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Using of Electro Fields to Disinfection of Cotton Seeds from Diseases

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ABSTRACT: The results of a brief analysis of the current state of disinfecting cotton seeds against pathogenic microorganisms before sowing. Based on compared previous studies it is justified the necessity to use the super-high-frequency electric field for environmentally friendly disinfection, and some new processing parameters have been justified.

KEYWORDS: cotton, seeds, disease, disinfection, chemicals, super-high-frequency ultra-high frequency, electromagnetic field, power, technology, germination.

I.INTRODUCTION

The average recorded annual loss of cotton from various diseases is 13% of gross harvest [1]. Every year cotton seeds transfer such diseases like gummosis, root rot, wilt, and others.

Cotton seeds are a major source of transmission of bacterial gummosis from year to year, and wilt fungi infect up to 20% of seeds. In addition to pathogenic microflora on the surface of seeds, there are numerous thermophilic, mould and other microorganisms [2], which in the period of storage of seed have a negative impact on their biological activity due to the evolution of mycotoxins from them [3]. Therefore, seed disinfection against microorganisms, along with protection from diseases, plays a catalytic role.

II.STATE OF THE ISSUE

Currently disinfection of seeds against these microorganisms is in the form of treatment chemicals. For these purposes Bronotak, P-4 and other chemicals are used that are highly toxic for the environmental balance (soil and air), and particularly for human, and animal health, because a certain number of them get into their microorganisms through air, skin and food products [1].

The chemical treatment method with the chemical flow rate of 6-12 kg/1 is characterized by a large inequality of the distribution of a chemical between the individual seeds. As a result, there are frequent outbreaks of cotton diseases in large areas causing economic damage to farmers in the form of crop shortage and quality reduction. Furthermore, due to emptying on the seeds before sowing it is significantly lower than originally applied amount of chemical, which reduces the shielding effect of protection against pathogens. Therefore, every year large areas of crops are infected with various diseases, and their reseeding is required.

The biological method of disinfection of seeds against pathogens of bacterial, and fungal diseases, which uses natural enemies-antagonists has not found practical application due to the narrow spectrum of action, and dependence on weather conditions [6]. Application of temperature heating in water is distinguished by the complexity of the process, and high material expenditure, and narrow spectrum of action on microorganisms, and by reduction of sown seed quality [7].

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Cotton seeds treatment in the ozonated medium of corona discharge within 1 -5 minutes, and their seeding in the infected bacterial pathogen background revealed the ability to reduce the incidence of cotton gummosis from 96% to 12%-54%, root rot from 24% to 4-16%, wilt from 53% to 16.5%-49.5% while increasing field germination from 52% to 69%-72% [4].

Processing of seeds artificially infected with gummosis bacteria, in an electrostatic field of 2-8 kV / cm within 20-60 seconds showed the possibility of reducing the incidence of cotton leaves infection by 2-3 times (from 42.0 to 14.7%) while increasing germination to 10.7% depending on the exposure conditions.

In 1979-1984 electrochemical treatment was developed where particles of chemicals were applied on the surface of cotton seeds under the influence of electric forces of charges attraction of opposite poles [5]. Studies on the effects of electric fields during the preparation of pre-seeding revealed relatively high efficiency of this method. Treatment of artificially infected downy seeds by gummosis bacteria in the electrostatic field for only two seconds reduced cotton infection spread of leaved, and stem form by 1.5-2.0 times which may be caused by depressing action of electric field, and denaturation of microorganism proteins. Effects on the seeds in the electric field of corona discharge allowed reducing the incidence of cotton root rot by 2.5- 3.0 times.

The electrochemical method allowed only reducing pesticide application rate by 30-40% due to the reduction of variation in the distribution of the chemical between individual seeds. Therefore, in order to eliminate the use of harmful pesticides the environmentally friendly disinfection technology of sowing seeds by electromagnetic fields was developed, eliminating the use of chemicals for this purpose [8], which provides exposure to the seed ultrahigh-frequency (UHF) electromagnetic fields (EMF) with a devastating impact on the livelihoods of microorganisms, and stimulating the biological activity of the seeds.

As it follows from the previous studies, suppression by EMF and UHF occurs as a result of selective heating of cells [9], having higher humidity compared to seeds. This causes a partial denaturing of protein and inactivation of key enzymes [10]. With the passage of UHF electromagnetic radiation through microorganisms we cause strengthening of intermolecular friction, and heat generation, resulting in the destruction of cell membranes, and the death of microorganisms. In addition to the selective heating, general heating of humidified seeds surface with microorganisms located on it is possible [11]. The thin humidified surface layer of the seed is heated by a UHF field till the temperature is sufficient for microorganisms' death. In this case, the main active factor is the thermal effect of electromagnetic radiation.

The advantage of electromagnetic fields is that their application will achieve disinfection of cotton seed with simultaneous stimulation of their biological activity.

Pathogens are on the surface of the seed, and after getting the latter into the soil, the conditions for starting vital physiological processes are being created. The cotton seed start growing, and the root of the future plant begins to root in the soil. At the same time, gummosis bacteria, moving with their motor flagella, begin to penetrate into the body of the root, and move on it, that in the future will cause pathological changes of shoots, and its gummosis disease.

Therefore, in order to prevent seedling diseases it is critical to affect seeds, and located on the surface gummosis bacteria so that the effect of the external electric field would cause stimulation of biological activity, and strengthening of seed immunity, while terminating significantly vital metabolism processes in pathogenic microorganisms.

When applying to the membrane electric field of ultrahigh frequency some individual macromolecules of phospholipids that make up a separate layer begin to oscillate with the same frequency. As a result, the intermolecular mutual friction of lipids and proteins causes heating to a temperature sufficient to denature. This leads to the cessation of the synthesis of essential compounds, and destruction of microorganisms on the surface of seeds, and their disinfection without the use of toxic chemicals, which undoubtedly contribute to the cessation of the latter's contact with the biosphere, and to the improvement of the ecological balance of the environment.

III.MATERIALS AND RESEARCH METHOD

Downy seeds of selection variety C-6524 of medium fibrous cotton of the second reproduction have been chosen as a research target.

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Methods of seed infection by gummosis bacteria. In order to obtain a pure crop gummosis bacterium (Xanthomonas malvecearum Dowson) we used genuine dry leaves of infected cotton plants stored from the previous season in the phytopathology laboratory at the Uzbek Research Institute of Selection and Cotton Seedage. Sowing and germination of leaf powder was carried out in a thermostat at a temperature of 26-28°C in Petri dishes with potato agars. Pure crop gummosis was extracted by means of three-times reseeding with the subsequent germination. Such obtained strains were grown in test tubes for use in research.

Sterilization of necessary cups and test tubes was carried out at 1 atm. for 2 hours and bacteria reseeding were carried out near spirit flame. From the resulting pure crop the bacteria suspension to infect plants was prepared.

In the tests 6 kg of downy seeds were carefully, and manually mixed with 450 ml of gummosis bacteria suspension in three proportions of 150 ml each. The infected seeds were dried to 5-6 cm layer gage until the conditional humidity of 5-6 cm layer gage.

Sampling of seeds and their germination to determine the laboratory growing energy, and germination were carried out by a well known technique [13] in trays with sterilized sand, and filter paper method [14].

The study of laboratory cotton gummosis infection was conducted under phytotron condition at the Uzbek Research Institute of Selection and Cotton Seed- age in trays with sand size 25x18x8 cm in triplicate replication with 50 seeds in each one. The quantity of diseased plants was defined as appearance.

A. Processing in an electromagnetic field. The studies as a source of high voltage direct current used rectifier VS-50-50. Seed treatment was carried out in parallel plate electrodes. Intensity varied by adjusting the primary voltage of the rectifier from 2 to 8 kV/cm, and exposition from 20 to 60 seconds. Treatment of seeds, and bacteria in the electromagnetic field of ultrahigh frequency was carried out in microwave installation Samsung Ml736 NR according to plan Hartley 2 at a radiation power of 180 to 600 W with a duration from 1.5 to 10.0 minutes. The radiation power was varied by adjusting the voltage via an autotransformer.

IV. RESEARCH RESULTS AND DISCUSSION

Studies under phytotron conditions for disinfection of artificially infected cotton downy seeds with gummosis bacteria by means of electromagnetic field of ultra-high frequency confirm the validity of the above statements (see Table).

Growing, and germination energy of seeds compared to the control sample (Option 3) by treating in EMF and UHF vary in test seeds in the considerable limits. In options with pre-moisture the germination energy is greater than the options with treatment of air- dried seeds. This can be explained by the fact that the embryo in kernels of moistened seeds is heated to a lesser extent, and does not achieve the suppressing value due to greater absorption of field energy on the moistened surface layer. Average length of two-week cotton seedling was also highest for options with pre-moisture, and it is longer than the control samples by 3.66.8 cm. That is to say, the seeds of these treatments receive a stimulating dose of electromagnetic energy. A similar pattern was found later in the field experiment.

Disease rate of leaved-type gummosis was lowest also in options where it was 12.0-14.0 **%** (excluding Option 8), and was lower than the control sample by 1- 3 %, whereas the incidence rate of seedling from the source, and infected seed gummosis bacteria (Optionl and Option 2) was greater than the control samples by 12-20 %. This change is a result of the consequence of disinfection (thermal) action of the electromagnetic field.

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Table 1

No. Option	Seeds preparation technique	Treatment parameters in UHF and EMF		Index of seeds		
		Power, W	Exposition, min	**Germination rate,** *%*	**Average stem length, cm**	**Gummosis rate, %**
1	**Reference**	0	0	89,0	9,5	27,0
2	**Infected with gummosis bacteria**	0	0	92,0	11,6	35,0
3	**B2+chemical disin-fection (P-4, control)**	0	0	93,0	15,3	15,0
4	**B2+UHF EMF**	600	1,5	41,0	16,0	15,0
5	**B2+UHF EMF**	450	2,0	35,0	16,2	12,0
6	**B2+UHF EMF**	300	3,5	65,0	14,9	21,0
7	**B2+UHF EMF**	180	6,0	88,0	16,2	13,0
8	**B2+UHFEMF***	450	2,0	93,0	18,9	20,0
9	**B2+UHFEMF***	300	5,0	21,0	11,0	17,0
10	**B2+UHFEMF***	180	10,0	61,0	18,3	14,0
11	**B2+UH EMF***	180	7,0	84,0	20,2	12,0
12	**B2+UHF MF***	180	5,0	94,0	22,1	13,0

* -Options with pre-moistening of seeds surface

The study of seeds surface disinfection against gummosis bacteria, and other pathogenic, and saprophytic microorganisms was conducted by the method of seeding on potato agar. As a result, it was found that the microwave electromagnetic field under certain conditions provides 100% disinfection of seeds against microorganisms without using chemicals.

The analysis of the results of laboratory tests gives a ground to believe that the microwave electromagnetic field under the influence of the power inductor of 180 W for 5 and 7 minutes and 450 W for 2 minutes have a

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disinfecting effect on the infected with gummosis bacteria cotton seeds to an extent exceeding the results of the existing chemical treatment.

V. CONCLUSION

1. The existing methods and technical means do not provide the required quality of cotton seeds disinfection against pathogenic microorganisms, resulting in an annual loss of gross cotton crop and reseeding is carried out in large areas.
2. In order to eliminate the use of environmentally harmful chemicals in preparation for sowing seeds it is rational to use an electromagnetic field of ultrahigh frequency, allowing at the same time to have a devastating effect on the life of pathogens, and to stimulate the biological activity of future plant embryos.
3. The microwave electromagnetic field when exposed to power inductor of 180 W for 5 minutes (7 minutes), and 450 W for 2 minutes provides with 100% disinfection of artificially infected with gummosis and pre-moistened cotton seeds against microorganisms to an extent exceeding the existing chemical treatment. This suggests possible transition to environmentally friendly disinfection of seeds contributing to the balance preservation of biocoenosis in the areas of cotton cultivation.

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