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Report

Evaluating Seed Quality and Germination Potential of Different Bread Wheat (*Triticum aestivum* L.) Varieties at Kulumsa Agricultural Research Centre, Ethiopia

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Abstract: Bread wheat is one of the most important cereal crops produced and consumed in Ethiopia. But every production could not generate seed because seed is a living entity that need maximum care and required a serious of management procedures to fit minimum quality standard. Bread wheat seed production is the leading crops tested by both abiotic and biotic factors which reduce seed quality. Kulumsa Agricultural seed researcher's team is yearly testing quality of their seeds both at field and laboratory. The present study was carried out on Fifteen (15) breeder seeds and Twelve (12) pre-basic class a total of 27 bread wheat after Harvesting and post cleaning by Using RCBD design under laboratory. Seed germination (%), Moisture content (%), Seed physical purity (%) and thousands seed weight (TSW) were the quality parameters. data collected were Subjected to Analysis of variances by using SAS 9.3 software to confirm all varieties fit minimum seed quality standard or not. Analysis of variance revealed that there is a significant variation among treatments for seed purity, inert matter, TSW, HLW, MC and Germination (%) while no significant variation for other quality traits. The mean square of all the treatment revealed that they fit above minimum standard which is guides the all seeds had good input for Production and productivity.

Keywords: Bread Wheat, Seed Quality, Ethiopia, Germination, Physical Purity

1. Introduction

Wheat (*Triticum Aestivum* L.) is the most important crop among the major three cereal crops that provides 20% of total energy requirement in human diet [1]. Bread wheat (*Triticum aestivum* L.), with an annual global production of 772.6 million tons, is a staple food for more than 35% of the world's population [11]. Globally, China, India and Russia are the largest wheat producers, while South Africa and Ethiopia are the largest wheat producers in sub-Saharan Africa (SSA) [2]. Planting high quality seed is the first step to growing a successful crop [3]. Seed production is a series of well-defined specialized activities, requiring rigorous criteria to be followed by the seed producers at each of the stages to ensure that high- quality seed is produced and marketed [4]. Quality seed is very important thing for increasing the production [5]. Varietal purity is an essential quality requirement, which refers to the true-to-type seed, and is important in obtaining pure plant population of a specific variety. Varietal mixtures can cause uneven maturity, lower yield potential, increased susceptibility to disease and insect pests and poor adaptability to specific environmental conditions [6]. Seed quality is very important to optimum growth and yield production in farm which influenced by many factors such as genetic characteristics, viability, germination percent, vigor, moisture content, storage conditions, survival ability and seed health [7]. The productivity of the wheat remains low (2.4 tons ha-1) in the Ethiopia as compared to the world average yield 3.19 tons /ha [3]. In most cases, lack of stability is a result of non-uniformity because genetic

variability within a cultivar leads to variation in its response to environmental effects.

Germination potential seed is very crucial thing that determine good field emergence, best field performance and final productivity per unit area of land. A small change in seed moisture content has a large effect on the storage life of the seeds. Therefore it is important to know the moisture content in order to make a reasonably accurate prediction of the possible storage life of each accession. [8] Reported that the amount of Moisture content at which seed stored can affect the storability of bread wheat based on surrounding Relative humidity and temperature. Seed development and changes in germination potential and longevity of cereal crops like barley (Hordeum vulgare L.) and wheat (*Triticum aestivum* L.) are highly influenced by Moisture content [9]. Generally, factors such as genetic structure, environment and parental nutrition, maturity stage in harvest time, mechanical damages, seed storages, age and aging and pathogens, affect seed germination and vigor [2]. The weight of 1000 wheat kernels for different varieties ranges from low (30-35g), medium (36-45 g) to high (≥ 45 g) [9]. According to High thousand seeds weight will increase germination percent, seedling emergence, tillerring, density, spike and yield [7]. Thus seed weight or thousand grain weight has a large effect on seed germination, seed vigor, seedling emergency and yield production. [11] Reported Productivity and with different phenotypic traits of Bread wheat. [7] Reported that after flowering and during grain filling period of wheat, decreased the moisture percent and increased the dry matter percent (dry grain weight) and germination percent [5]. [11] Reported that rust suceptatablity and unstable condition of different bread wheat across different environments [12] which directly could result in poor seed quality. [10] Also report seed quality can affected by different rust. Cleaned grain and seed is of a higher quality and will therefore fetch a better price than 'dirty' grain that is full of impurities. Even if a producer does not have their own storage facilities, clean grain and seed will bring a higher return on investment for the producer. The main problem of recent Ethiopian Bread wheat variety is Poor quality seed with low germination, due to different abiotic and biotic factors like fungal disease occurring during field production.

This study were carried out on twenty seven (27) bread wheat seeds of which fifteen (15) breeder and twelve (12) were pre-basic of different varieties multiplied in the year 2022 main season for seed purposes. Internal Quality assurance is conducted annually to confirm the fitness of national seed quality standard and ISTA/ under Kulumsa Agricultural Seed laboratory. Seed lots which meet the prescribed seed standards (pure seed, germination, weed seeds, other crop seeds, and diseased seeds) alone will be eligible for allotment of seed certification tag according to Ethiopian seed National standard 2020. The cross check with External seed Regulatory body under different seed testing Laboratory for important Quality parameters also confirm the Accuracy of the work.

2. Materials and Methods

2.1. Description of the Study Area

The study was conducted at Kulumsa Agricultural Research Center (KARC) from January, 2022 to April, 2022 under laboratory conditions. The site is located at 8°00' N and 39°07' E at an elevation of 2210 m above sea level in Arsi Administrative Zone of Oromia Regional State, 167 km South East of Addis Ababa. The agro-climatic condition of the area is wet and receives a unimodal mean annual rainfall of 809.15 mm from March to September; however, the peak season is from July to August. The maximum and minimum mean temperature is 23.08 and 9.9°C, respectively [13].

2.2. Materials and Experimental Design

Totally twenty seven (27) treatments of Bread wheat seeds multiplied in 2021/2022 was taken from storage soon after cleaning. Among these (27) varieties Fifteen (15) of them were Breeder seeds while twelve of (12) of them were pre-basic seed classes.

The sample size was taken from each lot according to ISTA 2020 Seed testing procedure to improve the representativeness of the working sample.

This experiment was conducted under seed laboratory using RCBD design having four replication. Working bench (table) served to replicate of activity during this work. After Submission of sample from each seed lots the seeds of the same verities from each lot were subjected to mixing and only reduced working sample taken to seed purity analysis room. Seed physical purity were conducted According to ISTA from homogenized 120g of seeds finally composition of seed were identified by % for each verities. Seeds were sown in Petri dishes on moistened absorbent paper (blotter) thick layers to provide enough moisture for germination period. The supplementary water was dropped on the 4th day it was count after 8 days of sown.

2.3. Seed Cleaning Operation

Seed cleaning operation is the post-harvest process which improves the quality of the cleaned seed.

Grading aims to achieve the highest possible level of purity and normally targets specific contaminants. The cleaned seed may also be separated by quality (e.g. size, shape, weight/density and colour). During pre-cleaning, basic cleaning and fine cleaning, take samples for a rapid purity check and adjust the machines as necessary.

2.4. Data Collected

1) Total Raw seed produced and amount of Cleaned seed for each Varieties
2) Different seed physical purity components
3) Sample from each varieties based on seed lot after cleaning
4) Laboratory data like Moisture Content (%), Thousand seed weight (g), Hectolitre weight (hl), Germination (%), Normal (%) and Abnormal seedling (%)

Seed physical purity

Seed quality is a function of genetic, physical, physiological and health [14]. Purity is the expressions of how clean the seed lot is. It is calculated as follow according to ISTA 2020.

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

Moisture Content (%): Seed moisture content is the most important attribute influencing seed quality and storability.

It was measured soon after cleaning by using Moisture tester adjusted for wheat crops.

Thousand seed Weight: is the weight in grams of 1000 seeds of wheat and may indicate grain size and internal composition of seeds. It was taken from working sample after mixing the submitted lot taken from each lot of the same variety and replicated for times for all varieties. Automatic seed counter was adjusted to 1000 and used for counting of the seed.

Seed Germination data

A germination test allows seed producer to determine and Compare the quality of a seed lot before it is planted this information can be used to satisfy labeling laws and provide for standardized marketing of seed. The normal germinated seed lings after 9 days of planting was calculated excluding Dead (un germinated seed) and Abnormal seed ling at final count then percentage is calculated as follows.

$$\text{Seed germination (\%)} = \frac{\text{Number of normal seed ling(\#)} * 100}{\text{Total Planted seeds (\#)}}$$

During Germination test only normally germinated seedling can be counted as Germinated seed while Dead seed (ungerminated) and Germinated Abnormal seed ling cannot counted according to ISTA seed germination procedure.

Table 1. *Raw Seed produced and Relative percentage of different inert mater during cleaning process.*

Variety name	Raw seed (Uncleaned)	Mix-control (Quintal) by (%)	Broken, shriveled (underscored) seed and other Inert matter by (%)	Chaffs and light material by (%)	Cleaned seed (%)	Total Impurity by (%)
Shorima (pb)	78	1.28	5.13	0.00	93.59	6.41
Shorima (Br)	33.9	0.00	5.90	1.18	92.92	7.08
Abay (Br)	19.75	5.06	2.03	0.56	92.35	7.65
Pavan-76 (Br)	34	0.00	11.76	0.88	87.35	12.65
Balcha (pb)	39	2.56	7.69	2.56	87.18	12.82
Shake (br)	25	4.00	8.00	2.00	86.00	14.00
Daka (pb)	227.5	0.44	13.63	0.22	85.71	14.29
Boru (pb)	144	0.69	11.81	2.08	85.42	14.58
Ogolcho (pb)	274	0.00	15.69	0.73	83.58	16.42
Lemu (Br)	53.5	0.00	10.28	6.54	83.18	16.82
Boru (Br)	64.7	0.00	12.36	4.95	82.69	17.31
King bird (Br)	58	0.00	15.52	1.90	82.59	17.41
kakaba (PB)	608	0.25	15.30	2.19	82.26	17.74
Kakaba (Br)	66	0.00	16.67	1.74	81.59	18.41
Hidasse (pb)	117	0.85	15.38	2.78	80.98	19.02
Ogolcho (Br)	47	0.00	14.89	4.57	80.53	19.47
Danda.a (Br)	77.75	0.00	18.01	2.25	79.74	20.26
King bird (pb)	172	0.99	16.86	2.50	79.65	20.35
Pavan-76 (pb)	49	2.04	14.29	4.08	79.59	20.41
Daka (Br)	79.75	0.00	16.93	4.08	79.00	21.00
Dursa (Br)	42	4.76	14.29	2.38	78.57	21.43
Lemu (pb)	197	0.51	11.17	10.66	77.66	22.34
Danda.a (pb)	312.7	0.32	19.19	5.09	75.40	24.60
Hidasse (Br)	34.09	0.00	20.53	5.25	74.22	25.78
Balcha (Br)	27.4	0.00	21.90	7.96	70.15	29.85
Wane (Br)	23	0.00	21.74	8.70	69.57	30.43
Wane (pb)	424	0.24	25.12	6.23	68.42	31.58
Total	3328.04 (100%)	-	-	-	81.47%	18.53%

Notice: Raw seed (uncleaned) =Amount of Seed in Quintals soon before cleaning operation, Mix-Control=Amount of seed reduced to avoid mechanical mixing during seed cleaning, it is not applicable for different seed class of the same variety. Broken, shriveled (underscored) seed and other Inert matter by (%) = the sum up of impurity which sorted by cleaning machine at different steps. Chaffs and light material by (%) =Amount light material blower out during cleaning operation. Cleaned seed (%) =Amount of cleaned seed in Quintals converted to (%), Total Impurity by (%) =the all sum of impure material.

2.5. Data Analysis

The Collected data were homogenized thoroughly passed for Analysis using 9.3 software.

Analysis of variance and mean comparison among treatment were also carried out.

Table 2. *Analysis of variance (ANOVA) results.*

Quality parameters	Mean squares for Source of Variation			
	Rep (df=3)	Treatments (df=26)	Error (df=78)	Coff. Var. 5%
Days to Maturity (#)	0.00	134.872^{ns}	0.00	4.51
Seed Production (Quintal/ha)	0.00	163.601^{ns}	0.00	Infty
Seed purity (%)	0.00	0.2043 *	0.22799	0.22875
Inert matter (%)	0.00	0.04427*	0.2034	0.2043
Thousand seed weight (mg)	0.0113	51.95*	0.127	16.565
Moisture content (%)	0.00	2.257*	0.00	9.78033
Hectoliter weight (HLW)	0.2295	9.5587*	0.2956	0.511
Normal Germinated seedling (%)	0.000166	11.400*	2.5123	4.64897
Dead seed (ungerminated seed)	0.00	6.5084^{ns}	2.03836	53.9962
Abnormal seedling (%)	0.00	0.061^{ns}	3.12251	60.4003

DF=degree of freedom, Rep=Replications=Non significant variation and * = significant at p (0.05)

Table 3. *Mean comparison for seed qualities of 27 Bread wheat verities.*

No	Varieties name	Seed purity (%)	Inert matter (%) (g)	Thousand seed weight (mg)	Moisture content (%)	Hectoliter weight (HLW)	Normal Germinated seedling (%)	Abnormally seedling (%)	Dead/ Ungerminatedseed (%)
1	kakaba (PB)	99.532^{ABC}	0.4675 ^{ABC}	40 ^{I}	14^{A}	74.74 ^{CDE}	92^{F}	8^{F}	3.25^{C-F}
2	wane (pb)	99.655 ^{ABC}	0.345 ^{ABC}	35 ^{N}	12^{CD}	70.5 ^{M}	86 ^{K}	14^{A}	1^{F}
3	King bird (pb)	99.42 ^{ABC}	0.58 ^{ABC}	37 ^{L}	13 ^{B}	74.25^{DEF}	94^{C}	6^{I}	2.25^{DEF}
4	Boru (pb)	99.64 ^{ABC}	0.36 ^{ABC}	41^{GH}	12^{CD}	71.5^{KL}	91^{G}	9^{E}	4.5^{ABCD}
5	Daka (pb)	99.683 ^{ABC}	0.337 ^{ABC}	42 ^{EF}	12.5^{BC}	71.75^{KL}	95^{B}	5^{J}	2.25^{DEF}
6	Hidasse (pb)	99.55 ^{ABC}	0.45 ^{ABC}	45 ^{C}	12^{CD}	72.25^{JK}	93^{E}	7^{G}	2^{DEF}
7	Lemu (pb)	99.557 ^{ABC}	0.4425 ^{ABC}	34^{O}	12^{CD}	74 ^{EFG}	93^{E}	7^{G}	3.75^{BCDE}
8	Shorima (pb)	99.525 ^{ABC}	0.475 ^{ABC}	36 ^{M}	10.75^{E}	74 ^{EFG}	94^{C}	6^{I}	2^{DEF}
9	Balcha (pb)	99.703^{A}	0.2975^{C}	38^{K}	11.5^{DE}	73 ^{HIJ}	94^{C}	6^{I}	1^{F}
10	Ogolcho (pb)	99.645 ^{ABC}	0.355 ^{ABC}	42^{EF}	14^{A}	75 ^{CD}	89^{I}	11^{C}	6^{AB}
11	Danda.a (pb)	99.403^{BC}	0.597^{AB}	42^{EF}	13.25^{AB}	74 ^{EFG}	87^{J}	13^{B}	6.75^{A}
12	Pavan-76 (pb)	99.675^{ABC}	0.325 ^{BC}	35^{N}	12.43^{BC}	76^{AB}	95^{B}	5^{J}	1^{F}
13	Kakaba (Br)	99.482 ^{ABC}	0.5175 ^{ABC}	36^{M}	13^{B}	75^{CD}	94^{C}	6^{I}	3^{CDEF}
14	Wane (Br)	99.652 ^{ABC}	0.3475 ^{ABC}	40^{I}	11.5^{DE}	72 ^{K}	91^{G}	9^{E}	2.75^{CDEF}
15	King bird (Br)	99.545 ^{ABC}	0.455 ^{ABC}	36.8 ^{L}	12^{CD}	75.25^{BC}	94^{C}	6^{I}	2^{DEF}
16	Boru (Br)	99.653 ^{ABC}	0.3475 ^{ABC}	41.5^{FG}	11^{E}	73.5^{FGHI}	94^{C}	6^{I}	2^{DEF}
17	Daka (Br)	99.443 ^{ABC}	0.5575 ^{ABC}	38.9^{J}	12^{CD}	74.25^{DEF}	95^{B}	5^{J}	0.75^{F}
18	Hidasse (Br)	99.373 ^{C}	0.6275A	44.1^{D}	13^{B}	73.25^{GHI}	90 ^{H}	10^{D}	5^{ABC}
19	Lemu (Br)	99.48 ^{ABC}	0.52 ^{ABC}	38.8^{J}	12^{CD}	73.97^{FG}	92^{F}	8^{F}	2.5^{CDEF}
20	Shorima (Br)	99.542 ^{ABC}	0.4575 ^{ABC}	42.3 ^{E}	13^{B}	74.87^{CD}	97^{A}	3^{K}	2.75^{CDEF}
21	Balcha (Br)	99.557 ^{ABC}	0.4425 ^{ABC}	40^{I}	11^{E}	71 ^{LM}	93^{E}	7^{G}	3^{CDEF}
22	Ogolcho (Br)	99.49 ^{ABC}	0.505 ^{ABC}	42^{EF}	12.5^{BC}	72.96^{IJ}	94^{C}	6^{I}	1.75^{EF}
23	Danda.a (Br)	99.65 ^{ABC}	0.35 ^{ABC}	46.5^{B}	12^{CD}	76.25^{A}	93.92^{D}	6.07^{H}	2.25^{DEF}
24	Pavan-76 (Br)	99.55 ^{ABC}	0.447 ^{ABC}	40.8 ^{H}	13^{B}	72.94^{IJ}	92 ^{F}	8^{F}	3.75^{BCDE}
25	Abay (Br)	99.615 ^{ABC}	0.385 ^{ABC}	44^{D}	12^{CD}	73.75^{FGH}	90^{H}	10^{D}	5^{ABC}
26	Dursa (Br)	99.45 ^{ABC}	0.55 ^{ABC}	37^{L}	13^{B}	74.25^{DEF}	94^{C}	6^{I}	2.75^{CDEF}
27	Shake (br)	99.432 ^{ABC}	0.5675 ^{ABC}	47.8^{A}	12^{CD}	76.5^{A}	90 ^{H}	10^{D}	4.25^{ABCDE}
	Critica value of t (0.05)	0.1491	0.149	0.5029	0.45	0.384	0.0204	0.0204	1.265
	Least.Sig.Diff.	0.296	0.296	0.2526	0.897	0.765	0.0406	0.0406	2.518

Means with the same letters are not statistically significant. (Br)=Breeder seed class, (Pb) =pre basic seed class

Table 4. *Summary statistic for the seed quality parameters.*

Parameters	Number of observation	Min	Max	Sum	Mean	Std. error	Variance	Geom. mean	Coeff. var
Days to Maturity	27.00	120.00	138.00	3477.00	128.78	1.12	33.72	128.65	4.51
Grain Yield (ha)	27.00	19.50	42.90	806.96	29.89	1.23	41.07	29.20	21.44
Hectoliter weight (g)	27.00	70.87	76.19	1988.93	73.66	0.28	2.12	73.65	1.97
Moisture Content (%)	27.00	11.10	13.70	336.42	12.46	0.12	0.39	12.44	5.01
Thousand seed weight (g)	27.00	33.67	47.70	1083.63	40.13	0.70	13.34	39.97	9.10
Pure seed (%)	27.00	99.00	99.91	2687.89	99.55	0.04	0.04	99.55	0.21
Inert matter (%)	27.00	0.09	1.00	12.11	0.45	0.04	0.04	0.40	45.89
Normally Germinated seed (%)	27.00	86.00	96.50	2497.00	92.48	0.47	5.91	92.45	2.63
Abnormally seedling (%)	27.00	3.00	14.00	203.07	7.52	0.49	6.48	7.13	33.85

Parameters	Number of observation	Min	Max	Sum	Mean	Std. error	Variance	Geom. mean	Coeff. var
Dead/Ungerminated seed (%)	27.00	0.75	6.75	79.25	2.94	0.29	2.33	2.55	52.06

Dead seeds and inert matter composition highest CV value which implies only few of the varieties has impurity while most of the varieties record highest seed purity standard.

Table 5. *External Laboratory test result for some parameters and Decision made.*

Varieties	Purity (%)	Moisture Content (%)	Germination (%)	Decision
Daka (Pb)	99.9	13	91	Accepted
Danda.a (Pb)	99.6	13.1	86	Accepted
Hidase (Pb)	99.6	12.6	93	Accepted
Kakaba (Pb)	99.9	13.9	90	Accepted
Kingbird (Pb)	99.8	13.1	94	Accepted
Lemu (Pb)	99.7	13	94	Accepted
Ogolcho (Pb)	99.8	13.5	93	Accepted
Shorima (Pb)	99.6	11.3	91	Accepted
Pavan -76 (Pb)	99.5	12.1	91	Accepted
Boru (Pb)	99.9	12.2	94	Accepted
Balcha (Pb)	99.5	12.1	85	Accepted
Wane (Pb)	99.8	12.3	90	Accepted

Notes: Seed Expert have ability to decide the Acceptance or rejection of Breeder seed based Laboratory result while Pre-basic seed result were crosschecked with External result. Incase Certification/Tag, decision is based on External regulatory body result.

3. Results and Discussion

From table 3 The highest seed purity was recorded by Balcha (pb) with (99.703) followed by Daka (pb) with (99.68) while the lowest seed purity was observed on Hidase (br) with (99.3) all varieties were fitting the minimum purity standard for next seed production. The maximum inert matter (0.627%) was observed on Hidase (br) while the lowest inert matter (%) was observed on Balcha (pb). The highest thousand seed weight (47.8 g) was recorded by Shaki (br) while the lowest (34g) was recorded by Lemu (Pb). The maximum Moisture content (14%) at storage was observed on Kakaba (pb). Shorima (br) with (97%) showed the highest germination potential followed by Daka and pavan-76 (br) with (95%) of normal Germination while wane (pb) with (86%) showed the lowest germination. Generally all the variety was accepted for distribution of the seeds as they fit required seed quality parameters. Germination of seed can affected by environment where it produced [13]. Thousand seed weight of the variety may affected by where they grow and genetic potential of the variety according to [15]. Similarly authors [13] reported that physical characteristics are used to separate seeds were Size, Length, Weight, Color and Electrical conductivity. These parameters are very important for maintain the seed homogeneity which will guarantee for uniform seed emergency field emergency.

Figure 1. *Some of Pictorial recorded during the Activity.*

4. Summary and Conclusion

Planting high quality seed is the first step to growing a successful crop. High quality seed is important to ensure maximum seed germination and seedling vigor, which is turn is instrumental in achieving maximum yield. Poorer quality seeds show low viability, reduced germination and emergence rates, and poor tolerance to sub optimal conditions. Seed quality is also reflected in the final growth, maturity of plants, and their uniformity. As usual we did the study was conducted on Fifteen (15) Breeder seed and twelve (12) pre- basic seeds a total of 27 treatment start from raw seed till final packaging for distribution.

The mean square for Seed inert matter, Seed purity (%), TSW (g), HLW, MC (%), Germination (%) and seed purity showed significant variation which indicate that all treatment needs equal management during assuring internal seed quality process. The maximum inert matter from cleaned seed (0.62%) was observed on Hidase (br) while the lowest inert matter (0.29%) was observed on Balcha (pb). Shorima (br) with (97%) showed the highest germination potential followed by Daka (br &Pb) with (95%) of normal Germination while wane (br) with (86%) showed the lowest germination.

Generally the result from this study indicates that all the varieties fit minimum standard for the next seed production. To know more genetic purity and true to types of the seed further molecular based investigation is required.

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Conflicts of Interest

The authors declare no conflict of interest.

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