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Effect of duration of seed storage after shelling on seed quality of groundnut (*Arachis hypogaea* L.) varieties in Asossa district, Western Ethiopia

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Abstract

Inappropriate storage systems constrain seed yield and quality of the groundnut in Benishangul Gumuz region of Ethiopia. Therefore, laboratory experiments were conducted to evaluate the effect of duration of seed storage after shelling on seed quality of the crop. Laboratory experiments were conducted at Asossa and Holetta Agricultural Research Centres in the 2011 cropping season. The laboratory experiment consisted of two groundnut varieties (Manipintar and Bulki) and three durations of storage after shelling (10, 20, and 30 days), including one control treatment of after shelling of seed only for one day. The laboratory experiment was laid out as a completely randomized design with four replications. Generally analysis of the data obtained from the laboratory experiment revealed that variety and storage duration interacted significantly ($P < 0.05$) affect standard germination, average root length, seedling dry weight and vigour II. Seed health analysis revealed that seven fungal genera and two bacteria species were detected on seed samples stored for different durations. Manipintar was infected significantly higher than Bulki at all storage period.

Keywords: Groundnut, Duration of seed storage, seed quality, shelled seed, seed health, variety.

1. Introduction

Portuguese first introduced groundnut to northern Ethiopia in the 17th century, and somewhat later through the Arab influence to south-eastern part of the country (Brereton, 1980).

Groundnut is one of the three economically most important oilseed crops including noug (*Guizota abyssinica*.L) and sesame (*Sesamum indicum*) in Ethiopia and is largely produced in the eastern part of the country (Getnet and Nigussie, 1992). Groundnut is an important food and cash crop in the semi-arid areas of the eastern, western and north western parts of Ethiopia (Adugna, 1992). It has a noticeable function in maintaining and improving the soil nitrogen status through symbiotic nitrogen fixation (Hadad and

Loynanch, 1986). Thus, it is mostly grown in marginal soils without the use of inorganic fertilizer. Groundnut has also been found to have advantage of generating residual nitrogen in the soil, which benefits subsequent crops, especially when its residues are incorporated into the soil during ploughing (Anonymous, 2011).

Benishangul Gumuz is a potential area for groundnut production under rain-fed conditions. More than 15912.9 tonnes of dry pod of groundnut is produced from 13994.25 ha of land per annuum(BGRAB 2010/2011 report).In Asossa District, there has been a substantial increase in the cultivation of groundnut as both food and cash crop.

Seed production is successful if a high quality seed can be made available in a sufficient quantity at the required time, at a reasonable price and at the place where it is needed. Smallholder farmers retain groundnut seed after harvest, but large-scale producers buy new seed annually (Waele and Swanevelder, 2001). In the seed industry, there are two basic ways open to ensure a supply of seed for the production of next generation of crop viz (i) saving seed from own crop and (ii) buying in seed from elsewhere (Raymond and George, 1985).

In BenishangulGumuz Zone in Ethiopia, there are a number of problems that constrain the production of quality groundnut seed. One of these problems is Farmers sow seed, which is shelled at home at different times. In case the shelled seed prepared for planting or sowing is not enough to cover the whole land, farmers plant the remaining part of the land with seeds that have been shelled just before sowing. Shelling should be done immediately before seeds are required for consumption, marketing or planting. Seeds should be kept in the shell until as near as possible to the time of since the testa is easily damaged and viability of the seed declines rapidly after shelling (Copeland and McDonald, 2001).

In Asossa district, some smallholder farmers procure seeds of improved groundnut varieties from Asossa Agricultural Research Centre. However, most smallholder farmers use farm saved recycled seed in one year or the other. The seed that has been saved is then shelled at different times and sown. Seeds used for planting that way could cause poor crop stands in the field. In addition, when farmers do replacement sowing to substitute those un-germinated seed a week or so after the original sowing, the crop often reaches harvestable growth stage at different times causing patchy fields in terms of physiological maturity. Thus, there will be the propensity to harvest the crop at different times. Harvesting the crop at different maturity times severely affects the quality of seed that will be saved and used in the next season for planting. This research was, therefore, carried out with the objective of evaluating the effect of storage duration after shelling on seed quality of the crop.

2. Materials and Methods

Evaluation of the effect of duration of seed storage after shelling on seed quality was done in the laboratory at Assosa and HolettaAgricultural Research Centre in 2011. Shelled seeds were bulked and thoroughly mixed, and samples of seeds each weighing about ten kg was taken. The seeds were stored for three durations and tested for seed quality parameters as prescribed by ISTA rules.

2.1 Treatment and Experimental Design

The treatments consisted of two groundnut varieties (Manipintar and Bulki) and three durations of storage after shelling (storing for ten days, twenty days, and thirty days), including one control treatment with freshly shelled seeds and stored in sacks. The experiment was laid out as a completely randomized design with four replications per treatment.

2.2. Laboratory Data Collection and Measurements

2.2.1 Analytical purity

A single seed sample amounting to 1 kg was thoroughly mixed, and then divided by a seed divider until 600 g was obtained. Each sample was sorted to four components; pure seed, other crop seeds, inert mater and weed seed. After analysis, the percentage of each fraction based on weight was calculated, and recorded.

2.2.2 Determination of physiological quality

Standard Germination

The standard germination test was conducted by using between paper methods at room temperature as prescribed by ISTA (1996). The germination counts were taken on 14th day as a final count and were calculated as follows.

$$\text{Germination \%} = \frac{\text{Number of normal seedlings}}{\text{Total number of seed sown}} x100$$

Vigour Test

Two vigour indices for each sample were calculated. Vigour index one was calculated by multiplying the standard germination with the average sum of shoot length and root length after 14 days of germination whereas vigour index two was calculated by multiplying the standard germination with mean seedling dry weight.

Germination rate index

While conducting the germination test, daily count was taken from the emergence of seedlings and based on this observation, the germination rate index was calculated using following formula (ISTA, 1995).

$$GRI = \left(\frac{N1}{D1}\right) + \left(\frac{N2}{D2}\right) + \left(\frac{N3}{D3}\right) \ldots \left(\frac{Nn}{Dn}\right)$$

Where, GRI = Germination rate index
N1, N2, N3 ….Nn = Number of seedlings emerged on
D1, D2, D3 and Dnth days after putting

Field emergence

A pot experiment was conducted in the green house to compare seedling performances with the seed test results obtained from laboratory. The experiment was meant to assess seedling emergence from the potted medium, which was measured and recorded for 14 days of sowing in which case all seedlings emerged except the dead or un-germinated seeds. The field emergence was calculated using following formula (ISTA, 1985).

$$FE = \frac{\text{Number of seedlings emerged}}{\text{Number of days count frist}} + \cdots \frac{\text{Number of seedlings emerged}}{\text{Number of days final count}}$$

2.2.3 Seed health test

Seed samples were examined for the association of different fungal and bacterial seed-borne and soil borne pathogens. Identification of the different pathogens was based on an incubation method test using the blotter method described according to ISTA rules (ISTA, 2003). Twenty five seeds were planted and incubated for 7 days at 20 ^{0}C for 12 hours an alternating cycle of light and darkness. At the end of the incubation period, each seed was thoroughly examined under different magnification of stereomicroscope for development of fungi. Identification of fungi was based on morphological character of fruiting bodies, conidia observed under a compound microscope. The infection of each fungal pathogen was recorded as percentage of infection and used for comparison among treatments.

2.3 Data Analysis

All data were subjected to analysis of variance (ANOVA) using the Generalized Linear Model (GLM) method of SAS (SAS, 2002). Differences between treatment means were separated using the Least Significant Difference (LSD) test at 5% level of significance.

3. Results and Discussion

3. 1 Standard germination

It was found that seed, storage periods, and their interaction highly significantly (P < 0.01) influenced germination of shelled groundnut seeds (Table 1).

Both varieties exhibited the highest germination percent when stored only for one day after shelling. However, the germination percentage of Bulki significantly plummeted with prolonged storage. Thus, germination percentage of Bulki stored for one day exceeded the germination percentage of seeds of the same variety stored for 10, 20 and 30 days by about 33, 28,and 54%, respectively (Table 1). The germination percentage of shelled seeds of Manipintar stored for 10, 20, and 30 days exceeded the germination percentage of shelled seeds of Bulki stored for the same durations by about 14, 10, and 19%, respectively. This might be due to variation in genetics attributes of the cultivars. Results of the present study imply that groundnut seed storage life also differs among cultivars. Genotypic differences have been reported in terms of seed longevity (Rao *et al*., 2002); germinability (after six months storage) (Nkang and Umoh, 1996), seed deterioration and germination rate (Duangpatra*et al*., 1986). The highest germination was noted without storage of shelled seeds. The higher (84.8%) standard germination was observed for shelled Manipintar seeds after storage of 20 days followed by 10 days storage. Skin slip was the major problem observed on shelled seeds stored for 30 days. This might be due to high temperature and dry air in the study area under which the shelled seeds were stored. This result is in line with that of Copeland and McDonald, (2001) who reported that the degree of deterioration is associated with the concentration of seed exudates that may be found in the steep solution. These exudates are a reflection of the amount of membrane degradation that has occurred. The high EC of groundnut seeds under ambient-storage suggested that groundnut seed deterioration was faster under ambient conditions.

Table 1. Effect of variety and duration of storage after shelling on standard germination, Average root length, Seedling dry weight and Vigour index II of groundnut in Asossa during the main growing season of 2011

Variety	Treatments	Parameters			
	Duration of storage (day)	Standard germination	Average root length	Seedling dry weight	Vigour index II
Bulki (B)		98.61a	16.17b	1.26b	44.01b
	10	74.06c	12.38cd	0.74c	17.07d
	20	76.93c	11.23cd	0.75c	15.49d
	30	64.08d	11.75cd	0.72c	15.49d
Manipintar		97.57a	20.82a	3.26a	131.31a
	10	84.74b	12.60c	1.50b	37.56bc
	20	84.80b	10.63d	1.38b	30.23c
	30	75.97c	11.75cd	1.44b	31.54c
LSD (0.05)		3.24	1.90	0.30	8.92
CV (%)		2.28	8.15	12.63	12.63

Means followed by the same letter within a column are not statistically different at 5% level of significance. LSD = Least significant difference; CV = Coefficient of variation;

2.3. Average shoot and root length

It is assumed that seedlings with well-developed shoot and root systems would withstand adverse conditions and provide better seedling emergence and seedling establishment in the field (ISTA 1985).

According to the results of analysis of variance, storage duration highly significantly ($P \leq 0.01$) influenced seedling shoot length. However, variety as well as the interaction effect of variety and storage duration was not significant (Table 1). The main effects of variety as well as variety and duration of storage did not significantly affect seedling root length. However, the main effect of duration of storage after shelling highly significantly ($P < 0.01$) affected seedling root length (Table 2).

Shoot and root length significantly and linearly decreased with the increase in storage duration. Thus, in this study, the longest shoot and root was observed for shelled seeds that were not stored (stored only for one day) whereas the shortest shoot was recorded for seeds stored for 30 days. (Table 1and Table 2) .

2.4. Seedling dry weight

The effect of cultivar, storage period, and their interaction highly significantly ($P \leq 0.01$) influenced seedlings dry weight (Table1).

For both varieties, seedling dry weight significantly decreased with the increase in storage duration. However, the degree of decrease in seedling dry weight was much more pronounced for the Bulki than the Manipintar. The highest seed dry weight was recorded for seeds of the Manipintar stored for only one day after shelling, followed by seeds of the same variety stored for all other durations as well as seeds of the Bulki stored for only one day after shelling. On the other hand, the lowest seedling dry weight was obtained from seeds of Bulki that were stored for 10, 20, and 30 days, all which were in statistical parity. The results of this study indicate that deterioration in shelled seeds of groundnut is directly proportionally to the length of storage period (Table 1).

3.4 Vigour index

Results of vigour index one and two are presented in Table 2 and Table 1 respectively. According to analysis of variance, it was found that the effect of varieties and storage duration on seedling vigour index was significantly high at ($p \leq 0.001$) probability level. While the interaction effect of varieties with storage duration was found on vigour index two but not significant on vigour index one. The higher vigour index was observed on Manipintar than on Bulki Variety. As storage duration increased it was found that vigour index declined.

For both varieties, vigour index significantly decreased with the increase in storage duration. Therefore, highest (3682.09) mean value of vigour index I was found when grown without storage and the lowest (1523.02) was recorded as shelled seeds stored for 30 days. Similarly, higher mean value of vigour index two was recorded without storage.

However, in contrast to seedling dry weight, the decrease in vigour index II was markedly higher for the Bulki than the Manipintar. The highest vigour index II was recorded for seeds of Manipintar stored for only one day after shelling, closely followed by seeds of the same variety stored for all other durations after shelling. On the other hand, the lowest seedling dry weight was obtained from seeds of Bulki that were stored for 10, 20, and 30 days, all of which were in statistical parity. Seedling vigour index II of the Bulki stored for only one day after shelling was already significantly lower than the seedling vigour II of Manipintar stored for the same day after shelling. Thus, at this stage of storage, the seedling vigour II of Manipintar was higher than that of Bulki already by about 198% (Table 1). The significant differences in seedling vigour index of the two varieties might be attributed to differences in their genetic constitution that may impart differential resistance to aging. This result was corroborates that of Rao *et al.* (2002) who reported that genotypic differences were found between groundnut cultivars in terms of seed longevity.

Table 2. Main effects of variety and duration of storage after shelling on vigour index I**,** germination rate index and field emergence of groundnut in Asossa during the main growing season of 2011

Means followed by the same letter within a column are not statistically different at 5% level of significance. LSD = Least significant difference; CV = Coefficient of variation;

3.5 Germination rate index

Analysis of variance showed that the main effects of varieties and duration of storage after shelling significantly (P ≤ 0.05) affected the germination rate index while the interaction of the two factors was not significant on this parameter (Appendix Table 5).

The varieties differed significantly in terms of germination rate index. Thus, Manipintar had a germination rate index that was significantly higher than that of Bulki by about 13% (Table 2). Furthermore, germination rate index significantly decreased in response to increasing storage duration. Thus, seeds stored for only one day after shelling had significantly higher germination rate than seeds stored for 10, 20, and 30 days after shelling by about 52, 46, and 72%, respectively (Table 2). The decrease in germination rate index with the progress in storage time might be attributed to physical and biochemical deterioration of the seed. This result is consistent with that of Nautiyal (2000) who reported that at ambient farm storage, groundnut seeds interact with the storage humidity (RH percent) and temperatures, under which the seed rapidly loses its quality through biochemical changes-flavor change, rancidity, viability loss, physical changes such as shrinkage, weight loss, and absorption of odour and chemicals.

Treatments	Parameters			
Variety	Average shoot length (cm)	Vigour index I	Germination rate index	Field emergence
Bulki (B)	13.34a	2119.39b	4.37b	3.82b
Manipintar	13.28a	2393.11a	4.95a	4.28a
LSD (0.05)	ns	124.82	0.43	0.25
Duration of				
1	19.07a	3682.09a	6.38a	5.13a
10	13.00b	2022.22b	4.19bc	4.54b
20	11.29c	1797.68c	4.37b	4.12c
30	9.89d	1523.02d	3.70c	3.59d
LSD (0.05)	0.96	176.53	0.61	0.36
CV (%)		6.39	10.71	12.07

3.6 Field emergence

The analysis of variance showed that field emergence was significantly ($P < 0.05$) affected by variety and duration of storage after shelling. However, the interaction effect of variety with duration of storage after shelling did not significantly affect field emergence (Table 2).

Field emergence represents the performances of a crop stand in the field than other seeds quality parameters. Therefore, the mean values of field emergence found were lower than that of speed of germination. For both varieties, the highest mean value of field emergence (5.13) was recorded when the seeds were grown without being stored for both varieties. Thus, seeds stored for only one day after shelling had significantly higher field emergence than the ones stored for 10, 20, and 30 days (Table 2). The data also showed that Manipintar had significantly higher field emerging capacity than Bulkiby about 12% (Table 2).

In general, as storage duration was prolonged, the seed emergence capacity of both cultivars decreased drastically. This might be due to high temperature and dry air of the study area which might have caused accelerated aging and deterioration of the shelled seeds. This result agrees with that of Copeland and McDonald (2001) who reported that deterioration of seeds was observable in their lowered performance during germination. According to these authors, delayed seedling emergence is among the first noticeable symptoms, followed by a slower rate of seedling growth and development and decreased germination.

3.7 Seed Health Test

Based on storage period of shelled groundnut seed health analysis, it was noted that all fungi and bacteria that occurred during different harvesting times existed during analysis of shelled seeds stored for different storage times except *Phoma* species. Hundred percent infections by disease was recorded for seed of Manipintar stored for 30 days, followed by 95% for seeds of the same variety stored for 10 days. During this analysis, Bulki was infected by *Penicillium* spp, *Fusarium spp* and *Pseudomonas* spp whereas Manipintar was infected by all fungi and bacteria identified. No evidence was found on the influences of increased storage times on percentage occurrence of diseases except *Xanthomonas* spp and *Alternaria* spp which showed linear increase with storage period. Groundnut is susceptible to a number of stem, foliage, pod, and root diseases. Shazia*et al.* (2004) reported that *Fusarium solani*, *Fusarium oxysporum* cause damping off of groundnut seedlings, *Aspergillus flavus* attack germinating groundnut seed and *Aspergillus niger* cause crown rot disease of groundnut**.**

Table 3.Percentage occurrences of *A. flavus*, *A. niger*, *Penicillium* spp, *Xanthomonas* spp and *Alternaria* spp on groundnut samples tested for shelled stored seeds in Asossa during the main growing season of 2011

Treatments		Associated pathogens and mean percent of infected seeds								
Varieties	Duration of storage	*Aspergillus flavus*	*Aspergillus niger*	*Penicillium* spp	*Xanthomonas* spp	*Alternaria* spp	*Fusarium* spp	*Pseudomonas* spp	*Chaetomium* spp	*Sclerotium rofsii,*
Bulki	1	0.71(0) d	0.71(0) b	1.83(6.67)h	0.71(0) d	0.71(0) e	0.71 (0)b	0.71 (0) c	0.71 (0) d	0.71 (0) d
	10	0.71(0) d	0.71(0) b	3.33(22.22)g	0.71(0) d	0.71(0) e	1.83(6.67)a	0.71 (0) c	0.71 (0) d	0.71 (0) d
	20	0.71(0) d	0.71(0) b	3.80(28.89)f	0.71(0) d	0.71(0) e	0.71 (0)b	1.05(2.22)b	0.71 (0) d	0.71 (0) d
	30	0.71(0) d	0.71(0) b	4.47(40)d	0.71(0) d	0.71(0) e	0.71 (0)b	0.71 (0) c	0.71 (0) d	0.71 (0) d
Manipintar	1	0.71(0) d	1.72(5.89)a	4.22(35.56)e	0.71(0) d	1.83(6.67)d	0.71 (0)b	0.71 (0) c	0.71 (0) d	0.71 (0) d
	10	1.83(6.67)a	0.71(0) b	6.91(95.56)b	1.83(6.67)c	2.58(13.33)c	0.71 (0)b	1.05(2.22)b	1.83(6.67)b	3.16(20)c
	20	1.05(2.22)c	0.71(0) b	5.77(66.67)c	3.65(26.67)b	2.79(15.55)b	0.71 (0) b	1.49(4.45)a	1.05(2.22)c	4.47(40)b
	30	1.49(4.45)b	0.71(0) b	7.07(100)a	3.94(31.11)a	3.16(20)a	0.71 (0) b	0.71 (0) c	3.33(22.22)a	5.16(53.33)a
LSD		0.41(0.33)	1.21(2.95)	0.97(1.9)	0.79(1.24)	0.56(0.62)	0.71 (0)	0.45(0.41)	0.80(1.27)	0.56(0.62)
CV (%)		11.60	15.23	2.23	8.92	5.19	0.00	21.31	18.83	2.51

CV = Coefficient of variation; values with the same letter in a column are not statistically different at 5% level of significance;Data transformed by using square root; Original values are indicated in bracket

4. Conclusion

The quality of groundnut seed has been shown to deteriorate faster when stored shelled than when stored unshelled. Therefore, seeds should be stored within the intact pods for the next growing season and planted or used immediately after being shelled.Storing shelled seeds of both varieties led to rapid deterioration in quality. Therefore, the seed pods should be shelled immediately before sowing and planted without any delay.

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