Journal of AgriSearch 3(3):187-190
Peer Reviewed Quarterly

ISSN : 2348-8808 (Print), 2348-8867 (Online)
http://dx.doi.org/10.21921/jas.v3i3.11383

Short Note

# Effectiveness of Seed Processing Machinery on Seed Quality Improvement in Paddy (*Oryza sativa L.*)

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| ARTICLE INFO | | |
|---|---|---|
| Received on | : | 01.08.2016 |
| Accepted on | : | 18.08.2016 |
| Published online | : | 10.09.2016 |

## ABSTRACT

A series of seed-processing machines were used to evaluate seed quality improvement in paddy during the *Kharif* season 2013-14. The processing machines proved an efficient tool in producing quality seeds. The consistent and higher seed quality (germination 91.67% and physical purity 99.83%) could be achieved by efficient use of processing machines. The product and separate (reject) from individual machines were analysed to evaluate machine efficiency in separating the seed components as well as impurities from the harvested lot. The air-screen machines were found effective in removing dead seeds, whereas specific gravity separator removed abnormal seeds significantly. Gradual increase in seed quality was recorded with decrease in recovery in the processing line. Seed loss in reject port was always associated with handling of seed lots by each machine and observed only 1.30%. Specific gravity separator was found essential for the seed lot of medium-term storage or for the buffer stocking.

**Keywords**: Paddy seed, processing machinery, seed quality

Rice is the staple food of more than three billion people in the world including India; most of them are lived in Asia. Rice is important crop of Indo Gangetic Plains of Bihar (Singh *et al.*, 2012). In-spiteof high production and growth rate over the years in India, the productivity of paddy still remains low at around 2.3 tonnes/ha in 2011-12, much less than many other countries like China, Japan, Republic of Korea and Indonesia. To balance the food budget and meet the food requirement of the growing population in India, the production will have to reach at least 280.6 million tonnes by 2020-21. The country needs to boost the food grain production by 1.34 % annually to meet out the requirement in coming years, whereas the existing production is of about 265.57 million tonnes (2013-14). In this scenario, the productivity should be increased for food security in the country as well as export. The productivity can be enhanced to a greater extent by the use of quality seeds. Quality seed plays a vital role in sustainable agricultural production and productivity. The genetic purity, physical purity, viability, vigour and uniformity in seed size are important parameters to determine the quality of seed. Among these parameters, genetic purity is mainly dependent on source seed, crop husbandry and production techniques (Atwal and Sinha,2002), whereas other parameters are greatly affected by post-harvest handling methods. Seeds are required to be stored since harvest of the preceding season till sowing of the next season.The genetic purity, physical purity, free from pest, size uniformity and viability are important attributes of determining the quality seed. The genetic purity is linked with crop husbandry and production techniques(Atwal and Sinha, 2002). However, rest of the parameters is related to post-harvest handling of seed lot. The harvested seed lot contains impurities, immature and damaged seeds.These components of seed lot attract insects and micro-organisms during storage (Sinha, 1999).The storage of seed is essential, as it will be utilized in the next sowing season, which comes about 8-9 months after the harvest. The superiority of larger size seed over smaller ones in terms of yield, plant vigour and weight has been reported in several studies. The larger seed produces larger seedlings, and the advantage persists to increase final yield with it (Wood *et al.*, 1977). Uniformity in size and constituents of seed lot was emphasized for mechanical planting as well as better crop (Bishaw and Gastel, 1996). In this study, the effect of seed processing machines in improving the quality parameters of seed lots is investigated. Efficiencies of the basic seed processing machines and losses at different stages of rice seed processing were also evaluated.

**Seed component:** Seed lots of rice cultivars Swarna Sub-1 (S.S-1) and Rajendra Mahsuri -1 (R.M-1)grown at National SeedsCorporation Limited, grower field under seed production programme in Patna (Bihar), during the *Kharif* 2013-14 season were taken for the study.

**Pre-processing condition:** Parameters like moisture content, coarse weight of seed lot and 1OOO-seed weight were recorded for the received seed lots. The moisture content of seed lot varied from 13 to 15% (w. b). Therefore, seed drying was not considered necessary for processing. The visual evaluation of the harvested seed samples did not show broken seed, requiring length separation, and therefore the length separator was by-passed.

**Seed-processing machines:** Seeds were processed in Agrosaw (Ambala) make processing plant of 4 $t.h^{1}$capacity. The processing line comprised seed pre-cleaner-cum grader (PC), screen grader (SG), and specific gravity separator (SGS). All the machines were connected in series in that order with

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vertical bucket elevator. The pre- grader and screen grader was air screen machine. Both were equipped with feed control and rotary scalper-cum-seed spreader, scalping screen, grading screen and aspiration system. Screen aperture size in the top screen of pre-cleaner and screen grader were 5.5 mm and 5.4 mm respectively. The bottom screen for grading was selected as per recommendation ofIndian Minimum Seed Certification Standards (Trivedi and Gunasekaran, 2013). The essential parts of specific gravity separator were a porous deck, fan system that forces air through the porous deck, assemblies that oscillate and incline the deck. The inclination of deck and volume of air were adjusted for better separations of lowdensity seeds from the lot.

**Sampling and analysis:** Seed samples were drawn for quality assessments at feeding point, product outlets and reject outlets of each machine and also at the discharge point of vertical bucket elevator. About half kg of sample(s) were collected from above- said points at an interval of 30 min. All collected samples of each point were mixed separately. These samples were called as primary samples. Three replications weighing 1 kg were drawn from the primary samples, which were classified as representative samples. These representative samples were subjected to quality evaluation. The reject outlets of airscreen machines were classified in 3 classes, viz. under-size screen, over-size impurity and light impurity. The sampling from reject outlets was done only from the under-size screen outlet of air-screen machines.After the completion of processing of 1 variety, the total weight of product and weight ofrejects of individual machines were recorded. In case of air-screen machines, the weight of rejects of the 3 classes was recorded separately and recovery at each machine was calculated (Svarosky, 1979).

The seed-quality evaluation of sample was conducted as per ISTA rules (Anonymous, 2008). Four hundred seeds of each replication were kept between wet paper towels in the germinator for 8 days at 25°C. The number of normal and abnormal seedlings and dead seeds were recorded. The germination (%) was expressed on the basis of normal seedlings. Ten normal seedlings of each replication were drawn at random and were subjected to record vigour index (VI). The seedlings were dried at 104°C in oven for 8 hr to get seedling dry weight. The vigour index was obtained by multiplying germination % with seedling dry weight. The 1000seed weight of each sample was measured. The physical purity test was used to determine the composition of sample,i.e. type of sample; namely the type of contaminants present in the lot. During the analysis the sample was divided into 3 fractions (pure seed, other crop seed and inert matter) and reported on percentage basis. Germination capacity combined with analytical purity was used to determine the proportion of seed, which can produce normal seedlings, called as the pure live seed. (Agrawal, 1996).The data were statistically analysed using factorial randomised block design (Gomezand Gomez, 1984).

**Analytical techniques:** The purpose of seed processing is to remove the foreign materials other than seed and non-geminating seed from the harvested seed lot. Performance indices, e.g. cleaning efficiency (C), separation efficiency (S) and process efficiency (P), were computed for individual machine as well as for the series of machines (Sinha *et. al.,* 2001). Mathematical indices for cleaning efficiency, separation efficiency and process efficiency are computed from the basic data to determine machine performance.

The germination and physical purity of unprocessed seed lot of rice was 81.83 % and 87.57 % respectively (Table1), compared with the minimum standards of80 and 98% respectively. Seed lots of both the cultivars were found at par for their seedquality attributes viz. physical purity (%)dead seed (%), vigour index and 1OOO-seed weight, throughout the processing line. However, significant difference was observed for germination (%) (P = 0.05), abnormal seeds (%) (P = 0.0 1) and pure live seed (%) (P = 0.05). It may be due to genetic or development environment effect. Regarding physical purity, 1OOO-seed weight and pure live seed (%) significant difference were observed by all the treatments with each other. However, the air screen machines (pre-cleaner and screen grader) were found at par in improving germination (%), vigour index and reducing abnormal seeds from the lots.

**Table 1: Mean values of different quality attributes improved through mechanical seed processing in paddy.**

| Variety/ Stage | Physical Purity (%) | Germination (%) | Abnormal Seedling (%) | Dead seed (%) | Pure live seed (%) | Vigour Index-I | 1000 seed weight (q) |
|---|---|---|---|---|---|---|---|
| Variety | | | | | | | |
| S.S-1 | 93.05 | 86.00 | 8.17 | 5.83 | 80.02 | 7.82 | 21.72 |
| R.M-1 | 92.76 | 88.00 | 5.75 | 6.25 | 81.62 | 8.20 | 21.59 |
| P= 0.05 | NS | 1.78* | 1.18*** | NS | 1.57* | NS | NS |
| Stage | | | | | | | |
| Feed | 87.57 | 81.83 | 9.83 | 8.34 | 71.66 | 7.26 | 20.11 |
| PC | 92.61 | 86.00 | 7.50 | 6.50 | 79.64 | 7.81 | 21.41 |
| SG | 95.72 | 88.50 | 6.50 | 5.00 | 84.71 | 8.12 | 22.04 |
| SGS | 99.83 | 91.67 | 4.00 | 4.33 | 91.51 | 8.84 | 23.07 |
| P= 0.05 | 0.9*** | 2.52*** | 1.67*** | 1.25*** | 2.23*** | 0.82** | 0.24*** |

Note: PC- Pre-cleaner; SG- Seed grader; SGS- Specific gravity separator.

*P=0.05; **P=0.01; *** P=0.001

The desired quality parameters wereimproved significantly through processing. Finally much higher seed quality was achieved in the processed product, irrespective ofthe varieties. The germination increased from 81.83 % to 91.67%, whereas the physical purity from 87.57 % to 99.83 %. The improvement in physical purity and germination (%) at precleaning was observed 5.04 and 4.17 % points and at screen-grading stage 3.11 and 2.5 % points respectively. The specific gravity separation improved the physical purity and germination (%) in the range 4.11 and 3.17 % points respectively. Hence the precleaning appears to be the most effective stage regarding physical purity improvement, followed by specific gravity separator and screengrader. The increase in 1000-seed weight of product was recorded at each stage of processing. On the whole, the 1000-seed weight improved by 3 points. The maximum increase in vigour index was obtained after passing the seed lot on specific gravity separator. It indicates that specific gravity separator is essential for developing the best-quality seed. However, maximum pure live seed percentage increased at pre-cleaner, followed by specific gravity separator and screen grader. The improvement at initial stages is more rapid than the subsequent stages. It confirms the fact that it is normally difficult to improve the richer product than the poorer one (Sinha *et al.*, 2002).

On critical analysis of germination test it was observed that dead and abnormal seeds were removed from the seed lot at each stage of processing. The processing line was able to reduce abnormal and dead seeds to 83.11 and 89.81% respectively. The air-screen machines (pre-cleaner and screen grader) removed abnormal and dead seed to 33.88 and 40.05% respectively, of total. However, specific gravity separator alone removed 59.31 % abnormal and 49.14% dead seeds from the lot. Thus, the airscreen machines are effective in removing larger proportion of dead seeds, while specific gravity separator removes abnormal seeds. Hence it can be attributed that there is significant difference in size and aerodynamic behaviour of dead and good seeds. The abnormal seeds differed significantly with good seeds with respect to specific gravity or density. As the abnormal seed tends to become dead with the passage of time, its removal is essential from the lot especially when the seed is likely to be carriedover or meant for buffer stocking. In other words, specific gravity separation can be bypassed in processing for the lot, which is to be utilized in the coming season, if the standards are achieved with air-screen machines alone. This will help to maximize product recovery and reduce the processing cost.

Significant increase in vigour index was observed at each stage. Overall increase in vigour index was 7.26-8.84 by passing through the processing line. The maximum increment was registered at specific gravity separator, followed byprecleaner and screen grader. It indirectly indicates that seed vigour is more affected by seed density than seed size. Thus, the importance of specific gravity separator in rice seed processing is further strengthening.

The quality of the seed component of reject port was found far below the standards than that of product at each stage. It depicts the positive separation process at all the 3 stages. The germination (%) and vigour index of rejects at screen grader were recorded maximum (47 and 2.75) with respect to rejects of pre-cleaner and specific gravity separator. Hence screen grader stage can be bypassed. But as specific gravity separator stage requires clean mass for better separation, it cannot be done whether it is contributing to seed loss. It was also observed that reject gets infected in the order of pre-cleaner, screen grader and specific gravity separator. It again supports the fact that air-screen cleaning of paddy seed is essential, while specific gravity separation can be bypassed. Besides, the processing should be taken up as early as possible after the harvest. The physical purity of specific gravity separator reject was found maximum (67%), but vigour index indicates that its removal is essential to maximize seed quality.

Increase in all efficiencies was noted, as the seed lot moved from one machine to the next (Table 2). It indicates that the 3 machines contributed to purify or improve the seed lot. The cleaning efficiency was found higher than separation efficiency at air-screen machines for both varieties.

**Table 2: Process efficiencies percentage at different stages of paddy seed processing**

| Variety | Efficiency | Pre cleaner | Screen grader | Specific gravity separator |
|---|---|---|---|---|
| Swarna Sub -1 | $C_n$ | 38.66 | 58.95 | 88.54 |
| | $S_n$ | 25.60 | 37.12 | 52.40 |
| | $P_n$ | 29.08 | 43.77 | 64.88 |
| Rajendra Mahsuri-1 | $C_n$ | 39.44 | 66.16 | 91.76 |
| | $S_n$ | 25.43 | 43.00 | 66.49 |
| | $P_n$ | 29.90 | 51.19 | 76.25 |
| Mean | $C_n$ | 38.15 | 61.65 | 89.25 |
| | $S_n$ | 24.61 | 39.16 | 58.54 |
| | $P_n$ | 28.59 | 46.58 | 69.66 |

Note: $C_n$, cleaning efficiency; $S_n$, separation efficiency; $P_n$, process efficiency

The processed seed lot decreased with handling by each machine (Fig 1). However, each reduction in the processed weight was accompanied by simultaneous rise in quality. The seed loss in reject port was also observed at each stage of processing. The recovery was found about 97.04% and 94.80% at pre-cleaner and screen grader, respectively, the overall recovery was observed about 88.20%. The total seed loss in reject port was 1.30%. In general, seed loss in plant ranges between 2-10 % (Sinha *et al.*, 2001 and Sinha *et al.*, 2002). The efficient operational parameters of machines able to reduce the loss to only 1.30%. The loss at specific gravity separator stage was significantly higher than pre-cleaning and screen grading. It was observed that as the product recovery decreases, the loss increases. Similar observations have been studiesin wheat (Doshi *et al.*, 2013).

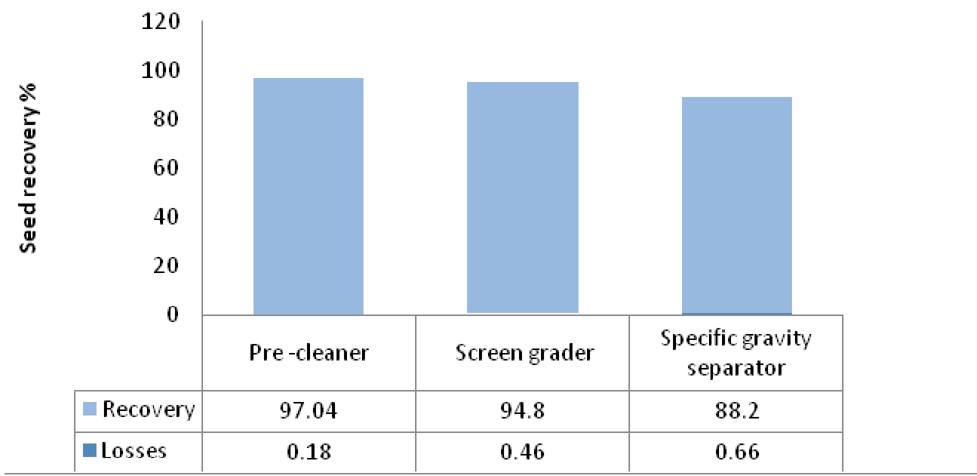


Fig.1 **Seed recovery and losses at different stages of paddy seed processing**

The pure live seed of processed seed in all the varieties was about 90%. The existing seed rate of 25 kg/ ha in paddy is apparently based on pure live seed value of 86.24% (considering germination 80% and physical purity 98%). Thus scope exists for lowering- seed rate to achieve same plant population, if we get the product quality (pure live seed) more than 86.24%. It will also facilitate in increasing availability of quality seeds as well as more area can be covered with same quantity without compromising the plant population.

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**Citation:**

Kumar R.2016. Effectiveness of seed processing machinery on seed quality improvement in paddy (*Oryza sativa L.*). *Journal of AgriSearch* **3**(3): 187-190