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Research paper

Exploring the relationship between organic seed treatments and storage period on seed quality of mungbean (*Vigna radiata* L.)

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ABSTRACT

The present investigation was undertaken on mungbean cv. MH 318 and MH 421 to evaluate the effect of organic seed treatments with botanical seed treatments, viz., *Trachyspermum ammi*, *Azadirachta indica*, *Dalbergia sissoo*, *Murraya koenigii*, *Ocimum tenuiflorum*, *Ocimum canum*, *Curcuma longa* rhizome and leaf powder, woodash, and *Ocimum basillicum* leaf powder and storage period on seed quality parameters. The fresh seeds were treated with the above-mentioned botanical powders and stored in polythene bags under ambient conditions for 18 months. The seed quality parameters were recorded just after treatment, 6, 12, and 18 months after treatment during storage. The results revealed that the six-month-old seeds of both varieties performed better in terms of seed quality parameters, i.e., germination, speed of germination, vigour index, emergence index, and seedling establishment, as compared to freshly treated seeds. With the extension of the storage duration, a steady decline in quality metrics was seen after 6 months of storage. Seed coating with turmeric rhizome powder enhanced and retained the seed quality after a storage period of 18 months.

Key words: Germination, Emergence index, Seed quality, Storage period, Vigour index.

INTRODUCTION

Mungbean (*Vigna radiata* L.) also known as mungbean belongs to family Leguminosae. It is one of the most prominent pulse crop and is grown extensively for its protein-rich edible seeds, fodder value, and as a green manure crop. It contributes significantly to human nutrition as a source of protein and enhances soil fertility by fixing atmospheric nitrogen in cooperation with *Rhizobium* bacteria present in root nodules (Ashraf and Shanbaz, 2003). India is the leading country in the production of mungbean with around 55% of the world's total area and 45% of the world's total production.

Seed is a vital input, as the yield potential of any crop depends on quality seed. To prevent quantitative and qualitative losses due to several biotic and abiotic factors during storage, various methods are being used, such as seed treatments with suitable chemicals or plant products as well as safe containers for seed storage (Abdul Baki and Anderson, 1973). The storage condition is one of the most important factor in maintaining the higher physiological quality of the seed lot during the period between harvesting and sowing (Bonner, 2008). Many of the synthetic chemicals look effective, but they are not readily degradable physically or biologically, which results in more harmful effects such as health hazards, residual toxicity, widespread environmental hazards, and increased cost of application. Therefore, there is a need for effective, environmentally friendly, and economical alternatives.

Organic seed treatments provide economical and relatively non-polluting delivery systems as compared to other field application systems (Taylor and Harman, 1990). Nowadays, consumers expect organic food to have good nutritional value and be free of chemical residues (Ditlevsen *et al.*, 2019). Therefore, organic seed treatment has been considered one of the least expensive, safest, and most effective means of maintaining seed quality during storage. Thus, keeping in view the above-stated facts, the present study was carried out to evaluate the effect of organic seed treatments and storage periods on seed quality parameters of mungbean.

MATERIALS AND METHODS

The present study was carried out at the laboratory and research farm of the Department of Seed Science and Technology, Chaudhary Charan Singh Haryana Agricultural University, Hisar during 2017-2019 to evaluate the effect of organic seed treatments and storage period on physiological parameters of mungbean. The experiment was laid out in randomized block design for the parameters recorded in the field and factorial complete randomized design for the parameters recorded in the laboratory, consisting of twelve treatments with three replications. The treatments were: T_0 - Control; T_1 - Gum coated: T_2 - *Trachyspermum ammi*; T_3 - *Azadirachta indica*; T_4 - *Dalbergia sissoo*; T_5 -*Murraya koenigii*; T_6 - *Ocimum tenuiflorum*; T_7 - *Ocimum canum*; T_8 - *Curcuma longa* rhizome; T_9 - *Curcuma longa* leaf powder, T_{10} - woodash; T_{11} - *Ocimum basillicum* leaf powder @ 10 g 100 g^{-1} of seed and 2 ml of Gum.

Seed treatment procedure:-

Seed (100 g)
↓
Adhesive (2 ml of Gum)
↓
Botanicals leaf powders (10 g)

The freshly harvested seeds of mungbean varieties *viz*., MH 318 and MH 421 were treated with the above mentioned botanical powders, and the seeds were stored in zip locked polythene bags of 700 gauge under ambient conditions for 18 months. Initial observations for the following seed quality parameters were recorded just after the treatment as well as after 6 months, 12 months, and 18 months of ambient storage. The observations recorded were as follows:

Test weight (g) - Randomly 1000 seeds replicated thrice were counted from each treatment in each replication. The seeds were weighed and averaged.

Standard germination (%) – Three replications each of 100 seeds in every treatment were placed between two layers of moist towel paper and kept at 25°C in the seed germinator. The seedlings were evaluated on the day of final count (8^{th} day) and normal seedlings were taken for standard germination as per rules of (ISTA, 2011).

Speed of germination - The seeds were germinated on top of paper medium with three replications of 100 seeds each in every treatment. The number of seeds germinated were recorded daily up to the day of final count. Speed of germination was calculated by taking the observations of newly radicle emergence on daily basis. It is calculated by formula as cited by Maguire (1962) given below:

$$\text{Speed of germination} = \frac{n_1}{d_1} + \frac{n_2}{d_2} \dots + \frac{n_n}{d_n}$$

n = number of newly emerged radicle on respective day

d = days after sowing upto the emergence of the radicle

Seedling length (cm) and seedling dry weight (mg) - Thirty normal seedlings from each replication were selected randomly to measure root and shoot length to get the average seedling length in centimetre. After measuring the seedling length, seedlings were dried in hot air oven for 72 hours at 80±1°C. The dried seedlings of each replication were weighed and the dry weight of single seedlings was calculated by taking the average for each.

Vigour indices were calculated by using the following formula suggested by Abdul-Baki and Anderson, (1973).

Electrical conductivity - After washing, 50 healthy and uninjured seeds in three replications of each treatment were soaked in 75 ml of distilled water. The beakers were covered with foil and then kept in an incubator for 24 hours at 25°C. Using a direct reading in conductivity meter (Digital Conductivity Meter (VSI-04ATC), the electrical conductivity of the leachates was recorded and expressed as $\mu Scm^{-1}g^{-1}$.

Insect damage (%) - Five adult pairs (male and female) of the pulse beetle (*Callosobruchus chinensis*) were infested with three replications of 200 seeds from each treatment. Following a 15-days inoculation period, the total number of injured seeds was counted, and the damage percentage was computed for each treatment.

Emergence index – The 100 seeds of each treatment in replications of three were sown at uniform depth in the trays filled with wet soil at various intervals *i.e.* (Fresh, 6 months, 12 months, and 18 months) during storage. The number of seedlings emerged daily were counted up to stable emergence and field emergence index was estimated by the formula:

$$\frac{\text{No. of seedlings emerged}}{1^{st}\text{ day of sowing}} + \dots + \frac{\text{No. of seedlings emerged}}{\text{Day of last count}}$$

Mean emergence time - All the newly emerged seeds were recorded on daily basis from 3rd day to 15th day after sowing in each replication. The mean emergence time was calculated by using the formula as described by Roberts and Ellis (1977).

Statistical analysis

The factorial RBD was used for the parameters recorded in the field and factorial CRD for the parameters recorded in the laboratory. The final data obtained was subjected to the analysis as per the standard statistical method given by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Organic seed coating significantly enhanced the test weight of both the mungbean varieties *i.e.* MH 318 and MH 421. Test weight of both the varieties (Table 1) at the end of 18 months storage, was recorded maximum in seed treated with wood ash powder (42.40 g). It might be due to the adherence attributes of gum and leaf powders which create a physical coating on the seed surface that increases the seed weight.

Significant effect of organic seed coating on germination (Table 2) was found in both the varieties *i.e.* MH 318 and MH 421. The germination percentage just after the treatment was observed highest in seed treated with turmeric rhizome powder in MH 318 (88.00%) at par with sheesham leaf powder (87.00%) and the maximum germination of MH 421 was observed in turmeric rhizome powder (76.67%) which was at par with curry leaf powder (76.00%), where as it was minimum in the seeds coated with gum (83.00% and 64.00%) as compared to control (83.33% and 66.00%) in both the varieties. The standard germination showed the significant difference in the interaction of varieties, storage periods and treatments at all the level. It might be due to the component found in turmeric roots, *viz.*, volatile oil, containing turmerone, and there are other colouring agents called curcuminoids in turmeric, which are considered to be natural antioxidants (Ruby *et al.*, 1995; Selvam *et al.*, 1995).

The freshly harvested mungbean seeds showed lower germination in both the varieties MH 318 and

Table 1. Overall mean performance for various seed quality parameters in mungbean during storage

Factors	1	2	3	4	5	6	7	8	9	10	11	12
Varieties (V)												
MH 318	42.07	84.60	86.54	43.05	17.70	3645	1492	547.75	22.82	16.95	4.79	66.20
MH 421	41.17	78.25	80.89	39.51	18.47	3104	1451	565.77	23.41	15.00	4.79	56.05
CD (p=0.05)	0.192	0.13	0.72	0.44	0.13	15.9	9.91	4.01	0.16	0.16	0.05	0.15
Storage period (P)												
0 (fresh)	42.88	77.52	86.54	38.63	17.18	3017	1332	315.63	21.42	16.61	4.32	61.57
6 months old	41.80	84.79	87.93	44.63	18.92	3789	1603	428.71	22.23	16.99	4.08	64.65
12 months old	41.12	82.46	82.67	41.20	18.34	3399	1509	646.21	23.52	15.62	5.08	60.24
18 months old	40.71	80.59	77.72	40.68	17.89	3295	1445	843.54	25.30	14.69	5.67	58.04
CD (p=0.05)	0.271	0.18	1.0	0.62	0.18	22.48	14.02	5.67	0.22	0.23	0.07	0.22
Treatments (T)												
Control	39.91	78.46	78.21	39.94	17.03	3,146	1,339	665.00	30.88	14.32	5.22	56.96
Gum	41.55	77.63	82.35	40.30	16.92	3,145	1,316	663.63	33.82	13.75	5.28	56.09
Ajwain leaf powder	41.63	82.00	86.30	42.13	18.80	3,465	1,541	482.88	21.38	17.63	4.52	59.46
Neem leaf powder	41.55	80.34	79.29	40.53	18.16	3,271	1,459	618.13	15.57	15.62	4.95	59.05
Sheesham leaf powder	41.64	83.96	87.64	42.32	18.93	3,518	1,578	454.88	27.00	18.15	4.00	66.80
Curry leaf powder	42.00	83.55	84.59	41.13	17.36	3,475	1,465	492.13	22.13	15.69	4.95	60.42
Ram Tulsi leaf powder	42.00	82.63	85.64	42.45	19.11	3,514	1,555	542.00	24.75	15.77	4.91	65.21
Kali Tulsi leaf powder	41.74	81.71	86.18	41.93	18.66	3,431	1,524	559.75	19.19	16.40	4.60	61.08
Turmeric rhizome powder	42.07	84.83	87.06	41.25	18.35	3,528	1,554	440.50	21.25	18.85	4.35	64.42
Wood ash powder	42.40	80.59	81.28	41.63	18.31	3,375	1,474	581.75	23.75	14.75	5.09	58.13
Turmeric leaf powder	41.67	80.96	84.46	40.68	17.66	3,305	1,431	587.00	20.32	15.42	4.78	64.17
Marua leaf powder	41.38	80.50	81.63	41.14	17.77	3,324	1,431	598.50	17.38	15.38	4.81	61.75
CD (p=0.05)	0.46	0.32	1.7	1.0	0.31	38.94	24.29	9.82	0.38	0.41	0.12	0.38

1. Test weight (g), 2. Germination percentage, 3. Speed of germination, 4. Seedling length (cm), 5. Seedling dry weight (mg), 6. Vigour index-I, 7. Vigour index-II, 8. Electrical conductivity, 9. Insect damage (%), 10. Emergence index, 11. Mean emergence time, 12. Seedling establishment

Table 2. Impact of organic seed coating on germination percentage of mungbean during storage

Treatment	Variety(V)									
	MH 318					MH 421				
	Storage Period (P)									
	0 (Fresh)	6 Months	12 Months	18 Months	Mean	0 (Fresh)	6 Months	12 Months	18 Months	Mean
Control	83.33 (65.88)	84.00 (66.40)	82.67 (65.37)	80.67 (63.89)	82.67 (65.39)	66.00 (54.31)	80.00 (63.41)	76.33 (60.87)	74.67 (59.76)	74.25 (59.59)
Gum	83.00 (65.63)	83.67 (66.14)	82.00 (64.88)	80.00 (63.43)	82.17 (65.01)	64.00 (53.11)	79.33 (62.94)	75.33 (60.20)	73.67 (59.10)	73.08 (58.84)
Ajwain leaf powder	85.33 (67.46)	87.33 (69.13)	84.33 (66.66)	83.00 (65.63)	85.00 (67.22)	70.00 (56.77)	84.33 (60.60)	81.67 (64.62)	80.00 (63.41)	79.00 (62.87)
Neem leaf powder	84.00 (66.40)	85.33 (67.46)	84.33 (66.66)	82.00 (64.88)	83.92 (66.35)	68.00 (55.53)	82.00 (64.88)	79.33 (62.94)	77.67 (61.77)	76.75 (61.28)
Sheesham leaf powder	87.00 (68.85)	88.00 (69.72)	85.33 (67.46)	85.33 (66.46)	86.42 (68.37)	72.67 (58.46)	84.67 (66.92)	83.00 (65.63)	82.33 (65.12)	80.67 (64.03)
Curry leaf powder	86.67 (68.56)	88.33 (70.00)	86.33 (68.28)	83.67 (66.14)	86.25 (68.24)	76.00 (60.65)	85.33 (67.46)	83.67 (66.14)	81.67 (64.62)	81.67 (64.18)
Ram Tulsi leaf powder	85.33 (67.46)	87.67 (69.42)	84.33 (66.66)	83.33 (65.88)	85.17 (67.35)	72.00 (58.03)	85.33 (67.46)	82.33 (65.12)	80.67 (63.89)	80.08 (63.63)
Kali Tulsi leaf powder	84.67 (66.92)	86.67 (68.56)	84.00 (66.40)	82.67 (65.37)	84.50 (66.81)	69.67 (56.56)	85.00 (67.19)	81.33 (64.38)	79.67 (63.17)	78.92 (62.83)
Turmeric rhizome powder	88.00 (69.72)	88.67 (70.30)	86.67 (68.56)	86.00 (68.01)	87.33 (69.15)	76.67 (61.09)	85.67 (67.73)	84.33 (66.66)	82.67 (65.37)	82.33 (65.21)
Wood ash powder	83.33 (65.88)	86.00 (68.01)	83.67 (66.14)	82.67 (65.37)	83.92 (66.35)	68.33 (55.73)	82.00 (64.88)	80.00 (63.41)	78.67 (62.47)	77.25 (61.62)
Turmeric leaf powder	84.33 (66.66)	86.33 (68.28)	83.67 (66.14)	82.00 (64.88)	84.08 (66.49)	68.67 (55.94)	83.33 (65.88)	80.33 (63.65)	79.00 (62.70)	77.83 (62.04)
Marua leaf powder	84.00 (66.40)	85.33 (67.46)	84.00 (66.40)	82.00 (64.88)	83.83 (66.28)	69.33 (56.35)	80.67 (63.89)	80.00 (63.41)	78.67 (62.47)	77.17 (61.53)
Overall Mean	84.92 (67.15)	86.44 (68.41)	84.28 (66.63)	82.78 (65.48)	84.60 (66.92)	70.11 (56.88)	83.14 (65.77)	80.64 (63.92)	79.11 (62.82)	78.25 (62.35)
	V	**P**	**T**	**V×P**	**V×T**	**P×T**	**V×P×T**			
SEm±	0.05	0.07	0.12	0.09	0.16	0.23	0.32			
CD (p=0.05)	0.13	0.18	0.32	0.26	0.45	0.64	0.90			

*Gum used as an adhesive @ 2 ml/100g of seed
*Organic powder of various botanicals is used for seed coating @ 10g/100g of seed

MH 421 (84.92% and 70.11%) which was improved after 6 months of storage and achieved maximum germination (86.44% and 83.14%). It might be due to presence of hardseededness in fresh mungbean seed which resulted in slow metabolic rate and at 6 month age the hormones responsible for hardseededness might be settled down and it gave the best seed performance in quality parameters. The hardseededness is the phenomenon that shields seed from commencing the germination process by impeding the absorption of water, which restrains the seed's ability to germinate both at plant and the initial stages of planting and α-amylase activities also control the seed germination by regulating different seed physiological activities (Lamichaney *et al.*, 2018).

The effect of storage period was also found significant in both the varieties. The highest germination was retained by seed treated with turmeric rhizome powder after 18 months of storage in both the varieties MH 318 (86.00%) and MH 421 (82.67%) followed by sheesham leaf powder (85.33% and 82.33%, respectively) while the minimum germination was observed in gum coated seed of both varieties *viz.*, MH 318 (80.00%) and MH 421 (73.67%) as compared to control (80.67% and 74.67%). According to the interaction of all the factors *i.e.*, varieties, storage periods and treatments, the germination was found to be maximum (88.67%) in the seeds of mungbean variety MH 318 treated with turmeric rhizome powder stored for 6 months. Such beneficial effect of turmeric rhizome powder on germination of seeds was reported by Singh and Sharma (2016) in seeds of two bamboo species.

Significant highest improvement in speed of germination (Table 1) was found in seed treated with sheesham leaf powder (87.64) followed by turmeric rhizome powder (87.06) as compared to control (78.21). The speed of germination retained (77.72) after 18 months of storage in both the varieties. The improvement in speed of germination could be due to the various phytochemicals found in sheesham, like terpenoids, steroids, tannins, saponins, alkaloids phenols, trisaccharides, and oligosaccharides. The dried leaf extract has anti-acterial properties, isoflavone-O-glycoside, and pods have dalberginone, dalbergin, and methyl dalbergin (Rana *et al*., 2009).

Maximum improvement in seedling length (Table 1) was found in ram tulsi leaf powder (42.45 cm) which was at par with sheesham leaf powder (42.32 cm) as compared to control (39.94 cm). The freshly harvested mungbean seeds showed lower seedling length (38.63 cm) which was improved after 6 months of storage and achieved maximum seedling length (44.63 cm). The positive effect of ram tulsi seed treatment might be due to its antifungal, anti-stress, antioxidant, antibacterial, antiviral, antifungal, antipyretic, and hypolipidemic properties (Mohan *et al*., 2011). Maximum improvement in seedling dry weight (Table 1) was found in ram tulsi leaf powder (19.11 mg) which was at par with sheesham leaf powder (18.93 mg) as compared to control (17.03 mg). The results are supported by Verghese *et al.* (2018) in blackgram by using fenugreek seed powder, custard apple and moringa leaf powder. Significantly maximum improvement in vigour index-I (Table 1) was found in turmeric rhizome powder (3528) followed by sheesham leaf powder (3518) and minimum in gum coated seed (3145) as compared to control (3146). The similar type vigour improvement was noticed with botanicals by Hridiya *et al.* (2017) in soybean. The fresh seed of both varieties showed lower vigour index-I (3017) and maximum vigour index-I was recorded at 6 months old seed (3789) after which the vigour was continuously declining along with the storage period among all the treatments in both the genotypes.

The maximum improvement in vigour index-II (Table 1) was found in sheesham leaf powder (1578) followed by ram tulsi leaf powder (1555) and minimum in gum coated seed (1316) as compared to control (1339). The similar type vigour improvement was noticed with the use of botanicals by Savitri *et al.* (1994) in sorghum.

The significant variation in electrical conductivity (Table 1) of seed leachate due to seed treatment with botanicals were observed and the minimum mean electrical conductivity was recorded in turmeric rhizome powder (440.50) followed by sheesham leaf powder (454.88) as compared to control (665.00). The fresh seed of both varieties showed lower electrical conductivity (315.78) after which it increased continuously along with the storage period *viz.*, after 6 months old seed (428.71) and retained (843.54) after 18 months of storage. The gradually increase in electric conductivity along with storage period is supported by (Lamichaney *et al.,* 2019) in chickpea. As compared to control, seeds treated with botanical powder had decreased electrolyte release. The study was in accordance with Channabasangowda *et al.* (2008).

The organic seed coating significantly affected the insect activity during storage of mungbean seed. The mean maximum insect damage (Table 1) was recorded in gum coated seed (33.82%) and minimum was recorded in neem leaf powder (15.57%) as compared to control (30.88%). It may be due to the insect repellent properties possessed by the neem leaf powder (Singh *et al*., 2001; Misra, 2000). The results also supported by Channabasangowda *et al.* (2008) in soyabean by using sweet flag rhizome powder, and Patil *et al*. (2002) and Tripathy *et al*., (2001) in blackgram by using neem leaf powder. The insect infestation impacts the seed's physiological quality by hindering the embryo's ability to grow and develop during germination, leading to poor seedling emergence. The botanical treatment reduces the insect infestation, prevents losses in seed weight and improves seed physiological parameters subsequent to the treatment (Misra, 2000).

Maximum emergence index (Table 1) was found in turmeric rhizome powder (18.85) followed by sheesham leaf powder (18.15) and was minimum in gum coated seed (13.75) as compared to control (14.32). The evaluation of different period of storage resulted that maximum field emergence index was highest at 6 month aged seed among all the storage periods (16.99) after which the emergence index was continuously declining along with the storage period and retained (14.69) after 18 months of storage among all the treatments in both the genotypes.

The minimum mean germination time (Table 1) was found in sheesham leaf powder (4.00) followed by turmeric rhizome powder (4.35) and found maximum in gum coated seed (5.28) as compared to control (5.22).

Significant variation in seedling establishment was found and the maximum improvement in seedling establishment (Table 1) was noticed by sheesham leaf powder (66.80%) followed by ram tulsi leaf powder (65.21%), and minimum in gum coated seed (56.09%) as compared to control (56.96%). The evaluation of different storage period resulted that highest improvement in mean seedling establishment noticed after 6 months storage (64.65%), after which the mean seedling establishment declined continuously along with the storage period among all the treatments (Fig.1). The presence of antioxidant components with high oxygen radical absorbance capacity that help in scavenging free radicals may be the cause of the improved performance of mungbean treated with botanicals (Hinnenberg *et al*., 2006; Mohan *et al*., 2011; Finkelman *et al*., 1990).

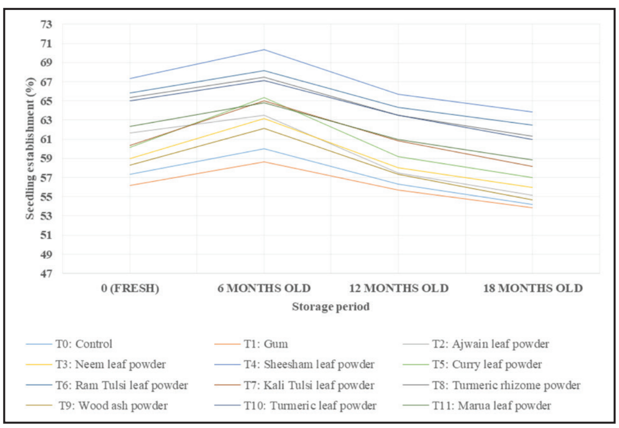

Fig. 1. Impact of various organic seed coating on mean seedling establishment (%) of mungbean during storage

CONCLUSION

On the basis of present investigation, it is concluded that the botanicals powder treatments significantly improved all the seed quality parameters in both varieties (MH 318 and MH 421) of mungbean during storage at ambient condition as compared to control. The seed treatment with turmeric rhizome powder was found best as it significantly improved standard germination percentage, field emergence index, vigour index I and decreased electrical conductivity and also retain the seed quality parameters after 18 months of ambient storage. The minimum insect damage was found in seed treated with neem leaf powder followed by kali tulsi leaf powder. With increase in storage period, reduction in seed quality parameters of treated and untreated seeds of mungbean was observed irrespective of seed treatment. The fresh seed of both varieties showed low quality attributes. The maximum quality attributes were showed after 6 months of storage among all the storage periods in both the varieties after which the quality declined continuously along with the storage period among all the treatments in both the genotypes.

REFERENCES

Abdul-Baki AA and Anderson JD. 1973. Vigour determination in soybean seed by multiple criteria 1. Crop Science **13**(6): 630-633.

Ashraf M and Shahbaz M. 2003. Assessment of genotypic variation in salt tolerance of early CIMMYT hexaploid wheat germplasm using photosynthetic capacity and water relations as selection criteria. Photosynthetica **41**: 273–280.

Bonner FT. 2008. Storage of seeds. Woody plant seed manual 85-96.

Channabasanagowda N, Patil KB, Patil BN, Awaknavar JS, Ninganur BT and Hunje R. 2008. Effect of organic manures on growth, seed yield and quality of soybean. Karnataka Journal of Agricultural Sciences **21**: 366-368.

Ditlevsen K, Sandoe P and Lassen J. 2019. Healthy food is nutritious, but organic food is healthy because it is pure: The negotiation of healthy food choices by Danish consumers of organic food. Food Quality and Preference **71**: 46–53.

Finkelman SI, Angel S, Mansur II and Ra'Anana IL. 1990. Navarro *et al*. Phytochemistry **29**(7): 2201-2205.

Hinnenburg I, Dorman HD and Hiltunen R. 2006. Antioxidant activities of extracts from selected culinary herbs and spices. Food chemistry **97**(1): 122-129.

Hridya VR, Lakshmi S and Ambika S. 2017. Dry dressing of soybean [*Glycine max* (L.) Merrill] cv. CO 3 seeds with near nano size botanicals to improve physiological performance during storage. Legume Research **40**(6): 1107-1112.

ISTA 2011. International rules for seed testing. Chapter 5: The Germination Test. ISBN 978-3-906549-53-8. International Seed Testing Association, Baserdorf, Switzerland.

Lamichaney A, Katiyar PK, Laxmi V and Pratap A. 2018. Variation in pre-harvest sprouting tolerance and fresh seed germination in mungbean (*Vigna radiata* L.) genotypes. Plant Genetic Resources **16**(5): 437-445.

Lamichaney A, Kumar V, Katiyar PK and Singh NP. 2019. Effect of storage condition and its duration on seed quality of chickpea (*Cicer arietinum* L.). Journal of Food Legumes **32**(3): 152-156.

Maguire JD. 1962. Speed of Germination—Aid In Selection and Evaluation for Seedling Emergence and Vigour 1. Crop science **2**(2): 176-177.

Misra HP. 2000. Effectiveness of indigenous plant products against the pulse beetle *Callosohauchus chinensis*on stored blackgram. Indian Journal of Entomology **69**(2): 218-220.

Mohan L, Amberkar MV and Kumari M. 2011. *Ocimum sanctum* Linn (Tulsi)—an overview. International Journal of Pharmaceutical Sciences Review and Research **7**(1): 51-53.

Panse VS and Sukhatme PV. 1985. Statistical methods for Agricultural workers (4th Edn.) ICAR. Publ. New Delhi.

Patil TV. 2002. Influence of organics on seed yield, quality and storability studies in greengram Cv. Chinamung. M. Sc. (Agri.) Thesis, Univ. Agric. Sci., Dharwad, Karnataka (India).

Rana V, Kumar V and Soni PL. 2009. Structure of the oligosaccharides isolated *from Dalbergia sissoo* Roxb. leaf polysaccharide. Carbohydrate Polymers **78**(3): 520-525.

Roberts EH and Ellis RH. 1977. Prediction of seed longevity at sub-zero temperatures and genetic resources conservation. Nature **268**(5619): 431.

Ruby AJ, Kuttan G, Babu KD, Rajasekharan KN and Kuttan R. 1995. Anti-tumour and antioxidant activity of natural curcuminoids. Cancer Letters **94**(1): 79-83.

Savitri H, Reddy MS and Reddy BM. 1994. Effect of seed treatment with fungicides and insecticides on seed-borne fungi, storage insect pest, seed viability and seedling vigour of sorghum. Seed Research **22**(2): 146-155.

Selvam R, Subramanian L, Gayathri R and Angayarkanni N. 1995. The anti-oxidant activity of turmeric (*Curcuma longa*). Journal of Ethnopharmacology **47**(2): 59-67.

Singh G and Sharma ML. 2016. Impact of Pelleting (Pre-storage) on the Germination Studies of two different Species of Ageing Bamboo Seeds. Emergent Life Sciences Research 2: 34-38.

Singh R, Singh B and Verma RA. 2001. Efficacy of different indigenous plant products as grain protectant against *Callosobruchus chinensis* L. on pea. Indian journal of Entomology **63**(2): 179-181

Taylor AG and Harman GE. 1990. Concepts and technologies of selected seed treatments. Annual Review of Phytopathology **28**(1): 321-339.

Tripathy MK, Sahoo P, Das BC and Mohanty S. 2001. Efficacy of botanical oils, plant powders and extracts against *Callosobruchus chinensis* L in attacking blackgram cv. T9. Legume Research **24**(2): 82-86.

Verghese FA, Naidu ST and Azim DO. 2018. Effect of botanicals in improving the performance of aged seeds in comparison with fresh seeds of blackgram variety. Advanced Journal of Seed Science and Technology **5**(2): 141-149.