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Effect of Polymer Coating, Chemicals and Biocontrol Agent on Storability of Black Gram (*Vigna mungo* L.)

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Authors' contributions

This work was carried out by author PV under the guidance of her advisor author PKR and author PKR has designed and managed the analyses of the study. Author PKR also approved the final manuscript. Both authors read and approved the final manuscript.

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ABSTRACT

The present storage experiment was conducted at Seed Testing Laboratory, Department of Genetics and Plant Breeding, Sam Higginbottom Institute of Agriculture, Technology & Sciences (SHIATS), Allahabad, Uttar Pradesh during 2014 - 2015 with black gram cv. T-9 obtained from Department of Genetics and Plant Breeding, SHIATS. The seeds were coated with polymer in combination with fungicide (thiram 3 g/kg seed), insecticide (imidacloprid @ 2.5 ml/kg seed), bioagent (*Trichoderma viride* @ 10 g/kg seed) and maintained untreated seeds (control) where T_1 is polymer coat alone, T_2 is polymer + thiram, T_3 is polymer + imidacloprid, T_4 is polymer + thiram + imidacloprid, T_5 is polymer + thiram + imidacloprid + *Trichoderma viride* and T_6 is control. Treated seeds were packed in cloth bag and polythene bag (700 gauge) (factor C_1 and C_2) at ambient conditions for assessment of seed germination, seedling length, seedling dry matter, seedling vigour indices, moisture content, total fungal colonies and protein content where data was subjected to factorial experiment laid out in completely randomized design. Germination percentage, root length, shoot length, seedling length, seedling dry weight, seedling vigour indices

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and protein content were high in T_5C_2 as compared to all other treatments. However, total fungal colonies and moisture content were less in T_5C_2.

Keywords: Germination; imidacloprid; polythene bag; thiram; T. viride.

1. INTRODUCTION

Black gram (*Vigna mungo* L.) belongs to family fabaceae. It is a self pollinated crop with chromosome number (2n= 2x= 22) grown in tropical and sub-tropical regions of the world. It is believed to be a native of India [1]. Black gram is also known as *urd bean, urd dal, mash*, black maple. India is world's largest producer of pulses with its total pulse production contributing a quarter of world's total production. In India, black gram is with an area of about 30 lakh ha with a total production of 15.1 lakh tons with an average productivity of 530.00 kg/ha [2]. Its seeds are highly nutritious with protein (26%), carbohydrates (60%), fat (1.5%), minerals, amino acids and vitamins. It has unique characteristics of maintaining and restoring soil fertility through fixing atmospheric nitrogen in symbiotic association with *Rhizobium* bacteria present in the root nodules. As seed is an efficient media for survival and dissemination of pathogens, in order to reduce the losses due to these pathogens and preserve viability, it is advisable to treat the seeds with fungicides without significant reduction in quality. One of the major constraints in black gram production is the non availability of quality seeds at the time of planting. Film coating is a plasticizer polymer which forms a flexible film that adheres, protects fungicide and insecticide and also provides a barrier to external hazards. It improves plant stand and emergence of seeds, accurate application of the chemicals reducing chemical wastage. [3] found that bean seeds coated with the polymer and fungicide recorded higher germination (89.00%) compared to control (75.00%) after two months of storage. [4] observed that polymer coated seeds deteriorated at a slower rate compared with the control and revealed high germination percentage over the control. Biocontrol agents protect seeds and seedlings from various pathogens. [5] reported among the biocontrol agents tested, *Trichoderma* isolate and *T. viride* were found to be significantly effective in reducing the seed borne fungi of cluster bean. Hence, this study assessed the effect of bioagents, chemical and polymer seed coating on storage of black gram seeds.

2. MATERIALS AND METHODS

The black gram cv. T-9 seeds obtained from Department of Genetics and Plant Breeding, SHIATS were coated with polymer in combination with fungicide (thiram @ 3 g/kg seed), insecticide (imidacloprid @ 2.5 ml/kg seed), bioagent (*Trichoderma viride* @ 10 g/kg seed) and maintained untreated seeds (control) where T_1 is polymer coat alone, T_2 is polymer + thiram, T_3 is polymer + imidacloprid, T_4 is polymer + thiram + imidacloprid, T_5 is polymer + thiram + imidacloprid + *Trichoderma viride* and T_6 is control. Treated seeds were packed in cloth bag and polythene bag (700 gauge) (factor C_1 and C_2) for assessment of seed germination, seedling length, seedling dry matter, seedling vigour indices, moisture content, total fungal colonies and protein content where data was subjected to factorial experiment laid out in completely randomized design. After imposition of seed treatments, the treated seeds were packed in cloth bag and polythene bag and stored under ambient conditions of 27℃ temperature and 73% relative humidity at Seed Testing Laboratory, Department of Genetics and Plant Breeding, Sam Higginbottom Institute of Agriculture, Technology & Sciences, Allahabad, Uttar Pradesh for six months i.e. from July 2014 to January 2015. The seed samples drawn at bimonthly intervals were evaluated for various seed quality attributes in order to determine the suitable treatment for better storage.

Standard germination test was conducted in the laboratory as per ISTA [6] by formula:

$$\text{Germination percentage} = \frac{\text{Number of seeds germinated}}{\text{Total number of seeds}} \times 100$$

The ten normal seedlings which were selected for measuring seedling length were kept in a butter paper and dried in a hot air oven at 103℃ temperature for 24 hr later allowed to cool for 30 minutes and the dry weight was recorded and expressed in grams as per [7].

Seedling vigour index was calculated using the formula given by [8].

SVI = Seedling length (cm) × Germination percentage (%)

Moisture content of seed was determined as per [9].

$$\text{Moisture content} = \frac{W_2 - W_3}{W_2 - W_1} \times 100$$

Where,

W_1 - Weight of the empty container with its cover (g)
W_2 - Weight of container its cover and ground seeds before drying (g)
W_3 - Weight of container its cover and ground seeds after drying (g)

Total fungal colonies were known by blotter method as suggested by (10) and expressed in percentage. Protein content was estimated from black gram seed by using Lowry's method [11].

3. RESULTS

3.1 Germination Percentage

Among the seed treatments, T_5 followed by T_4 recorded significantly higher germination over other seed treatments after six months of storage. Treatment T_4C_2 was effective for maintaining the germination (92%) over T_6C_1 (74.5%) (Table 3.1).

3.2 Seedling Length

Significant differences in seedling length were observed in seed treatments and storage containers (Table 3.2). However, the interaction between seed treatments and containers was found non - significant at two months of seed storage. At the end of six months of storage period, the highest seedling length was recorded in T_5 (20.50 cm) followed by T_4 (18.63 cm), T_3 (17.25 cm), T_2 (16.13 cm), T_1 (14.50 cm) and the lowest shoot length was recorded in T_6 (12.25 cm). At the end of six months of seed storage period, higher seedling length was recorded in seed stored in polythene bag (22.00 cm) as compared to cloth bag which recorded lower seedling length (11.50 cm).

3.3 Seedling Dry Weight

Significant differences in seedling dry weight were observed in seed treatments and storage containers (Table 3.3). At the end of six months of seed storage period, T_5 (0.30 g) recorded highest seedling dry weight followed by T_1 (0.29 g), T_4 (0.28 g), T_2 (0.26 g), T_3 (0.25 g) and the lowest seedling dry weight was recorded in T_6 (0.21 g). The seedling dry weight differed significantly due to container during the storage period. T_5C_2 recorded the maximum seedling dry weight (0.36 g) over T_6C_1 bag which showed minimum seedling dry weight (0.15 g).

3.4 Seedling Vigour Index

Seedling vigour index gradually decreased with period of seed storage in all the treatments and storage containers (Table 3.4). Seeds stored in polythene bag showed higher seedling vigour index than cloth bag in all the treatments especially in polymer + thiram + imidacloprid + *T. viride*. At the end of six months period of seed storage, T_5C_2 recorded maximum SVI (1980.00) while T_6C_1 had minimum SVI (855.75).

3.5 Seed Moisture Content

At the end of six months of storage period, the lowest moisture content was recorded in T_5 (10.47%) followed by T_4 (11.38%), T_3 (11.64%), T_2 (11.82%), T_1 (12.26%) and the highest moisture content was recorded in T_6 (12.62%). The moisture content differed significantly due to container and seed treatments during the storage period (Table 3.5). The results of the present study revealed that the moisture content of the seeds increased with increase in period of storage. It ranged from 9.02% at the time of storage to 13.67% (T_6C_1) at six months after storage.

3.6 Total Fungal Colonies

The increase in total number of fungal colonies over initial storage to six months was high in cloth bag (5.36%) as compared to polythene bag (4.86%) seed storage. Seed treatments especially T_5 recorded lesser number of fungal colonies followed by T_4 as compared to during all the period of seed storage (Table 3.6). Treated seed stored in polythene bag had less number of fungal colonies as compared to untreated seed stored in cloth bag. At the end of six months period of storage, T_5C_2 showed minimum number of fungal colonies (5.75%) and T_6C_1 showed maximum number of fungal colonies (10.13%).

3.7 Protein Content

The decline in seed protein content over initial seed storage period was high in cloth bag

(4.57%) as compared to polythene bag (3.15%) storage (Table 3.7). At the end of six months period of seed storage, the seed treatments, T_5 (22.92%) recorded higher protein content and it was on par with T_4 (22.24%) followed by T_2 (21.83%) and T_3 (21.41%) over T_6 (19.72%). At the end of six months of storage period, T_5C_2 (21.99%) was effective for increasing the protein content over T_6C_1 (20.66%).

4. DISCUSSION

4.1 Germination Percentage

The decline in seed germination percentage over the storage period may be attributed to ageing effect leading to depletion of food reserves, decline in synthetic activity of embryo, fluctuating temperature, relative humidity and seed moisture content as influenced by storage containers. Coating of seeds with polymer, insecticides and fungicides might have protected the seed from influence of above factors resulting in maintenance of seed viability for a comparatively longer period. The similar findings are in agreement with the results obtained by [12] and [13].

4.2 Seedling Length

The decline in seedling length at the end of the storage period might be attributed to age induced decline in seed germination as well as damage caused by fungi, insects and toxic metabolites which might have hindered the seedling growth. Similar findings were also reported by [14] in mungbean [15,16].

Table 3.1. Effect of seed treatments and containers on germination percentage

Treatments	Initial	2 months			4 months			6 months		
		C_1	C_2		C_1	C_2		C_1	C_2	
T_1	90.00	87.75	89.00		84.75	87.50		79.75	81.25	
T_2	90.75	89.00	89.75		87.00	88.25		81.00	84.25	
T_3	91.00	88.50	88.75		86.75	87.75		80.00	82.75	
T_4	92.50	90.50	91.00		87.50	89.50		81.00	92.00	
T_5	94.00	92.75	93.50		91.25	92.50		86.00	91.00	
T_6	89.50	85.50	88.00		83.25	86.50		74.50	80.75	
		2 months			4 months			6 months		
		T	C	T × C	T	C	T × C	T	C	T × C
SEm±		0.04	0.02	0.05	0.02	0.01	0.03	0.13	0.07	0.18
CD at 5%		0.10	NS	NS	0.06	0.03	NS	0.36	0.21	0.51

Where T_1 : Polymer coating alone, T_2 : Polymer + thiram @ 3g kg^{-1} of seed, T_3 : Polymer + imidacloprid @ 2.5ml kg^{-1} of seed, T_4 : Polymer + thiram @ 3g kg^{-1} + imidacloprid @ 2.5ml kg^{-1}, T_5 : Polymer + thiram @ 3g kg^{-1} + imidacloprid @ 2.5ml kg^{-1} + T. viride @ 10g kg^{-1}, T_6 : Untreated control, C_1 : Cloth bag, C_2 : Polythene bag (700 guage), SEm : Standard error of mean, CD : Critical difference, NS: Non significant

Table 3.2. Effect of seed treatments and containers of seedling length (cm)

Treatments	Initial	2 months			4 months			6 months		
		C_1	C_2		C_1	C_2		C_1	C_2	
T_1	9.16	8.66	9.00		8.00	8.66		5.50	12.50	
T_2	11.66	11.26	11.50		10.33	10.83		7.00	15.00	
T_3	11.50	10.23	10.63		10.00	10.16		8.00	16.50	
T_4	10.76	9.40	9.66		9.00	10.00		9.00	18.00	
T_5	12.40	12.03	12.25		11.66	12.16		9.00	19.00	
T_6	10.43	9.00	10.00		8.00	8.33		5.50	11.50	
		2 months			4 months			6 months		
		T	C	T × C	T	C	T × C	T	C	T × C
SEm±		0.03	0.02	0.04	0.02	0.01	0.03	0.04	0.02	0.06
CD at 5%		0.07	0.04	NS	0.07	0.04	0.09	0.12	0.07	0.17

Where T_1 : Polymer coating alone, T_2 : Polymer + thiram @ 3g kg^{-1} of seed, T_3 : Polymer + imidacloprid @ 2.5ml kg^{-1} of seed, T_4 : Polymer + thiram @ 3g kg^{-1} + imidacloprid @ 2.5ml kg^{-1}, T_5 : Polymer + thiram @ 3g kg^{-1} + imidacloprid @ 2.5ml kg^{-1} + T. viride @ 10g kg^{-1}, T_6 : Untreated control, C_1 : Cloth bag, C_2 : Polythene bag (700 guage), SEm : Standard error of mean, CD : Critical difference, NS: Non significant

Table 3.3. Effect of seed treatments and containers on seedling dry weight (g)

Treatments	Initial	2 months			4 months			6 months		
		C_1	C_2		C_1	C_2		C_1	C_2	
T_1	0.58	0.42	0.44		0.30	0.39		0.29	0.29	
T_2	0.58	0.48	0.50		0.36	0.40		0.25	0.28	
T_3	0.57	0.45	0.47		0.33	0.37		0.23	0.27	
T_4	0.55	0.42	0.52		0.30	0.42		0.22	0.34	
T_5	0.57	0.45	0.54		0.33	0.45		0.24	0.36	
T_6	0.58	0.38	0.49		0.36	0.39		0.15	0.28	
		2 months			4 months			6 months		
		T	C	T × C	T	C	T × C	T	C	T × C
SEm±		0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.01
CD at 5%		0.02	0.01	0.03	NS	0.02	NS	0.02	0.01	0.03

Where T_1 : Polymer coating alone, T_2 : Polymer + thiram @ 3g kg^{-1} of seed, T_3 : Polymer + imidacloprid @ 2.5ml kg^{-1} of seed, T_4 : Polymer + thiram @ 3g kg^{-1} + imidacloprid @ 2.5ml kg^{-1}, T_5 : Polymer + thiram @ 3g kg^{-1} + imidacloprid @ 2.5ml kg^{-1} + T. viride @ 10g kg^{-1}, T_6 : Untreated control, C_1 : Cloth bag, C_2 : Polythene bag (700 guage), SEm : Standard error of mean, CD : Critical difference, NS: Non significant

Table 3.4. Effect of seed treatments and containers on seedling vigour index

Treatments	Initial	2 months			4 months			6 months		
		C_1	C_2		C_1	C_2		C_1	C_2	
T_1	1855.80	1646.61	1705.66		1497.01	1633.11		780.00	1340.69	
T_2	2110.84	2017.39	2065.12		1377.66	1882.60		1215.00	1453.31	
T_3	2098.46	1905.61	1966.43		1773.25	7833.78		1320.00	1489.50	
T_4	2080.32	1913.25	1963.06		1662.50	1894.29		1475.63	1732.25	
T_5	2315.22	2233.65	2277.39		2098.75	2204.53		1651.13	1980.00	
T_6	1819.53	1530.00	1698.78		1318.05	1521.51		855.75	1049.69	
		2 months			4 months			6 months		
		T	C	T × C	T	C	T × C	T	C	T × C
SEm±		0.02	0.16	0.39	2.10	1.21	2.97	1.64	0.95	2.32
CD at 5%		0.78	0.45	NS	5.93	3.42	8.39	4.64	2.68	6.57

Where T_1 : Polymer coating alone, T_2 : Polymer + thiram @ 3g kg^{-1} of seed, T_3 : Polymer + imidacloprid @ 2.5ml kg^{-1} of seed, T_4 : Polymer + thiram @ 3g kg^{-1} + imidacloprid @ 2.5ml kg^{-1}, T_5 : Polymer + thiram @ 3g kg^{-1} + imidacloprid @ 2.5ml kg^{-1} + T. viride @ 10g kg^{-1}, T_6 : Untreated control, C_1 : Cloth bag, C_2 : Polythene bag (700 guage), SEm : Standard error of mean, CD : Critical difference, NS: Non significant

Table 3.5. Effect of seed treatments and containers on seed moisture content (%)

Treatments	Initial	2 months			4 months			6 months		
		C_1	C_2		C_1	C_2		C_1	C_2	
T_1	9.02	10.62	9.54		12.01	1.80		12.73	11.80	
T_2	9.02	10.17	9.43		11.30	10.88		11.90	11.74	
T_3	9.03	10.61	9.34		12.23	10.36		11.74	11.55	
T_4	9.03	10.70	9.52		12.24	11.08		11.88	10.88	
T_5	9.02	9.95	9.25		10.10	9.38		11.56	9.38	
T_6	9.04	10.93	11.15		12.20	11.31		13.67	11.58	
		2 months			4 months			6 months		
		T	C	T × C	T	C	T × C	T	C	T × C
SEm±		0.12	0.07	0.17	0.10	0.06	0.14	0.07	0.04	0.10
CD at 5%		NS	NS	NS	NS	NS	NS	0.20	0.11	0.28

Where T_1 : Polymer coating alone, T_2 : Polymer + thiram @ 3g kg^{-1} of seed, T_3 : Polymer + imidacloprid @ 2.5ml kg^{-1} of seed, T_4 : Polymer + thiram @ 3g kg^{-1} + imidacloprid @ 2.5ml kg^{-1}, T_5 : Polymer + thiram @ 3g kg^{-1} + imidacloprid @ 2.5ml kg^{-1} + T. viride @ 10g kg^{-1}, T_6 : Untreated control, C_1 : Cloth bag, C_2 : Polythene bag (700 guage), SEm : Standard error of mean, CD : Critical difference, NS: Non significant

Table 3.6. Effect of seed treatments and containers on total fungal colonies (%)

Treatments	Initial	2 months			4 months			6 months		
		C_1	C_2		C_1	C_2		C_1	C_2	
T_1	9.02	10.62	9.54		12.01	1.80		12.73	11.80	
T_2	9.02	10.17	9.43		11.30	10.88		11.90	11.74	
T_3	9.03	10.61	9.34		12.23	10.36		11.74	11.55	
T_4	9.03	10.70	9.52		12.24	11.08		11.88	10.88	
T_5	9.02	9.95	9.25		10.10	9.38		11.56	9.38	
T_6	9.04	10.93	11.15		12.20	11.31		13.67	11.58	
		2 months			4 months			6 months		
		T	C	T × C	T	C	T × C	T	C	T × C
SEm±		0.12	0.07	0.17	0.10	0.06	0.14	0.07	0.04	0.10
CD at 5%		NS	NS	NS	NS	NS	NS	0.20	0.11	0.28

Where T_1 : Polymer coating alone, T_2 : Polymer + thiram @ 3g kg^{-1} of seed, T_3 : Polymer + imidacloprid @ 2.5ml kg^{-1} of seed, T_4 : Polymer + thiram @ 3g kg^{-1} + imidacloprid @ 2.5ml kg^{-1}, T_5 : Polymer + thiram @ 3g kg^{-1} + imidacloprid @ 2.5ml kg^{-1} + T. viride @ 10g kg^{-1}, T_6 : Untreated control, C_1 : Cloth bag, C_2 : Polythene bag (700 guage), SEm : Standard error of mean, CD : Critical difference, NS: Non significant

Table 3.7. Effect of seed treatments and containers on protein content (%)

Treatments	Initial	2 months			4 months			6 months		
		C_1	C_2		C_1	C_2		C_1	C_2	
T_1	25.10	23.33	24.14		21.02	22.83		18.55	21.10	
T_2	25.18	24.24	24.43		23.02	23.63		21.33	22.33	
T_3	25.18	24.18	24.22		22.77	23.24		21.07	21.75	
T_4	25.15	24.32	24.88		23.33	23.68		21.82	22.66	
T_5	25.18	24.79	24.50		23.78	24.30		22.57	23.27	
T_6	25.10	23.14	24.10		21.15	22.65		18.61	20.82	
		2 months			4 months			6 months		
		T	C	T × C	T	C	T × C	T	C	T × C
SEm±		0.01	0.00	0.01	0.01	0.01	0.02	0.01	0.00	0.01
CD at 5%		0.02	0.01	0.03	0.03	0.02	0.04	0.02	0.01	0.03

Where T_1 : Polymer coating alone, T_2 : Polymer + thiram @ 3g kg^{-1} of seed, T_3 : Polymer + imidacloprid @ 2.5ml kg^{-1} of seed, T_4 : Polymer + thiram @ 3g kg^{-1} + imidacloprid @ 2.5ml kg^{-1}, T_5 : Polymer + thiram @ 3g kg^{-1} + imidacloprid @ 2.5ml kg^{-1} + T. viride @ 10g kg^{-1}, T_6 : Untreated control, C_1 : Cloth bag, C_2 : Polythene bag (700 guage), SEm : Standard error of mean, CD : Critical difference, NS: Non significant

4.3 Seedling Dry weight

The seedling dry weight due to seed coating polymer and additives varied significantly during the storage period. However, seeds treated with polymer, fungicide, insecticide and bioagent showed higher seedling dry weight due to advantage of polymer seed coating. It indicates that there is a positive effect of seed coating polymer which could be effective for better storage of seeds. These results are in conformity with findings of [14] in mungbean and [17].

4.4 Seedling Vigour Index

The decrease in the seed vigour index may be due to age induced decline in germination, decrease in root and shoot length and seedling dry weight and higher electrical conductivity. Higher seed vigour index in polymer coating along with fungicide and insecticides is due to more germination, root and shoot length, seedling dry weight, lesser infection by storage fungi and very low infestation of insects. Similar findings were reported by [18,13,12,19,16].

4.5 Seed Moisture Content

The results revealed that the moisture content of the seeds increased with increase in period of storage. It ranged from 9.00% at the time of storage to 13.67% at six months after storage. Increase in seed moisture might be due to metabolic release of water during respiration and the hygroscopic nature of seed. Similar results were recorded by [20,21,15].

4.6 Total Fungal Colonies

The per cent total fungal colonies gradually increased with the period of seed storage in different seed treatments and containers. Irrespective of containers, seeds treated with polymer, thiram, imidacloprid and *T. viride* (T_5)

exerted a significant influence on total fungal colonies of the black gram seeds when stored for a period of six months. This might be due to inhibition of seed borne pathogens and thus preventing seed deterioration and loss of membrane integrity. Similar findings were reported by researchers [22-24] in mungbean.

4.7 Protein Content

The pattern of reduction in the protein content may be related to oxidation of the amino acids, due to increase in the respiratory activity and advance in the deterioration process of the stored seeds. The decline in protein content over the storage period may be attributed to ageing effect and because of fungal invasion, insect attack, fluctuating temperature, relative humidity, increase in moisture content, and storage containers. Similar results were observed by [25] and [21].

5. CONCLUSION

Combined seed treatment with polymer + fungicide + insecticide + bioagent (T_5) found effective for improving germination, seedling length, seedling dry weight, seedling vigour index and it is also found effective in controlling the seed mycoflora during storage conditions. Seeds stored in polythene bag (700 gauge) was effective for extending the seed longevity and maintaining the storability than the cloth bag over a period of six months.

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COMPETING INTERESTS

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REFERENCES

1. Zukovskiji PM. Cultivated plants and their wild relatives. Commonwealth Agriculture Bureau, London; 1962.
2. Anonymous. Ministry of Agriculture, Government of India; 2014.
   Available:http://www.commoditiescontrol.com/eagritrader/staticpages/index.php?id=37
3. Larissa LP, Cladio B, Jefferson LSC. Storage of dry bean seeds coated with polymer and treated with fungicides. Pesqagropee Brasilia. 2004;39(7):2-10.
4. Kumar J, Nisar K, Kumar MBA, Walia S, Shakil NA, Prasad R, Parmer BS. Development of polymeric seed coats for seed quality enhancement of soybean (*Glycine max*). Indian Journal of Agriculture Science. 2007;77(11):738-43.
5. Shivanna MB, Shetty MB. Effect of selected biochemical agents and their combination with fungicides on the mycoflora and quality of seeds in cluster bean. Journal of Biological Control. 1989; 3:113-116.
6. Anonymous. International rules for seed testing. Seed Science and Technology. 2007;29(Supplement):1-348.
7. ISTA. International rules for seed testing. Seed Science and Technology 1985; 13:299-355.
8. Abdul Baki AA, Anderson JD. Vigour deterioration in soybean by multiple criteria. Crop Science. 1973;13:630-633.
9. ISTA. International rules for seed testing, rules. Seed Science and Technology. 1996;24(supplement).
10. Ellis MB. Dematiaceous Hyphomycetes. Commonwealth Mycological Institute. Kew, Surrey, England. 1971:608.
11. Lowry OH, Roesbrough NJ, Farr A, Randall RJ. Protein measurement with the folin phenol reagent. Journal of Biological Chemistry. 1951;193:265-275.
12. Verma O, Verma RS. Effect of seed coating material and storage containers on germination and seedling vigour of soybean (*Glycine max* L.). SAARC Journal of Agriculture. 2014;12(2):16-24.
13. Almeida ADS, Deuner C, Borges CT, Jauer A, Meneghello GE, Tunes LM, Villela FA and Zimmer PD. Physiological performance of rice seeds treated to thiamethoxam and placed under storage. American Journal of Plant Science. 2014;5:3788.
14. Paul SR, Sharma NN, Sarma D, Borah RK, Nath PD. Maintenance of viability and vigour of stored mungbean seeds under

the ambient conditions in the hills zone of Assam. Annals of Agricultural Research. 1996;17(2):196-198.
15. Monira US, Amin MHA, Aktar MM and Mamun MAA. Effect of containers on seed quality of storage soybean seed. Bangladesh Research Publications Journal. 2012;7(4):421-427.
16. Kaushik SK, Rai AK, Singh V. Seed quality of maize with polymer film coating in storage. International Journal of Innovative Research Science, Engineering and Technology. 2014;3(7):14353-14358.
17. Patil NKB, Shekhargouda M. Seed storage studies in rice hybrid. Karnataka Journal of Agriculture Science. 2007;20(3):618-621.
18. Oyekale KO, Nwangburuka CC, Denton OA, Daramola DS, Adeyeye JA, Akinkuotu AO. Comparative effects of organic and inorganic seed treatments on the viability and vigour of sesame seeds in storage. Journal of Agricultural Science. 2012;4(9):2012.
19. Gomathi G, Malarkodi K and Ananthi M. Pre-sowing seed management techniques on intial seed quality parameters in black gram Cv. ADT 3. International Journal of Scientific Research. 2014;3(1):13-14.
20. Malimath SD, Merwade MN. Effect of storage containers on seed storability of garden pea (*Pisum sativum* L.). Karnataka Journal of Agriculture Science. 2007;20(2):384-385.
21. Chattha SH, Jamali LA, Ibupoto KA, Mangio HR. Effect of different packing materials and storage conditions on the viability of wheat seed (TD-1 variety). Science, Technology and Development. 2012;31(1):10-18.
22. Pawar K, Mishra SP, Singh RK. Efficacy of bioagents and fungicides against seed borne fungi of soybean. Annals of Plant and Soil Research. 2015;17(1):77-81.
23. Gholve VM, Tatikundalwar VR, Suryawanshi AP, Dey U. Effect of fungicides, plant extracts/botanicals and bioagents against damping off in brinjal. African Journal of Microbiology Research. 2014;8(30):2835-2848.
24. Singh S, Sinha A, Mishra J. Evaluation of different treatment on the occurrences of seed borne fungi of mungbean (*Vigna radiata* L.) Wilczek seed. African Journal of Agricultural Research. 2014;9(44):3300-3304.
25. Sharma S, Kaur A, Bansal A, Gill BS. Positional effects on soybean seed composition during storage. Journal of Food Science and Technology. 2013; 50(2):353-359.

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