g thousand seed weight, while the 1.6 mm sieve achieved the highest recovery (99.74%) with reduced seed quality (germination: 95.33%, thousand seed weight: 22.12 g). In green gram, sieve sizes ranging from 3.4 mm to 2.7 mm were evaluated for three varieties:

Table 1. Effect of sieve sizes on seed recovery and seed quality parameter during processing of wheat variety WH 1309

Sieve Size (s)	Recovery (%)	Length (mm)	Breadth (mm)	First count (%)	Germination (%)	Physical purity (%)	1000 seed weight (g)	Moisture content (%)
2.5	43.63	6.25	3.36	66.00	94.00	99.67	41.73	8.77
2.4	63.22	6.14	3.32	65.67	94.67	99.33	40.28	8.87
2.3	75.43	5.97	3.21	64.33	94.00	98.67	37.67	8.90
2.1	93.61	5.87	2.97	64.33	95.00	98.00	34.96	8.97
1.8	97.43	5.73	2.85	63.00	92.67	97.33	24.88	9.00
1.7	97.52	5.65	2.67	60.67	90.67	96.67	24.70	9.03
1.6	97.74	5.52	2.33	57.00	88.67	95.33	21.05	9.07
SEm±	0.08	0.01	0.01	0.74	1.79	0.31	0.02	0.05
C.D. (P=0.05)	0.24	0.03	0.04	2.25	NS	0.95	0.07	0.14

Table 2. Effect of sieve sizes on seed recovery and seed quality parameter during processing of wheat variety WH 1402

Sieve Size (s)	Recovery (%)	Length (mm)	Breadth (mm)	First count (%)	Germination (%)	Physical purity (%)	1000 seed weight (g)	Moisture content (%)
2.5	49.73	6.58	3.50	63.33	92.00	99.67	48.71	8.93
2.4	56.63	6.32	3.48	62.67	93.33	99.33	41.64	9.00
2.3	65.52	6.21	3.16	62.00	94.33	99.00	40.53	9.03
2.1	83.84	6.08	3.10	61.67	90.67	98.67	35.85	9.07
1.8	89.56	5.87	2.68	60.67	89.67	97.67	29.38	9.07
1.7	90.50	5.79	2.71	59.33	90.67	97.67	23.16	9.13
1.6	92.07	5.57	2.35	54.67	87.33	96.33	18.19	9.20
SEm±	0.10	0.01	0.07	0.82	1.60	0.31	0.04	0.09
C.D. (P=0.05)	0.31	0.04	0.22	2.50	N.S.	0.95	0.13	N.S.

Table 3. Effect of sieve sizes on seed recovery and seed quality parameter during processing of wheat variety DBW 303

Sieve Size (s)	Recovery (%)	Length (mm)	Breadth (mm)	First count (%)	Germination (%)	Physical purity (%)	1000 seed weight (g)	Moisture content (%)
2.5	48.91	6.45	3.60	69.00	96.67	99.67	47.52	8.80
2.4	67.21	6.03	3.34	66.33	95.33	99.33	43.43	8.90
2.3	78.28	5.98	3.31	65.00	94.00	98.67	41.53	8.97
2.1	95.27	5.96	3.24	65.00	95.33	98.00	38.12	9.00
1.8	99.43	5.64	2.94	63.67	95.33	97.33	29.18	9.03
1.7	99.54	5.43	2.82	62.00	96.67	96.67	25.29	9.07
1.6	99.74	5.36	2.59	58.00	95.33	95.33	22.12	9.13
SEm±	0.03	0.01	0.01	0.56	0.87	0.31	0.04	0.05
C.D. (P=0.05)	0.09	0.05	0.03	1.73	N.S.	0.95	0.12	0.15

MH 1762, MH 1142, and MH 421. Larger sieves retained bold, high-quality seeds, while smaller sieves gave higher recovery but lower seed quality. For MH 1762, the boldest seeds (3.4 mm) had 95.33% germination, 100% purity and the highest thousand seed weight (48.21 g), though recovery was only 0.29%. Maximum recovery (69.99%) was obtained with the 2.7 mm sieve but with reduced germination (90%) and thousand seed weight (31.72 g). In MH 1142, the 3.4 mm sieve gave the best seed quality (88.67% germination, 100% purity, 49.76 g thousand seed weight), but recovery was only 0.32%. The highest recovery (89.69%) was at 2.7 mm sieve, accompanied by a decline in seed quality (germination: 91.33%, thousand seed weight: 31.44 g). Similarly, MH 421 showed best seed quality at 3.4 mm sieve (germination: 87.33%, thousand seed weight: 47.38 g, 100% purity), with a recovery of only 0.29%. The highest recovery (95.44%) at 2.7 mm sieve was associated with decreased seed quality (germination: 87.33%, thousand seed weight: 31.34 g).

Table 4. Effect of sieve sizes on seed recovery and seed quality parameter during processing of moongbean variety MH 1762

Sieve Size (s)	Recovery (%)	Length (mm)	Breadth (mm)	First count (%)	Germination (%)	Physical purity (%)	1000 seed weight (g)	Moisture content (%)
3.4	0.29	4.57	3.53	58.00	95.33	100.00	48.21	8.07
3.3	2.40	4.34	3.51	54.33	93.33	99.33	47.57	8.03
3.2	2.92	4.22	3.44	53.33	93.33	99.00	46.52	8.10
3.1	3.86	4.18	3.38	52.00	92.67	98.67	45.83	8.03
3.0	18.72	3.97	3.03	52.00	92.67	98.67	39.97	8.10
2.9	32.96	3.95	3.01	51.00	91.33	98.67	32.88	8.13
2.8	51.93	3.92	2.99	49.67	90.67	98.67	31.76	8.17
2.7	69.99	3.87	2.98	49.00	90.00	98.33	31.72	8.17
SEm±	0.08	0.01	0.01	0.71	1.55	0.35	0.02	0.05
C.D. (P=0.05)	0.24	0.03	0.03	2.14	N.S.	N.S.	0.05	N.S.

Table 5. Effect of sieve sizes on seed recovery and seed quality parameter during processing of moongbean variety MH 1142

Sieve Size (s)	Recovery (%)	Length (mm)	Breadth (mm)	First count (%)	Germination (%)	Physical purity (%)	1000 seed weight (g)	Moisture content (%)
3.4	0.32	4.65	3.58	49.00	88.67	100.00	49.76	8.13
3.3	5.79	4.61	3.51	48.67	88.00	99.33	49.19	8.07
3.2	6.86	4.57	3.48	49.67	90.00	99.67	45.29	8.03
3.1	14.80	4.56	3.44	48.00	89.33	99.00	42.58	8.03
3.0	52.25	4.51	3.26	49.00	91.33	98.67	39.85	8.10
2.9	65.31	4.16	3.08	50.33	88.67	98.67	35.87	8.17
2.8	81.03	4.15	2.97	48.67	91.33	98.33	33.87	8.20
2.7	89.69	4.09	2.90	49.33	91.33	98.00	31.44	8.20
SEm±	0.16	0.04	0.01	0.49	1.47	0.26	0.02	0.05
C.D. (P=0.05)	0.48	0.13	0.02	N.S.	N.S.	0.80	0.05	N.S.

Table 6. Effect of sieve sizes on seed recovery and seed quality parameter during processing of moongbean variety MH 421

Sieve Size (s)	Recovery (%)	Length (mm)	Breadth (mm)	First count (%)	Germination (%)	Physical purity (%)	1000 seed weight (g)	Moisture content (%)
3.4	0.29	4.61	3.45	49.00	87.33	100.00	47.38	8.03
3.3	6.48	4.58	3.43	48.33	86.67	100.00	46.85	7.97
3.2	7.14	4.54	3.42	49.33	86.67	99.67	46.15	7.93
3.1	14.25	4.52	3.24	48.00	89.33	99.00	45.84	8.00
3.0	63.45	4.48	3.07	48.67	91.67	99.00	41.08	8.10
2.9	83.45	4.26	2.92	50.00	90.33	98.67	37.33	8.10
2.8	91.10	4.24	2.89	48.67	87.33	98.67	32.04	8.17
2.7	95.44	4.19	2.88	49.00	87.33	98.33	31.34	8.17
SEm±	0.15	0.01	0.01	0.59	1.90	0.24	0.02	0.08
C.D. (P=0.05)	0.45	0.03	0.03	N.S.	N.S.	0.71	0.06	N.S.

Across all three wheat varieties (WH 1309, WH 1402 and DBW 303), a consistent trend was observed where larger sieve sizes (2.5–2.3 mm) yielded lower recovery percentages but higher seed quality in terms of physical purity, 1000 seed weight, and germination. Specifically, the 2.5 mm sieve, although associated with the lowest recovery (43.63% in WH 1309, 49.73% in WH 1402, and 48.91% in DBW 303), provided the highest 1000 seed weight, seed size and first count germination, reflecting better physiological vigour. In contrast, smaller sieve sizes (1.6–1.8 mm) exhibited the highest recovery percentages (up to ~99%), but with a notable reduction in seed size, weight, and germination performance, indicating the inclusion of undersized and possibly immature or shriveled seeds. In green gram, similar trends were observed across all three varieties (MH 1762, MH 1142 and MH 421). The larger sieve sizes (3.4–3.2 mm) consistently resulted in the highest seed quality (100%

physical purity and superior 1000 seed weight), though with very low recovery percentages (<7%). As sieve size decreased to 2.9–2.7 mm, recovery significantly increased (up to ~95% in MH 421), albeit with marginal reductions in physical purity, seed weight, and germination. Unlike wheat, the differences in germination across sieve sizes in green gram were not statistically significant, though physical parameters such as seed length and breadth declined with decreasing sieve size. The sieve size of 3.0 mm in MH 1142 and 2.9 mm in MH 421 appeared to provide a suitable compromise between quality and recovery. 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 [5]. In green gram [6] and in red gram [7] 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 [8]. Sieve size of 2.2 mm (r) screen aperture was found to be the optimal size for seed processing of the sunnhemp local variety, as it resulted in higher seed recovery without compromising seed quality parameters [9]. Similarly sieve size of 2.00 mm (BSS 8) was reported optimum for grading of dhaincha seeds [10]. A 2.75 mm sieve resulted in better seed recovery, higher physical purity, improved germination percentage, and better first count in AAIW6 and AAIW9 wheat genotypes [11]. 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 [12].

CONCLUSION

This study confirms that sieve size is a critical determinant in seed grading operations, directly affecting both seed recovery efficiency and quality parameters. While larger sieves ensure better quality by removing undersized and low vigour seeds, they lead to reduced seed recovery. Conversely, smaller sieves improve recovery but may compromise seed quality due to the inclusion of inferior seeds. The study concludes that wheat varieties WH 1309, WH 1402 and DBW 303 are optimally graded using a 2.1 mm (s) sieve, while moongbean varieties MH 1762, MH 1142 and MH 421 are best graded with a 2.7 mm (s) sieve. These findings will support the development of variety-specific sieve standards and enhance seed processing efficiency.

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