

Effect of accelerated ageing on germination and vigour in pigeonpea (*Cajanus cajan*)

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ABSTRACT The study was conducted at SRTC, Rajendranagar, during 2007 to find out the effect of accelerated ageing (AAT) on germination and vigour in pigeonpea (*Cajanus cajan* L.). The germination was high in fresh seed lots compared to carry-over seed lots in all the genotypes (Asha, Palnadu and Laxmi) at different intervals after AAT. Gradual decrease in accelerated ageing was noticed with increase in period of accelerated ageing. Similar trend was noticed with respect to seedling vigour index on length and dry-weight basis. Seedling vigour index on length and dry-weight basis was found to be more in Asha, followed by Laxmi using both the methods of evaluation. The electrical conductivity of seed leachates gradually increased with the period of accelerated ageing and was high in carry-over seed lots compared to fresh seed lots in all the genotypes. The increase in EC was more for Palnadu (252.26%), followed by Laxmi (180.39%) and Asha (110.98%).

Key words: Pigeonpea, accelerated ageing test, germination, vigour

Seed deterioration is an inseparable aspect of ageing. Economically, seed deterioration is a major problem in agricultural production. The climatic conditions of India greatly accelerate seed deterioration under ambient storage environment causing loss of viability of seed [1]. Seeds undergo deterioration at various levels during storage, resulting in low vigour and poor germinability. It may also result in poor field performance which affects plant growth, development and yield [2, 3, 4, 5 and 6]. Since information on ageing on germinating in pigeonpea (*Cajanus cajan*) are lacking, an experiment was conducted to find out the effect of accelerated ageing on germination and vigour.

MATERIALS AND METHODS

Three different varieties of pigeonpea, viz. LRG 30 (Palnadu), Laxmi (ICPL 85063) and Asha (ICPL 87119) were used for standardization of seed vigour tests. Four different lots, i.e. two fresh (FL1 and FL2) and two carryover (CL1 and CL2) seed lots were used for the study. Four replications,

each comprising 100 seeds were evaluated using between paper and sand media (7). For between paper method, 100-seeds in each replication were selected randomly and placed between two layers of wetted germination paper towels, rolled and placed in walk-in-germinator in upright position [7]. The normal seedlings were counted and expressed as germination %.

$$\text{Germination percentage (G\%)} = \frac{\text{Number of normal seedlings}}{\text{Total number of seeds planted}} \times 100$$

Ten seedlings were selected randomly in each replication from germination test (between paper) for recording seedling length (cm). The same seedlings were dried in hot air oven at 80°C for two days and seedling dry weight was recorded in as (g).

Seedling vigour index (SVI) was calculated using the formula by Abdul-Baki and Anderson [8].

$$\text{SVI} = \text{Average seedling length} \times \text{G\%}$$

SVI on dry-weight basis = average seedling dry weight \times G%

Fifty seeds were selected randomly in each replication and soaked overnight in 50 ml distilled water for collecting the seed leachates. Electrical conductivity (EC) of seed leachates was measured by digital EC meter and expressed in mhos cm^{-1} [9].

About 250 g of fresh and carry-over seed lots each of three different genotypes of pigeonpea with initial germination percentage were subjected to accelerated ageing by keeping them on perforated cloth in accelerated ageing chamber at 45°C and 90% RH for 21 days [10]. Then seeds were tested for germination and electrical conductivity of seed leachates at 3 days interval.

Total fungal colonies were counted at bimonthly interval by adopting standard blotter method (7). The 100-seeds selected randomly for each replication were planted on blotter paper in 10 Petri plates @10 seeds/plate and incubated at 25°C temperature under alternate cycles of 12 hr light and 2 hr darkness for 7 days in BOD incubator. The plates were examined under stereo binocular microscope on 7 day and total number of fungal colonies were counted and expressed as %.

RESULTS AND DISCUSSION

The seed vigour tests showed that germination (%) was higher in fresh seeds (FL) than carry-over (CL) seeds in all genotypes at 0, 6, 12, 18 and 21 days after accelerated ageing test. Germination (%) decreased gradually with increase in period of accelerated ageing in all the seeds lots in different varieties in both between paper (72.7 to 19.3%) and sand media (59.1 to 12.3%) (Tables 1a and 1b). Such decline in germination due to accelerated ageing was high in Palnadu (27.02%), low in Asha (26.02%) and moderate in Laxmi (26.76%) using between paper method, as, it was high in Asha (22.41%), moderate in Laxmi (20.97%) and low in Palnadu (20.69%). Babu [11] reported that there was a significant progressive reduction in germination (%) with increase in duration of accelerated ageing in all rice genotypes.

The seedling dry weight and seedling vigour index on length- and dry-weight basis using

between paper and sand method was high in fresh seed lots compared to the carry-over seed lots in all the three genotypes. Sridhar *et al.* [12] recorded significantly higher vigour index in fresh seeds of cotton, sorghum, maize, pigeonpea and greengram.

The seedling dry weight (0.79-0.16) using between paper method and 0.76-0.28 using sand media and seedling vigour index on length basis (1316.0-84.1) using between paper method and (14673-77.2) using sand media and seedling vigour index on dry-weight basis (56.80-3.12) using between paper and 45.23-3.56 using sand media were reduced due to accelerated ageing in all genotypes (Tables 1e to 1j). This might be due to changes that include impairment or shift in metabolic activity, decline in enzyme activity, cytological and cellular changes and differences in initial seed vigour levels [13]. Accelerated ageing employed to determine genotypic differences for seed vigour, viability and seedling growth is well accepted as one of the important stress tests for evaluation of seed vigour to predict storage potential of seed [14]. The reduced seedling vigour in revalidated seeds was due to reduction in germination (%) and seedling length (Table 1a-1d).

The electrical conductivity of seed leachates gradually increased with increased period of accelerated ageing (470.8-1246.8) in all three genotypes (Table 1k). The increase in EC was more for Palnadu (252.26%), followed by Laxmi (180.39%) and Asha (110.98%). The results indicated a gradual increase in electrical conductivity of seed leachates. The increase in fresh seed lots is 165.29% and 164.83% in carry-over seed lots. The increase was more in carry-over seed lots compared to fresh seed lots. Such increase in electrical conductivity of seed leachates was high in Palnadu, followed by Laxmi and Asha. Electrical conductivity of seed leachates was high, especially in untreated aged seeds which might be due to destructive changes in cellular membrane system, resulting in more leakage of organic solutes (free sugars, fatty acids and amino acids). Seed soaking in water effectively controlled leakage of electrolytes, sugars and amino acids from seed [15, 16 and 17]. The seed quality parameters indicated that seed vigour and membrane integrity was less

Table Ia. Effect of AAT on germination (BP method) in different seed lots

Seed lot	Days from AAT																													
	0						6						12						18						21					
	A	L	P	M	A	M	A	L	P	M	A	L	P	M	A	L	P	M	A	L	P	M	A	L	P	M				
FL1	77	81	77	78.3	70	72	71	71.0	53	50	51	51.3	30	31	30	30.3	20	20	20	20.0										
FL2	77	81	75	77.7	71	74	69	71.3	54	51	52	52.3	31	30	31	30.7	21	21	20	20.7										
CL1	70	61	73	68.0	63	52	61	58.7	50	46	49	48.3	29	29	29	29.0	18	18	19	18.3										
CL2	68	60	72	66.7	61	56	60	59.0	50	44	49	47.7	26	28	30	28.0	17	18	19	18.0										
Mean	73.0	70.8	74.3	72.7	66.3	63.5	65.3	65.0	51.8	47.8	50.3	49.9	29.0	29.5	30.0	29.5	19.0	19.3	19.5	19.3										

Table Ib. Effect of AAT on germination (Sand media) in different seed lots

Seed lot	Days from AAT																													
	0						6						12						18						21					
	A	L	P	M	A	M	A	L	P	M	A	L	P	M	A	L	P	M	A	L	P	M	A	L	P	M				
FL1	60	65	64	63.0	49	49	48	48.7	35	32	31	32.7	20	21	19	20.0	15	15	14	14.7										
FL2	60	65	63	62.7	48	49	48	48.3	35	32	31	32.7	20	21	19	20.0	15	15	14	14.7										
CL1	56	58	52	55.3	44	43	42	43.0	31	30	30	30.3	19	18	18	18.3	11	10	9	10.0										
CL2	56	58	52	55.3	43	42	42	42.3	31	30	30	30.3	18	18	17	17.7	10	11	9	10.0										
Mean	58.0	61.5	57.8	59.1	46.0	45.8	45.0	45.6	33.0	31.0	30.5	31.5	19.3	19.5	18.3	19.0	12.8	12.8	11.5	12.3										

Table Ic. Effect of AAT on total seedling length (BP method) in different seed lots

Seed lot	Days from AAT																													
	0						6						12						18						21					
	A	L	P	M	A	M	A	L	P	M	A	L	P	M	A	L	P	M	A	L	P	M	A	L	P	M				
FL 1	17.8	19.3	19.5	18.87	13.7	12.8	13.2	13.23	9.4	8.8	8.4	8.87	7.2	6.4	5.8	6.47	5.4	4.8	4.2	4.80										
FL2	17.7	18.8	18.7	18.40	13.8	12.4	13.4	13.20	9.6	8.6	8.7	8.97	7.4	6.3	5.9	6.53	5.5	4.8	4.0	4.77										
CL1	17.0	16.9	18.6	17.50	12.1	12.6	12.7	12.47	7.3	6.4	6.4	6.70	5.3	4.9	4.8	5.00	4.1	3.8	3.8	3.90										
CL2	16.9	16.8	18.5	17.40	12.4	12.7	12.1	12.40	7.4	6.4	6.3	6.70	5.2	4.9	4.8	4.97	4.1	3.7	3.9	3.90										
Mean	17.35	17.95	18.83	18.04	13.00	12.63	12.85	12.83	8.43	7.55	7.45	7.81	6.28	5.63	5.33	5.74	4.78	4.28	3.98	4.34										

A = Asha (ICPL87119); L = Laxmi (ICPL 85063); P = Palnadu (LRG 30); M = Mean; FL = Fresh lot; CL = Carry-over lot

Table Id. Effect of AAT on total seedling length (Sand media) in different seed lots

Seed lot	Days from AAT																													
	0						6						12						18						21					
	A	L	P	M	A	M	A	L	P	M	A	M	A	L	P	M	A	M	A	L	P	M	A	M	A	L	P	M	A	M
FL1	26.7	28.9	28.7	28.r0	18.3	21.3	24.3	21.30	13.2	15.2	17.3	15.23	9.6	10.1	10.1	10.1	9.93	6.5	7.3	7.4	7.07									
FL2	25	27.6	26.3	26.30	18.2	20.8	21.4	20.13	13.8	15.6	17.2	15.53	9.2	9.8	10.2	9.73	6.2	7.2	7.4	6.93										
CL1	22.8	20.2	23.3	22.10	17.4	16.4	19.6	17.80	11.6	11.6	11.8	11.67	7.2	7.6	7.8	7.53	5.2	5.4	5.3	5.30										
CL2	20.8	23.1	22.6	22.17	17.2	17.6	19.7	18.17	10.8	11.4	11.4	11.20	7.4	7.4	7.6	7.47	4.8	5.2	5.2	5.07										
Mean	23.83	24.95	25.23	24.67	17.78	19.03	21.25	19.35	12.35	13.45	14.43	13.41	8.35	8.73	8.93	8.67	5.68	6.28	6.33	6.09										

Table Ie. Effect of AAT on seedling dry weight (BP Method) in different seed lots

Seed lot	Days from AAT																													
	0						6						12						18						21					
	A	L	P	M	A	M	A	L	P	M	A	M	A	L	P	M	A	M	A	L	P	M	A	M	A	L	P	M	A	M
FL1	0.89	0.74	0.81	0.81	0.52	0.49	0.52	0.51	0.41	0.31	0.33	0.35	0.23	0.18	0.19	0.20	0.19	0.15	0.14	0.16										
FL2	0.85	0.71	0.66	0.74	0.56	0.52	0.49	0.52	0.39	0.32	0.31	0.34	0.24	0.19	0.21	0.21	0.20	0.14	0.14	0.16										
CL1	1.06	0.92	0.64	0.87	0.55	0.61	0.38	0.51	0.36	0.42	0.28	0.35	0.20	0.24	0.18	0.21	0.17	0.20	0.13	0.17										
CL2	0.73	0.83	0.58	0.71	0.52	0.60	0.39	0.50	0.36	0.41	0.27	0.35	0.21	0.24	0.19	0.21	0.16	0.21	0.12	0.16										
Mean	0.88	0.80	0.67	0.79	0.54	0.56	0.45	0.51	0.38	0.37	0.30	0.35	0.22	0.21	0.19	0.21	0.18	0.18	0.13	0.16										

Table If. Effect of AAT on seedling dry weight (Sand media) in different seed lots

Seed lot	Days from AAT																													
	0						6						12						18						21					
	A	L	P	M	A	M	A	L	P	M	A	M	A	L	P	M	A	M	A	L	P	M	A	M	A	L	P	M	A	M
FL1	0.91	0.80	0.63	0.78	0.83	0.73	0.53	0.70	0.70	0.58	0.43	0.57	0.51	0.40	0.31	0.41	0.38	0.29	0.26	0.31										
FL2	0.97	0.82	0.58	0.79	0.86	0.72	0.54	0.71	0.73	0.59	0.44	0.59	0.52	0.41	0.29	0.41	0.39	0.30	0.24	0.31										
CL1	0.96	0.78	0.59	0.78	0.81	0.69	0.50	0.67	0.66	0.55	0.41	0.54	0.40	0.39	0.27	0.35	0.29	0.26	0.20	0.25										
CL2	0.89	0.72	0.51	0.71	0.82	0.68	0.46	0.65	0.65	0.56	0.39	0.53	0.42	0.38	0.26	0.35	0.30	0.27	0.19	0.25										
Mean	0.93	0.78	0.58	0.76	0.83	0.71	0.51	0.68	0.69	0.57	0.42	0.56	0.46	0.40	0.28	0.38	0.34	0.28	0.22	0.28										

A = Asha (ICPL87119); L = Laxmi (ICPL 85063); P = Palnadu (LRG 30); M = Mean; FL = Fresh lot; CL = Carry-over lot

Table Ig. Effect of AAT on seedling vigour index on seedling length basis (BP method) in different seed lots

Seed lot	Days from AAT																			
	0				6				12				18				21			
	A	L	P	M	A	L	P	M	A	L	P	M	A	L	P	M	A	L	P	M
FL1	1370.6	1563.3	1501.5	1478.5	959.0	921.6	937.2	939.3	498.2	440.0	428.4	455.5	216.0	198.4	174.0	196.1	108.0	96.0	84.0	96.0
FL2	1362.9	1522.8	1402.5	1429.4	979.8	917.6	924.6	940.7	518.4	438.6	452.4	469.8	229.4	189.0	182.9	200.4	115.5	100.8	80.0	98.8
CL1	1190.0	10309	1357.8	1192.9	762.3	655.2	774.7	730.7	365.0	294.4	313.6	324.3	153.7	142.1	139.2	145.0	73.8	68.4	72.2	71.5
CL2	1149.2	1008.0	1332.0	1163.1	756.4	711.2	726.0	731.2	370.0	281.6	308.7	320.1	135.2	137.2	144.0	138.8	69.7	66.6	74.1	70.1
Mean	1268.2	1281.3	1398.5	1316.0	864.4	801.4	840.6	835.5	437.9	363.7	375.8	392.4	183.6	166.7	160.0	170.1	91.8	83.0	77.6	84.1

Table Ih. Effect of AAT on seedling vigour index on seedling length basis (Sand media) in different seed lots

Seed lot	Days from AAT																			
	0				6				12				18				21			
	A	L	P	M	A	L	P	M	A	L	P	M	A	L	P	M	A	L	P	M
FL1	1602.0	1878.5	1836.8	1772.4	896.7	1043.7	1166.4	1035.6	462.0	486.4	536.3	494.9	192.0	212.1	191.9	198.7	97.5	109.5	103.6	103.5
FL2	1500.0	1794.0	1656.9	1650.3	873.6	1019.2	12027.2	2973.3	483.0	499.2	533.2	505.1	184.0	205.8	193.8	194.5	93.0	108.0	103.6	101.5
CL1	1276.8	1171.6	1211.6	1220.0	7656	705.2	823.2	764.7	3596	348.0	354.0	353.9	136.8	1368	140.4	138.0	57.2	54.0	47.7	53.0
CL2	1164.8	1339.8	1175.2	12226.6	739.6	739.2	827.4	768.7	334.8	342.0	342.0	339.6	133.2	133.2	129.2	131.9	48.0	57.2	46.8	50.7
Mean	1385.9	1546.0	1470.1	1467.3	818.9	876.8	961.1	885.6	409.9	418.9	441.4	423.4	161.5	172.0	163.8	165.8	73.9	82.2	75.4	77.2

Table li. Effect of AAT on seedling vigour index on seedling dry weight basis (BP method) in different seed lots

Seed lot	Days from AAT																			
	0				6				12				18				21			
	A	L	P	M	A	L	P	M	A	L	P	M	A	L	P	M	A	L	P	M
FL1'	68.53	59.94	62.37	63.61	3640	35.28	36.92	36.20	21.73	15.50	16.83	18.02	6.90	5.58	5.70	6.06	3.80	3.00	2.80	3.20
FL2	65.45	57.51	49.50	57.49	39.76	38.48	33.81	37.35	21.06	16.32	16.12	17.83	7.44	5.70	6.51	6.55	4.20	2.94	2.80	3.31
CL1	74.20	56.12	46.72	59.01	34.65	31.72	23.18	29.85	18.00	19.32	13.72	17.01	5.80	6.96	5.22	5.99	3.06	3.60	2.47	3.04
CL2	49.64	49.80	41.76	47.07	31.72	33.60	23.40	29.57	18.00	18.04	13.23	16.42	5.46	6.72	5.70	5.96	2.72	3.78	2.28	2.93
Mean	64.46	55.84	50.09	56.80	35.63	34.77	29.33	33.24	19.70	17.30	14.98	17.32	6.40	6.24	5.78	6.14	3.45	3.33	2.59	3.12

A = Asha (ICPL87119); L = Laxmi (ICPL 85063); P = Palnadu (LRG 30); M = Mean; FL = Fresh lot; CL = Carry-over lot

Table Ij. Effect of AAT on seedling vigour index on seedling dry weight basis (Sand media) in different seed lots

Seed lot	Days from AAT																			
	0			6			12			18			21							
	A	L	P	A	L	P	A	L	P	A	L	P	A	L	P					
FL1	54.60	52.00	40.32	48.97	40.67	35.77	25.44	33.96	24.50	18.56	13.33	18.80	10.20	8.40	5.89	8.16	5.70	4.35	3.64	4.56
FL2	58.20	53.30	36.54	49.35	41.28	35.28	25.92	34.16	25.55	18.88	13.64	19.36	10.40	8.61	5.51	8.17	5.85	4.50	3.36	4.57
CL1	53.76	45.24	30.68	43.23	35.64	29.67	21.00	28.77	20.46	16.50	12.30	16.42	7.60	7.02	4.86	6.49	3.19	2.60	1.80	2.53
CL2	49.84	41.76	26.52	39.37	35.26	28.56	19.32	27.71	20.15	16.80	11.70	16.22	7.56	6.84	4.42	6.27	3.00	2.97	1.71	2.56
Mean	54.10	48.08	33.52	45.23	38.21	32.32	22.92	31.15	22.67	17.69	12.74	17.70	8.94	7.72	5.17	7.28	4.44	3.61	2.63	3.56

Table Ik. Effect of AAT on electrical conductivity in different seed lots

Seed lot	Days from AAT																			
	0			6			12			18			21							
	A	L	P	A	L	P	A	L	P	A	L	P	A	L	P					
FL1	555	485	296	445.3	725	643	498	497.3	998	814	688	833.3	1188	1012	884	1028.0	1243	1166	989	1132.7
FL2	564	329	323	405.3	731	587	487	502.7	976	826	693	831.7	1174	1014	903	1030.3	1251	1172	943	1122.0
CL1	762	520	318	533.3	914	727	522	608.3	1094	958	793	948.3	1381	1276	1043	1233.3	1493	1394	1243	1376.7
CL2	686	492	320	499.3	853	684	503	579.7	1072	924	812	936.0	1372	1299	1032	1234.3	1429	1387	1252	1356.0
Mean	641.8	456.5	314.3	470.8	805.8	660.3	502.5	547.0	1035.0	880.5	746.5	887.3	1278.8	1150.3	965.5	1131.5	1354.0	1279.8	1106.8	1246.8

A = Asha (ICPL87119); L = Laxmi (ICPL 85063); P = Palnadu (LRG 30); M = Mean; FL = Fresh lot; CL = Carry-over lot

in aged seeds due to deterioration. Similar findings were reported by several researchers [10, 18, 19, 20 and 12].

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