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ANALYTICAL FOUNDATIONS OF ELECTROTECHNOLOGICAL TREATMENT METHODS FOR AGRICULTURAL CROP SEEDS

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Abstract
The article presents an analysis of devices that enhance the efficiency of electrotechnological treatment of agricultural crop seeds.

Keywords: Seed, laboratory, field, physico-mechanical, electric field, biological, opposite, field, dispersibility, density, electric sorter device, ultraviolet light, equipment, pneumatic, mechanical, seedling..

Introduction

Scientific sources indicate that in order to obtain high-quality seeds with similar biological properties, high germination rates under laboratory and field conditions, and high potential yield, it is necessary to apply electrotechnological treatment to agricultural crop seeds based on all essential physico-mechanical properties. Electrotechnological treatment of agricultural crop seeds involves the application of an electric field of varying intensity while considering all their important physico-mechanical characteristics. As a result, unlike pneumatic and mechanical methods, the electric field enables the sorting of agricultural crop seeds based on key physico-mechanical properties such as mass, density, geometric dimensions, electrical conductivity, dielectric permeability, and other similar attributes. Moreover, the electric field has a positive effect on seeds by enhancing their germination ability under laboratory and field conditions, accelerating seedling growth and development, and ultimately increasing crop yield [1, 2, 3, 4].

Main Body. Patent research on triboelectric and dielectric devices was conducted to improve the efficiency of the electrotechnological sorting of agricultural crop seeds, focusing on the electric sorter device, where the electric field arises due to the friction between two dielectric materials and between oppositely charged electrodes. The patent searches were based on updates from the

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Uzbek Research Institute of Mechanization and Electrification of Agriculture (UzMEI) and internet sources over the last 40 years [5,6].

Technological schemes of treatment and irradiation devices for large seeds (such as corn, beets, pumpkins, melons, cotton, and others) before sowing were developed by the All-Union Research Institute of Agricultural Mechanization in 1980. Unfortunately, these schemes did not progress beyond experimental trials [7,8].

A group of biologists and physicists developed a device for processing seeds of certain agricultural crops with an electromagnetic field. The main drawbacks of this device include the high intensity of the electromagnetic field it generates and the difficulty in ensuring uniform seed treatment.

Ultraviolet radiation has a positive effect on agricultural crop seeds, ensuring their disinfection and promoting their development before sowing. Many years of research by practitioners have shown that treating seeds with ultraviolet radiation is an ecologically clean «green energy» technology, eliminating the need for toxic chemical stimulants and salts. It also ensures disinfection and pre-sowing stimulation of seeds, accelerates initial growth processes, and enhances plant growth and development. UV radiation effectively destroys microorganisms on seed surfaces, activates chemical and biological processes, and increases germination energy and the productivity of treated crops [9,10,11,12].

In 2008, as a result of research conducted by scientists from the Institute of Electrophysics and Radiation Technologies of the National Academy of Sciences of Ukraine in collaboration with engineers from the Kharkiv Electrotechnical Company, an experimental device was developed for pre-sowing ultraviolet stimulation of seeds. This device can process up to 4 tons of seeds per day. In 2009, a drum device for uniform ultraviolet irradiation of seeds in combination with their photochemical activation (microelements and biostimulants) was developed together with the Kharkiv Electrotechnical Company and the National Academy of Sciences of Ukraine.

However, despite its advantages, electrotechnological treatment of agricultural crop seeds has certain drawbacks that negatively affect its widespread use in seed preparation technologies in agricultural production. For example, in a corona discharge electric field, the quality and stability of seed sorting are negatively influenced by air temperature and relative humidity. Additionally, expensive sources are needed to generate high-voltage electric fields around 30-40 kV for sorting seeds in corona and electrostatic fields. To implement seed sorting technology in electric fields on a large scale, these drawbacks need to be addressed.

A deep analysis of the results from many years of scientific research, design and engineering work, and laboratory-field experiments shows that using the dielectric method for sorting agricultural crop seeds can overcome the aforementioned drawbacks. Unlike corona and electrostatic methods, the dielectric method allows the technological process of sorting seeds to be carried out in alternating and constant electric fields without charging them with free charges, reducing the negative impact of external air temperature and humidity on the process.

Based on the above, this article aims to develop an energy- and resource-efficient electric sorter device designed to enhance the technological efficiency of sorting agricultural crop seeds to obtain high-quality seeds with similar biological characteristics, high germination rates under laboratory and field conditions, and high potential yield. It also aims to substantiate the constructive dimensions and operating modes of this device.

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Conclusion

The set objective is achieved by generating electric fields under two different conditions—between oppositely charged electrodes and through the friction of two dielectric materials—on the surface of a working body made from a single dielectric drum. This increases the value of the electrostatic attraction force and enables the sorting of agricultural crop seeds based on all their essential physico-mechanical properties. The seeds are then separated into distinct fractions according to their respective detachment angles.

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