Study of the electrical resistance of the components of healthy cotton seeds and those infected with gummosis

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Abstract The article provides data on the impact of high-voltage current of electric spark discharges on the culture of gummosis located on the surface of a cotton seed, special electrodes were made to determine electrical resistance, a method for conducting research experiments was developed, the liquid was from the outside of the peel, an electronic megohmmeter was used for measurement, for conducting experiments have drawn up a block diagram of the research methodology. The analysis of the works shows the absence of any data on the electrophysical parameters of the moistened pubescent seeds before sowing. Therefore, the study of the electrophysical characteristics of sown moistened pubescent cotton seeds is of scientific and practical importance for substantiating the operating parameters of electric spark treatment. Before sowing, pubescent cotton seeds are sorted (low-quality seeds are separated up to 10-15%), then moistened. The morphology and the mechanism of wetting cotton seeds are reflected in the analyzed works, and in the sectional view of the cotton seed. In the process of moistening, the main site of moisture absorption at the initial stage of moistening after backfilling is chalaza. Together with moisture, oxygen also enters the crumpled cotyledons, after which the root makes its way through the micropile. The peel protects the seed core from excessive oxygen supply. At the same time, the skin of the seed prevents the rapid flow of moisture into the seed. An electrical circuit is presented that ensures the completeness of seed treatment. And also the materials are given regarding the "electric hardening" of the water being humidified. Preconditions have been made for the automation of the seed moistening process.

1. Introduction
In Uzbekistan, the affection of cotton by gummosis in different years manifested itself in different ways. However, the consequences are drastically reflected in the quality of the fiber and lead to yield losses. Many studies to combat gummosis disease have been based on the use of pesticides. Pesticides negatively affect the health of people and warm-blooded animals, pollute the environment. Electrospark treatment of cotton seeds in order to disinfect them from gummosis disease is an environmentally friendly technology and helps to improve the ecological situation in the region. A.A. Babayan in his article "Methods of centralized dressing of cotton seeds" [1] writes that dressing of cotton seeds is mainly directed against gummosis (Psedomonos malvacearum), which is the most common disease of this crop. It is also noted here that, depending on the climatic conditions of the area, the degree of resistance of the cultivated variety to diseases, the agricultural technology used, the harm from gummosis can reach different sizes (for example, in Armenia, before the obligatory use of dressing in 1929 and 1930, the damage rate of cotton in% was 40 and 9-23).
As the author notes in his scientific work [2], there are different physical methods for disinfecting cotton seeds from infection with the causative agent of gummosis. Some researchers in their works studied the effect of temperature (in the direction of its increase) on the causative agent of cotton gummosis. For example, in the studies of A.A. Babayan gave a negative result on heating cotton seeds in a dry or humid environment. In this work, the seeds were heated with dry air at temperatures from 50 to 100 °C for one hour. In particular, in the work "Singing as a method of delintering and disinfecting cotton seeds from gummosis", the authors disclosed in detail the essence of singing in the treatment of seeds with hot flue gases at a temperature of 800-1000 °C for 1-3 seconds, while the scorched seeds completely lose their puffs. This method, proposed by P.A. Kolomiytsev, technically implemented by M.Yu. Lurie. As a result, a decrease in germination was observed.

The experiments carried out by R.E. Eyyubov, gave positive results when used for the disinfection of cotton seeds from homoza infection [3]. This physical process consumes little energy. Despite this, this work did not find practical application due to low productivity.

The work carried out to study the effect of the magnetic field on the causative agent of cotton gummosis also yielded positive results [4]. In this work, to establish the survival of X.malvacearum under the influence of a magnetic field, an initial suspension of X.malvacearum was prepared, which corresponded to 1 billion cells in 1 ml, and then a series of dilutions was performed. Were investigated the fourth, fifth, sixth, seventh methods, which were exposed to radiation. The power of the source corresponded to 4000 oersted, and the irradiation was carried out with exposures of 10.20.30.40.60 minutes. Irradiated suspensions were plated in 0.1 ml increments on solid potato nutrient medium in Petri dishes. An unirradiated bacterial suspension was used as a control. The cell viability was counted by the method of counting macroclonies. As a result, the highest degree of disinfection was obtained with an exposure time of 60 minutes. Then, after carrying out the above experiments, the infected seeds were treated and the effect of the magnetic field on seed germination was checked. The results obtained from the experiments (experiments) made it possible to suggest that the magnetic field affects the germination of seeds and reduces the susceptibility of cotton to the causative agent of gummosis. However, due to the large exposure of the time of seed treatment and low technology, this method has not found practical application.

The use of electric current for the disinfection of cotton seeds requires substantiation of the electrophysical parameters of the electrophysically processed material. When stored in the factory, seeds have a moisture content of 10-12%. The technology of sowing pubescent seeds requires moistening the seed before sowing. In this case, the moisture content of the seeds increases two and three times. Measurement of the electrical resistance of various parts (components) of the peel of pubescent cotton seeds infected with gummosis infection and the development of research methods for the study of electrophysical parameters is an urgent task.

In the monograph by Rashidova D.K. long-term results of scientific and practical research are analyzed and summarized and an extensive literature review on the use of chemical plant protection agents based on chitosan, a natural polysaccharide that promotes disease resistance, for pre-sowing seed preparation of agricultural crops is presented. The monograph covers the use of the domestic environmentally safe dressing agent with a stimulating effect UZKHITAN, which is a polymer preparative form of chitosan, as well as the results on the effect of this drug on the sowing characteristics of cotton seeds encapsulated with a polymer plant protection regulation agent [5].

Crop losses from plant diseases in the world tend to increase for many crops. The use of disease resistant varieties and pesticides cannot resist this. Eradication efforts pose many environmental problems. It is known that from 11 to 18 kg / ha of pesticides are introduced into the soil annually, which causes serious concern and environmental pollution. It is known that state policy in developed countries is aimed at improving the quality of life and, above all, the quality of food, in connection with which huge resources are spent on solving environmental problems. Every year there is an increasing interest in environmentally friendly technologies, including biologically based methods of pest control of agricultural crops. The use of CPPP (chemical plant protection products) - pesticides is associated with their effect on the human ecology and the environment, often with serious consequences. An
An important task facing researchers is the ecologization and optimization of methods for pre-sowing seed treatment with biologically active compounds [5,6]. These methods of seed treatment were called encapsulation, the technology of which was developed at the Institute of Chemistry and Physics of Polymers of the Academy of Sciences of the Republic of Uzbekistan [6].

It is known that the life cycle of the latter is completed by the formation and full maturation of the seed of a once fruiting plant. From the moment of biological separation of the seed from the mother plant, the life of a new generation begins. Therefore, the seed is a kind of carrier of life of a certain genotype. And as a carrier of life, the seed is characterized by vitality - the ability to preserve life, reproduce the species. The first visible manifestation of the viability of seeds is their germination, a complex biological phenomenon, the mechanisms of which are largely unknown [7].

Germination is a very rapid transition of a mature, viable air-dry seed from an almost inactive state of dormancy to the activation of metabolic processes. To understand the physiology and biochemistry of germination, first of all, it is necessary to find out how such a rapid start of physiological and biochemical processes that provide and carry out the beginning of embryo growth is regulated. The main metabolic processes are associated with the start of growth and, first of all, the reading of genetic programs [8, 9].

Table 1. Determination of chlorophyll at the experimental site NISSAVKH in the season of 2014 (arbitrary units)

| №  | Variants | Date of determination of chlorophyll in cotton leaves |
|----|----------|------------------------------------------------------|
| 1  | Control  | 02.07 07.08 15.07 30.07 17.08 30.08               |
| 2  | P-4      | 46.5 47.1 49.3 50.6 50.2 48.4                      |
| 3  | UZKHitAN | 47.9 48.6 49.8 50.0 48.5 48.1                      |
| 4  | Chitosan | 48.3 48.5 50.9 49.6 50.2 49.4                      |
| 5  | Chitosan + Si | 47.6 48.6 52.0 51.3 50.8 50.2 |
| 6  | KMH      | 47.5 48.6 49.0 50.9 50.3 49.9                      |
| 7  | Control the seeds pubes. | 47.5 48.2 49.5 50.8 51.3 50.5 |
| 8  | UZKHitAN the seeds pubes. | 47.9 49.2 53.5 52.9 51.7 50.3 |

Experiments to determine chlorophyll in cotton leaves were carried out on a SPAD-502 device.
SPAD-502 plus Chlorophyll meter (see Figure 1) can measure the relative chlorophyll content, the destructive effect on the leaves. The measured datum of the map will be displayed in the trend graph. It can be used to increase the use of nitrogen fertilizers.

Figure 1. Electronic device SPAD-502

In the monograph by Kazansky V.V. [27] described the electrophysical parameters of wet seeds selected for measurement immediately after the harvest of raw cotton.

In this work, the electrical properties of cotton seeds (ε, tgδ, ρ) were investigated using fractional meters E9-4 and E9-5, an admittance meter E10-2 and a terahmometer E6-3 at discrete frequencies of 0; 0.1; 0.4; 1; ten; and 100 MHz.

However, the physicomechanical properties of the kernel, underfilling and seed coat change significantly during their storage. The peel of the seed becomes woody, the moisture content of the kernel decreases. The microelements that make up the core and rind are also subject to change before sowing. The morphology and moisture mechanism of cotton seeds are reflected in the works [28,29,30]. Analysis of these works shows the absence of any data on the electrophysical parameters of moistened pubescent seeds before sowing. Therefore, the study of the electrophysical characteristics of sown moistened pubescent cotton seeds is of scientific and practical importance for substantiating the operating parameters of electric spark treatment.

Under the leadership of Professor A. Mukhammadiev, a lot of research work was carried out on the electrical treatment of seeds and the use of environmentally friendly electrical technologies in the agricultural sector [31,32]. The technique and results of studying the electro-pulse treatment of cotton seeds moistened with electroactivated water (water with altered pH values) for their germination at different voltages of the electric spark discharge and the capacity of a high-voltage capacitor are considered.

In its implementation, the pubescent cotton seeds of the AN-Bayaut variety were moistened with electroactivated water at a rate of Q = 250 l / t (150 l / t anolyte pH = 5.0 + 100 l / t catholyte pH = 9). Then, 10 seeds were selected from a batch of these seeds and subjected to an electric pulse effect at a discharge voltage of 2, 4, 6, 8, 10 kV (the experiment was repeated five times). The treated seeds were wrapped in absorbent paper and dipped in a glass of water, and seeds were germinated in a Petri dish. The results were recorded after 6 days and the number of germinated seeds was counted. The capacity of the high-voltage capacitor was 220, 330, 470, and 1000 pF [32].

The germination capacity of seeds moistened with normal and activated water and subjected to additional electric pulse treatment was determined by sowing them in a Petri dish. Moreover, each experiment was carried out in duplicate, i.e. sowed 50 seeds in two Petri dishes. The seeds were moistened once and twice with ordinary tap water, as well as with electroactivated water (anolyte pH = 5.0 ÷ 7.0 and catholyte pH = 9 ÷ 11), then they were subjected to additional electric pulse treatment at 4 kV and C = 470 pF. At the same time, part of the treated seeds was transferred to a special laboratory to determine the effect of electrical treatment on the presence of gummosis infection, and the other part for microscopic analysis in order to study the presence of microcracks and micro punctures on the seed skin.
The influence of electric spark discharges on pure culture of gummosis (X. malvacearum) was also studied. To carry out the experiments, special electrodes were made from copper wire and pre-sterilized. The electrodes were placed in a test tube so that they could be connected to two poles of a high-voltage spark discharge current source, and between them, inside the test tube, were the bacteria of the causative agent of gummosis to be processed [33, 34].

2. Methodology
To solve this problem and carry out experimental research, a technique was developed, the general structural diagram of which is shown in Figure 2. It reflects the sequence of scientific research and helps to eliminate methodological error. In the given structural diagram of the research methodology for studying the electrophysical characteristics of moistened cotton seeds (see Figure 2), the sequence of operations is laid out as follows: studying the morphology of cotton seed and infection of the causative agent of gummosis; study of methods for measuring electrical resistance and assessing errors; planning a one-factor experiment: measuring electrical resistance; to study the effect of spark discharge current; components of moistened seeds; layers of moistened seeds; for a pure culture of the causative agent of gummosis; on laboratory germination of cotton seeds. At the end of the block diagram, the processing and analysis of research results and conclusions are given.

But when seeds germinate, there is a high probability of contamination with diseases located on the surface of the seeds and in the soil. To prevent plant diseases, seeds are disinfected by pre-sowing seed treatment. The existing methods of such preparation of seeds are based on the treatment of seed material with various reagents, often toxic. In the presence of positive results, these methods have a number of negative aspects, namely the possibility of poisoning the operating personnel and contamination of the environment. Presowing treatment of agricultural seeds contributes to the creation of optimal conditions at the stage of germination, stimulates the emergence of full-fledged seedlings and seedlings with increased germination energy, protects seedlings from pests and diseases, enhances the adaptation of a developing plant organism to changing environmental conditions.

The pubescent cotton seeds are moistened, and in Figure 3. shows a cross-section of a cotton seed. In the process of moistening, the main site of moisture absorption at the initial stage of moistening after prefilling 2 is chalaza 1. Together with moisture, oxygen is also supplied to the crumpled cotyledons 3, after which the root 4 makes its way through the micropil 5. The peel 6 protects the kernel (3 and 4) of the seed from excessive oxygen intake. At the same time, the skin of the seed prevents the rapid flow of moisture into the seed. The effect of the peel in the process of swelling of the kernel of a cotton seed is shown in Table 2. (based on the work of Gubanov G.Ya.).

| Water in the kernel of a cotton seed, % | Swelling time, hour |
|--------------------------------------|---------------------|
|                                      | 0  | 10 | 20 | 30 | 40 | 50 |
| without peel                         | 10 | 51 | 53 | 55 | 58 | 60 |
| with skin                            | 8  | 20 | 33 | 41 | 44 | 46 |

The table shows that in the presence of a peel, cotton seeds swell slowly.

According to the study of the morphology of the underfloor, there are the following data: more than 70% of the surface of pubescent seeds are covered with underfills, up to 5 mm long, while their thickness ranges from 12 to 42 microns. These data refer to the underfloor of air-dry seeds. Regarding the morphology of the infection of the causative agent of gummosis, according to Babayan (1963), the measurement of bacteria on various media gave the following results: on MPA - 1.9-2.5 / 0.8-1 microns, on MPA - 1.8-3.0 / 0.8-1 microns, on potatoes - 1.25 / 0.8-1 microns and on milk - 2.5 / 0.6-0.8 microns. In these environments, bacteria can be considered swollen.

When initially dry spores are moistened with water, the size of infections will increase to the above limits. Compared to the size of the underfloor (thickness and length), infection spores are an order of magnitude smaller.
For the experiments, we used pubescent cotton seeds of medium fiber variety C-6524, zoned in the conditions of the Tashkent region. To measure the weight of the seeds, we used a lever table balance, brand 9033RN-20 g (TU 205 RSFSR HI-07-103-83). And to determine the mass of small parts of the seed (for example, the weight of the peel or kernel), we used a scale for bulk materials VSM (TU 64-I-3849-84).

**Figure 2.** Structure diagram of research methods

**Method for studying the electrophysical characteristics of wetted cotton seeds**

**Study of the morphology of cotton seed and infection of the causative agent of gommosis**

**Study of methods for measuring electrical resistance and estimating errors**

**Planning a one-way experiment**

**By measuring electrical resistance**
- components of moistened seeds
- layers of moistened seeds

**By studying the impact of spark discharge current**
- on a pure culture of the causative agent of gommosis
- on laboratory germination of cotton seeds

**Processing and analysis of research results**

**CONCLUSIONS**
Table 3. The nature of the change in the electrical resistance of components of healthy and infected with gummosis cotton seed, depending on the duration of hydration

| Electrical resistance of cottonseed components. | Duration of humidification, sec |
|----------------------------------------------|---------------------------------|
|                                              | 0     | 30    | 60    | 90    | 120   |
| Chalaza: healthy seed                        | 2.6   | 1.55  | 1.16  | 1.04  | 0.95  |
| contaminated seed                            | 2.54  | 1.72  | 1.34  | 1.03  | 0.86  |
| Micropil                                     |       |       |       |       |       |
| healthy seed                                 | 3.36  | 2.88  | 2.58  | 2.42  | 2.24  |
| contaminated seed                            | 4.16  | 3.70  | 3.26  | 3.08  | 2.78  |
| Peel (lateral surface)                       |       |       |       |       |       |
| healthy seed                                 | 2.3   | 1.26  | 0.81  | 0.61  | 0.46  |
| contaminated seed                            | 3.24  | 2.70  | 2.21  | 1.50  | 1.19  |

The table shows that despite the same variety of seeds, the resistance of the moist components of healthy and infected seeds is different. The indicators of the electrical resistance of infected seeds are higher, especially in those parts of the components of cotton seeds, where the underfills are densely located (in the parts of the micropil and peel). The results of the experiments are shown in Table 3.

3. Results and Discussion

Apparently, in infected seeds, moisture first enters the infection of the causative agent of gummosis, promotes the swelling of the infection, and then begins to flow to the peel of the seeds. In the process of moistening, the gummosis infection located on the surface of the seeds, absorbing moisture, swells much faster than the puffs and peel.

When studying the electrical resistance of moistened sown cotton seeds, the effect of the duration of moistening on the parameter of seed resistance was taken into account. Since the technology of preparation of pubescent seeds on a drum humidifier is carried out within two minutes, the basis of the exposure for measuring the electrical resistance of the components of the cotton seed was taken for a period of time equal to the time of a single humidification. The components of cottonseed are chalaza, micropil, and rind (see Figure 3).

![Figure 3. Seed of cotton in the section: 1-chalaza; 2-backs; 3-crumpled cotyledons; 4-spine; 5-micropile; 6-peel (lateral surfaces).](image-url)
The procedure for obtaining the components of the seed is as follows. Air-dry seeds were cut into two parts along the longitudinal and cross section. Remains of the nucleus were recovered from the obtained parts. Then the electrical resistance was measured.

To reduce the influence on the result of measurements of leakage currents, a specially provided screen was used, which was grounded during the measurement. To measure the electrical resistance of the components of healthy and infected cotton seeds, a device was made (Figure 4.). Measured sample 1 was obtained by separating dry cotton seeds along and across, followed by cleaning the kernel. One end of the electrode of the megohmmeter 3 is connected to the insulating support 2, the other 4 - to the metal plate 5. The object to be measured is placed between the needle and flat electrodes. The insulating support 2 with the same force presses the sample to the metal support 6. The metal support is made in the form of an open vessel and is fixed rigidly on the surface of the metal plate. The measurement of the object was carried out in the process of wetting.

Figure 4. A device for measuring the electrical resistance of the components of healthy and gummosis-infected cotton seeds: a - 1-chalaza, micropropyl or peel (side part); 2-insulating support; 3, 4 electrodes; 5-metal plate; 6-metal stand; 7-water

Methods for measuring resistances are very diverse due to the fact that in practice it is necessary to measure resistances of different magnitudes and of a different nature. Of these, meegger measurement methods are straightforward. Megohm meters are mainly produced for measuring insulation resistance. Since the seeds have high resistance, in our work we used a megohmmeter of the F 4101 brand (Figure 5.). This figure shows the wiring diagram for connecting to a megohmmeter.

The experiments were carried out taking into account the errors according to known methods. The results were used to calculate the average value of the electrical resistance of the components of the seed for a certain duration of hydration. The stopwatch "Agat" was used.

The peel of healthy seeds absorbs moisture faster (relative to the peel of infected seeds), since they lack a "screen" - the causative agents of gummosis. Consequently, with the simultaneous electric pulse treatment of seeds, current pulses selectively (selectively) pass along the surface of the infected seeds through the swollen infection.

When the tractor is moving, the sowing of seeds occurs simultaneously in four rows. Since an electrode system is installed on the removable sidewall of the ejection window (from where the seeds are thrown into the field) (Figure 6), connected to a high-voltage source of electrical spark discharges (Figure 7), the seeds passing through the cavity inside the sidewall are in contact with the electrodes. At the same time, a spark discharge penetrates each seed.
Figure 6. Special electrode system for electrospark seed treatment: 1-holes for fixing flat textolite on the unit (insulating base on the suspended unit - seeder); 2-terminals (electrodes) for connecting a high-voltage (+) positive electrode; 3-flat textolite; 4-electro-treated seed; 5-grounding (metal case); 6-second, (-) negative flat grounded metal electrode.

The source of electrical spark discharges contains a high-voltage transformer, a diode, a capacitor and an arrester. The primary winding of the transformer is connected to the tractor generator, the secondary through the diode to the storage capacitor, which is connected at one end through the spark gap to the electrode system, and at the other end to the tractor body (grounded metal electrode).

Figure 7. A source of electrical spark discharges. TV - high voltage transformer, VD1…VD3 - high voltage diode, C1…C3high voltage capacitor and FU1…FU3 - high voltage arrester. Ground - grounded metal electrode.

High-voltage electrodes for supplying a pulse current to each seed are installed with an ejection window 13 mm wide. It was necessary to determine the voltage at which the breakdown of the interelectrode gap occurs when the seed is in it and without it. To achieve the efficiency of the electric pulse processing of each seed emerging from the ejection window of the electric seeder, with the capacity of the high-voltage capacitor $C = 220 \text{ pF}$, the interelectrode voltage of the spark discharge should be $6 \text{ kV}$, with $C = 330 \text{ pF} - 5 \text{ kV}$, with $C = 470 \text{ pF} - 4.0 \text{ kV}$ and at $C = 1000 \text{ pF} - 3.5 \text{ kV}$.

The down arrow indicates the direction of the seed through the ejection window to the planting nest. The figure on the left is a front view, on the right is a side view.

4. Conclusions
Cotton hommosis often affects this crop in Uzbekistan. The first step to decontaminating cotton begins with the electrical treatment of wetted cotton seeds, which has a positive effect. By measuring the electrical resistance, it is possible to distinguish between healthy and infected seeds and to draw conclusions about the moisture content of the peel. Cotton seed, which is a poor insulator in an air-dry state, becomes an element of the electric spark discharge circuit due to moisture. At the same time, the surface of the pubescent moistened sowing seeds of cotton is disinfected from pathogenic infections.
Completeness of electrical treatment of each cotton seed is achieved by applying a new engineering solution at the level of the invention.

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