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Quality Analysis of Maize (Zea mays) Seed in West Guji Zone Southern Oromia, Ethiopia

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Abstract
Study was carried out to analyze the impact of traditional storage structures on quality of two maize seed varieties of farmers saved seed collected from three traditional storage structures (i.e.; hang above fire places, sack and gotera in or outside home) used by farmers of study area with an objective of analyze the impact of traditional storage structures on maize seed quality. Different quality tests of physical and physiological parameters were evaluated and laboratory results were analyzed by SAS version 9.0.software. The experimental result shows highly significant differences for physical quality parameters between varieties and storage structures across location at $P<0.001$ for pure seed, inert matter and thousand seed weight. The result of interaction between varieties and storage structures shows significant variation for mean comparison of physical purity components parameters. The result of physiological quality parameters shows highly significant variation for normal germination percentage, abnormal seedling, shoot and root length and speed of germination and the result of variety and storage interaction for mean percentage comparison of physiological quality parameters shows highly significant variation. Finally the result of seed sampled from storage structures of hang above fire places were recorded higher percentage, which followed by sample from sack storage structures whereas seed sampled from Gotera shows variation from the rest of storage structures
Keywords: Seed quality, Maize, Storage structures and West Guji Zone

Introduction

Agriculture is the backbone of the Ethiopian economy, employing 85% of the working population and supplying 70% of raw materials for agro- industry but this sector predominantly of small holders or subsistence farms, however it contributes about 94% of agricultural product (crop and livestock) and hence, major suppliers of food and export commodities in the country (Regasa, 2006). In this regards small farmers lack the capital and know-how to efficiently harvest, store and market their surplus yields (Winters; et al., 2006). Maize production covers about 90% of total land and it is one of the five major cereals grown in the country, where the production is dominated by small-scale farmers that comprise 80% of Ethiopia's population are primary producers and consumers. In support of the growing popularity of maize, from its arrived in Ethiopia around 17th century (Huffnagel 1961 cited in (Abate et al., 2015)) , an extensive maize seed industry has emerged in Ethiopia over the last several decades (Alemu et al., 2008) and was mainly grown as a subsistence crop in the mid-altitudes (1500– 2000 m above sea level) in southern, south-central, and southwestern parts of the country. In spite of its popularity that covers large cultivable land of country farmers severs with lack of formal seed access. The return from seed planted including different investment inputs only profitable when plant a quality seed hence, enhances a crop production and productivity that play significant role in economical and efficient inputs for agricultural development(Alemu, 2015).

For thousands of years, generations of farmers across the globe have been observing, selecting, nurturing, breeding and saving seed, so that with every generation agricultural diversity has increased and all of us as descendants of our seed selecting ancestors are living proof of the successful knowledge and diversity that farmers have enhanced and bequeathed to each generation(Anderson, 2013). The availability of, and access to, quality seeds of a diverse range of adapted crop varieties is essential for achieving food and livelihood security and for eradicating hunger, especially in developing countries, in another ways the absence of policies guidelines which control seed quality at different stages of seed production weakens the national capacity to provide smallholders with adequate access to quality seed(Agriculture and Food Organization, 2015).

Farmers needs to access and use good quality seeds for producing their crops and thus requires clear rules and guidance in seed production and testing and the seed quality assurances guarantees farmers to have good quality seed. Most countries in Africa still mainly depend on farmer-saved seeds in which, about 80-90% of seeds come from the farmer-saved seeds, even though improved, superior varieties have been developed in most of those countries (Scoones and Thompson, 2011) cited in (Kebede, 2016 unpublished) this true in Ethiopia too. In another hand the post-harvest loss in Africa estimated 20-40% (Wambugu et al., 2009; Kapur et al., 2011) cited in (Abass et al., 2014) thus impaired seed quality. Thus farmers saved seed stored in different forms such as; ears, maize cobs or grains, placed in plastic containers (jerry can), placed in pots, hanging above fire places with cobs; usually in their kitchen, and store underground in pit under improved or traditional storage structures it impacts on seed quality (Murdolelono B and Hosang E, 2009) and the formal seed supply judged in high quality is less than yearly seed demand in the area of research conducted. Farmers saved seeds don't fulfill seed quality requirements and there is no reports or limited research work has been done on its quality(Kebede, 2016). A seed quality is hampered by different factors at various production stages and thus study sample seed from informal seed sources stored under farmers storage structures. The demand of subsistence oriented smallholder farmers is more interested in the characteristics such as storage quality and resist storage pest but, despite the importance of maize in country as well as at study areas, little is known about various types of storage structures impact on seed quality is scarce in Ethiopia (Bishaw, 2004) as well as at study areas (Borena Zone Agricultural office). Therefore, the study was conducted with the objective of analyze the impact of traditional storage structures on maize seed quality.

MATERIALS AND METHODS

Description of the Study Areas:- The study was conducted at West Guji Zone districts of Bule Hora, Galana and Abbaya during 2016/ 2017 cropping season, it is about 467Km far away from capital city of the country in south. It receives a bimodal rainfall; ganna-long rains (mid-February to mid-May) and hagayya-short rains (September to November (Lemessa, 2003), (Amsalu and Adem, 2009). It is dominated by mixed farming, livestock herding and crop production with sedentary forms of living. A zone has favorable climate for production of different cereals crops wheat, barley, haricot bean, Pea, teff and maize is the major crops observed during assessment (Personal Observation, 2017). The climate of the study area is semi-arid and arid type with average annual rainfall ranging between 350 and 800mm and average annual temperature between 19 and 29^{o}C. The area belongs to the dry sub-humid to the semi-arid moisture regimes (Amsalu and Adem, 2009).

Seed Sample: A two varieties of seed sample were collected from three types of storage structures used by farmers such as; sack, hanging above fire places and gotera in or outside home) for laboratory test to compare storage quality. Varieties, location and storage structures were used as sources of variation.

Laboratory Tests

Seed collected from three storage structures were divided for different physical and physiological parameters of seed quality test. All tests were done according to (ISTA 2004) rules procedures at Assela Seed Health and Quality control center

Physical seed Quality: A 900g of working sample were sorted and separated into four purity components such as pure seed, other crop seeds, inert mater and weed seed and finally, the percentage of each fraction based on weight were calculated.

Physiological seed quality: Different physiological quality parameters were tested and measured such as normal germination, seedling vigor; speed of germination; seedling dry weight and seedling shoot and root length.

Data Analysis

A data collected from laboratory experiment were subjected to SAS version 9.0 software analyses of variances (ANOVA). Mean separation was carried out using least significance differences (LSD) at 5% level of significance. A Complete Random Design in three replication of factorial arrangement, sources and varieties as a factor were used.

Result and Discussion

The result discussed below is the laboratory experiments conducted to determine the performances of seed stored at farmers' level of two varieties sampled from three storage techniques.

Mean percentage comparison of physical purity components and thousand seed weight between varieties and storage structures

Physical purity test was conducted for a two varieties of seed sampled from three locations of three storage structures. The result of physical test were shows significant variation between location for pure seed at ($p<0.05$) and highly significant variation for thousand seed weight at ($P<0.001$), but did not show variation for inert matters. Varieties show highly significant variation for inert matter and thousand seed weight at ($P<0.001$) and significant variation for pure seed at ($P<0.01$) whereas its interaction with location show significance difference at ($P< 0.01$) for both pure seed and inert matter. The interaction of variety and storage shows highly significant variation at ($P<0.001$) for pure seed, inert matter and thousand seed weight (ANOVA Table1 and Table 1). Inline of the present study, the result of purity percentages conducted on maize seed sampled from different agro-ecological condition of Ghana for certified and farmer saved seed sources shows significant variation at ($P<0.05\%$) (Kebede, 2016). A seed sampled from Bule Hora shows higher percentages for pure seed and the least for thousand seed weight.

Table 1; Mean percentage comparison of physical purity components across location

Location	PS	IM	OCS	WS	TSW
Bule Hora	97.77a	2.23a	0.00	0.00	351.34b
Abaya	97.39b	2.36a	0.00	0.00	363.68a
Galena	97.46b	2.34a	0.00	0.00	356.11b
LSD	0.29	0.28	0.00	0.00	6.21

Key: PS = Pure Seed, IM = Inert Matter, OCS = other crop seed, WS = weed seed and TSW = Thousand seed weight

Mean Percentage Comparison of Physiological Quality Components across Location

A result of physiological quality components across location shows significant variation for normal germination percentage and abnormal seedling at (P<0.05), whereas show highly significant variation between variety for normal germination percentage, abnormal seedling, shoot length, root length at (P<0.001) and at (P<0.01) for standard germination percentage (ANOVA Table and Table 1). The result of storage structures show highly significant variation for normal germination percentage, abnormal seedling, shoot length, root length and standard germination percentage at (P<0.001) for physiological quality test. In contrary of this study the result of seeds hung above the fireplace had less vigour and viability than seed stored in gunny bags and airtight containers (Wambugu et al., 2009). The interaction between variety and storage structures shows significant variation for normal germination percentage, abnormal seedling, shoot length and standard germination percentage at (P<0.001) and for root length at (P<0.01) for a seed collected from West Guji Zone of three Districts (ANOVA Table and Table 2). Seed physiological quality may affected by the different factors likes; environment in which seed produced, genotype and seed size; thus selection characteristic must be considered in genetic breeding program (Evangelista Oliveira et al., 2013). Inline of this study the result for certified seed sample shows significant variation for normal seedling across location whereas significant variation was recorded for abnormal seedling a farmers seed sources (Kebede, 2016). There was no significant variation observed for a seed collected from Bule Hora and Galana whereas seed collected from Abaya shows significant variation from the rest (Table 2).

Table 2 Mean percentage comparison of physiological quality components across location

Location	N	A	SL	RL	SPG	SDW	D
Bule Hora	80a	11b	6.45a	14.52a	6.27a	0.0442a	9.39a
Abaya	78ab	14a	6.57a	14.58a	6.37a	0.0433a	9.04a
Gelana	77b	13ab	6.56a	14.58a	6.37a	0.0425a	10.17a
LSD	2.02	2.21	0.26	0.69	0.423	0.0034	1.81

Key: N = normal seedling, A = abnormal seedling, SL = shoot length, RL = root length, SPG = speed of germination, SDW = seedling dry wait and D = dead seeds

Mean Comparison of Physical Quality Components between Storage structures and Varieties

The result of physical quality test between storage structures shows highly significant variation for pure seed, inert matter and thousand seed weight at (P<0.001) and also the result of varieties shows significant variation for pure seed at (P<0.01), inert matter and thousand seed weight at (P<0.001) and interaction between varieties and storage shows highly significant variation for pure seed, inert matter and thousand seed weight at (P<0.001) (ANOVA Table and Table 3). A pure seed and inert matter result shows significant variation from a seed sample taken from three different storage structures. The result seed sampled from storage structures of hang seed above fire places were recorded higher percentage, which followed by seed sampled from sack storage structures whereas seed sampled from Gotera shows variation from the rest of storage structures (Table3.). A two varieties from which seed sampled that used by farmers of study areas are shows significant variation for pure seed, inert matter and thousand seed weight

Table3. Mean Percentage Comparison of physical quality components between storage structures and Varieties

Storage	PS	IM	OCS	WS	TSW
Hang on Fire	98.15a	1.75c	0.00	0.00	382.93a
Sack	97.61b	2.19b	0.00	0.00	377.97a
Gotera	96.86c	2.98a	0.00	0.00	310.23b
LSD	0.29	0.28	0.00	0.00	6.21
Variety					
BH540	97.25b	2.53a	0.00	0.00	374.98a
MH140	97.84a	2.09b	0.00	0.00	339.10b
LSD	0.24	0.229	0.00	0.00	5.07

Key: PS = Pure seed, IM = Inert matter, OCS = other crop seed, WS = weed seed, TSW = thousand seed weight

Mean Percentage Comparison of Physiological Quality Components between Storage structures and Varieties

The result of physiological quality test shows significant variation between storage structures for Normal germination percentage, abnormal seedling, shoot length and speed of germination percentage at (P<0.001), whereas shows significant variation between variety for normal germination percentage, abnormal seedling, shoot length and root length at (P<0.001) and at (P<0.01) for speed of germination percentage. The interaction between storage structures and variety shows significant variation for normal germination percentage, abnormal seedling, shoot length and speed of germination percentage at (P<0.001) and at (P<0.1) root length (ANOVA Table and Table 4). In the case of tests of physiological quality of seeds for sowing purpose and merchantability, germination tests are of great importance and is recommended to be performed under ideal conditions, artificial or both, capable of producing high germination values(Pinto et al., 2012).

Table4. Mean Percentage comparison of physiological quality components between varieties and Storage techniques

Storage and variety	N	A	SL	RL	SPG	SDW	D
Storage							
Hang on fire	83.00a	10.25b	7.169a	14.4958a	7.1908a	0.0446a	6.8b
Sack	69.00b	17.08a	6.288b	14.607a	6.6113b	0.0425a	13.92a
Gotera	83.5a	9.33b	6.127b	14.5796a	5.2108c	0.0429a	7.73b
LSD	2.65	2.21	0.261	0.6896	0.423	0.0034	1.81
Variety							
MH140	83a	9b	6.28b	13.74b	6.598a	0.0431a	7.94b
BH540	74b	15a	6.77a	15.38a	6.077b	0.0436a	11.24a
LSD	2.16	1.8	0.21	0.56	0.345	0.0028	1.48

Key: N = normal germination percentage, A = abnormal seedling, SL = seedling length, RL = root length, SPG = speed of germination percentage, SDW = seedling dry weight and D = dead seed

Conclusion

An experiment result of two varieties of seed sample collected from different structures at different location shows significant variation for different test parameters. A physical purity test results were shows significant variation between location for pure seed and thousand seed weight. The highest values recorded for pure seed and thousand seed weight on seed sampled from Bule Hora and Abaya districts respectively. The experimental results of varieties show significant variation for inert matter, thousand seed weight and pure seed whereas it's interaction with location shows variation for pure seed and inert matter and its interaction with storage significant for pure seed, inert matter and thousand seed weight test parameters. Physiological quality components across location shows significant variation for normal germination percentages and abnormal seedling whereas interaction of varieties with storage structures for physiological quality components shows significant variation for shoot and root length, normal germination percentages, abnormal seedling and standard germination percentages. A seed collected from Bule Hora districts has high performances for normal germination percentages for physiological quality components across location. Finally the result for seed sampled from storage structures of hang seed above fire places were recorded higher percentage, which followed by seed sampled from sack storage structures whereas seed sampled from Gotera shows variation from the rest of storage structures. From this study to identify pre-storage impact of seed condition storage construction at farmers condition level is important point future activities

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Annex (1)

Table 1; ANOVA Table

		Parameters								
sources of variation	DF	PS	IM	TSW	N	A	SL	RL	SPG	SDW
location	2	0.937*	0.113ns	928.9***	76.16*	57.55*	0.112ns	0.037ns	0.07ns	0.00ns
variety	1	6.27**	3.458***	23166***	1530.88***	747.55***	4.27***	48.5***	4.88**	0.00ns
storage	2	9.99***	9.36***	39597***	1626***	430.38***	7.55***	0.08ns	24.86***	0.00ns
loc*var	2	2.043**	1.2**	49.43ns	13.388ns	2.888ns	0.03ns	0.10ns	0.017ns	0.00ns
loc*storage	4	0.386ns	0.26ns	459.2**	7.66ns	2.38ns	0.06ns	0.02ns	0.02ns	0.00ns
var*storage	2	25.04***	27.28***	2754.3***	1792.88***	304.05***	2.22***	8.18**	12.63***	0.00ns
CV		0.515	20.82	2.98	5.777	30.94	6.859	8.12	11.44	13.57