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The Effect of Stage of Harvest and Storage on the Seed Quality of Chickpea (*Cicer arietinum* L.)

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Abstract

Laboratory experiments were carried out to determine the effects of harvesting stages on the seed quality of chickpea. Chickpea seed of three varieties (BARI Chola-5, BARI Chola-6 and BARI Chola-8) were collected at three harvestings times i.e. from three different times at 7 days interval prior to harvesting, viz. i) when the pods were yellowish with a few yellow greens (H_1 stage), ii) when most of the pods were light brown with a few yellow (H_2 stage), and iii) when all the pods were completely brown and dry (H_3 stage). Significant variation was observed in three varieties of chickpea for all the parameters studied except vigour-I. The highest germination percentage, root length, shoot length, root plus shoot length and vigour-II was observed in BARI Chola-5 which was significantly higher over BARI Chola-8. Dry weight was found to be significantly higher in BARI Chola-8 which was identical to BARI Chola-6. Moisture content was significantly higher in BARI Chola-8. Seed collected at the stage when most of the pods were light brown with a few yellow (H_2 stage) recorded the highest germination percentage, dry weight, vigour-I and root length. Pods (H_1 stage) gave the highest moisture content in seeds. BARI Chola-5 seeds recorded the highest germination at H_2 stage. Interaction effects of varieties and harvesting stage had non-significant effect on germination percentage, vigour-I, shoot length and vigour-II in both the years.

Keywords: Chickpea, Harvesting stage, Storage, Vigour, Moisture, Germination

Introduction

Seed development is the period between fertilizer and maximum fresh weight accumulation and seed maturation begins at the end of seed developments and continues till harvested (Mehta *et al.,* 1993). The seed reaches its maximum dry weight at physiological maturity.

Storability of seed is mainly a genetical character and is influenced by pre-storage history of seed, seed maturation, environmental factors during pre and post harvest stages, etc. (Mahesha *et al.,* 2001b). Early harvested seeds will be immature and poorly development and as such are poor storers compared to seed harvest at physiological maturity (Singh and Lachanna, 1995).

At physiological maturity, seed shall have maximum viability and vigour. Attainment of physiological maturity is a genotypic character which is influenced by environmental factors (Mahesha *et al.,* 2001a). As such harvesting of seed crop at optimum stage of seed maturation is essential to obtain better seed quality.

Moisture content of harvested crop affects seed quality and hence it determines with which moisture content the crop should be threshed. Harvesting at high moisture content increases the changes of mycofloral infection on seed while harvesting at low moisture content increases mechanical damage to seed (Yadav *et al*. 2005). Seeds harvested at early were immature and poorly developed and as such are poor storers compared to seed harvested at physiological maturity (Mahesha *et al.,* 2001a). Kumar *et al*. (2002) reported that seed yield and quality largely depends on the stage of maturity. As such, harvesting of seeds at right stage of maturity is most important since harvesting either at early or late stage results in lower yields with poor quality seeds.

Harvesting time of any crop for seed quality depends on its maturity time and on physiological maturity. Harvesting of

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seeds at optimum stage of maturity helps to obtain better quality seed. Harvesting stage influences the quality of seed in relation to germination, vigour, viability and also storability. Seed quality in storage is also influenced by the condition, which not yet studied for chickpea seed storage. Therefore, the investigation was carried out to find out the right time of harvest to ensure seed quality of chickpea.

Materials and Methods

Laboratory experiments were carried out at Seed Technology Division Laboratory in the Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur, Bangladesh during the period from August to September 2004 and 2005 to determine the effects of harvesting stages on seed quality of chickpea under laboratory conditions. Previously chickpea seeds of three varieties viz. BARI Chola-5, BARI Chola-6 and BARI Chola-8 were collected from Pulses Research Centre experimental field of BARI, Bangladesh in rabi seasons of 2003-04 considering three different times of harvest at 7 days interval, viz. i) when the pods were yellowing with a few yellow greens (H_1 stage), ii) when most of the pods were light brown with a few yellow (H_2 stage), and iii) when all the pods were completely brown and dry (H_3 stage). The collected seeds were preserved in the earthen pot. Before setting up the field experiment, laboratory experiment was carried out for recording the seed quality data. Laboratorial experiments were conducted in Complete Randomized Design with the above seeds of chickpea. The following quality parameters (moisture %, germination %) and seed vigour contributing characters were recorded:

Determination of moisture content

The moisture content of seed samples were determined by ISTA, 1976. Grinded (10 g) seed samples each of chickpea were taken into moisture cup and put into a pre-heated oven at temperature of 103 ± 2^{O}C for one hour. Three replicates were taken. After cooling, the weight of the container with its cover and contents were taken. The seed samples were cooled in desiccators and weighed to work out the percent moisture content of the grains. The seed moisture content was determined by dry weight basis and was calculated by the following formula:

$\{(M_2-M_3) / (M_2-M_1)\} \times 100$

Where, M_1 is the weight in gram of the container and its cover, M_2 is the weight in gram of the container, its cover and its contents before drying, and M_3 is the weight in gram of the container, its cover and contents after drying.

Determination of germination test

Germinations were carried out according to ISTA rule 1976. For each treatment, 100 seeds were put into petri dishes. Four replicates were used. The petri dishes were put up on a laboratory table at room temperature (25±2^{O}C). After ten days, normal, abnormal and diseased seeds were counted.

Measurement of root and shoot length

After ten days, ten plants were randomly selected for study, taking from each replicate of each treatment. The seedlings were cut into root and shoot parts. They were measured (in cm) and the mean value was computed.

Determination of fresh and dry weight of seedling

After measuring the root and shoot length as described above, fresh weight of seedlings was recorded. Then the root and shoot were put into paper packet separately, and placed into the preheated oven (70^{O}C) for 48 hours. After cooling in desiccators, the dry weight was taken.

Determination of seed vigour

Seedling vigour was calculated based on the following formulae (Reddy and Khan, 2001):

Vigour index-I: Percent germination x total dry weight of seedling.

Vigour index-II: Percent germination x length of seedling.

The data for different characters were compiled and tabulated in proper form and then subjected to statistical analysis following a computer IRRISTAT package programme adjusted the means. The correlation co-efficient were done for different variables wherever needed.

Results and Discussion

Moisture percentage

Observation on moisture percentage in three chickpea varieties revealed that varieties differed significantly among themselves (Table I). The highest moisture percentage

Table I. Effects of different varieties of chickpea on different seed quality parameters

Variety	Moisture (%)	Germination (%)	Dry weight (g)	Vigour I	Root length (cm)	Shoot length (cm)	Root + shoot length (cm)	Vigour II
2004								
BARI Chola-5	8.85b	86.2a	0.45b	38.4	14.43a	12.84a	27.28a	2351a
BARI Chola-6	9.21b	83.3a	0.49ab	40.7	13.14b	12.63ab	25.78b	2146a
BARI Chola-8	10.16a	77.1b	0.53a	41.2	12.83b	11.58b	24.41b	1879b
SE (±)	0.167	2.05	0.015	-	0.250	0.258	0.335	55.1
Sig.	**	*	**	NS	**	**	**	**
2005								
BARI Chola-5	8.67b	86.0a	0.46b	39.7	14.67	13.54a	28.21a	2429a
BARI Chola-6	8.87b	83.1a	0.50ab	42.0	13.27	13.27a	26.53ab	2207ab
BARI Chola-8	10.69a	78.3b	0.55a	43.3	12.83	11.63b	24.47b	1918b
SE (±)	0.168	0.88	0.023	-	-	0.24	0.38	79.2
Sig.	**	**	*	NS	NS	**	**	**

In a column, the figure(s) having same letter are not significantly different
*Significant at 5% level, **Significant at 1% level, NS: Not significant

(10.16% in 2004 and 10.69% in 2005) was observed in BARI Chola-8, which was statistically different from BARI Chola-5 and BARI Chola-6. The lowest moisture percentage (8.85% in 2004 and 8.67% in 2005) was observed in BARI Chola-5. Shahjahan (2003) observed that chickpea seed contained 8.74-13.40% moisture content after nine months of storing in six types of containers. Morshed *et al.* (2003) reported that chickpea seed contained 9.28-11.75% moisture content after six months of storing. There was a highly significant effect of harvesting stage on moisture percentage (Table II). Pods collected at the stage of yellow with a few yellow green (H_1 stage) recorded higher moisture percentage (9.94% in 2004 and 9.87% in 2005). The lowest moisture (8.84% in 2004 and 9.20% in 2005) was observed by the seed that were collected at the stage of light brown with a few yellow green (H_2) and when all the pods were completely brown and dry (H_3), respectively. Mehta *et al.* (1993) reported that seed harvested at 29 days after anthesis (DAA) showed the highest moisture percentage while seed harvested at 45 DAA showed the lowest moisture percentage. Moisture content was the highest in H_1 stage i.e. seed collected at 30 days after flowering (DAF) and the lowest moisture content in H_3 stage i.e. at 40 DAF (Mahesha *et al.*, 2001a). The decrease in seed moisture content (Robertson *et al.*, 1978), increase in test weight (Robertson *et al.*, 1978) and germination percentage (Shete *et al.*, 1992) were reported with the advancement of harvesting dates. The interaction between varieties and harvesting stages was significant for moisture percentage (Table III). Moisture percentage was the highest due to the interaction effect of BARI Chola-8 x H_3 in 2004 and BARI Chola-8 x H_2 in 2005. The lowest moisture percentage was observed in V_1H_2 in 2004, and in V_2H_2 and V_2H_3 in 2005.

Germination percentage

The tested chickpea varieties differed in germination percentage (Table I). Among three varieties, germination percentage was higher (86.2% in 2004 and 86.0% in 2005) in BARI Chola-5 which was identical to BARI Chola-6. The lowest germination percentage (77.1% in 2004 and 78.3% in 2005) was observed in BARI Chola-8. Morshed et al. (2003) reported that khesari seed gave 85.0-95.0% germination while mungbean seed gave 85.0-95.0% germination percent after six months of storing. Bhingarde and Dumbre (1993) reported that large sized seed gave higher germination percentage (48%) and smaller size seed gave lower germination percentage (46.0%). Borate *et al.* (1993) observed that germination was higher (89.6%) in large size seed and lower (85.2%) in small size seed of groundnut. Mahesha *et al*. (2001b) reported that varieties differed significantly on germination percentage. Harvesting stage markedly did not markedly increase the germination percentage (Table II). Seed collected in H_2 stage gave the highest germination percentage (83.4% in 2004 and 83.5% in 2005). The lowest germination percentage was observed in H_1 stage. It indicated that germination was less in early harvested seed compared to seed harvested at later stages. Lesser germination (%) attributes in early harvested seed may due to presence of more number of immature and unfilled seed. Harvesting the

Table II. Effects of chickpea seeds collected from different harvesting stages on different seed quality parameters

Harvesting Stage	Moisture (%)	Germi-nation (%)	Dry weight (g)	Vigour I	Root length (cm)	Shoot length (cm)	Root + shoot length (cm)	Vigour II
2004								
H_1	9.94a	80.1	0.49	38.8	13.17	12.38ab	25.54ab	2046
H_2	8.84b	83.4	0.50	41.5	13.67	11.68b	25.34b	2118
H_3	9.46ab	83.1	0.48	40.0	13.58	13.00a	26.58a	2212
SE (±)	0.167	-	-	-	-	0.258	0.335	-
Sig.	**	NS	NS	NS	NS	**	*	NS
2005								
H_1	9.87a	81.2	0.50	40.8	13.07	12.90	25.97	2113
H_2	9.21b	83.5	0.51	42.5	13.90	12.94	26.84	2248
H_3	9.20b	82.7	0.50	41.6	13.80	12.60	26.40	2193
SE (±)	0.168	-	-	-	-	-	-	-
Sig.	*	NS	NS	NS	NS	NS	NS	NS

In a column, the figure(s) having same letter are not significantly different
*Significant at 5% level, **Significant at 1% level, NS: Not significant
H_1: When pods were yellow with a few yellow green
H_2: Most pods were light brown with a few yellow green
H_3: All the pods were completely brown and dry

crop earlier resulted in poor seed quality owing to immaturity (Jayaraj and Karivaratharaju, 1992). Mehta *et al.* (1993) reported that seed harvested at 37 to onwards of DAA recorded higher germination percentage while seed harvested at 33 DAA showed the lower germination percentage. They also observed that seed harvested before 33 DAA drastically reduced the germination percentage. Significant differences were also noted in germination due to harvesting. Seed collected 40 days after anthesis registered lowest germination (25.0%) and it was the highest (91.3%) on 60th day after anthesis (Jayaraj and Karivaratharaju, 1992). Germination percentage was the highest in H_2 stage i.e. seed collected at 35 days after flowering (DAF) and the lowest in H1 stage i.e. at 30 DAF (Mahesha *et al.*, 2001a, 2001b). The decrease in seed moisture content (Robertson *et al*., 1978), increase in test weight (Robertson *et al.*, 1978) and germination percentage (Shete *et al*., 1992) were reported with the advancement of harvesting dates. In the present study, the highest germination percentage (89%) was observed in 2004 by the interaction of BARI Chola-5 x H_2 and BARI Chola-6 x H_2, and 87.5% in 2005 by the interaction of BARI Chola-5 x H_3 (Table III). The lowest germination percentage was observed in interaction of BARI Chola-8 x H_3. In all varieties, H_2 gave the highest percentage and H_1 gave the lowest.

Dry weight

Shoot dry weight of BARI Chola varieties was significant. BARI Chola-8 recorded the highest shoot dry weight, which was significant over BARI Chola-5 but identical to BARI Chola-6 (Table I). Tomar *et al*. (2000) reported that among four varieties of lentil genotype Pant L 639 recorded significantly higher dry weight. Effect of harvesting stage on dry weight was non-significant (Table II). The maximum shoot dry weight (0.51g plant^{-1} in 2005) was recorded in the harvesting stage of H_2, which differed to H_1. Dry weight was the highest in H_2 stage i.e. seed collected at 35 days after flowering (DAF) and the lowest in H_1 stage i.e. at 30 DAF (Mahesha *et al.*, 2001b). The effect of variety x harvesting stage on shoot dry weight was significant in 2004 (Table III). The maximum shoot dry weight (0.58 g plant^{-1} in 2004) was recorded by BARI Chola-8 x H_1, which was significantly different from all other treatments but identical to V_1H_3, V_2H_2, and V_3H_3 in 2004. The minimum shoot dry weight was observed in BARI Chola-5 x H_1 in 2004 and in BARI Chola-5 x H_2 in 2005.

Vigour-I

The maximum vigour-I was produced by BARI Chola-8 (Table I). This might be due to higher germination percentage and dry weight. The lowest vigour-I (38.4 in 2004 and

Table III. Interaction effects of chickpea varieties and seeds collected from different harvesting stages on different seed quality parameters

Treatment	Moisture (%)	Germination (%)	Dry weight (g)	Vigour I	Root length (cm)	Shoot length (cm)	Root + shoot length (cm)	Vigour II
2004								
V_1H_1	9.81abc	84.0	0.40c	33.7	15.20a	13.07	28.27a	2378
V_1H_2	7.90d	89.0	0.44b	39.2	14.07ab	12.17	26.23bcd	2334
V_1H_3	8.85bcd	85.7	0.50ab	42.2	14.03ab	13.30	27.33ab	2339
V_2H_1	10.11ab	78.0	0.48bc	37.2	12.30cd	13.00	25.30de	1960
V_2H_2	8.85bcd	83.0	0.53ab	44.2	13.23bcd	12.13	25.37d	2103
V_2H_3	8.68cd	89.0	0.46bc	40.7	13.90ab	12.77	26.67bc	2376
V_3H_1	9.89abc	78.3	0.58a	45.4	12.00d	11.07	23.07f	1800
V_3H_2	9.76abc	78.3	0.52b	41.0	13.70bc	10.73	24.43e	1916
V_3H_3	10.84a	74.7	0.50ab	37.1	12.80bcd	12.93	25.73cd	1921
SE (±)	0.289	-	0.027	-	0.433	-	0.580	-
Sig.	**	NS	*	NS	*	NS	*	NS
CV (%)	5.3	7.5	9.4	12.5	5.6	6.3	3.9	7.8
2005								
V_1H_1	9.10bc	83.3	0.47	39.2	14.10	13.50	27.60	2301
V_1H_2	8.50c	87.1	0.45	39.2	14.90	13.93	28.83	2512
V_1H_3	8.40c	87.5	0.46	40.5	15.00	13.20	28.20	2474
V_2H_1	10.00ab	82.1	0.49	40.3	12.80	13.40	26.20	2153
V_2H_2	8.30c	85.1	0.52	44.3	13.30	13.30	26.60	2266
V_2H_3	8.30c	82.0	0.50	41.3	13.70	13.10	26.80	2203
V_3H_1	10.50a	78.2	0.55	43.0	12.30	11.80	24.10	1885
V_3H_2	10.83a	78.2	0.56	43.9	13.50	11.60	25.10	1967
V_3H_3	10.73a	78.5	0.55	43.0	12.70	11.50	24.20	1902
SE (±)	0.292	-	-	-	-	-	-	-
Sig.	*	NS	NS	NS	NS	NS	NS	NS
CV (%)	5.4	3.2	13.9	16.6	11.4	5.7	8.4	10.9

In a column, the figure(s) having same letter are not significantly different
*Significant at 5% level, *Significant at 1% level, NS: Not significant
V_1H_1: BARI Chola-5 x When pods were yellow with a few yellow green
V_1H_2: BARI Chola-5 x Most pods were light brown with a few yellow green
V_1H_3: BARI Chola-5 x All the pods were completely brown and dry
V_2H_1: BARI Chola-6 x When pods were yellow with a few yellow green
V_2H_2: BARI Chola-6 x Most pods were light brown with a few yellow green
V_2H_3: BARI Chola-6 x All the pods were completely brown and dry
V_3H_1: BARI Chola-8 x When pods were yellow with a few yellow green
V_3H_2: BARI Chola-8 x Most pods were light brown with a few yellow green
V_3H_3: BARI Chola-8 x All the pods were completely brown and dry

39.7 in 2005) was noted in BARI Chola-5. Harvesting stage showed non-significant effect on vigour-I (Table II). Higher vigour-I was noted with H_2 harvesting stage and the lowest were observed by H_1. Harvesting the seed before the attainment of physiological maturity recorded lesser viability and vigour potentials due to more number of immature seeds with relatively low degree of embryo development and high moisture content as reported in pea by Matthews (1973)

Interaction of variety x harvesting stage on vigour-I showed non-significant (Table III). The highest seed vigour-I (45.4 in 2004 and 44.3 in 2005) was observed by the interaction of BARI Chola-8 x H_1 in 2004 and Chola-6 x H_2 in 2005. The lowest vigour-I was noted by the interaction of BARI Chola-5 x H_1.

Root length

The maximum root length (14.43 cm in 2004) produced by BARI Chola-5 was significantly superior to other two varieties (Table I). In 2005, root length was also higher in BARI Chola-5 though the length was at par with other two varieties. The lowest root length was recorded by BARI Chola-8. Singh (1992) observed that L 9-12 gave higher root length of 7.2 cm and HP L-5 gave the lower root length of 6.7 cm. Harvesting stage produced non-significant root length (Table II) though the highest root length was recorded in the H_2 stage and the lowest was found in H_1. The interaction effect of harvesting stage on root length of three chickpea varieties revealed that root length was markedly improved by harvesting stages in all the varieties in 2004 (Table III). In BARI Chola-5, H_1 harvesting stage resulted in maximum root length (15.2 cm) in 2004 and BARI Chola-5 x H_3 (15.0 cm) in 2005. Interaction effect of BARI Chola-8 x H_1 recorded the lowest root length.

Shoot length

The maximum shoot length of 12.84 cm in 2004 and 13.54 cm in 2005 was produced by BARI Chola-5, which was identical to BARI Chola-6 (Table I). The lowest shoot length was noted in BARI Chola-8. Singh (1992) observed that L 9-12 gave higher shoot length of 9.8 cm and HP L-5 gave the lower shoot length of 8.6 cm. Significantly higher shoot length (13.0 cm) was produced with H_3 in 2004 (Table II). But in 2005, shoot length was also higher with H2 though the value was non-significant. Interaction of variety x harvesting stage did not differ significantly in respect of shoot length (Table III). The highest shoot length of 13.30 cm was recorded by the interaction of V_1H_3 in 2004 and of 13.93 cm by the interaction of V_1H_2 in 2005. The lowest shoot length was observed in V_3H_2 in 2004 and V_3H_3 in 2005.

Root plus shoot length

The maximum root plus shoot length (27.28 cm and 28.21 cm in 2004 and 2005) was noted by BARI Chola-5, which was significantly superior to BARI Chola-8 (Table I). Mahesha *et al.* (2001b) reported that varieties differed significantly on seedling length. Harvesting stage produced significantly higher root plus shoot length only in 2004 (Table II). The highest root plus shoot length was recorded in H_2 stage (2005), which might have been resulted from higher germination percentage and vigorous growth. Seedling length (root plus shoot length) was the highest in H_2 stage i.e. seed collected at 35 days after flowering (DAF) and the lowest in H_1 stage i.e. at 30 DAF (Mahesha *et al.*, 2001b). The effect of harvesting stage on root plus shoot length of three chickpea varieties revealed that root plus shoot length was markedly improved by harvesting stages in all the varieties in 2004 (Table III). The maximum root plus shoot length was observed by the interaction of V_1H_1 in 2004 and by V_1H_2 in 2005. The minimum root plus shoot length was noted in V_3H_1.

Vigour-II

BARI Chola-5 gave significantly higher vigour-II over BARI Chola-8 (Table I). Lower vigour-II was noted in BARI Chola-8. Decreased of the vigour-II in BARI Chola-8 might be due to lower germination percentage and root plus shoot length (Khare and Satpute, 1999). Similar varietal difference was reported by Matthews (1973) in peas. Borate *et al.* (1993) observed that vigour-II was higher (2568) in large size seeds and lower (2111) in small size seed of groundnut. Harvesting stage of H_2 did not markedly increase vigour-II (Table II). Seeds harvested at the stage of light brown with a few yellow green of pods (H_2) showed numerically higher seed vigour-II, probably due to associative effect of germination percentage and seedling length. Increased seed vigour-II might be due to maturation of seeds in H_2 stage resulting in improvement of germination percentage and seedling length (Gore *et al.*, 1997). The vigour index showed a steady increase from 1592 to 26454 with the advancement of days after anthesis from 40 to 60. The highest seed put value vigour-II (2378 and 2512) was recorded by interaction of V_1H_1 in 2004 and by V_1H_2 in 2005 (Table III). The lowest seed put value vigour-II (1800 in 2004 and 1885 in 2005) was noted by V_3H_1.

Correlation

Correlation matrix among the plant characters of chickpea has been shown in Table IV. A positive and significant correlation was observed between germination percentage and vigour-I (2004), root plus shoot length (2005), vigour-II (2004 and 2005); dry weight and vigour-I (2004 and 2005), root plus shoot length (2004 and 2005), vigour-II (2004 and 2005); vigour-I and root plus shoot length (2005), vigour-II (2005); root plus shoot length and vigour-II (2004 and 2005). A negative correlation was found between moisture percentage and germination percentage, vigour-I (2004), root plus shoot length (2004), vigour-II (2004). Similar negative correlatios was observed between germination percentage and

Table IV. Correlation matrix among different parameters of chickpea

Characters	Year	Correlation coefficient (r value)				
		Germination	Dry weight	Vigour-I	Root + shoot length	Vigour-II
Moisture	2004	-0.289	0.200	-0.015	-0.315	-0.118
	2005	-0.052	0.590**	0.608**	0.336	0.296
Germination	2004		-0.266	0.431*	-0.130	0.460*
	2005		-0.043ns	0.259ns	0.656**	0.798**
Dry weight	2004			0.754**	0.257	-0.199
	2005			0.944**	0.403*	0.403*
Vigour-I	2004				-0.356	0.121
	2005				0.615**	0.55**
Root + shoot length	2004					0.338*
	2005					0.967**

** Significant at 1% level, * Significant at 5% level

dry weight (2004 and 2005), root plus shoot length (2004), and dry weight and vigour-II (2004). A positive correlation (r=0.596) between germination and dry matter was shown (Mehta *et al.,* 1993). They also observed that germination showed negative correlations (r=0.856) with moisture content of seed and (r=0.573) with fresh weight of pod wall. Reddy and Khan (2001) found a positive and significant correlation between germination and seedling dry weight (0.68**), vigour index-I (0.91**) and vigour index-II (0.97**).

Conclusion

The highest germination percentage, root length, shoot length, root plus shoot length and vigour-II was observed in BARI Chola-5 which was significantly higher over BARI Chola-8 and the lowest in BARI Chola-8. Seed collected at the stage when most of the pods were light brown with a few yellow (H_2 stage) recorded the highest germination percentage, dry weight, vigour-I and root length. Pods collected at the stage of yellow with a few yellow green (H_1 stage) gave the highest moisture content in seeds. BARI Chola-5 seeds collected (H_2 stage) recorded the highest germination.

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