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Quality Improvement in Paddy Seeds during Seed Processing

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ABSTRACT

The improvement of paddy seed quality through basic processing machines comprising seed pre-cleaner, seed grader and a specific gravity separator was investigated. The product and rejects of these machines were evaluated for seed quality parameters. There was an enhancement in seed quality parameters after passing through the seed processing machines. The seed germination from reject outlet of processing machines ranged from 27.00% to 54.67%, which increased to 71.67%, whereas unprocessed seeds recorded a germination rate of 64.80%. There was an improvement by 12.56%, 21.32%, 28.19%, and 27.91% in 1000-seed weight, seedling dry weight, vigour index-I, and vigour index-II, respectively in processed seeds, compared to unprocessed seeds. All the seed quality parameters were significantly lower in reject samples. Principal component analysis (PCA) reveals that all the samples from rejects, except one, grouped into a single cluster. PCA reveal a close relationship between vigour index-II and 1000-seed weight with PC1. The results from the study indicate that seed processing is beneficial in removing low-quality seeds and improving seed quality at various processing stages. The selection of seeds up to specific gravity separator outlet 4 is beneficial for obtaining high-quality seeds in paddy.

Keywords: Paddy, Seed processing, Germination, Seed quality

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INTRODUCTION

Rice serves as the primary dietary staple for over three billion individuals globally, with a significant concentration in Asia, notably in countries like India. India is the second largest producer of the world followed by China (FAO, 2021). Despite witnessing substantial production and growth in India, the productivity of paddy has persisted at a relatively low level. This figure is considerably lower than the yields observed in several other nations such as Egypt, USA, Japan and China. The lower productivity of rice in India can be attributed to various factors, with one of the major reasons being the limited availability of quality seeds.

Quality seed plays a vital role in enhancing agricultural production and productivity (Yalamalle *et al*. 2020). The seed quality parameters include genetic purity, physical purity, viability, vigour, uniformity in seed size and seed health. The genetic purity and seed health can be managed by controlling the seed source and better management practices, whereas physical purity is maintained by seed processing. The harvested seed lot contains impurities like inert matter, weed seeds, immature and damaged seeds. These must be separated before selling the seeds (Doshi *et al*. 2013). The seed processing not only get rid of undesirable substances in seeds it also upgrades the seed lot by removing immature and light weight seeds, which are typically have low viability and vigour. In this study, the effect of seed processing machines i.e., pre-cleaner, screen grader and specific gravity separator in improving the quality parameters of seed lots was investigated.

MATERIALS AND METHODS

Seed Material

The seeds of the paddy variety PB 1847 were procured from the Seed Production Unit at ICAR-Indian Agricultural Research Institute, New Delhi, in January 2022. The initial quality of the seed materials was documented before processing. The seed moisture content at the time of processing was recorded at 14.2%.

Seed-processing machines

Seeds were processed using processing machinery manufactured by Osaw Agro Industries Private Limited, Ambala, Haryana. The machinery comprised a series of machines, starting with a pre-cleaner-cum-grader (PC), followed by a screen grader (SG), and ending with a specific gravity separator (SGS). After processing in each machine, the seeds were manually transferred to different machines. The pre-cleaner and screen grader employed an air screen machine, both equipped with features such as feed control, rotary scalper-cum-seed spreader, scalping screen, grading screen, and an aspiration system. The screen aperture sizes for the top and bottom screens in the pre-cleaner and screen grader adhered to the recommendations outlined in the Indian Minimum Seed Certification Standards (Trivedi and

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Gunasekaran, 2013).

1000 seed weight

Eight replicates of 100 seeds each were weighed, and the mean 1000-seed weight was calculated following the procedures outlined by ISTA 2021. Standard germination testing was performed using three replicates of 50 seeds each. Seeds were placed on two layers of crepe kraft germination paper. Germination was performed by the roll towel method. Seeds were kept in a walk-in germinator at a constant temperature of 25°C in the presence of continuous cool white light 4000K. The final count was made on the 14th day and normal seedling were counted for calculating germination percentage.

Seed Vigour Indices

Seed vigour was determined following the method outlined by Abdul-Baki and Anderson (1973). On the 14th day, ten randomly selected normal seedlings were chosen, and their lengths were measured. Subsequently, the same seedlings were dried at 60°C ± 1 until a constant weight was achieved. Seedling vigour index-I and Seedling vigour index-II ae per formula.

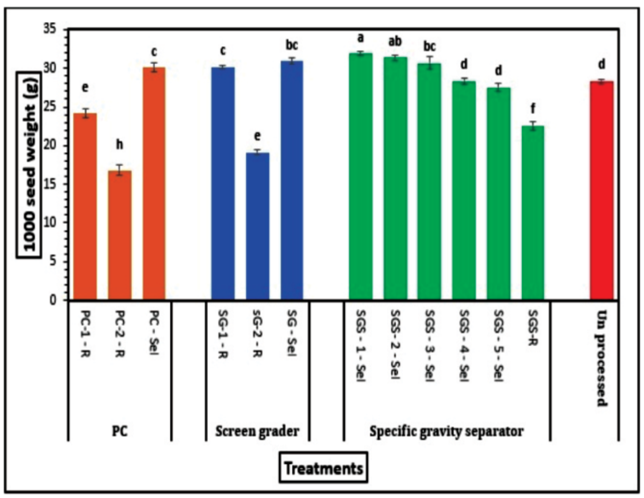

Fig. 1: Effect of seed processing on 1000 seed weight in paddy variety PBB-1847. Abbreviations: PC- pre-clean, SG- screen grader, SGS- specific gravity separator, R- reject, Sel- selected.

***Seed germination*:** The treatments had a significant effect on percent seed germination ($p < 0.01$) (Fig. 2-5). The germination of unprocessed seeds were 63.67%, with highest germination (71.67%) obtained from specific gravity separator select-1, which was statistically at par with specific gravity separator select-1-4, pre-clean select, screen grader select and un-processed seeds. The lowest germination (27.00%) was observed in pre-clean reject-2, which was statistically at par with screen grader reject-2. The improvement in seed germination due to seed processing has been previously reported by Kumar R (2016) in paddy. It is important to note that the germination obtained in all the samples in lower than Indian Minimum Seed Certification Standards (Trivedi and Gunasekaran, 2013). The reason could be due to the presence of dormancy in freshly harvested seeds. The low germination due to the presence of physiological dormancy in paddy has been previously reported (Shiratsuchi *et al.* 2017).

***Seedling length*:** The treatments had a significant effect on seedling length ($p < 0.01$) (Table 1). Among the treatments, the

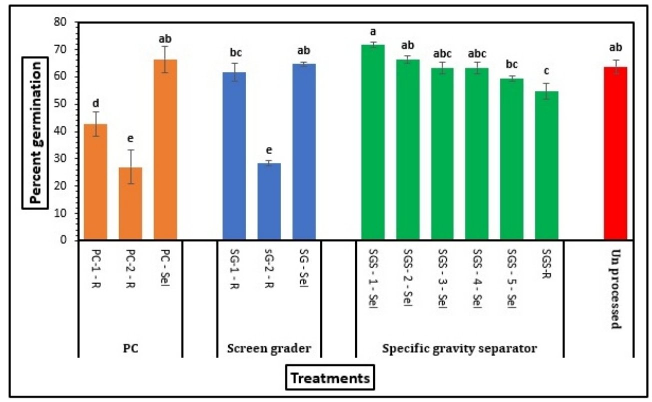

Fig. 2: Effect of seed processing on percent germination in paddy variety PBB-1847 seeds. Abbreviations: PC- pre-clean, SG- screen grader, SGS- specific gravity separator, R- reject, Sel- selected.

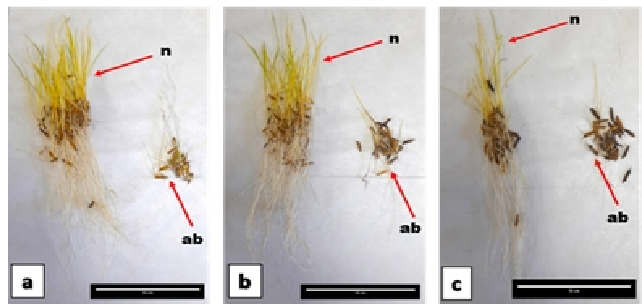

Fig. 3: Effect of pre-cleaning on seed germination in paddy variety PBB-1847 a) pre-clean select b) pre-clean reject-1 c) pre-clean reject-2.

Abbreviations: n- normal seedlings, ab- abnormal and dead seeds. Scale bar = 10 cm.

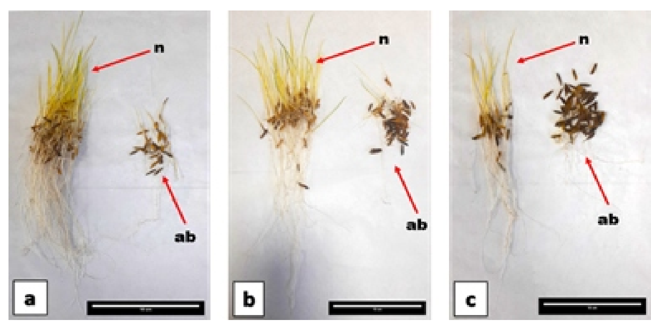

Fig. 4: Effect of screen grader on seed germination in paddy variety PBB-1847 a) screen grader select b) screen grader reject-1 c) screen grader reject-2.

Abbreviations: n- normal seedlings, ab- abnormal and dead seeds. Scale bar = 10 cm.

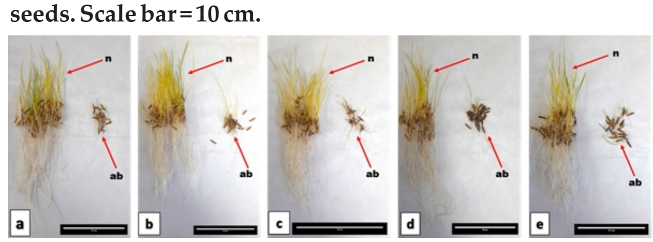

Fig. 5: Effect of specific grader on seed germination in paddy variety PBB-1847 a) specific gravity separator select-1 b) specific gravity separator select-2 c) specific gravity separator select-3 d) specific gravity separator select-3 e) specific gravity separator reject. Abbreviations: n- normal seedlings, ab- abnormal and dead seeds. Scale bar = 10 cm.

highest seedling length was recorded in specific gravity separator select-2 (23.52 cm), which was statistically at par with specific gravity separator select-1, 3 and 4, screen grader select, screen grader reject-1 and un-processed seeds. While the lowest seedling length was recorded in pre-clean reject-2 (15.48 cm), which was statistically similar to pre-clean reject-1 and specific gravity separator reject. Similar results were obtained by Doshi *et al.* (2013) and Kumar (2016) in wheat and paddy respectively, post-processing.

***Seedling dry weight*:** The treatments had a significant effect on seedling dry weight ($p < 0.01$) (Table 1). Among the treatments, the highest seedling dry weight was recorded in specific gravity separator select-2 (7.86 mg), which was statistically at par with specific gravity separator select-1 and 3. While the lowest seedling dry weight was recorded in pre-clean reject-2 (4.96 mg), which was statistically similar to screen grader reject-2, pre-clean reject-2 and specific gravity separator reject. The improvement in seed quality due to seed processing has been reported by Sinha *et al*. 2001 in wheat.

***Vigour index-II*:** The treatments had a significant effect on vigour index-I ($p < 0.01$) (Table 1). Among the treatments, the highest vigour index-I was recorded in specific gravity separator select-1 (1640.78), which was statistically at par with specific gravity separator select-2 and 4, pre-clean select and screen grader select. While the lowest vigour index-I was recorded in pre-clean reject-2 (419.87), which was statistically similar to screen grader reject-2.

***Vigour index-II*:** The treatments had a significant effect on vigour index-I ($p < 0.01$) (Table 1). Among the treatments, the highest vigour index-II was recorded in specific gravity separator select-1 (526.98), which was statistically at par with specific gravity separator select-2 and 3 and pre-clean select. While the lowest vigour index-II was recorded in pre-clean reject-2 (132.82), which was statistically similar to screen grader reject-2.

The seed quality parameters like seedling length, seedling dry weight, seed germination and vigour indices are closely linked to 1000 seed weight (Tomar *et al*. 2015, Zhang *et al*. 2017). In paddy Zhang *et al.* (2017) reported positive correlation between 1000 seed weight, seedling length and seedling dry weight. Chopra *et al.* 2002 reported positive correlation between 1000 seed weight and seed vigour in paddy. As evident from the study there was improvement in several seed quality parameters which could be attributed in enhanced 1000 seed weight. The seed processing also removes under sized and un-filled seeds, which typically have low seed quality (Tomar *et al*. 2015).

Principal Component analysis

The results of the PCA are presented in Table 2. Only one of the principal components had eigenvalues greater than 1.0, and it was the only one considered. According to a widely accepted rule of thumb, coefficients exceeding 0.3 are regarded as having a substantial effect. In the first principal component, all the coefficients were greater than 0.3. The first axis had

Table 1: Effect of seed processing on seed quality improvement in paddy variety PB-1847.

Treatments	Seedling length (cm)	Seedling dry weight (mg)	Vigour index-I	Vigour index-II
Pre-clean reject-1	15.71 de#	5.96 ef	777.58 de	252.06 e
Pre-clean reject-2	15.48 e	4.96 g	419.87 f	132.82 f
Pre-clean select	21.34 abc	6.75 cde	1426.41 abc	449.58 abcd
Mean pre-clean	**18.26**	**5.89**	**874.62**	**278.16**
Screen grader reject-1	21.02 abc	6.33 def	1298.89 bc	392.65 d
Screen grader reject-2	15.71 de	4.95 g	446.01 ef	139.99 f
Screen grader select	21. 34 abc	6.90 bcd	1399.74 abc	445.99 bcd
Mean screen grader	**19.46**	**6.06**	**1048.21**	**326.21**
Specific gravity separator select-1	22.92 ab	7.36 abc	1640.78 a	526.98 a
Specific gravity separator select-2	23.52 a	7.86 a	1563.11 ab	521.53 ab
Specific gravity separator select-3	20.43 abc	7.77 ab	1292.80 bc	492.05 abc
Specific gravity separator select-4	21.76 abc	6.83 cde	1380.78 abc	433.22 cd
Specific gravity separator select-5	18.73 bcde	6.93 bcd	1113.45 cd	410.82 d
Specific gravity separator reject	15.83 de	5.42 fg	866.75 d	297.37 e
Mean specific gravity separator	**20.53**	**7.03**	**1309.61**	**446.99**
Un-processed	19.99 abcd	6.48 cde	1279.96 bc	411.99 d
CD	0.83***	0.91***	338.53***	79.17***

#means sharing at least one common letter are not statistically significant. *** significant at $p < 0.01$.

eigenvalues of 5.65, accounting for 94.25% of the total variation percentage of variance due to seed processing. The first principal component (PC) was related to 1000-seed weight (0.41), seedling dry weight (0.40), percent germination (0.40), seedling length (0.40), seedling vigour index-I (0.42), and seedling vigour index-II (0.42). Additional insights were gained by plotting the PC scores for individual observations concerning the axes of PC1 and PC2 (Fig. 6). The PCA indicated a close relationship between vigour index-II and 1000-seed weight with PC1. Additionally, the reject samples (pre-clean reject-1, pre-clean reject-2 and screen grader reject-2) formed a closely grouped cluster.

Table 2: Eigen values, Percentage of variance, Cumulative percentage of variance and eigen vectors of seed quality traits.

Variables	PC1	PC2	PC3	PC4	PC5	PC6
1000 seed weight	0.41	-0.07	-0.05	-0.89	0.14	-0.02
Seedling dry weight	0.40	0.70	0.50	0.06	-0.28	-0.24
Percent germination	0.40	-0.62	0.22	0.12	-0.60	0.14
Seedling length	0.40	0.32	-0.74	0.15	-0.23	0.33
Vigour index-I	0.42	-0.22	-0.23	0.29	0.31	-0.73
Vigour index-II	0.42	-0.05	0.30	0.27	0.62	0.53
Eigenvalue	5.65	0.17	0.14	0.04	0.00	0.00
Percentage of variance	94.25	2.85	2.27	0.59	0.03	0.00
Cumulative percentage of variance	94.25	97.10	99.40	99.96	99.99	100

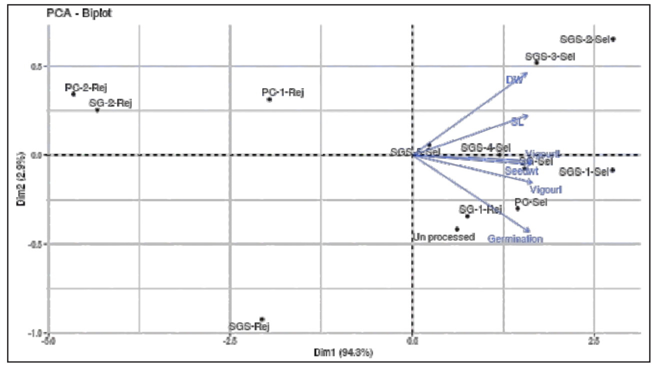

Fig. 6: Biplot from first (PC 1) and second (PC 2) principal components of PCA for different seed quality variables. Abbreviations: PC- pre-clean, SG- screen grader, SGS- specific gravity separator, R- reject, Sel- selected. SL- seedling length, DW- seedling dry weight, Seedwt- 1000 seed weight.

CONCLUSION

The results from the study indicate that seed processing is beneficial in removing low-quality seeds and improving seed quality at various processing stages. The germination enhanced from 63.67% in unprocessed seeds to 71.67% in specific gravity separator select-1. The processing also improved the 1000 seed weight which led to enhanced seed vigour parameters. The selection of seeds up to specific gravity separator outlet 4 is beneficial for obtaining high-quality seeds in paddy. Further research may be conducted to know if there is scope to upgrade the reject samples through seed processing or improved their germination performance by techniques like seed priming so that the quantity of reject samples may be reduced.

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