Seed Research 47(1): 59-64, June, 2019

Effect of Packaging Materials on Pigeon pea Seeds Stored under Ambient Conditions

UB MANJUNATHA*, BASAVEGOWDA, SR DODDAGOUDAR, IM SANGEETA AND N SUSHILA[1]

Department of Seed Science and Technology, [1]Department of Agricultural Entomology,
University of Agricultural Sciences, Raichur, Karnataka - 584104, India
*manjunathktr10@gmail.com

(Received: October 2018; Revised: May 2019; Accepted: June 2019)

ABSTRACT: The present investigation was conducted to evaluate and identify the suitable packaging materials for storage of pigeon pea cv. TS-3R seeds under ambient conditions. The graded seeds were treated with the combination of fungicide and insecticide (thiram @ 2g/kg + emamectin benzoate 5SG 40 mg/kg of seeds) and packed in seven packaging materials *viz.*; gunny bag, polylined (700 gauge) gunny bag, HDPE bag with lamination, purdue improved crop storage (PICS) bag, grain pro bag, zero fly bag and trial bag under ambient storage conditions with initial seed moisture content less than 7.9%. The results revealed that treated seeds differed significantly after six months of storage and among the packaging materials the seeds stored in PICS bag recorded higher seed germination (95.17%), seedling vigour index (2211), seedling dry weight (78.92 mg), lowest seed moisture content (7.95%), lower seed infection (1.7%) and electrical conductivity (0.622 dSm^{-1}) which was on par with grain pro bag and Trial bag whereas the lowest was recorded in seeds stored in gunny bag (91.00%, 1891, 76.98 mg, 9.09%, 11.70% and 0.697 dSm^{-1}, respectively). The interaction of seed treatment and packaging material were found to be non-significant throughout the storage period.

Keywords: Pigeon pea, Treatments, Packaging materials, Storage seed quality

Pigeon pea {*Cajanus cajan* (L.) Mill sp.} is an important protein rich legume. It is a crop of the tropical and sub-tropical regions of the world and is considered to be native to Peninsular India. It is mainly cultivated and consumed in developing countries of the world. In India, it is cultivated in an area of about 3.85 m ha with a productivity of about 729 kg ha^{-1}. The major storage pests of pigeon pea during storage are bruchids (*Callosobruchus* spp.) these fast feeders have high fecundity under stored conditions, which results in drastic reduction in seed quality, prices in the markets and they become totally unfit for dal making and export. There is need to maintain seed longevity with no adverse effect on seed quality parameters. In view of above problem the present investigation is undertaken to study the effect of different packaging materials on seed quality of pigeon pea during storage.

MATERIALS AND METHODS

Freshly harvested seeds of pigeon pea (cv.) TS-3R were treated with the combination of fungicide (thiram @ 2 g/kg of seeds) and insecticide (emamectin benzoate 5SG 40 mg/kg of seeds) and seeds are packed in six different packaging materials *viz*., C_1-Gunny bag, C_2- Polylined (700 gauge) gunny bag, C_3- HDPE bag with lamination, C_4- PICS (perdue improved crop storage) bag, C_5- Grain pro bag, C_6- Zerofly bag and C_7- RICS (Raichur improved crop storage) bag under ambient conditions. The different observations on seed germination (%), seedling vigour index –I (germination per cent x seedling length) and II, seedling dry weight (mg), seed moisture content, seed infection and electrical conductivity were taken at bimonthly interval. The experiment was laid out using factorial CRD and the critical differences between the treatments and containers were worked out at one per cent level of significance.

RESULTS AND DISCUSSION

Effect of Seed Treatment during Storage

There was no significant difference in moisture content between the seed treatments up to the end of the storage period. However, numerically lowest moisture content (8.21%) was recorded in seeds treated with thiram + emamectin benzoate (T_2) compared to control (T_1) (8.24%) (Table 1).

Table 1. Effect of seed treatment and containers on moisture content (%) of pigeon pea during storage

Treatment	Months after storage				
	2	4	6	8	10
T_1	8.06	8.13	8.06	8.04	8.24
T_2	8.03	8.10	8.04	8.00	8.21
Mean	8.05	8.12	8.05	8.02	8.22
SEm(±)	0.01	0.02	0.01	0.01	0.01
CD (p=0.01)	NS	NS	NS	NS	NS
C_1	8.44	8.70	8.54	8.37	9.09
C_2	7.98	8.02	7.97	7.97	7.99
C_3	8.03	8.12	8.02	7.99	8.33
C_4	7.94	7.96	7.93	7.93	7.95
C_5	7.95	7.98	7.95	7.94	7.97
C_6	8.01	8.07	7.99	7.98	8.25
C_7	7.97	7.99	7.96	7.96	7.98
Mean	8.05	8.12	8.05	8.02	8.22
SEm(±)	0.02	0.03	0.02	0.01	0.02
CD (p=0.01)	0.09	0.12	0.08	0.05	0.06

NS: Non Significant

Seed Treatments (T): T_1: Control and T_2: Thiram (2 g/kg seed) + Emamectin benzoate5SG (40 mg/kg seeds)

Containers (C): C_1: Gunny bag, C_2: Polyline (700 gauge) gunny bag, C_3: HDPE bag, C_4: PICS bag, C_5: Grain pro bag, C_6: Zero fly bag and C_7: Trial bag

The moisture fluctuation was more in untreated seeds compared to treated seeds because when seeds treated with chemicals it cover the pores in the seed coat and prevents the entry of both water and fungal mycelia and provide protection from physical damage which can occur during handling and storage [1]. The results are in accordance with the findings of [2] in cotton and [3]. Significantly higher seed germination (94.29%) was recorded in seeds treated with thiram + emamectin benzoate (T_2) over control (T_1) (92.81%) at the end of storage period (Table 2).

Higher germination percentage was seen in treated seeds and it is was due to pathogen and pest suppressive nature of chemicals. In general, the beneficial effect of thiram seed treatment on germination may be related to its anti-fungal effects. Storage fungi cause qualitative and quantitative damage to seeds in storage and degrade seed lipids and cause rapid seed deterioration and increased production of free fatty acids. It reduces the impact of ageing enzymes, seed deterioration due to fungal invasion and physiological ageing. The observed reduction in percentage seed germination over time could also be linked to the reduction in enzyme activity within

Table 2. Effect of seed treatment and containers on germination (%) of pigeon pea during storage

Treatment	Months after storage				
	2	4	6	8	10
T_1	97.67(81.26)	96.71(79.65)	95.67(78.07)	94.33(76.30)	92.81(74.51)
T_2	97.67(81.26)	96.95(80.02)	96.05(78.53)	94.76(76.89)	94.29(76.29)
Mean	97.67(81.26)	96.83(79.83)	95.86(78.33)	94.55(76.59)	93.55(75.40)
SEm(±)	0.10	0.17	0.10	0.16	0.15
CD (p=0.01)	NS	NS	NS	NS	0.59
C_1	97.33(80.64)	96.00(78.62)	94.67(76.68)	92.83(74.48)	91.00(72.96)
C_2	97.67(81.26)	96.67(79.50)	95.50(77.77)	94.50(76.45)	93.67(75.48)
C_3	97.33(80.64)	96.33(78.98)	95.17(77.31)	93.50(75.24)	92.33(73.93)
C_4	98.00(81.87)	97.50(80.95)	97.00(80.03)	96.17(78.75)	95.17(77.35)
C_5	98.00(81.87)	97.50(80.95)	96.83(79.77)	95.50(77.80)	94.67(76.70)
C_6	97.33(80.64)	96.67(79.50)	95.50(77.77)	94.17(76.03)	93.50(75.30)
C_7	98.00(81.87)	97.17(80.33)	96.33(78.98)	95.17(77.38)	94.50(76.49)
Mean	97.67(81.26)	96.83(79.83)	95.86(78.33)	94.55(76.59)	93.55(75.40)
SEm(±)	0.18	0.31	0.40	0.43	0.28
CD (p=0.01)	NS	NS	1.57	1.70	1.10

***Figures in the parentheses are arc sine transformed values NS: Non Significant

Seed Treatments (T): T_1: Control and T_2: Thiram (2 g/kg seed) + Emamectin benzoate5SG (40 mg/kg seeds)

Containers (C): C_1: Gunny bag, C_2: Polyline (700 gauge) gunny bag, C_3: HDPE bag, C_4: PICS bag, C_5: Grain pro bag, C_6: Zero fly bag and C_7: Trial bag the seed and with the reduction in germination percentage there was reduction in all the seed quality parameters [4-6].

Higher seedling vigour index (2134) was recorded in seeds treated in thiram + emamectin benzoate (T_2) over control (T_1) (2093) similarly, highest seedling dry weight (78.36 mg) recorded in seeds treated with thiram + emamectin benzoate (T_2) over control (T_1) (78.28 mg). The seedling dry weight (Table 4) and seedling vigour index (Table 3) are significantly higher in treated seeds compared to untreated seeds this is may be due to longer shoot and root length recorded in our study which had a direct correlation with seedling dry weight and seedling vigour index. The fungicide and insecticide protected the seed deterioration by reducing the fungal invasion, insect damage and favoured the seed germination and other quality parameters [7]. The results are in line with the [3] recorded significantly higher seedling dry weight and seedling vigour index by treating pigeon pea seeds with thiram (3 g/ kg of seeds). The results are in line with the findings [8, 9] in soybean seeds.

Table 3. Effect of seed treatment and containers on seedling vigour index-I of pigeon pea during storage

Treatment	Months after storage				
	2	4	6	8	10
T_1	2620	2519	2383	2265	2093
T_2	2628	2535	2401	2285	2134
Mean	2624	2527	2392	2275	2113
SEm(±)	9	11	4	8	3
CD (p=0.01)	NS	NS	NS	NS	13
C_1	2562	2406	2256	2078	1891
C_2	2621	2528	2393	2293	2140
C_3	2596	2488	2332	2219	2051
C_4	2666	2592	2474	2373	2211
C_5	2661	2585	2462	2350	2191
C_6	2608	2525	2387	2278	2129
C_7	2657	2573	2443	2334	2181
Mean	2624	2527	2392	2275	2113
SEm(±)	27	25	23	22	9
CD (p=0.01)	NS	NS	90	84	34

NS: Non Significant

Seed Treatments (T): T_1: Control and T_2: Thiram (2 g/kg seed) + Emamectin benzoate5SG (40 mg/kg seeds)

Containers (C): C_1: Gunny bag, C_2: Polyline (700 gauge) gunny bag, C_3: HDPE bag, C_4: PICS bag, C_5: Grain pro bag, C_6: Zero fly bag and C_7: Trial bag

Table 4. Effect of seed treatment and containers on seedling dry weight (mg) of pigeon pea during storage

Treatment	Months after storage				
	2	4	6	8	10
T_1	81.16	80.59	79.84	79.05	78.28
T_2	81.22	80.63	79.89	79.08	78.36
Mean	81.19	80.61	79.87	79.06	78.32
SEm(±)	0.12	0.12	0.06	0.01	0.02
CD (p=0.01)	NS	NS	NS	NS	0.07
C_1	81.03	80.17	79.13	78.37	76.98
C_2	81.20	80.60	79.90	78.91	78.56
C_3	81.09	80.38	79.70	78.66	77.90
C_4	81.32	80.93	80.20	79.58	78.92
C_5	81.28	80.89	80.16	79.54	78.83
C_6	81.13	80.49	79.87	78.88	78.49
C_7	81.25	80.79	80.12	79.51	78.80
Mean	81.19	80.61	79.87	79.06	78.35
SEm(±)	0.22	0.22	0.11	0.17	0.07
CD (p=0.01)	NS	NS	0.43	0.69	0.27

NS: Non Significant

Seed Treatments (T): T_1: Control and T_2: Thiram (2 g/kg seed) + Emamectin benzoate5SG (40 mg/kg seeds)

Containers (C): C_1: Gunny bag, C_2: Polyline (700 gauge) gunny bag, C_3: HDPE bag, C_4: PICS bag, C_5: Grain pro bag, C_6: Zero fly bag and C_7: Trial bag

The seed infection (Table 5) was not recorded in seeds treated with thiram + emamectin benzoate (T_2) whereas maximum seed infection was recorded in control (T_1) (7.6%) at the end of storage period. This may be due to seeds treated with fungicides help in inhibiting the growth of fungi this might be due to the fungicidal effect on production of pectolytic and cellulolytic enzymes by the fungi and thereby reducing the incidence of fungal pathogen [10]. The results are in conformation with the finding in chickpea [11] and cotton seeds [12].

The lower electrical conductivity (0.643 dSm^{-1}) recorded in seeds treated with thiram + emamectin benzoate (T_2) over control (T_1) (0.652 dSm^{-1}) at the end of storage period. This may be due to insecticide and fungicide make the seed antifeedant and unpalatable to insects and reduces the cracks and aberrations of the seed coat and reduce the leaching of the electrolytes (Table 6). These results are in agreement with [13] in soybean.

Table 5. Effect of seed treatment and containers on seed infection (%) of pigeon pea during storage

Treatment	Months after storage		
	6	8	10
T_1	1.4 (6.80)	3.3 (10.47)	7.6 (14.42)
T_2	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)
Mean	0.7	1.7	3.8
SEm(±)	0.5	0.6	1.0
CD (p=0.01)	NS	2.3	3.7
Containers (C)			
C_1	3.3 (10.47)	5.0 (12.92)	11.7 (20.00)
C_2	0.0 (0.00)	1.7 (7.49)	1.7 (7.49)
C_3	1.7 (7.49)	3.3 (10.47)	6.7 (15.00)
C_4	0.0 (0.00)	0.0 (0.00)	1.7 (7.49)
C_5	0.0 (0.00)	0.0 (0.00)	1.7 (7.49)
C_6	0.0 (0.00)	0.0 (0.00)	1.7 (7.49)
C_7	0.0 (0.00)	1.7 (7.49)	1.7 (7.49)
Mean	0.7	1.7	3.8
SEm(±)	0.9	1.1	1.3
CD (p=0.01)	NS	NS	4.8

*****Figures in the parentheses are arc sine transformed values
NS: Non Significant

Seed Treatments (T): T_1: Control and T_2: Thiram (2 g/kg seed) + Emamectin benzoate5SG (40 mg/kg seeds)

Containers (C): C_1: Gunny bag, C_2: Polyline (700 gauge) gunny bag, C_3: HDPE bag, C_4: PICS bag, C_5: Grain pro bag, C_6: Zero fly bag and C_7: Trial bag

Table 6. Effect of seed treatment and containers on electrical conductivity (dSm^{-1}) of pigeon pea during storage

Treatment	Months after storage				
	2	4	6	8	10
T_1	0.442	0.492	0.537	0.616	0.652
T_2	0.438	0.488	0.531	0.610	0.643
Mean	0.440	0.490	0.534	0.613	0.648
SEm(±)	0.006	0.006	0.004	0.003	0.001
CD (p=0.01)	NS	NS	NS	NS	0.003
Containers (C)					
C_1	0.463	0.518	0.579	0.649	0.697
C_2	0.446	0.490	0.532	0.615	0.643
C_3	0.455	0.505	0.556	0.634	0.666
C_4	0.419	0.468	0.507	0.586	0.622
C_5	0.422	0.476	0.512	0.591	0.627
C_6	0.449	0.492	0.534	0.618	0.647
C_7	0.426	0.479	0.518	0.597	0.631
Mean	0.440	0.490	0.534	0.613	0.648
SEm(±)	0.011	0.011	0.006	0.008	0.001
CD (p=0.01)	NS	NS	0.025	0.029	0.004

NS: Non Significant

Seed Treatments (T): T_1: Control and T_2: Thiram (2 g/kg seed) + Emamectin benzoate5SG (40 mg/kg seeds)

Containers (C): C_1: Gunny bag, C_2: Polyline (700 gauge) gunny bag, C_3: HDPE bag, C_4: PICS bag, C_5: Grain pro bag, C_6: Zero fly bag and C_7: Trial bag

Effect of Packaging Materials on Seed Quality

The seeds packed in PICS bag recorded the minimum seed moisture content (7.95%) which was on par with grain pro bag, Trial bag, and polylined (700 gauge) gunny bag (C_2) (7.97, 7.98 and 7.99%, respectively) followed by zerofly bag (C_5) and HDPE bag with lamination (8.25 and 8.33%, respectively) whereas, the maximum moisture content (9.09%) was recorded in gunny bag at the end of storage period.

The lower moisture content may be due to hermetic seal of PICS bags shielded the grain from changes in relative humidity, resulting in little impact on RH within seed mass or in seed moisture content [14] (Table 1). The results are in consistent with the findings [15, 16]. Grain pro bag may be attributed to the impervious nature to moisture vapour and thus it has caused less fluctuation in seed moisture content and it eliminates deterioration and enhances the seed longevity. These findings were in conformity with findings of [17] in pigeon pea.

The data on seed germination differed significantly due to the influence of containers except for initial four months. The higher seed germination (95.17%) was recorded with seeds packed in PICS bag which was on par with grain pro bag and trial bag (94.67 and 94.50%, respectively) followed by seeds packed in polylined (700 gauge) gunny bag, zerofly bag and HDPE bag with lamination (93.67, 93.50 and 92.33% respectively). While, the lowest seed germination (91.00%) was recorded with seeds packed in gunny bag at the end of storage period (Table 2)

Among the containers, the moisture impervious containers like PICS bag, grain pro bag and trial bag were found superior in maintaining seed germination for longer period than the previous containers. The prolonged quality of seeds depends on thickness and impervious nature of these containers. The superiority of these packaging materials in maintaining seed germinability for longer period might be due to inverse relationship between seed moisture content and germination percentage. Similarly [18] reported that maize seeds stored in hermetic bags (super grain bag) recorded highest germination (82%) and least for jute bags at the end of storage period. The present findings confirmed the reports of previous workers [19, 20].

The highest seedling dry weight (Table 4), seedling vigour index (Table 3) was recorded in seeds packed in PICS bag which was on par with the seeds packed in grain pro bag, trial bag and followed by polylined (700 gauge) gunny bag, zerofly bag, HDPE bag with lamination. Whereas, the lowest seedling dry weight, seedling vigour index-I were recorded in gunny bag at the end of the storage period. The seedling dry weight decreased as the storage period progressed irrespective of the type of packaging material used. Reduction of seedling dry weight was always greater when the seeds were stored in moisture pervious container, which is mainly due to increased seed deterioration there was decreased seedling dry weight due to loss of viability [21].

The seed infection (Table 5) varied less in the seeds stored in PICS bag which was on par with grainpro bag, trial bag, polylined (700 gauge) gunny bag, zerofly bag followed by HDPE bag with lamination. Whereas, more seed infection was recorded in gunny bag. The fluctuations in moisture content of seeds stored in cloth bag may also contribute for higher infections, fungi are generally active when the seed moisture content was above 8-9 per cent [22]. Further, the low moisture content in impervious containers also prevents activity of storage fungi. Therefore, it is evident from the results and supported reviews of literature that seeds stored in pervious containers have more seed infection than the moisture impervious containers and the results are in conformity with [23] in pigeon pea and [24] in cotton.

The seeds packed in PICS bag reported lower electrical conductivity (Table 6) which was on par with the seeds packed in grain pro bag and Trial bag which was followed by polylined (700 gauge) gunny bag, zerofly bag and HDPE bag with lamination. Whereas, the higher electrical conductivity was recorded in seeds stored in gunny bag. Measurement of electrical conductivity of seed leachate gives an indication of the extent of damage caused to cell membranes during storage. Higher electrical conductivity of seed leachate implies more damage to cell membrane and thus reduced vigour. Many workers reported negative correlation between EC and seed quality [25] in lablab, [26] in marigold.

Interaction Effect of Seed Treatment and Packaging Materials on Seed Quality during Storage

In the study, interaction effect of seed treatment and storage containers differed non significantly on all the quality parameters throughout the storage period. This may be due to seeds treated with insecticide and fungicide helps in maintaining the seed quality parameters for a longer period of time compared to untreated seeds. This can be due to insecticidal and fungicidal property of the chemicals. The seeds packed in moisture impervious containers like PICS bag, grain pro bag, Trial bag helps in maintaining the seed quality without causing any damage to the seeds. The hermetic shield of PICS bag and grain pro bag which is specially made of UV resistant PVC membrane helps in protecting the seeds from insect, fungi, light and dust damage. Among the best packaging materials, the cost of trial bag was lowest (104.00 Rs/quintal) followed by grain pro bag (240.00 Rs/quintal) and PICS bag (275.86 Rs/quintal)

CONCLUSION

The seeds treated with recommended fungicide and insecticide (thiram @ 2g/kg + emamectin benzoate 5SG 40 mg/kg of seeds) were recorded higher seed quality parameters and maintained seed vigour up to 10 months during storage compared to untreated seeds. Among packaging materials PICS bag maintained good seed quality parameters up to 10 months of storage which was on par with grain pro bag and trial bag. Considering the cost the trial bag (104 rs/50 kg capacity bag) found economical for storage of pigeon pea seeds.

REFERENCES

1. WEST SH, SK LOFTIN, M WAHL, BATICH AND CL BEATTY (1985). Polymer and seed treatment as a moisture barrier to maintain seed quality. *Crop Science,* **25**: 941-944.
2. SHIVAYOGI R, PNK BIRADAR, RS GIRREDI AND IS KATAGERI (2009). Effect of acid delinting seed treatment and containers on storability of cotton hybrid, *Karnataka Journal of Agricultural Sciences*, **22**(1): 56-60.
3. SHIVAGOUDA P, PS RAJENDRA, B BHARAMARAJ, H YEGAPPA, K MARUTI AND SHANKRAYYA (2014). Impact of seed treatment chemicals on seed storability in pigeon pea. *Bioscan*, **9**(3): 985-989.
4. IQBAL NA, M SHAHZAD, BASRA AND UR KHALIL (2002). Evaluation of vigour and oil quality in cotton seed during accelerated aging. *International Journal Agriculture Biology*, **4**(3): 318-322.
5. RUZROKH M, KG GOLOZANI AND A JAVANSHIR (2003). Relation between seed vigour with growth and yield in

pea (*Cicer arietinum* L.). *Nahal-o-Bazr Research Journal*, **18**: 156-169.

6. DEMIRKAYA M, KJ DIETZ AND HO SIVRITEPE (2010). Changes in antioxidant enzymes during aging of onion seeds. *Notulae Botanicae Horti Agrobotanici Cluj-Napoca*, **38**(1): 49-52.

7. SUNDARESH HN, KJ RANGANATHAN, A JANARADHAN AND SR VISHWANATHA (1987). Chemical seed treatment against seed borne fungi in soybean. *Current Research*, **16**: 110-111.

8. RAGHAVANI KL, KV BUHCHA, RP JUNEJA AND LM LUKOSE (2002). Studies on joint action of insecticides and fungicides on viability of pearl millet seeds during storage. *Seed Research*, **30**(1): 122-127.

9. MUTHURAJ R, K KANT AND DD KULSRESHTA (2002). Screening of soybean cultivars for seed mycoflora and effect of thiram treatment there on. *Seed Res*earch, **30**(1): 118-121.

10. MEHTA A, CHOPRA AND P MEHTA (1990). Fungicides inhibitory agent of cell wall degrading enzymes. *Journal of Indian Phytopathology*, **43**: 117-120.

11. CHAOUDARY, MM, DHM CHANDRASHKAR, C RAKESH, A JAIME, DS TEIXEIRA AND BALAKRISHNA (2011). Influence of packaging materials and seed treatment on physiological attributes during storage of rice (*Oryza sativa* L.). *Seed Science and Biotechnology,* **5**(1): 15-20.

12. VIJAYKUMAR K, RAVI HUNJE, NK BIRADAR PATIL AND BS VYAKARNHAL (2007). Effect of seed coating with polymer, fungicide and insecticide on seed quality in cotton during storage. *Karnataka Journal of Agricultural Sciences*, **20**(1): 137-139

13. MAHESHBABU HM AND H RAVI (2008). Effect of seed treatment with botanicals on storability of soybean. *Karnataka Journal of Agricultural Sciences*, **21**(3): 357-360.

14. BRETT L AND W CHARLES (2017). Impact of storage environment on the efficacy of hermetic storage bags. *Journal of Stored Products Research,* **72**: 83-89.

15. MARTIN D, D BARIBUSTA, JE HUESING, SB WILLIAMS AND LL MURDOCK (2015). PICS bags protect wheat (*Triticum aestivum* L.) grain, against rice weevil, *Sitophilus oryzae* (L.). *Journal of Stored Products Research,* **63**: 22-30.

16. VALES MI, GV RANGA RAO, H SUDINI, SB PATIL AND LL MURDOCK (2014). Effective and economic storage of pigeon pea seed in triple layer plastic bags. *Journal of Stored Products Research,* **58**: 29-38

17. SHANTAPPA T AND H RAMAIAH (2006). Effect of seed treatment and containers on storability of red gram seeds. *Abstracts*, XII National seminar on prosperity through quality seed, pp: 139.

18. ANURADHA K, A SUREKHA, KB ANIL, B PRASAD, BPM SWAMY, T LONGVAH AND N SARLA (2010). Evaluating rice germplasm for iron and zinc concentration in brown rice and seed dimensions. *Journal of Phytological Research,* **4**(1): 19-25.

19. SAHOO P, SK SWAIN, BC DAS, SK DAS AND DK KAR (1999). Effect of containers on viability and vigour of tomato seeds stored varying initial moisture levels. *The Orissa Journal of Horticulture*, **27**: 84-91.

20. GUPTA RB, VL MAJUMDAR AND GC BHATNAGAR (1992). Influence of seed dressing fungicides on mycoflora and viability of wheat seed under storage. *Seed Research*,**18**(2):157-159.

21. ABDUL-BAKI AA AND JD ANDERSON (1973). Vigour determination in soybean seed by multiple criteria. *Crop Science*, **13**(6): 630-633.

22. HARRINGTON JF (1973). Seed storage and longevity in seed biology. (Ed.) T. T. Kozylowski, *Academic Press,* New York and London. **3**: 145-245.

23. PATIL SK, SV TANPURE, VR SHELAR AND AD DUMBRE (2002). Efficacy of insecticides and fungicides on seed germination, insect infestation and seed mycoflora on pearl millet during storage. *Seed Research*, **32**(2): 189-192.

24. HEMASHREE K (2010). Influence of seed treatments and containers on storage potential of *Bt* and non-*Bt* cotton varieties. *M.Sc. (Agri.) Thesis,* Univ. of Agric. Sci., Dharwad.

25. KATHIRAVAN M, A VIJAYAKUMAR AND C VANITHA (2008). Effect of dry dressing treatments and containers on seed quality parameters in lablab (*Lablab purpureus* L.) under natural ageing conditions. *Indian Journal of Agricultural Research,* **42**(1): 62 – 66.

26. TEJASHWI PK, AM ASHA, JB MARUTHI AND K VISHWANATH (2014). Influence of seed treatment chemicals and containers on seed quality of marigold during storage. *The Bioscan,* **9**(3): 937-942.