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EFFICIENCY OF A DEVICE FOR COATING FUZZY COTTONSEEDS WITH PROTECTIVE AND NUTRIENT COMPOUNDS AND DRYING THEM

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Annotatsiya. *Maqolada tukli chigitlarni ekishga tayyorlash jarayonida ular yuzasiga ko‘p komponentli himoyalovchi-oziqlantiruvchi qavat surtish (kapsulalash) va ularni keyinchalik quritish masalalari yoritilgan. Chigitlarni muloyim issiqlik tartibida (*38–43°*C) va muallaq qatlam rejimida quritadigan qurilma konstruksiyasi taklif etilgan. Tadqiqot natijalari ushbu usul himoya qavatining mustahkamligini saqlab qolgan holda, urug‘lik chigitlarning yuqori unuvchanligini va ularning optimal namlik (*8–9%*) darajasigacha bir tekis qurishini ta’minlashini ko‘rsatdi.*

Аннотация. *В статье рассматриваются вопросы подготовки опушенных семян хлопчатника к посеву путем нанесения многокомпонентной защитно-питательной оболочки и последующей их сушки. Предложена конструкция сушильного устройства, работающего в режиме псевдоожиженного слоя при мягком температурном режиме (*38–43°*C). Приведены результаты исследований, подтверждающие сохранение целостности защитной оболочки, высокую всхожесть семян и равномерность их сушки до оптимальной влажности (*8–9%*).*

Abstract. *This article discusses the preparation of fuzzy cotton seeds for sowing by applying a multi-component protective and nutritive coating, followed by their drying process. A drying device design operating in a fluidized bed mode under mild temperature conditions (*38–43°*C) is proposed. The study demonstrates that this method preserves the integrity of the protective layer, ensures high seed germination rates, and achieves uniform drying to an optimal moisture content of* 8–9%.

Kalit so‘zlar: *tukli chigitlar, kapsulalash, pelletirish, himoya-oziqlantiruvchi qobiq, quritish qurilmasi, muallaq qatlam, ekish sifati.*

Ключевые слова: *опушенные семена хлопчатника, капсулирование, дражирование, защитно-питательная оболочка, сушильное устройство, псевдоожиженный слой, посевные качества.*

Keywords: *fuzzy cotton seeds, seed encapsulation, seed pelleting, protective-nutritive coating, drying equipment, fluidized bed, seed quality.*

Introduction. Ensuring the high quality of seed cotton preparation for sowing and guaranteeing its rapid, healthy germination under field conditions is one of the primary agrotechnical tasks in agriculture. Particularly, in order to protect fuzzy seeds from pests and diseases, as well as to provide them with necessary nutrients during the initial growth stage, coating them with special compounds is widely practiced.

Coating the seeds of hard-to-flow crops was practiced even in ancient times. For instance, in Central Asia, China, and other countries, seeds were soaked in water and then mixed with wood ash or road dust to enhance their flowability. In India, to this day, farmers mix fuzzy seed cotton with fresh cow dung or waste materials and dry it in the shade to improve flowability [1]. At one

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time in the USA, coating fuzzy seed cotton with a liquid prepared by dissolving 1 kg of flour in 16 liters of water was considered cost-effective. After the seed cotton dried, the dough paste separated, and the stuck fibers increased their flowability without interfering with sowing. In Ceylon, seed cotton was treated with starch obtained from corn or other cereal crops. Bone meal, saltpeter, superphosphate, cottonseed cake meal, and similar substances were used to increase the seed granularity; these also served as nutrients for plants or as agents to fight diseases [2].

Sorting and calibrating seeds coated by these methods led to significant errors because the dough-like mass did not adhere uniformly to all seeds. Consequently, the flowability of the seeds was temporary; after the coating dried, a portion of it peeled off, and some detached fibers became entangled with one another [2, 3].

Taking these factors into account, attempts were made to use hygroscopic substances as filler elements. For example, using methylcellulose as a filler compound improved the wetting of seed cotton and increased its germination rate. A group of scientists proposed coating low-fuzz seed cotton with a film made from a polymer material derived from petroleum refining.

The multi-component mixture applied to the surface of fuzzy seed cotton includes fungicides, insecticides, microelements, and biostimulants. To hold these substances securely on the seed surface, special polymeric adhesive agents are utilized. As a result, a protective and nourishing environment forms around the seed cotton. However, during this process, a certain amount of moisture enters the seed surface. Storing or planting seed cotton with high moisture content increases the risk of decay. Therefore, drying the coated seed cotton to a high-quality and safe moisture level represents a crucial stage.

Seed drying is a complex technological process that requires adherence to established movement and ventilation regimes, as well as operational rules for the drying equipment. By properly organizing the drying of agricultural seeds, including artificially coated fuzzy seed cotton, it is possible not only to store them for extended periods but also to enhance their quality. It is well known that raw materials are dried using various methods, all operating on two basic principles: changing or not changing the state of matter (converting liquid into vapor). Thermal drying is applied to remove excess moisture from materials. When dried thermally, moisture from the material turns into vapor due to the applied heat and is discharged into the drying chamber; that is, moisture evaporates from the material during thermal drying [4].

Material and methods. In some cases, the temperature of the material being dried rises to the boiling point of water; for example, vapor is driven off in a vacuum environment.

Scientific literature indicates that the drying rate is directly proportional to the partial pressure difference between the vapor on the material surface and the surrounding environment. To accelerate the drying process, it is necessary to increase the pressure on the surface of the material being dried or reduce the ambient pressure. Increasing the pressure on the material surface is achieved by raising the drying temperature, whereas reducing the ambient pressure is accomplished by altering the heat balance of the dryer or creating a variable effect. Based on the method of heat transfer from the energy source to the material, drying is classified into convective, conductive, and radiant methods. Recently, combined methods and drying in a high-frequency electrical field have also been applied.

Equipment designed for drying coated fuzzy seed cotton must differ from standard dryers, as high temperatures or mechanical stress can peel off the protective layer on the seed surface or decompose the biologically active substances within it:

- Gentle Thermal Regime: The air temperature inside the device must not exceed the specified limit (35–40 °C). This prevents seed kernel damage and the decomposition of active chemical compounds.
- Fluidized Bed Technology: Air supplied from the bottom of the device chamber suspends the seeds in the air. This method ensures uniform drying on all sides of each seed and

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prevents them from sticking together.

- Rotary Drum System: As an alternative to a fluidized bed, low-speed rotary drums equipped with specialized flights are used. Soft paddles inside the drum gently mix the seeds continuously without damaging the outer coating.

Table 1

Technological Parameters of the Drying Process

Indicator Name	Optimal Value
Air stream temperature	35–40 °C
Initial seed cotton moisture content	18–20%
Final moisture content at outlet	8–10%
Drying time	15–20 min
Air stream velocity	1.2–1.5 m/s

Seed drying is a complex technological process that requires strict adherence to specified movement and ventilation regimes, as well as operational guidelines for the drying equipment. By properly organizing the drying of agricultural crop seeds, including artificially coated fuzzy seed cotton, it is possible not only to store them for long periods but also to improve their quality. It is known that raw materials can be dried using various methods, but all operate on two primary principles: changing or maintaining the physical state of the substance (converting liquid into vapor). Thermal drying is used to remove excess moisture from materials. During thermal drying, moisture evaporates from the material due to the heat applied and is released into the drying chamber [5].

In certain instances, the temperature of the material being dried increases to the boiling point of water; for example, vapor is evacuated in a vacuum environment.

It is established in scientific literature that the drying speed is directly proportional to the partial pressure difference between the material surface and the surrounding environment. To accelerate the drying process, one must either increase the pressure at the material surface or reduce the ambient pressure. Increasing the surface pressure of the material is achieved by elevating the drying temperature, while reducing the ambient pressure is realized by disrupting the thermal balance of the dryer or generating an alternating effect. According to the method of delivering heat energy from the source to the material, drying methods are categorized as convective, conductive, and radiant. In recent years, combined drying methods and drying in a high-frequency electric field have also been utilized.

Literature analysis indicates that for free-flowing materials (such as seeds of agricultural, vegetable, and melon crops), the convective method–passing heated air through the layer of drying seeds–is the most widely accepted. In this process, thermal energy heats the material, evaporates the moisture, and carries it outward via the moving heat carrier (gas drying agent, typically heated air or a fuel-gas mixture). Thus, in convective drying, the heat-transfer agent serves simultaneously as the heat supplier and moisture collector. Convective drying is widely used in agriculture for drying granular and loose materials due to its easy process control, low cost, and simplicity in equipment preparation and operation.

Particular attention is also paid to conductive drying, where the material directly absorbs heat from a heated surface to remove moisture. However, this method cannot be used for stationary agricultural seeds, as seeds contacting the hot surface experience localized overheating. Although conductive drying offers the advantage of aligning the temperature gradient with the moisture gradient–enabling rapid moisture movement from the interior to the exterior–it is not widely applied due to its operational complexity and low thermal efficiency.

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Drying in an electric field relies on the thermal effect generated under high-frequency electromagnetic fields. The main reason this method has not gained widespread adoption is that it remains insufficiently studied and exhibits low economic efficiency.

Conclusion. Analysis of material drying methods demonstrates that among all evaluated options, the convective drying method is the most suitable for agricultural crop seeds, including coated fuzzy seed cotton.

After coating fuzzy seed cotton with protective and nutrient compounds, it must be dried in specialized devices using low-temperature, gentle airflow. This technological solution preserves seed germination capacity, enhances pre-sowing preparation efficiency, and ensures smooth, uniform seed flow through sowing machinery.

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