Vol. 14(33), pp. 1649-1658, October, 2019
DOI: 10.5897/AJAR2019.14292
Article Number: 838129661990
ISSN: 1991-637X

http://www.academicjournals.org/AJAR

ACADEMIC JOURNALS
expand your knowledge

African Journal of Agricultural Research

Full Length Research Paper

Assessment of seed quality parameters in different seed sources of chickpea (*Cicer arietinum* (L.)

Nigussu Bekele[1*], Bulti Tesso[2] and Asnake Fikre[3]

[1]DebereZeit Agricultural Research Center, EIAR, Ethiopia.
[2]School of Plant Sciences, College of Agriculture and Environmental Science, Haramaya University, Ethiopia.
[3]International Crops Research Institute for the Semi-Arid Tropics -- ICRISAT, Addis Ababa, Ethiopia.

Received 4 July, 2019; Accepted 26 August, 2019

In Ethiopia, chickpea is an important grain legume next to faba bean and common bean. Quality seed production and associated technologies could be mentioned among the major challenges that limit chickpea production and productivity in Ethiopia. This study was conducted to assess the quality of seeds at different generation classes as obtained from various sources that would contribute an estimate of more than half the chickpea seed suppliers. Thirty one seed samples taken from ten different formal seed sources and four seed classes were used to test physical, physiological and seed health parameters. The result of the laboratory study indicated that seed sources and classes have affected highly significantly the moisture content and hundred seed weight. Correlation analysis showed that seed purity had positive and highly significantly influenced standard germination, vigor index, seedling dry weight and hundred seed weight. Similarly, vigor index was correlated positively and highly significantly with speed of standard germination and root length. Considering seed health as standard quality parameters showed that no seed sources and classes met the standards set by the national seed quality. The seed regulatory unit should be considered in the future in enhancing the seed standard levels and on undermined factors associated to seed health.

Key words: Physical purity, seed class, seed health, seed vigor.

INTRODUCTION

Chickpea is the world's second most important grain legume after common bean (*Pharsalus vulgaris* L.) (Guar et al., 2012). It is an important source of human food and animal feed, and traditionally grown in many parts of the world. It is a readily available source of protein (19%), carbohydrates (60%), and minerals (phosphorus, calcium, and iron) (Ibrikci et al., 2003). Chickpea returns a significant amount of residue nitrogen to the soil and adds organic matter and fertility (Pande et al., 2005). It is used in crop rotation with cereals like *Tef* or wheat on heavy soils (Geletu and Anbessa, 1996) in Ethiopia. Chickpea is the major pulse crop in the world with a total production of 12.33 million tons from 12.90 million ha (FAO, 2015).

Ethiopia is considered as a secondary center of genetic diversity for chickpea, it shares 2% among the most chickpea producing countries next to India (64%), Turkey (8%) and Pakistan (7%) (ICRISAT, 2004). It is among the

*Corresponding author. E-mail: nardbekele@gmail.com.

most important pulse crops grown in Ethiopia dominantly in crop-livestock based farming systems of the Central, North and Northwest highlands of Ethiopia where Vertisols are dominating. From 1,652,844.19 hectares of land allocated for pulse in 2015/2016 production season, chickpea covered 258,486.29 (15.6%) hectares of land with 472,611.388 tons (19%) of grain production with the productivity of 1.83 t/ha (CSA, 2016).

On average, chickpea yield in Ethiopia on farmer's field is below 1.96 t/ha, although its potential is more than 5 t/ha (CSA, 2016). Several numbers of biotic and a biotic factor are responsible for its low yield like traditional local cultivar, seed borne diseases and low population density of plants (Melese, 2005). The use of high yielding, disease and pest resistant and a biotic stress tolerant variety, coupled with improved crop management practices, is indispensable for increasing chickpea productivity and production.

The genetic potential of improved varieties is realized only if quality seeds of the varieties are used. Seed quality includes genetic purity as well as aspects of physical and physiological parameters such as seed physical purity, moisture content, viability, germination, seed vigor, etc., and seed health. These seed quality parameters are liable to deterioration due to various factors if standard conditions are not maintained along the seed value chain. Seed deterioration is a serious problem in developing countries where seeds are usually stored in places without a proper control of humidity and temperature. Temperature and seed moisture content (and/or relative humidity) are the main factors influencing seed deterioration and viability loss in storage (Abbas et al., 2014). Low temperature and humidity result in delayed seed deteriorative process and aging which there by leads to shortening viability period. Seed ageing is generally marked by reduction in vigor (Gupta and Aneja, 2004), viability, rate and capacity of germination (Arefi and Abdi, 2003), increased solute leakage (Basra et al., 2003) and susceptibility to stresses and reduced tolerance to storage under adverse conditions. High seed vigor, that is rapid, uniform and complete emergence of vigorous seedling, leads to high grain yield potential of crop, by enhancing the establishment of optimum canopy structure that minimizes interplant competition and maximizes crop yield. Rapid emergence provides the plants temporal and spatial advantages to compete with weeds (Soltani et al., 2001).

Several factors affect the quality of seeds at different developmental stage of the crops. Therefore, seed quality assessments in the chickpea major growing areas are very important to determine the planting value of seed produced in the study area. The quality standards of seeds produced by the different seed sources are not studied well in Ethiopia. Therefore, this study was initiated with the objectives of evaluating different classes of seed produced by different local sources

MATERIALS AND METHODS

Description of the study area

The study was conducted from producers in Ada Dendi, Hetosa, Sinana and lume districts of Oromia Region and from two research centers, Debre Zeit and Holeta agricultural research center. The five districts have altitudinal range of 1500 to 2300 m above sea level. The seed quality evaluation of the seed source entities was conducted at Debere Zeit and Holeta Agricultural Research Centers.

Seed sampling procedure

All samples collected were tested for seed quality parameters. One kg of chickpea seed sample was drawn from properly stored seed lots before planting for each seed sources and seed classes. Seed samples from 10 formal and informal seed producers were collected and assessed against National seed quality standards as indicated in Table 1. Samples of the basic and certified seed classes were collected from Ethiopia seed enterprises, Adama-Lume and Yerer unions and from farmer seed Producers of Megertu, Kolbe, Chala and Biftu located in Ada and Lume districts. Breeder and pre-basic seeds samples were collected from Debere Zeit, Holeta and Sinana Agricultural Research centers. All tests were performed according to procedures described by International Seed Testing Association (ISTA, 2004) rules, and tests outside tolerance limits were repeated.

Method of data collection

Seed purity test

Based on International Seed Testing Authority (ISTA, 2004), purity analysis for each 'pure' seed source 200 g samples was separated from 1 kg working samples sorted and categorized into four components including (i) pure seed, (ii) other crop seeds, (iii) inert mater and (iv) weeds seed. The percentage of each fraction was recorded on a weight-by-weight basis.

$$\text{Purity (\%)} = \frac{\text{Weight of pure seed (g)}}{\text{Total weight of sample (g)}} \times 100$$

Seed weight

Thousand seed weight was determined by counting hundred seeds and weighing and multiply the weight (g) by ten to get a thousand-seed weight. This was done on eight times to be counted (replicate) to get information that is more accurate from pure seed sample.

Seed moisture content

The moisture content of seed samples was determined according to

Table 1. Sampling Sites, Varieties and seed classes of chickpea from Different Seed Sources.

S/N	Sample area/seed source	Geographical location of Sampling	Seed class	Variety
1	DZARC	East Showa zone, Ada District	Breeder seed Pre-basic seed Basic seed	Arerti, Habru, Natoli, Ejere Arerti, Habru, Natoli, Ejere Arerti, Habru,
2	Sinana ARC	Bale Zone Sinana District	Pre basic	Arerti, Habru, Ejere
3	Holeta ARC	West Shoa Zone, Dandi District	Basic seed	Arerti, Natoli
4	Ethiopian SE	Arsi Zone, Hetosa District	Pre basic Basic seed Certified	Arerti Arerti Arerti
5	Yerer Union	East Shoa zone, Ada District	Certified	Arerti, Natoli
6	Adama Lume Union	East Shoa zone, Lume District	Certified	Arerti,
7	Megertu Seed Producers	East Shoa zone, Ada District	Basic seed	Arerti, Habru, Natoli, Ejere
8	Kolbe Seed Producer	East Shoa zone, Ada District	Basic seed	Arerti, Habru, Ejere
9	Chala Seed Producer	East Shoa zone, Lume District	Certified	Arerti, Habru
10	Biftu Seed Producer	East Shoa zone, Lume District	Certified	Arerti

ISTA (2004). Twenty gram of seed was taken for each sample, fine ground and half of the ground materials were passed through a wire sieve meshes of 0.50 mm. Five grams was put in the container to measure pre-drying weight. The drying temperature used was 103°C±1 for 17 h following high constant temperature oven method. The container was covered and placed in desiccators to cool for 30-45 min and weighed. The seed moisture content was determined on dry weight basis by ‘difference’ method and was calculated by the following formula:

$$\text{Moisture content} = \frac{M_2 - M_3}{M_2 - M_1} \text{ x } 100$$

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

Standard germination

Germination test was carried out according to ISTA (2004). For each treatment, 400 seeds were counted at random from the working seed sample. Then, 100 seeds were planted from each replication in sterilized sand media. The planted seeds germinated in seed germinator at a temperature of 25°C for eight days. After eight days, normal, abnormal and diseased seeds were sorted.

Speed of germination

For each sample, 100 seeds were taken and divided into four replicates and kept at the temperature of 25°C for eight days in the seed germinator. The seeds were assessed for the presence of normal seedlings: first count was made on the fourth day and final count was done eight days and normal seedlings were removed each day. Then, speed of germination (SPG) was calculated following procedures described by Maguire (1962).

$$\text{SPG} = \frac{\text{Number of normal seeding}}{\text{Days of first count}} + \frac{\text{Number of normal seeding}}{\text{Days of final count}}$$

Seedling dry weight

The seedlings dry weight was measured after the final count in the standard germination test. Ten seedlings were randomly selected from each replication and cut free from their cotyledons weighed, and placed in an envelope then dried in an oven at 80°C for 24 h (ISTA, 2004). The seedlings were dried and weighed to the nearest milligram and the average seedling dry weight was determined.

Vigor index-I

Vigor index-I is the percent germination x the sum average of shoot length and root length.

Vigor index-II

Vigor index-II is the percent germination x average seedling dry weight.
Mean value of treatment were used for correlation analysis using SAS analysis.

Seed health test

Samples collected from each source and sampling unit were used for the health test. Seed borne pathogens of chickpea was assessed

Table 2. Physical seed quality in different seed sources.

Seed Source	PS (%)	MC (%)	HSW (g)
DZARC	98.5[a]	9.7[b]	30.14[a]
SARC	97.7[ab]	10.0[ab]	28.36[c]
HARC	95.4[c]	10.0[ab]	27.59[cd]
ESE	96.3[bc]	10.3[a]	28.73[c]
YEU	94.57[c]	10.0[ab]	29.50[ab]
ADLU	95.1[c]	9.0[d]	28.50[c]
MSP	95.3[c]	9.6[bc]	28.83[bc]
KSP	95.86[bc]	9.8[b]	29.71[ab]
CSP	91.8[d]	9.8[b]	28.74[c]
BSP	90.4[d]	9.6b[c]	27.06[d]
LSD (0.05)	2.19	0.47	0.88
CV (%)	1.06	4.31	2.44

PS= pure seed, MC= moisture content, HSW= hundred seed weight, means followed by the same letter along column are not significantly different from each other at 5% probability.

by subjecting the samples to agar plate method. The seeds were treated with 1% sodium hypochlorite (NaOCl) solution for 5 min and then washed three times with sterile water. Hundred seeds were taken at random for seed health test. Ten seeds were placed at equal distance on Petri-dishes replicated four times, and then incubated at a temperature of 28±1°C with alternating light and darkness period of 12 h for 5-8 days. Pathogen identification was carried out using standard reference manuals and expert confirmation. Identification was based on morphological traits including colony features, structures, and spores using stereo and compound microscopes.

Method of data analysis

Data collected from laboratory test was analyzed using the General Linear Model (GLM) procedure of SAS software for analysis of variance (ANOVA). Mean comparison was done using least significant difference (LSD) test at 5% level.

RESULTS AND DISCUSSION

The major attributes of chickpea seed quality considered in this study were physical purity and physiological performances and seed health test. Samples of different seed sources and seed classes were collected from formal and informal seed sources and subjected to seed quality analyses were interpreted.

Physical purity, moisture content and hundred seed weight

The results of seed quality analyses are given in Table 2. Purity of seeds varied significantly (P<0.05) between the different seed sources. The relatively highest purity was obtained from DZARC (98.5%) and the lowest (90.4%) was from BISP. Significance differences were observed in seed purity among the primary sources, which might be due to the existence of divergence seed processing procedures and generation advancement of seeds. The seeds, however, had minimal impurities and met the minimum prescribed standard (98%) according to the Quality and Standards Authority of Ethiopia (QSAE, 2012).

Seed sources and seed class affected moisture content significantly. The highest moisture content was recorded from Ethiopian Seed Enterprise (10.3%) followed by both SARC and YU (10.0%) whereas the lowest moisture content (9.0%) was from Adama-Lume farmers' cooperative union. Despite their differences, all were within the range of storage moisture content prescribed (11%). This shows that better storage managements and awareness contributed for maintaining proper moisture contents on seed.

Similarly, different seed sources and classes also affected seed weight. Among the different sources, the highest seed weight was recorded from DZARC (30.1 g) followed by KOSP (29.7 g) and YU (29.5 g), while the lowest record was from BISP (27.1 g). Seed weight could be varied for a variety due to either moisture content variations or seed plumpness that is linked to production conditions. Hossein et al. (2011) reported that the effect of seed size was significant on germination percentage and seedling dry weight, which is an important yield determinant, and is highly affected by both genetic and

Table 3. Seed classes on physical purity of chickpea seed.

Seed class	PS	MC	HSW
BRS	97.7	10.3[a]	29.67[ab]
PBS	97.9	9.7[c]	29.95[a]
BS	97.5	9.7[c]	28.93[bc]
CS	96.3	9.8[b]	28.41[c]
LSD (0.05)	NS	0.07	0.88
CV (%)	1.06	4.31	2.44

NS= non-significant, PS= pure seed, MC= Moisture content, HSW= hundred seed weight. Means followed by the same letter in the column are not significantly different from each other at 5% probability level.

environmental factors (Table 2).

In this study, the effect of seed class showed inconsistent trend (Table 3) and was different from national seed quality standard of 98 % for breeder and pre basic seed (QSAE, 2012). Breeder's seed had high moisture content (10.3%) followed by certified seed (9.8%), while samples from pre- basic and basic seeds showed lower mean values (9.7%) which is still within the proper range of moisture content for legume crop. Different seed classes also affected hundred seed weight. The highest seed weight was recorded from breeders seed (29.7 g) and the lowest from certified seeds (28.4 g), indicating the rigor of seed processing as cautious action is allotted on breeder seed than other generations), which all are consistent with the national seed quality standards of Ethiopia. In line with this study, Adebisi et al. (2011), reported seed size variation and its effects on germination and the performance of the whole plant).

Variations were observed on hundred seed weight among seed sources, seed classes and their interactions. Among the different sources, the highest seed weight was recorded from DZARC (30.1 g) followed by KSP (29.7 g) and YU (29.5 g) while the lowest record was from BSP (27.1 g). Hossein et al. (2011) reported that the effect of seed size was significant on germination percentage and seedling dry weight, which is an important yield determinant, is highly affected by both genetic and environmental factors. Different seed classes affected similarly hundred seed weight. The highest seed weight was recorded from breeder's seed (29.7 mg) and the lowest from certified seeds (28.4 mg) indicating differential investment and is consistent with the national seed quality standards of Ethiopia. Adebisi et al. (2011) suggested seed size variation and its effect on the performance of the whole plant and their germination.

The two ways interaction of seed source x seed class showed that, pre basic seed sourced from DZARC gave highest mean value of seed weight (30.9 g) and the lowest value was recorded from certified seeds collected from Ethiopian seed enterprise (26.42) (Table 4). In conformity to the present result, Jan et al. *(*2000) who reported that seed weight decreased as the seed generations increased due to environmental impacts. Ayaz et al. (1999) also reported that agronomic practices had significant effects on hundred-grain weight. It is suggested that the seed selection intensity during the processing has contributed to the variation prevailing among the seed generations of chickpea.

Physiological seed quality parameters

The standard germination was significantly ($P \leq 0.05$) affected by the seed source and seed class, and by their interaction (Table 5). The highest mean values of standard germination were observed from DZARC while the lowest from Biftu primary seed producer cooperative. In this study, it is noted that standard germination recorded across different sources showed similar trend in line with the national seed quality standards of Ethiopia. Significant differences were found among the seed classes. The highest germination was recorded in breeder seed (98.3%) followed by PBS (94.6%) and BS (94.3%) and the least was in certified seed (92.7%) (Table 5).The finding was more than the standards set by National Seed Quality Standards of Ethiopia and in agreement with the work of Fredy et al*.* (2005) who reported seed classes and sources affect that standard germination.

Seedling shoot length was significantly affected by both seed sources and classes (Table 5). Highest seedling shoot length was recorded in ADLU (7.65 cm) followed by MSP (6.85 cm) and least was in KSP (4.75 cm). Seedling shoot length ranged from (5.44 cm) in breeder seeds to (6.13 cm) in basic seed which is inconsistent to the standard set by the authority.

Table 4. Interaction effect of seed source X seed class on physical purity of chickpea.

Seed class	Seed source	PS	MC	HSW
BRS	DZARC	97.7^{ab}	10.3^{ab}	29.67^{ab}
PBS	DZARC	98.1^{a}	9.3^{b}	30.90^{a}
BS	DZARC	97.3^{a}	9.4^{b}	29.55^{a}
PBS	SARC	97.7^{a}	10.0^{ab}	28.40^{bc}
BS	HARC	96.9^{b}	10.0^{ab}	27.60^{c}
PBS	ESE	97.4^{ab}	10.6^{a}	30.88^{a}
BS	ESE	96.6^{b}	10.1^{ab}	28.48^{bc}
CS	ESE	96.9^{b}	10.1^{ab}	26.82^{c}
CS	YEU	96.6^{b}	10.0^{ab}	29.50^{b}
CS	ADLU	96.2^{bc}	9.0^{b}	28.50^{bc}
BS	MSP	97.9^{a}	9.6^{b}	28.80^{bc}
BS	KSP	97.9^{a}	9.8^{ab}	29.70^{ab}
CS	CSP	96.4^{bc}	9.8^{ab}	28.70^{bc}
CS	BSP	95.5^{c}	9.6^{b}	27.10^{c}
LSD (0.05)		0.98	0.89	1.30
CV (%)		1.06	4.31	2.44

PS= pure seed; MC= Moisture content; HSW= hundred seed weight. Means followed by the same letter along column are not significantly different from each other at 5% probability level.

Table 5. Effect of seed source on germination, vigor index 1 and 2, speed of germination, Shoot length, root length and seedling dry weight of chickpea from different seed sources.

Seed source	Germ	V I	V II	SPG	SHL	RL	SDWT
DZARC	97.2^{a}	1856.94^{bc}	2764.05^{a}	3.98^{b}	5.839^{d}	13.27^{bc}	28.35^{a}
SARC	97a^{b}	1938.96^{b}	2539.33^{a}	4.17^{a}	6.11^{cd}	13.9^{bc}	26.17^{ab}
HARC	94^{c}	1670.72^{d}	1998^{b}	4^{b}	5.68^{de}	12.078^{de}	21.25^{c}
ESE	90.67^{d}	1643.19^{d}	1945.33^{b}	3.81^{c}	6.63^{bc}	11.35^{e}	21.33^{bc}
YU	93.5^{c}	1884.55^{b}	1783^{b}	4.16^{ab}	5.75^{de}	14.39^{b}	19^{c}
ADLU	93^{cd}	2000.42^{ab}	1772^{b}	4.06^{ab}	7.65^{a}	13.87^{bc}	19^{c}
MSP	94.25^{bc}	2117.31^{a}	2001.25^{b}	4.02^{b}	6.85^{b}	15.6^{a}	22b^{c}
KSP	93.33^{cd}	1654.75^{d}	1824.67^{b}	3.72^{cd}	4.75^{e}	12.98^{cd}	19.67^{c}
CSP	92.5^{cd}	1707.19^{cd}	1944^{b}	3.8^{cd}	5.38^{de}	13.11cd	21^{c}
BSP	89^{d}	1684.24^{d}	1626^{b}	3.69^{cd}	5.07^{de}	13.89^{bc}	18.5^{c}
Mean	94.65	1837.39	2239.40	3.96	5.95	13.44	23.65
LSD (0.05)	2.75	149.75	531	0.14	0.73	1.19	4.83

Germ= Germination; VI= Vigor Index one; VII= Vigor Index two; SPG= Speed of germination; SHL= Shoot length; RL=Root length; SDWT= Seedling dry weight; Means followed by the same letter along column are not significantly different from each other at 5% probability level.

Analysis of variance showed that seed sources and seed classes significantly affected seedling root length. The highest seedling root length (15.6 cm) was obtained from MSP while the lowest (11.35 cm) was from Ethiopian seed enterprise (Table 5). The highest root length (14.08 cm) was obtained from breeder seeds while the lowest was (12.85 cm) in pre basic seeds (Table 6). It is assumed that seedlings with well-developed shoot and root systems originated from vigor seed and would likely withstand any adverse conditions and provide better

Table 6. Physiological seed quality parameter of chickpea seed on seed class.

Seed class	Germ	VG I	VG II	SPG	SHL	RL	SDWT
BRS	98.75[a]	1928.03[a]	3020.625a	4.08[a]	5.44[b]	14.08[a]	30.5[a]
PBS	94.63[b]	1785.93[b]	2512.75[b]	3.91[b]	5.97[a]	12.85[c]	26.38[b]
BS	94.33[b]	1853.53[b]	2006.75[b]	3.94[b]	6.13[a]	13.5[b]	21.54[c]
CS	92.86[b]	1816.73[b]	1879.43[ab]	3.974[b]	5.92[a]	13.66[ab]	20.21[c]
LSD (0.05)	1.73	74.10	506.0	0.07	0.21	0.57	4.11
CV (%)	3.72	10.06	14.85	4.42	11.94	10.86	14.61

Germ= Germination; VI= Vigor Index one; VII= Vigor Index two; SPG= Speed of germination; SHL= Shoot length; RL=Root length; SDWT= Seedling dry weight; Means followed by the same letter along column are not significantly different from each other at 5% probability level.

seedling emergence and seedling establishment in the field (Zewdie, 2004). According to Isely (1957), vigorous seeds mobilize reserves from storage tissues to the embryo axis more efficiently and this capacity is reflected in seedling growth that could ultimately be explained on plant productivity.

Seedling dry weight varied significantly among the different seed sources. Highest seedling dry weight was recorded in DZARC (28.3 mg) followed by SARC (26.2 mg), and least in BSP (18.5 mg). There were significant reductions of seedling dry weight from breeder seeds (30.5 mg) to certified seeds (20.2 mg) (Table 6). This result is inconsistent with those of the National Seed Quality Standards of Ethiopia (QSAE, 2012).

Seedling vigor index-I

The result of this study revealed that, seedling vigor index-I was significantly affected by the effect of seed sources (Table 5). Seedling vigor index I ranged from 1643 (ESE) to MSP (2117.3) with mean value of 1837.4. Similarly, seedling vigor index affected significantly by seed classes (Table 6). The highest seedling index I (1928.03) was from breeder seed followed by basic seed (1853.5) and the least was in pre basic seed (1785.93) which is inconsistent with those of the standards. This might be due to differences in crop management practices observed in the different seed classes' institutional sources.

Seedling vigor index-II

Seedling vigor index-II was significantly affected by seed source, seed class and their interactions (Table 5). Seedling vigor index-II was highest in DZARC (2764.05) followed by SARC (2539.33) and MSP (2001.25) and the least was observed in BSP (1626). Similarly, the highest seedling vigor index-II was obtained from breeder seed (3020.6) followed by pre basic (2512.8) and basic seeds (2006.8). The least seedling vigor index-II was observed in certified seeds (1879.4) (Table 7). The trend was consistently followed by the standard that existed across the different classes.

Speed of germination

The fastest speed of germination was recorded from BSP (3.69 days). It was followed by KSP (3.72 days) and CSP (3.8 days). SARC was the least (4.17) in day's germination. With regard of seed classes, result showed inconsistent trend on speed of germination where pre-basic seed was faster than all the other seed classes (Table 7). Toumey and Korstian (1942) emphasized rapid germination as an important component of the seed vigor, and it usually corresponds to more rapid seedling emergence in the field.

Association of physical and physiological seed quality parameter

The simple correlation result revealed that seed purity was positively and highly significantly correlated with germination (rg=0.787**), vigor index II (rg=0.83**), seed dry weight (0.81**) and hundred seed weight (rg=0.66**) (Table 8). Similarly, vigor index I correlated positively and highly significantly with speed of germination root length (rg=0.83**), shoot length (rg=0.59**) and speed of germination (rg=0.79**). Hundred seed weight was positively and highly significantly correlated with vigor index II (rg=0.55*) and seedling dry weight (rg=0.53*). Germination was positively and highly significantly with vigor index II (rg=0.84**) and seedling dry weight (rg=0.79**). Similarly, Zewdie (2004) reported that standard germination showed highly significant and

Table 7. Interaction effect of seed source X seed class on physiological parameter.

Seed source	Seed class	Germ	VG I	VG II	SPG	SHL	RL	SDWT
DZARC	BRS	98.8^{a}	1928.0^{ab}	3020.6^{a}	4.08^{ab}	5.44^{c}	14.08^{ab}	30.50^{a}
DZARC	PBS	96.3^{ab}	1792.9^{b}	2713.5^{ab}	3.89^{b}	5.79^{bc}	12.85^{b}	28.13^{ab}
DZARC	BS	96.0^{ab}	1842.9^{b}	2352.0^{ab}	3.97^{ab}	6.73^{ab}	12.47^{b}	24.50^{ab}
SARC	PBS	97.0^{ab}	1939.0^{ab}	2539.3^{ab}	4.17^{a}	6.11^{bc}	13.90^{ab}	26.17^{ab}
HARC	BS	94.0^{ab}	1670.7^{b}	1998.0^{b}	4.00^{ab}	5.68^{bc}	12.08^{b}	21.25^{b}
ESE	PBS	81.0^{c}	1299.1^{c}	1630.0^{b}	3.18^{c}	6.29b^{c}	9.64^{b}	20.00^{b}
ESE	BS	95.0^{ab}	1781.5^{b}	1902.0^{b}	4.06ab	7.12^{ab}	11.64^{b}	20.00^{b}
ESE	CS	96.0^{ab}	1849.0^{b}	2304.0^{ab}	4.18a	6.48^{b}	12.78^{b}	24.00^{ab}
YU	CS	93.5^{b}	1884.6^{ab}	1783.0^{b}	4.16^{a}	5.75^{bc}	14.39^{ab}	19.00^{b}
ALU	CS	93.0^{b}	2000.4^{ab}	1772.0^{b}	4.06^{ab}	7.65^{a}	13.87^{ab}	19.00^{b}
MSP	BS	94.3^{ab}	2117.3^{a}	2001.3^{b}	4.02^{ab}	6.86^{ab}	15.60^{a}	22.00^{b}
KSP	BS	93.3^{b}	1654.7^{b}	1824.7^{b}	3.72^{b}	4.75^{c}	12.98^{b}	19.67^{b}
CSP	CS	92.5^{b}	1707.2^{b}	1944.0^{b}	3.78^{b}	5.38^{c}	13.11^{b}	21.00^{b}
BSP	CS	89.0^{b}	1684.2^{b}	1626.0^{b}	3.69^{b}	5.07^{c}	13.89^{ab}	18.50^{b}
LSD 0.05)		4.84	258.2	750.2	0.26	1.00	2.08	7.70
CV (%)		3.72	10.06	14.62	4.43	11.94	10.86	14.61

Germ= Germination; VI= Vigor Index one; VII= Vigor Index two; SPG= Speed of germination; SHL= Shoot length; RL=Root length; SDWT= Seedling dry weight; Means followed by the same letter along column are not significantly different from each other at 5% probability level.

positive correlation with seedling dry weight and vigor index II in bread wheat. In contrary to this finding, Latha (2014) reported that standard germination was negatively correlated with seed dry weight and seedling vigor II. The same author compared between root length and shoot length and reported a negative correlation in contrast to this result.

Seed health

Seed health is one of the critical components, which has less consideration in the seed quality parameters analysis. The result of the laboratory health test showed that six pathogenic fungi genera associated with seed borne diseases were identified (Table 9). These were *Aschochyta rabei*, *pencillium, Aspergillus, Rizocotinia solani* and *Fusarium oxysporium* load on the samples (Table 9). The rest fungi and bacteria species found were not associated on its pathogenic effect transmit from seeds to seedlings of the next generations.

The study is in line with Hulluka et al. (1991) that 15 fungal species isolated from chickpea seed collected from farmers and experimental stations in central Ethiopia among which the genera of *Aschochyta*, *Alternaria*, *Helminthosporium (Bipolaris)* and *Fusarium* are predominant.

The Ethiopian seed certification standard (QSAE, 2012) requires the maximum permitted percent infection for seed-borne diseases to be zero for breeder and pre-basic seed, 0.05% for basic seed, 0.2% for certified (1 up to certified 4); and 0.4% for emergency seed. In this study, all samples were above threshold limit compared with the national healthy seed standard permitted in certified seeds. This might be due to the

Table 8. Pearson's simple combined correlation coefficients of Physical and physiological seed quality parameters of from different seed source tested under different seed class chickpea seed.

	PS	MC	HSW	Germ	VG_I	VG_II	SPG	SHL	RL	SDWT
PS		0.3407^{ns}	0.66**	0.78**	0.26^{ns}	0.83**	0.39^{ns}	0.17^{ns}	-0.13^{ns}	0.81**
MC			0.15^{ns}	0.27^{ns}	-0.33^{ns}	0.41^{ns}	0.07^{ns}	-0.45^{ns}	-0.33^{ns}	0.42^{ns}
HSW				0.52*	0.14^{ns}	0.55*	0.08^{ns}	-0.06^{ns}	-0.01^{ns}	0.53*
Germ					0.52*	0.84**	0.65*	0.01^{ns}	0.28^{ns}	0.79**
VG_I						0.24^{ns}	0.76**	0.59*	0.83**	0.19^{ns}
VG_II							0.31^{ns}	-0.07^{ns}	-0.01^{ns}	0.97**
SPG								0.44^{ns}	0.50^{ns}	0.25^{ns}
SHL									0.16^{ns}	-0.09^{ns}
RL										-0.06^{ns}
SDWT										

*; **; ns = significantly correlated; highly significant and non-significant at P < 0.01; PS= Pure seed; MC= Moisture content; Germ= Germination; VI = Vigor index I; VII = Vigor index II; SPG = Speed of germination; SHL = Shoot length; RL = Root length; SDWT = Seedling dry Weight.

Table 9. Mean percent of seeds infected by fungal species, on different source of seed.

Disease type (%)	Percent infection by seed source									
	DZARC	HARC	SARC	ESE	YU	ADLU	MSP	KSP	CSP	BSP
Ascochyta	55.33	73.33	76.67	73.33	51.67	76.67	68.33	80.00	80.00	86.67
Pencillium	35.00	46.67	20.00	16.67	31.67	60.00	45.00	51.11	81.67	73.33
Aspergillus	17.33	30.00	1.67	1.11	1.67	13.33	21.67	7.78	3.33	10.00
Fusarium	0.00	0.00	5.00	5.56	0.00	0.00	0.00	2.22	0.00	0.00
Rhizoctonia	0.33	0.00	1.67	5.56	0.00	0.00	0.00	11.11	0.00	0.00
Rhizopus	0.00	0.00	6.67	5.56	5.00	0.00	2.50	0.00	3.33	3.33
Mean	18.00	25.00	18.61	17.97	15.00	25	22.92	25.37	28.06	28.89

Germ= Germination; VGI= Vigor Index one; VGII= Vigor Index two; SPG= Speed of germination; SHL= Shoot length; RL=Root length; SDWT= Seedling dry weight; Means followed by the same letter along column are not significantly different from each other at 5% probability level.

association of the fungi with seeds from the source, sub-optimal storage condition, and favorable climatic condition for the development of pathogens in the field during growth and development of the crop.

The health quality of chickpea seed samples obtained from seed growers was checked for the presence of seed-borne pathogens. The highest percent infections by *Aschochyta rabei, pencillium* and *Aspergillus* were 86.7, 81.7, and 21.7% respectively. These fungal species had infected all seed samples in similar manner (Table 9). This is implicated on the crop production phase as the microbes can be carried over through the seed, which by itself poses cost on production.

Conclusion

In Ethiopia, lack of quality seed production and associated technologies could be mentioned among the major challenges that limit chickpea production and productivity. This study was therefore conducted to assess the quality of seeds obtained from different seed sources and seed classes. The result of the laboratory study clearly indicated that different seed sources and classes varied on physical and physiological seed quality parameters. Seeds obtained from primary sources, DZARC showed better performance on physical and physiological seed quality parameters. It is confirmed from the above result that seeds sourced from the national coordination research center (DZRAC) helped to maintain higher germination, vigor index, seedling dry weight, seed purity and hundred seed weight of chickpea system. Similarly, breeder seed helped to maintain higher physiological quality parameters under study except shoot length and significantly lowest germination, vigor index II, speed of germination and seedling dry weight was recorded for certified seed. Overall, physical and physiological parameters showed similar trend across different seed classes. Correlation analysis revealed that seed purity associated positively and highly significantly with hundred seed weight, germination, vigor index II and seedling dry weight, hundred seed weight also correlated positively and significantly with germination vigor index II and seedling dry weight. Germination correlated highly significantly and positively with vigor index II and seedling dry weight. No seed sources and classes considered seed health as a standard quality parameters thus all seed sources and classes did not meet the standards set by the National Seed Regulatory Authority. Therefore, seed assessment would strongly be commended to strengthened seed health aspects in order to prevent pathogenic seed borne diseases transmitted from seed to seedling of the next generation.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

REFERENCES

Abbas B, Lynne CB, Hosein S (2014). Effects of seed deterioration and inoculation with *Mesorhizobium Ciceri* on chickpea plant performance under laboratory conditions, Scientific Papers. Series A. Agronomy 57:116-118.

Adebisi MA, Kehinde TO, Ajela MO, Olowu EF, Rasaki S (2011). Assessment of seed quality and potential longevity in elite tropical soybean *(Glycine Max L.)* Merrill grown in Southwestern Nigeria. Nigerian Agricultural Journal 42:97-103.

Arefi HM, Abdi N (2003). Study of variation and seed deterioration of Festucaovina germplasm in natural resources gene bank. Iranian Journal of Rangelands and Forests Plant Breeding and Genetic Research 11:105-125

Ayaz S, Shah P, Sharif HM, Ali I (1999). Yield, yield components and other important agronomic traits of wheat as affected by seed rate and planting geometry. Sarhad Journal of Agriculture 15(4):255-262

Basra MAS, Ehsanullah EA, Warraich MA, Afza I (2003). Effect of storage on growth and yield of primed canola (Brassica napus) seeds. International Journal of Agriculture and Biology 5:117-120

Central Statistical Agency (CSA) (2016). Agricultural sample survey report on area and production of crops private peasant holdings, meher season. Addis Ababa, Ethiopia.

Food and Agriculture Organization (FAO) (2015). FAOSTAT Statistical Database of the United Nation Food and Agriculture Organization (FAO) Statistical Division. Rome. Available at: http://faostat.fao.org/site/ Accessed Jan 2016

Fredy RR. Kathleen D, David JH (2005). The effect of seed source, light during germination and cold-moist stratification on seed germination in three species of Echinacea for organic production HortScience. The American Society for Horticultural Science 40(6):1751-1754

Geletu B, Anbessa Y (1996). Breeding chickpea for resistance to *drought.* International symposium on pulse research, April 2-6. New Delhi, India pp. 145-146.

Guar PM, Jukanti AK, Varshney RK (2012). Impact of genomic technologies on chickpea breeding strategies. Agronomy 2:199-221.

Gupta A, Aneja KR (2004). Seed deterioration in soybean varieties during storage-physiological attributes. Seed Research 32:26-32

Hossein F, Moaveni P, Marouf K (2011). Effect of seed size on germination percentage in green gram (*Vigna radiata* L.). Advances in Environmental Biology 5(7):1674-1679.

Hulluka M, Woldeab G, Andnew Y, Desta R, Badebo A (1991). Wheat pathology research in Ethiopia pp.173-217. *In:* Gebremariam, H., Tanner, D.G. and Hulluka,M. (eds.) Wheat research in Ethiopia: A historical perspective. Addis Ababa: IAR/CIMMYT

Ibrikci H, Knewtson S, Grusak MA (2003). Chickpea leaves as vege green for humans: Evolution of mineral composition. Journal Science Food Agriculture 83:945-950.

International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) (2004). Area production and productivity of Chickpea (*Cicer arietinum* L.). Patancheru, Hyderabad India pp. 31-35.

Isely D (1957). Vigor tests. Proceedings of Association of Official Seed Analysts 47:176-182.

International Seed Testing Association (ISTA) (2004). International Rules for Seed Testing, Published by the International Seed Testing Association.

Jan A, Hamid I, Muhammad TJ (2000). Yield and yield component of wheat as influenced by seeding rates and sowing dates. Pakistan Journal of Biological Sciences 3(2):323-325.

Latha CN (2014). Evaluation of Seed Characters and their Relationships with Seed Quality Chickpea in (*Cicer arietinum* L.) Genotypes. MSc Thesis, University of Agricultural Sciences, Bangalore, Bangalore.

Maguire JD (1962). Speed of germination, an aid in selection and evaluation for seedling emergence and vigor. Crop Science 2:176-177.

Melese D (2005). Morphological and RAPD marker variation analysis in some drought tolerant and susceptible chickpea (*Cicer arietinum* L.) genotypes of Ethiopia. M.Sc Thesis, Addis Ababa University, Ethiopia pp. 2-5.

Pande S, Siddique KM, Kishore GK, Bayaa B, Gaur PM, Gowda CLL, Bretaga TW, Crouch JH (2005). Ascochyta blight of chickpea (*Cicer arietinium* L.): a review of biology, pathogenicity and disease management. Australian Journal of Agricultural Research 56:1-4.

Quality and Standards Authority of Ethiopia (QSAE) (2012). Quality and Standards Authority of Ethiopia. Ethiopian standard wheat seed specification. First edition, ES 414 p.

Soltani A, Zeinali E, Galeshi S, Latifi N (2001). Genetic variation for and interrelationships among seed vigor traits in wheat from the Caspian Sea Coast of Iran. Seed Science and Technology 29:653-662.

Toumey JW, Korstian CF (1942). Seeding and planting in the forestry practice. Ed. 3. John Wiley and Sons Inc., New York.

Zewdie B (2004). Wheat and barley seed system in Ethiopia and Syria. PhD Dissertation, Wagenigen University, Netherlands.