STORAGE LIFE OF SOYBEAN *(Glycine max L.* Merril) SEEDS AFTER SEED DRESSING

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ABSTRACT

The longevity of seeds of three soybean varieties treated with four seed dressing chemicals was estimated using probit modelling to evaluate possible enhancement of seed physiological quality under ambient tropical storage condition. Seeds were treated with fungicides and/or insecticides including Apron Plus, Fernazan D, Almithio and Aldrex T at recommended dosages. An untreated seed lot of each variety was maintained as control. The seeds were stored for 180 days (6 months) under laboratory ambient conditions (32°C, 50%RH) with initial seed moisture content of about 10%. Seed germination was monitored in storage and seed survival was evaluated by probit analysis of the serial germination data. Results showed that seed dressing with fungicides and/or insecticides reduced seed deterioration for two months of storage in M-351 and three months in Samsoy 1 and TGX 1740-3F. Probit analysis showed negative slope (1/a) values for all the seed lots indicating certain degree of deterioration irrespective of seed lot or seed dressing treatment, that is, none of the seed dressing chemical was able to totally arrest soybean seed deterioration. Except for M-351 seeds treated with Apron Plus, Almithio and Aldrex T, all treated seed lots showed significantly longer storage life than untreated seeds.

Key words: Soybean, seed storage life, probit modeling

INTRODUCTION

Soybean *(Glycine max (L.)* Merrill) seed production in southwestern Nigeria is hampered by the speed with which the seeds lose their viability when exposed to warm, moist air that characterizes the ambient humid tropical climate. To arrest the rapid rate of seed deterioration under the prevailing adverse storage conditions, soybean seeds are maintained in dry-cold conditioned stores for conservation of genetic resources (Ng, 1988), a facility that is uneconomical for commercial seed production in Nigeria. Possible cheaper alternatives to achieving seed longevity extension and quality enhancement need to be investigated for commercial soybean seed production in the humid tropics.

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), and pest and pathogen damages in storage (Kulik, 1995). Usually, seeds are treated with broad-spectrum fungicides such as Thiram and Carboxin in the seed processing plants, and they are known to be effective against a wide range of seed storage pathogens (Chanhan *et al* ;1984, Subramanya *et al.*, 1988; FAO, 1999). Moreover, Shekaramurthy *et al.* (1994) concluded that seed treatment with Thiram could delay the seed deterioration process under adverse storage conditions. Quantifying the longevity of seeds after these treatments would further elucidate the effects of these pesticides on the physiological quality of dressed seeds and elicit possible procedures of seed treatment for improving seed longevity along with seed health under adverse storage conditions.

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).* 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).*

The purpose of this trial was to investigate possible economical ways of improving soybean seed longevity and seed physiological quality in storage for commercial seed . production under the adverse storage environments of the humid tropics. This paper reports estimates of seed longevity parameters of soybean seeds stored under the ambient humid tropical condition with or without seed dressing (insecticides and fungicides) treatments.

MATERIALS AND METHODS

The storage physiology of seeds of three genotypes of soybean treated with some seed dressing fungicides and/or insecticides was examined in this framework.

Seeds of three varieties of soybean from the 1997 harvests were provided by the Department of Plant Breeding and Seed Technology, University of Agriculture, Abeokuta, Nigeria. The varieties were Samsoy 1, a variety obtained from the Institute of Agricultural Research (IAR). Samaru, Nigeria; M-351 and TGX 1740-3F obtained from International Institute of Tropical Agriculture (IITA) varieties.

One kilogram of seeds from each of the three genotypes was treated with four different seed dressing chemicals using the recommended rate of treatment. The chemicals were Apron Plus, Almithio, Aldrex T and Fernazan D. Besides Aldrex T that has only fu regicidal effect, all the other chemicals have both fungicidal and insecticidal activities (Table 1).

Seeds were placed into transparent polythene bags and the recommended doses of the chemicals were added (Table 1). The mixture was agitated thoroughly, and thereafter each treated seed lot was divided into three parts to form three replicates of 333g each. An untreated control seed lot was also included in the tests for each variety to give a total of 45 experimental units.

Seed Storage

Immediately after the seed dressing treatments, seeds were stored in the transparent polythene bags under ambient laboratory conditions for 183 days from 1" October, 1997 to 28`x' March. 1998 at the Plant Breeding and Seed Technology Laboratory, University of Agriculture, Abeokuta, Nigeria (7 30N, 3 55E). The average room temperature was maintained at approximately 32°C and Relative Humidity (RH) was 50% during the time of

Table 1. Recommended dosage and active ingredients of chemicals used for dressing the soybean seeds

I Chemical name*	Active ingredient I	Recommended dose	Chemical type
Apron plus SODS	10% metalaxyl 60% carboxin 34% furathiocarb	5g/kg seed	Fungicide/insecticide
1 Almithio 20/25	20% lindane p/p 25% thiram p/p	0.9g/kg seed	Fungicide/insecticide
Aldrex T	Aldrin/thiram	3g/kg seed	fungicide
Fermazan D	20% w/w thiram	3g/kg seed	Fungicide/insecticide

* Chemical trade name

storage. Seeds were removed from each treatment bag for testing at 30-day intervals for six months.

Seed Viability Test

Standard germination tests were carried out using the moistened paper towel method under laboratory conditions (ISTA. 1985). Seeds were germinated in four replications of 100 seeds from each storage experimental unit. A germination count was taken after seven days of culture when the radicle had elongated beyond the length of the seed. Seed viability was evaluated as the percentage of germinated seeds from total number of seeds cultured per replicate.

Statistical Analysis

Probit analysis of mean percentage seed germination of serial germination data was done with SAS™ PROC PROBIT statements that first sorted the data by variety and chemical seed treatments. Seed longevity parameters were estimated from the procedure based on six germination test data points for each seed treatment. Estimates of intercept (time = 0) of the seed survival line, slope *i.e.* the rate of seed deterioration (1/s) and time taken for seed ageing to decline to 50% viability ($P_{s„}$) were estimated by the PROBIT procedure for each of the treated and control seed lots. Seed storage life was estimated as double of the seed half-life. 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 treatments.

RESULTS

Table 2 shows the initial percentage viability of the seed lots before storage. Percentage germination before treatment and storage was highest in the M-351 seed lot (86%) and lowest in the TGX 1740-3F seed lot (82%). Seed moisture content ranged from 9.70% (f. wb) in M-351 to 10.05% (f. wb) in TGX 1740-3F seeds.

Seed Survival

It was observed that, seeds of all the varieties responded positively to the seed dressing treatments by having a higher percentage germination than the control seed lot within the first two months (60 DAS) of storage. The positive response to

Table 2. Genotypes and initial seed quality of the seed lots of soybean seeds used in the trial

Genotype	$ Initial germination (%)	I Moisture content (%) (f.wb)
M - 351	1 86	9.70
Samsoy	i 84	a 9.85
TGXI740-3F 8		10.05

all the seed dressing chemicals persisted in Samsoy 1 through the six months of storage, all treated seeds had higher percentage germination than the control seed lot at the sixth month of storage (Table 3). Though no clear trend was shown among the varieties in the seed viability decline of dressed seeds in response to the individual seed dressing chemicals, M-351 showed the most notable loss of seed viability when dressed with Almithio, Apron plus and Aldrex T (Table 3). Differences in seed lot responses to the seed dressing chemicals were apparent : Samsoy I treated with Fernazan D had the highest percentage germination at the sixth month of storage.

Seed longevity estimations

The PROC PROBIT programme gave values of intercept, slopes, and half-life *(P5o)* as shown in Table 4. The values of intercept (estimates of initial probit viability and a measure of seed quality before storage) were generally higher in Samsoy 1 than M-351 and lowest in TGX 1740-3F seed lots (Table 4). This corroborates the actual seed percentage germination before storage for the seed lots (Table 2).

Table 4 also showed the negative values of estimates of slope of the seed survival data for all the seed lots, indicating a certain degree of deterioration irrespective of variety or seed dressing treatment. It must be noted from Table 3 that the percentage seed germination of the treated Samsoy 1 seed lots never declined below the initial 84% in the first three months of storage.

Table 3. Results of viability tests of three soybean varieties treated with four chemicals during storage of 180 days

Variety d	Chemical storage period (days)						
		130	`60	f90	120	150	180
Samsoy I	Control	83.5(0.50) '	90.0(3.71)	80.0(6.73)		132.5(3.23)	
	Apron plus	87.0(1.73) '	89.0(3.14)	91.0(3.00)		55.0(8.16)	15.0(2.15)
	Almithio	1 82.0(4.76)	98.0(1.15)	94.0(2.58)		42.5(4.33)	15.0(1.00)
	AldrexT	95.5(1.71)		86.0(1.15)	80.0(4.56)	60.0(9.12)	20.0(3.65)
	FermazanD	' 98.0(0.81)	94.0(1.15)	94.0(2.58)	80.0(6.45)	42.0(7.21)	26.0(2.58)
M-351	Control	3 87..5(2.98)	77.0(9.84)	72.0(4.89)	42.0(3.29)	16.0(3.65) 1	10.0(2.58)
	Apron plus	86.0 (1.82)	1 80.0(3.65)	i 62.0(7.39)	40.0(3.65)	16.0(3.26)	4.0(1.63)
	Almithio	86.5(1.50)	176.0(5.16)	62.0(4.16)	154.0(4.76)	18.0(5.77)	
	AldrexT	83.0(3.41)	78.0(2.58)	j 54.0(2.58)	40.0(5.97)	18.0(2.58) s	6.0(2.00)
	FermazanD	186.0(2.94)	i 86.0(4.76)	56.0(6.68)	169.0(7.18	37.0(3.42)	17.0(3.42)
TGX1740-3F	Control	[73.5(1.71)	63.0(14.91)	46.0(4.76)	63.75(5.5)	30.0(6.60) '	10.0(1.15)
	Apron plus	'78.5(0.95)	76.0(1.63)	72.0(9.93)	51.3(8.27)	33.0(3.42) :	18.0(2.58)
	Almithio	83.5(2.06)	74.5(0.95)	68.0(6.93)	57.5(4.78)	26.0(5.77)	15.0(5.74)
	AldrexT	81.0(1.73)	74.0(4.76)	64.0(5.16)	60.0(3.53)	36.0(4.89)	123.0(1.92)
	FermazanD	, 84.0(2.16)	68.0(2.31)	66.0(4.16)	52.5(4.33)	26.0(4.16)	13.0(3.00) I

That is, if the seed germination data up to three months only had been used in the probit modeling, the value of slope of the survival curve would have been positive, indicating zero seed deterioration On the rate of deterioration shown by the magnitude of negative slope values, treated and untreated seed lots of Samsoy 1 and M351 with higher estimates of intercepts (initial probit viability) showed significantly higher rates of deterioration than TGX 1740-3F seed lots.

Seed dressing with fungicides and insecticides also resulted in significant increase of seed longevity extension in some soybean varieties as shown by estimates of seed half-life *(P_{so})* and storage life (Table 4). All the treated seeds of Samsoy 1 and TGX1740-3F had significantly higher estimates of seed halflife and storage life than the control. In M351, however, there were no significant differences in seed longevity estimates of control and treated seeds, -and only seeds dressed with Fernazan D showed significantly higher estimates of seed storage life than the control . Moreover, estimate of seed storage life was highest in Samsoy 1 (10.2 months) in response to Aldrex T followed by Fernazan D (9.9 months), M-351 seeds dressed with Fernazan D (8.3 months) and TGX 1740-F seeds dressed with Adrex T (8.2 months) and with Almithio (7.6 months) (Table 4).

DISCUSSION

The differences in estimates of intercepts from the probit modeling of the soybean

Table 4. Probit parameter estimates for the soybean seed survival data after storage

Variety	Chemical	*Intercept (Probit (Germination)	** Slope	P50 in days	Seed storage life in months
Samsoy I	Control	2.248	; -0.53(0.028)	1	8.61)0.113)
	Apron plus	1.921	-0.40(0.017)	j 147	9.77(0.302)
	Almithio	2.281	1-0.50(0.062)	! 142	9.52(0.110)
	Aidex T	'2.750	-0.55(0.046)	152	10.25(0.485)
	Fermazan D	3.064	-0.64(0.049)	149	9.99(0.212)
M-351 i	Control	1.859	-0.55(0.068)	106	17.03(0.403)
	Apron plus	1.894	-0.57(0.042)	1	6.68(0.256)
l	Almithio	1.865	-0.55(0.042)	1	6.89(0.291)
	Aldex T	1.641	-0.51(0.027)	98	6.50(0.207)
	Fermazan D	1.656	-0.41(0.022)	125	8.28(0.462)
TGX1740-3F	i Control	1.020	! -0.32(0.061)	98	6.33(0.618)
	Apron plus	= 1.156	1-0.32(0.025)	1110	7.33(0.515)
	+Ahnithio	1.548	1-0.41(0.024)	1114	7.59(0.151)
	Aldex T	1.305	1-0.32(0.023)	i 122	8.17(0.27F
	Fermazan D	(1.455	_040(0.013)	108	7.22(0.129)

*Intercept is probit estimate of initial seed viability. **Slope is the rate of seed deterioration (11s), 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 either treated with a seed dressing chemical or untreated (control) before storage. (Standard error of means are in brackets) seed survival curves establish reports of variety and seed lot differences in potential seed longevity among soybean varieties (Zanakis *et al.,* 1993). However the result of this study may not lead to a conclusion of varietal superiority in seed longevity since the intercept parameter is a seed lot parameter (Ellis and Roberts, 1980)but it has demonstrated that seed deterioration rate and eventual seed storage life is dependent on the initial quality of seed moved into storage. As earlier pointed out in other works, the higher the quality of seed moved into storage, the longer the expected seed storage life (Demir and Ellis, 1992; Zanakis *et al.,* 1994). We may, therefore, conclude from these results that given high initial seed lot quality, seed dressing with fungicides and/or insecticides could arrest seed deterioration within the first three months of storage under the adverse storage conditions of the humid tropics as already suggested by Aschermann-Koch *et al.* (1992) and Shekaramurthy *et al.* (1994).

Seed germination data at the earlier periods of storage showed no deterioration, thus implying an initial improvement in seed germination capacity in treated seeds over the control, followed by a rapid decline of germination capacity. Rangaswamy *et al.* (1970) reported degradation of seed dressing fungicides (Thiram) during storage, and Adebisi and Ajala (2001) suggested that this reduction in the potency of active ingredients of the seed dressing chemicals under tropical conditions was the possible explanation for the decline in seed germination. Evidence from this study, however, suggests that there were other causes of rapid seed deterioration other than microbial activity or inactivity because the decline in percentage germination between the third and fourth months of storage was high in all treated and control seed lots. Soybean seed deterioration is a physiological mechanism (Parish and Leopold, 1978), exacerbated by the warm and humid conditions of unconditioned tropical stores. So, seed dressing should be accompanied by conditioned storage under these climates and must be more than three months. The negative slope values of seed survival curves of treated and control seed lots mean that none of the seed dressing chemicals was able to totally arrest soybean seed deterioration during the six months of storage, and so cannot replace conditioned storage, especially for long-term seed storage.

The significantly longer seed storage life estimated for most treated seed lots as compared to the untreated seed lots shows that seed dressing offers some benefits that commercial seed producers in this region may explore. Nevertheless, further investigations into the mechanisms of physiological responses to seed dressing will help to develop products that might serve the dual purpose of seed protection and viability enhancement and so improve seed quality economically.

In summary, these results showed that improving the seed health of soybean by seed dressing with chemicals that have pesticide activity before storage invariably extends the seed storage life and improves seed physiological quality under the adverse seed storage conditions of the humid tropics, within the first two to three months of storage. These findings are important for the enhancement of seed quality in soybean in the humid tropics. Since the storage treatments are cheap and easily affordable, the results will benefit small and medium-scale investments in seed production in this region, where resources for advanced conditioned storage are scarce. Such enterprises that produce low volume of seeds can dispose their treated seed stock as highly viable seeds within two to three months of seed production and storage under the ambient storage conditions. To achieve high physiological quality, seed for crop production must be produced within the same year and the carryover stock treated immediately after harvest to achieve high initial seed quality for longer storage life.

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