RESEARCH ARTICLE Legume Research- An International Journal, Volume 46 Issue 6: 752-756 (June 2023)

Influence of Seed Quality Upgrading by Processing Machines in Soybean var. DSb-21

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10.18805/LR-4409

ABSTRACT

Background: Soybean is the "Miracle crop" of the 21st century due to its nutritional value and multiple uses. Maintenance of soybean seed quality is a major issue as it is more vulnerable to mechanical damage from harvesting to next sowing. Seed processing.by use of individual or combination of machineries will help in getting physically pure, uniform, healthy sound seeds with enhanced planting value. With the advent of new improved varieties, it is advisable to find out the individual or combination of seed processing machines like air screen cleaner, specific gravity and spiral separator to find out the effective and economical seed processing to get maximum recovery with up-graded quality of seeds.

Methods: The seeds of soybean var. DSb-21 were used for seed size grading using different sieve sizes and the good seeds obtained from different size grading were processed through specific gravity separator and the good seeds obtained from specific gravity separator were further processed through spiral separator and the processed seeds obtained from these machine combinations were used to assess the seed quality. The seed processing was carried out at Seed Processing Unit and seed quality studies were carried out in the Seed Quality and Research Laboratory, Seed Unit, University of Agricultural Sciences, Dharwad during 2017-18. The experiment was laid in completely randomized design.

Result: The influence of sequential processing through seed size grader followed by specific gravity separator and spiral separator on seed quality revealed that, the good seeds obtained from spiral separator after seed grading with recommended sieve size 3.75 mm recorded higher recovery (76.95%), seed germination (89.00%), seedling vigour index (3567) and lower seed mechanical damage (11.67%) followed by 4.00 mm (74.80%, 87.33%, 3418 and 12.33%, respectively) and 4.80 mm (65.64%, 85.00%, 3209 and 13.67 %, respectively).

Key words: Seed quality, Seed size grader, Soybean, Specific gravity separator, Spiral separator.

INTRODUCTION

Soybean [*Glycine max* (L.) Merrill] is a major oil seed crop of the world grown in India. The crop is also called as "Golden Bean" or "Miracle crop" of the 21st century on account of its multiple uses. It has the highest protein (40%) and rich oil (20%). It is also rich source of minerals and essential amino acids. Hence, an highly potential crop among the grain legume crops for combating acute malnutrition. It is being cultivated mainly in USA, Brazil, China, Argentina and India. In India, it occupies 11.40 million hectares area and production of 11.50 million tonnes with productivity 1.01 tonnes per ha (Anonymous, 2017).

The maintenance of seed quality is a major issue in soybean. The soybean seeds are more vulnerable to mechanical damage from harvesting to next sowing season. Many reports are available on the effect of different processing equipments on seed quality of soybean seeds during storage. Seed processing is one of the important segment of seed industry, done to upgrade the planting value of the seeds. Majority of the seed produced is being processed through different seed processing machineries. Soybean seed with a thin seed coat and embryo placed on cotyledon is susceptible to mechanical damage during the processing operations as the seeds are being lifted through elevators and poured into processing machines from the top. Hand cleaning is the best alternative, to avoid the damage but, it becomes highly impractical and uneconomical as it is laborious and time consuming process. Hence, it is necessary to identify the suitable machine combinations among the available ones for effective and economical seed processing to get maximum recovery with better seed quality with less mechanical damage.

The ability of the seed processing in getting seeds free from inert material, weed seeds and other crop species depends largely on the arrangement, order and choice of the cleaning and separation equipment used during processing. In general, for the processing of soybean seeds the equipments used are: pre-cleaning machine, dryer, air-

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How to cite this article: Vishwanath, Hunje, R. and Shinde, P. (2023). Influence of Seed Quality Upgrading by Processing Machines in Soybean var. DSb-21. Legume Research. 46(6): 752-756. doi: 10.18805/LR-4409.

Submitted: 02-05-2020 **Accepted:** 08-01-2021 **Online:** 27-02-2021

screen machine (cleaning machine), size grader, gravity separator and spiral separator. The recommended sieve size is 4.00 mm for grading soybean seed as per Seed Certification Agency is for old varieties which are out of cultivation in seed production chain and this is not at all suitable for newly released high yielding varieties which are under large scale cultivation. It is often observed that the seed growers are loosing considerable quantity of good seed due to rejection, when 4 mm screen is used for seed processing. In order to avoid unnecessary rejection during processing and to meet the huge demand for certified seed of soybean for the newly released varieties, there is an urgent need to standardize the sieve size for grading soybean seed. Hence, the present research on standardization of optimum sieve size and the type of screen for grading of soybean seed was planned and undertaken to find out the effective and economical seed processing to get maximum recovery with better quality of seeds using individuals or combination of processing machineries.

Seed cleaning and size grading will be done by sieve grading, the gravity separator removes the seeds of lower density and, therefore, positively influences the physical and physiological quality of the seed batch (Peske *et al*., 2012). The spiral separator equipment operates by gravity and separates the seeds according to their shape, density, degree of sphericity and ability to roll (Vaughan *et al*., 1976), removing from the seed batch those ones irregularly shaped, empty, attacked by insects or that have had their shape compromised. At present routinely used seed processing machine for processing of soybean is seed grading machine (Air screen cleaner). Use of different machineries in combination helps in getting physically pure, uniform and healthy sound seeds. With advent of new improved varieties, it is advisable to check various seed processing machines with different screen aperture size, specific gravity separator and spiral separator to find out its impact on seed recovery and upgradation in seed quality.

MATERIALS AND METHODS

The laboratory experiment was conducted to study the Influence of seed grading, specific gravity separator and spiral separator on seed quality parameters. The seeds of soybean var. DSb-21 were used for seed size grading using different sieve sizes and the good seeds obtained from different size grading were processed through specific gravity separator and the good seeds obtained from specific gravity separator were further processed through spiral separator and the processed seeds obtained from these machine combinations were used to assess the seed quality. The experiment consisted of following treatments namely, T_1: [Good seeds obtained from spiral separator after processing through seed grader from recommended sieve size - 4.00 mm, followed by specific gravity separator], T_2: [Seeds obtained from spiral separator after processing through seed grader from recommended sieve size - 4.00 mm, followed by specific gravity separator (Rejected)], T_3: [Good seeds obtained from spiral separator after processing through seed grader from below recommended sieve size - 3.75 mm, followed by specific gravity separator], T_4: [Seeds obtained from spiral separator after processing through seed grader from below recommended sieve size - 3.75 mm, followed by specific gravity separator (Rejected)], T_5: [Good seeds obtained from spiral separator after processing through seed grader from above recommended sieve size - 4.80 mm, followed by specific gravity separator], T_6: [Seeds obtained from spiral separator after processing through seed grader from above recommended sieve size - 4.80 mm, followed by specific gravity separator (Rejected)], T_7: [Unprocessed seeds (Bulk seed) as control] which was laid out in completely randomized design with three replications. The seeds that retained on the screen were collected separately and there quality parameters were evaluated at Seed Quality and Research Laboratory, National Seeds Project, University of Agricultural Sciences, Dharwad during 2017-18.

The seed germination percentage and physical purity were worked out as per the procedure given by ISTA (Anonymous, 2014), shoot and root length was measured in cm, seedling vigour index was worked out as per the formula given by Abdul-Baki and Anderson (1973), seedling dry weight by Evans and Bhatt (1977), electrical conductivity of seed leachate by Presley (1958). Whereas, the seed recovery percentage due to various grading methods were determined by using the following formula and expressed in percentage:

$$\text{Seed recovery (\%)} = \frac{\text{Weight of seeds retained on sieves (kg)}}{\text{Weight of bulk seeds (kg)}} \times 100$$

The data collected in respect of various parameters on seed quality attributes, were analyzed statistically as described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

The good graded seeds obtained from grader were processed on specific gravity separator. Further, heavy seeds obtained in specific gravity separator were processed through spiral separator. Good seeds obtained during processing were used for quality testing. The seeds graded with 3.75 mm sieve size recorded higher seed recovery of 76.95 per cent compared to seeds graded with 4.00 mm and 4.80 mm sieves with recovery of 74.80 and 65.64 per cent, respectively (Table 1). The reduction in seed recovery in 4.00 and 4.80 mm may be due to bold and bigger in seed size than seeds retained on 3.75 mm sieve and presence

Table 1: Influence of seed quality upgrading processing machines in soybean var. DSb-21.

Sieve size (r)	Seed recovery		
	Good (kg)	Rejected (kg)	Percentage (%)
4.00 mm	374.04	1.95	74.80
3.75 mm	384.75	3.25	76.95
4.80 mm	328.21	1.78	65.64

of more amount of small seeds in seed lot. In present experiment, three machine combinations of seed grader, specific gravity and spiral separator for processing resulted in most effective with highest physical purity and all shrivelled, other crop seeds, irregular seeds, weed seeds were removed and after specific gravity separation heavy seeds were used for quality testing so recovery per cent is much less in this machine combination. As the screen size decreased from 4.80 to 3.75 mm, the per cent seed recovery was increased. These results are in conformity with the findings of Anuradha *et al*. (2009) in chickpea, Ganiger *et al*. (2016) in greengram and Kausal *et al*. (2008) in soybean.

Among the graded seeds, variation in physical purity may be due to the removal of shrivelled seeds, soil particles during grading and weed seeds, other crop seeds and other impurities in spiral and specific gravity separator, which otherwise might not have been possible during threshing. Significantly higher physical purity of 99.90, 99.87 and 99.82 per cent was recorded in processed seeds *i.e* seeds retained on sieves (T_3, T_1 and T_5, respectively) as compared to bulk seeds (99.31 %) and rejected seed lot of different sieves (T_7 and T_2, T_4, T_6 respectively) (Table 2) due to effective processing, as during processing all impurities were removed and whereas rejected seed lot contains almost impurities so less physical purity was observed. Similar observations of improved physical purity have been reported by Ganiger *et al*. (2016) in greengram.

The test weight differed significantly due to seed grading. The higher test weight (11.23 g) in T_5[seeds graded with 4.80 mm sieve size] (Table 2) might be due to its larger seed size and more reserve food in seed as compared over rest of treatments. As the screen size increases during grading, test weight increases indicating the positive association of seed size and seed weight [Ganiger *et al*. (2016) in greengram and Kausal *et al*. (2008) in soybean]. Soybean seed with thin seed coat is susceptible to the mechanical damage during processing. In the present study, it was observed that mechanical damage was more (13.67%) (Table 3) when seeds processed with above recommended sieve size of 4.80 mm (T_5) compared to T_1 (12.33%) and T_3 (11.67%). It may, because of a greater intensity and impact of the processing equipment's felt by the large size seeds due to its larger diameter than the small size seeds and due to intensive fast movement (jumping) of seed on deck by air flow during processing through specific gravity separator and seeds were moved along sheet-metal flights wound on a central tube in the form of a spiral while, in spiral separator chances of mechanical damage was more than isolated seed grading. Gagare *et al.* (2014) reported that mechanical damage was more in soybean when processed through specific gravity separator. Roberts (1972) reported that the small and spherical seeds generally escape mechanical injury during harvesting, handling and processing and tends to suffer less damage, whereas larger or irregularly shaped

Table 2: Influence of seed quality upgrading processing machines in soybean var. DSb-21.

Treatment	Physical purity (%)	Test weight (g)	Mechanical damage (%)	Field emergence (%)	Germination (%)	Root length (cm)	Shoot length (cm)	Seedling vigour index	Seedling dry weight (mg)	Electrical conductivity (dSm^{-1})
T_1	99.87	10.56	12.33	84.00	87.33	20.83	18.30	3418	83.66	0.787
T_2	29.53	7.35	28.33	47.67	61.00	14.18	12.97	1654	68.81	1.450
T_3	99.90	10.37	11.67	84.67	89.00	21.75	18.33	3567	81.08	0.757
T_4	28.83	7.33	23.67	52.00	62.67	13.83	12.77	1665	66.10	1.392
T_5	99.82	11.23	13.67	82.67	85.00	19.89	17.86	3209	85.38	0.802
T_6	22.27	8.21	29.00	46.67	57.00	13.75	12.71	1508	71.35	1.542
T_7	94.31	10.12	7.33	72.33	77.33	18.71	17.03	2764	69.28	0.787
Mean	67.79	9.31	18.00	67.14	74.19	17.56	15.71	2541	75.09	1.074
S. Em. ±	0.22	0.18	0.44	0.84	1.33	0.26	0.30	35	0.50	0.02
C. D. @ 1%	0.67	0.54	1.32	2.53	4.03	0.80	0.90	107	1.53	0.07

T_1: Good seeds obtained from spiral separator after processing through seed grader from recommended sieve size - 4.00 mm, followed by specific gravity separator.

T_2: Seeds obtained from spiral separator after processing through seed grader from recommended sieve size - 4.00 mm, followed by specific gravity separator (rejected).

T_3: Good seeds obtained from spiral separator after processing through seed grader from below recommended sieve size - 3.75 mm, followed by specific gravity separator.

T_4: Seeds obtained from spiral separator after processing through seed grader from below recommended sieve size - 3.75 mm, followed by specific gravity separator (rejected).

T_5: Good seeds obtained from spiral separator after processing through seed grader from above recommended sieve size - 4.80 mm, followed by specific gravity separator.

T_6: Seeds obtained from spiral separator after processing through seed grader from above recommended sieve size - 4.80 mm, followed by specific gravity separator (rejected).

T_7: Unprocessed seeds (Bulk seed) control.

and elongated seeds are likely to be extensively damaged. Paulsen *et al.* (1981) reported that per cent damage was greater for varieties having bold seed size.

The seeds processed through different sieve size during grading followed by specific gravity and spiral separator exhibited significant variation in seed quality. The higher field emergence (84.67%), seed germination (89.00%), root length (21.75 cm), shoot length (18.33 cm), seedling vigour index (3567) were observed in T_3 [Good seeds obtained from spiral separator after processing through seed grader from below recommended sieve size - 3.75 mm, followed by specific gravity separator] compared to other machine combinations and control (Bulk seeds) (T_7) (72.33%, 77.33%, 18.71 cm, 17.03 cm and 2541, respectively) (Table 2) which might be due to smaller in seed size and lesser mechanical damage. The variation in percentage of germination and field emergence among sieve size used during processing may be due to amount of mechanical damage caused during grading and physical purity percentage obtained.

Variation in germination within sieve size used may be due to controlled conditions in germination chamber than during field emergence. According to Negi *et al.* (1998) large seeds had more breaks in embryonic axis and other important seed parts than the small seeds and therefore showed poor germination and viability. While, small seeds had better germination uniformity and getting reserves more and faster than larger ones to seedlings in soybean cv. Katul (Rastegar and Kandi, 2011).

Similarly, significantly higher shoot length, root length and seedling vigour index in seeds graded with 3.75 mm sieve size is probably due to the differences in the rate of growth of seedlings wherein, the small size (seeds graded with 3.75 mm sieve size) seeds required less moisture than the large size (seeds graded with 4.00 and 4.80 mm sieve size) seeds and would have completed the process of imbibition earlier than the large size seeds (Singh *et al.,* 1972). Thus, the seeds graded with 3.75 mm sieve size would have put fourth longer seedlings and higher germination resulted higher values for seedling vigour index.

Higher seedling dry weight (85.38 mg) in T_5 [seeds graded with 4.80 mm sieve size] (Table 2) may be due to the fact that the large seeds contained in them posses more number of cells per cotyledon in the form of reserve food material and thus had greater rates of dry matter accumulation and final dry weights (Guldan and Brun, 1985). Longer *et al.* (1986) concluded that the bold size seeds of two soybean cultivars Mark and Hill had higher seedling fresh weight accumulation than ungraded and small size seeds. McDonald (1985) revealed that seed size may influence electrical conductivity results because larger seed leak more electrolytes due to more mechanical damage than smaller seeds of equivalent quality [seeds graded with 3.75 mm sieve size] (Table 2), which results in lower electrical conductivity. These observations are also in confirmation with the results of Mohanrao (1993) in soybean.

CONCLUSION

It can be concluded that the good seeds obtained from spiral separator after seed grading from below recommended sieve size 3.75 mm followed by specific gravity separator (T_3) recorded higher recovery (76.95%), seed germination (89.00%) and seedling vigour index (3567) followed by 4.00 mm (T_1) (74.80%, 87.33% and 3418, respectively) and 4.80 mm sieve size (T_5) (65.64%, 85.00% and 3209, respectively). Whereas, lesser seed mechanical damage (11.67%) was noticed in 3.75 mm sieve size (T_3) followed by 4.00 (T_1) (12.33%) and 4.80 mm sieve size (T_5) (13.67%) indicating that processing equipment's have greater impact on mechanical damage of seeds during processing.

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