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Pre-sowing treatment of flax seeds with a growth activator and polymer

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Abstract. Effective work with seed material contributes to an increase in germination and sustainable development of agricultural plants. In this study, experiments were conducted on the pre-sowing treatment of flax seeds with a formulation containing an activator of growth processes – hydrogen peroxide and a polymer of natural origin – inulin, which helps to reduce mucus secretion during semi-dry treatment. The experimental results obtained confirm the effectiveness of the proposed formulation, which helps to increase the germination of plants and facilitates the procedure for performing mechanized stages during technological operations with seed material.

1 Introduction

Since ancient times and nowadays, flax has been cultivated to produce fiber and oil, the characteristics of the products produced make flax the most valuable technical and oilseed crop at the same time. The importance of flax in modern agriculture in the Russian Federation is significantly increasing, since great hopes are pinned on this crop today as the main raw material source for the powder industry [1]. Unpretentiousness to growing conditions makes flax an excellent raw material for the traditional direction of use – the production of fabrics, in modern macroeconomic realities – instead of imported cotton [1, 2].

In this regard, detailed attention to the elements of flax cultivation technology is becoming increasingly relevant. One of the promising directions for the introduction of innovative developments in technology is the development of new environmentally friendly methods of pre-sowing seed treatment [3, 4]. Such processing is aimed at increasing the yield and quality of agricultural products, and according to its parameters should ensure the safety of working personnel, reduce labor costs compared with pre-sowing seed treatment with traditional chemical stimulants [5, 6], as well as simplify technological operations associated with the mechanized stages of seed processing. In general, pre-sowing treatment with non-chemical methods can achieve maximum results at minimal cost [7].

It has been revealed that pre-sowing treatment of seeds of various plants, depending on the processing method, can play a significant role in the release and accumulation of various substances in tissues. Germination before sowing also has a strong effect on improving the tissue structure, nutritional and functional properties of plants [8, 9]. Germination enhances

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the enzymatic activity of α-amylase and protease in grains, as well as increases the total phenol content and antioxidant activity, such as in chickpeas [10], buckwheat [11] and oats [12].

A characteristic biological feature of flax seeds is the abundant secretion of mucus when moistened. The seeds covered with mucus stick together, which significantly slows down and complicates the process of pre-sowing preparation of the seed material of this crop [7]. In the natural environment, the secreted mucus has a positive effect on the spread of flax seeds to distant territories, for example, by sticking to animal hair [13]. Also, in natural conditions, mucus is a moisture-retaining component, helps to retain moisture and nutrients around the seed, which increases the competitive ability of wild flax species.

In agricultural crops, mucus is often, on the contrary, an obstacle to natural germination, because in most cases the soil already contains a sufficient amount of moisture, and this advantage of flax loses its meaning here. Many agricultural varieties secrete an increased amount of mucus when moistened, which makes germination difficult and in some cases even makes flax unsuitable.

The purpose of this study is to develop the concept of modern innovative ecological pre-sowing seed treatment and a practical assessment of the prospects for its application.

To stimulate the growth, development and increase the stress resistance of flax seeds, as well as to counteract sticking during soaking, rapid germination and decrease mucus secretion, we have developed a pre-sowing treatment technique.

2 Materials and methods

A promising variety of flax, the Universal flax, was treated with a plant growth and development regulator created on the basis of hydrogen peroxide. A polymer was added to the same solution. Inulin was used as a polymer. Inulin was chosen because it is able to form a film on the seed, which easily disintegrates later when plants germinate. The polymer film does not allow the seeds to stick together during sowing, which makes the process of sowing flax convenient and does not interfere with compliance with the seeding standards of this crop. The film also prevents flax seeds from producing excessive mucus when the seeds are already in the soil. This accelerates the germination process and prevents the development of pathogenic bacteria and rotting.

Flax seeds of the promising Universal variety of the 2020 harvest were taken as the object of research. Before sowing, the seeds were treated with an environmentally friendly working composition.

The working solution placed in the spray was a two-component composition, including an aqueous solution of hydrogen peroxide with a concentration of 2.94×10-6 - 82.00× 10-6 M and inulin. Hydrogen peroxide in the presented concentration is a stimulant of plant growth and development, therefore it was chosen for seed treatment and activation of biochemical processes aimed at germination in them.

To obtain hydrogen peroxide of the required concentration, a "device for producing an environmentally friendly hydrogen peroxide solution to stimulate plant growth and development" (RU 2773011 C1) was used. Hydrogen peroxide obtained by this method does not contain stabilizers, artificial activators and other impurities and is an environmentally friendly substance [4].

To ensure the accuracy of the dosage, it was necessary to control the concentration of an aqueous solution of hydrogen peroxide. The iodometry method was used to determine the concentration [4,15].

Inulin is a natural polymer and consists of D-fructose (Fig. 1).

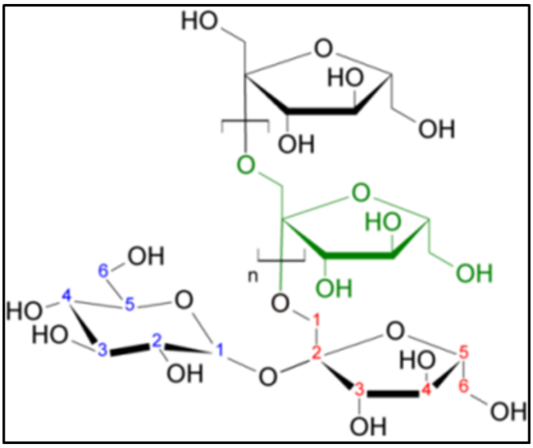

Fig. 1. Structure of inulin

D-fructose can be obtained in the laboratory from vegetable raw materials. The most convenient way to obtain it is synthesis from the roots of the Jerusalem artichoke plant [14]. Also, this component of the solution can be purchased in pharmacies and chemical reagent stores. D-fructose is highly soluble in water, respectively, and in an aqueous solution of hydrogen peroxide, which makes this technique very convenient for rapid processing of seed material.

Inulin concentration of 1.5-2.5% for our experiment was isolated from Jerusalem artichoke roots according to the described method RU 2485958 C1 [16]. This technique has been modified to suit our experiment and our laboratory conditions. In our case, the processing of Jerusalem artichoke roots was carried out in a rotary pulsation apparatus.

Flax seeds of the Universal variety were divided into experimental groups: in the first group, the seeds were treated with hydrogen peroxide and inulin, in the second - with deionized water and inulin, in the third - they were treated only with deionized water (control experiment).

In the first case, a thoroughly mixed aqueous solution of hydrogen peroxide and inulin was applied to the surface of the seeds with a spray gun at a rate of 20-30 l / t, followed by 3-4 hours of exposure, ventilation and drying. 50 ml of the solution was applied to 100 g of seeds. After applying the solution, the seeds were thoroughly mixed with a spatula, distributed in a thin layer and dried at a temperature of 20 ° C for 60 minutes. During this time, the seeds completely dried out.

In the second case, deionized water and inulin were taken instead of the working solution. In the third, only deionized water. The liquid was also applied with a spray gun at the rate of 50 ml per 100 g of seeds. Further actions were similar to those in the case of treatment with a working solution of the first group.

The processed and control seeds were placed in Petri dishes of 100 pieces each and kept for a day at room temperature. Next, the seeds were transferred to Petri dishes on water-moistened filters and placed in a thermostat at a temperature of +20 ° C. The beginning of germination was determined by the number of seeds that had accumulated 2,3,4 days after treatment. On the third day, seeds with a root length of ≥ 2 mm were recorded.

One of the first tests by which it is possible to determine the beginning of the seed awakening process is the fixation of the release of metabolites from seeds when they are soaked in water, which indicates the beginning of seed activation. The seeds were placed in special quartz cuvettes with an optical path length of L = 1 cm: 10 seeds were filled with 3 ml of distilled water. Water samples for measurement in the control and experiment were taken after a certain time. The kinetic curves of the release of metabolites into the aqueous medium were determined within 100 minutes. The absorption spectrum of metabolites was recorded on a Specord UV-VIS spectrophotometer in the ultraviolet region at λ max = 210 nm at a temperature of +19-20 °C. There was bidistilled water in the comparison ditch.

3 Results and discussions

The results obtained. As a result of our experiments, we noted that there was no adhesion of flax seeds in the first group, that is, where the seeds were treated with an aqueous solution of hydrogen peroxide and inulin (Table 1).

Table 1. Results of the germination assessment of flax seeds of the Universal variety

Polymer	Cipher	Slime formation	Seed germination, %		
			2 day	3 day	4 day
Inulin (hydrogen peroxide and inulin)	IGK	Missing	56	83	90
Control (deionized water)		High	61	87	92

The second group of seeds treated with deionized water and inulin showed intermediate results in adhesion and mucus formation, that is, we can use inulin dissolved in deionized water to partially reduce mucus formation and reduce seed adhesion.

Already in the first hours after processing and soaking, while the seeds had not yet begun to hatch, we could track the results of exposure to the solution by taking into account the exiting metabolites from the seeds. Thus, the measured value of the optical density (D) at the absorption maximum at λ = 210 nm in control and experiments can be considered as an indicator of the intensity of seed awakening in an aqueous medium (output of metabolites) at the earliest stages of their activation (Figure 2).

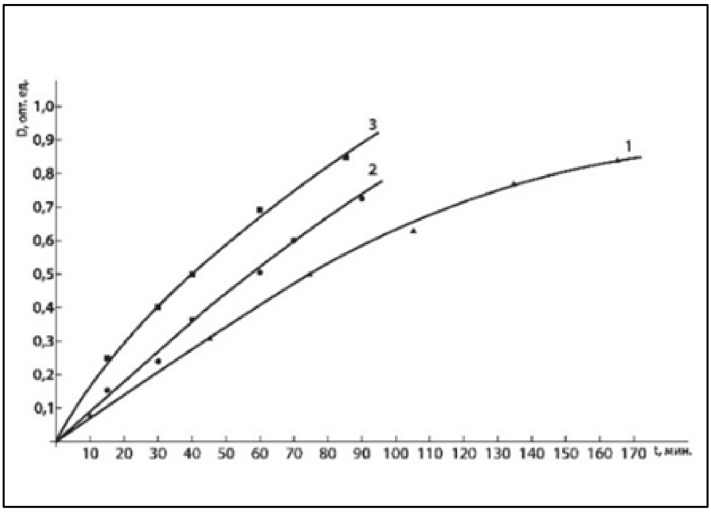

Fig. 2. Kinetic curves of the release of metabolites over time from flax seeds of the Universal variety when soaked after treatment: curve 1- control group treated with deonized water; curve 2 – group treated with a solution of inulin and water; curve 3 – group treated with hydrogen peroxide and inulin.

Figure 2 shows the kinetic curves of the release of metabolites from flax seeds of the Universal variety into water in the control and experimental groups. The release of metabolites into the aqueous medium was observed almost immediately in all experimental groups, however, the highest rate of their release was characteristic of curves 2 and 3, that is, after treatment of seeds with aqueous solutions of hydrogen peroxide and inulin and after treatment with deionized water and inulin. The minimum rate of metabolite release was observed in the control experiment (curve 1). Consequently, according to the data of the release of metabolites, the process of seed awakening occurs as intensively as possible when processing flax seeds with a working solution consisting of hydrogen peroxide and inulin. This correlates with the results observed at the second stage of plant development.

We considered the second stage of plant development to be the stage of seed awakening (pecking), and it was noted already on the 2nd day of the experiment. On days 2.3 and 4, the number of germinated seeds was taken into account. Seeds with a root length ≥ 2 mm were considered germinated. (Table 1). The dependence of the germination effect on the treatment of seeds with hydrogen peroxide and inulin, as well as on the treatment of seeds with deionized water and inulin, is determined. A stronger effect of seed germination stimulation was observed in the first group. Compared with the third, control group, the germination of seeds of the first group increased by 30%.

Thus, we noted that hydrogen peroxide and inulin, when processed together, prevent the seeds from sticking together, reduce mucus formation and improve their germination. Inulin in deionized water also has similar effects, but in a much smaller value.

4 Conclusion

A new scientific and methodological approach to the pre–sowing treatment of flax seeds is presented, which consists in using a formulation that includes a growth–stimulating compound - hydrogen peroxide and a water-soluble polymer of natural origin - inulin. Semi-dry processing of seed material with the proposed formulation helps to increase the germination of long-lived flax plants of the Universal variety, and also facilitates the implementation of mechanized stages of the processes of pre-sowing and sowing of flax. The results obtained can be recommended for use in farms cultivating flax.

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