Doi: HTTPS://DOI.ORG/10.23910/IJBSM/2017.8.2.1716a

Effect of Seed Coating with Polymer, Fungicide and Insecticide on Seed Quality in Sorghum (*Sorghum bicolor* (L.) Moench) during Storage

P. S. Rao*, M. Sudha Rani, R. Ankaiah, M. Rajasri and K. V. S. Meena Kumari

Seed Research and Technology Centre, Rajendranagar, Hyderabad, Andhra Pradesh (500 030) India

Corresponding Author

P. S. Rao
e-mail: sampalrao@gmail.com

Article History

Manuscript No. AR1716a
Received in 25th October, 2016
Received in revised form 19th March, 2017
Accepted in final form 5th April, 2017

Abstract

The present study was undertaken with sorghum hybrid CSH 9 during 2009−10 and 2010−11 through seed coating with polymers in combination with pesticide and fungicide. The objective was to standardize the seed coating protocol for enhancement of seed quality during storage. The experiment was carried out with different seed coating materials viz., polymer coating (Polykote @ 3 ml kg^{-1} of seed), polymer coating+thiram 75% wp @ 2.5 g kg^{-1} of seed, polymer coating+imidacloprid @ 4 ml kg^{-1} seed, polymer coating+thiram 75% wp @ 2.5 g kg^{-1} of seed+imidacloprid @ 4 ml kg^{-1} seed and vitavax 200 @ 2 g kg^{-1} seed along with untreated seed. The seed material was stored in both cloth bags and 700 guage polythene bags and data was recorded on various quality parameters during storage. The results revealed that irrespective of the storage container, significantly superior germination percent (76 and 75), seedling vigour index (2895 and 2205) and field emergence (81 and 79%) was recorded with polymer coating+thiram+imidacloprid over untreated control at ten months of storage during 2009 and 10 when stored in polythene bag. There was no incidence of pathogen in the seed lots of all the treatments initially, which rose up to 4.5% in control. However, a lower per cent of infection of 0−2.5 was maintained in the seed lots stored in 700 gauge polythene bags coated with polymer coating+thiram+imidacloprid at ten months of storage. Thus, the sorghum seed treated with polymer coating+thiram+imidacloprid before storage can maintain the seed quality up to ten months of storage.

Keywords: Seed coating, synthetic polymer, sorghum, seed storage

1. Introduction

Sorghum popularly known as Jowar is the fifth most important cereal crop in the world after wheat, rice, maize and barley. It is found in the arid and semi arid parts of the world, due to its feature of being extremely drought tolerant. The nutritional value of sorghum is same as that of corn and that is why it is gaining importance as livestock feed. Sorghum is also used for ethanol production, starch production, production of adhesives and paper other than being used as food and fodder. Out of the total area under sorghum cultivation in India, 50% is cultivated in Maharashtra. Similarly, out of the total production of sorghum in the nation, 52% is from Maharashtra, Karnataka, Andhra Pradesh and Tamil Nadu (India). One more advantage of this crop is that it can be grown in both *kharif* and *rabi* seasons. Also, it can handle and grow on a wide range of soil types starting from fertile to less nutrient soils. It is realized that there is a wide scope to make the crop popular in dry farming areas and that this crop requires redesigning of agricultural strategy to improve the productivity of the crop by introducing new hybrid seeds and improving input facilities and seed quality during seed storage.

Modern high-tech agriculture with its modern technology demands that each and every seed material should readily germinate and produce a vigorous seedling for ensuring high marketable yield (Maiti and Pramanik, 2013). So, maintenance of seed vigour and viability during storage is a matter of concern in India. Seed coating involves application of required materials to the seed-soil interface and the method allows using minor amounts of materials to affect micro environment of each seed (Gevrek et al., 2012). Seed coating practices have recently become the most studied area with its benefits of reducing costs and increasing the efficiency of the materials (Zeng and Shi, 2008; Tiwari et al., 2011). The losses of stored grain may occur to the extent of 10−15% due to storage pests and fungal moulds development (Pradhan, 1964). The nutritive value of food, viability, vigour and the cooking quality of sorghum seed will be deteriorated due to these biotic constraints during storage. Film coating technology is a sophisticated process of applying precise amount of active ingredients along with a liquid material directly on to the seed surface without obscuring its shape and the total seed weight may increase upto 1 to 2% (Kunkur et al., 2007; Shakuntala et al., 2010). The film formulations consist of a mixture of polymer, plasticizer and colourants

(Robbani, 1994) that are commercially available as ready to use liquids or as dry powders (Ni, 1997). Seed coating provides an opportunity to package effective quantities of materials so that they can improve the germination and seedling growth. The polymer film coating may act as physical barrier, which has been reported to reduce the leaching of inhibitors from the seed coverings and may restrict oxygen diffusion to the embryo (Vanangamudi et al., 2003). Seed coating with synthetic polymer (polykote) in combination with fungicides may be a potent tool for quality hybrid seed storage and effective disease management against seed and soil-borne pathogens (Pham Long Giang and Rame Gouda, 2007). It is a need of the day to develop polymer based seed coats that can prevent moisture entry, fungus penetration and insect attack during storage (Kumar et al., 2007). Hence, the preset study was taken up with an objective of understanding the effect of polymer coating along with insecticide and fungicide on viability, vigour and other qualitative parameters of sorghum over a period of storage.

2. Materials and Methods

The study was conducted at Seed Research and Technology Centre, Rajendranagar, ANGRAU, Hyderabad (India) during 2009–10 and 2010–11. Freshly harvested produce of sorghum hybrid CSH-9 was collected and cleaned, dried and treatments viz., Polymer coating @ 3 ml kg^{-1} seed (T_1); Polymer coating+Thiram (75% wp @ 2.5 g kg^{-1}) (T_2), Polymer coating+Imidacloprid (@ 4 ml kg^{-1}) (T_3), Polymer coating+Thiram+Imidacloprid (T_4) and Vitavax 200 @ 2 g kg^{-1} seed (T_5) along with untreated control (To) were imposed. The treated and un-treated seed packed in cloth and polythene bags (700 Gauge) were stored under ambient storage conditions in the laboratory. Data were collected on various seed quality parameters during storage at bimonthly intervals. The analysis was carried out using Factorial CRD. The statistical analysis was done as per procedure described by Panse and Sukhatme (1985).

3. Results and Discussion

3.1. *Effect of polymer coating on germination of seed*

The germination per cent was gradually decreased with increase of storage period. After 10 months of storage it was observed that the seed coating with polymer+imidacloprid and polymer coating+thiram+imidacloprid were found to be superior with highest percent of germination (76) when stored in polythene bag during 2009−10 (Table 1). The decline in the germination per cent might 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 and storage conditions (Kunkur et al., 2007). Thiram act as a protective agent seed deterioration due to fungal invasion and physiological ageing as a result of which seed viability was maintained for a comparatively longer period of time (Savitri et al., 1994). The film formed around the seed coat acts as a physical barrier. The higher germination of seed coated with polymer is due to increase in rate of imbibition. There was no significant difference between the containers used. Both cloth bag and polythene bag performance with respect to germination per cent was on par with each other. When the experiment was repeated during 2010−11 also the treatment similar results were realized (Table 2). The same treatment polymer coating+thiram+imidacloprid recorded significantly superior performance with respect to germination (75%) was recorded over other treatments besides control. These findings are in agreement with the results of Veraja and Rai (2015) in blackgram and Rattinassababady et al. (2012).

Table 1: Influence of seed coating with polymer, fungicide and insecticide on germination (%) of sorghum seeds during storage (2009−10)

Treatment (T)	Duration (Months after storage)												
Container (C)	Initial		2		4		6		8		10		Mean
	C_1	C_2	C_1	C_2	C_1	C_2	C_1	C_2	C_1	C_2	C_1	C_2	
T_0	86	88	91	93	80	82	74	78	70	74	62	66	79
T_1	88	89	90	91	81	83	79	80	72	75	66	70	80
T_2	89	90	92	95	86	90	82	85	76	81	70	74	84
T_3	89	90	89	91	84	86	79	85	77	80	73	76	83
T_4	88	89	92	90	87	90	79	84	78	82	75	76	84
T_5	88	89	79	92	80	87	78	80	74	76	67	71	80
Mean	88	89	89	92	83	86	78	82	74	78	68	72	
	C		T		D		C×T		C×D		T×D		C×T×D
CD (p=0.05)	0.31		0.54		0.54		0.76		0.76		1.35		1.88

C_1: Cloth bag; C_2: Polythene bag (700 gauges); Duration (D): Months after storage; T_0: Untreated (Control); T_1: Polymer coating (Polykote @ 3 ml kg^{-1} seed); T_2: Polymer coating+thiram (75% wp @ 2.5 g kg^{-1}); T_3: Polymer coating+Imidacloprid (@ 4 ml kg^{-1}); T_4: Polymer coating+thiram+Imidacloprid; T_5: Vitavax 200 @ 2 g kg^{-1} seed

Table 2: Influence of seed coating with polymer, fungicide and insecticide on germination (%) of sorghum seeds during storage (2010–11)

Container (C)	Initial		2 MAS		4 MAS		6 MAS		8 MAS		10 MAS		Mean
	C_1	C_2	C_1	C_2	C_1	C_2	C_1	C_2	C_1	C_2	C_1	C_2	
T_0	86	88	85	87	82	84	74	72	69	70	61	65	77
T_1	88	89	88	83	81	83	78	79	71	75	68	70	79
T_2	89	91	86	90	82	84	73	78	70	74	58	60	78
T_3	89	90	87	89	81	80	74	72	71	67	69	65	78
T_4	88	89	90	93	84	89	80	85	74	77	70	75	83
T_5	88	89	84	86	78	83	72	78	70	75	65	70	78
Mean	88	89	86	88	81	84	75	77	70	72	65	67	
	C		T		D		C×T		C×D		T×D		C×T×D
CD (*p*=0.05)	0.35		0.60		0.60		0.85		0.85		1.48		2.09

3.2. *Effect of polymer coating on seedling vigour index (SVI)*

Similarly, After 10 months of storage the highest seed vigour index of 2895 and 2205 was recorded with treatment polymer coating+thiram+imidacloprid during 2010 and 2009 respectively which is significantly superior over control when the seed was stored in polythene bag (Table 3 and 4). The sorghum seed stored in polythene bag was proved to be superior over cloth bag with respect to seedling vigour of 2604 and 1987 during 2009 and 2010, respectively. The higher SVI in polymer coating along with fungicide and insecticides might be due to more germination, root and shoot length and seedling dry weight. These findings are in line with Verma and Verma (2014) in sorghum, Almeida et al. (2014) in rice Kaushik et al. (2014) in maize and Gomathi et al. (2014) in blackgram. The polymer coating and chemical treatments keep the seed intact, as it acts as binding material; it covers the minor cracks and aberration as the seed coat thus blocking the fungal invasion. It may also act as a physical barrier, which reduces leaching of inhibitors from seed covering and restricts oxygen movement and thus reducing the respiration of embryo thereby reducing the ageing effect on seeds (Vanangamudi et al., 2003). Further, the synergetic effect of both polymers and chemicals might have contributed for better germination and vigour and slow down the process of deterioration as compared to control.

3.3. *Effect of polymer coating on field emergence*

Superior performance was also noticed for field emergence in sorghum seed coated with polymer coating+thiram+ imidacloprid and stored in polythene bag. Mean field emergence to a tune of 81% was noticed in this treatment. However, untreated control seed lot recorded only 69% of field emergence during 2010. The superiority was also seen during 2009, where 79% of field emergence recorded in the treated lot (T_4) (Table 5 and 6). The higher field emergence of seed coated with polymer was due to increased rate of imbibitions, where the fine particles of coating act as moisture attracting material. However, control showed 69% of field emergence. Similar results were also reported by Pham Long Giang and

Table 3: Influence of seed coating with polymer, fungicide and insecticide on vigour index of sorghum seeds during storage (2009–10)

Treatment (T)	Duration (Months after storage)												
Container (C)	Initial		2		4		6		8		10		Mean
	C_1	C_2	C_1	C_2	C_1	C_2	C_1	C_2	C_1	C_2	C_1	C_2	
T_0	2552	2564	2416	2897	2492	2622	2454	2418	1805	2132	1174	1735	2271
T_1	2894	3771	2776	3207	2400	2320	2380	2765	1986	2290	1896	1922	2550
T_2	2525	3712	2721	3395	2217	2953	2163	2724	2120	2485	1920	2215	2595
T_3	1694	2795	2411	2685	2010	2215	2065	2173	1965	2169	1695	1964	2153
T_4	2920	2959	2685	2903	2290	2840	2286	2836	2037	2705	1987	2205	2526
T_5	2009	2009	2903	2112	1601	2064	1562	1905	1455	1809	1105	1603	1741
Mean	2432	2968	2390	2866	2168	2502	2151	2469	1894	2265	1629	1940	
	C		T		D		C×T		C×D		T×D		C×T×D
CD (*p*=0.05)	3.36		5.82		5.82		8.23		8.23		14.25		20.15

Table 4: Influence of seed coating with polymer, fungicide and insecticide on vigour index of sorghum seeds during storage (2010–11)

Treatment (T)	Duration (Months after storage)												
Container (C)	Initial		2		4		6		8		10		Mean
	C_1	C_2	C_1	C_2	C_1	C_2	C_1	C_2	C_1	C_2	C_1	C_2	
T_0	2945	2832	2632	2749	2509	2432	2497	2334	2205	2125	1959	2014	2436
T_1	2861	3428	2424	3572	2386	3221	2308	3187	2251	2734	1985	2336	2724
T_2	2592	2636	2363	2376	2245	2234	2120	2187	1986	1854	1854	1756	2183
T_3	2564	2756	2456	2572	2325	2364	2154	2031	1965	2014	1554	1959	2226
T_4	3051	3203	3185	3570	2935	3315	2930	3004	2709	2914	2604	2895	3026
T_5	2954	3016	2735	2861	2532	2741	2233	2630	1924	2241	1654	1965	2457
Mean	2828	2632	2489	2374	2173	1935	2978	2950	2718	2562	2314	2154	
	C		T		D		C×T		C×D		T×D		C×T×D
CD (p=0.05)	1.61		2.80		2.80		3.96		3.96		6.85		9.69

Table 5: Influence of seed coating with polymer, fungicide and insecticide on field emergence (%) of sorghum seeds during storage (2009–10)

Treatment (T)	Duration (Months after storage)												
Container (C)	Initial		2		4		6		8		10		Mean
	C_1	C_2	C_1	C_2	C_1	C_2	C_1	C_2	C_1	C_2	C_1	C_2	
T_0	76	82	73	76	70	74	66	70	62	67	54	61	69
T_1	83	85	78	75	77	78	73	75	67	70	62	68	74
T_2	85	84	71	69	72	72	70	72	60	70	63	65	71
T_3	84	85	80	80	76	79	73	75	69	70	63	68	75
T_4	86	86	84	87	80	84	75	80	70	75	68	72	79
T_5	83	86	80	80	75	76	70	72	65	69	66	65	74
Mean	82	85	78	78	75	77	71	74	65	70	63	66	
	C		T		D		C×T		C×D		T×D		C×T×D
CD (p=0.05)	0.43		0.74		0.74		1.05		1.05		1.81		2.57

Table 6: Influence of seed coating with polymer, fungicide and insecticide on field emergence (%) of sorghum seeds during storage (2010–11)

Treatment (T)	Duration (Months after storage)												
Container (C)	Initial		2		4		6		8		10		Mean
	C_1	C_2	C_1	C_2	C_1	C_2	C_1	C_2	C_1	C_2	C_1	C_2	
T_0	76	82	73	76	70	74	66	70	62	67	54	61	69
T_1	83	85	75	79	72	79	71	75	65	70	59	65	73
T_2	83	84	78	77	67	80	73	87	69	78	63	73	76
T_3	84	85	72	84	68	73	72	79	69	70	65	69	74
T_4	86	87	85	87	82	89	80	84	75	79	70	73	81
T_5	82	88	76	78	73	74	70	72	68	71	62	69	74
Mean	82	85	76	80	72	78	72	78	68	72	62	68	
	C		T		D		C×T		C×D		T×D		C×T×D
CD (p=0.05)	0.36		0.62		0.62		0.88		0.88		1.52		2.15

Rame Gowda (2007) in hybrid rice. Higher field emergence recorded in chemical treated seeds might be due to the protection of seeds by the chemicals and polymers against storage insects and moulds development, which intern help in better establishment of seedling.

4. Conclusion

Efforts were made to identify the suitable polymer combination treatment that could reduce the deterioration and improve the seed viability during storage. From the observations it is inferred that the seeds coated with different combinations of polymer with insecticides and fungicides deteriorate at slower pace as manifested with higher percentage germination and vigour with less seed infection over the control.

5. References

Almeida, A.D.S., Deuner, C., Borges, C.T., Jauer, A., Meneghello, G.E., Tunes, L.M., Villela, F.A., Zimmer, P.D., 2014. Physiological performance of rice seed treated to thiamethoxam and placed under storage. American Journal of Plant Science 5, 3788.

Gevrek, M., Gulden, A.D., Ali, Y., 2012. Growth and yield response of rice (*Oryza sativa* L.) to different seed coating agents. International Journal of Agriculture and Biology 14(5), 826–830.

Gomathi, G., Malarkodi, K., Ananthi, M., 2014. Pre sowing seed management techniques on initial seed quality parameters in blackgram Cv. ADT-3. International Journal of Scientific Research 3(1), 13–14.

Kaushik, S.K., Rai, A.K., Singh, V., 2014. Seed quality of maize with polymer film coating in storage. International Journal of Innovative Research Science, Engineering and Technology 3(7), 14353−14358.

Kumar, J., Nisar, K., Arun Kumar, M.B., Walia, S., Shakil, N.A., Prasad, R., Parmer, B.S., 2007. Development of polymeric seed coats for seed quality enhancement of Soyabean (*Glycine max*). Indian Journal of Agricultural Sciences 77(11), 738–43.

Kunkur, V., Hunje, R.N.K., Patil, B., Vyakaranahal, B.S., 2007. Effect of seed coating with polymer, fungicide and insecticide e on seed quality in cotton during storage. Karnataka Journal of Agricultural Sciences 20(1), 137–139.

Maiti, R., Pramanik, K., 2013. Vegetable seed priming: a low cost, simple and powerful technique for farmers' livelihood. International Journal of Bio-resource and Stress Management 4(4), 475–481.

Ni, B.R., 1997. See coating, film coating and pelleting. In: Seed Industry and Agricultural Development. Chinese Association of Agricultural Sciences. DOA, Ministry of Agriculture, Beijing, China Agriculture press, 737–747.

Panse, V.G., Sukhatme, P.V., 1985. Statistical Methods for Agricultural Workers. ICAR Publication, New Delhi, 327–340.

Pham, L.G., Gowda, R., 2007. Influence of seed coating with synthetic polymers and chemicals on seed quality and storability of hybrid rice (*Oryza sativa* L.). Omonrice 15, 68–74.

Pradhan, S., 1964. Assessment of losses caused by insect pests of crops and estimation of insect population. Entomology in India (Silver Jubilee Number) 17, 50.

Rettinassababady, C., Ramanadane, T., Renuka, R., 2012. Role of polymer coating on seed quality status of hybrid rice (*Oryza sativa* L.) during storage under coastal ecosystem. Journal of Biological and Chemical Research 29(2), 142–150.

Robbani, H., 1994. Film coating horticultural seed. Horticultural Technology 4, 104–105.

Savitri, H., Sugunakar Reddy, M., Murali Mohan Reddy, B., 1994. Effect of seed treatment with fungicides and insecticides on seed-borne fungi, storage insect pests, seed with fungicides and insecticides on seed borne fungi, storage insect pests, seed viability and seedling vigour in sorghum. Seed Research 22(2), 146–155.

Shakuntala, N.M., Vyakaranahal, B.S., Shakargowda, I., Deshpande, V.K., Pujari, B.T., Nadaf, H.L., 2010. Effect of seed polymer coating on growth and yield of sunflower hybrid RSFH-130. Karnataka Journal of Agricultural Sciences 23(5), 708–711.

Tiwari, D.K., Pandey, P., Giri, S.P., Dwivedi, L., 2011. Effect of gibberellic acid (GA_3) and other plant growth regulators on hybrid rice seed production. Asian Journal of Plant Science 10, 133–139.

Vanangamudi, K., Srimathi, P., Natarajan, N., Bhaskaran, M., 2003. Current scenario of seed coating polymer. In: proceedings of ICAR-short course on seed hardening and pelleting technologies for rainfed garden land ecosystems, New Delhi, 80–100.

Veraja, P., Rai, P.K., 2015. Effect of polymer coating chemicals and biocontrol agents on storability of blackgram (*Vigna mungo* L.). International Journal of plant and soil science 8(6), 1-8.

Verma, O., Verma, R.S., 2014. Effect of seed coating material and storage containers on germination and seedling vigour of soybean (*Glycine max* L.). SAARC Journal of Agriculture 5, 3788.

Zeng, D., Shi, Y., 2008. Preparation and application of a novel environmentally friendly organic seed coating for rice. American-Eurasian Journal of Agronomy 1, 19–25.