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Studies on effects of seed treatments, polymer coating and packaging materials on seed quality parameters of stored cowpea (*Vigna unguiculata*) seeds

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Abstract

The present experiment was conducted at Post Graduate Laboratory, Department of Genetics and Plant Breeding, Sam Higginbottom University of Agriculture, Technology and Sciences, Uttar Pradesh during 2015 - 2016 with cowpea variety Kashi unnati obtained from Department of Genetic and Plant Breeding, SHUATS. The seeds were treated with polymer in combination with fungicide (mancozeb), inorganic chemical (ferrous sulphate), bioagent (*Trichoderma viridae*) and plant product (neem oil) along with control (untreated seeds). After treatment, seeds were stored in plastic container (P₁) and cloth bag (P₂) for evaluation of seed germination, seedling length, seedling dry matter, seedling vigour indices, protein content and carbohydrate content where data was analysed by factorial experiment laid out in completely randomized design. Germination per cent (95.33), seedling length (37.50 cm), seedling vigour index (SV-I 3573.95), protein content (25.54 %) and carbohydrate content (80.17 %) were recorded high with seed treatment T₇ and seedling dry weight (0.60 g) were recorded high with seed treatment T₄ over all other seed treatments after storage period of 6 months.

Keywords: Cowpea, polymer, ferrous sulphate, *Trichoderma viridae*, mancozeb, neem oil, germination, seed vigour, plastic container, storage.

1. Introduction

Cowpea (*Vigna unguiculata* L.), a dicotyledonous plant belongs to family Leguminosae. It is an annual legume and self-pollinated crop having chromosome no 2n= 22. Cowpea was originated in Africa. Cowpea is commonly referred to as black eyed pea, southern pea, crowder pea, lubia or marble pea. The World's total production of cowpea hovers around 3 million tons, of which Nigeria is the leading producer contributing 2.1 million tons. In India, cowpea is grown in almost 1.3 m ha area with an average productivity of 600-750kg grains/ha, particularly in Western, Central and Peninsular regions. The nutrient composition of cowpea seed constitutes 24.8% protein, 1.9% fat, 63.6% carbohydrate and 6.3% fiber.

Storage is one of the major constraints in the endeavor of increasing productivity in cowpea. Several factors affect the longevity of seeds storage which includes variety of seed, storage conditions, initial seed quality, moisture content, insect, pests, bacteria and fungi. The rate of seed deterioration could be slowed down either by storing the seeds under ambient conditions or by imposing suitable seed treatments.

Seed treatment is an efficient technology replacing wasteful foliar and soil application of chemicals. Seed fortification is a process to improve the germinability and vigour of the seeds by infusion of bioactive chemicals into the seed by soaking in growth regulators and micro nutrient solutions. Polymer coating is a new concept in which the plasticizer polymer forms a flexible film that improves plant stand and emergence of seeds, accurate application of the chemicals (Larissa *et al.*, 2004) [12]. Packaging is essential for storage and protection against climatic factors, mechanical and physical hazards during storage, transport and distribution (Harrington, 1973) [6]. Hence, the present investigation was taken up to evaluate the effects of individual and combination of seed treatments, packaging materials (plastic container and cloth bag) on seedling parameters of cowpea seeds during storage.

2. Materials and Methods

The cowpea variety Kashi Unnati seeds obtained from Department of Genetics and Plant Breeding, SHUATS were treated with T₀ is control (untreated seeds), T₁ is ferrous sulphate @ 1% (fortification for 16 hours), T₂ is *Trichoderma viridae* @ 4g/Kg seed, T₃ is Mancozeb @ 3g/Kg seed, T₄ is Neem oil @ 10ml/Kg seed, T₅ is ferrous sulphate + polymer coating (@ 2ml/Kg seed) + *Trichoderma viridae*, T₆ is mancozeb + polymer coating + neem oil and

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T₇ is ferrous sulphate + mancozeb + polymer coat + neem oil + trichoderma. The treated seeds were packed in plastic container and cloth bag (factor P₁ and P₂) and stored at Post Graduate Laboratory, Department of Genetics and Plant Breeding, Sam Higginbottom University of Agriculture, Technology and Sciences, Uttar Pradesh for a period of six months i.e. from July 2015 to January 2016. The seed samples drawn at trimonthly intervals were evaluated for various seed quality parameters viz., seed germination, seedling length, seedling dry matter, seedling vigour index, protein content and carbohydrate content where data was subjected to factorial experiment laid out in completely randomized design.

Germination per cent was calculated as per (ISTA, 1985) [8], seedling vigour index (Abdul-Baki and Anderson 1973) [1], protein content (Lowry *et al.*, 1951) [11] and carbohydrate content (Anthrone method, Hedge and Hofreiter, 1962) [7].

3. Results

3.1 Germination per cent:

At the end of six months of storage period, highest germination percentage was recorded in T₇ (ferrous sulphate + mancozeb + polymer coat + neem oil + trichoderma) of 95.33%, followed by T₄ (neem oil) of 94.67%. Significantly, the higher germination percentage was recorded in Plastic container (P₁) (89.29%) as compare to the cloth bag (P₂) (87.37%) at the end of storage period.

3.2 Seedling length (cm):

At the end of six months of storage period, the highest seedling length was recorded in T₇ (ferrous sulphate + mancozeb + polymer coat + neem oil + trichoderma) (37.50 cm) followed by T₅ (ferrous sulphate+ Polymer + trichoderma) (34.02 cm) and the lowest seedling length was recorded in T₀ (untreated control) (28.51cm). Higher seedling length was recorded in seed stored in plastic container (34.69

cm) as compared to cloth bag which recorded lower seedling length (30.32 cm).

3.3 Seedling dry weight (g):

At the end of six months of storage period, T₄ (neem oil) (0.60 g) recorded highest seedling dry weight followed by T₅ (ferrous sulphate+ Polymer + trichoderma) (0.44g) over control. Treated seeds stored in plastic container (0.35g) were found effective in increasing the seedling dry weight over untreated seeds stored in cloth bag (0.34).

3.4 Seedling vigour index:

At the end of six months period of storage, seeds treated with T₇ (ferrous sulphate + mancozeb + polymer coat + neem oil + trichoderma) recorded maximum SV-I (3573.95) while T₀ (control) had minimum SV-I (2314.14). Seeds stored in plastic container SV-I (3148.32) had significantly higher seedling vigour index over cloth bag, SV-I (2685.65).

3.5 Protein content:

At the end of six months period of storage, T₇ (ferrous sulphate + mancozeb + polymer coat + neem oil + trichoderma) (25.54%) recorded higher protein content followed by T₅ (ferrous sulphate+ Polymer + trichoderma) (25.13%) over T₀ (control) (20.62%). Treated seed stored in plastic container (23.18%) was effective for increasing the protein content over seeds stored in cloth bag (22.45%).

3.6 Carbohydrate content:

At the end of six months period of storage, T₇ (ferrous sulphate + mancozeb + polymer coat + neem oil + trichoderma) (80.17%) recorded higher carbohydrate content followed by T₃ (mancozeb) (76.98%) over T₀ (control) (57.19%). Treated seeds stored in plastic container (69.70%) were effective for increasing the carbohydrate content over seeds stored in cloth bag (66.58%).

Table 1: Effect of seed treatments and packaging materials on germination per cent (%)

Treatments	Initial	3 Months			6 Months		
		P1	P2	Mean	P1	P2	Mean
T0	86.00	89.33	87.33	88.33	85.33	84.33	84.83
T1	92.67	92.00	90.67	91.33	86.00	84.33	85.165
T2	94.00	90.67	90.00	90.33	86.33	84.00	85.165
T3	94.00	92.00	90.00	91.00	87.67	85.67	86.67
T4	96.00	97.00	94.67	95.83	94.67	90.00	92.335
T5	92.00	92.33	92.67	92.50	87.00	88.00	87.5
T6	94.00	92.67	92.00	92.33	92.00	90.33	91.165
T7	95.33	96.67	96.00	96.33	95.33	92.33	93.83
Mean	93.00	92.83	91.66		89.29	87.37	
		3 Months			6 Months		
		T	P	T×P	T	P	T×P
	SEm±	0.80	0.40	1.13	1.29	0.65	1.83
	CD at 5%	1.15	2.30	NS	3.72	1.86	NS

Where, T₀ : control (untreated seeds), T₁: Ferrous sulphate (Fe₂SO₄) @ 1%, T₂: Trichoderma viridae@ 4g/kg seed, T₃ :Mancozeb @ 3g/kg seed, T₄ :Neem oil @ 10ml/kg seed, T₅ : ferrous sulphate + polymer coating (@ 2ml/Kg seed) + Trichoderma viridae, T₆ : mancozeb + polymer coating +

neem oil, T₇: ferrous sulphate + mancozeb + polymer coat + neem oil + trichoderma, P₁: Plastic container, P₂: Cloth bag, SEm : Standard error of mean, CD : Critical difference, NS: Non-significant.

Table 2: Effect of seed treatments and packaging materials on seedling length (cm)

Treatments	Initial	3 Months			6 Months		
		P1	P2	Mean	P1	P2	Mean
T0	42.08	33.40	33.95	33.675	31.89	28.51	30.2
T1	47.64	39.05	35.84	37.445	30.47	28.39	29.43
T2	48.28	42.02	35.86	38.94	28.09	29.10	28.595
T3	44.46	39.42	35.09	37.255	32.25	28.05	30.15
T4	45.09	45.37	37.54	41.455	33.28	28.28	30.78
T5	51.13	41.59	35.70	38.645	34.02	26.31	30.165
T6	48.14	47.53	35.60	41.565	33.20	27.24	30.22
T7	53.58	49.85	39.96	44.905	37.50	32.13	34.815
Mean	47.55	42.27	36.19		34.69	30.32	
		3 Months			6 Months		
		T	P	T×P	T	P	T×P
	SEm±	1.09	0.55	1.54	0.69	0.34	0.97
	CD at 5%	3.14	1.57	4.45	1.99	0.99	2.81

Where, T_0 : control (untreated seeds), T_1 : Ferrous sulphate (Fe_2SO_4) @ 1%, T_2 : Trichoderma viridae@ 4g/kg seed, T_3 :Mancozeb @ 3g/kg seed, T_4 :Neem oil @ 10ml/kg seed, T_5 : ferrous sulphate + polymer coating (@ 2ml/Kg seed) + Trichoderma viridae, T_6 : mancozeb + polymer coating + neem oil, T_7 : ferrous sulphate + mancozeb + polymer coat + neem oil + trichoderma, P_1 : Plastic container, P_2 : Cloth bag, SEM : Standard error of mean, CD : Critical difference

Table 3: Effect of seed treatments and packaging materials on seedling dry weight (g)

Treatments	Initial	3 Months			6 Months		
		P1	P2	Mean	P1	P2	Mean
T0	0.34	0.32	0.32	0.32	0.33	0.32	0.32
T1	0.38	0.33	0.40	0.36	0.37	0.33	0.35
T2	0.35	0.28	0.36	0.32	0.33	0.30	0.32
T3	0.39	0.46	0.38	0.42	0.35	0.42	0.38
T4	0.35	0.38	0.28	0.33	0.60	0.35	0.48
T5	0.31	0.37	0.30	0.33	0.44	0.37	0.41
T6	0.39	0.35	0.35	0.35	0.35	0.32	0.34
T7	0.36	0.41	0.36	0.38	0.37	0.38	0.38
Mean	0.36	0.35	0.34		0.35	0.34	
		3 Months			6 Months		
		T	P	T×P	T	P	T×P
	SEm±	0.01	0.00	0.01	0.01	0.00	0.01
	CD at 5%	0.02	0.01	0.02	0.02	0.01	0.03

Where, T_0 : control (untreated seeds), T_1 : Ferrous sulphate (Fe_2SO_4) @ 1%, T_2 : Trichoderma viridae@ 4g/kg seed, T_3 :Mancozeb @ 3g/kg seed, T_4 :Neem oil @ 10ml/kg seed, T_5 : ferrous sulphate + polymer coating (@ 2ml/Kg seed) + Trichoderma viridae, T_6 : mancozeb + polymer coating + neem oil, T_7 : ferrous sulphate + mancozeb + polymer coat + neem oil + trichoderma, P_1 : Plastic container, P_2 : Cloth bag, SEM : Standard error of mean, CD : Critical difference

Table 4. Effect of seed treatments and packaging materials on seedling vigour index-I

Treatments	Initial	3 Months			6 Months		
		P1	P2	Mean	P1	P2	Mean
T0	3619.37	2984.57	2965.63	2975.1	2722.69	2314.14	2564.355
T1	4415.95	3588.18	3248.08	3418.13	2620.29	2391.78	2506.035
T2	4539.48	3810.51	3231.43	3520.97	2423.09	2444.60	2433.845
T3	4180.07	3631.55	3164.04	3397.795	2823.94	2400.89	2612.415
T4	4326.37	4401.63	3551.85	3976.74	3153.67	2544.38	2849.025
T5	4704.57	3840.69	3310.76	3575.725	2961.15	2406.02	2637.645
T6	4522.53	4404.35	3273.23	3838.79	3053.50	2460.64	2757.07
T7	5110.76	4820.45	3840.92	4330.685	3573.95	2965.28	3269.615
Mean	4427.39	3902.51	3403.27		3148.32	2685.65	
		3 Months			6 Months		
		T	P	T×P	T	P	T×P
	SEm±	114.32	57.16	161.68	68.57	34.28	96.97
	CD at 5%	329.33	164.66	465.74	197.51	98.76	279.33

Where, T_0 : control (untreated seeds), T_1 : Ferrous sulphate (Fe_2SO_4) @ 1%, T_2 : Trichoderma viridae@ 4g/kg seed, T_3 :Mancozeb @ 3g/kg seed, T_4 :Neem oil @ 10ml/kg seed, T_5 : ferrous sulphate + polymer coating (@ 2ml/Kg seed) + Trichoderma viridae, T_6 : mancozeb + polymer coating + neem oil, T_7 : ferrous sulphate + mancozeb + polymer coat + neem oil + trichoderma, P_1 : Plastic container, P_2 : Cloth bag, SEM : Standard error of mean, CD : Critical difference

Table 5: Effect of seed treatments and packaging materials on protein content (%)

Treatments	Initial	3 Months			6 Months		
		P1	P2	Mean	P1	P2	Mean
T0	22.40	23.19	21.33	22.26	20.81	20.62	20.71
T1	25.05	23.53	22.05	22.79	22.42	22.85	22.64
T2	25.15	23.01	22.95	22.98	23.50	22.18	22.84
T3	24.05	23.92	22.74	23.33	23.61	21.70	22.65
T4	23.89	24.59	24.14	24.37	24.88	21.55	23.22
T5	24.49	24.73	23.31	24.02	25.13	23.21	24.17
T6	24.98	24.79	21.79	23.29	24.98	20.49	22.74
T7	25.93	25.69	24.64	25.16	25.54	24.28	24.91
Mean	24.55	24.44	22.98		23.18	22.45	
		3 Months			6 Months		
		T	P	T×P	T	P	T×P
SEm±		0.57	0.28	0.80	0.70	0.35	0.99
CD at 5%		1.64	0.82	2.32	2.01	1.00	2.84

Where, T_0 : control (untreated seeds), T_1 : Ferrous sulphate (Fe_2SO_4) @ 1%, T_2 : Trichoderma viridae@ 4g/kg seed, T_3 : Mancozeb @ 3g/kg seed, T_4 : Neem oil @ 10ml/kg seed, T_5 : ferrous sulphate + polymer coating (@ 2ml/Kg seed) +

Trichoderma viridae, T_6 : mancozeb + polymer coating + neem oil, T_7 : ferrous sulphate + mancozeb + polymer coat + neem oil + trichoderma, P_1 : Plastic container, P_2 : Cloth bag, SEm : Standard error of mean, CD : Critical difference

Table 6: Effect of seed treatments and packaging materials on carbohydrate content (%)

Treatments	Initial	3 Months			6 Months		
		P1	P2	Mean	P1	P2	Mean
T0	62.82	57.95	58.57	58.26	59.23	57.19	58.21
T1	62.99	65.44	67.44	66.44	67.12	65.70	66.40
T2	71.11	75.34	75.03	75.18	75.11	75.26	75.18
T3	72.37	76.45	74.29	75.37	76.98	73.77	75.37
T4	76.75	73.49	72.78	73.13	73.80	72.46	73.13
T5	72.32	74.09	77.43	75.76	75.15	76.37	75.76
T6	62.99	77.77	68.84	73.30	75.95	70.65	73.30
T7	77.87	81.69	74.78	78.23	80.17	75.96	78.06
Mean	69.90	69.82	66.67		69.70	66.58	
		3 Months			6 Months		
		T	P	T×P	T	P	T×P
SEm±		1.01	0.51	1.43	1.27	0.63	1.79
CD at 5%		2.91	1.46	4.12	3.65	1.83	5.16

Where, T_0 : control (untreated seeds), T_1 : Ferrous sulphate (Fe_2SO_4) @ 1%, T_2 : Trichoderma viridae@ 4g/kg seed, T_3 : Mancozeb @ 3g/kg seed, T_4 : Neem oil @ 10ml/kg seed, T_5 : ferrous sulphate + polymer coating (@ 2ml/Kg seed) + Trichoderma viridae, T_6 : mancozeb + polymer coating + neem oil, T_7 : ferrous sulphate + mancozeb + polymer coat + neem oil + trichoderma, P_1 : Plastic container, P_2 : Cloth bag, SEm : Standard error of mean, CD : Critical difference

4. Discussion

4.1 Germination per cent

The decline in germination percentage over the storage period was due to ageing effect leading to depletion of food reserves, seed deterioration, fluctuating temperature, relative humidity and seed moisture content as influenced by storage packaging materials. These findings were similar with Jitendra *et al.*, (2007) [9].

4.2 Seedling length (cm)

The decline in seedling length at the end of the storage period were due to reduced seed germination and damage caused by insect, pests during storage which might have hindered the seedling growth. Similar findings were reported with Jitendra *et al.*, (2007) [9], Geetharani *et al.*, (2006) [5].

4.3 Seedling dry weight (g)

Seedling dry weight showed positive effect with seed treatments of polymer, fungicide, plant product and bioagent which could be effective for better storage of seeds. These findings were similar with Basavaraj *et al.*, (2008) [3], Manjunatha *et al.*, (2008) [13].

4.4 Seedling vigour index

The decrease in seedling vigour index may be due to declined germination and seedling length. However, high seedling vigour index in polymer coat with combination of fungicide, bioagent and plant product is due to more germination, seedling length and dry weight. Similar findings were also reported with Sinta *et al.*, (2014) [14], Kamara *et al.*, (2014) [10].

4.5 Protein content

The reduction in the protein content may be attributed to oxidation of the amino acids, due to increase in the respiratory activity as a result of deterioration process of the stored seeds. These findings were similar with Veraja *et al.*, (2015) [15].

4.6 Carbohydrate content

The pattern of reduction in carbohydrate content over storage period may be due to the depletion of starch reserves, infestation of pests, fluctuating storage conditions of the

seeds. These findings were similar with Kamara *et al.*, (2014)^[10], Akter *et al.*, (2014).

5. Conclusion

Seed treatment T₇ (ferrous sulphate + mancozeb + polymer coat + neem oil + trichoderma) was found effective for improving the germination per cent, seedling length, seedling vigour- I, protein and carbohydrate content. T₄ (neem oil) recorded highest seedling dry weight. Seeds stored in plastic container (P1) was very effective for extending the seed longevity and maintaining the storability than the cloth bag (P2) over a storage period of six months.

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