

Seed Singulation in Agriculture

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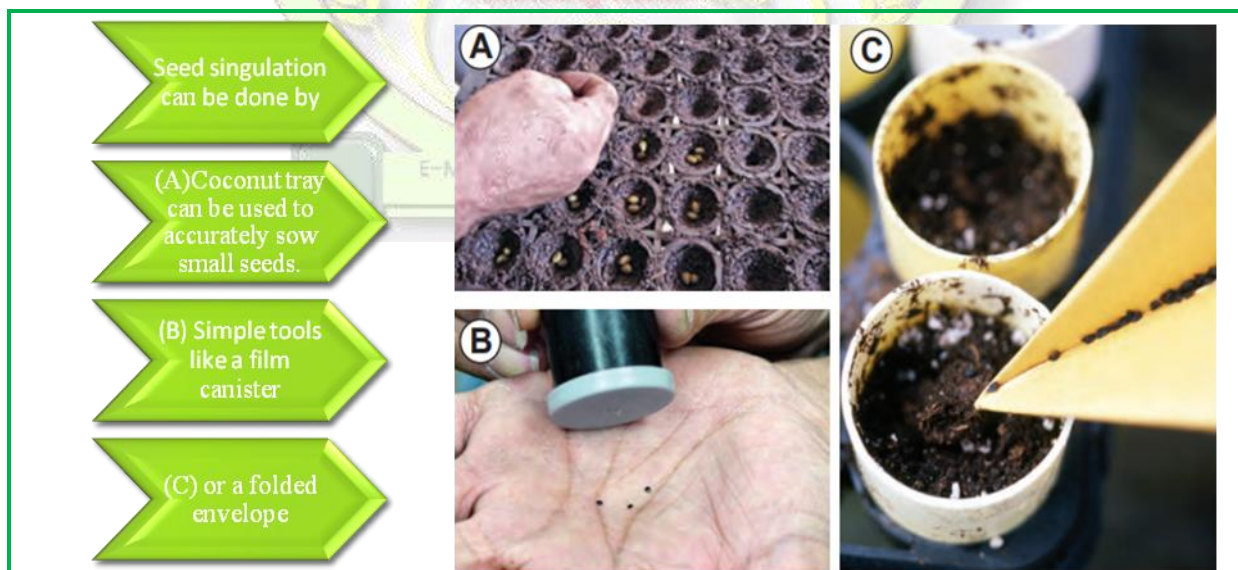
Seed singulation refers to coating of seeds with certain substances *e.g.* Bentonite clay, to form pellets of desired size. Seed Singulation is also done by placing individual seeds on plastic or paper tape. The Importance of Seed Singulation is that it is critical for uniform crop growth and increased yield.

Significance of Seed Singulation

- **Uniform Germination:** Ensures even seedling emergence.
- **Reduced Competition:** Minimizes seed-to-seed competition for resources.
- **Controlled Spacing:** Provides adequate space for each seed.
- **Optimized Conditions:** Ensures consistent soil contact and moisture levels.
- **Soil Contact:** Good soil contact enhances moisture absorption and root establishment.

How to Improve Seed Singulation

- **Sizing:** Seeds can be sorted by size using screens and sieves.
- **Shaping:** Round Seeds are more likely to clump together than elongated seeds.
- **Surface Modification:** Seed surface treatments like coating and pelleting can make seeds uniform in shape which can improve singulation.
- **Magnetic separation:** It can be used to separate seeds from other debris such as weed seeds. This can help to improve seed singulation. *e.g.* separating Vetch seeds (contains small amount of iron) from ryegrass seeds.
- **Placing of seed:** Single seed sowing can improve seed singulation.



Main Methods of Seed Singulation

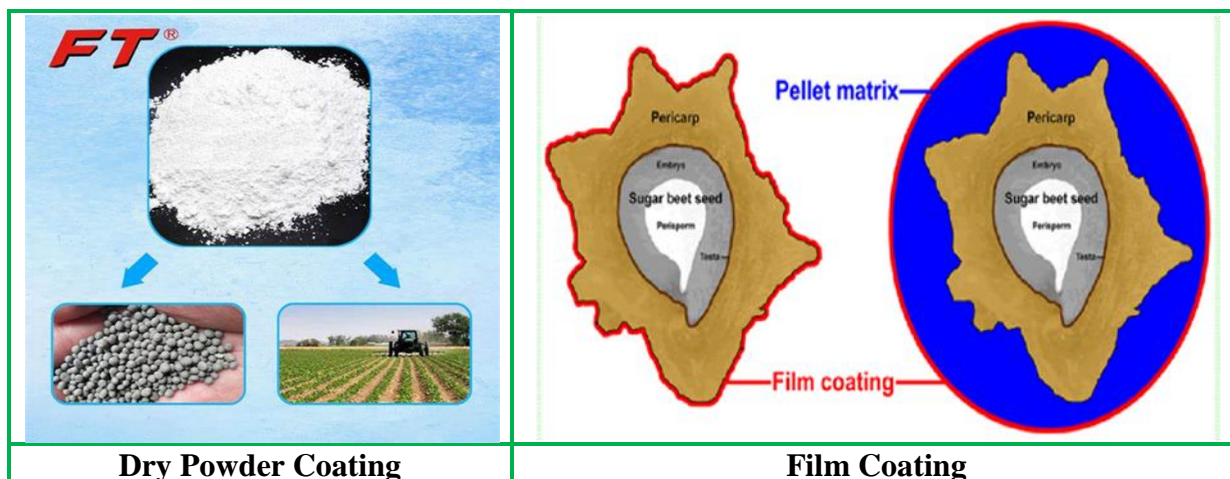
- **Seed coating:** Seed coating requires a special binder is used with a formulation to enhance adherence to the seed. Coating requires advanced treatment technology, by the industry (Upadhyaya, 2013). The first method used involved piling the seed to be treated on a solid surface and then dusting the top of the pile with the fungicide. Later, a rotating drum was used to mix the seed with dust formulations of materials such as copper carbonate. This involved mounting a barrel at an angle, such that when it was turned by hand crank, the grain would tumble back and forth thus coating itself with the fungicide (Taylor *et al.*, 2008). Adhesive like Carboxy methyl cellulose, Dextran, Gum Arabic, Vegetable/Paraffin oil is used (Mathre *et al.*, 2001).

Benefits of Seed Coating:

- ✓ *Even Emergence:* Uniform heat and moisture in the seed zone are critical for consistent emergence. Variability in residue covering the seed row affects moisture and, to a lesser extent, soil temperature early in the season.
- ✓ *Vertical Seed Position:* Proper seed-to-soil contact ensures uniform emergence. Coated seeds, due to their additional weight, help maintain consistent vertical positioning during planting.
- ✓ *Seed Coatings and Microbes:* Coating seeds with beneficial microbes (PBM) can enhance seedling establishment, germination, and overall yields.

Limitations of Seed Coating:

- ❖ Method is not of much use for treating maize, bean, peanut and vegetable seeds which may get injury during process.
- ❖ Higher concentrations of chemicals are required.
- ❖ Doses are changed with seed moisture, seed size and duration of treatments; therefore, it is very difficult to make recommendations.
- ❖ The seed coating did not improve germination and actually had a deleterious effect under dry conditions.
- **Seed coating with plant beneficial microbes (PBM):** Plant beneficial microbes (PBM) play an indispensable role in fostering plant growth and preserving their well-being by establishing a mutualism bond with plants. Coating seeds with PBM is a common and real approach to promoting seed singulation with eco-friendly approach. Plant growth-promoting bacteria (PGPB) rhizobia are commonly employed for nitrogen fixation in pulse crops, contributing to a reduction in the need for chemical fertilizers. *Arbuscular mycorrhiza* and *Trichoderma* are two types of fungi that have long been utilized to enhance nutrient uptake and acquisition in plants. For instance, *Arbuscular mycorrhiza* can contribute up to 80% of the phosphorus acquired by plants, while plants, in return, transfer about 20% of the fixed carbon to the fungi. *Trichoderma parareesei*, were combined in a talc-based consortium formulation to treat tomato seeds. (Jeffries, 2016).
- **Dry powder coating:** Dry powder application is a seed coating method used for mixing seeds with a dry powder. Dry powders, also known as dusts, are used for fungal or bacterial treatments followed by drying (hydration/dehydration) and seeds can have a shorter shelf-life after application. Dry powder coated seed (or dry powder coating) is primarily used for adding bacterial or fungal treatments to protect seeds. The most common materials in dry powders for seed coatings are talc or graphite. Typically, the coating ranges from 0.1% to 2% of the seed weight. During planting, the coated seeds are dispensed one by one from the planter. The dry powder coating ensures that seeds don't clump together, allowing for precise singulation (Chirag *et al.*, 2023).
- **Film coating:** A more recent development 'film coating' is being used in which active materials are dispersed or dissolved in liquid adhesive and applied to seeds either with a Fluidized Bed Treater or pharmaceutical coating drum. Film coating is often used on seed species that do not require pelleting (*Brassica spp.*) for precision planting but the seed requires some encapsulation due to plant protectant application (Hill, 1999). Polymeric coating has been investigated to retard imbibition rates when seeds are sown in wet soil.



• Requirements of film coating

1. Seed

2. Coating material *i.e.* Actives crop protection chemicals (*e.g.* fungicides/insecticides), biologicals (*e.g.* Fungi/bacteria), growth regulators (*e.g.* Gibberellins)

3. Adhesives or polymers

4. Solvents/ dilutants like Water or any other organic solvent.

5. Equipments like fluidized bed seed coating apparatus.

- **Seed encrusting:** Encrusting is a seed coating process that rises seed weight by 8-100% without significantly altering the seed's shape. The encrusting process involves two important phases: "before coating" (BC) and "coating phase" (CP). In the BC phase, the initial weights of the seed, precipitate, and binder are noted. The CP involves the actual coating process, where small amounts of precipitate and binder are applied to the seed to safeguard good binding (Pedrini *et al.*, 2017).
- **Seed Pelleting:** "Seed pelleting is a process of enclosing a seed into a small quantity of inert matter just large enough to produce a globular unit of standard size to facilitate precision planting." Many crop seeds are small and irregular in shape which does not permit the accurate metering by mechanical planting equipment. The original purpose of pelleting was to increase the apparent seed size and weight to alter seed shape for precision planters.



Materials used in pelleting

- **Adhesive material:** The physical integrity of coating/ pelleting is decided by the types of adhesives and this highly influence the handling, transport and planting operations of pelleted seeds.
 - Commonly used adhesives: Gum Arabic, Methyl cellulose, Gelatin, Plastic Resins, Poly Vinyl Acetate, Methyl Ethyl Cellulose, Poly Urethane, Poly Vinyl Alcohol, Polyelectrolyte or Dextran, Poly Ethylene Oxide and Carboxy Methyl Cellulose (CMC).
 - Amongst these Carboxy Methyl Cellulose (CMC) is widely used due to ease of availability, low cost and low rate of application.

- Concentrations of adhesives: Carboxy Methyl Cellulose 3 % W/V, Methyl Ethyl Cellulose 5% W/V, Gum Arabic 45%, Nitric Coat 4.3 % W/V in water.
- *Coating or filler material:* The material used as filler in pelleting must be beneficial and harmless to both seed and rhizo-sphere. Commonly used filler material: –
- Diatomaceous earth (a naturally occurring, soft, siliceous sedimentary rock that is easily crumbled into a fine white to off- white powder), lime, gypsum, dolomite or rock phosphate, charcoal etc.
- Other material used: – Vermiculite, peat, moss, etc.
- Botanical material used: – (*Low cost & environmentally friendly*) Leaf powders of Arappu (*Albizia amara*), Neem (*Azadirachta indica*), Moringa (*Moringa pterygosperma*) Tamarind (*Tamarindus indica*), Prosopis (*Prosopis juliflora*) can be used. They are recommended @ 200-300g/ kg of seed.

Benefits of Seed Pelleting:

- ✓ Singulation of seed is achieved, helpful in precision planting in mechanized farming.
- ✓ Small seeds and irregular shaped seeds are made easy to handle.
- ✓ Accurate dosing of seed with chemicals is possible and wastage is prevented.
- ✓ Stress conditions can be overcome by pelleting even in low water holding capacity.
- ✓ Chemicals/ fertilizers can be applied with seed.
- ✓ Uniform field establishment and increased yield.

Limitations of Seed Pelleting:

- ❖ When seed is pelleted, its cost and weight is more than bare seed.
- ❖ If proper pelleting techniques / machines is not used, there would be missing of seed during pelleting (blank pellet) or some times more than one seed may be there in a pellet (Doublets or triplets).
- ❖ Pelleted seeds require more moisture for germination since pellet must be dissolved first.
- ❖ Delayed field emergence at low moisture level.
- **Seed Taping:** Seed tape was discovered by Schindler George Antony. Seed tape is a pre-sowing technique where seeds are laid in the tissue layer or water-soluble film or degradable layer at proper spacing for proper growth and development of the crop.



Types of Seed Tapes: The seed tape will be 5 to 10m long containing pelleted or unpelleted seeds on the transparent film based on which the tapes are divided into 3 types -

- Seed tape with unpelleted seed: High vigor seeds unpelleted used in the tape.
- Seed tape with pelleted seed: High vigour seeds pelleted used in the tape.
- Seed tape with marker crop: A marker seed with distinct character added in the tape which has faster germination than the main crop for easy differentiation of the rows and the spacing followed. (Jabeen *et al.* 2022).

Benefits of Seed Taping:

- ✓ Reduction in requirement of labours for cultural practices like thinning and gap filling.
- ✓ Proper germination and establishment of the seedlings.
- ✓ Preventing the consumption of seeds by birds, ants or other insects.
- ✓ Maintenance of adequate spacing and proper resource utilization
- ✓ The tape is biodegradable or water-soluble causing no harmful environmental effects

Limitations of Seed Taping:

- ❖ There is a high cost of establishment.
- ❖ The high rate of seed tapes than the normal pelleted seeds.
- ❖ There is a reduction in the quality of seeds.
- ❖ The less availability of seed tapes and its equipment.

Conclusion

- ✓ Seed singulation is vital for optimal seed placement, leading to uniform growth and improved yields.
- ✓ There are various ways to improve seed singulation i.e. Sizing, Shaping, Surface Modification, Magnetic separation and placing of seed.
- ✓ There are Main methods of seed singulation i.e. Seed Coating, Seed Encrusting, Seed Pelleting and Seed Taping.
- ✓ Future Outlook: Continued advancements in technology and seed science will further enhance singulation efficiency.

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