

Research Article

## Standardization of optimum sieve size for maximizing seed quality in *Amaranthus* (*Amaranthus tricolor* L.)

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**Abstract**

Vegetables have a critical function in human health and nutritional security. Vegetables are considered an essential building block of any diet. Out of the leafy vegetables, *Amaranthus* is the most popular and salable vegetable consumed by people all over India. Seed processing experiment was undertaken in *Amaranthus tricolor* (CO 2) by using the sieves placed inside the mechanical seed shaker (Gyratory sieve shaker) to improve the quality of *Amaranthus* seeds. The seeds of *Amaranthus* were size graded with seed shaker attached with various sieve size of BSS 18 X 18 (R), BSS 20 X 20 (R), BSS 22 X 22 (R) and BSP 22 X 22 (P). During processing, the machine could be adjusted for 2, 3, 4 and 5 minutes with an oscillating speed of 1440 rpm. The separated seeds were evaluated for seed quality characteristics such as seed germination percentage, shoot length, root length, dry matter production, 1000 seed weight and seed recovery percentage. The results revealed that the sieve size of BSS 22 X 22 (R=retained) mesh sieve had the better quality seeds with a maximum recovery of 67.41 g and when it is operated for a period of 5 minutes. The germination percentage was improved from 77 % to 95 % with 1000 seed weight of 73.21 mg, and the observed recovery was 56 per cent with the vigour index of 1145. Hence, BSS 22 X 22 retained mesh sieve with a duration of 5 minutes could be recommended as an optimum sieve size for grading *Amaranthus* seeds for improving the seed quality.

**Keywords:** *Amaranthus tricolor*, Gyratory sieve shaker, Seed size grading, Seed germination, Seed quality

**INTRODUCTION**

*Amaranthus* belongs to the family *Amaranthaceae* and is a native to North America, comes under the group of C4 plant and is distinguished by its high photosynthesis productivity. It is also known as pseudo cereals and pigweeds, It possesses three times the calcium and vitamin B of spinach leaves, as well as twenty times the iron of lettuce (Bradtko, 2013). Hence, it is known as "Poor Man's Spinach". In Mexico, *Amaranthus* seeds are used to make "Alegria", known as popcorn cookies. Chandraprakash *et al.*, (2019) indicated that when the weight of the seed in castor drops, the oil and protein

content reduces.

According to Shevtsova and Krol (1976), the seeds produced at different position would influence the yield and the quality of the produced seeds. Seeds harvested from central umbels produced productive plant in carrot. Due to indeterminate flowering behaviour of *Amaranthus tricolor* var. CO 2, posing a problem for seed processing were many ill-filled and immature seeds are produced by late-formed spikes. Hence, an attempt was undertaken to access the influence of grading seeds through seed shaker with various sieve size to upgrade the quality of *Amaranthus* var seeds CO<sub>2</sub>.

## MATERIALS AND METHODS

Seed processing experiment was conducted at Agricultural Engineering College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, by operating seed shaker model (Gyratory sieve shaker) (Plate 1). The separated seeds are tested for its quality parameters in the Department of Seed Science and Technology, Agricultural College and Research Institute, Coimbatore. The seed shaker was filled with 100g of freshly collected *Amaranthus tricolor* (CO 2) seeds. It works on the principle of size separation. The seeds were sorted by size using the sieves viz., BSS 18 X 18 (R), BSS 20 X 20 (R), BSS 22 X 22 (R) and BSS 22 X 22 (Passed out seeds of BSS 22 X 22) in a nest. The seeds are subjected to agitation for a period of 2, 3, 4 and 5 minutes, with an rpm of 1440.

A sample of 100 g seeds was deposited on top of the sieve. Sieves of different sizes were arranged in a nest. The coarsest sieves are at the top of a nest then the whole sieve set is fixed to the mechanical shaker apparatus and then shaken for a period of 2-5 minutes. Each sieve's retained seeds and these seeds were weighed. Vibratory motion, side tap motion, and rotational motion had an impact on how the sieves move on and the following determinations were made on the above size grades as well as the control (ungraded) seeds viz., 1000 seed weight (International Seed Testing Association, 1999) was determined by recording the mean of eight replications and expressed in milligram. For germination percentage, 100 seeds were germinated at the temperature of  $25 \pm 1^\circ\text{C}$  and RH  $95 \pm 2\%$  with diffused light in 4 replications. After eight days, the seedlings were evaluated and the normal seedlings produced were counted and expressed in per cent as per the ISTA (1999). From the germinated seedlings, root

length (cm), shoot length (cm), dry matter production (mg/10 seedlings) were observed. The vigour index was calculated using the following formula as per Abdul-baki and Anderson (1973) and expressed in the whole number:

$$\text{Vigour index} = \text{Germination (\%)} \times \text{Total seedling length (cm)} \quad \dots\dots\dots \text{Eq.1}$$

The resultant data were analysed statistically as per Completely Randomized Design to note the variance and evaluated (t-tested) for a significant difference of ( $P=0.05$ ) as proposed by Panse and Sukhatme (1999), Percentage values were transformed to sine values prior to statistical analysis.

## RESULTS AND DISCUSSION

The highest seed recovery percentage was recorded in the sieve size of BSS 22 X 22 retained seeds irrespective of the time duration. The seed recovery percentage ranged from 67.41% - 56% for a period of 2 minutes to 5 minutes. The seed recovery percentage decreased with an increase in the time period of seed grading. The seed recovery of 2 minutes and 3 minutes graded seeds and 4 minutes and 5 minutes graded seeds were on par with each other. The seed graded for 2 minutes recorded a 1000 seed weight of 61.21 mg and with increased time duration, the 1000 seed weight showed higher values of 63.74 mg, 67.32 mg and 73.21 mg. Similarly, the other seed quality parameter recorded a similar trend by recording 77% germination for 2 minutes, 89% for 3 minutes, 91% for 4 minutes and 95% for 5 minutes (Table 1 to 4).

The highest recovery was observed in the treatment of  $T_4$  (BSS 22 X 22 R = 67.41% ) under an agitation period of 2 minutes followed by  $T_5$  (BSS 22 X 22 (P) (29.14%) but the other quality parameters such as



Plate 1. Gyratory Seed shaker for size grading

**Table 1.** Standardization of optimum sieve size for a period of 2 minutes

Treatment/Size grades (BSS)	Seed Recovery (%)	1000 seed weight (mg)	Germination (%)	Root length (cm)	Shoot length (cm)	Dry matter production (mg)	Vigour Index
T <sub>1</sub> - Ungraded	-	55.32	72(58.053)	5.7	3.1	10.01	721
T <sub>2</sub> -18 X 18(R)	0.16	72.91	91(72.544)	6.7	3.5	13.17	1198
T <sub>3</sub> -20 X 20(R)	2.86	67.25	88(69.734)	6.5	3.1	12.18	1072
T <sub>4</sub> - 22 X 22(R)	67.41	61.21	77(61.343)	6.3	3.4	11.63	896
T <sub>5</sub> - 22 X 22(P)	29.14	53.72	60(50.769)	5.1	3.0	7.63	458
SEd	0.0765	3.1488	0.4806	0.0880	0.0434	0.1451	18.9402
CD(P=0.05)	0.1666	6.6754	1.0472	0.1917	0.0946	0.3161	41.2676

**Table 2.** Standardization of optimum sieve size for a period of 3 minutes

Treatment/Size grades (BSS)	Seed Recovery (%)	1000 seed weight (mg)	Germination (%)	Root length (cm)	Shoot length (cm)	Dry matter production (mg)	Vigour Index
T <sub>1</sub> - Ungraded	-	55.32	72(58.053)	5.7	3.1	10.01	721
T <sub>2</sub> -18 X 18(R)	-	-	-	-	-	-	-
T <sub>3</sub> -20 X 20(R)	2.95	69.71	93(74.660)	7.1	3.8	14.17	1318
T <sub>4</sub> - 22 X 22(R)	66.56	63.74	89(70.632)	6.9	3.7	11.72	1043
T <sub>5</sub> - 22 X 22(P)	29.87	55.36	63(52.536)	5.1	2.9	8.47	534
SEd	0.5253	0.8218	1.0295	0.0299	0.0393	0.2333	18.7009
CD(P=0.05)	1.1446	1.7906	2.2431	0.0652	0.0857	0.5084	40.7462

**Table 3.** Standardization of optimum sieve size for a period of 4 minutes

Treatment	Seed Recovery (%)	1000 seed weight (mg)	Germination (%)	Root length (cm)	Shoot length (cm)	Dry matter production (mg)	Vigour Index
T <sub>1</sub> - Ungraded	-	55.32	72(58.053)	5.7	3.1	10.01	721
T <sub>2</sub> -18 X18(R)	-	-	-	-	-	-	-
T <sub>3</sub> -20 X20(R)	3.29	74.32	95(77.081)	6.8	3.2	16.34	1552
T <sub>4</sub> - 22 X22(R)	56.53	67.32	91(72.544)	6.7	3.4	13.17	1198
T <sub>5</sub> - 22 X 22(P)	40.18	57.62	65(53.730)	5.8	2.9	7.26	472
SEd	0.2573	0.5463	0.7778	0.0563	0.0625	0.1678	13.1205
CD(P=0.05)	0.5607	1.1902	1.6947	0.1227	0.1361	0.3655	28.5874

1000 seed weight (72.91 mg), germination percentage (91%), root length (6.7 cm), shoot length(3.5cm), dry matter production (13.17mg/10 seedlings) and vigour index II = 1198 were observed to be higher in T<sub>2</sub> (BSS 18 X 18 R) but with lowest recovery of 0.16 %. According to Paramasivam (1990), higher germination, vigour index and other quality attributes in large seeds of peas than the smaller ones. Sieve size of BSS 20 X 20 R and BSS 22 X 22 R were on par. The seeds passed out through BSS 22 X 22 had the lowest germination (60%) than the ungraded seeds (72%) (Table 1). Germination

was higher in heavier seeds due to a well-developed embryo and sound seed filling resulting in a huge amount of energy that is expressed in seedling length and seedling vigour (McDaniel, 1969).

Under the agitation period of 3 minutes, the seeds with the highest recovery (66.56 %) were observed to be high in T<sub>4</sub> (BSS 22 X 22 R) with 89% germination, root length (6.9 cm), shoot length (3.7 cm), DMP (11.72 mg/10 seedlings) and vigour index II (1043), whereas the lowest recovery (2.95 %) was observed in T<sub>3</sub> (BSS 20 X 20) with the highest seed quality parameters

**Table 4.** Standardization of optimum sieve size for a period of 5 minutes

Treatment	Seed Recovery (%)	1000 seed weight (mg)	Germination (%)	Root length (cm)	Shoot length (cm)	Dry matter production (mg)	Vigour Index
T <sub>1</sub> - Ungraded	-	55.32	72(58.053)	5.7	3.1	10.01	721
T <sub>2</sub> -18 X 18(R)	-	-	-	-	-	-	-
T <sub>3</sub> -20 X 20(R)	3.93	77.14	97(80.028)	7.9	3.9	15.33	1487
T <sub>4</sub> - 22 X 22(R)	56.00	73.21	95(77.081)	7.2	3.6	14.31	1145
T <sub>5</sub> - 22 X 22(P)	40.07	60.24	68(55.551)	6.1	3.2	9.84	669
SEd	0.1394	1.1937	0.4842	0.0787	0.0584	0.1546	7.7262
CD(P=0.05)	0.3036	2.6009	1.0550	0.1715	0.1273	0.3369	16.8341

(Table 2), because of the increased seed size and nutritional reserves. Patil and Sarode (1988) found that the seed weight of the heaviest graded seeds in agricultural crops was greater and heavier than the light and lighter seeds. According to Manikandan and Srimathi (2014), 1000 seed weight was higher in the heaviest fraction of seed gathered.

When seed shaker was operated under 4 minutes, the maximum level of seed recovery (55.63 %) was noted in T<sub>4</sub> (BSS 22 X 22 R) with germination percentage (91 %), root length (6.7 cm), shoot length (3.4 cm), DMP (13.17 mg/10 seedlings) and Vigour Index (1198), whereas T<sub>3</sub> (BSS 20 X 20 R) had top most level of 1000 seed weight (74.32 mg) with minimum recovery percentage of 3.29 % which will be uneconomical for commercial purpose. Seed quality parameters lesser than ungraded seeds were observed in T<sub>5</sub> (BSS 22 X 22 P). Hence, T<sub>4</sub> (BSS 22 X 22 R) was considered suitable treatment under 4 minutes duration with fine seed quality characteristics and maximum recovery (Table 3). Palanisamy (1990) reported that the superiority of large and medium-size seeds would influence the via-

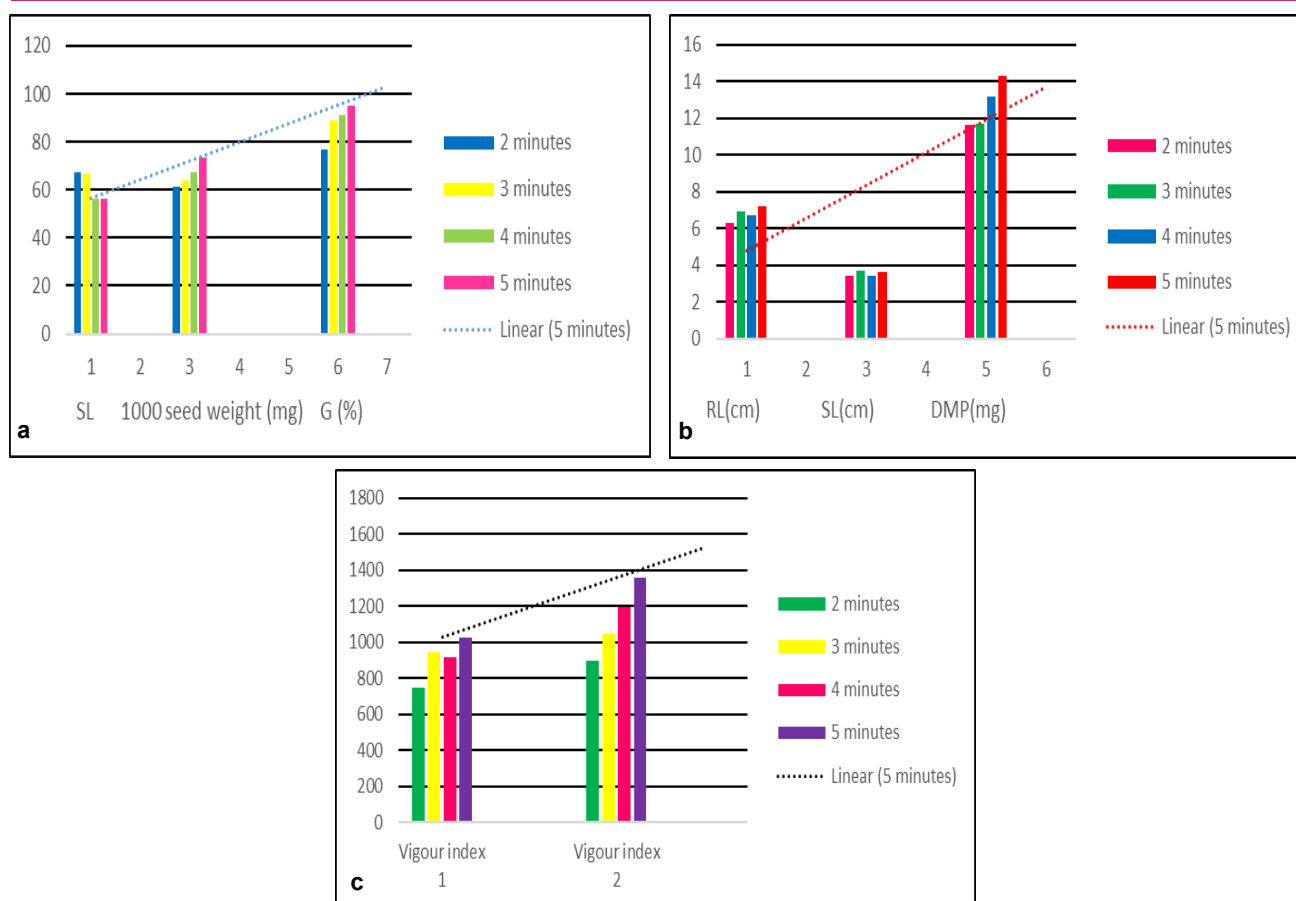
bility of tomatoes.

When seed shaker was ruined for a period of 5 minutes, the highest recovery (56 %) was observed under T<sub>4</sub> (BSS 22 X 22) with 1000 seed weight of 73.21 mg, germination (95%), root and shoot length (7.2 cm and 3.6 cm), DMP (14.31 mg/10 seedlings) and vigour index (1145). Hence, T<sub>4</sub> (BSS 22 X 22 R) was considered to be a suitable treatment (Table 4). Pandita and Randhawa (1996) suggested that sowing of medium to large size seeds will significantly increase seed yield and quality in beet leaves. Several studies like that of Sivasubramaniam (2008) in kolinji (*Nigella sativa*), Jerlin et al. (2010) in jute (*Corchorus capsularis*); Sadeghi et al. (2011) in safflower (*Carthamus tinctorius*); Udhaaya et al. (2016) in sunn hemp (*Crotalaria juncea*); Ragupathi (2017) in proso millet (*Panicum miliaceum*); Sivasubramaniam et al. (2017) in tephrosia (*Terphrosia purpurea*) and Pozhilarasi et al. (2018) in amaranthus (*A. viridis*) reported a positive association between size and weight of seeds.

Various parameters observed on BSS 22 X 22 R sieve under the duration of 2, 3, 4 and 5 minutes were tabu-

**Table 5.** Fixation of suitable sieve size with optimum duration for effective grading

S.NO	Duration (minutes)	Sieve size	Seed Recovery (%)	1000 seed weight (mg)	Germination (%)	Root length (cm)	Shoot length (cm)	Dry matter Production (mg)	Vigour index
1	2		67.41	61.21	77 (61.343)	6.3	3.4	11.63	896
2	3		66.56	63.74	89 (70.632)	6.9	3.7	11.72	1043
3	4		56.53	67.32	91 (72.544)	6.7	3.4	13.17	1198
4	5	BSS-22 X 22	56.00	73.21	95 (77.081)	7.2	3.6	14.31	1359
Sed			0.7844	0.5011	0.6504	0.0616	0.0615	0.1809	16.4230
CD(P=0.05)			1.7091	1.0919	1.4172	0.1342	0.1340	0.3943	35.7829



**Fig. 1 a-c.** Graphical representation of suitable sieve size with optimum duration for effective grading, a) Seed recovery percentage b) Root length, shoot length and Dry matter production c) Vigour Index (SL-Shoot length, G (%)-Germination per cent, RL-Root length, SL-Shoot length, DMP-Dry matter production

lated in Table 5. Since large seeds have faster breaks in the embryonic axis with increased activity of redox enzyme that breaks the larger complex reserve food materials into simpler soluble sugars and also in other seed parts than small seeds, which have the lowest germination, large seeds have the highest germination (Negi *et al.*, 1998.) and the size of the seeds may have a direct impact on the seedling vitality. Recovery percentage was higher under a duration of 2 minutes (67.41%) followed by 3 minutes (66.56%), 4 minutes (56.53%) and 5 minutes (56%). The study indicated that the larger seeds retained by BSS 22 X 22R showed greater seed germination and vigour than smaller ones (Fig. 1 a and b). This will define that huge seeds have a mature embryo with larger food reserves and nutrients, providing physiological stamina to the seeds (Pollock and Roos, 1972). The most important parameter, i.e., vigour index was observed to be higher under a period of 5 minutes [vigour index I (1026) and vigour index II (1359) (Fig.1 c). Yogeeshia *et al.* (2013) found that heavier seed weight was associated with the highest vigour index in okra. Menaka and Balamurugan (2008) reported that heavier seed weight was associated with the highest vigour index in *Amaranthus*.

## Conclusion

Seed recovery and maximum quality parameters were considered the most important criteria for quality seed production and greens cultivation under a commercial scale. Considering this criterion BSS 22 X 22 R mesh sieve was standardized as a suitable sieve for grading *Amaranthus*. It is recommended that for obtaining the maximum quantity of quality seeds through size grading in *Amaranthus* CO 2, the seeds should be graded by a mechanical seed shaker for a duration of 5 minutes with the sieve size of BSS 22 X 22.

## Conflict of interest

The authors declare that they have no conflict of interest.

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