



REVOLUTIONIZING VISTAS IN HORTICULTURE: HOW SEED PELLETTING AND COATING TECHNIQUES ARE SHAPING THE FUTURE OF FARMING

Padi Mahesh^{1*}, Dr. Qazi Altaf Hussain Dar¹, Edigi Akhil Maharshi² and Vankadvath Nagaraju³

¹M.Sc. Scholar, Division of Floriculture and Landscaping, SKUAST-Kashmir¹ Professor cum Chief Scientist, Division of Floriculture and Landscaping, SKUAST-Kashmir.

²M.Sc. Scholar, Department of Vegetable Science, Dr. PDKV, Akola, Maharashtra.

³Ph.D. Scholar, Division of Fruit Science, SKUAST-Kashmir.

*Corresponding Author Mail ID: maheshreddypadi@gmail.com

Introduction

Seed pelleting is the process of encasing a seed in a small quantity of filler material, resulting in a spherical unit of uniform size that provides essential nutrients to young seedlings. The application of coatings made from filler substances to seeds, a technique known as pelleting, ensures consistency in the seeds' dimensions and appearance.

These coated seeds can be directly planted in the field or placed in trays for later transplantation, enhancing the accuracy of seeding and the overall efficiency of the planting process. Initially developed for seed marking purposes, the practice of seed coating and pelleting has advanced to encompass the incorporation of bioactive compounds, nutrients, and beneficial microorganisms suitable for both dry and moist sowing conditions.

The principal objective of seed coating is to facilitate mechanized planting, promoting uniform plant spacing while also acting as a carrier for substances that protect plants. Adhesive and filler materials represent the primary categories utilized in seed pelleting.

Diverse pelleting techniques are utilized, such as Inoculant pelleting, Protective pelleting, herbicide pelleting, nutrient pelleting, hydrophilic/hydrophobic coating, and oxygen-supplying coating. Seed pelleting plays a crucial role in mitigating deterioration rates, particularly in vegetable crops, reducing both quantitative and qualitative losses while maintaining seed viability over prolonged storage durations.

Innovations in seed coating methodologies have resulted in decreased pesticide levels per seed and lower expenses due to improved seed adhesion. This paper highlights the significance of seed pelleting in enhancing seed quality and viability and lowering production expenses ultimately decreasing seed consumption rates and lowering the need for thinning practices in production.

Introduction

Seed represents a fundamental input in the realm of agriculture. Substandard seed quality leads to subpar performance and a low yield potential, resulting in significantly high production costs.

Certain ornamental and vegetable crops like Lawn grass, Orchids, Begonia,

lettuce, and Snapdragon etc. possess minute seeds that pose challenges during sowing, leading to increased seed rates. These factors collectively contribute to elevated seed production expenses. Therefore, enhancing seed quality through seed improvement techniques is imperative. Among these techniques, seed pelleting stands out as a crucial process for enhancing seed quality characteristics.

This method involves encapsulating a seed with a small amount of inert material to form a spherical unit of standardized size, providing essential nutrients to young seedlings.

Pelleting is described as the application of a layer of inert substances that may alter the original seed shape and size, leading to a considerable weight gain and improved plantability. Conversely, film coating maintains the seed's shape and size with minimal weight increase. By employing this process, seeds achieve uniformity in size and shape, enabling direct seeding in the field or sowing in flats for transplantation.

Pelleted seeds facilitate precise seeding and enhance overall efficiency in the seeding process. The pelleting of seeds involves a tumbling process with coating material and gradual moisture addition. Upon reaching the desired size, the pelleted seeds undergo a drying phase. The coating should form a continuous layer to reduce product dust-off.

Both techniques may incorporate polymers, pesticides, biological substances, colorants, or other additives. A critical aspect of precision planting lies in singling seeds for accurate placement at predetermined depths and spacing in the soil, ensuring uniform

coverage at an optimal planting speed. Singling poses challenges for seeds with low density and irregular shapes, concerns that can be addressed through the seed pelleting process.

Seed coating and pelleting technology were initially developed to facilitate the process of seed singulation. This involved the addition of bioactive chemicals, nutrients, and beneficial microbes to enhance the overall quality of the seeds.

Furthermore, these technologies were designed to cater to sowing seeds under varying conditions, both dry and wet. It was believed that by incorporating these techniques, the seeds would be more resilient and better equipped to withstand different environmental challenges.

Evolution of Seed Pelletization Machines

Coating the seed using appropriate binder, filler, and bioactive substances is centered on enhancing the efficacy of seeds in terms of attaining the intended population, ensuring a high likelihood of successful germination for each seed sown, and enabling accurate seed placement, which serves as the fundamental principle for prosperous crop and seed cultivation.

The presence of seed and seedling diseases has been identified as a significant factor contributing to the decline in seed germination rates and the overall establishment of plant stands. This, in turn, leads to an uneven distribution of crops and an increase in weed density within the agricultural fields.

As a result, there is a noticeable decrease in crop yield, which can have detrimental effects on the overall productivity of the farming operation.

Therefore, it is crucial to address these issues effectively to ensure optimal crop growth and development.

Period	Key Developments
Early Stages (Before 1950s)	<ul style="list-style-type: none"> - Manual coating with materials like clay, lime, or ash - Basic equipment like drum mixers and pans
Mechanical Improvements (1950s-1970s)	<ul style="list-style-type: none"> - Introduction of mechanical seed coaters - Use of adhesives - Seed priming techniques
Automation and Precision (1980s-1990s)	<ul style="list-style-type: none"> - Automated seed coaters - Fluidized bed coating technology - Introduction of pelletizing agents
Advancements in Material Science (2000s)	<ul style="list-style-type: none"> - Development of biodegradable coatings - Integration of microbial inoculants - Precision agriculture
Modern Innovations (2010s-Present)	<ul style="list-style-type: none"> - Smart seed coating machines with AI and IoT - Use of nanotechnology - Focus on eco-friendly solutions

Various seed treatment techniques have been introduced to combat the prevalence of seed and soil-borne diseases.

These methods include seed-dressing, polymer film coating, pelleting, and entrustment with pesticides, insecticides, biologicals, micro-nutrients, and growth regulators.

Through the application of these treatments, it is possible to deliver a wide range of protective agents directly into the seeds, thereby enhancing their resistance to diseases.

Ultimately, this results in the production of higher quality seeds that are better equipped to thrive in diverse environmental conditions.

The main purpose of seed-coating technologies revolves around two key objectives.

Firstly, they aim to facilitate mechanical sowing processes to achieve a more uniform distribution of plants within the field.

By ensuring consistent plant spacing, farmers can optimize the use of their land and resources, leading to improved crop yields. Secondly, seed coatings act as carriers for various plant protectants, which serve to safeguard the seeds from potential threats such as diseases and pests.

Through the utilization of these technologies, farmers can enhance the overall health and productivity of their crops, ultimately contributing to a more sustainable and efficient agricultural system.

Process of seed pelleting:

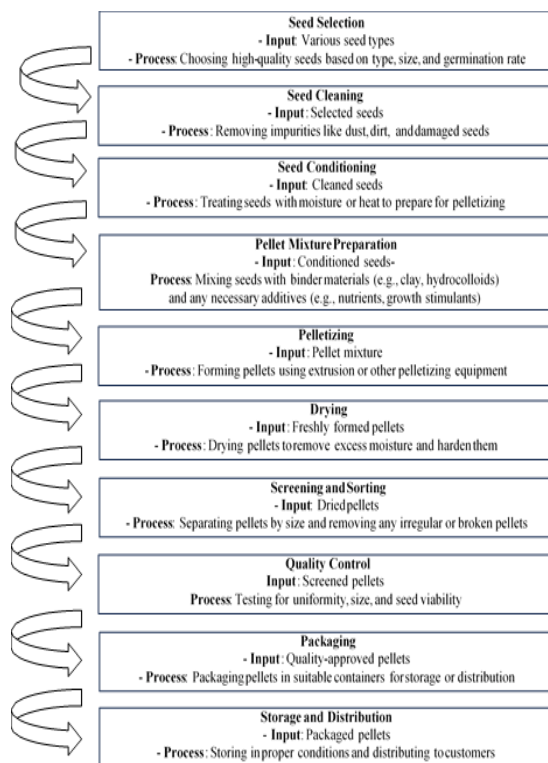


Figure 1: Seed pelletization process

Purpose of Pelleting

To decrease the speed of deterioration, particularly in flower and vegetable crops, while also diminishing both the quantity and quality of losses, and preserving the seed's quality for extended storage periods.

Advantages in terms of nutrients availability

Providing protection against abiotic or biotic stress, enhancing seed germination, ensuring the safe use of agricultural chemicals, safeguarding against rodents, birds, and insects, as well as aiding in brand identification.

Suitable crops for essential for seed palletization

Some crop seeds are too light and small such as Lawn grass, Orchids, Begonia, lettuce, and Snapdragon etc.

Categories of pelleting and coating materials

The two types of materials utilized for pelleting are:

A. Adhesive materials

Adhesive materials, such as gumarabic, Methyl cellulose, nitric coat, gelation, plastic rexins, and dextran, and filler materials, including lime, gypsum, dolomite, rock phosphate, clay minerals, dried blood, poultry manure, and moss.

Properties of adhesive materials

Adhesive materials must exhibit an affinity for both the seed coat and the chosen filler material, possess the necessary level of water solubility to facilitate emergence, have the required by strength and plasticity to prevent dusting and breakage, and maintain suitable viscosity for each application.

B. Filler materials

Filler Material, such as lime, gypsum, dolomite, rock phosphate, clay minerals, dried blood, poultry manure, and moss, are utilized to provide protection for seeds.

Properties of Filler materials

It is imperative that filler materials exhibit porosity, are prone to easy degradation, come at a low cost, and have fine particle sizes (150-300 mesh sieve). Benefits include ensuring pelleted seeds have consistent size and shape to prevent blockages in mechanical planters, enabling precise singulation and efficient planting of directly sown crops.

This accuracy in seeding and spacing facilitates easier thinning of stands or may eliminate the need for thinning altogether. Moreover, it simplifies handling for small-seeded crops like Lawn grass, orchids, larkspur, lettuce and carrots by preventing seed clogging.

Filler materials also attract moisture, provide essential growth-regulating nutrients, stimulate germination, influence the micro-environment, reduce the need for chemicals and fertilizers in the soil, and supply oxygen. They protect seeds during aerial seedling by enhancing their ballistic ability.

Importance of Seed Pelletization in Transforming Horticultural Practices:

Seed pelletization plays a crucial role in horticulture for a variety of reasons. Firstly, enhanced seed handling is achieved through the use of pelletized seeds, which exhibit a consistent size and shape, thereby reducing the likelihood of errors in planting and ultimately enhancing planting efficiency. Secondly, improved germination is facilitated as pellets are often enriched with nutrients, growth stimulants, and protective coatings that shield seeds from pests and diseases, resulting in higher germination rates.

Furthermore, the uniformity of pellet size enables precise and uniform planting, contributing to more even crop growth and increased yield. Additionally, pelletization helps to minimize seed wastage by addressing the challenge of accurately planting small or irregularly shaped seeds. Moreover, the controlled release of nutrients and pesticides through pellet coatings optimizes their accessibility to seedlings, fostering healthier growth.

Lastly, the coating on pellets improves the contact between seeds and soil, a critical factor for successful germination and seedling establishment. In conclusion, seed pelletization serves to enhance efficiency, reduce wastage, and elevate both crop yield and quality in horticultural practices.

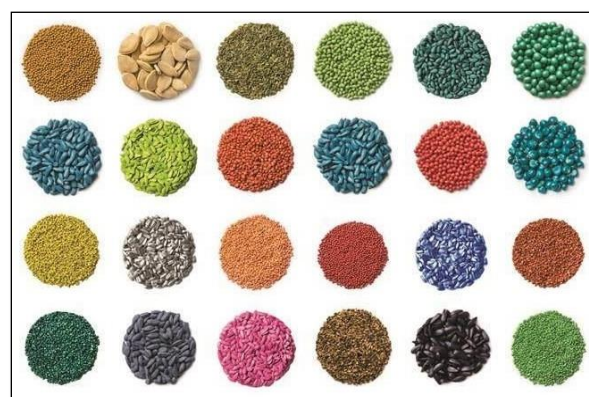
Types of Seed Coater

Sl. No	Type of Coater	Description	Applications
1	Pan Coaters	Rotating pan that tumbles seeds while coating material is gradually added.	Small to medium-sized seeds; uniform coating with minimal thickness.
2	Rotary Drum Coaters	Large, rotating cylindrical drum where seeds are coated as they move through.	Large-scale operations; seeds needing multiple layers of coating (e.g., cereals, legumes).
3	Fluidized Bed Coaters	Seeds are suspended in an upward flow of air while coating material is sprayed.	Delicate seeds requiring precise, consistent coating; often used for high-value seeds like vegetables or flowers.
4	Centrifugal Coaters	Seeds are spun rapidly in a chamber,	Seeds needing a thicker, robust

		ensuring even coating distribution via centrifugal force.	coating; suitable for seeds requiring resilience in harsh conditions.
5	Continuous Coaters	High-volume, continuous process where seeds move through the machine while being coated.	Large-scale seed treatment; efficient for coating large batches.
6	Batch Coaters	Treats a specific quantity of seeds in a batch; controlled environment with pauses between batches.	Smaller operations; seeds requiring special attention like organic or untreated seeds.
7	Drum Pelletizer	Rotating drum rolls seeds while applying sticky coating, followed by powder to form pellets.	Large, robust seed pellets; easy to handle and plant, often used in mechanized planting systems.
8	Spray Coaters	Fine mist of coating material sprayed onto seeds	Ideal for fine, uniform coating; often used for primed seeds

		as they are agitated or tumbled.	or those treated with specific nutrients.
9	Electrostatic Coaters	Uses an electric charge to attract coating materials, ensuring uniform adherence.	Efficient, minimal waste; critical for seeds needing precise application of coating.
10	Integrated Coating and Drying Systems	Combines coating and drying in one machine, allowing continuous processing.	High-throughput operations; speed and efficiency in commercial seed production.

Figure 2: Seed pelleting in various Horticultural crops



CONCLUSION

In conclusion, seed pelleting and coating technologies are vital in modern agriculture,

addressing challenges related to seed size, uniformity, and germination. These processes not only enhance seed quality by improving size and shape, which facilitates precise planting and seeding errors but also offer protection against various abiotic and biotic stresses. By incorporating adhesives, fillers, and advanced polymers, these techniques ensure effective nutrient delivery, disease resistance, and reduced pesticide dust-off, thereby supporting higher crop yields and efficient farming practices. As agricultural demands evolve, ongoing advancements in seed pelleting and coating will continue to play a crucial role in optimizing crop production and sustainability