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DEVELOPMENT OF A METHOD OF PRE-SOWING TREATMENT OF COTTON SEEDS WITH OZONE

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ABSTRACT

The article presents the results of studies on the effect of ozone treatment on the sowing qualities of cotton seeds. The dependences of germination and germination energy on ozone treatment regimes are investigated. It has been shown that with optimal exposure to ozone with a concentration of about 5 mg / l and a time of 40-50 minutes (dose of about 25 g/ton), germination is observed to increase to 20%. Microbial contamination of seeds is reduced tenfold. A comparative analysis suggests the appropriateness of using pre-sowing ozone treatment instead of chemicals.

KEYWORDS: ozone, cotton, seeds, pre-sowing treatment, generator of ozone-containing gases.

1. INTRODUCTION

The provision of food and the production of industrial crops is an important factor in the development of the economy of any State. Significant in the decision to obtain consistently high crop yields is plant protection. So, according to the Food and Agriculture Organization (Food and Agriculture Organization), crop losses from fungal and bacterial diseases amount to 25-30%, and in the years of the unfavorable spread of diseases reach 50-60%.

The main direction in the plant protection system is the fight against bacterial, viral and fungal diseases that are transmitted through seed material. The seed stock has various microflora, part of which is pathogenic and includes various types of viruses, bacteria and fungi. Thus, pre-sowing seed treatment is an effective measure to protect plants from diseases and pests. In some cases, processing can stimulate the growth and development of plants, which allows to obtain a high and high-quality crop.

However, seed treatment with various organic and mineral compounds (pesticides) leads to environmental poisoning and the accumulation of pesticides in products and soil. Such treatments are gradually being superseded by safer ones, among which biological and physical methods of protecting and stimulating growth have prospects.

At the same time, environmentally friendly technologies come to the fore in which the use of pesticides is eliminated or minimized. The basic properties of ozone, methods for its production and use in various industries are well known.[1,2] It is known that ozone treatment processes can effectively disinfect, sterilize, deodorize processed objects. In particular, the effects of ozone can be successfully used for pre-sowing treatment of seeds.[3,4,5]

There are various devices and methods for pre-sowing seed treatment using ozone, including in combination with other influences.[6,7] However, the effect of ozone treatments on a crop such as cotton and the features of such pre-treatment compared to fungicides are not well investigated.[8]

2. MATERIALS AND METHODS

Research objective determination of features and modes of pre-sowing treatment of cotton seeds with ozone, optimization of technical devices for pre-sowing treatment with ozone, comparative analysis of pre-sowing treatments of cotton.

To process cotton seeds, was used a corona discharge ozone generator (ozone-air or ozone-oxygen mixture).[9] For the synthesis of ozone, was used a cylindrical reactor, which had tip electrodes at high potential in the central part. The power supply unit provided positive corona discharge currents of up to 10 mA at voltages of up to 15 kV.

Processing of seeds of agricultural plants was carried out according to a simple scheme using an ozonizer that processes seeds directly in bags for their storage and transportation. Figure 1 shows a simple scheme for treating seeds with an ozone-air mixture in paper bags at a storage location in a ventilated room or in the field.

The complex included an oil-free compressor, a filter, an ozone generator (an ozone synthesis reactor, a control and power unit), a battery and a converter (if necessary), equipment for processing, a relatively ozone-resistant polymer film (polyethylene, polyethylene terephthalate).

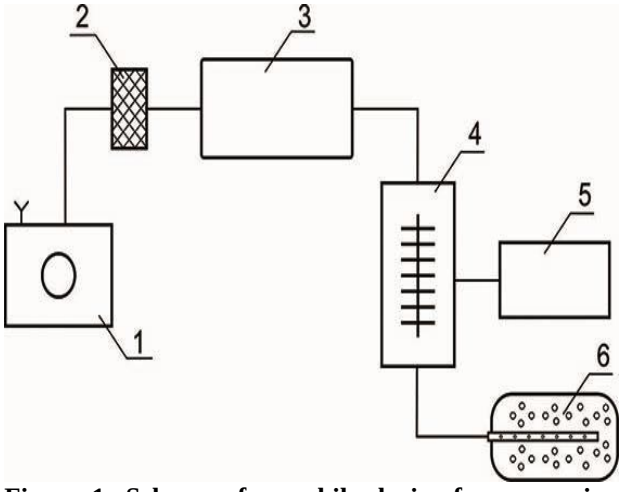

Figure 1: Scheme of a mobile device for processing seeds with an ozone-air mixture. 1-compressor, 2-filter, 3-receiver, 4-ozonizer, 5- power supply, 6-bag.

Another option for pre-sowing treatment is the exposure of seeds in bags to ozone with an oxygen mixture. In this case, can be used the oxygen flow from a standard cylinder with a reducer or liquid oxygen after evaporation from a Dewar vessel with a heated oxygen supply.

Figure 2 shows a diagram of the treatment of seeds with an ozone-oxygen mixture in paper bags at a storage location or in the field.

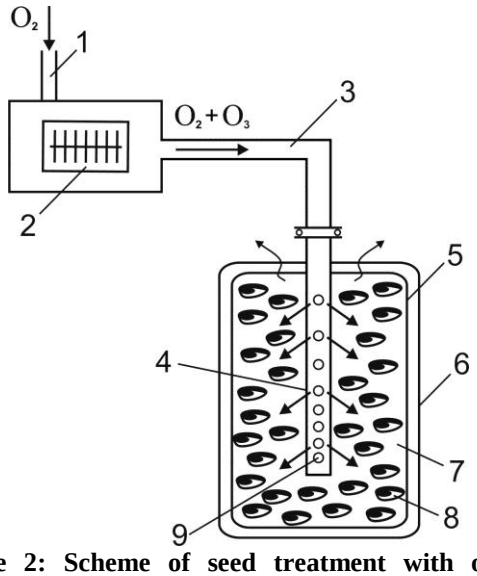

Figure 2: Scheme of seed treatment with ozone-oxygen mixture in bags. 1-oxygen stream, 2- ozonizer, 3-ozone line, 4-tube, 5-paper bag, 6-polymer bag, 7-volume, 8-seeds, 9-holes.

A standard technique was used to determine germination and germination energy of cotton seeds [10]. Small batches of pubescent and bare seeds were treated in ozone. After processing, the seeds were stored for a certain time (time " dormant ") in linen bags at a temperature of 20-25 ºC and then sown in batches of 100-200 pieces in standard bathtubs made of galvanized iron the size of which was filled with sand. Germination of seeds was carried out at an average daily temperature of 25-28 ºC and a relative humidity of 65%. Watering of seeds was carried out at the same time of day with boiled water, cooled to 25 ºC. Germination energy was determined on the fifth day, and seed germination on the seventh day after planting.

3. RESULTS AND DISCUSSION

Preliminary studies based on x-rays of randomly selected cotton seeds showed that the percentage of seed filling is between 96 and 98%. This figure indicates the maximum possible number of viable seeds. However, despite such a high viability index, the germination rate (average value) of the control untreated seeds for C-6524 variety was 72%, and for C-6540 variety it was 64%, that is, about 25-35% of the seeds died at the initial stage of development.

Seed treatment in ozone led to a change in the observed pattern. At relatively low concentrations of ozone (of the order of 0.2-1.0 mg/l), depending on the exposure time, the germination of cotton seeds increased by about 10% compared with untreated seeds. The most significant change in germination was not observed immediately, but only some time after treatment. During the "dormant", the treated seeds were stored in canvas bags at a constant temperature of 20 ºC. For variety C-6524, the most favorable was 5 days after treatment, and for variety C-6540 10 days after treatment. In this case, the

seed germination energy increased by about 10%.

An increase in ozone concentration to average values (4.0–5.0 mg/l) led to an increase in the germination of seeds of both varieties by 15–20% with an exposure time of 30–45 minutes in ozone. When treating cotton seeds of cultivar C-6540 with ozone with a concentration of 5 mg / l, with an exposure time of 40-45 minutes, seed germination increased from 64%, for untreated seeds, to 80% for treated seeds, with a "dormant" time of 10 days. With the same processing parameters, the seed germination energy increased from 21% to 51% with a 7-day "dormant" time. With a "dormant" of 10 days, this figure varied within 21-30%.

The following values were obtained for cotton variety C-6524: germination on the 7th day of "dormant" increased from 72% to 88%, and the germination energy from 28% to 70%. An increase in the exposure time in an ozone-air mixture above 50 minutes and an increase in the time of "dormant" of seeds after treatment for more than 10 days, as a rule, led to a decrease in the parameters under consideration.

A further increase in the ozone concentration in the container to 7.0–9.0 mg/l led to the fact that the germination rate was higher than that of untreated seeds, but began to decrease compared to the same values for optimal ozone concentrations.

Figure 3 shows photographs of cotton plants planted in the ground without treatment with ozone (a) and after treatment with ozone (b).

Moving from the dependences of the time of processing the seeds of cotton and the concentration of ozone in the air mixture to the more objective "dose" dependences of the ozone treatment, we can obtain the optimal exposure dose, for example, to the seeds of cotton, which gives an effective change in the parameters of the development of seeds.

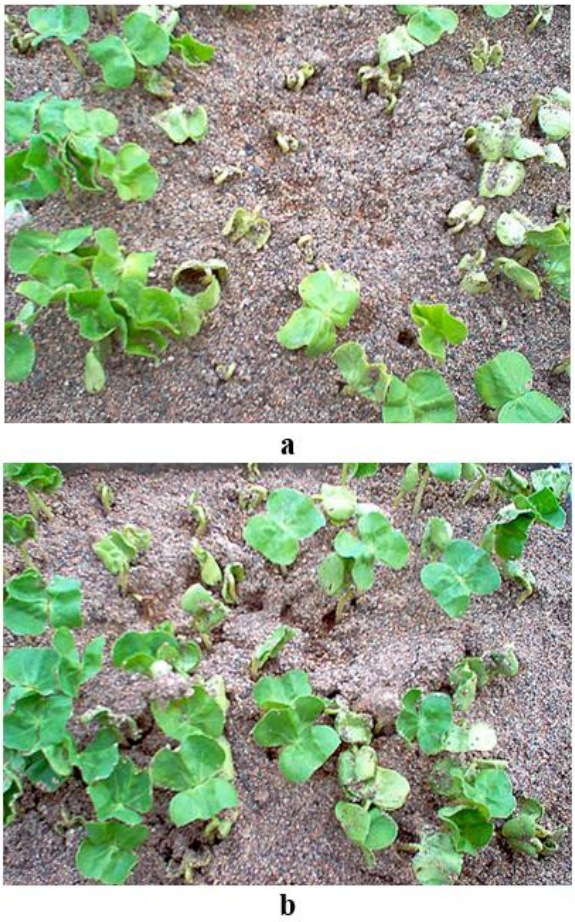

Figure 3: Photographs of cotton plants planted in soil without treatment with ozone (a) and after treatment with ozone (b).

If we take for the exposure dose of ozone treatment F_{oz} the value of the product of the current concentration of ozone C_{oz} by the effective time of T_{eff}, we can determine a rather narrow range of optimal doses for treating the ozone-air or ozone-oxygen mixture (ozone concentration 1-10 g / m3) of cotton seeds, namely:

$$F_{oz} = C_{oz}\, T_{eff} = (1{,}0\text{-}1{,}5)\cdot 10^4$$

Where: F_{oz}- dose, gram sec/m^3, C_{oz}- ozone concentration, g/m^3, T_{eff} - time, s.

At the same time, the optimal interoperation time for cotton seeds of the studied varieties is 6-8 days from the day of ozone treatment. These values can be considered the optimal mode of exposure to cotton seeds by ozone. Calculations show that a dose value of the order of 25 g of ozone / ton of seeds corresponds to this treatment regimen.

Microbiological studies have shown that treatment with ozone significantly reduces microbial contamination of seeds. Figure 4 shows photographs of the development of bacteria.

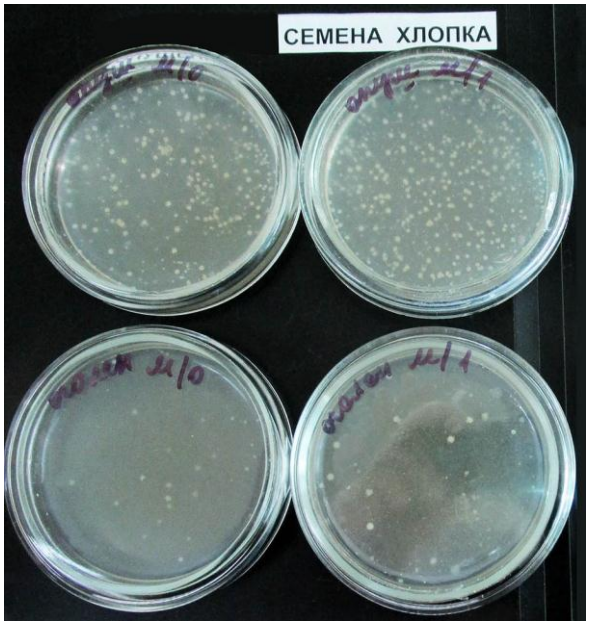

Figure 4: Photographs of the development of colonies in flushing with cotton seeds.

In the upper Petri dishes flush with untreated seeds. In the lower part with treatment with ozone (ozone-oxygen mixture). can be seen a significant difference in technologies for pre-sowing seed treatment of agricultural crops based on chemical influences and ozone treatments.

To compare different technologies for pre-sowing seed treatment (seed etching), in particular cotton and wheat seeds, you can use well-known chemical treatments with drugs manufactured by Electrokimoyozavod (Navoi region).

One of the recommended seed dressing products is Vitaros, which is a concentrate containing 198 g/l carboxine and 198 g/l thiram. A similar drug is Vitasil and Vitavax 200FF, WSC. The cost of the drug exceeds 8-10 US dollars per 1 liter. The drugs Esteron, Dialen super, Dianat, Diamin have the same cost.

Vitaros etching is carried out well in advance of sowing seeds. When pickling seeds, they must be brought to a moisture content 1% lower than the conditional value so that spontaneous combustion does not occur during storage. To process 1 ton of barley and wheat seeds, 10 l of working fluid is usually used (3 l of the preparation and 7 l of water).

To process the seed, stationary equipment is used, for example, KPS-10, APZ-10, and mobile machines PS-10, PS-10A, PSSh-5, Mobitox.

It should be noted that seed etching machines have significant weight and size parameters and high cost. So, for example, the PSK-15 chamber seed etcher, designed for applying suspensions to seeds, has dimensions of 5600×2100×2200 mm, weight about 800 kg, consumes more than 6 kW from a three-phase network.

Table Comparative characteristics of presowing treatments.

Pre-sowing conditions and parameters	Chemicals, "Vitaros"	Ozone Mixture Processing
The purpose of pre-sowing seed treatment, type of exposure	Bactericidal action, solution	Bactericidal effect, gas
Toxicity after seed treatment	yes	no
Accumulation of toxins in soil and water after seed treatment	yes	no
The need for additional seed treatments before exposure	yes	no
The need for moving seeds, loading, unloading	yes	no
Stimulating plant growth with optimal seed treatment	yes	yes (10-20%)
Performance of the process of seed treatment	3-5 tons / hour	0.5-1.0 tons / hour (experienced device)
Estimated cost of materials for processing 1 ton seeds, usd	more than 15	Free (air)

From the description of the Bronopol and Vitaros preparations, it follows that the process of pre-sowing seed treatment (mordant) is associated with the chemical treatment of seeds with aqueous solutions, the use of stationary or mobile equipment, harmful working conditions, the need for additional drying of seeds, and also the consumption of harmful preparations (II hazard class) that end up in soil and water. Mutagenic activity of drugs is noted.

Table 1 presents comparative data on seed treatment.

4. CONCLUSIONS

Studies show the specifics of treating cotton seeds, in particular the need to use substantially large doses of seed treatment with ozone in comparison with cereals. Optimal treatment with ozone leads to an increase in the germination capacity of cotton seeds up to 20% and a noticeable decrease in microbial contamination.

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