

Optimization of Sieve Size for Enhancing Seed Quality and Germination in Wheat (*Triticum aestivum* L.) Genotypes AAIW6 and AAIW9

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ABSTRACT: Wheat seeds collected from the field often vary in size, physical purity, and viability. To ensure uniformity in seed lots, cleaning and grading using seed processing equipment is essential. However, standard sieve sizes (2.10 mm and 2.30 mm) recommended by the Indian Minimum Seed Certification Standards (IMSCS) may not be optimal for all wheat varieties, as seed size differs across cultivars. This study, conducted at All India Co-ordinated Research Project on Seed (Crops), Department of Genetics and Plant Breeding, SHUATS, Prayagraj, aimed to identify the most suitable sieve size for grading seeds of released wheat varieties. Results indicated that a 2.75 mm sieve provided superior seed recovery, physical purity, germination percentage, and first count for both AAIW6 and AAIW9 genotype.

Keywords: Wheat, AAIW6, AAIW9, sieve size, seedling parameters

INTRODUCTION

Wheat (*Triticum aestivum* L.), a major staple crop, plays a vital role in global food security by contributing significantly to human nutrition and caloric intake. [1]. Seed quality—particularly size and uniformity—is a key factor influencing germination, seedling vigor, and overall crop performance. Grading seeds using sieves of varying mesh sizes is a standard seed processing practice aimed at improving lot uniformity by removing undersized and less viable seeds. This process directly affects critical seedling parameters such as germination rate, vigor, root and shoot growth, and dry weight accumulation.

High-quality seeds, defined by their viability and physical and genetic purity, are essential for maximizing crop yields. As harvested seed lots are inherently heterogeneous, grading becomes a crucial post-harvest step to eliminate non-seed materials, foreign seeds, and low-quality seeds of the same species, thus enhancing planting value and marketability [2, 3, 4]. Research on seed size-based seed grading in relation to seed quality characteristics is necessary since the amount of food reserve in a seed is a fundamental prerequisite for its subsequent manifestation as germination, vigor, and final establishment in the field. Size grading is also necessary to produce a uniform or marketable seed lot.

Seed processing machines perform three essential operations: cleaning, scalping, and grading. Cleaning is accomplished using aspirators, which remove lightweight impurities from the seed mass. During scalping, larger debris is separated and directed to a separate outlet, while viable seeds fall through sieve perforations. In the final stage, smaller particles pass through finer sieve openings, and the remaining seeds proceed over the grading sieve for size-based separation.

For wheat, the Indian Minimum Seed Certification Standards (IMSCS) recommend using 2.10 mm and 2.30 mm slotted sieves for grading [5]. However, significant variations in seed size have been observed between newly released wheat varieties and older cultivars. To ensure the production of high-quality seeds and to meet the physical purity standards prescribed by IMSCS, it is essential to adjust the grading sieve size during seed processing. In this context, the present study was conducted to evaluate the efficiency of different sieve sizes and their impact on seedling parameters in wheat varieties.

MATERIAL AND METHODS

The experiment was conducted at Notified State Seed Testing Laboratory, Department of Genetics and Plant

Breeding, Sam Higginbottom University of Agriculture, Technology And Sciences, Prayagraj, India during July 2024 to February 2025. Freshly harvested seeds (unprocessed) of two wheat genotype SHUATS AAIW6 and SHUATS AAIW9 were collected and procured from the Department of Genetics and Plant Breeding. The specified amounts of raw seed material were sieved for three to five minutes at a rate of 25 to 30 strokes per minute using a sieve shaker. Seed material that has been kept after passing through each grading sieve were examined to determine its quality. The screen that keeps the most seeds of the highest quality was considered ideal and the following characteristics of seed quality were examined in the collected seeds after they were separated and weighed after being retained over each sieve.

The recovery percentage was calculated as the weight of seeds retained on each sieve divided by the total initial seed weight. Physical purity was determined by separating pure seeds from impurities and inert matter, expressed as a percentage of the total sample weight. Moisture content was measured using a hot air oven method at 103°C for 17 hours, following ISTA guidelines [6]. Seed size parameters, including length, breadth, and thickness, were measured using a digital vernier caliper on 100 randomly selected seeds per sieve size. The 1000-seed weight was determined by weighing eight replicates of 100 seeds and scaling to 1000 seeds, expressed in grams. Germination percentage was assessed using the paper towel method, with 400 seeds (four replicates of 100 seeds) per sieve size placed in a germination chamber at 20°C for 7 days, and the first count percentage was recorded on the fourth day. All observations, including recovery (%), first count (%), physical purity (%), moisture content (%), seed size (mm), germination (%), and 1000-seed weight (g), were recorded and analyzed statistically

Seed recovery (%) = (Weight of seeds retained in each sieve / Total weight of seeds) × 100

Physical purity (%) = (Weight of pure seed fraction / Total working sample weight) × 100

Pure live seed (%) = (Physical purity (%) × Germination (%)) / 100

Germination (%) = (Number of normal seedlings / Total number of seeds placed for germination) × 100

Statistical analysis

The process outlined by [7] was used to statistically

analyze the experiment's results utilizing a completely randomized design. The software program Grapes 1.1.0 was utilized to determine the crucial differences (CD) values at a 5% probability level, the crucial differences (CD) were computed.

RESULTS

The overall trait performance of the two genotypes, AAIW9 and AAIW6, showed notable differences across various parameters. In terms of recovery percentage, AAIW9 exhibited a higher mean (87.0%) compared to AAIW6 (85.0%), with a difference of 2.0%, indicating a statistically significant difference. For seed size traits, AAIW6 recorded a higher mean seed length (6.7 mm) than AAIW9 (6.1 mm), and the difference of 0.6 mm was statistically significant. However, for breadth, AAIW9 showed a slightly higher mean (2.6 mm) compared to AAIW6 (2.5 mm), with a difference of 0.1 mm, which was not statistically significant. Similarly, in terms of thickness, AAIW9 (3.1 mm) slightly surpassed AAIW6 (3.0 mm) by 0.1 mm; however, this difference was not significant. Regarding first count percentage, AAIW9 recorded a higher mean (92.3%) than AAIW6 (91.3%), but the difference of 1.0% was not statistically significant. In germination percentage, both AAIW9 and AAIW6 had identical means (91.5%), no significant difference was observed. Physical purity was the same for both genotypes (98.0%), and a CD of 0.00 confirmed no difference. For 1000 seed weight, AAIW6 had a higher mean (39.0 g) than AAIW9 (36.8 g), with a difference of 2.2 g; however, the difference was not significant. Lastly, in terms of moisture content, AAIW9 exhibited a slightly higher mean (6.7%) compared to AAIW6 (6.5%), with a difference of 0.2%, which was also not statistically significant (Table 1).

The results of the sieve size standardization experiment (Fig. 1) on wheat genotype (AAIW6 and AAIW9) revealed significant variations in seedling parameters across different sieve sizes (2.0 mm, 2.25 mm, 2.5 mm, and 2.75 mm). For AAIW6 at 2.0 mm, recovery was 89.00%, with seed breadth, length, and thickness measuring 2.22 mm, 6.30 mm, and 2.72 mm, respectively. The first count and germination percentages were 89.18% and 89.75%, respectively, with physical purity at 98%, test weight at 25.29 g, and moisture content at 6.5%. At 2.25 mm, recovery increased to 91.00%, with seed dimensions of 2.24 mm (breadth), 6.86 mm (length), and 3.34 mm (thickness), showing improved first count (90.12%) and germination (91.62%), alongside a test weight of 38.47

Table 1. Mean Performance of wheat varieties based on different seed grading parameters

Traits	Genotype	Mean	SE	CV (%)	Max	Min	CD
Recovery (%)	AAIW9	87.00	0.00	0.00	87.0	87.00	1.23
	AAIW6	85.00	0.00	0.00	85.00	85.00	
Seed Size L (mm)	AAIW9	6.10	0.22	7.07	6.60	5.50	0.70
	AAIW6	6.70	0.19	5.55	7.20	6.30	
Seed Size B (mm)	AAIW9	2.60	0.16	12.70	2.90	2.10	0.34
	AAIW6	2.50	0.13	10.55	2.80	2.20	
Seed Size T (mm)	AAIW9	3.10	0.19	11.97	3.40	2.60	0.41
	AAIW6	3.00	0.16	10.37	3.30	2.70	
First Count (%)	AAIW9	92.30	0.64	1.38	94.10	90.90	1.96
	AAIW6	91.30	0.95	2.08	93.50	89.20	
Germination (%)	AAIW9	91.50	0.58	1.28	92.80	90.00	1.18
	AAIW6	91.50	0.58	1.28	92.90	89.80	
Physical Purity (%)	AAIW9	98.00	0.00	0.00	98.00	98.00	0.00
	AAIW6	98.00	0.00	0.00	98.00	98.00	
1000 Seed Weight	AAIW9	36.80	4.60	24.98	46.50	24.40	11.16
	AAIW6	39.00	4.81	24.65	49.40	25.30	
Moisture Content (%)	AAIW9	6.70	0.06	1.88	6.80	6.50	0.26
	AAIW6	6.50	0.00	0.00	6.50	6.50	

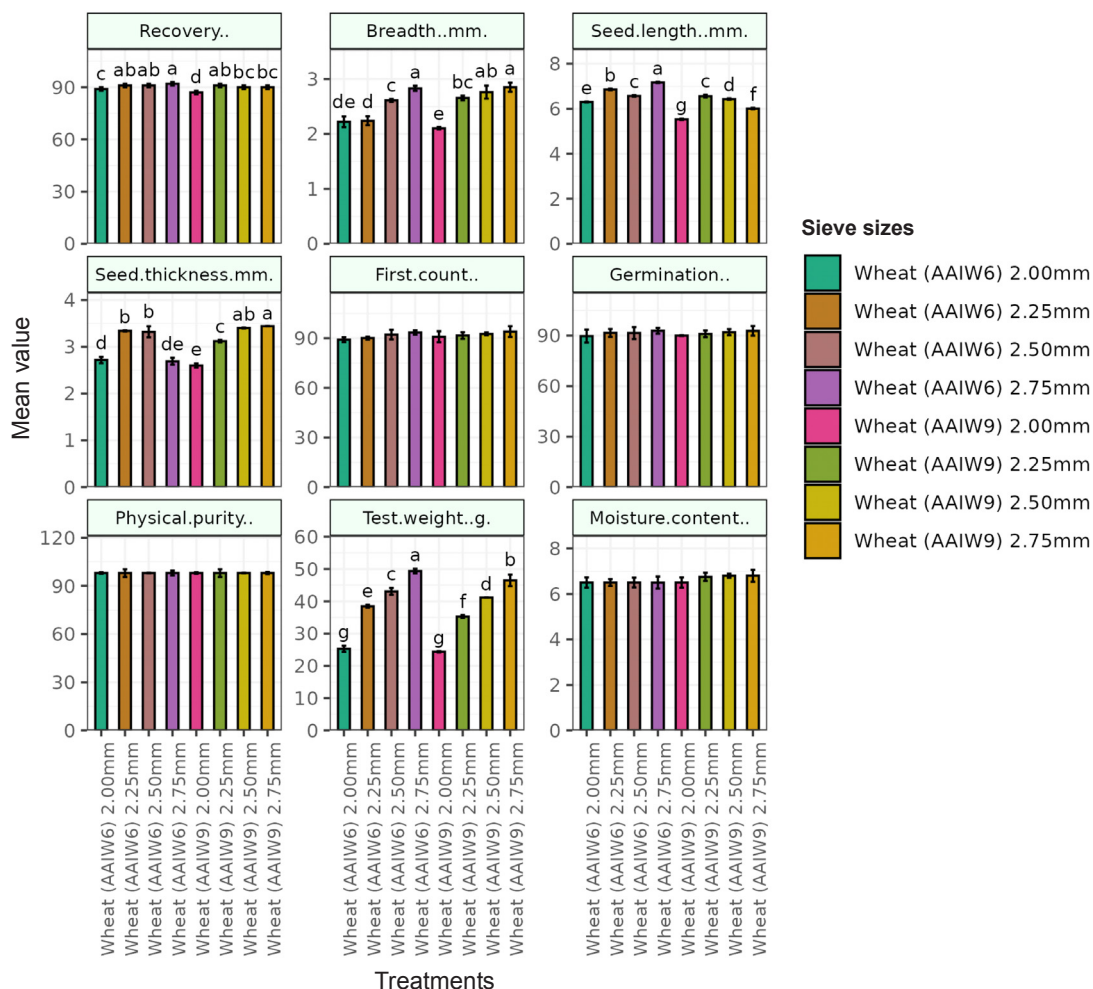
**Figure1.** Bar graph grouping of wheat varieties with various sieve sizes on different parameters of wheat genotype



Figure 2. Seed samples of AAIW6 and AAIW9



Figure 3. Evaluating physical purity

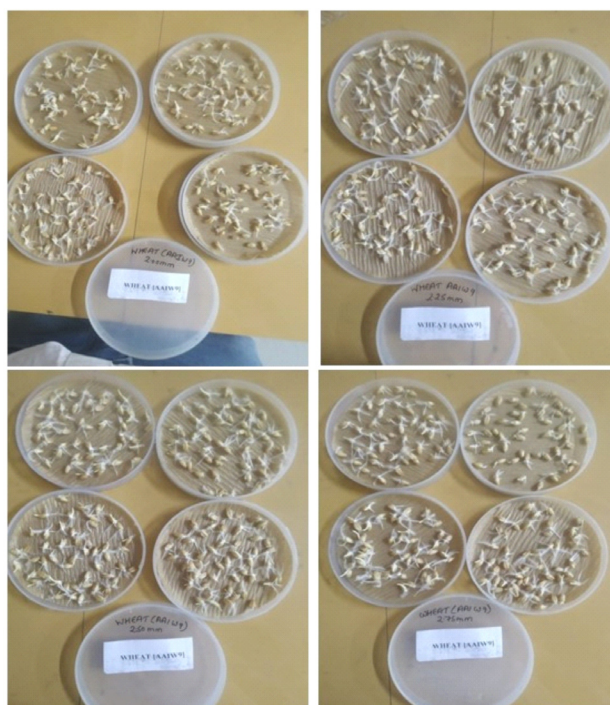
g. The 2.5 mm sieve yielded a recovery of 91.00%, with seed breadth at 2.61 mm, length at 6.57 mm, and thickness at 3.32 mm, achieving a first count of 92.25%, germination of 91.56%, and a test weight of 43.07 g. At 2.75 mm, recovery dropped to 87.00%, with seed dimensions of 2.10 mm, 5.53 mm, and 2.60 mm, respectively, and a first count of 90.93%, germination of 90%, test weight of 24.37 g, and moisture content of 6.5%. For AAIW9 at 2.5 mm, recovery was 90.00%, with seed breadth at 2.76 mm, length at 6.43 mm, and thickness at 3.40 mm, showing a first count of 92.68%, germination of 92.06%, and a test weight of 41.15 g. At 2.75 mm, recovery was highest at 92.00%, with seed dimensions of 2.85 mm, 6.01 mm, and 3.44 mm, respectively, achieving a first count of 94.06%, germination of 92.81%, and a test weight of 46.48 g, with moisture content at 6.8%.

DISCUSSION

The results of the sieve size standardization experiment on wheat genotype (AAIW6 and AAIW9) revealed notable trends in seed quality and seedling parameters across different sieve sizes, irrespective of genotype. Seed



(a)



(b)

Figure 4. Germination of (a) AAIW6 and (b) AAIW9 seeds after grading from different sieve sizes

recovery increased with a decrease in sieve size, with the highest recovery of 91.00% observed at 2.25 mm and 2.5 mm for AAIW6, compared to 87.00% at 2.75 mm.

This trend is consistent with findings in green gram [8] and in wheat [9] varieties WH-711, PBW-502, HD-2967 and WH-283, where a 2.2 mm sieve size achieved maximum recoveries of 94.1%, 91.3%, 92.7%, and 92.7%, respectively, with a 2.40 mm sieve being optimal for WH-283. However, this increase in recovery with smaller sieves often compromises seed quality, as smaller seeds may include underdeveloped or less viable ones, impacting seedling performance.

In contrast, physical purity, seed size (length, breadth, and thickness), 1000-seed weight, germination percentage, and first count improved with an increase in sieve size. For example, AAIW9 at 2.75 mm showed the highest germination (92.81%), first count (94.06%), and test weight (46.48 g), with larger seed dimensions (breadth: 2.85 mm, length: 6.01 mm, thickness: 3.44 mm) compared to smaller sieve sizes. Physical purity remained high at 98% across all sizes, but the proportion of impurities decreased with larger sieves, likely due to the exclusion of smaller, underdeveloped seeds and inert matter. This aligns [9], who reported physical purities of 98.8% to 99.7% with larger sieves (2.2 mm and 2.40 mm) in wheat, meeting Indian Minimum Seed Certification Standards (IMSCS). The reduction in physical purity with smaller sieves, as observed in this study, may be attributed to a higher proportion of impurities, a finding in green gram [10].

The positive correlation between seed size and seed weight was evident, with 1000-seed weight increasing from 25.29 g at 2.0 mm to 46.48 g at 2.75 mm for AATW9, consistent with in green gram and red gram [8], in Indian mustard [11] and in sesame [12]. Recent wheat research by [13] further confirms this, noting that larger wheat seeds exhibit higher test weights, enhancing seedling vigor and yield potential due to greater nutrient reserves. The first count, germination percentage, and pure live seed percentage were also higher in larger seeds, as seen with AAIW9 at 2.75 mm (first count: 94.06%, germination: 92.81%), mirroring [13], who reported germination rates of 92% to 95% with 2.2 mm and 2.40 mm sieves. This improvement is attributed to larger seeds having mature embryos with greater food reserves and nutrients, providing physiological stamina [14] and increased redox enzyme activity, which breaks down complex reserves into soluble sugars [15].

The enhancement of seed quality parameters with increasing sieve size is supported in greengram [6] and in redgram [8], with [9] adding that larger sieves (2.2 mm

to 2.40 mm) optimized wheat seed quality while balancing recovery. However, the trade-off between recovery and quality necessitates variety-specific standardization, as smaller sieves maximize recovery but retain lower-quality seeds. This study, alongside recent wheat research, highlights the importance of tailoring sieve sizes, such as 2.75 mm for AAIW9 or 2.2 to 2.40 mm as per [9], to optimize seedling parameters and crop establishment in wheat.

Recent studies in other crops like French bean, where selecting appropriate screen sizes ensures effective separation of viable seeds from inert material, enhancing seed recovery and planting value has been reported [16]. Similarly, in teak [17], understanding the variability in seed number and fruit characteristics supported better processing and classification strategies. These studies underscore the importance of crop-specific grading standards to ensure uniformity, quality, and efficiency in seed production and processing systems. It is also important that mobile processing plants be made available in villages, for ensuring effective seed processing [18].

CONCLUSION

The study shows that both AAIW6 and AAIW9 seed lots had desirable germination and high seed quality. AAIW6 had slightly larger seeds and higher weight, while AAIW9 showed better recovery and first count germination. A 2.75 mm sieve size improved recovery, first count, and germination in both varieties, highlighting the importance of sieve size in optimizing seed quality and seedling vigor.

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