

## Seed coating in pulses: An innovative approach for improving seed quality and crop performance

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### ABSTRACT

Seed coating in broad sense includes seed film coating seed coloring and seed pelleting. It enables accurate and uniform sticking/ coating of chemicals, makes room for including all the required ingredients like inoculants, protectants, nutrients, herbicides etc. It ensures dust free handling of treated seed. Polymer coating acts as a temperature switch and protective coat in regulating the intake of water. In pulse seeds the seed coating technology has been tested since more than two decades and positive and significant response of polymer seed coating alone or in combination with insecticide// fungicide//bio-agents//natural fillers on germination seedling vigor, growth, yield improvement, storability and control on pest infestation during storage have been reported by several workers in Soybean, chickpea, pigeon pea, field pea, green gram, black gram, cow pea and beans. Seed coating with polymers along with combination of blitox, hoagland solution and imidachloprid in prescribed doses significantly enhanced the seed quality parameters, growth and yield of soybean over uncoated control. Applying fungicides and rhizobium inoculant to seed for the control of Ascochyta blight in chickpea and field pea and powdery mildew, Downy mildew Seedling root rots (damping off) and Chocolate spot in field pea have also been discussed.

**Key words:** Biochemical attributes, Germination, Growth, Seed Coating, Seed quality, Vigor

### INTRODUCTION

Seed is the most important determinant in effecting productive agriculture on which the efficacy of other agricultural inputs is dependent. Majority of farmers used traditional and poor methods of seed storage which results in the deterioration of seed viability and storability causing poor germination, vigor and plant stand in several crops. The problem of storability is also common in soybean and other crops. To enhance quality of seeds, enhancement techniques viz., priming coating and pelleting can be used. Enhancement of seed quality is very much essential to achieve early and uniform seedling establishment in the field. These enhancement techniques have been evolved along with the development of the crop husbandry, got enriched over time and are being refined in the modern agriculture. Seed quality enhancement technique viz., seed priming, seed pelleting, seed film coating and seed colouring are being applied in agriculture

on different crops as reported by several workers for negotiating adverse biotic and abiotic situations, protecting crops and prolonging the viability and storability of seed. Applying nutrients/fungicides/ insecticides /natural filler through seed coating to protect the crop and also to minimize the cost of cultivation may also be explored.

Any post-harvest treatment that improves germination/seedlings emergence or facilitate the development of more number of normal, rapid, uniform and healthy seedlings in the field condition is termed as seed enhancement. [M C Donald, 2000]

There are two goals of seed enhancement-

- ✓ seed functioning
- ✓ seed designing

These above goals can be achieved by using seed enhancement techniques including seed invigoration (Priming), seed coating and seed pelleting.

### Seed enhancement has two categories

<b>1. Seed Invigoration or Priming</b> a. Osmo priming b. Hydro priming c. Solid matrix Priming d. Halo priming e. Bio priming f. Drum priming	<b>2. Seed Coating</b> a. Seed film coating b. Seed coloring c. Seed Pelleting
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Among the seed enhancement technology, seed coating has a prominent role in future agriculture. Seed coating in broad sense includes

### Differences among the seed coating technologies

Particulars	Seed film coating	Seed coloring	Seed pelleting
Adhesive	Polymer (Plasticizer)	Natural/ synthetic dye	Adhesive, nutrients, filler materials
Use of fungicides /insecticides	Can be	Can be	Can be
Shape of the seed	Not obscured	Not modified	Shape modified in globular unit
Size of the seed	Not modified	Not modified	Modified due to the filler materials
Use of nutrient and bio-fertilizers	Usually combined	Not combined	Can be combined
Process	Coating	Colouring	Stamping, coating and rolling
Safety	Safe	Safe	No safety
Resistance to mechanical injury	More Resistance	No Resistance	More Resistance
Stability	More stable	Depending upon pigment/ dye used	Less Stable
Seed germination and seedling vigour	Improved	Improved	Improved but not preferred by consumers
Applicability	Suitable for dry, garden and wet land	Suitable for dry, garden and wet land	Suitable for only garden / wet land

seed film coating seed coloring and seed pelleting. The differences among these are as under-

**Seed Films coating:** Application of precise amount of active ingredient along with a liquid material directly on to the seed surface without obscuring its shape

**Seed Coloring:** Application of precise amount of dyes or pigments directly on to seed to improve its brand identity and marketability

**Seed Pelleting:** The process of enclosing the seed with small quantity of ingredients along with filler materials to produce a globular unit of uniform size to facilitate precision plantings.

#### Advantage of Film Coating:

Enables accurate and uniform sticking/ coating of chemicals

- It makes room for including all the required ingredients like inoculants, protectants, nutrients, herbicides etc.

- It ensures dust free handling of treated seed
- Addition of colorant helps visual monitoring of placement accuracy
- Provides resistance against mechanical damage in the seed drill
- Polymer coating acts as a temperature switch and protective coat in regulating the intake of water.

#### Seed Pelleting

Seed pelleting is the mechanism of applying needed materials in such a way that they influence the seed or soil and the seed- soil interface (Scott, 1989).

#### Seed Pelleting Technique: Three basic steps-

- Stamping
- Coating
- Rolling

#### Materials Needed:

- Seed
- Adhesive
- Filler material

#### Advantage of Pelleting

- Pelleting regulates the size of seeds for precision planting by machine/ man.
- Singling of seeds and prevention of clogging.
- Attraction of moisture
- Supply of plant growth regulators and micronutrients
- Protection from birds, animals and insects.
- Adoptable even under water stress condition.
- Enhance storability in certain cases and accommodate well with other physiological treatments.

Seed coating is one of the most economical approaches for improving seed performance. The post-harvest seed treatment with polymer chemicals and fungicides and dyes would bring qualitative improvement in the seed, particularly germinability, greater storability and better field performance than the corresponding untreated control. Polymer is a film coating chemical normally applied over seeds without significantly increasing the size or weight of seed. This kind of plasticizer polymer form flexible film that prevents dusting off and loss of fungicide during handling and is readily soluble in water (hydrophilic) so as not to impede with normal germination. (Sherin and Susan John, 2003). They again emphasized that film coating provides protection from the stress imposed by accelerated ageing, which include fungal invasion. It improves plant stand and emergence of seeds and this technique is recommended for high value agricultural crops. The application of polymers to seed serves as an extra exterior shell in order to give the desired seed characteristics viz., quick or delayed water uptake and enhanced germination that would be beneficial for better emergence and establishment in the given condition (Taylor et.al.1998). The positive and significant response of polymer seed coating alone or in combination with insecticide/fungicide/bio-agents/natural fillers on germination seedling vigor, growth and yield improvement have been reported by several workers in Soybean (Hwang and Sung 1991, Gupta and Aneja, 2000) Indian mustard (Rana et.al 2001), and Tomato (Ramya, 2003) crops but the information's in pulse crops in relation to influence of seed coating along with insecticide, fungicide and natural fillers on enhancement of seed quality parameters, control of seed borne diseases and storage pest is very limited and scattered hence an effort has been made to review the works conducted to date as under.

#### **I. Seed coating in relation to germination, growth and yield attributes**

Seed film coating provides an ideal method for application of chemical and or biological seed treatments (Taylor and Harman, 1990). In soybean seed treated with thiram 75 WP + disulfoton + prometryne recorded higher emergence (98.00%) and grain yield (15.16 kg/ha) compared to control (70.00% and 849.00 kg/ha, respectively) as reported by Kawale *et al* (1989). Seed treated with thiram recorded higher germination (75.00%) compared to control (72.00%) after 28 months of storage in

cowpea (Gupta and Dharm Singh, 1990). Seed treatment with 15.00 g imidacloprid (70% ws) per kg of seeds showed positive influence on seedling height and chlorophyll content of leaves (Jarande and Dethe 1994). Soybean seeds Coating with a hydrophilic polymer regulated the rate of water uptake, reduced imbibitional damage and improved the emergence of soybean seeds. Film coating retains the shape and general size of raw seed with minimal weight of the grain (Butler, 1993). The increase in the concentration of coating materials reduced the germination percentage, calcium carbonate was better combined with hydroxymethyl cellulose and carboxymethyl cellulose (Jeong and Cho, 1995). seed coating with thiram increased the percentage of seedling survival in soybean when compared to untreated control (Omar and Rahhal, 1993) treated with thiram recorded higher field emergence (73.70%) and seed yield (74.70 g/plot) compared to control (53.70% and 71.30 g/plot, respectively) as reported by Gupta and Aneja (2000). Soybean seeds treated with thiram (2.00 g/kg of seeds) improved germination (80.75%) and field emergence (70.72%) compared to untreated control. The association of coating and a wettable powder treatment showed a higher germination percentage in dry beans after two months of storage (Pires *et al.*, 2004). to control (79.10% and 58.63%, respectively) as reported by Muthuraj *et al* (2002). Bean seed coated with the polymer and fungicide recorded higher germination (89.00%). Slurry coating of seed with polymer (3.00 g per kg of seed) along with carbendazim (2.00 g per kg of seed) and halogen mixture (3.00 g per kg seed) enhanced the germination and vigor index values by 24.00 per cent, whereas, the pathogen infection was lessened by 1.00 per cent compared to uncoated seeds. This treatment also enhanced the field emergence by 29.00 per cent in the nursery sowing (Geetharani *et al* 2006) Film coating showed that 6 g white red polykote @ 6 g kg<sup>-1</sup> registered higher values for germination, root length, shoot length and vigor index than the uncoated seeds (Vinitha, 2006) compared to control (75.00%) after two months of storage (Larissa *et al* 2004). Deltamethrin 2.8EC@0.3ml/kg seed+vitavax powder@3g/kg seed+polymer seed coating@5ml/kg seed was found superior to enhance growth and yield performance of pigeon pea over untreated control (Vinod Kumar et.al.2014). Seed coating with polymers along with combination of blitox, Hoagland solution and imidachloprid in prescribed doses significantly enhanced the seed quality parameters, growth and yield of soybean over uncoated control and seed coated with polymer alone (@ 3ml/kg seed.

Conclusively, polymer seed coating in combination of fungicide (Blitox@2.5g/kg seed), hoagland solution (5ml/kg seed) and insecticide (imidachloprid @2.5ml/kg seed) may be recommended for improving the seed quality parameters, growth and yield of soybean crop specially when the crop is grown using one-year-old seed lot (Tiwari et.al.2015). Seed treatment with thiram alone or in combination with polymer (PVP or PEM) significantly enhance the germination and field performance of chickpea. The old seed lots give better results than fresh seed lot as reported by Kumar et.al. 2015. Seed polymer coating( @6ml/kg) of chickpea seeds with combination of ZnSo4+Boron+Ammonium Molybdate+FeSO4(each@2.0g/kg) of seed along with two foliar sprays(0.5%+0.2%+0.1%+0.5% respectively as ZnSo4 and FeSo4 in EDTA form) at an interval of 10 days during flowering stage (50 and 60 DAS) recorded significantly higher leaf area index, chlorophyll content, plant height, effective root nodules/plant, seed yield compared to all other treatments and control(Shinde et.al. 2017).

The application of (imidachloprid 17.8%SL @3ml/kg of seed + mancozeb @3g/kg of seed + PSB @4g/kg seed+ polymer coat @5ml/kg of seeds) was found to be significantly superior in growth, seed yield and quality parameter viz. No. of primary branches, number of pod per plant, number of seeds per pod, seed yield per plant and seed yield per hectare as compare to control (T0). Seed quality parameters were also influenced as compare to untreated control (Ovalesha et. al. 2017). Kabuli chickpea seeds treated with polymer (20 ml/kg seed) +Vitavax (3g/kg seed) recorded significantly higher seed quality parameters, yield attributes and better storability (Roopashree et.al. 2018). Application of polymercoat@3ml/kg seed+combi product of carbendazim 12% and mancozeb 63%(saaf)23g/kg seed+*Pseudomonas fluoescens* @30 g/kg seed was found superior for improvement of seed quality parameters, growth and yield attributes of green gram over untreated control (Heena kouser et.al. 2020). Talha Zaved et. al. 2022 reported that application of coatings through seed coating improves germination phases, advance phenological events, enhance physio-morphological attributes, yield and most importantly the restoration efficacy of seed. In addition, seed coating offers an attractive option as a tool for enhancing crop establishment by propelling the challenges faced to agricultural systems and restoration of degraded system. This review summarizes comprehensive information on various seed coating technologies and their

potential role for achieving a cost effective eco system by increasing food security.

## II. Seed coating in relation to control of seed borne diseases-

Seed treatment is a term that describes both products and processes. The usages of specific products and specific techniques can improve the growth environment for the seed, seedlings and young plants. Seed treatment complexity ranges from a basic dressing to coating and pelleting. **Seed dressing** is the most common method of seed treatment. The seed is dressed with either a dry formulation or wet treated with a slurry or liquid formulation. Dressings can be applied at both farm and industries. Low cost earthen pots can be used for mixing pesticides with seed or seed can be spread on a polythene sheet and required quantity of chemical can be sprinkled on seed lot and mixed mechanically by the farmers. Whereas in **Seed coating**, a special binder is used with a formulation to enhance adherence to the seed. Coating requires advanced treatment technology, by the industry. **Seed pelleting** is the most sophisticated Seed Treatment Technology, resulting in changing physical shape of a seed to enhance pelletibility and handling. Pelleting requires specialized application machinery and techniques and is the most expensive application. Several fungicides and insecticides have been found to be effective in combination with polymer for controlling seed borne fungi and pest to enhance seed quality. Soybean seeds treated with thiphanatemethyl (Topsin-M) and benomyl effectively controlled the fungus *Macrophomina phaseolina* (Ali et al 1995) Whereas seed treatment with thiram and emison found to be more effective in controlling seed mycoflora.

Treating pulse seed with a fungicide reduces the establishment of seed-borne diseases in crops and also protects seed from infection by soil-borne fungi. Some fungicide seed dressings also protect seedlings from external airborne infection for the first few weeks. This is important in reducing the subsequent establishment and spread of disease within crops. Seed treatments provide effective control for a maximum of four to six weeks after sowing, but do not provide absolute control. Application is important for seed treatments to be evenly distributed on seed to ensure each seed gets an effective dose. This is enhanced for flowable seed treatments by dilution with water (refer to the label). Secondary mixing of treated seed through an auger assists to obtain even seed coverage. Correct

calibration of the applicator and a consistent seed flow are critical for the recommended rate of seed treatment to be applied.

### **Applying fungicides and rhizobium inoculants to seeds.**

Some fungicides are toxic to rhizobium, and should not be mixed together before application to seed. Read the labels for compatibilities. Ideally, seed should be treated with fungicide and then, in a separate operation, inoculated with rhizobium just before sowing. Sowing should occur immediately after rhizobium has been applied, particularly in acid soils. Granular or liquid injection of inoculum in-furrow eliminates the contact between seed treatments and rhizobia

### **Chickpea - Ascochyta blight (*Ascochyta rabiei*)**

A seed treatment containing thiram (eg. Thiragranz, Thiraflo, Thiram) or thiram plus thiabendazole (eg P-Pickel T, Fairgro, Reaper TT) is essential to control seed-borne infection. Epidemics can start from a very low level of seed infection, and it is recommended that all seed be treated.

**Field Pea - Ascochyta blight (*Mycosphaerella pinodes*, *Phoma medicaginis*, *Ascochyta pisi*, *Phoma koolunga*)**

Paddock selection and sowing time are the keys to minimize yield loss to ascochyta blight in pea. Treat seed with products containing thiram plus thiabendazole, (Pickel T, Fairgro or Reaper TT) to minimize the establishment of disease early or in new areas. Early sown peas (May) and those sown next to pea stubbles are more likely to benefit from seed treatment. Later sown peas (mid-June) will have less black spot infection and seldom benefit from seed treatment. On acidic soils where the survival of seed applied rhizobium and maximizing nodulation is important, seed treatment with thiram plus thiabendazole is only recommended for high disease risk situations (e.g. if crop rotation with field pea is short). Use of granular or liquid injection of inoculants may alleviate rhizobia-fungicide conflicts.

### **Downy mildew (*Peronospora viciae*)**

There is a high risk of downy mildew at crop emergence if the disease has occurred in the paddock previously. Downy mildew is effectively controlled with products containing metalaxyl (Apron XL, Rampart or Mantle or Medley) used as a seed treatment. Treatment can improve yield by as

much as 60% in susceptible varieties, but will have little benefit in resistant varieties (eg. Snow peak).

### **Powdery mildew (*Erysiphe polygoni*)**

Seed treatment for powdery mildew is not effective. Resistant varieties are available (such as Yarrum A) that require no treatment for control. For susceptible varieties, apply foliar fungicides that contain either: triadimefon (Triad in SA; Turret or Kenso Ag Care Triadimefon in WA; various products including Triad, Turret, Slingshot, Triadan and Triadimefon products in NSW, Vic); or tebuconazole (various, eg Folicur, Blast, Orius, Hornet, Tebuconazole). Spray at the first sign of disease in early spring (September to early October). Disease-spread is rapid so delay can be costly. If powdery mildew develops at the end of the growing season (last 4 weeks), yield losses will be minimal and fungicide applications may be uneconomic.

### **Seedling root rots (damping off)**

Seed treatments containing thiram or thiram plus thiabendazole (P-Pickel T, Fairgro or Reaper TT) or metalaxyl (Apron XL, Rampart, Mantle or Medley) will help with crop establishment by also controlling *Pythium* and/or *Fusarium* root rots.

### **Chocolate spot (*Botrytis fabae*, *Botrytis cinerea*)**

Varieties with partial resistance (Nura A) do not require as many applications to control chocolate spot as older varieties (eg Fiord). Products containing carbendazim (eg Bavistin, Spinflo), mancozeb (numerous), chlorothalonil (various, including Barrack, Bravo), procymidone (various, eg Sumisclax), metiram (Polyram) or copper (eg copper oxychloride products) provide chocolate spot control at varying efficacies and cost. If chocolate spot pressure is high, then carbendazim or procymidone are preferred fungicides. Risk of chocolate spot is greatest in dense, early sown or lodged crops. A precautionary seed treatment should be applied at early stage.

## **III. Seed coating in relation to control of storage insect pest**

The most common insect damaging pulses in field and storage are referred as bruchids or pulse beetles. The genus *Callosobruchus* has large number of species representing *C. maculatus* (Fabricius), *C. chinensis* (Linnaeus), *C. analis* (Fabricius) and *C. phaseoli* (Gyllenhal) are more common in subtropical regions. However, *C. rhodesianus* (Pic

and *C. sunnotatus* (Pic) are also present in tropical region. *C. theobromae* (Linnaeus) is also found in pods of pigeon pea in India. *Acanthoscelides obtectus* is serious pest in rajmash. Other insects' pests which cause damage to stored legumes are *Trogoderma granarium* (Everts), *Rhizopertha dominica* (Fabricius), *Tribolium castaneum* (Herbst), *Ephestia cautella* (Walker), *Corcyra cephalonica* (Stainton), *Latheticus oryzae* (Waterhouse), *Lasioderma serricornis* (Fabricius), *Stegobium paniceum* (Linnaeus), *Oryzaephilus surinamensis* (Linnaeus), *Cryptolestes ferrugineus* (Steph) and few species of mites. Fungi from genera *Penicillium* and *Aspergillus* in association with these insects enhance the rate of deterioration. In India, pulses are mostly consumed in form of dal or dehusked split, which in absence of seed coat are prone to moisture gain and fungal infestation, besides preferred by insects other than bruchids. The split pulses are attacked by *Rhizopertha dominica*, *Trogoderma granarium*, *Tribolium castaneum* and *Cadra cautella* under storage conditions. The losses due to insect activity during storage are physical loss, loss in carbohydrates and proteins, nutritional losses and contamination of product with uric acid, fragments and faecal matter.

Cowpea seeds treated with BHC + Dithane M-45 recorded higher germination (99.00%) and dry weight of seedlings (0.690 g) compared to control (43% and 0.613, respectively) after six months of storage (Hunje *et al* 1990). Higher vigor of soybean seeds treated with Dithane M-45 @ 2.00 g per kg of seed and malathion @ 5.00 g per kg of seed recorded higher germination (80.00%) even after 180 days of storage compared to control (58.50%) as noticed by Ramesh (1993). Pre-storage seed treatment with thiram was found to give protection against fast deterioration of seed quality as well as development of seed borne fungi during storage (Asalmol and Zade 1994). Mung bean seeds treated with malathion 2.00 g per kg + captan 5.00 g per kg of seed proved better with respect to germination percentage (81.52%), seedling length (26.32 cm) and vigor index (21.45) after nine months of storage (Paul *et al* 1996). Mung bean seeds treated with deltamethrin + thiram and stored in polybag for 18 months recorded higher germination (89.40%) compared to control (87.70%) as noticed by Gupta *et al* (1998). Chickpea seeds treated with different chemicals malathion @ 5.00 g per kg of seed recorded significantly higher germination (68.87%) with less insect infestation (33.51%) compared to control (64.17% and 61.35%, respectively) (Arati, 2000). Significant increase was recorded in germination (64.15%), vigor index (1443) and seedling dry weight (1.73 g) in captan

treated chickpea seeds as compared to untreated control (54.06%, 1312 and 1.54 g, respectively) after ten months of storage (Merwade 2000). Similarly, Jawale *et al* (2001) observed that soybean seeds treated with thiram (2.00 g/kg seeds) could maintain germination percentage above the seed certification standard (70.00%) up to seven months of storage. Chickpea seeds treated with endosulfan, monocrotophos and chlorpyrifos provided maximum protection against storage pests. Endosulfan and chlorpyrifos had no adverse effect on germination (Choudhary and Dashad 2002). In bean the polymer coated and fungicide treated seeds maintained the higher germination compared to control after two months of storage (Larissa *et al* 2004) black gram seeds treated with malathion 50 EC @ 0.50 per cent recorded significantly higher germination (87.66%) over control (70.04%) after 180 days of storage (Deshpande *et al* 2004). Rocha *et al.* (2019) have reported that plant beneficial microbes (PBMs), such as plant growth-promoting bacteria, rhizobia, arbuscular mycorrhizal fungi, and *Trichoderma*, can reduce the use of agrochemicals and increase plant yield, nutrition, and tolerance to biotic-abiotic stresses. Yet, large-scale applications of PBM have been hampered by the high amounts of inoculum per plant or per cultivation area needed for successful colonization and consequently the economic feasibility. Seed coating, a process that consists in covering seeds with low amounts of exogenous materials, is gaining attention as an efficient delivery system for PBM. Microbial seed coating comprises the use of a binder, in some cases a filler, mixed with inocula, and can be done using simple mixing equipment (e.g., cement mixer) or more specialized/sophisticated apparatus (e.g., fluidized bed). Binders/fillers can be used to extend microbial survival. The most reported types of seed coating tested in more than 50 plant species with seeds of different dimensions, forms, textures, and germination types (e.g., pulses, vegetables, and other legumes), has been studied using various species of plant growth-promoting bacteria, rhizobia, *Trichoderma*, and to a lesser extent mycorrhizal fungi. Most of the studies regarding PBM applied *via* seed coating are aimed at promoting crop growth, yield, and crop protection against pathogens. Studies have shown that coating seeds with PBM can assist crops in improving seedling establishment and germination or achieving high yields and food quality, under reduced chemical fertilization. Studies reported, seed coating being used for adaptation and protection of crops under abiotic stresses. There are still challenges mainly

related with the scaling up from the laboratory to the field and proper formulation, including efficient microbial combinations and coating materials that can result in extended shelf-life of both seeds and coated PBM. These limitations need to be addressed in order to allow a wider use of seed coating as a cost-effective delivery method for PBM in sustainable agricultural systems.

## CONCLUSION

In pulse seeds the seed coating technology has been tested since more than two decades and positive and significant response of polymer seed coating alone or in combination with insecticide/fungicide/bio-agents/natural fillers on germination seedling vigor, growth, yield improvement, storability and control on pest infestation during storage have been reported by several workers in Soybean, chickpea, pigeon pea, field pea, green gram, black gram, cow pea and beans. This review summarizes comprehensive information on various seed coating technologies and their potential role for achieving a cost effective eco system by increasing food security.

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