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RESEARCH ARTICLE

Effect of seed coating polymers on performance in soybean (*Glycine max*. L) Var. JS335

■ **Jitendra Kumar S. Hilli, Rehan Malik, A.G. Vijayakumar and Ravi Hunje**

SUMMARY

Seed coating especially film coating, is one such technique which has gained commercial importance owning to its practical utility as an effective delivery system as seed protectant and fortifying chemicals which maintain good germinability and vigour in field as well as laboratory *viz.,*strong seedlings grow faster than less vigorous ones, are more tolerant to adverse conditions in the seedbed and are better to resist diseases. Seeds of soybean cv. JS-335 were coated with polymer (*(DISCO AG SP RED L-200)*, protectant (thiram and carboxin), bioagent (*Mycorrhiza*) and polymer untreated seeds as control. It was observed that, irrespective of the treatments, the seed quality parameters declined progressively with the increase in storage period (12 months). Under field conditions, higher vigour (2348) was noticed in seed treated with polymer (DISCO AG SP RED L-200) + Thiram + Quick roots **/ *Mycorrhiza* and lower vigour was seen inno polymer treatment or water + thiram. The field emergence (%) revealed that all the three polymer seed coating treatments were on par at 30 DAS (78.07 %, 77.19 % and 77.19 %) and 50 DAS (80.99 %, 80.11 % and 79.56 %) when compared to control treatment *i.e.,* no polymer treatment or water + thiram at 30 DAS (71.68 %) and 50 DAS (71.30 %), respectively. Among the yield attributes, significant difference was observed in seed yield/plant with treatment polymer (DISCO AG SP RED L-200) + Thiram + Quick roots **/ mycorrhiza registering highest (22.20 g) yield, while the lowest (18.40 g) yield was observed in polymer untreated or water + thiram.

Key Words : Soybean, Polymer coating, *Mycorrhiza,* Germination, Seed vigour, Protectants

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Soybean [*Glycine max* (L.) Merrill] is known as Golden bean and is commonly referred as 'miracle crop' or 'gold from soil'. It is playing an important role in overcoming the present shortage of edible oil and vegetable proteins in India as it contains 20 per cent oil, 21 per cent starch and 40 per cent high quality protein.

One of the major constraints in the endeavor of increasing productivity in soybean is its susceptibility to a large number of diseases caused by fungi, bacteria, viruses and nematodes. Another constraint is seed viability and vigour which is a major factor in crop stand establishment and subsequent productivity in many parts of the world. Losses in seed quality occur during field weathering, harvesting and storage, if the crop is exposed to high temperature and humidity. Seed coating materials are known to improve the germination and increase the seedling emergence at changing soil moisture especially in the suboptimal range (Mucke, 1987).

When seeds are exposed to high temperature and high humidity, the incidence of micro flora is mainly responsible for the degradation of protein and other food reserves resulting in reduction in viability, vigour and germination. Seed is an efficient media for survival and dissemination of pathogens and pests. To reduce the losses and preserve the viability for longer time, it is advisable to coat the seeds with polymer, fungicide and insecticide. Seed polymer coating is the sophisticated process of applying precise amount of active ingredients along with a liquid polymer directly on to the seed surface without obscuring its quality. It is one of the most economic approaches for improving the performance of seed, which enables accurate and uniform coating of chemicals and reduces chemical wastage. It also paves way for including all the required ingredients like inoculants, protectants, nutrients, hydrophilic substances, herbicides, oxygen suppliers etc. (Sherin *et al*., 2005).

Increased germination can be observed in polycoated seeds, due to increase in the rate of imbibition's where the fine particles in the coating act as a 'wick' or moisture attracting material or perhaps to improve soil seed contact. Coating with hydrophilic polymer regulates the water uptake, reduces imbibitional damage and improves the emergence of soybean seeds (Hwang and Sung, 1991). By encasing the seed within a thin film of biodegradable polymer and adherence of seed treatment chemicals to the seed, it ensures dust free handling and makes treated seed both useful and environment friendly. The polymer coating is simple to apply, diffuses rapidly and is non- toxic to the seed during germination . Polymer coating makes sowing operation easier due to the smooth flow of seeds. Addition of colorant helps in visual monitoring of placement accuracy, enhance the appearance, marketability and consumer preference. Inview of these aspects, the present investigation was carried out to pursue consequences of seed polymer coating on performance in soyabean.

MATERIAL AND METHODS

The experiment was conducted in National Seed Project, University of Agricultural Sciences, Dharwad during *Kharif* season, 2017-18. Five kilograms of freshly harvested seed of soybean cv. JS-335 was collected and sent to INCOTEC Pvt Ltd. to treat the seeds with the polymers and recommended general plant protectants/ additives. The polymer and recommended additives treatedmaterial was assessed under laboratory conditions for seed quality parameters, storability studies for one year at every two months intervaland evaluated under field conditions. The experiment was laid out in Randomized Block Design (RBD) with a plot size 5 m x 5 m with four replications and four treatments. Recommended package of practices were followed. The different seed treatment combinations used for the experiment were:

T_1 : No polymer treatment or water + thiram

T_2 : Polymer (DISCO AG SP RED L-200) + Thiram+ Carboxine

T_3 : Polymer (DISCO AG SP RED L-200) + Thiram + Genius Coat **

T_4: Polymer (DISCO AG SP RED L-200) + Thiram + Quick Roots **/ mycorrhiza

The laboratory studies comprised of germination per centage and seedling vigour index at 2 month interval for one year storage period in laboratory as well as field condition. The field observations included field emergence (%) at 30 days and 50 days, plant height at vegetative stage, flowering stage and at harvest, final plant stand at maturity, days to 50 per cent flowering, number of branches per plant, number of pods per plant, hundred seed weight (g) and seed yield per plant (g).

RESULTS AND DISCUSSION

The rate of seed deterioration can be slowed down either by storing the seeds under controlled conditions or by imposing certain treatments with either chemicals or any other protectants. Seed coating with polymer is one such pre-storage treatment that can be used either singly or in combination with other fungicides/pesticides/ seed enhancing chemicals to protect the seeds against pest and diseases as well as improved performance. Duan and Burris (1997) explained the possibilities of using polymers along with other chemicals to maintain the quality of the seeds. The rapid deterioration of stored seed is a serious problem, particularly in the tropical and sub-tropical regions where high temperature and relative humidity prevails and is associated with accelerated ageing phenomenon. Since, the controlled condition involves huge cost; the polymer seed coating could be one of the best alternative approaches to maintain seed quality during storage and protects the crop during their growth stages.

Germination per cent and seedling vigour index under laboratory conditions:

In the present investigation, irrespective of the treatments, the seed quality parameters declined progressively with the increase in storage period. The treatments differed significantly for germination percentage and seedling vigour index (Table 1 and 2) under lab conditions during course of storage. In the initial months, the germination per cent (85.60 %, 85.22% and 84.64 %) was found on parin the treatments *viz*., polymer (DISCO AG SP RED L-200) + Thiram + Genius Coat **, Polymer (DISCO AG SP RED L-200) + Thiram + Quick roots **/ mycorrhiza and polymer (DISCO AG SP RED L-200) + Thiram+ Carboxine, respectively and lower (78.60 %) in polymer untreated (water + thiram). Whereas, seedling vigour didnot show significant difference for treatments. After 12 months of storage significant differences were observed with a higher germination per cent and seedling vigour (46.33 % and 1083) in Polymer (DISCO AG SP RED L-200) + Thiram + Genius Coat ** and lower (33.47 % and 666) in polymer untreated (water + thiram).

Increase in storage period leads to decrease in vigour index, which was noticed irrespective of seed treatments. This decrease in seed quality during storage may be attributed to ageing effects, leading to depletion of food reserves and decline in synthetic activity of the embryo apart from death of seeds because of fungal invasion (Gupta *et al.,*1993). The fungicide protected by polymer enhances their efficiency till the end of storage period. It forms a flexible film that adheres and protects the fungicides preventing dusting off and loss of fungicide

Table 1: Effect of polymer coating on germination per centage under laboratory conditions during storage in soyabean

	Treatments	Intial months	2 months	4 months	6 months	8 months	10 months	12 months
T_1	Polymer untreated (water + thiram)	78.60	71.80	70.70	61.31	52.12	40.82	33.47
T_2	Polymer (DISCO AG SP RED L-200) + Thiram+ Carboxine	84.64	81.25	78.55	71.48	60.76	49.21	40.36
T_3	Polymer (DISCO AG SP RED L-200) + Thiram + Genius Coat *	85.60	82.71	79.77	72.59	65.61	53.14	46.33
T_4	Polymer (DISCO AG SP RED L-200) + Thiram + Quick Roots **/ mycorrhiza.	85.22	81.81	78.42	71.98	61.18	49.56	40.64
S.E.±		1.43	1.64	1.45	2.18	2.12	1.56	1.07
C.D. (P=0.01)		4.40	5.05	4.47	6.71	6.54	4.81	3.29

Table 2: Effect of polymer coating on seed vigour under laboratory conditions during storage in soyabean

	Treatments	Intial months	2 months	4 months	6 months	8 months	10 months	12 months
T_1	Polymer untreated (water + thiram)	2609	2305	2022	1535	1148	803	666
T_2	Polymer (DISCO AG SP RED L-200) + Thiram+ Carboxine	2938	2744	2484	2112	1526	1137	923
T_3	Polymer (DISCO AG SP RED L-200) + Thiram + Genius Coat **	2952	2744	2476	2126	1683	1255	1083
T_4	Polymer (DISCO AG SP RED L-200) + Thiram + Quick Roots **/ mycorrhiza.	2981	2767	2476	2135	1597	1190	947
S.E.±		118	98	89	104	83	55	37
C.D. (P=0.01)		NS	302	274	319	255	170	116

NS= Non-significant

during storage.The polymer also prevents moisture content fluctuations during storage (West *et al*., 1985). Thus, may result in higher percentage and better germination of seedlings in seeds coated with polymer, fungicide and insecticide as this protects fungi invasion and insect attack thereby good and better germination and subsequent higher root and shoot length. Struve and Hopper (1996) reported cotton seeds coated with polymer recorded slower imbibitional rate, reduced the imbibitional damage, lowered the electrical conductivity values and improved the germination. These findings are in agreement with results obtained by Hunje *et al*. (1990) in cowpea.

Seedling vigour, field emergence, plant growth and yield attributes under field conditions:

Under field conditions, significant variations in vigour was noticed for various treatments under study and the data is represented in Table 3. Higher vigour (2348) was noticed in treatment polymer (DISCOAG SP RED L-200) + Thiram + Quick roots **/ mycorrhizaand lower (1707) in polymer untreated (water + thiram). Incase of field emergence per centage, all the three polymer seed coating treatments were on par at 30 DAS (78.07 %, 77.19 % and 77.19 %) and 50 DAS (80.99 %, 80.11 % and 79.56 %) when compared to control treatment *i.e.,* polymer untreated (water + thiram) at 30 DAS (71.68 %) and 50 DAS (71.30 %), respectively.

All the seed polymer coating treatments have shown better performance in respect of field emergence as compared to untreated polymer. The higher germination percentage can be seen in polymer coated seeds, it is due to increase in the rate of imbibition where the fine particles in the coating act as moisture attracting material to improve germination and vigour under stress conditions. Similar results were also reported by Geetharani *et al*. (2006) in chilli and Kunkur *et al*. (2007) in cotton. The polymer coat on seed acts as a physical barrier that has been reported to reduce leaching of inhibitors from the seed coverings and may restrict oxygen diffusion to the embryo (Duan and Burris, 1997).

In case of bioagent, *mycorhizza* showed higher field

Table 3 : Effect of polymer coating on seed vigour under field conditions during storage in soyabean

	Treatments	Intial months	2 months	4 months	6 months	8 months	10 months	12 months
T_1	Polymer untreated (water + thiram)	1707	1327	1056	941	630	440	350
T_2	Polymer (DISCO AG SP RED L-200) + Thiram+ Carboxine	1914	1541	1284	1109	777	574	456
T_3	Polymer (DISCO AG SP RED L-200) + Thiram + Genius Coat **	2003	1702	1457	1258	936	646	554
T_4	Polymer (DISCO AG SP RED L-200) + Thiram + Quick Roots **/ mycorrhiza.	2348	1963	1604	1443	1160	693	567
S.E. ±		118	94	65	79	54	30	24
C.D. (P=0.05)		364	289	202	245	166	91	74

Table 4: Effect of polymer coating on field emergence and plant height in soyabean

	Treatments	Field emergence (%)		Plant height (cm)		
		30 DAS	50 DAS	Vegetative stage	Flowering stage	Harvest stage
T_1	Polymer untreated (water + thiram)	71.68	70.30	34.28	43.19	58.74
T_2	Polymer (DISCO AG SP RED L-200) + Thiram+ Carboxine	77.19	79.56	35.07	44.19	60.10
T_3	Polymer (DISCO AG SP RED L-200) + Thiram + Genius Coat **	78.07	80.99	40.01	50.42	68.56
T_4	Polymer (DISCO AG SP RED L-200) + Thiram + Quick Roots **/ mycorrhiza.	77.72	80.11	40.37	50.87	69.18
S.E.±		1.30	1.60	1.03	1.30	1.77
C.D. (P=0.05)		4.01	4.94	3.18	4.01	5.46

emergence with minimum activity of the pathogen which subsequently enhanced seed germination. It could be attributed due to production of not only antifungal compounds but also growth regulating chytinolytic enzymes like glucanases and proteases and thereby reducing the pathogenic activity. Improvement of seedling emergence in seed coating with polymer might be due to regulated rate of water uptake, reduced imbibition damage and improved germination. Similar observations were made by Krishnamurthy *et al.,* (2003) in pulses.

Plant height, number of branches/plant, days to 50 per cent flowering and final plant stand at maturity

Significant differenceswere noticed in plant height at vegetative stage, flowering stage and harvest stage that recorded higher values (40.37 cm, 50.87 cm and 69.18 cm, respectively) in treatment Polymer (DISCO AG SP RED L-200) + Thiram + Quick Roots **/ mycorrhiza, which was on par (40.01 cm, 50.42 cm and 68.56 cm, respectively) with the treatment Polymer (DISCO AG SP RED L-200) + Thiram + Genius Coat ** and lowest plant height (34.28 cm, 43.19 cm and 58.74 cm, respectively) in polymer untreated (water + thiram). Similar results were also obtained by Vinodkumar *et al.* (2013) in pigeonpea, Suma and Srimathi (2014) in sesame and Verma and Verma (2014) in soybean.

Number of branches per plant were recorded higher (9.73) in Polymer (DISCO AG SP RED L-200) + Thiram + Quick roots **/ mycorrhiza and lower (7.50) in polymer untreated (water + thiram). However, number of days taken to 50 per cent flowering was lower (42.05 days) in polymer (DISCO AG SP RED L-200) + Thiram+ Carboxine and higher (45.60 days) in polymer (DISCO AG SP RED L-200) + Thiram + Quick roots **/ mycorrhiza. Better seedling growth and vigour due to enhanced metabolic activities in early phases of germination leading to more number of branches per plant. These results are in conformity with the earlier findings of Taylor *et al.* (2001) in onion, Vanangamudi *et al*. (2003) in maize and Larissa *et al.* (2004) in bean.

Final plant stand at maturity was highest (79.19 %) in treatment polymer (DISCO AG SP RED L-200) + Thiram + Quick roots **/ mycorrhiza and lowest (65.67 %) in polymer untreated (water + thiram). Seed treatment with bioagent and fungicide produced better seedling stand than untreated polymer. This may be due to the suppression of seed borne pathogens during germination. A biological control agent that can function in combination with fungicide seed treatments suppresses and control seedling diseases. Similar results were reported by Howell *et al.* (1997).

Hundred seed weight did not differ significantly yet highest seed weight (11.70 g) was recorded in polymer untreated (water + thiram) and lower (10.57 g) in polymer (DISCO AG SP RED L-200) + Thiram + Quick roots **/ mycorrhiza. The increase in seed weight in the respective treatment may be due to number of pods/ plant were found lower which resulted in more dry matter production and availability ofphotosynthates for sink which ultimately resulted in more seed weight. Similar findings were observed by Tripathi and Singh (1991); Anuja *et al.* (2000); Taywede *et al.* (2002) and Rezende *et al.* (2003).

Number of pods/plant and seed yield/plant:

Among the yield attributes, significant difference was observed in number of pods/plant and seed yield/ plant with highest (50 and 22.20 g) in treatment *i.e.,*

Table 5 : Effect of polymer coating on yield attributes in soyabean

	Treatments	Final plant stand at maturity (%)	Number of branches/ plant	Days to 50 % Flowering	Number of pods per plant	Seed yield per plant (g)	Hundred seed weight (g)
T_1	Polymer untreated (water + thiram)	65.67	7.50	43.13	40	18.40	11.70
T_2	Polymer (DISCO AG SP RED L-200) + Thiram+ Carboxine	74.20	8.41	42.05	44	19.90	11.46
T_3	Polymer (DISCO AG SP RED L-200) + Thiram + Genius Coat **	77.73	9.01	43.76	48	20.60	10.71
T_4	Polymer (DISCO AG SP RED L-200) + Thiram + Quick Roots **/ mycorrhiza.	79.19	9.73	45.60	50	22.20	10.57
S.E. ±		1.70	0.43	1.30	2.14	0.72	0.38
C.D. (0.05)		5.25	1.32	NS	6.59	2.22	NS

NS= Non-significant

Polymer (DISCO AG SP RED L-200) + Thiram + Quick Roots **/ mycorrhiza and lowest (40 and 18.40 g) in polymer untreated (water + thiram). This increase in the yield parameters may be attributedto higher plant height, seed filling percentage and 100 seed weight. Similar results were also opined by Zholbolsynova *et al.* (1992) who reported that the seed coating with polymer sincreased the yield from 0.93 tonnes to 1.62 tonnes per ha in wheat. Bhatnagar and Porwal (1990) reported higher seed yield of 1.39 t/ha with 200 g/ha seed coating of super absorbent polymer in chickpea.

The increase in number of pods may be due to the more number of branches per plant, decreased flower drop and increased pod setting, nutrient mobilization, nutrient uptake, release of plant growth promoting substances by microbial inoculants and antagonistic activity against pathogens. Similar response due to seed treatment was observed by Tripathi and Singh (1991) and Kanti *et al.* (2013). The increase in per plant yield mass may be attributed to good plant growth and development of the seeds promoted by polymer coating, fungicide and insecticide. Similar results were also reprted by Chikkanna *et al.* (2000); Shakuntala *et al.* (2010) and Vinodkumar *et al.* (2013).

Plant growth promoting substances secreted by microorganism helped in various metabolic activities and reduction of pathogens and in the proliferation of benefical organisms in the rhizosphere which led to higher number of branches and number of pods per plant which in turn led to higher seed yield per plant. Similar findings due to seed treatments were observed by Kawale *et al.* (1989) ; Tripathi and Singh (1991) and Kanti *et al.* (2013) in soybean.Thus, appreciable increase in yield may be attributed to extensive root development and better uptake translocation of nitrogen and phosphorous towards above ground parts.

Conclusion:

The increase in germination per cent, seedling vigour, other growth and yield attributes under laboratory during storage as well as in field condition was better in all the polymer coated treatments compared to no polymer coated seeds. The treatments polymer (DISCO AG SP RED L-200) + Thiram + Quick roots **/ mycorrhiza and polymer (DISCO AG SP RED L-200) + Thiram + Genius coat ** were the best outcome of the investigation.The enhanced germination and quality parameters in treated seeds with fungicides and polymer coating is because of the combined favorable effects of these two chemicals. The fungicides protected the seed from deterioration by reducing the fungal invasion. The effectiveness of fungicides and polymer coating may be due to the compatibility and synergetic effect, which reduced the growth of the pathogen and favored germination and other parameters.

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