

DETERIORATION OF DIFFERENT QUALITY SOYBEAN SEED UNDER HUMID TROPICAL CONDITIONS IN SRI LANKA

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ABSTRACT

Good, medium and poor quality seeds of soybean (*Glycine max* (L.) Merr.) cultivar Pb—1 were stored for a period of 9 months under ambient and controlled conditions at the Agricultural Research Station, Maha Illuppallama. Viability and vigour of good and medium quality seeds under ambient and controlled storage increased up to 3 months and declined thereafter. Nevertheless, good and medium quality seeds under controlled conditions retained viability and vigour even up to 9 months of storage. Viability and vigour of good quality seeds were significantly better than those of poor quality seeds during all stages of storage, but this was true only at the later stages for medium quality seeds.

KEY WORDS : Seed quality, Soybean, Humid tropics

INTRODUCTION

Good quality seed is fundamental to crop production. It is well known that a major constraint in tropical soybean production is the rapid breakdown of seed viability. This could be attributed either to low quality or rapid deterioration during storage under humid tropical conditions.

Mature seeds of normal size, appearance, relatively free of mechanical damage and micro-organisms causing storage losses that have not been exposed to unfavourable weather conditions during maturation, harvesting and processing are pre-requisites that determine seed quality. Conditions that affect any of these characters can affect seed storability by promoting the process of seed deterioration (Justice and Bass, 1978). The importance of high initial viability at the beginning of seed storage has been emphasized by Barton (1941). Seeds of high initial viability were much more resistant to unfavourable storage humidities and temperatures than those with low initial viability. This was found true for Australian winter peas (McKee and Musil, 1948), grasses legumes, vegetables and root crops (Brett, 1952a and 1952b; Mackay and Tonkin, 1967). Bunch (1958) reported that immature seeds were liable to lose viability rapidly in storage.

Soybean seed storage in Sri Lanka has been identified as a serious problem. Therefore an investigation was initiated to study the rate of deterioration of soybean seed lots of different quality under ambient humid tropical conditions and controlled storage conditions. Conclusions of the study will be a useful guide for soybean seed storage in Sri Lanka,

MATERIALS AND METHODS

Good, medium and poor quality seed lots of the soybean cultivar Pb—1 were stored in paper bag under ambient and controlled conditions for a period of 9 months (Table 1). The experiment was a factorial in completely randomized design with treatments replicated 4 times. Germination tests were performed initially and after periods of 3, 6 and 9 months of storage. Seed lots of different quality utilized in this experiment were produced at Bandarawela, Maha Illuppallama and Gannoruwa during maha 1983/84. Freshly harvested seeds were sun-dried and kept in airtight metal cans under cold storage (10°C and 45% RH) until the commencement of the experiment on 9 March 1984. Classification of the seed lots (Table 2) was based on the percentage of good seed (mature with normal size and appearance, plump and well-developed) and bad seed (crinkled, immature, off-shaped and discoloured).

Twenty-four 100g samples of each quality seed lot (good, medium and poor) were placed in paper bags. Of these, 12 of each quality were stored under ambient conditions, characterized by typically mean maximum temperature of 32.6°C, mean minimum temperature of 23.5°C and mean relative humidity of 73.2%, and the balance 12 under controlled conditions (Table 1) for a period of 9 months. At each germination test 4 samples of each quality group were withdrawn from each storage.

Twenty-five seeds from each sample were drawn at random, treated with Captan (N[(Trichloromethyl) thio]—4—cyclohexane 1, 2 dicarboximide) (80% WP) and planted in moist sterilized sand contained in plastic boxes. Seeds were germinated under illumination for 8 h a day, using fluorescent lamps of 750—1000 lux at a constant temperature of $30^{\circ} \pm 1^{\circ}\text{C}$, which is the known approximate optimum for soybean seed germination (Delouche, 1952). Another 25 Captan-treated seeds were planted in the field under conditions favourable for germination but the soil temperature was variable

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for different germination tests (Table 3). Emerged seedlings were counted after 5 and 8 days of planting. Seedlings were carefully uprooted and classified in accordance with the criteria of the Association of Official Seed Analysts (1970). Seedling length and dry weight were determined using 5 seedlings taken at random from each experimental unit. Seedling length was measured from the point of attachment of the cotyledons to the root tip. The same seedlings were used to determine the dry weight gravimetrically after drying in an oven at 60°C for 48 hours.

Germination percentage was used as a measure of seed viability. Reported germination values included only normal seedlings. Germination percentages were transformed to arcsine degree scale for the purpose of statistical analysis. The seedling length and dry weight were the measurements assigned to seed vigour, in addition to emergence rate which was computed as

$$\frac{1}{2} \left[\frac{\text{number of seedlings emerged after 5 days of planting}}{5} - \frac{\text{number of seedlings emerged after 8 days of planting}}{8} \right]$$

This is the modification of the method suggested by Maquire (1962).

Data obtained on viability and vigour of seed lots of different quality under ambient and controlled conditions were processed and subjected to the standard analysis of variance. Means were compared using Least Significant Difference (Snedecor and Cochran, 1967).

RESULTS AND DISCUSSION

Initial germination of good, medium and poor quality seeds was respectively 78.8, 66.2 and 63.7% in sand at 30°C and 69.1, 39.7 and 34.4% in the field (Table 4). Germinability of good quality seeds was not adversely affected when planted under suboptimal conditions in the field compared to optimum conditions in sand at 30°C. In contrast, medium and poor quality seed germinability was adversely affected under field conditions. Germination of good and medium quality seeds showed a slight increase up to 3 months of storage and declined at a faster rate thereafter with the advancement of storage period when stored under ambient conditions. Poor quality seeds however, continued to decline in germination from the

time of storage under the same test conditions (Table 4). Different quality seeds under controlled conditions had an increase in germination up to 3 months and the germination declined thereafter in these seeds. Good and medium seeds stored under controlled conditions, however, maintained high germinability even after 9 months. Germination of good and medium quality seeds was always significantly higher than poor quality seeds during storage but good quality seeds showed significantly better germination than medium quality seeds only after 9 months of storage under both conditions, in sand germination test (Table 4). Results indicate that poor quality seeds are poor in retaining viability under any kind of storage. These are in agreement with Barton (1941) who emphasized the importance of high viability of seed at the beginning of storage. In addition, several other workers reported that seeds of high viability were less susceptible to unfavourable storage conditions than those with low viability in crops like peas, grasses, vegetables and root crops (Mckee and Musil, 1948; Brett, 1952a and 1952b; Mackay and Tonkin, 1967).

Temporary increase in germination, particularly in good and medium quality seeds, during early part of storage can be attributed to the after-ripening effect. Other factors like hardness of seed coat and micro-organisms associated with seeds that decline during storage can also be considered for such an increase in germination. Increase was observed under ambient and controlled storage (Table 4). Similar pattern of viability behaviour was noticed by El Bagoury *et al.* (1980) and Arulnandhy *et al.* (1984).

Emergence rate, seedling length and seedling dry weight under sand and field germination conditions are given in Tables 5—7. Emergence rate, seedling length and seedling dry weight of good, medium and poor quality seeds increased up to 3 months and declined thereafter with the advancement of storage period under both conditions of storage, with the exception of emergence rate of poor quality seeds that was found declining from the time of storage under ambient conditions. It was also noticed that seed vigour after 9 months of storage under controlled conditions was similar to initial vigour. Nevertheless the emergence rate, seedling length and seedling dry weight of good quality seeds were found to be always significantly higher

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than poor quality seeds, and slightly better than medium quality seeds under both conditions of storage. Therefore, a good quality seed lot is apparently better in vigour than a poor quality seed lot under any type of storage.

From these results there is evidence to indicate that good quality seeds deteriorate at a slower rate than medium or poor quality seeds in ambient storage. However, medium quality seeds if kept under controlled storage can preserve viability and vigour like good quality seeds. Good and medium quality seeds can retain initial viability and vigour up to 3 months in ambient storage unlike poor quality seeds that begin to lose viability from the time they are placed in storage. This is in support of the statement made by Gregg (1982) that the quality of seed entering storage is an important factor that needs careful attention.

CONCLUSION

Medium to good quality seed lots can be stored without a loss in viability and vigour for 3 months in ambient storage and for 9 months in controlled storage of 20°C and 60% RH in the humid tropics. On the other hand, poor quality seed lots cannot be stored satisfactorily in any type of storage because of rapid deterioration. Good quality seed lots which maintain viability and vigour at a higher level than medium and poor quality seed lots are apparently better for storage in the humid tropics. In soybean one has to look into seed quality very carefully before storage since initial seed quality appears to be a pre-requisite for storage under humid tropical conditions.

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Table 1. Seed qualities and storage conditions evaluated in the experiment

<i>Seed quality (Factor 1)</i>	<i>Storage condition (Factor 2)</i>
1. Good (> 80 % good seed)	1. Ambient
2. Medium (60—80 % good seed)	2. Controlled (20° ± 1°C and
3. Poor (< 60 % good seed)	60 % relative humidity)

Table 2. Actual recorded percentage of good and bad seed in the seed lots used

<i>Seed quality</i>	<i>Good seed</i>	<i>Bad seed</i>
Good	93.4	6.6
Medium	73.0	27.0
Poor	26.8	73.2

Table 3. Mean soil temperatures at a depth of 5 cm during field germination tests

<i>Storage period (months)</i>	<i>Germination test no.</i>	<i>Soil temperature (°C)</i>
0	1	31.0 ± 1.1
3	2	30.4 ± 0.6
6	3	31.0 ± 1.2
9	4	24.7 ± 0.6

Table 4. Mean germination of 3 quality seed lots in sand at 30°C and field after storing under ambient and controlled conditions

SAND GERMINATION									
Storage condition	Seed quality	Initial germination		Months in storage					
		P ¹	A ¹	3		6		9	
				P	A	P	A	P	A
Ambient	Good	78.8	62.6	81.2	64.3	57.1	49.1	31.6	27.5
	Medium	66.2	54.4	72.0	58.0	53.0	46.8	23.9	16.4
	Poor	63.7	53.0	44.9	42.0	18.0	9.5	0.0	4.1
Controlled	Good	78.8	62.6	95.6	78.0	82.2	65.0	93.4	75.1
	Medium	66.2	54.4	97.6	81.2	77.1	61.4	84.1	66.5
	Poor	63.7	53.0	68.1	55.5	25.2	30.3	53.1	46.8
LSD (P=0.05) for seed quality within storage condition		NS		4.8		4.9		4.9	

NS= not significant

FIELD GERMINATION									
Storage condition	Seed quality	Initial germination		Months in storage					
		P	A	3		6		9	
				P	A	P	A	P	A
Ambient	Good	69.1	56.2	70.5	57.1	24.2	16.8	0.0	4.1
	Medium	39.7	40.8	68.1	55.5	17.7	9.3	0.0	4.1
	Poor	34.4	32.9	25.6	18.7	13.1	5.1	0.0	4.1
Controlled	Good	69.1	56.2	83.5	60.3	82.4	65.2	76.5	61.0
	Medium	39.7	40.8	71.2	57.6	67.3	55.1	58.1	49.6
	Poor	34.4	32.9	58.8	50.1	38.9	36.2	30.2	32.3
LSD (P=0.05) for seed quality within storage condition		4.5		4.0		5.0		4.3	

¹ Per cent² Arcsine transformed values

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Table 5. Mean emergence rate of stored soybean seeds of different qualities in sand and field

Storage condition	Seed quality	Sand germination				Field germination			
		Initial	Months in storage			Initial	Months in storage		
		emergence				emergence			
		rate (day ⁻¹)	3	6	9	rate (day ⁻¹)	3	6	9
Ambient	Good	3.02	3.19	2.06	1.01	1.71	2.51	0.57	0.00
	Medium	2.68	2.84	2.00	0.57	1.23	2.01	0.46	0.00
	Poor	2.39	1.70	0.38	0.00	0.75	0.67	0.06	0.00
Controlled	Good	3.02	3.82	3.06	3.53	1.71	3.17	3.14	2.87
	Medium	2.68	3.69	2.94	3.04	1.23	2.69	2.47	2.41
	Poor	2.39	3.35	1.28	2.03	0.75	2.26	1.54	1.23
LSD (P=0.05) for seed quality within storage condition		0.50	0.28	0.26	0.27	0.20	0.32	0.35	0.26

Table 6. Mean seedling length of stored soybean seeds of different qualities in sand and field

Storage condition	Seed quality	Sand germination				Field germination			
		Initial	Months in storage			Initial	Months in storage		
		seedling				seedling			
		length (cm)	3	6	9	length (cm)	3	6	9
Ambient	Good	30.6	31.2	20.7	20.2	7.5	8.6	5.2	0.0
	Medium	26.2	29.2	14.7	10.3	7.1	8.3	4.7	0.0
	Poor	24.7	25.7	9.4	0.0	6.7	7.6	3.8	0.0
Controlled	Good	30.6	33.5	29.0	29.4	7.5	13.8	10.9	9.5
	Medium	26.2	31.9	29.5	28.4	7.1	13.0	11.1	9.4
	Poor	24.7	29.4	19.5	27.5	6.7	12.8	9.7	9.7
LSD (P=0.05) for seed quality within storage condition		2.2	1.9	3.3	3.5	NS	0.8	NS	NS

NS= Not significant

Table 7. Mean dry weight of seedlings of stored soybean seeds of different qualities germinated in sand and field

Storage condition	Seed quality	Sand germination				Field germination			
		Initial seedling dry weight (mg)	Months in storage			Initial seedling dry weight (mg)	Months in storage		
			3	6	9		3	6	9
Ambient	Good	102.5	110.0	109.5	85.7	127.5	130.7	72.2	0.0
	Medium	69.0	98.8	97.1	42.3	124.0	111.0	53.6	0.0
	Poor	47.5	96.2	30.0	0.0	84.0	87.0	37.4	0.0
Controlled	Good	102.5	176.3	149.0	127.5	127.5	192.6	146.8	128.0
	Medium	69.0	161.9	145.0	120.8	124.0	166.4	121.8	107.9
	Poor	47.5	141.3	61.5	98.1	84.0	133.4	119.2	98.3
LSD (P=0.05) for seed quality within storage condition		25.9	15.6	20.5	37.8	19.1	15.4	26.1	27.1