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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 condition (32°C). Seed germination was monitored in storage and seed survival was evaluated by probit analysis of the serial germination data. Germination results showed that seed dressing with fungicides and/or insecticides reduced seed deterioration for two months in M-351 and three months of storage in Samsoy 1 and TGX 1740-3F. Probit analysis showed negative slope ($1/\sigma$) 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 under the adverse storage conditions of the humid tropics and so cannot replace conditioned storage if seed storage period must be more than three months. 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. The treatments will benefit small-scale seed production outfits with low carryover stock and no resources for advanced conditioned storage facilities.

Key words: Probit modeling, Seed dressing, soybean, storage life.

INTRODUCTION

Soybean (*Glycine max* L. Merril) seed production in South Western Nigeria is hampered by the speed with which the seeds lose their ability to germinate 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 condition, 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 (Chauhan et al., 1984, Subramanya et al., 1988, FAO, 1999). Moreover, Sekaramarthy 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 treatments for improving seed longevity along with seed health under adverse storage conditions.

In quantifying seed deterioration, Ellis and Robert (1980) observed that seed deterioration in storage follows a negative cumulative normal distribution

Table 1. The chemicals used for dressing soybean seeds

Chemical name*	Active ingredient	Recommended dose	Chemical type
Apron plus 50DS	10% metalaxyl 60% carboxin 34% furathiocarb	5g/kg seed	fungicide/insecticide
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
Fernazan D	20% w/w thiram	3g/kg seed	fungicide/insecticide

Chemical trade name

pattern. This makes it possible to estimate seed longevity from seed survival data using the 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 (σ) and the seed half-viability period (P_{50}). Ki is an estimate of initial seed viability and index of seed quality before storage while σ 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 storage physiology of seeds of three genotypes of soybean treated with some seed dressing fungicides and/or insecticides was examined in this framework. The purpose of the trials 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 chemical (insecticides and fungicides) treatments.

MATERIALS AND METHODS

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 Institute of Agricultural Research (IAR), Samaru, Nigeria; M-351 and TGX 1740-3F obtained from International Institute of Tropical Agriculture (IITA) varieties.

One kilogramme of seeds from each soybean 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 fungicidal 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 1st October, 1997 to 28th March, 1998 at the Plant Breeding and Seed Technology Laboratory, University of Agriculture, Abeokuta, Nigeria (7 30N; 3 55E). The average room temperature was ~32°C and Relative Humidity (RH) was 50% during the time of storage. Seeds were removed from each treatment bag for testing at 30 days interval 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 7 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 ($1/\sigma$) and time taken for seed ageing to decline to 50% viability (P_{50}) 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 least 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 genotypes responded positively to the seed dressing treatments with higher percentage germination than the control seed lot within the first two months (60 DAS) of storage. The positive response to all the seed dressing chemicals persisted in Samsoy 1 seeds through the 6 months of storage. All the treated seeds had higher percentage germination than the control seed lot up to the 6[th] month of storage (Table 3). Though no clear trend was shown among the genotypes in the seed viability decline of dressed seeds in response to the individual seed dressing chemicals. M-351 seed lots showed 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 1 treated with Fernazan D had the highest percentage germination at the 6[th] month of storage.

Seed longevity estimations

The PROC PROBIT programme yielded values of intercept, slopes, and half-life (P_{50}) 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 least 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 showed the negative values of estimates of slope of the seed survival data for all the seed lots and this indicated certain degree of deterioration irrespective of genotype or seed dressing treatment. On the rate of deterioration shown by the magnitude of negative slope values, treated and untreated seed lots of Samsoy 1 and M-351 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 caused significant increases of seed longevity in the tested soybean varieties as shown by estimates of seed half-life (P_{50}) and storage life (Table 4). All the treated seeds of Samsoy 1 and TGX 1740-3F had significantly higher estimates ($p < 0.05$) of seed half-life and storage life than control. However, in M-351, there were no significant differences in seed longevity estimates between the control and treated seeds. Only seeds dressed with Fernazan D showed significantly higher estimates of seed storage life than control seeds. Moreover, estimates of seed storage life was highest in Samsoy 1 seeds (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).

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

Genotype	Initial germination (%)*	Moisture content (%) (f.wb)
M - 351	86	9.70
Samsoy	84	9.85
TGX1740-3F	82	10.05

*Initial quality assessment before seed dressing.

DISCUSSION

The differences in estimates of intercepts from the probit modelling of the soybean seed survival curves establish reports of variety and seed lot differences in potential seed longevity among soybean varieties (Zanakis et al. 1993). From this study, it was demonstrated that seed deterioration rate and eventual seed storage life is dependent on the initial quality of seed lots moved into storage although this did not imply genotype superiority in seed longevity. It is well reported that the higher the quality of seeds moved into storage, the longer the expected seed storage life (Demir and Ellis, 1992; Zanakis et al. 1994). Thus this trial showed 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 and thus agreed with Aschermann-Koch et al. (1992) and Sekaramurthy et al. (1994).

Table 3. Seed viability as indicated by percentage germination of six soybean genotypes treated with four chemicals during storage for 180 days

Variety	Chemical	Storage Period (days) 30	60	90	120	150	180
Samsoy I	Control	83.5	90.0	80.0	90.0	32.5	1.0
	Apron plus	87.0	89.0	91.0	79.0	55.0	15.0
	Almithio	82.0	98.0	94.0	75.0	42.5	15.0
	Aldrex	95.5	96.0	86.0	80.0	60.0	20.0
	FernazanD	98.0	94.0	94.0	80.0	42.0	26.0
M-351	Control	87.5	77.0	72.0	42.0	16.0	10.0
	Apron plus	86.0	80.0	62.0	40.0	16.0	4.0
	Almithio	86.5	76.0	62.0	54.0	18.0	2.0
	Aldrex	83.0	78.0	54.0	40.0	37.0	6.0
	FernazanD	86.0	86.0	56.0	69.0		17.0
TGX1740-3F	Control	73.5	63.0	46.0	69.0	37.0	17.0
	Apron plus	78.5	76.0	72.0	51.3	33.0	18.0
	Almithio	83.5	74.5	68.0	57.5	26.0	15.0
	Aldrex	81.0	74.0	64.0	60.0	36.0	23.0
	FernazanD	84.0	68.0	66.0	52.5	26.0	13.0

Table 4. Probit parameters estimates for the soybean seed survival data after storage. Seeds were either treated with a seed dressing chemical or untreated (control) before storage. (Standard error of means are in brackets)

Variety	Chemical	*Intercept (probit germination)	**Slope	P_{50} in days	***Seed Storage life in months
Samsoy I	Control	2.248	-0.53(0.028)	129	8.61(0.113)
	Apron plus	1.921	-0.40(0.017)	147	9.77(0.302)
	Almithio	2.281	-0.50(0.062)	142	9.52(0.110)
	Aldex T	2.750	-0.55(0.046)	152	10.25(0.485)
	Fernazan D	3.064	-0.64(0.049)	149	9.99(0.212)
M-351	Control	1.859	-0.55(0.068)	106	7.03(0.403)
	Apron plus	1.894	-0.57(0.042)	101	6.68(0.256)
	Almithio	1.865	-0.55(0.042)	104	6.89(0.291)
	AldrexT	1.641	-0.51(0.027)	98	6.50(0.207)
	FernazanD	1.656	-0.41(0.022)	125	8.28(0.462)
TGX1740-3F	Control	1.020	-0.32(0.061)	98	6.33(0.618)
	Apron plus	1.156	-0.32(0.025)	110	7.33(0.513)
	Almithio	1.548	-0.41(0.024)	114	7.59(0.151)
	AldrexT	1.305	-0.32(0.023)	122	8.17(0.278)
	Fernazan D	1.455	-0.40(0.013)	108	7.22(0.129)

*Intercept is probit estimate of initial seed viability. **Slope is the rate of seed deterioration ($1/\sigma$), 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.

It must be noted from the results that the percentage seed germination of the treated Samsoy 1 seed lots never declined below the initial of 84% in the first three months of storage, that is, if the seed germination data up to 3 months only were used in the probit modeling, the value of slope of the seed survival curve will be positive. This means that seed germination data at the earlier periods of storage showed no deterioration implying an initial improvement in seed germination capacity in treated seeds over control, followed by a rapid decline of germination capacity. Ranswamy 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. However, the evidence from this study suggests that there were other causes of rapid seed deterioration other than microbial activity or inactivity. This is 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 must be more than three months. The negative slope values of seed survival curves of treated and control seed lots is an indication that the seed dressing chemicals might not be able to totally arrest soybean seed deterioration during the 6 months of storage, and so cannot replace conditioned storage especially for long-term seed storage.

Longer seed storage life estimated for most treated seed lot than the untreated seed lots indicates that seed dressing offers some benefits that commercial seed producers in this region may explore. Nevertheless, further investigations into the mechanisms of the seed 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 conclusion, it is shown from this study that improving the seed health of soybean by seed dressing pre-treatment with chemicals that have pesticide activity before storage invariably extends the seed storage life. While controlling insect infestation and pathogen infection the seed dressing chemicals also improved 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 condition. 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.

REFERENCES

Adebisi, M. A. and M. O. Ajala 2001. Effect of seed dressing chemicals and period of storage on soybean seed vigour. *Journal of Tropical Forest Resources* 16 (1), 20 – 28.

Aschermann – Koch C.;P. Hafmann and A.M. Steiner. 1992. Preserving treatment for improving seed quality in cereals I: Germination and Vigour. *Seed Science and Technology* 20. 435-440.

Chanhan, K.P.S.; M.C.S. Negi and M.M. Verma. 1984. The effects of Thiram on the incidence of ageing induced changes in seeds. *Seed Research*, 12, 110-119.

Daniel, I. O. 1997. Conservation of West African Yam (*Dioscorea spp*) germplasm: Physiology of Seed and pollen Storage. *Ph.D. Thesis: University of Ibadan*, Nigeria. pp 148.

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.

Demir, I. and Ellis, R. H. 1992. Development of pepper (*Capsicum annum*) seed quality. *Annals of applied Botany* 121, 385-399.

Ellis, R. H. and Roberts, E. H. 1980. Improved Equations for the prediction of seed longevity. *Annals of Botany*, 45, 13-30.

Finney, D. J. 1971. *Probit Analysis*, 3rd Edition. Cambridge University Press, London. 33pp.

Food and Agriculture Organization (FAO) 1999. *Manual for training in seed production*. Eds. R. K. Trivedi, I. A. Usman and J. C. Umah. FAO. United Nations. 116pp.

Harrington, J. F. 1972. Seed storage and longevity. In: Seed Biology. Vol. 3. Ed. T. T. Koslowski. Academic Press, N. Y. pp 145-245.

ISTA, 1985. International rules for seed testing. *Seed Science and Technology*, 13, 299-355

Kulik, M. M. 1995. Seed quality and microorganisms. In: Seed Quality: Basic mechanisms and agricultural implications. Ed

A. S. Basra. Food Products Inc. NY Pg 153-171.

Ng. N. Q. 1988. Long-term seed conservation. In: *Proceedings of International Conference on Crop Genetic Resources of Africa. Kenya.* Eds. F. Attere, N. Ng and P. Perino. Pg. 135 - 148.

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

Rangaswamy, J. R., P. Poornima and S. K. Majunder. 1970. Rapid Colorimetric Method for Estimation of Thiram residue on grains. *Journal of Association in Agricultural Chemistry,* 53, 519-522.

Roberts, E. H. 1973. Predicting the storage life of seeds. *Seed Science and Technology* 1. 499-514.

Shekaramurthy, S.K L. Patkar, S. A., Shetty, H. S. Prakash and H. S. Shetty. 1994. Effect of Thiram treatment on sorghum seed quality in relation to accelerated ageing. *Seed Science and Technology* 22: 607-617.

Subramanya, K. N., H. S. Prakash, H. S. Shetty and N. G. K. Karanth. 1988. Effect of Thiram and Baristin on sorghum seeds stored under different conditions. *Pesticides* 22. 25-27.

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

Zanakis, G. N., R. H. Ellis and R. J. Summerfield. 1994. Seed quality in relation to seed development and maturation in three genotypes of soyabean (*Glycine max*). Experimental Agriculture 30 139-156.