

Formulations for Improved Seed Storage and Quality

BALRAJS. PARMAR AND JITENDRA KUMAR

Division of Agricultural Chemicals, Indian Agricultural Research Institute, New Delhi 110 012

Formulants play a key role during coating of seed protectants on their surface. Those ensure uniform and non-removable coating; improve efficacy and safety of the coated material and process and result in high quality treated seed for diverse uses. Seed coating is undertaken to protect high value seeds, hold pesticide at the point of seed germination, eliminate one or more toxicant applications in field and reduce risk of exposure to toxic chemicals. It has potential to deliver the designed effect of active ingredient at a low dosage level.

Development of coating materials

Screening: The choice of active ingredient and auxiliaries is a crucial step and is finalized through well planned screening trials. Key requirements of most seed treatments include:

- Efficacy
- Uniform, non-removable coating
- Safety (during handling, planting, etc.)
- Wide safety margin between target and non-target organisms
- Compatability with other materials, if any, used on seed
- Lack of residues on plants/soil.

These requirements are apparently simple but difficult to achieve in a single product.

Formulation and characterization: A consumer is normally interested in a ready to use product, capable of effectively performing the intended job. Thus, a proper formulation based on satisfactory compliance of active ingredient - auxiliary(ies) interaction is intended. It has to comply with the physico-chemical and chemical, shelf life

bioefficacy, phytocompatibility and other related requirements that are prescribed by the international/national (standards) organizations. The major formulations used for seed treatment are listed in table 1. The reader may refer to the requirements of individual products in the respective standard specifications. A recent book by Parmar and Tomar [1] provides information on the subject.

Table 1. Major formulations for seed treatment

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- Dust
 - Wettable powder/water dispersible powder (WP)
 - True solution (LS)
 - Emulsifiable concentrate (EC)/emulsion concentrate (EW)
 - Wet flowable (SC)
 - Capsule suspension (CS)
 - Polymers for coating or controlled release
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Optimization of coating properties of the formulations: The selection of formulation for use in a given situation is one aspect and its uniform coating on the seeds is another. For a chosen formulation, application technology has to be defined to ensure uniform and thorough coating to deliver the required amount of the active to manage the target pest. A chemist has to take care of all of the various interactions and factors and develop a coating technology meeting to maintain the physical stability of the active ingredient and the performance criteria along with abrasion resistance of the coating, flowability of the coated seeds through the planter, and the assurance of no negative effects on seed germination.

The seed coating technology may often reduce the amount of pesticide that enters the environment because it is concentrated in a small area rather than spread over a large one.

Compatibility with other compounds: At times, seed may be given treatment for various other purposes besides the pest control. These may include, hormones, nutrients, bio-agents, etc. The compatibility of pest control compositions with such treatments is necessary for the desired performance. Additional studies to adjudge compatibility may be essential as per need.

Performance appraisal: A theoretical selection of materials is often done to achieve the desired results. Such a calculation may go way hire, if not supported by performance results. The product appraisal needs to be undertaken under each of the diverse use situations.

Key formulants

Solid and liquid carriers and diluents, surfactants, encapsulants, binders, stickers, safeners, etc. are the key adjuvants of interest. Besides, dyes are used to colour seeds for ready identification. In various products, choice of formulants is made by the normal principles of formulation. Lately, the use of various natural (ex. chitosan, polysaccharides, lignin, cellulose, etc.) and synthetic (ex. polyvinylchloride, latex emulsion cross linked polyurea, etc.) polymers for coating seeds has been on the rise. Key attributes of the polymers used for seed coating are listed in table 2. Depending upon a use situation, the polymer can be identified and through laboratory and field evaluation studies.

Table 2. Attributes of polymers to be used for seed coating

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- Biodegradable
 - Non-toxic
 - Water resistant
 - Protective coating
 - Moisture scavenger
 - Repulpable
 - Compatible with water soluble materials
 - Suspension agent
 - Low inclusion binder
 - Emulsion stabilizer
 - Dispersant
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Lately, fluidized bed treator or pharmaceutical drum is used for film coating. Active materials are dispensed or dissolved in a liquid adhesive and applied. It permits multiple coats and increases seed weight by 1-10 per cent.

Innovative applications

Fluid seedling: Coated alfalfa seed containing Rhizobium inoculant and fungicide added to liquid fertilizer tank and applied.

Temperature responsive polymers: Act by preventing inhibition of water by seed until the desired temperature is reached. The set point at which the polymer becomes permeable to water is a function of its composition. These help to synchronize germination (ex. maize seeds).

Biocontrols: Coatings can provide storage protection and a microenvironment for establishment of organisms such as *Trichoderma harzianum*, *Pseudomonas* sp., *Bacillus* sp., etc., for their application along with seeds.

Precision sizing: Coating expensive seeds to a precise size to decrease planting rates (ex. coating of alfalfa seeds with stacked genes).

Moisture barrier: Control exposure to moisture e.g. PVC in maize and soybean.

Herbicide protectant: Ex. sorghum seed coated with the protectant oxabetrinil (Concep II) saves from the herbicide metolachlor. Grass seeds coated with charcoal protect against herbicides.

Seed markers: Colourants or other chemicals to distinguish seeds with different genetic traits or to tell varieties apart. Could help misapplication of agricultural chemicals or used in liability claim cases.

Fertilizer protection: Survival of rhizobia decreases as the period of exposure to fertilizer increases. Lime coating on alfalfa protects the rhizobia in the coating.

Slow release chemical: Alfalfa seed coated with slow or CR products prolonged protection and prevented damage due to toxicant. Seed encapsulation effective.

Dusting off of toxicant: Cotton seeds coated with toxicant in a polymer to prevent dusting.

Improved planting: Delinted cotton seed coated with polymer containing toxicant.

Vigour index: Coating of seed with polymer containing toxicant improves the vigour index, a function of germination x dry weight of seedling.

Alleviation of seed imbibitional injury: Ex. maize, soybean, dry beans coated with polymer.

Preliminary investigation of polymer coatings containing thiram fungicide on soybean and maize seeds showed that the vigour index was significantly improved in soybean but there was no improvement in maize as compared with thiram alone at the same concentration. Polymer specificity in relation to test seed is indicated (Table 3).

Table 3. Effect of polymer coatings containing thiram on the vigour index* of soybean and maize

| Treatment | Vigour index | |
|-----------|--------------|-------|
| | Soybean | Maize |
| PM-I | 45 | 110 |
| PM-II | 49 | 113 |
| PM-III | 68 | 112 |
| PM-IV | 61 | 110 |
| PM-V | 38 | 102 |
| PM-VI | 33 | 104 |
| Control | 17 | 113 |

*Vigour index = Germination x seedling dry weight;

Control = Thiram @ 2%; PM = Polymer+Thiram @ 2%

REFERENCE

1. PARMAR B.S. & S.S. TOMAR (2004). Pesticide Formulation - Theory and Practice. CBS Publishers, New Delhi, p. 415.