Application of cold plasma for bioactivation of sowing material

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Abstract. An innovative installation for pre-sowing treatment of seeds of various crops with cold plasma, it allows to increase their germination, resistance of plants to external stresses, productivity and ecological value of the product were proposed in this paper.

1. Introduction
Currently, the ecological situation is characterized by a high level of anthropogenic impact on agroecosystems, which entails several disadvantages for the environment, leads to an increase in the number of phytophages and the prevalence of pathogens. The deep destructive crisis of 1992-2005 led to changes in land use systems in all regions of the country and phytosanitary destabilization as a result of violation of the integrity of agroecosystems.

The modern method of protection still continues to dominate the chemical method, it often used without a comprehensive assessment of environmental effects. At that a necessity arises for more rational use of natural resources, adaptive potential of species and varieties of cultivated plants, as well as technogenic factors. The main condition of the strategy of adaptive intensification for agriculture should include the improvement of plant protection systems against pests and diseases, the transition to environmental management. The problem of increasing sowing, productive qualities of seeds and adaptive properties of plants were grown from them, the obtaining environmentally organic products and increasing of the various crops production.

At the present stage of scientific and technological development, there is a change of technologies and methods which ensure high efficiency of disinfection of grain and its products. When growing crops in ecological farming. A search is conducted of new, more effective elements of the fight against pathogenic organisms, which ensure the quality indicators of grain and its ecological safety. Physical methods are distinguished by environmental cleanliness, manufacturability, which is important in modern conditions of high anthropogenic pressure on the environment, but their impact on agroecosystems at the species and biocenotic levels has not been studied enough. It should be noted that the effect on the seeds of an artificially created plasma is close in nature to sunlight, and the biological systems from which the plant organism is formed are used as an object for plasma bioactivation [1-10]. That is why one of the promising ways of influencing organic and inorganic structures is plasma radiation. New plasma technologies, along using of traditional methods, in the future will be the most important direction in the modern agro-industrial complex, as will develop ways to control active systems and organisms using weak and ultra-weak physical fields and radiation.
2. Experimental studies

The high technical and economic efficiency of the plasma treatment process largely depends on the design of the plasma torches [1-3].

In order to obtain cold plasma, a cold plasma generator for seed bioactivation was developed and investigated (Figure 1) [2–3].

![Figure 1. Cold plasma generator](image)

Characteristics of the generator of cold plasma for bioactivation of seed are presented in table 1 and figures 2-3.

| $U_{вх}$, В | $U_{р}$, В | $I_{р}$, мА |
|----------|----------|-----------|
| 130      | 2000     | 6,9       |
| 140      | 2000     | 8,1       |
| 150      | 2000     | 8,3       |
| 160      | 1200     | 10,4      |
| 170      | 1160     | 10,7      |

![Figure 2. Volt-ampere characteristic of the discharge at L = 4mm, G = 2 l / min](image)

![Figure 3. The change in temperature of cold plasma from the gap l.](image)

Experimental studies were conducted to determine the effective modes of combustion of this plasma torch; the positive effect of cold plasma flow (increase in germination) on a number of cultivated plants (tomatoes, dill, wheat, barley, buckwheat) was proved.
The research results are presented in Figures 4-5 and Tables 2-3. Samples were subjected to different processing modes:
1. Cold plasma, processing time 1 min.
2. Control, without treatment.

![Figure 4. The germination of dill seedlings, called Lesnogorodskaya](image1)

![Figure 5. The germination of barley seedling](image2)

| Table 2. Mass and number of dill seedlings of Lesnogorodsky |
|-----------------|-----------------|
| 1               | 2               |
| 37              | 28              |
| 38.0g           | 27.6g           |

| Table 3. Mass and number of barley seedlings |
|-----------------|-----------------|
| 1               | 2               |
| 36              | 29              |
| 36.28g          | 27.32g          |

This variety of dill has a 70% germination rate, and as a result of cold plasma treatment, the germination rate increases to 92.5%.

Barley has a 58% germination rate, and as a result of cold plasma treatment, the germination rate increases to 72%.

3. Conclusion
The use of cold plasma has a beneficial effect on the germination of various seeds. Moreover, the worse the germination of untreated seeds, the greater the effect of the use of cold plasma. When processing cold plasma germination can increase up to 4 times.

With good germination of not treated seeds, cold plasma treatment does not lead to a negative effect on germination, also these seeds grow faster and give a greater yield of green.
References

[1] Klebanov D D and Grigoriev S N 2005 Physical basis of application of concentrated energy flows in materials processing technologies Moscov IC MSTU "Stankin" Janus-K, 220p

[2] Gabdrakhmanov A T, Israphilov I H and Galiakbarov A T 2014 Study generator of a cold plasma for sterilization Contemporary engineering sciences Vol. 7, no. 17–20, pp. 973-978

[3] Gabdrakhmanov A T, Galiakbarov A T and Gabdrakhmanov Al T 2015 Analysis of specifications of a cold plasma generator International Journal of Applied Engineering Research, Volume 10, Issue 24, pp. 44650-44655

[4] Tazmeev A Kh, Tazmeeva R N and Sarvarov F S 2016 The features of high-current gas discharge in a narrow gap between the liquid electrolyte and solid electrode Journal of Physics: Conference Series Volume 669, Article number 012056

[5] Rakhimov R R, Saubanov R R and Israfilov I H 2017 Analysis of the impact of informative heat treatment parameters on the properties of hardening of the surface layers Journal of Physics: Conference Series Volume 789, Issue 1, Article number 012040

[6] Gabdrakhmanov A T, Galiakbarov A T, Samigullin A D and Galiakbarov R T 2016 The calculation of a thermal field in the surface of a processed part under the influence of a low-temperature plasma IOP Conf. Ser.: Mater. Sci. Eng., Volume 134, Issue 1, Article number 012040

[7] Gabdrakhmanov A T, Israphilov I H, Galiakbarov A T and Samigullin A D 2016 Improving the efficiency of plasma heat treatment of metals Journal of Physics: Conference Series Volume 669, Article number 012014

[8] Gabdrakhmanov A T, Israphilov I H and Galiakbarov A T 2014 The study the erosion of the electrodes under the influence moving electric arc Journal of Physics: Conference Series Volume 567, Issue 1, Article number 012013

[9] Gabdrakhmanov A T, Shafigullin LN, Galimov E R and Ibragimov A R 2017 Surface thermohardening by the fast-moving electric arch IOP Conf. Series: Journal of Physics: Conf. Series. Volume 789 Article number 012010

[10] Denisov D G, Kashapov N F and Kashapov R N 2015 The appearance of shock waves in the plasma electrolytic processing Iop conference series: materials science and engineering №012005