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Seed Coating Technologies: Applications and Benefits

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Seed coating enhances seed quality, plant establishment, and crop productivity. Various coatings include organic, inorganic, hybrid, and bioactive materials. Applications improve seed germination, drought tolerance, pest resistance, and nutrient uptake. Specialized equipment such as drum, pan, fluidized bed, and electrostatic coaters are used. Benefits include increased crop yields (up to 20%), improved seedling emergence (up to 30%), reduced seed waste (up to 15%), and enhanced environmental sustainability. Seed coating is a valuable technology for agricultural productivity, sustainability, and environmental stewardship, contributing to global food security.

Keywords: Seed coating, Seed technology, Crop productivity, Sustainability.

Introduction

Seeds are essential for future plants and food production, serving as the foundation of the food chain and a critical element of food security. As the cornerstone of crop production, no farming practice can improve yields beyond the potential inherent in the seed. Producing high-quality seeds is crucial for agricultural success, with the goal of ensuring every seed germinates readily and develops into a vigorous seedling that guarantees a good harvest. Popular sayings like "Care with the seed and joy with the harvest" and "Good seed doesn't cost; it always pays" emphasize the value of quality seeds. Farmers are deeply interested in seed management practices that are safe, environmentally sustainable, and scientifically validated. Given the importance of quality seeds in agriculture, much of the focus has been on optimizing seed quality, both as a product and as a means of establishing robust crops. Seed quality enhancement refers to any post-harvest treatments that boost germination, promote seedling growth, or ease the delivery of seeds and accompanying materials at planting time. It encompasses a range of seed treatments applied after harvesting and conditioning, but before sowing. These enhancements include techniques such as priming, hardening, pre-germination, pelleting, encrusting, and film coating, while excluding treatments aimed at controlling seed-borne pathogens (Black *et al*. 2006).

Objectives of Seed quality enhancement

- Enhance germination and seedling development by modifying seed vigor or physiological condition.
- Facilitate planting through methods like pelleting, coating, and encrusting.
- Supply essential materials (excluding pesticides) required at sowing, such as nutrients, biofertilizers, and inoculants.

- Eliminate weak or non-viable seeds using advanced upgrading techniques, including density separation, color sorting, and other methods.
- Mark seeds with visible pigments or other markers to ensure traceability and preserve identity.

Seed Coating

Seed coating refers to the application of a substance onto seeds that does not alter their shape. Examples of seed coatings include fungicides, microbiological treatments, and micronutrients. One of the main advantages of seed coating is the precise application of enhancement materials directly onto the seed, making it a more economical option compared to broadcasting. This process involves adding a layer of external material around the seed's natural coat to alter its physical properties. The coating improves seed handling by standardizing seed weight and size, while also facilitating the delivery of active ingredients such as protectants, nutrients, symbionts, soil conditioners, phytoactive compounds, growth regulators, colors, tracers, and more.

Different types of seed coating

There are three main types of seed coating—film coating, encrusting, and pelleting—each categorized based on physical attributes like weight, size, and sorting properties. Film coating involves applying a thin layer of material, typically less than 10% of the seed's weight, which doesn't significantly change the seed's size or weight. Encrusting, on the other hand, involves applying a thicker coating that increases the seed's weight and volume but maintains its original shape. The use of high-quality polymers in film coating creates a very thin layer that causes minimal changes in seed size and weight. While both encrusting and pelleting involve the application of a thick external coating, pelleting differs in that it alters the original shape of the seed, whereas encrusting retains the seed's natural shape. Film coated and encrusted seeds are generally distinguished by their weight, while pelleted seeds are sorted by diameter. The synthetic polymers used as binders during seed coating ensure that active ingredients adhere to the seed and assist in modifying water absorption, promoting early germination (Leubner, 2019).

- **Seed coating with plant beneficial microbes (PBM)**

Plant beneficial microbes (PBM) are essential in promoting plant growth and maintaining their health through a mutually beneficial relationship with plants. Coating seeds with PBM is a practical and effective method to boost crop growth, enhance yields, and protect plants from pathogens.

- **Nutrient seed coating**

Coating seeds with essential macronutrients and micronutrients not only enhances germination but also helps prevent weed growth, which is a common issue when applying major fertilizers in the field. Additionally, seed coating with fertilizers can lower production costs.

- **Biostimulants seed coating**

Biostimulants are substances that enhance plant growth when applied to plants and seeds, yet they do not fall under the categories of fertilizers, pesticides, or soil amendments. Common types of biostimulants include microbial inoculants, beneficial bacteria and fungi, nitrogen-containing compounds, biopolymers, and plant extracts (Rouphael and Colla., 2019).

How is seed coated?

Seed coating utilizes technology originally developed by the pharmaceutical industry for making medicinal pills. In commercial coating processes, seeds are placed in a rotating pan, misted with water or another liquid, and gradually coated with a fine, inert powder, such as diatomaceous earth. Each misted seed acts as a nucleus around which the powder aggregates, increasing in size over time. The tumbling action in the pan smooths and rounds the seeds, akin to pebbles on a beach. The coating powder is compacted by the weight of the material within the pan. Binders are typically added towards the end of the coating process to harden the outer layer and reduce dust during handling, shipping, and sowing. However, care must be taken with binders to ensure they do not negatively impact germination rates. The specific materials used as binders are often proprietary information held by the coating companies. To maintain quality, blanks and doubles are eliminated through rigorous screening and various techniques. The uniformity of seed size and the rate at which they increase in size are monitored throughout the process with frequent manual screening. At intervals during the coating process and at the end, all coated seeds are removed from the pan and mechanically sorted using vibrating screens. Smaller seeds are returned to the pan to be coated further until they match the size of the rest of the batch. After drying, typically with a controlled forced-air system, the seeds are screened one final time before packaging. Undersized seeds may either be re-coated or discarded, while oversized seeds are discarded. Over the past decade, one commercial coating company has achieved a recovery rate of approximately 97% for coated seeds. Uniformity in size post-coating is a key quality criterion, with a standard tolerance of ±1/64 inch (approximately 0.4 mm), consistent with U.S. seed trade standards established prior to the introduction of coatings. For instance, coated lettuce seeds are typically sown using a belt planter through 13/64-inch diameter round holes, necessitating that the coated seeds be sized over a 7.5/64-inch screen and through an 8.5/64-inch screen. These tolerances help ensure a simulation rate of over 95% in the field, with precise placement controlled to within less than 1/2 inch. The accuracy of seed placement can be influenced by the weight of the coated seeds and their size tolerances. Additionally, factors such as the skill of the equipment operators, the condition and adjustments of the seeder, and the speed of the tractor during planting can all affect sowing accuracy. The same considerations apply to greenhouse seeding, where experience, attention to detail, and the right equipment are essential to maximize the benefits of coated seeds (Kaufman., 1991).

Major Benefits of Seed Coating

- **Grower benefits**

Seed treatment provides significant advantages for growers, enabling them to cultivate high-quality crops. These treatments facilitate earlier and faster planting, leading to higher plant populations and increased crop yields. After planting, seed treatments effectively control early season pests and diseases, both below and above ground, thereby minimizing the need for additional rescue treatments or replanting. They safeguard the seed, which holds considerable intrinsic value, and enhance the value of the harvested crop through improved yields and substantially higher commodity prices. By using GM seeds treated with crop protection products, farmers can achieve optimal crop protection.

- **Healthier crops**

Seed treatment is an effective way to protect seeds from pathogens, insects, and other pests, thereby contributing to the production of high quality crops. Broad-spectrum crop protection products applied to seeds manage both pre- and post-emergence insects and diseases. Insecticides used in seed treatments promote a healthy, uniform crop by controlling insect populations. Seed treatments can target insect control at several stages: during storage, to prevent seedling damage, to limit early foliar feeding, and to protect roots from damage (Huseth *et al*., 2010).

- **Positive environmental impacts**

Seed treatment allows for the precise application of crop protection products on the surface of seeds, significantly reducing the need for wide spread application across entire fields. This targeted approach minimizes the potential off-target exposure to these products for both humans and animals. Modern seed coating technologies can achieve high levels of effectiveness against early-season insects and diseases while using lower rates compared too many foliar or soil-applied alternatives (Hutmacher, 2005).

- **Precision application**

When used as seed treatments, crop protection products provide precise and effective application, significantly reducing the amount of pesticides applied to the land. By applying these products directly to the seeds, seed treatments can decrease soil surface exposure by up to 90% compared to in-furrow applications and up to 99% compared to surface applications.

This method is convenient, as it targets the crop protection product directly to the intended area (Kubik, 2010).

- **Integrated pest management**

The FAO International Code of Conduct on the Distribution and Use of Pesticides, adopted in 2002, defines Integrated Pest Management (IPM) as the comprehensive evaluation of all available pest control strategies, followed by the integration of suitable measures that prevent pest populations from developing. It aims to maintain pesticide use and other interventions at economically justifiable levels while minimizing risks to human health and the environment (Chandler, 2008). IPM promotes healthy crop growth with minimal disruption to agro-ecosystems and encourages natural pest control mechanisms. Seed treatments serve as a crucial component of a successful Integrated Pest Management Program for sustainable agriculture, as they effectively target pests and diseases with lower amounts of active ingredients per hectare and do not contribute to atmospheric pollution. Without seed treatments, growers would face significant challenges in managing certain seed borne and early-season pests and diseases, likely leading them to rely on more costly and less environmentally friendly solutions.

- **Improvements to seed treatment equipment**

Seed treatment application technology has evolved from a coarse application of ounces per hundredweight of seed to a precise application measured in milligrams per individual seed. There have been notable advancements in equipment designed to apply milligram-level loading rates of crop protection products per seed. Computerized treating systems now calculate the total application rate for each batch of seed, adjust the flow of seeds and products accordingly, and make real-time corrections for each new lot.

Coating Materials

A diverse array of materials is employed in seed treatments and coatings. These materials are classified based on their composition and origin into four categories: synthetic chemicals (SYN), natural products or their derivatives (NP), biological agents (BIO), and minerals extracted from the earth (MIN). Additionally, seed treatments and coatings are categorized by their function, which includes active components, liquids, or solid particulates.

Conclusion

Seed coating technologies have various applications, including protecting seeds from pests and diseases during sowing and enhancing flow ability for precise seeding. Using suitable seed coating equipment, methods, and materials can lead to improved stand establishment and seedling vigor under both biotic and abiotic stresses. The demand for coated seeds is on the rise, with numerous small and large companies operating in the market. However, despite the abundant information available on natural and synthetic active components, coating methods, and polymers, the seed industry in many developing countries has been slow to adopt this technology. Farmers in these regions often lack resources, resulting in a stark contrast to the near total adoption seen in developed nations. Economical treatments are generally favored, especially if costs do not exceed USD 20 per hectare planted. Effective seed coating technology relies on the use of affordable and easily accessible coating agents. There is a pressing need for cost effective, straightforward materials and methods suitable for use in developing countries.

References

1. Black M., Bewley J. D., Halmer P. (2006). The Encyclopedia of Seeds Science, Technology and Uses. Wallingford: CABI Publishing; 528.
2. Chandler, D., Davidson, G., Grant, W. P., Greaves, J. and Tatchell, G. M. (2008). Microbial biopesticides for integrated crop management: an assessment of environmental and regulatory sustainability. *Trends in Food Science & Technology*, ***19***(5), 275-283.
3. Huseth, A. and Groves R. L. (2010). Novel seed treatment and in-furrow uses for cucurbit insect pests, University of Wisconsin Extension/Midwest Pickle Growers Association.

4. Hutmacher, B., Keeley, M., Marsh, B. and Rothrock, C. (2005). Seed fungicide treatment trials-update and data summary. *University of California Cooperative Extension: Davis, CA, USA*.
5. Kaufman, G. (1991). Seed coating: a tool for stand establishment; a stimulus to seed quality. *Hort Technology*, **1**(1), 98-102.
6. Kubik K., 2010, Seed fungicides and insecticides…what's out there? Harris Moran Seed Company Seed Technology Newsletter, **16**.
7. Leubner, G. (2019). The Seed Biology Place-Seed Biology Place. http://www.seedbiology.de
8. Rouphael, Y. and Colla, G. (2018). Synergistic biostimulatory action: Designing the next generation of plant biostimulants for sustainable agriculture. *Frontiers in plant science*, **9**, 1655.