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Influence of size grading on seed quality of Kabuli chickpea (*Cicer arietinum* L.) varieties

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Abstract
Seed size grading is the important practice for better crop establishment and to improve efficiency of planting ratio in field and also useful in separation of quality seed in a seed lot. In the present study, the influence of seed grading on seed quality parameters were evaluated by using different sieves of two kabuli chickpea varieties *viz.,* BG1105 and MNK-1. Grading of seeds by different sieves had significant influence on seed quality parameters. Among the sieve sizes, 6.50 mm (round) recorded significantly higher seed recovery (96.87%) and germination (100%) in V_1-BG1105 variety, while, MNK-1 variety with maximum seed recovery (97.96%) and germination (98.50%) and other physiological seed quality parameters. The study indicates small to medium size seed had better seed quality parameters as compared to undersized and oversized seeds. The maximum seed recovery per cent and seed quality can be obtained by using 6.50 mm (round) sieve size for kabuli chickpea varieties.

Keywords: grading, kabuli chickpea varieties, sieve size and seed quality

Introduction
Chickpea (*Cicer arietinum* L.) is a old world pulse crop commonly known as bengalgram, garbanzo bean, gram, chana, kadlee and is the third most important pulse crop in the world after beans and peas. The world of chickpea is predominantly by desi type which accounts 80 per cent of production as compared to kabuli type which accounts 20 per cent of production. Chickpeas are classified based on seed size, shape and colour. Two main types of chickpea cultivars grown globally are *kabuli* and *desi*, representing two diverse gene pools. In India white seeded ‘Kabuli chickpea’ being grown in northern parts and brown seeded ‘Desi’ type grown in southern parts of India.

Kabuli types are categorized into three groups based on seed size; large-seeded, medium seeded and small-seeded chickpeas. The use of small seeds can reduce the production costs of *kabuli* chickpea by 15 to 25 per cent by reducing the amount of seed needed per unit area (Gan *et al*., 2003) [5]. In particular, larger seed size coupled with other desirable traits (Eg. Light colour) commands price premiums in a market dependant manner (Graham *et al*, 2001) [9]. Consumer prefers the large-seeded types for whole seed consumption, confectionary products, salads, and savory meals (Regan and Siddique, 2006) [21]. The extra large (>50 g per 100 seed weight) *kabuli* cultivars are sold at three times the price of *desi* and twice the price of kabuli types with 100-seed weight from 25 to 40 g in India (Gaur *et al*, 2006) [6]. High quality seed has the potential to attract premium prices.

Seed size *per se* is an important aspect of seed vigour which is manifested through higher plant stand, plant growth and yield. Generally big seeds with higher amount of initial food reserves emerge early and uniformly and grow vigorously in field and exhibit early advantage of plant vigour with respect to plant performance and yielding ability compared to small and medium seeds in several crops (Poma *et al.*, 1990) [19]. On the contrary in some crops even medium, small and bulk seeds were also found to have equal beneficial effects as that of big seeds with respect to field performance. The small and medium seeds require less moisture for germination, emerge early, establish early, grow vigorously and yield equally as that of big seeds (Kurdikeri, 1991) [14]. As the seed size *per se* is still a controversial issue and there is a need to study the influence of seed size on quality in Kabuli varieties as they show much variations in seed size. Presently, screen size of 5.00 mm, 5.50 mm and 6 mm round (R) are recommended as per Indian Minimum Seed Certification Standards for processing of almost small to medium size Desi type chickpea seeds. There is lack of information on screen size and no specific screen size has been standardized for kabuli type chickpea. To improve the processing efficiency of seed material without sacrificing the seed quantity and quality, it is necessary to find out optimum screen size which can give reasonably higher seed recovery percent and higher seed quality values with special reference to kabuli chickpea varieties.

Materials and Methods

The laboratory experiment was carried out in Complete Randomized Design in Factorial concept. Seed quality parameters were evaluated at Seed Quality and Research Laboratory of National Seed Project (Crops) Seed Unit, University of Agricultural Sciences, Dharwad. Freshly harvested bulk seed lots of BG1105 and MNK-1 were used for size grading. The seeds of each variety were graded using eight different sieve sizes S_1-8 mm, S_2-7.50 mm, S_3-7.00 mm, S_4-6.5 mm, S_5-6.00 mm, S_6-5.50 mm, S_7-5.0 mm and S_8-Bulk. The seeds that retained on the screen were collected separately and there quality parameters were evaluated.

Seed recovery: Seed recovery was calculated by using following formula and was expressed in per cent (%)

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

Test weight: The hundred seed weight in grams (g) was recorded from each treatment combination as per the procedure given by ISTA (Anon., 1999) [2].

Germination: Germination test was conducted using eight replicates of 50 seeds each in the paper (between paper) medium and incubated in the walk in seed germination room maintained at 25 ± 1 °C temperature and 90 ± 5% relative humidity. The number of normal seedlings in each replication was counted at the end of eight days and the mean germination percentage (%) was calculated (ISTA, 2013) [13].

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

Speed of germination: Seeds were germinated on paper medium with eight replications of 50 seeds each as per the procedure as explained under 3.2.6.4.2 and the daily germination counts were taken upto the final count (8^{th} day). The speed of germination was calculated by using the formula given by Maguire (1962) [15].

$$\text{Speed of germination} = \frac{X_1}{Y_1} + \frac{X_2 - X_1}{Y_2} + \dots\dots\dots\dots + \frac{X_n - (X_n - 1)}{Y_n}$$

Where,

X_n = Number of seeds germinated at n^{th} count

Y_n = Number of days from sowing to n^{th} count

Root length: Ten normal seedlings were selected randomly in each treatment from all the replications on 8^{th} day. The root length was measured from the tip of the primary root to base of hypocotyl and mean root length was expressed in centimeter.

Shoot length: Ten normal seedlings used for measuring the root length were used for measuring the shoot length. The shoot length was measured from the base of the primary leaf to the base of the hypocotyl and mean shoot length was expressed in centimeter.

Seedling dry weight: Ten normal seedlings used for measuring the root and shoot length were kept in a butter paper packet and dried in hot air oven maintained at 80 ^{0}C for 24 hours. Then the seedlings were cooled in a desiccator for 30 minutes and the weight of the dried seedlings was recorded using electronic balance and was expressed in milligram per seedling (Evans and Bhatt, 1977) [4].

Seedling vigour index: The seedling vigour index was calculated by using the formula [Seedling vigour index = Germination (%) x Total seedling length (cm)] as suggested by Abdul-Baki and Anderson (1973) [1].

Electrical conductivity of seed leachate: Electrical conductivity of seed leachate test was conducted thirty days after harvest. Five grams of seeds were weighed and surface sterilized with 1.0 per cent mercuric chloride solution for five minutes and washed four times with distilled water. Then these seeds were soaked in 25 ml of distilled water for 12 hours at room temperature (25 ^{0}C). The leachate was decanted into beaker for measuring the electrical conductivity with the help of conductivity meter and expressed as dSm^{-1} (Presley, 1958) [20].

Field emergence: Field emergence was estimated by sowing 100 seeds in 4 replications in the field. Observations were recorded on 14^{th} day after sowing. The emergence was expressed as percentage of seedling emerged.

$$\text{Field emergence (\%)} = \frac{\text{Number of normal seedling produced}}{\text{Total number seeds sown}} \times 100$$

Mobilization efficiency: Mobilization efficiency is defined as mobilization and utilization of food reserves during seed germination and expressed in per cent (%). It is calculated by the following formula as given by Srivastava and Sareen (1974) [24].

$$\text{Mobilization efficiency (\%)} = \frac{\text{Dry weight of seedlings}}{\text{Dry weight of seeds}} \times 100$$

The results were subjected to analysis of variance and tested for significance according to Gomez and Gomez (2010) [8]

Results and Discussion

Seed size grading had a profound influence on seed recovery and seed quality parameters in both kabuli chickpea varieties. Among the varieties, highest seed recovery (96.73%), test weight (32.54 g) and electrical conductivity (1.541 dSm^{-1}) was recorded by MNK-1 (V_2) variety as compared to BG1105 (V_1) variety (78.05%, 20.54 g and 1.507 dSm^{-1}, respectively). While, BG1105 (V_1) recorded higher field emergence (67.39%), speed of germination (48.98), mobilization efficiency (47.10%), seed germination (96.42%), root length (18.45 cm), shoot length (9.32 cm), seedling dry weight (690 mg) and seedling vigour index (2688) as compared to MNK-1 (V_2) (60.69%, 36.26, 22.08%, 94.53%, 17.69 cm, 9.14 cm, 552 mg and 2542, respectively) (Table 1 & 2) this may be due to genetic character governed in both varieties. Similar results were obtained by Merwade (2002) [16] and Gnyandev *et al.* (2015) in Chickpea

The seed recovery percentage differed significantly due to sieve sizes. Among the sieve sizes 6.00 mm sieve (S_5) recorded significantly higher seed recovery (98.35%) which was on par with 6.50 mm sieve (S_4) (97.36%) followed by 7.00 mm sieve (85.49%), 7.50 mm sieve (72.42%) (Table 1) (Fig 1 and 2). Seed retained on sieve size of 6 mm and 6.5 mm indicated a minimum possible rejection of undesired and shriveled seeds during processing and was helpful in upgrading the physical quality of seed lot kabuli chickpea. Significantly lower recovery percentage (45.47%) was recorded with 8 mm sieve. Since, sieve size of 5.00 and 5.50 mm were smaller than kabuli chickpea seed, they were not suitable for seed grading. The interaction effects between sieve sizes and varieties were also significant. The difference in seed recovery percentage was due to the removal of undersized from the sieves and retention of only medium to bold seeds on the sieve. Similar results of decrease in recovery percentage with increase in sieve size were reported by Merwade (2002) [16] in chickpea. Similarly the sieve size 6.50 mm sieve (S_4) recorded significantly higher seed germination (99.25%), while lower germination percentage (92.00%) was recorded in bulk seed (Table 1) (Fig 1 and 2). The interaction effects between sieve sizes and varieties were also significant. The difference in germination may be due to differences in seed size were, small and spherical seeds generally escape injury caused due to mechanical damage during harvesting, handling and processing and tends to suffer less damage, whereas larger or irregularly shaped and elongated seeds are likely to be extensively damaged (Roberts, 1972) [22]. The large cotyledons and location of embryo axis represent a structure that will tolerate only low level of impact leading to difference in germination. These results are in conformation with Merwade (2002) [16] and Gyandev (2009) [7] in chickpea.

The sieve size of 6.50 mm recorded significantly higher speed of germination (51.35) as compared to in bulk seeds (37.66) (Table 1). The interaction effects between sieve sizes and varieties were also significant. This may be probably due to the difference in the rate of growth of seedlings, wherein the small to medium size seeds required less moisture than the large size seeds and would have completed the process of imbibitions earlier than the large size seeds (Singh *et al.*, 1972) [23]. Thus, the small to medium seeds would have put fourth longer seedlings and when seedling length was used along with germination to compute vigour index resulted in higher values for vigour index. A similar finding suggest that small-seeded variant of Lee had better germination, greater early hypocotyl development and lower leakage of sugars than the large-seeded type (Gupta 1976) [11].

Significantly higher root length (21.20 cm), shoot length (11.34 cm), seedling dry weight (846 mg) was recorded by seeds retained on sieve sizes 6.50 mm sieve as compared to bulk seeds (15.39 cm, 7.09 cm and 372 mg, respectively) (Table 2). The interaction effects between sieve sizes and varieties were also significant. This may be due to the adequate quantity of reserve food material in the small to medium sized seeds endosperm and better supply of food to the embryo for a long period of time which help in higher mobilization efficiency of reserve food material during germination leading to more number of cells per cotyledon in the form of reserve food material resulting in increased root, shoot length and seedling dry weight (Guldan and Brun, 1985) [10]. On the other side larger sized seed lack in mobilization of food reserves leading to less seed germination reduced root and shoot length. The increased per cent of germination and seedling length lead to higher vigour index (3230) when compared to bulk seeds (2068) (Table 2).

Similarly seeds retained on sieve sizes 6.50 mm sieve recorded significantly lower electrical conductivity (1.305 dSm^{-1}) and higher electrical conductivity (1.786 dSm^{-1}) was recorded in bulk seeds (Table 2). The interaction effects between sieve sizes and varieties were also significant. This might be due to smaller seed size with less exposure of seed surface to imbibition injury and leaching of less electrolyte as compared to larger size seed which have more surface area leading to more imbibitions damage and leaching of leacheate which increase electrical conductivity. Similar report by Verma and Gupta (1975) [25] observed lower free fatty acids, sugars and electrolytes in the seed leachate in case of small size seeds than the large size seeds and further reported that the small seeded varieties of soybean deteriorated slowly than the large seeded varieties

The sieve sizes 8.00 mm sieve recorded significantly highest test weight (32.82 g) and lower test weight (15.09 g) was recorded in 6.00 mm sieve size (Table 1). The interaction effects between sieve sizes and varieties were also significant. This may be due to grading of seeds based on sieve sizes leading to increased test weight with increase in sieve sizes. Higher field emergence (81.63%) and mobilization efficiency (45.94%) was recorded by seeds retained on 6.50 mm when compared to bulk seeds (50.08 and 21.13%, respectively) (Table 1). This may be due to smaller and medium size seed which may be more resistant to mechanical damage with increased mobilization efficiency. While large seed may be prone to mechanical damage to embryonic axis leading to leaching of electrolytes which might have lead to increased activity of pathogen leading to damage of radicle and plumule resulting in abnormal seedling with less field emergence and also smaller the seed size less was the resistance by the planting media during emergence (Burris *et al.* 1973). Consequently, increased emergence was associated with decreased seed sizes. It may also be due to the reasons that the large size seeds had received more mechanical injuries as evident from the results on extent of mechanical damage. The large soybean seeds which were wrinkled and ruptured had more breaks in the embryonic axis and other important seed parts and showed poor germination and viability as compared to the smooth small seeds (Negi *et al.* 1988) [18]. These results are also in confirmation with the findings of Hopper *et al.*, 1979; and Mohanrao, 1993) [17].

Conclusion: The present investigation on influence of seed size grading had a profound effect on seed quality of kabuli chickpea varieties. The seed retained on sieve size of 6.50 mm (round) significantly recorded higher seed recovery (96.87%) and germination (100%) in BG1105 variety, while, MNK-1 variety with maximum seed recovery (97.96%) and germination (98.50%) with better seed physiological parameters. The study indicates small to medium size seed had better seed quality parameters as compared to undersized and oversized seeds. The maximum seed recovery per cent and seed quality can be obtained by using 6.50 mm (round) sieve size for kabuli chickpea varieties.

Table 1: Influence of sieve size grading on seed recovery (%), test weight (g), field emergence (%), speed of germination, mobilization efficiency (%) and germination (%) in kabuli chickpea varieties

Varieties (V)	Seed recovery (%)	Test weight (g)	Field emergence (%)	Speed of germination	Mobilization efficiency (%)	Germination (%)
V_1	78.05	20.54	67.39	48.98	47.10	96.42
V_2	96.73	32.54	60.69	36.26	22.08	94.53
S. Em. ±	0.22	0.1	1.16	0.21	1.20	0.14
C. D. @ 1%	0.84	0.39	4.42	0.8	4.57	0.52
Seive sizes (S)						
S_1-8 mm	45.47	32.82	62.81	41.75	36.81	96.38
S_2-7.50 mm	72.42	27.82	66.31	46.70	41.96	97.98
S_3-7.00 mm	85.49	23.17	75.06	51.12	45.94	98.38
S_4-6.5 mm	97.36	20.83	81.63	51.37	42.84	99.25
S_5-6.00 mm	98.35	15.09	60.31	38.91	35.91	93.21
S_6-5.50 mm	100.00	30.68	58.13	37.51	26.65	93.23
S_7-5.0 mm	100.00	30.33	57.98	36.86	25.49	93.36
S_8-Bulk	100.00	31.58	50.08	36.74	21.13	92.00
S. Em. ±	0.44	0.20	2.33	0.42	2.41	0.27
C. D. @ 1%	1.68	0.78	8.83	1.60	9.14	1.04
Interactions (V X S)						
V_1S_1	6.20	31.42	66.88	50.24	42.16	98.50
V_1S_2	50.54	27.03	72.38	56.19	47.46	99.50
V_1S_3	73.39	22.06	75.38	57.25	65.01	100.00
V_1S_4	96.87	17.67	85.25	57.71	68.01	100.00
V_1S_5	97.47	11.01	64.88	44.76	41.96	92.50
V_1S_6	100.00	18.19	60.71	42.06	41.91	93.50
V_1S_7	100.00	17.84	60.51	41.86	39.64	93.85
V_1S_8	100.00	19.09	60.41	41.76	30.68	93.50
V_2S_1	84.74	34.23	58.75	33.26	31.46	94.25
V_2S_2	94.30	28.61	60.25	37.21	36.46	96.45
V_2S_3	97.58	24.28	74.75	44.99	26.88	96.75
V_2S_4	97.96	23.98	78.00	45.04	17.68	98.50
V_2S_5	99.24	19.17	55.75	33.06	29.85	93.93
V_2S_6	100.00	43.16	55.55	32.96	11.38	92.95
V_2S_7	100.00	42.81	55.45	31.86	11.33	92.88
V_2S_8	100.00	44.06	39.75	31.71	11.58	90.50
Mean	87.39	26.54	64.04	42.62	34.59	95.47
S. Em. ±	0.63	0.29	3.29	0.60	3.41	0.39
C. D. @ 1%	2.38	1.10	12.49	2.26	12.92	1.47

Table 2: Influence of sieve size grading on root and shoot length (cm), seedling dry weight (mg), seedling vigour index and electrical conductivity in kabuli chickpea varieties

Varieties (V)	Root length (cm)	Shoot length(cm)	Seedling dry weight (mg)	Seedling vigour index	Electrical conductivity (dSm^{-1})
V_1	18.45	9.32	690	2688	1.507
V_2	17.69	9.14	552	2542	1.541
S. Em. ±	0.12	0.03	7	12	0.005
C. D. @ 1%	0.44	0.11	25	45	0.019
S_1-8 mm	18.08	9.25	676	2637	1.504
S_2-7.50 mm	18.61	10.03	734	2808	1.399
S_3-7.00 mm	20.97	10.89	759	3135	1.337
S_4-6.5 mm	21.2	11.34	816	3230	1.305
S_5-6.00 mm	16.95	8.55	631	2376	1.536
S_6-5.50 mm	16.81	8.43	558	2353	1.586
S_7-5.0 mm	16.56	8.23	422	2314	1.738
S_8-Bulk	15.39	7.09	372	2068	1.786
S. Em. ±	0.23	0.06	13	24	0.01
C. D. @ 1%	0.89	0.23	51	90	0.037
V_1S_1	19.46	9.71	710	2873	1.504
V_1S_2	20.28	9.99	808	3011	1.398
V_1S_3	21.08	11.15	841	3223	1.308
V_1S_4	21.23	11.76	907	3298	1.285
V_1S_5	17.33	8.31	707	2371	1.510
V_1S_6	17.08	8.17	580	2360	1.560
V_1S_7	16.58	7.92	507	2299	1.725
V_1S_8	14.60	7.52	457	2068	1.760
V_2S_1	16.69	8.79	643	2401	1.504
V_2S_2	16.94	10.06	659	2605	1.399
V_2S_3	20.87	10.63	677	3048	1.366
V_2S_4	21.17	10.93	725	3162	1.325
V_2S_5	16.56	8.78	554	2380	1.562
V_2S_6	16.55	8.70	537	2346	1.612
V_2S_7	16.54	8.55	337	2330	1.750
V_2S_8	16.19	6.66	287	2068	1.812
Mean	18.07	9.23	621	2615	1.52
S. Em. ±	0.33	0.09	19	34	0.014
C. D. @ 1%	1.25	0.32	72	127	0.053

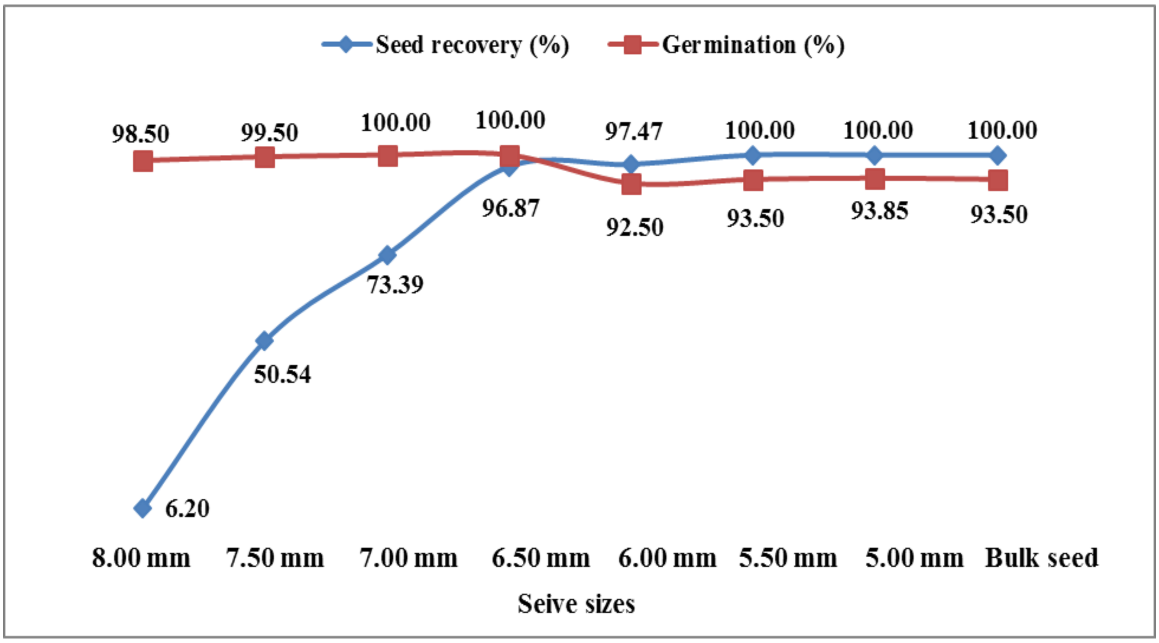

Fig 1: Influence of seive size grading on seed recovery and germination percentage for BG1105 (V_1) kabuli chickpea variety

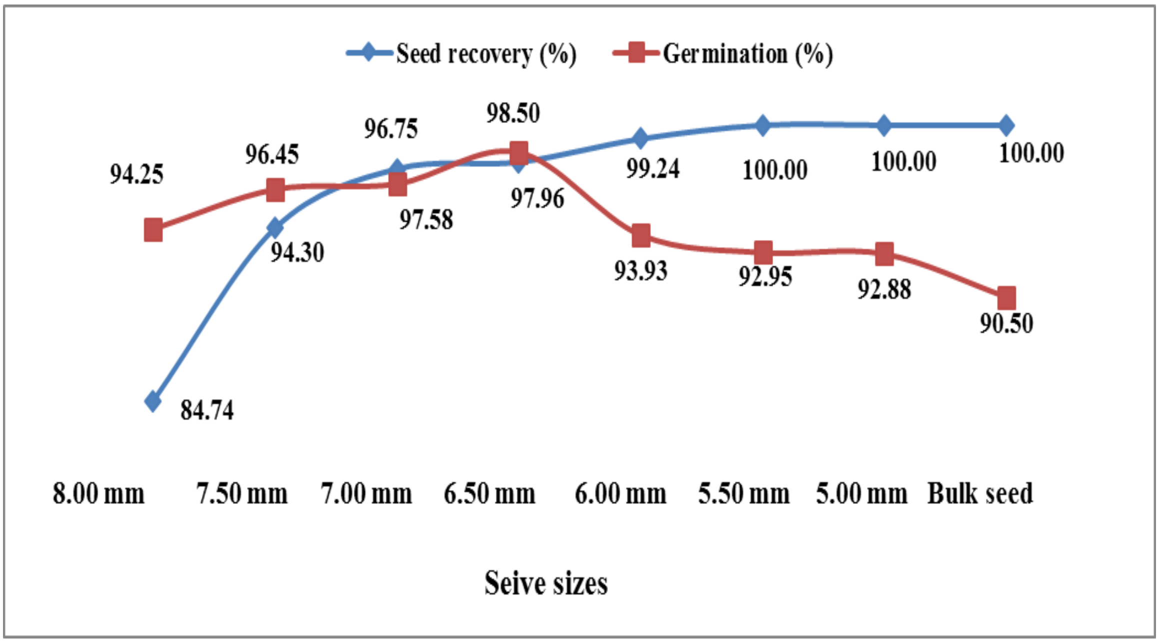

Fig 2: Influence of seive size grading on seed recovery and germination percentage for MNK-1 (V_2) kabuli chickpea variety

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