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Physiologically active (nano) chips for seeds preseeding processing of the wheat by method of capsulation

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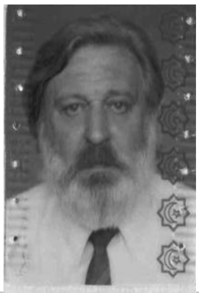

INTRODUCTION

Contemporary agricultural production is conducted while being exposed to global natural and anthropogenic challenges. Climate changes, environmental pollution with ecotoxicants, emergence of large arid areas, substrate salinization, and water shortage result in a reduction in the agricultural planting footprint, lower plant tolerance to adverse environmental factors, and the emergence of new populations of pathogenic microorganisms and cultural plant pests along with their rising aggressiveness. All of the above factors result in decreased agricultural yields, lower-quality produce, seed with short shelf life and low germination, and price increases in consumer markets.To improve adaptability of plants to adverse factors in storage, to obtain full-value and healthy sprouts and good plant development, and to increase seed productivity and quality in subsequent generations, a new agrobiological nanotechnology has been developed that features a composition with properties, such as lability and mobility, that can be modified based on predictions to ensure steady seed production and plant growth and to improve the agricultural industry in general.

It is an object of the nanotechnology, to provide physiologically active multifuctional nanochips and a method of application for production of high-quality seed. It is another object to provide the aforementioned nanochips to be pretreated for sowing on the basis of a nanotechnology that enhances seed and plant adaptability to real-life adverse environmental conditions and to be constructed as multifunctional nanochips that are integrated in the nanopores of the seed cover. It is a further object to provide a method for presowing treatment wherein based on a prediction of adverse effects on plant growing, the composition and properties of the biologically active nanochips can be modified by populating pores of carriers with appropriate biologically active nanoparticles and phytosanitary nanoparticles, which enhance plant tolerance to new adverse environmental factors, improve germination properties, and increase yield and productivity. Further objects are to provide the aforementioned chips and method of application that will: extend seed dormancy; allow the planting seeds to be stored for a long time without compromising quality; initialize termination of seed dormancy under changing environmental conditions by using variously composed and structured biologically active nanochips for seed preparation before planting; enhance seed germination, enhance seed tolerance to pathogens, salinization, draught, frost, and other adverse environmental effects; increase yield; improve produce quality; reduce the rate of consumption of physiologically active and phytosanitary components; easily adapt to currently existing technologies of seed preparation for planting.

MATERIALS AND METHODS

The biologically active nanochip of the nanotechnology comprises a carrier (such as mineral, clay, turf, or polymer and others) having nanopore-filling molecules of physiologically active substances (such as plant development and growth control components, micro- and macro-elements of plant nutrition, phytosanitary substances, etc.). Depending on the nature and structure of the carrier, dimensions of biologically active nanochips range from several microns to 1 to 2 mm, whereas pores of the carrier may range from less than 2 nm (micropores) to 2 to 50 nm (mesopores), or 50 nm and greater (macropores). Herein, the prefix “nano” is used in view of nano dimensions of the carrier pores.

The biologically active nanochip of the nanotechnology contains biologically active components that protect the plants from unfavorable factors and increase production efficiency of agricultural goods. Each biologically active nanochip has a carrier with nanopores penetrable by the aforementioned biologically active substances. When, after sowing, the seeds come into contact with moisture, the physiologically active substances that fill the pores of the carrier are “sucked” through the pores of the seeds into a space between the seed coat and seed embryo where they fulfill their functions. According to another aspect of the nanotechnology, the carrier, which is preloaded with respective physiologically active and phytosanitary substances, is ground to the dimension of the carrier pores, and then the finely ground carriers with physiologically active components are incorporated into the nanopores of the seed cover by means of any conventional method of presowing treatment of seeds (wetting, spraying, blowing, powdering, encapsulating, incrusting, etc.). The method and biologically active nanochips of the nanotechnology apply to seed of various types, such as cotton seed, sugar-beet seed, rice seed, soybean seed, wheat seed, etc.

RESULTS AND DISCUSSION

The work relates to natural nano devices, such as seeds of various plants irrespective of species, varieties, and geographical spread. The term “nanotechnology,” as used in the present work, covers nanoparticle-control technology that is used as a basis for developing new methods for processing, producing, and modifying states and properties of raw materials, materials, or semiproducts. “Nanotechnology” was previously known as “supramolecular architecture” and later as control of “ultradispersive particles” or “nanoparticles.” In the field of biotechnology, manipulations with DNA, in view of DNA dimensions, were also referred to as “nanotechnology.”Nanotechnology development, which allows use of natural seed adaptation systems and biologically active nanochips in seed cover pores, is the most effective way to enhance seed reliability and resistance to adverse environmental factors.

Nanotechnology of the above-described type allows for modifying the composition of physiologically active substances, including phytosanitary substances, and altering their character based on specifics of nanosystem formation and on interactions of components (nanoparticles) on molecular and supramolecular levels within biologically active nanochips, depending on specific soil/climatic conditions of cultivation of various plants, specifics of diseases caused by microorganisms and soil-based and other pests, and extending planting seed shelf life without compromising planting properties.

The biologically active nanochips are constructed according to several methods (synthesis and modification) based on the following:character of nanochip components; functional tasks of the chip, such as shelf life; seed and plant protection against phytopathogens and pests;
enhanced tolerance to adverse environmental effects (plant salinity and draught, and the like),
enhancement of growth processes, and the like; production of subsequent seed generations that have high planting properties; increased yield; conditions under which seeds are produced and used.

The composition and quantity of the biologically active nanochips to be applied to the seeds depend on the results of the monitoring of agricultural plant cultivation conditions, environmental statistics, and also predictions of the following indicators for the coming year: soil and ambient temperatures, humidity, attacks of pathogenic microorganisms, nature of diseases, seed types, true or light dormancy, as well as seed size and seed potentials such as germination energy and germinating capacity. In addition, the biologically active nanochip composition is defined with consideration of availability of digestible forms of potassium, phosphorus, nitrogen, and various nutrient trace elements such as zinc, copper, cobalt, iron, lithium, manganese, molybdenum, and other nutrient micro- and meso-elements in the soil. For this reason, nanochip components vary within the very broad range of $1 \cdot 10^{-10}$ % to 100%. Trace quantities of nanochip components are used for steeping plant seeds, macro quantities are used for dusting seeds, and intermediate quantities are used for pelleting.

From the processing point of view, the difference in the use of biologically active nanochips for treating plant seeds having different dormancy types consists of the fact that seeds with light dormancy are treated without using additional steps, whereas seeds that have true dormancy are subjected to scarification, i.e., mechanical damage to seed cover. Scarification allows the biologically active nanochips to penetrate deep into the seed cover pores so as to affect growth activation and to contribute to and induce the protective response of the plant to phytopathogens that cause diseases, as well as to stress conditions caused by soil salinization, ecotoxicants, and shortage of molecules providing nutrition for the plants at the earliest stages of development (nutrient macro-, meso-, and microelements).

It follows from the above that a biologically active nanochip in its simplest form comprises only two components, i.e., at least one carrier and at least one biologically active substance, both selected with reference to anticipated adverse factors such as cold weather, salinization of soil, and emergence of new populations of pathogenic microorganisms and cultural plant pests along with their rising aggressiveness, etc. The biologically active nanochips may be produced either as vendible products as agents, as dry or liquid substances, or in the form of a preparation. Thus the increase in the productivity caused by use (nano) of systems for preseeding processing of seeds of a wheat has made in separate variants of experience from 1,6 c/he up to 25,8 c/he depending on structure and concentration of used components in the developed multifunctional nanochips.

CONCLUSION

Thus, the aforementioned nanochips are pretreated for sowing on the basis of nanotechnology that enhances seed and plant adaptability to real-life adverse environmental conditions and are constructed as multifunctional nanochips that are integrated in the nanopores of the seed cover.

REFERENCES

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