STORAGE LIFE OF SESAME (*Sesamum indicum* L.) SEEDS UNDER HUMID TROPICAL CONDITIONS

ADEBISI, M. A[1]., OLA, J.A., AKINTOBI, D. A. C. and DANIEL, I.O.

Department of Plant Breeding and Seed Technology,
University of Agriculture, Abeokuta, P. M. B. 2240, Abeokuta, Ogun State, Nigeria.
[1]Corresponding author - email address: mayoadebisi @ yahoo.co.uk

ABSTRACT

The longevity of seeds of ten genotypes of sesame (*Sesamum indicum* L) was estimated using probit modeling to evaluate storage potential of these seed lots stored under humid tropical storage conditions. The seeds were stored for 240 days (8 months) under ambient conditions in two environments; University of Agriculture, Abeokuta (UNAAB) (32°C, 50%RH) and Babcock University, Ilisan, (BABCOCK), (31°C, 60%RH) with initial seed moisture content of between 10.0% and 12.8%. Seed viability was monitored in storage and seed survival was evaluated by probit analysis of the serial seed viability data. The seed viability data during storage showed that there were variable survival patterns under the two storage environments. Viability of seeds at the earlier periods (30-90days) of storage showed low deterioration as higher viability was still retained in most cases. Probit analysis showed negative slope ($^1/ä$) values for all the seed lots suggesting certain degrees of deterioration over the 240 days (8 months) irrespective of genotype's storage environment. The values of the slope revealed that speed of deterioration was reduced under UNAAB environment and higher in BABCOCK environment. The half-life (P_{50}) values derived by probit analysis of viability decline curves during storage of seeds of the ten sesame genotypes in two environments suggests that seed longevity can be prolonged by storage in favourable environment. Seed storage life of the ten genotypes was prolonged in UNAAB environment compared to BABCOCK environment. The highest seed storage life of approximately 11 months was derived for seeds of 530-3 genotype stored in UNAAB environment, followed by E8 with seed storage life of 10 months under UNAAB environment. Seeds of C-K-2 and 530-6-1 genotypes stored in UNAAB environment had high storage life of about 9 months. The shortest seed storage life of approximately 3 months was estimated for seeds of 73A-97 genotype stored in BABCOCK environment. The results showed that the storage of seed under favourable ambient environments offer good potential for short-term sesame seed quality maintenance.

Keywords: Longevity, probit modeling, seed viability, sesame tropics

INTRODUCTION

The longevity of seeds in storage is a good indicator of seed quality and vigour in many crops (Ellis and Roberts, 1980; Roberts, 1973; Hampton, 2002, Adebisi *et al.,* 2003). Ellis and Roberts (1980) have developed probit analysis methods to quantify the initial quality of a seed lot and its rate of deterioration using controlled deterioration tests. It is already well known that seed longevity is a function of storage temperature and seed moisture content (Harrington, 1972; Roberts, 1973), stresses before seed storage and initial seed quality (Ellis and Roberts, 1980), genetic make-up (Adebisi *et al.*, 2004b) and pest and pathogen damages in storage (Kulik, 1995).

Ellis and Robert (1980) observed that seed deterioration in storage follows a negative cumulative normal distribution pattern. This makes it possible to estimate seed longevity from seed survival data using probit analysis (Finney, 1971), and thus assessing the seed physiological quality during storage under specified conditions (Daniel, 1997; Daniel *et al.,* 1999, Adebisi *et al*., 2003). The parameters of seed longevity that can be determined by the PROBIT procedure are: the intercept constant (*Ki*), standard deviation of the distribution of seed deaths in time *(s*) and the seed half-viability period (P_{50}). *Ki* is an estimate of initial seed viability and index of seed quality before storage while *s* is the reciprocal of the slope of probit seed survival curves, the slope being the rate of seed deterioration. The seed P_{50} is time taken for viability to fall to 50% and a measure of absolute seed longevity (Ellis and Robert, 1980).

Sesame seed quality components depend upon the environment, genotype and their interaction (Adebisi, 2004a, Adebisi *et al,*. 2005c). Sesame seed production in South Western Nigeria is hampered by the speed with which the seeds lose their viability when exposed to warm, moist air that characterizes the ambient humid climate. Even in good storage, the signs of physiological deterioration in terms of slower germination and reduced seedling growth of carry-over seeds are apparent (Ramamoorthy, 1989). Moreover, quantifying the longevity of seeds would further elucidate the relative influence of adverse storage conditions on the physiological quality of seeds and elicit possible strategies for improving seed longevity under adverse storage conditions.

The seeds of sesame are generally referred to as oil seed (Iwo and Idowu, 2002). Although no details on its storage physiology are documented in Nigeria, but being an oil seed, the handling and storage of sesame continues to be a difficult problem with increase in the demand of the crop internationally. Therefore, this study was conducted to estimate seed longevity of ten sesame genotypes stored under the ambient humid tropical conditions.

MATERIALS AND METHODS

Seed Materials

Seeds of 10 sesame genotypes (93A-97, Type-A, 73A-11, 530-6-1, 73A-94, E_8, Domu, 73A-97, C-k-2 and 530-3) harvested from seed yield trials at Teaching and Research Farm of the University of Agriculture, Abeokuta in December 2003 were utilized for the study. These genotypes were sourced from National Cereal Research Institute (NCRI) Badeggi, Niger State, Nigeria and three genotypes (Domu, Goza and C-K-2) were local varieties while the others were genotypes introduced through the Ahmadu Bello University, Zaria, Nigeria.

The genotypes employed in this study had not been fully characterized and nothing was known about their seed storability potentials. Instead, they were selected on the basis of what little was known about desirable characters, such as the seed quality components. Seed samples were cleaned by using seed tray to remove the chaffs from the seed and tested for initial seed germination and moisture content (Table 1).

Seed Preparation and Storage

500g of each seed lot from each of the genotypes was determined and put into transparent thick polythene bags of 12cm in length and 10cm in breadth and then sealed with electric heat sealer. The experiment was a 3-factorial in a completely randomised design with three replicates. The factors were genotypes, storage environments and duration in storage environment. A total of 90 treatment units were used for each environment while a total of 180 treatment units were utilized for this study. Seeds in the polythene bags were stored under ambient laboratory conditions for 240 days (8 months) from April to November 2004 at the Seed

Table1: Mean monthly temperature(T) and relative humidity (RH) for the study months in 2004.

Months	BABCOCK		UNAAB	
	T(°C)	RH (%)	T(°C)	RH (%)
April	28.4	83.0	23.8	78.0
May	27.5	85.0	23.1	83.7
June	26.4	86.0	22.3	76.2
July	26.1	87.0	21.3	81.6
August	25.7	88.0	21.2	86.5
Sept.	26.2	86.0	21.9	86.8
October	27.1	85.0	22.8	76.9
Nov.	28.0	86.0	23.4	71.2
Mean	26.93	85.75	80.11	22.48

Source: Babcock University, Ilisan and Institute of Research and Training (IR&T), Ikenne and Ogun-Osun River Basin Development Authority, Abeokuta in 2004.

Laboratory, University of Agriculture, Abeokuta, Ogun State and Agricultural Laboratory, Babcock University, Ilisan Remo, Ogun State, Nigeria. The average room temperature was approximately 30°C and relative humidity was 58% for UNAAB environment while the temperature was 32°C and relative humidity 54% for BABCOCK environment. Seeds were taken from each polythene bags for seed viability test at 30-day interval for 8 months during the time of storage. A detailed summary of climatological data of the experimental sites collected from meteorological unit of Ogun-Osun River Basin Development Authority (ORBDA), Alabata, Abeokuta and Babcock University, Ilisan to explain the effects of weather conditions during seed storage is presented in Table 2.

Table 2: Genotypes and initial seed quality of the seed lots of sesame seeds used in the study.

Genotype	Initial germination	Moisture content (%) F.Wb
93A-97	81.20	12.8
Type-A	85.40	11.8
73A-11	86.30	11.4
530-6-1	86.98	11.6
73A-94	80.40	11.6
E8	81.43	10.0
Domu	80.60	12.0
73A-97	73.86	11.4
C-K-2	86.53	11.2
530-3	87.50	11.8

F. Wb= Fresh weight basis

Seed Viability Test

Standard germination test was performed on three sub–samples of 100 seeds planted on paper towels moistened with 5ml of distilled water inside 11cm diameter petri–dishes and germinated at 25°C in an incubator. Germination counts of normal seedlings were conducted at seven days after seedling (ISTA, 1995) when the radicle had elongated beyond the length of the seed. The seed viability was evaluated as percentage normal seedlings seeds cultured for each replicate.

Statistical Analysis

Data on seed viability were transformed using angular transformation (arcsine $\sqrt{Sin^{1}}$). Seed deterioration rates and absolute longevity estimates were subjected to ANOVA to determine if there were significant differences at 5% probability level among the seed lots and storage environments. PROBIT analysis of mean percentage seed viability data was done with

SAS™ PROC PROBIT statements that first sorted the data by genotype and storage environment. Seed longevity parameters were estimated from the procedure based on six viability test data points for each environment. Estimates of intercept (*time=0*) of the seed survival line, slope *i.e.* the rate of the seed deterioration (*1/s*) and time taken for seed ageing to decline to 50% viability (P_{50}) were estimated by the PROBIT procedure for each of the seed lots. Seed storage life was estimated as double of the seed half-life.

RESULTS

Initial Seed Quality

Table 2 shows the initial percentage viability and moisture content of the seed lots before storage. Percentage seed viability before storage was highest in the 530-3 seed lot and lowest in the 73A-97 (73.86%). Seed moisture contents ranged from 10% (f.wb) in E8 to 12.8% (f.wb) in 93A-97.

Seed Survival

Results of seed viability tests of ten sesame genotypes stored in two storage environments for 240 days are presented in Table 3. Differences in seed lot responses to the storage environments were apparent. By the 5th months (150 days) of storage, seeds of 530-3, E8, C-K-2 and 530-6-1 stored in UNAAB storage environment still maintained above 50% viability while the same genotypes only maintained viability above 40% in BABCOCK storage environment. At the 8th month of storage (240 days), there was a sharp decline in seed viability to less than 25%, irrespective of storage environment and genotype. It was interesting to note that high seed viability of between 36 and 46% was retained in seeds of E8, C-K-2 and 530-3 genotypes after 7 months (210 days) of storage. Seeds of C-K-2 stored for 180 days under UNAAB storage environment had significantly highest seed viability of 51.7% compared to other genotypes while the corresponding BABCOCK storage environment retained 38% viability.

Seed Longevity Estimations

Data in Table 4 show the probit parameters for the sesame seed survival data after storage in two environments for 240 days. The values of intercept (estimates of initial probit viability and a measure of seed quality before storage) were generally higher in 530-6-1, E8, C-K-2 and 530-3 in both storage environments than other genotypes but lowest in 73A-97 and Domu. This corroborates the actual percentage seed germination before storage for the seed lots (Table1).

Negative values of estimates of slope of the seed survival data for all the seed lots (Table 4), indicate a certain degree of deterioration, irrespective of storage environment and genotype. The value of the slopes also indicated that speed of deterioration was reduced in most cases in seeds stored under UNAAB environment. However, the lowest reduction occurred with C-K-2 under UNAAB (0.055) and BABCOCK (0.177) environments.

The favourable storage environment experienced in UNAAB also resulted in significant increase of seed longevity extension in some sesame genotypes as indicated by estimates of seed half-life (P_{50}) and storage life (Table 4). Seeds of all the genotypes had significantly higher estimates of seed half-life (P_{50}) and storage life in UNAAB than BABCOCK storage environment. Under UNAAB storage environment, estimates of seed storage life were highest in 530-3 (10.6 months), followed by E8 (10.33 months), C-K-2 (9.4 months) and 530-6-1 (9.0 months) while it was lowest with 73A-97 (5.2 months and 93A-97 (5.6months). All other genotypes had seed storage life of above 6 months. On the other hand, under BABCOCK environment, the estimates of seed storage life were maximum in 530-3 (8.4 months followed by E8 (7.93 months), C-K-2 (7.73 months) and 530-6-1 (6.20 months).

Table 3: Results of seed viability tests of ten sesame genotypes stored under two storage environments for 240 days.

Genotype	Storage environment	Storage periods (days)							
		30	60	90	120	150	180	210	240
93A-97	UNAAB	81.7	58.7	43.30	32.7	33.0	28.3	16.6	12.3
	BABCOCK	77.0	42.7	38.0	28.0	21.3	20.0	12.0	0.14
Type-A	UNAAB	88.0	62.7	57.7	40.7	33.0	29.7	26.0	18.3
	BABCOCK	86.3	46.7	43.3	34.3	23.3	24.0	12.0	0.15
73A-11	UNAAB	74.3	62.7	61.3	58.7	49.7	36.3	28.0	4.7
	BABCOCK	71.3	55.5	52.3	43.3	34.7	20.3	15.7	0.19
530-6-1	UNNAB	73.7	73.3	71.0	67.8	50.8	45.0	27.7	10.0
	BABCOCK	73.3	60.3	59.3	48.7	40.6	29.7	23.0	0.19
73A-94	UNAAB	69.0	63.7	61.3	42.7	38.0	31.7	24.3	15.3
	BABCOCK	69.5	49.3	47.3	25.0	19.7	16.7	13.0	0.91
E8	UNAAB	74.7	75.1	71.3	68.0	50.3	47.3	40.3	13.0
	BABCOCK	70.0	66.0	64.7	41.7	35.3	35.3	34.3	10.3
Domu	UNAAB	69.7	58.4	54.7	53.7	49.3	30.7	29.0	11.7
	BABCOCK	70.0	47.7	41.7	31.3	26.0	24.3	21.7	0.24
73A-97	UNAAB	68.0	47.0	46.7	45.7	44.7	33.0	16.0	11.0
	BABCOCK	65.0	35.0	33.3	24.3	21.0	17.7	9.0	0.35
C-K-2	UNAAB	87.0	72.7	64.7	64.0	54.6	51.7	46.3	23.7
	BABCOCK	81.0	68.3	66.7	41.7	41.3	38.0	35.7	13.7
530-3	UNAAB	82.7	78.5	75.7	73.3	66.3	37.3	36.3	16.0
	BABCOCK	80.0	66.7	57.0	55.0	46.7	41.0	37.7	2.0
SE		**2.53**	**1.92**	**2.33**	**2.42**	**1.81**	**1.76**	**1.68**	**1.54**

However, the lowest seed storage life was obtained in 73A-11 (3.69 months), 73A-97 (2.27 months) and 93A-97 (2.46 months) while seeds of other genotypes had storage life above 4.0 months (Table 4). Seed storage life of 93A-97 and 73A-97 was generally low in the two storage environments.

Table 4: PROBIT parameters for the sesame seed survival data after storage in two storage environments.

Genotype	Storage environment	*Intercept (Probit viability)	** Slope	P_{50} in days	*** Seed Storage life in months
93A-97	UNAAB	0.710	-0.251 (0.39)	2.825 (84)	5.60 (0.18)
	BABCOCK	0.259	-0.248 (0.09)	1.046 (37)	2.46 (0.39)
Type-A	UNAAB	0.806	-0.240(0.022)	3.366 (101)	6.73 (0.10)
	BABCOCK	0.756	-0.284(0.066)	2.667 (80)	5.30(0.30)
73A-11	UNAAB	0.940	-0.269(0.022)	3.495 (105)	7.00(0.11)
	BABCOCK	0.367	-0.201(0.065)	1.829 (55)	3.67 (0.30)
530-6-1	UNAAB	1.474	-0.228(0.328)	4.502 (135)	9.00(0.29)
	BABCOCK	0.888	-0.285(0.048)	3.111 (93)	6.20 (0.22)
73A-94	UNAAB	0.743	-0.211(0.021)	3.524 (106)	7.07 (0.16)
	BABCOCK	0.797	0.322(0.042)	2.475 (74)	4.93 (0.18)
E8	UNAAB	1.201	-0.233(0.033)	5.165 (155)	10.33 (0.17)
	BABCOCK	0.953	-02.40(0.033)	3.972 (119)	7.93 (0.16)
Domu	UNAAB	0.762	-0.202(0.034)	3.763 (113)	7.53 (0.17)
	BABCOCK	0.654	-0.254(0.043)	2.579 (77)	5.13 (0.20)
73A-97	UNAAB	0.447	-0.173(0.033)	2.586 (78)	5.20 (0.16)
	BABCOCK	0.267	-0.239(0.043)	1.118 (34)	2.27 (0.19)
C-K-2	UNAAB	0.116	-0.055(0.096)	4.688 (140)	3.862 (116)
	BABCOCK	0.685	-0.177(0.049)	9.40 (0.48)	7.73 (0.24)
530-3	UNAAB	1.442	-0.262(0.043)	5.298 (159)	10.60 (0.22)
	BABCOCK	1.113	-0.266(0.062)	4.185 (126)	8.40 (0.30)

* Intercept is PROBIT estimate of initial seed viability.
** Slope is the rate of seed deterioration ($^1/s$), PROBIT viability loss per day.
***Seed storage life was estimated as half-life (P_{50}) value multiplied by 2 then divided by the 30 days of a month. Seeds were stored in two storage environments. (Standard errors of means are in brackets).

DISCUSSION

The seed viability data during storage showed that there were variable survival patterns under the different storage environments. Seed viability at the earlier periods (30 to 90days) of storage showed low deterioration as higher viability was still retained in most cases. Thereafter, a sharp decline in seed viability to less than 20% was observed in seeds of the genotypes in both storage environments at between 120 and 240 days of storage. These observations confirm the seed storage characteristics of sesame seeds, thus the viability of sesame seeds declined with the storage length (Ramamoorthy, 1989). Seed deterioration is a physiological mechanism (Parish and Leopold, 1978), exacerbated by the warm and humid conditions of unconditioned tropical stores.

The result has demonstrated that seed deterioration rate and eventual seed storage life is dependent on the initial quality of seed moved into storage and thereafter decline steadily. The sharp decline in seed viability after the first three months (90 days) may be due to adverse storage conditions of the humid tropics as already suggested by Adebisi (1999) and Adebisi and Ajala (2000). Differences in estimates of intercept from the probit modeling of seed survival establish reports of genotype and seed lot differences in potential longevity of sesame. This is in agreement with the reports of Zanakis *et al.* (1993) and Adebisi *et al.* (2003) in soybean varieties. However, since the intercept parameter is a seed lot parameter (Ellis and Roberts, 1980), there cannot be a conclusion of genotypic superiority in seed longevity in sesame.

Seeds of the ten sesame genotypes showed some degrees of deterioration over the 240 days (8 months) of storage as evidenced by the negative values of slopes of all seed survival curves. The values of the slope revealed that speed of deterioration was reduced under UNAAB storage environment and higher in BABCOCK storage environment. This finding further confirms that temperature and humidity of seed storage environment play an important role in seed deterioration. BABCOCK environment recorded higher rainfall, humidity and low temperature, which enhanced high microorganism activities compared to UNAAB environment (Table 1). This, therefore, suggests that the warm and humid storage environments of the uncontrolled tropical stores enhanced high seed deterioration. So seeds storage under these climates and the storage period must be more than 90 days (3 months).

Seed storage life estimated as twice half-life values was highest in 530-3, followed by E8 genotypes when seeds were stored in UNAAB environment. This means that if seeds of these two sesame genotypes were stored in UNAAB environment, some seeds could remain viable for approximately 10 or 11 months. Also in UNAAB storage environment, seeds of C-K-2 and 530-6-1 could remain viable for approximately 9 months as indicated by estimate of seed storage life. Seed shortest storage life of approximately 3 months was estimated for seeds of 73A-97 genotype stored in BABCOCK environment. Seed storage life of the ten sesame genotypes was prolonged in UNAAB compared to BABCOCK environment.

Within the experimental storage environment of this study, the most appropriate storage environment for sesame seeds for short-term basis would be UNAAB while genotypes 530-3 and E8 as well as C-K-2 and 530-6-1 in that order were identified with superiority in seed longevity. Further investigation into products that might serve the dual purpose of seed protection and seed viability enhancement to improve seed quality economically is advocated.

CONCLUSIONS

Within the purview of this study, when preserving sesame seeds, consideration should be given to the storage environment and genotype as well as storage time. UNAAB storage environment provided better favourable conditions which enhanced high seed viability compared to BABCOCK environment.

There is the need for investigation into the products for enhancement of seed viability in sesame in the humid tropics. Since the storage treatments are cheap, easily affordable and readily available, the results will benefit small and medium-scale investments in seed production in the Southwest region, where resources for advanced conditioned storage are scarce.

REFERENCES

Adebisi, M. A. (1999). Effect of chemical seed treatments on viability and vigour in soyabean cultivars. *M. Agric Thesis.* University of Agriculture, Abeokuta, Nigeria. 73pp.

Adebisi, M. A. and Ajala, M. O. (2000). Effect of seed dressing chemicals and period of storage on soyabean seed vigour. *Journal of Tropical Forest Resources* 16 (1): 126-135.

Adebisi, M. A., Daniel, I. O and Ajala, M. O. (2003). Storage life of soybean seed after seed dressing. *Journal of Tropical Agriculture* 42: 3-7.

Adebisi, M. A. (2004). Variation, stability and correlation studies in seed quality and yield characters of sesame. *Unpublished PhD Thesis,* University of Agriculture, Abeokuta.

Adebisi, M. A., Ajala M. O. and Ariyo, O. J. (2004). Genetic studies on seed quality in sesame. *Proceeding of the 29th annual conference of Genetics Society of Nigeria.* 209-212.

Adebisi, M .A., Ajala, M..O., Ojo, D. K. and Salau, A.W. (2005). Influence of population density and season on seed yield and its components in Nigerian sesame genotypes. *Journal of Tropical Agriculture (India)* 43(1-2), 13-18.

Daniel, I. O. (1997). Conservation of West African yam (*Dioscorea spp*) germplasm. Physiology of seed and pollen storage. *PhD Thesis.* University of Ibadan, 148 pp

Daniel, I.O. Ng, N. Q. Tayo, T. O and Togun, A. O. (1999). West African yam seeds stored under cold and desiccated conditions are orthodox. *Seed Science and Technology* 27, 969-975.

Ellis, R.H. and Roberts, E. H. (1980). Improved equation for the prediction of seed longevity. *Annals of Botany*; 45, 13.30.

Finney, D. J. (1971). Probit analysis. 3rd Edition Cambridge University Press, London. 333 pp

Hampton, J. G. (2002). What is seed quality? *Seed Science and Technology* 30: 1-10.

Harrington. J. F. (1972). Seed storage and longevity. In: Seed Biology. Vol.3. Ed. T. T. Koslowski. Academic Press. NY. Pp 145-245.

ISTA (International Seed Testing Association) (1995). International rules for seed testing. Rules 1995. *Seed Science & Technology* 13: 322-326.

Iwo, G.A. and Idowu, A.A. (2002). Impact of research and development on sesame towards poverty alleviation in Nigeria. *NOMA Magazine. Vol.* 16: 15 – 21.

Kulik, M. M (1995). Seed quality and microorganisms. In: Seed quality: Basic mechanism and agricultural implications. Eds. A.S Basara Food Products Inc. NY 153-171.

Parish, D. J. and Leopold, A. C. (1978). On mechanism of ageing in soybean seeds. *Plant Physiology*; (61): 365-368.

Ramamoortly, V. (1989). Maintenance of vigour and viability of stored gingelly (*Sesamum indicum L.*) seeds. *M. Sc. Dissertation.* Department of Seed Technology, Tami/Nada Agricultural University, Coinbatore– 641003, India

Roberts, E. H. (1973). Predicting the storage life of seeds. *Seed Science and Technology* 1, 499-522.

Zanakis, G.N., Ellis, R. H. and Summerfield, R. J. (1993). Response of seed longevity to moisture content in three genotypes of soybean (Glysine max). *Experimental Agriculture* 29, 449-459.