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Storage life of soybean (*Glycine max* L. Merril) seeds after seed dressing

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Abstract

Effects of four seed dressing chemicals on seed storability of three soybean varieties were evaluated by probit modelling. Seeds treated with fungicides and/or insecticides, viz., Apron Plus, Fernazan D, Almithio and Aldrex T at manufacturer's recommended doses, along with control lots were stored under ambient conditions for six months. Results show that seed dressing reduced deterioration for two months in M-351 and three months in 'Samsoy 1' and TGX 1740-3F. In particular, seeds treated with Apron Plus, Almithio and Aldrex T showed significantly longer storage life than untreated seeds, except for the variety M-351. Probit analysis also indicated negative slopes ($1/\sigma$) implying that some deterioration occurred irrespective of the seed lots and dressing treatments. Furthermore, no chemical was able to completely arrest seed deterioration, and so cannot replace conditioned storage, especially if storage exceeded three months. Nevertheless, these treatments will benefit small-scale producers, with low carryover stocks and no resources for advanced conditioned storage.

Key words: Seed deterioration, germination, probit modeling, seed dressing, tropics

Introduction

Loss of viability of stored seeds often hampers soybean (*Glycine max* L. Merril) production in South-western Nigeria. Exposure to warm, moist air—typical of the humid tropical regions—is principally responsible for this. To arrest seed deterioration in storage, therefore, dry-cold conditioned storage structures are recommended, which are, however, expensive (Ng, 1988). In the search for cheaper alternatives, seed treatments with broad-spectrum fungicides such as thiram and carboxin hold promise. They are not only effective against a wide range of pathogens (Subramanya et al., 1988, FAO, 1999), but also are thought to delay seed deterioration during storage (Shekaramurthy et al., 1994). Therefore, to investigate the possible economical ways for improving soybean seed longevity under adverse storage environments of the humid tropics, a trial involving four chemical treatments was undertaken. Seed deterioration typically follows a negative cumulative normal distribution pattern (Ellis and Roberts 1980), signifying the possibility of estimating seed longevity from the seed survival data by probit analysis (Finney, 1971). This will also help in assessing the physiological changes during storage (Daniel, 1997; Daniel et al., 1999), which may be variable for different genotypes. This paper reports seed longevity parameter estimates from probit modeling for three soybean genotypes (cv. 'Samsoy 1' M-351 and TGX 1740-3F) with and without chemical (insecticides and fungicides) treatments.

Materials and methods

Seeds of three locally important soybean varieties (1997 harvest) were obtained from the Institute of Agricultural Research, Samaru, Nigeria (cv. 'Samsoy 1') and the International Institute of Tropical Agriculture, Ibadan, Nigeria (M-351 and TGX 1740-3F). Pre-treatment germination percentage ranged from 82 to 86% (Table 1). The seed samples (1 kg) were treated with four different seed dressing chemicals (Apron Plus, Almithio, Aldrex T and Fernazan D) at recommended doses (Table 2) in transparent polythene bags. The mixture was agitated thoroughly, and each seed lot was subdivided into three parts to form replicates of 333 g each. An

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Table 1. Genotypes and initial quality of soybean seeds used

Genotype	Germination (%)	Moisture content[1] (%)
'Samsoy 1'	84	9.85
M–351	86	9.70
TGX 1740-3F	82	10.05

[1]fresh wt. basis

untreated control was included for each variety to give a total of 45 experimental units.

Seed storage and viability testing

Immediately after treatment, the seeds were transferred to transparent polythene bags and stored under ambient conditions for 183 days (from 1st October, 1997 to 28th March, 1998) at the Plant Breeding and Seed Technology Laboratory, Abeokuta, Nigeria (7°30'N; 3°55'E). The average room temperature was ~32°C and relative humidity ~50% during the storage period. Seed samples were removed from each treatment for viability testing at 30-day intervals for six months. Standard germination tests were performed using paper towel method (ISTA, 1985) in four replicates of 100 seeds each. Germination count was made seven days after sowing, when radicle emerged.

Statistical analysis

Probit analysis of the serial seed germination data was done with SAS™ PROC. PROBIT statements first sorted the data by variety and chemical seed treatments. Seed longevity parameters such as the intercept (*Ki*), standard deviation of the distribution of seed mortality in time (σ) and the seed half-viability period (P_{50}) were estimated based on six germination data points, treatment-wise. *Ki* is an estimate of initial viability and index of seed quality before storage while σ is the reciprocal of the slope of probit survival curves, the slope being the rate of seed deterioration. P_{50} is time taken for viability to drop to 50% and is a measure of absolute seed longevity (Ellis and Roberts, 1980). Seed storage life was estimated as twice the half-life. Seed deterior-ation rates and absolute longevity estimates were subjected to ANOVA to determine whether treatment differences were significant or not.

Results

Seed survival

Seeds of 'Samsoy 1' and TGX 1740-3F genotypes responded positively to the chemical treatments with higher germination percentages than the control, especially during the first two months of storage. Moreover, the positive response persisted in 'Samsoy 1' seeds through a six month-long storage period (Table 3). In contrast, M-351 seed lots showed notable loss of viability when dressed with Almithio, Apron plus and Aldrex T, in particular after 180 days of storage. Differences in dressing chemicals were also apparent in this respect, with Fernazan D showing higher germination values than other chemical treatments.

Seed longevity estimates

The PROC PROBIT programme gave 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 in M-351, and it was the least in TGX 1740-3F seed lots. This is consistent with the

Table 2. Chemicals used for dressing soybean seeds

Chemical trade name	Active ingredient	Recommended dose	Chemical type
Apron plus 50DS	60% carboxin 34% furathiocarb	5 g kg^{-1} seed	Fungicide/insecticide
Almithio 20/25	20% lindane p/p 25% thiram p/p	0.9 g kg^{-1} seed	Fungicide/insecticide
Aldrex T	aldrin/thiram	3 g kg^{-1} seed	Fungicide
Fernazan D	20% w/w thiram	3 g kg^{-1} seed	Fungicide/insecticide

pre-treatment seed germination values (Table 1). Furthermore, Table 4 showed negative values for all slope estimates, indicating a certain degree of seed deterioration, regardless of genotypes and chemical treatments. Treated and untreated seed lots of 'Samsoy 1' and M-351 with higher estimates of intercepts (initial probit viability) showed significantly greater levels of deterioration than TGX 1740-3F seed lots.

Treated seeds of 'Samsoy 1' and TGX 1740-3F, however, had significantly higher estimates ($p<0.05$) of seed half-life and storability than the control (Table 4). Conversely, in M-351, there was no significant difference in seed longevity between control and treated seeds except in respect of Fernazan D, which nevertheless, showed higher estimates. Overall, 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).

Discussion

Differences in estimates of intercepts from the probit modeling and survival curves highlight variations in potential seed longevity of soybean varieties. Results of this study also demonstrate that seed deterioration rate and eventual seed storage life is dependent on the initial quality of seeds. Although such results were previously reported (Demir and Ellis, 1992; Zanakis et al., 1993; 1994), the present study emphasizes that given high initial seed quality, seed dressing with fungicides and/or insecticides could arrest seed deterioration in soybean for three months of storage even under the adverse storage conditions of humid tropics. For cereal and millet seeds, however, similar observations were reported earlier by Aschermann-Koch et al. (1992) and Shekaramurthy et al. (1994).

It must be also noted that the percentage germination of treated 'Samsoy 1' seed lots never declined below the initial of 84% in the first three months of storage. That is, if the germination data up to three months only were used in the probit modeling, the value of slope of the seed survival curve would have been positive. This was, nevertheless, followed by a rapid decline of germination capacity both in treated as well as control seed lots. Rangaswamy et al. (1970) reported that seed dressing fungicides (thiram) degrade during storage and Adebisi and Ajala (2001) further suggested that reduction in the

Table 3. Seed viability of three soybean genotypes treated with four chemicals during storage for 180 days

Variety	Chemical	Germination at different intervals (%)					
		30d	60d	90d	120d	150d	180d
'Samsoy 1'	Control	83.5(0.50)	90.0(3.71)	80.0(6.73)	90.0(4.56)	32.5(3.23)	1.0(1.00)
	Apron plus	87.0(1.73)	89.0(3.14)	91.0(3.00)	79.0(3.89)	55.0(8.16)	15.0(2.15)
	Almithio	82.0(4.76)	98.0(1.15)	94.0(2.58)	75.0(2.04)	42.5(4.33)	15.0(1.00)
	Aldrex T	95.5(1.71)	96.0(1.63)	86.0(1.15)	80.0(4.56)	60.0(9.12)	20.0(3.65)
	Fernazan D	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	87.5(2.98)	77.0(9.84)	72.0(4.89)	42.0(3.29)	16.0(3.65)	10.0(2.58)
	Apron plus	86.0(1.82)	80.0(3.65)	62.0(7.39)	40.0(3.65)	16.0(3.25)	4.0(1.63)
	Almithio	86.5(1.50)	76.0(5.16)	62.0(4.16)	54.0(4.76)	18.0(5.77)	2.0(1.15)
	Aldrex T	83.0(3.41)	78.0(2.58)	54.0(2.58)	40.0(5.97)	18.0(2.58)	6.0(2.00)
	Fernazan D	86.0(2.94)	86.0(4.76)	56.0(6.68)	69.0(7.18)	37.0(3.42)	17.0(3.42)
TGX 1740-3F	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)
	Aldrex T	81.0(1.73)	74.0(4.76)	64.0(5.16)	60.0(3.53)	36.0(4.89)	23.0(1.92)
	Fernazan D	84.0(2.16)	68.0(2.31)	66.0(4.16)	52.5(4.33)	26.0(4.16)	13.0(3.00)

d= days of storage
Parenthetical values indicate standard errors

Table 4. Probit parameters estimates for soybean seed survival after storage (Standard errors of means are in the brackets)

Variety	Chemical	[1]Intercept	[2]Slope	P_{50} (days)	[3]Seed storage
'Samsoy 1'	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	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)
	Aldrex T	1.641	-0.51 (0.027)	98	6.50 (0.207)
	Fernazan D	1.656	-0.41 (0.022)	125	8.28 (0.462)
TGX 1740-3F	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)
	Aldrex T	1.305	-0.32 (0.023)	122	8.17 (0.278)
	Fernazan D	1.455	-0.40 (0.013)	108	7.22 (0.129)

[1]Intercept is the probit estimate of initial seed viability. [2]Slope is the rate of seed deterioration ($1/\sigma$), probit viability loss per day. [3]Seed storage life is half-life (P_{50}) multiplied by 2, divided by 30 (days).

potency of active ingredients of the seed dressing chemicals under tropical conditions is a probable expla-nation for the rapid decline in germination of treated seeds.

The evidence from this study, however, suggests that there are other causes of rapid seed deterioration, besides microbial activity. This is because the decline in germination percentage between the third and fourth months of storage was consistently high. Presumably, soybean seed deterioration is a physiological mechanism (Parish and Leopold, 1978), which is exacerbated by the warm and humid conditions of unconditioned tropical stores. Seed dressing, therefore, should be accompanied by conditioned storage under these climates if storage exceeds three months. Moreover, the negative slope values of seed survival curves of treated and control seed lots is a probable indication of the fact that that the seed dressing chemicals might not be able to totally arrest soybean seed deterioration during a six months storage, and so cannot replace conditioned storage especially for long-term storage. Longer storage life estimated for treated seed lots, nevertheless, indicate that seed dressing offer some potential benefits that the commercial seed producers in this region can, possibly, explore.

In conclusion, improving seed health of soybean by pre-treatment with chemicals having pesticide activity extends the storage life of seeds. In addition to controlling insect infestation and pathogen infection, the seed dressing chemicals improve seed quality under the adverse storage conditions of the humid tropics—usually for short term storages not exceeding two to three months. Since these storage treatments are cheap and easily affordable, the results will benefit small and medium scale investments in seed production in regions where resources for advanced conditioned storage are scarce.

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