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Standardization of Optimum Grading Sieve Size for Seed Processing in Black Gram [*Vigna mungo* (L.) Hepper] Varieties

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ABSTRACT

Background: The seeds harvested from the field may not be homogenous in seed size, physical purity and viability in Black gram. Seeds are to be cleaned and graded using seed processing machineries to maintain uniformity of a seed lot. Every variety is having its individuality in seed size. Hence, the common recommendation of 2.8 mm sieve size recommended by Indian Minimum Seed Certification Standards (IMSCS) for grading black gram seeds may not be suitable to recover a maximum quality seeds in all varieties while processing. The present study was carried out to identify a suitable grading sieve size for newly released black gram varieties for getting good quality seeds with better seed recovery during processing.

Methods: The study was conducted at Seed Technology Research Unit, Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal during the year 2020-2023. The experiment was laid out in completely randomized design with four replications. Four newly released black gram varieties *viz.,* ADT 6, VBN 8, VBN 10 and VBN 11 were taken for the study. Specified quantities of unprocessed seeds have been sieved using slotted sieves of three sizes above (3.4 mm, 3.2 mm and 3.0 mm) and two sizes below (2.7 mm and 2.5 mm) the recommended sieve size of 2.8 mm for black gram varieties as per the IMSCS. The seeds retained over each sieves were collected separately and tested for seed quality parameters.

Result: The results revealed that the seed recovery per cent increased with decrease in sieve size while the seed quality parameters found higher with increase in sieve size. The sieve size of 2.7 mm (slotted) registered the maximum cumulative seed recovery of 87% and 89.9%, respectively in black gram seeds of cv. ADT 6 and VBN 10 along with required seed standards. However, seeds retained from the sieve size of 3.0 mm (slotted) registered the maximum cumulative seed recovery of 91.2% and 87.5%, respectively in VBN 8 and VBN 11 with requisite seed germination and physical purity as per the IMSCS (75% and 98%). Hence, it is suggested that the sieve size of 2.7 mm may be considered as grading sieve size for seed processing in black gram seeds of cv. ADT 6 and VBN 10 and 3.0 mm may be used as grading screen (Bottom screen) for VBN 8 and VBN 11 for getting good quality seeds with higher seed germination, physical purity and pure live seeds.

Key words: Blackgram, Grading, Seed processing, Seed recovery, Seed size, Sieves.

INTRODUCTION

Blackgram [*Vigna mungo* (L.) Hepper] is one of the important grain legumes cultivated in India for its nutritional quality and suitability to most of the cropping system. India ranks first in terms of production, consumption and cultivated area of pulses. Black gram is cultivated in an area of 41.42 lakh ha and production of 22.29 lakh tones with the productivity of 538 kg/ha (Anonymous, 2021). Black gram seeds are rich in protein (25-26%), carbohydrate (60%), fat (1.5%), minerals, amino acids and vitamins (Parveen *et al.,* 2011). The major constraint in pulse production is the lower productivity, which may be due to the use of poor quality seeds for sowing (Ganiger *et al.,* 2020). The quality seed is a primary need to get a better yield of every crop. The seed quality includes physical and genetic purity and viability. Mostly, harvested produce is heterogeneous in nature. To separate non seed materials, other foreign seeds and low quality seeds of same species, grading act as an integral part of seed production and enhances the planting value. Grading, the separation of good seed from poor quality seed is one of the basic post harvest operation of any seed crop (Agrawal, 1996). Studies pertaining to seed grading based on seed size in relation to seed quality characters are warranted as amount of food reserve in seed is the basic requirement for its future expression as germination, vigour and final establishment at field. In addition, to obtain homogeneous or market appealing seed lot, size grading is inevitable.

In seed processing machine, three major functions have been carried out *viz*., cleaning, scalping and grading. Cleaning is done using aspirator, in which light material is removed from the seed mass. While

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scalping, the good seeds were dropped through sieve holes; but larger material is carried over the sieve into a separate discharge. Finally, seeds dropped from scalper were ride over grading sieve, while smaller particles drop through the sieve hole. The grading sieve size recommended by IMSCS for black gram is 2.8 mm (slotted). Now a days, newly released black gram varieties had more differences in seed size as compared to older varieties. Hence, the alteration is needed in grading screen size while seed processing for getting good quality seeds to confirm the physical purity standards set by IMSCS while processing of black gram seeds. With this background, the study was conducted to standardize the grading sieve size for seed processing on newly released Black gram varieties.

MATERIALS AND METHODS

The experiment was conducted at Seed Technology Research Unit, Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal during the year 2020-2023. Freshly harvested seeds (unprocessed) of four newly released Black gram varieties *viz.,* ADT 6, VBN 8, VBN 10 and VBN 11 were taken for the study. Specified quantities (250 g) of unprocessed seeds have been sieved using slotted sieves (Fig 2) of three sieves above (3.4 mm, 3.2 mm and 3.0 mm) and two sieves below (2.7 mm and 2.5 mm) the recommended sieve sizes of 2.8 mm for black gram varieties as per the Indian Minimum Seed Certification Standards (Trivedi and Gunasekaran, 2013) in ROTAP sieve shaker for 2 minutes at the rate of 25-30 strokes per minute. The seeds retained over each sieves were collected separately and weighed. Collected seeds were tested for the following seed quality traits:

Seed recovery (%) (ISTA, 1993)

The seeds retained in each sieve were weighed and seed recovery was calculated in percentage using the following formula:

$$\text{Seed recovery (\%)} = \frac{\text{Weight of seeds retained in each sieve}}{\text{Total weight of seeds}} \times 100$$

Physical purity (%)

The working (test) sample is separated into the following three component parts: Pure seed, other seeds, inert matte and the percentage of each part is determined by weight. The separation of the pure seed must be on such a basis that it can be made by visible seed characteristics, mechanical aids or using pressure without impairing the capacity for germination (ISTA, 1993).

The physical purity percentage was calculated by the following formula:

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

Seed size (mm)

The seed size (seed length, breadth and thickness) was measured in randomly selected 10 seeds using micrometer screw gauge (ISMA, 2022).

Test weight (100 seed weight)

Four replicates of hundred seeds were drawn from each treatment, weighed in sensitive electronic balance and expressed in gram.

First count and seed germination (%)

Four replicates of hundred seeds were tested using between paper method and kept under the test conditions of 25°±1°C and 95°±3 per cent relative humidity maintained in a germination room illuminated with fluorescent light. The first count was calculated based on the seeds germinated after the test period of four days. Whereas germination was calculated after seven days of test period, the normal seedlings were counted and the mean values expressed as percentage to the total number of seeds placed for germination (ISTA, 2013).

$$\text{First count (\%)} = \frac{\text{Number of seeds germinated on } 4^{th} \text{ day}}{\text{Total number of seeds placed for germination}} \times 100$$

$$\text{Germination (\%)} = \frac{\text{Number of normal seedlings}}{\text{Total number of seeds placed for germination}} \times 100$$

Pure live seed (%)

Pule live seed was calculated using the following formula:

$$\text{Pure live seed (\%)} = \frac{\text{Physical purity (\%)} \times \text{Germination (\%)}}{100}$$

Statistical analysis

The data collected from the experiment was statistically analysed using completely randomized design by adopting the procedure described by Panse and Sukatme (1978). AGRES software package was used for finding critical differences (CD) values. The critical differences (CD) were calculated at 5 per cent probability level. Wherever necessary, percentage values were transformed to arc sine values before carrying out the statistical analysis.

RESULTS AND DISCUSSION

Seed grading is done for removal of impurities and small sized seeds which are believed to be underdeveloped from the seed lot and to get a maximum of pure seeds to satisfy the minimum seed certification standards resulting in uniform germination and higher planting value (Suma *et al.,* 2014). Among the different sieve sizes, highly significant variation was observed for almost all the characters studied.

The sieve size of 2.7 mm (slotted) registered the maximum cumulative seed recovery of 87% and 89.9%, respectively in Black gram seeds of cv. ADT 6 and VBN 10

along with required seed germination and physical purity as per the IMSCS. It increased the seed recovery to the tune of 9.5% (Table 1) and 6.9% (Table 3), respectively in Black gram seeds of cv. ADT 6 and VBN 10 as compared to existing sieve size of 2.8 mm recommended for black gram varieties as per Indian Minimum Seed Certification Standards (Trivedi and Gunasekaran, 2013).

Seeds retained from the sieve size of 2.8 mm (slotted) registered the physical purity of 97.8% and 95.1%, respectively in VBN 8 and VBN 11, which failed to fulfill the seed certification standard set by IMSCS (98%). However, the seeds retained from 3.0 mm (slotted) sieve size registered the maximum cumulative seed recovery of 91.2% and 87.5%, respectively in VBN 8 and VBN 11 along with requisite seed germination and physical purity as per the IMSCS (75% and 98%, respectively). In addition, nearly 11.35% enhanced seed germination was also observed in VBN 8 (Table 2). Whereas in Black gram cv. VBN 11, even though there was no difference in seed germination, the physical purity was increased to the tune of 3.3% (Table 4) while using 3.0 mm sieve for grading screen as compared to existing sieve size of 2.8 mm recommended for black gram varieties as per Indian Minimum Seed Certification Standards (Trivedi and Gunasekaran, 2013).

Based on the results, irrespective of varieties, the seed recovery was increased with decrease in sieve size. These results are in conformity with the findings of Ganiger *et al.* (2016) in green gram. In addition, the physical purity, seed size, 100 seed weight, seed germination and pure live seed percentage were also increased with increase in sieve size. Proportion of small and underdeveloped seeds with good quality seeds in seed lot will decide the physical purity. Those impurities proportion was decreased with increase in sieve size. It might be the reason for the reduction in physical purity while decreasing the sieve size. Seed size and seed weight are positively correlated because the seed weight increased with increase in sieve size in the present study. The positive association of seed weight and seed size was earlier reported by Ganiger *et al.* (2016) in green gram, Kumar *et al.* (2005) in Indian mustard and Suma *et al.* (2014) in sesame. Irrespective of varieties, the first count, seed germination and pure live seed percentage were also higher in large sized seeds (Fig 1, 2, 3 and 4). It might be due to the large sized seeds have a mature embryo with larger food reserves and nutrients, providing physiological stamina to the seeds (Pollock and Roos, 1972) and higher amount of food reserves and increased activity of redox enzymes in the seeds helping in breaking down the complex food reserves into simple soluble sugars (Gurbanov and Berth, 1970). The improvement in seed quality parameters with increase in sieve size is also confirmed by Axay *et al.* (2014) in green gram and Ganiger *et al.* (2016) in red gram.

Table 1: Effect of sieve size on seed quality of black gram cv. ADT 6.

Slotted sieve size (mm)	Seed recovery (Cumulative) (%)	Seed length (mm)	Seed breadth (mm)	Seed thickness (mm)	First count (%)	Germination (%)	Physical purity (%)	Pure live seed (%)	100 seed weight (g)
3.4	27.8(31.80)	5.23	4.20	3.30	98.0(81.87)	97.3(80.60)	99.8(87.66)	97.2(80.32)	5.32
3.2	66.4(54.55)	4.80	3.70	2.94	92.0(73.57)	89.3(70.94)	99.8(87.23)	89.1(70.75)	4.20
3.0	75.9(60.57)	4.50	3.50	2.69	90.0(71.57)	87.3(69.15)	99.3(85.20)	86.7(68.63)	3.52
2.8*	77.5(61.70)	4.43	3.48	2.58	86.0(68.03)	83.3(65.91)	99.0(84.17)	82.5(65.25)	3.19
2.7**	87.0(68.88)	4.40	3.40	2.46	82.7(65.40)	80.0(63.43)	98.5(82.97)	78.8(62.59)	3.06
2.5	94.1(75.97)	4.10	3.38	2.16	82.0(64.90)	80.0(63.43)	96.3(78.91)	77.0(61.37)	2.61
SED	0.35	0.04	0.04	0.06	2.57	2.86	0.38	2.52	0.02
CD (0.05)	0.73	0.09	0.08	0.12	5.59	6.24	0.83	5.49	0.05

*Existing screen size for black gram; **suggested for ADT 6 (Values in parenthesis indicate the arc sine values).

Table 2: Effect of sieve size on seed quality of black gram cv. VBN 8.

Slotted sieve size (mm)	Seed recovery (Cumulative) (%)	Seed length (mm)	Seed breadth (mm)	Seed thickness (mm)	First count (%)	Germination (%)	Physical purity (%)	Pure live seed (%)	100 seed weight (g)
3.4	44.2(41.68)	4.63	3.77	3.27	90.7(72.21)	90.0(71.57)	99.2(84.71)	89.2(70.85)	5.06
3.2	87.3(69.16)	4.43	3.57	3.00	89.3(70.94)	86.7(68.58)	99.0(84.12)	85.8(67.83)	3.96
3.0**	91.2(72.71)	4.22	3.48	2.71	85.3(67.48)	84.0(66.42)	98.2(82.29)	82.5(65.26)	3.21
2.8*	91.9(73.42)	3.97	3.20	2.64	77.3(61.57)	72.7(58.48)	97.8(81.47)	71.1(57.46)	2.95
2.7	93.8(75.53)	3.97	3.10	2.55	70.7(57.21)	70.0(56.79)	84.6(66.89)	59.2(50.31)	2.77
2.5	95.3(77.43)	3.90	3.10	2.37	59.3(50.38)	58.7(49.99)	81.3(64.38)	47.7(43.68)	2.46
SED	1.41	0.09	0.09	0.04	0.85	0.63	0.12	0.55	0.06
CD (0.05)	3.07	0.19	0.20	0.08	1.85	1.37	0.27	1.21	0.12

*Existing screen size for black gram; **suggested for VBN 8 (Values in parenthesis indicate the arc sine values).

Table 3: Effect of sieve size on seed quality of black gram cv. VBN 10.

Slotted sieve size (mm)	Seed recovery (Cumulative) (%)	Seed length (mm)	Seed breadth (mm)	Seed thickness (mm)	First count (%)	Germination (%)	Physical purity (%)	Pure live seed (%)	100 seed weight (g)
3.4	22.7(28.4)	4.68	3.63	3.19	81.7(64.6)	86.0(68.03)	98.7(83.45)	84.9(67.12)	5.00
3.2	73.9(59.3)	4.53	3.53	2.89	89.3(70.9)	90.7(72.21)	98.8(83.71)	89.6(71.17)	4.01
3.0	82.1(65.0)	4.27	3.37	2.58	78.7(62.5)	85.3(67.48)	98.7(83.45)	84.2(66.60)	3.30
2.8*	83.6(66.1)	4.17	3.33	2.54	78.7(62.5)	78.7(62.49)	98.9(83.98)	77.8(61.89)	3.03
2.7**	89.9(71.4)	4.10	3.30	2.48	78.7(62.5)	78.0(62.03)	98.0(81.87)	76.4(60.96)	2.92
2.5	94.7(76.6)	4.03	3.27	2.34	65.3(53.9)	66.7(54.74)	97.1(80.20)	64.7(53.57)	2.51
SED	1.48	0.13	NS	0.04	1.60	1.68	0.20	1.60	0.04
CD (0.05)	3.22	0.28	NS	0.09	3.48	3.67	0.43	3.48	0.08

*Existing screen size for black gram; **suggested for VBN 10 (Values in parenthesis indicate the arc sine values).

Table 4: Effect of sieve size on seed quality of black gram cv. VBN 11.

Slotted sieve size (mm)	Seed recovery (Cumulative) (%)	Seed length (mm)	Seed breadth (mm)	Seed thickness (mm)	First count (%)	Germination (%)	Physical purity (%)	Pure live seed (%)	100 seed weight (g)
3.4	21.1(27.32)	4.55	3.80	3.29	88.0(69.73)	90.0(71.57)	99.8(87.44)	89.8(71.39)	5.08
3.2	80.3(63.63)	4.40	3.18	2.95	84.7(66.95)	86.7(68.58)	99.0(84.26)	85.8(67.86)	3.11
3.0**	87.5(69.27)	4.25	3.07	2.75	82.7(65.40)	86.0(68.03)	98.4(82.73)	84.6(66.91)	3.33
2.8*	88.5(70.21)	3.98	2.85	2.56	82.0(64.90)	86.0(68.03)	95.1(77.21)	81.8(64.74)	3.01
2.7	91.1(72.61)	3.82	2.75	2.51	77.3(61.57)	82.7(65.40)	93.6(75.35)	77.4(61.60)	2.80
2.5	93.9(75.66)	3.78	2.72	2.41	76.0(60.67)	82.0(64.90)	93.3(75.00)	76.5(61.01)	2.67
SED	0.81	0.09	0.09	0.03	1.52	NS	0.26	2.91	0.58
CD (0.05)	1.76	0.19	0.19	0.07	3.30	NS	0.57	6.34	1.27

*Existing screen size for black gram; **suggested for VBN 11 (Values in parenthesis indicate the arc sine values).



Fig 1: Effect of seed size on germination in black gram cv. ADT 6.



Fig 2: Effect of seed size on germination in black gram cv. VBN 8.

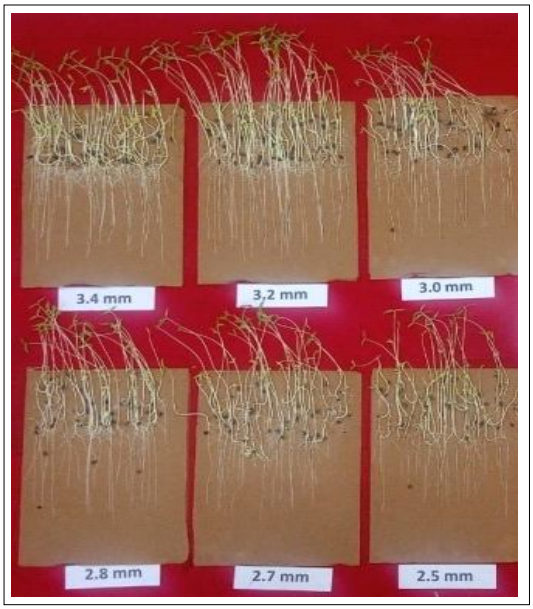


Fig 3: Effect of seed size on germination in black gram cv. VBN 10.

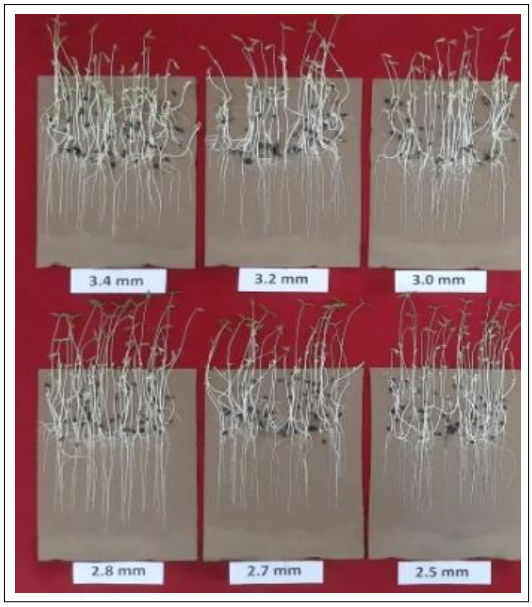


Fig 4: Effect of seed size on germination in black gram cv. VBN 11.

CONCLUSION

Instead of using 2.8 mm sieve size as grading screen as recommended by Indian Minimum Seed Certification Standards for size grading of black gram seeds, it is suggested that the sieve size of 2.7 mm may be considered as grading screen (Bottom screen) for seed processing of black gram cv. ADT 6 and VBN 10 and the sieve size of 3.0 mm may be used for VBN 8 and VBN 11 for getting good quality seeds with higher seed germination, physical purity and pure live seeds.

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Conflict of interest

All authors declared that there is no conflict of interest.

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