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Rajeshwari MC
M.Sc. Agri, Department of Seed Science and Technology, University of Agricultural Sciences, Dharwad, Karnataka, India

Ravi Hunje
Professor, Department of Seed Science and Technology, University of Agricultural Sciences, Dharwad, Karnataka, India

Bharamaraj BA
Assistant Professor, Department of Seed Science and Technology, University of Agricultural Sciences, Dharwad, Karnataka, India

Corresponding Author:
Rajeshwari MC
M.Sc. Agri, Department of Seed Science and Technology, University of Agricultural Sciences, Dharwad, Karnataka, India

Influence of fungicides and bioagents seed treatment on storability of soybean (*Glycine max* (L.) Merrill)

Rajeshwari MC, Ravi Hunje and Bharamaraj BA

Abstract
An experiment was carried out at Seed Quality Testing Laboratory, Seed Unit, University of Agricultural Sciences, Dharwad, to study the influence of fungicides and bio agents on storability of soybean var. DSb 21. The seed treatment of Carboxin + Thiram @ 3g/kg of seed recorded significantly higher seed germination (88.33%), seedling dry weight (95.82 mg), seedling vigour (2138) and lower electrical conductivity (0.592 dS m^{-1}), seed infection (11.00%) at the end of storage period which is on par with seed treatment with Penflufen @ 1g/kg of seed (86.00%, 92.05 mg, 0.605 dS m^{-1}, 2027 and 13.33%) respectively, compared to control. Therefore the present investigation was carried out to know the effect of seed treatment with bioagents and fungicides on seed quality during storage.

Keywords: Soybean, seed treatment, quality traits

Introduction
Soybean (*Glycine max* (L.) Merrill) is an important oilseed crop, is listed as poor storer. It loses viability quickly under warm and humid storage conditions. One of the chief constraints in soybean cultivation is the non-availability of high vigour seeds at the time of sowing. In order to increase the production of soybean, a source of high quality, disease free seed must be established and maintained. Now-a-days, the area and production of this crop is increasing gradually, but productivity remains almost constant (Mahesh Babu and Hunje, 2008) [6].

Seed mycoflora are primarily responsible for the deterioration of seed and its quality in storage and reduce the viability of seeds. (Hamman *et al.*, 1996) [5] observed that germination percentage was reduced due to the effect of seed-borne pathogens, which resulted in relatively large numbers of dead seeds, abnormal seedlings and damaged seed coats, also found highly significant correlations between the number of dead seeds and the incidence of fungal infection and between the number of abnormal seedlings, seed coat damage of soybean seeds.

Significant amounts of seeds are lost during storage due to biotic and abiotic factors. To prevent quantitative and qualitative loss of seed in storage, different prophylactic methods are used in many agricultural crops, i.e. by treating seeds with appropriate bioagents or fungicides. However, besides the negative effects on the environment and human health, one main problem reported in the country is that fungicides often drastically reduce the viability of *Bradyrhizobium* cells, decreasing nodulation and nitrogen fixation rates. The quality seed production and safe storage are the two main facets of successful seed production in soybean. Seed treatment is one of the best methods to manage seed borne diseases. (Mane *et al.*, 2010) [6] studied the impact of various fungicidal seed treatment on seed mycoflora and seed germination during storage of sorghum. The continuous and indiscriminate use of chemicals to control diseases results in accumulation of harmful residues of chemicals in the soil, water and seed.

Materials and Methods
The experiment consists of eight treatments *viz.*, T_1: Untreated control, T_2: Carboxin + Thiram @ 3g/kg of seed, T_3: Carbendazim + Mancozeb @ 2g/kg of seed, T_4: *Trichoderma harzianum* @ 10g/kg of seed, T_5: *Pseudomonas fluorescens* @ 4g/kg of seed, T_6: *Bacillus subtilis* @ 10g/kg of seed, T_7: Tebuconazole @ 2g/kg seed and T_8: Penflufen @ 1g/kg of seed. Laboratory experiment was carried out at Seed Quality and Research Laboratory, National Seed Project (Crops), Dharwad, Department of Plant Pathology, Dharwad. Laboratory experiment was conducted by using CRD design. Foundation seeds of soybean variety *viz.*, DSb 21 were collected from the National Seed Project (Crops), University of Agricultural Sciences, Dharwad.

Laboratory experiment

The germination percentage was worked out as per the procedure given by ISTA (Anon., 2011) [2], seedling dry weight measured in mg, electrical conductivity seed leachate by Presley (1958) [7] measured in dS m^{-1}, seed infection in per cent, seedling vigour index was worked out as per the formula given by (Abdul-Baki and Anderson, 1973) [1].

Results and Discussion

The gradual decrease in seed quality parameters were recorded with the advancement in storage period. The mean germination percentage documented at early and last month of storage was 92.96 and 82.04% correspondingly. Seed treatment of Carboxin + Thiram @ 3g/kg of seed (T_2) (88.33%) documented superior germination percentage during the storage period followed by Penflufen @ 1g/kg seed treatment (T_8) (14.01%), whereas untreated control (T_1) reported the minimum germination (77.00%) at the end of nine month of storage. The decline in germination percentage may be attributed to ageing effect leading to depletion of food reserves and decline in synthetic activity of embryo apart from death of seed because of fungal invasion, insect damage, fluctuating temperature, relative humidity. Similar results were reported by (Vidhyasekaran *et al*., 1980) [13] in sorghum and millet. The soybean seeds having only high initial germination (>80-90%) could be recommended for one season storage. Storing soybean seeds beyond first planting season at room temperature may not be successful even in moisture resistant containers. Up to second planting season soybean could be safely stored in cold storage (4-5 °C temperature and 50-60% relative humidity).

Seeds treated with Carboxin + Thiram @ 3g/kg (T_2) showed superior seedling dry weight (95.82 mg), whereas T_1 recorded the minimum seedling dry weight (82.27 mg) at the end of nine months of storage. This steady reduction in seedling dry weight may be due to natural ageing, resulting in decay of seed, reduces germination percentage and seedling length. The results are similar with the results of (Sherin Suhan John, 2003) [10] in maize, (Rathinavelu and Raja, 2007) [8] in cotton.

The mean SV I documented at initial and end of storage time was 2709 and 1758, correspondingly. Seeds treated with Carboxin + Thiram @ 3g/kg of seeds (T_2) recorded superior SV I (2138), whereas T_1 recorded the minimum SV I (1391) at the last month of storage.

The mean electrical conductivity documented at initial and last month of storage period was 0.459 and 0.625 dS m^{-1}, correspondingly. T_2 recorded the least electrical conductivity during the storage period (0.592 dS m^{-1}), while T_1 recorded the higher electrical conductivity (0.665 dS m^{-1}). As the storage period progressed, the electrical conductivity of seed leachate was enhanced owing to enhanced membrane permeability and decreased plant coat integrity, resulting in surplus electrolyte discharge resulting in greater electrical conductivity of seed leachate. Similar results have also been recorded by (Sajjan *et al.*, 2010) [9] in sunflower, (Sitara and Hasan, 2011) [11] in chili. Among the treatments T_2 recorded the lower seed infection (11.00%), while T_1 recorded the higher seed infection (22.33%) at the last month of storage. These findings were also inclining with the reports of (Dhyani *et al*., 1991) [3] in chilli, (Gupta *et al*., 1992) [4] in chilli.

Superior seed quality parameters were observed in the seed treatment with fungicide and insecticide because of its antioxidant and repellent property and fungicidal insect repellent nature (Vadivelu *et al.*, 2001) [12] resulting in improved protection of seeds against membrane disintegrity, antioxidation and lipid peroxidation and storage pathogens.

Table 1: Effect of seed treatment on seed germination (%) in soybean during storage period

	Storage period (months)									
Treatments	**Initial**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
T_1	90.00 (71.54*)	88.67 (70.36)	87.67 (69.41)	85.67 (67.72)	85.00 (67.35)	82.67 (65.46)	81.67 (64.65)	79.67 (63.24)	78.00 (62.05)	77.00 (61.33)
T_2	95.67 (77.95)	94.33 (76.42)	94.00 (75.79)	93.33 (75.00)	93.00 (75.00)	92.67 (74.50)	92.00 (73.56)	91.00 (72.53)	88.67 (70.35)	88.33 (70.03)
T_3	93.00 (74.63)	92.00 (73.60)	91.00 (72.51)	88.67 (70.30)	87.33 (69.28)	86.67 (68.74)	84.67 (67.04)	84.00 (66.44)	81.33 (64.40)	80.67 (63.91)
T_4	94.00 (75.79)	93.67 (75.54)	92.33 (73.89)	91.67 (73.19)	91.00 (72.58)	89.67 (71.30)	88.00 (69.89)	87.33 (69.16)	84.33 (66.67)	83.33 (65.90)
T_5	90.67 (72.18)	90.00 (71.54)	88.33 (70.00)	86.67 (68.55)	84.67 (66.94)	83.33 (65.88)	82.67 (65.38)	82.00 (64.88)	80.67 (63.90)	80.00 (63.42)
T_6	92.00 (73.54)	91.33 (72.86)	90.33 (71.85)	88.33 (69.99)	86.67 (68.58)	85.00 (67.19)	84.00 (66.40)	83.33 (65.89)	80.67 (63.90)	79.67 (63.20)
T_7	93.67 (75.39)	92.67 (74.29)	91.67 (73.20)	89.67 (71.22)	89.00 (70.71)	87.67 (69.48)	86.33 (68.35)	85.00 (67.28)	82.33 (65.14)	81.33 (64.42)
T_8	94.67 (76.62)	94.00 (75.79)	93.67 (75.40)	92.67 (74.26)	92.33 (73.90)	91.67 (73.23)	90.00 (71.59)	88.67 (70.36)	87.00 (68.90)	86.00 (68.09)
Mean	92.96 (74.58)	92.08 (73.80)	91.13 (72.64)	89.58 (71.14)	88.63 (70.51)	87.42 (69.47)	86.17 (68.36)	85.13 (67.47)	82.88 (65.66)	82.04 (65.04)
S.Em+	0.95	1.03	1.08	1.18	1.37	1.44	1.29	1.12	0.97	1.03
C. D. @ (1%)	3.93	4.28	4.48	4.80	5.67	5.93	5.33	4.63	3.99	4.29

Table 2: Effect of seed treatment on seedling dry weight (mg) in soybean during storage

	Storage period (months)									
Treatments	**Initial**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
T_1	92.63	92.03	91.40	89.90	89.41	87.39	85.61	84.42	83.02	82.27
T_2	104.17	103.80	103.27	101.63	101.10	99.66	98.85	97.49	96.18	95.82
T_3	98.63	97.98	97.63	96.73	95.48	94.03	92.92	92.16	90.80	89.47
T_4	99.43	98.73	98.33	97.48	96.57	95.09	93.69	92.28	90.99	90.67
T_5	96.23	95.86	95.43	94.77	93.46	92.25	90.94	90.37	88.85	87.51

T_6	96.50	96.19	96.02	95.14	94.57	93.53	92.83	91.89	90.62	88.95
T_7	99.11	98.64	98.30	97.06	96.31	94.69	93.51	92.22	90.82	89.52
T_8	100.51	99.46	99.10	98.13	97.42	95.72	95.72	93.97	92.52	92.05
Mean	98.40	97.84	97.43	96.35	95.54	94.04	93.02	91.85	90.47	89.53
S.Em+	1.65	1.62	1.58	1.54	1.61	1.53	1.56	1.52	1.50	1.40
C. D. @ (1%)	6.82	6.70	6.53	6.40	6.67	6.34	6.44	6.28	6.21	5.78

Table 3: Effect of seed treatment on electrical conductivity (dS m^{-1}) of soybean during storage under ambient condition

	Storage period (months)									
Treatments	**Initial**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
T_1	0.497	0.503	0.513	0.530	0.556	0.586	0.593	0.610	0.643	0.665
T_2	0.432	0.440	0.452	0.477	0.508	0.519	0.530	0.546	0.581	0.592
T_3	0.461	0.472	0.488	0.505	0.529	0.548	0.556	0.575	0.612	0.620
T_4	0.448	0.465	0.468	0.493	0.518	0.543	0.550	0.569	0.602	0.616
T_5	0.476	0.481	0.502	0.527	0.552	0.575	0.582	0.606	0.637	0.654
T_6	0.469	0.477	0.498	0.523	0.547	0.564	0.572	0.585	0.618	0.628
T_7	0.451	0.466	0.471	0.496	0.525	0.548	0.553	0.572	0.609	0.618
T_8	0.440	0.454	0.464	0.491	0.515	0.542	0.548	0.565	0.592	0.605
Mean	0.459	0.470	0.482	0.505	0.531	0.553	0.560	0.579	0.612	0.625
S.Em+	0.010	0.009	0.010	0.009	0.008	0.005	0.008	0.009	0.008	0.009
C.D. @ (1%)	0.043	0.037	0.041	0.035	0.031	0.021	0.031	0.036	0.031	0.037

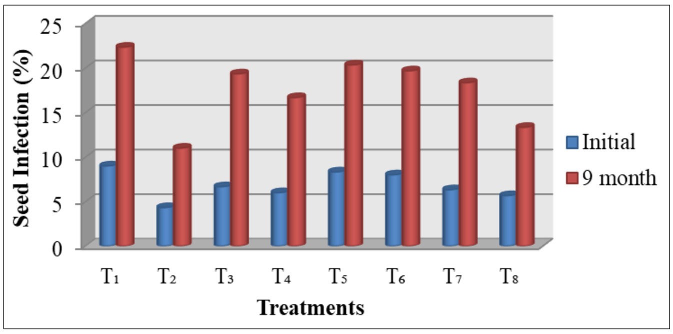

Fig 1: Effect of seed treatment on seed infection (%) at initial and 9th month of storage period

Conclusion

It can be concluded that seed treatment of soybean with Carboxin + Thiram @ 3g/kg seed recorded higher seed germination, seedling dry weight seedling vigour, lower electrical conductivity and seed infection during the storage period which is at par with seed treatment of Penflufen @ 1g/kg seed. The probable reason for variation in storability of seed treatment with chemicals and bio agents might be due to variation in their effectiveness in managing the seed borne pathogen and also might be due to the persistence of these chemicals on seed surface throughout storage.

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