Preparation of product for environmentally friendly plant protection

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Abstract. The paper discusses environmentally friendly ways to improve the productivity of crop production. Drugs made from plants containing terpenes are capable to protect crops from various diseases and stimulate their development. Outer bark of birch may contain triterpene alcohol betulin up to 40% of the mass, which allows to obtain environmentally friendly plant protection products. Experimental studies are devoted to studying the process of extracting betulin from birch bark, creating a betulin-containing preparation “Stimulin” for treating seeds and vegetative plants, as well as testing “Stimulin” on various agricultural cultures. The results of the use of the drug showed a significant increase in yield (by 8-35 %%) of crops such as wheat, barley, buckwheat, soybeans, and watermelons. The test of the fungicidal activity of "Stimulin" was carried out on sea buckthorn, the main causative agent of diseases and the cause of drying of which is the Fusarium mushroom. The fungicidal activity of "Stimulin" is comparable to potent synthetic agrochemicals.

1. Introduction. Rationale

Essential problems in cultivation of crops, are the lack of nutrients in the soil, weeds, plant diseases, pests. In Siberia, this is exacerbated by a short growing season, late frosts, excessively rainy or, conversely, dry seasons, early cold snaps. Another task of agricultural producers is to increase the period of post-harvest storage of plant products [1].

Modern plant growing practices the use of growth promoters and plant protection products. Preparations of synthetic origin are widely used, most often imported or with the use of active and auxiliary substances imported from different countries of the world. Production in the Russian Federation of the most well-known compounds, for example, glyphosate, dicamba, sulfonylurea, are absent.

The beneficial effect of the use of chemicals may be accompanied by their phytotoxicity, accumulation of residual quantities of drugs or metabolites in the soil and in plants, as a rule, negatively affecting living organisms. In addition, there are problems with the storage, mixing, disposal of agrochemicals, resistance of agricultural pests, etc. This leads to the development and production of new synthetic drugs that have selectivity, effective when introduced in small doses. The development of the agrochemical industry is also promoted by new methods for studying the reactions of biological objects to chemicals [2,3].

For environmentally safe farming, new products are needed that effectively protect plants, increase yields, but are not ecotoxicants.
The search for plants with antimicrobial, as well as fungicidal properties, the use of their extracts, the synthesis of preparations based on plant raw materials has long been an area of research for scientists all over the world [4,5]. The authors claim that natural plant products are an important source of antifungal compounds with low toxicity for mammals and safe for the environment. Products based on them can successfully serve as substitutes for synthetic fungicides in the production of plant products.

Essential oils of mint, bush basil, oregano, thyme, juniper exhibit have pronounced antimicrobial and antifungal effects, which is explained by the presence of terpenes in them [6]. They are active against a large number of bacteria, mold and yeast. Components of papaya, onion, carrot, avocado also have pronounced fungicidal properties [1].

In light of the foregoing, we can conclude that to create a biological fungicide, you need to pay attention to plants containing terpenes in large quantities. Betulin triterpene alcohol is the main component of extractive substances extracted from the outer part of birch bark. It is widely used in medicine (including in the composition of birch tar), for the manufacture of cosmetics, sometimes added to food. Its choleretic, anti-lithogenic, hypocholesterolemic effect, antihypoxic and antitumor activity, as well as anti-HIV activity were noted. [7,8].

Based on the established biological activity of betulin in relation to the human body and animals, assumed its possible effectiveness as a plant growth promoter and fungicide.

Birch bark has two clearly distinguishable parts - the outer (birch bark) and the inner (bast), which are significantly different in chemical composition. The outer bark is richest in extractive substances [9, 10]. Special attention has recently been paid to the development of methods for extracting birch bark betulin.

In the Altai Territory, birch grows ubiquitously: in dry areas on chestnut soils, and in more favorable conditions, on black soil. Hanging birch (Betula pendula) is a large tree up to 25-35 meters high and 0.6-0.9 meters in diameter. The lower part of the trunk is covered with a thick crust with deep blackish cracks, and the upper part is white, smooth, leafy bark. Birch bark rots more slowly, unlike other trees, the bark mass decreases with natural decomposition of only 7% per year. Obviously, it contains substances that are resistant to biological destruction and have fungicidal properties.

Birch forests create an extensive resource base for the forest industry. The outer layer of birch bark, has long been used to create household items, birch bark letters. At present, wood is more in demand: it is soft, easy to process, furniture, tool handles, skis, plywood and veneer are made from it. Since the bark of a birch is a waste, usually burnt or disposed of, its processing will somehow solve the problems of disposal [11,12].

2. Statement of the problem
The goal of this work was to create a plant protection product that would be a growth stimulant, an immunomodulator, had fungicidal properties and was environmentally safe. It is clear that a single product can not solve all the problems of plant growers, but can reduce the harm in solving some local problem.

To achieve this goal, a search was conducted for a substance with growth-promoting, immunomodulatory and fungicidal action and having a natural origin. The complex of natural compounds extracted from birch bark, known as "birch bark extract", was chosen as the object of research. Due to the wide range of actions, it is successfully used in pharmacology, but its effect on the suppression of plant diseases, root rot, growth stimulation has not previously been carried out.

3. Experimental part
The study of the process of isolating the betulin-containing component in the laboratory was carried out on a Soxhlet apparatus. Experimental studies carried out the variation of extractants, which were considered ethyl and isopropyl alcohols and their mixtures with water, acetone and its mixture with water, methyl tertiary butyl ether. We studied the solubility of the extractive components of birch bark in these solvents, as well as the effect of water addition on the extraction and crystallization of betulin.
Indicators of the effectiveness of extractants were: extract yield by weight of raw materials (bark), the content of betulin in the dry extract. Analysis of the extracts was carried out by HPLC and mass spectrometry. The extract yield was 20-30% by weight of dry bark, the content of betulin in the product reached 87-93% of the mass.

The work paid attention to the rational use of solvent. It was regenerated, providing the minimum specific consumption of the extractant at low energy consumption. In addition, the high volatility of the solvent, the explosiveness of its vapors mixed with air impose increased requirements for production safety, which will require additional costs for the implementation of the technology. According to all the criteria, a mixture of isopropyl alcohol and water was recognized as the best solvent (3:1).

Based on the research, a technology has been developed for producing birch bark extract and a semi-industrial plant has been created, which includes the stages: preparation of raw materials (crushing, sieving), extraction, filtration, washing and drying of the extract, solvent regeneration.

The use of betulin-containing extract as a plant protection agent required creating a convenient preparative form in order to use universal spraying machines and devices for treating seeds and plants. Thus, the agrochemical "Stimulin" was obtained, which is a suspension glycolic concentrate of betulin (10% by mass), which meets the requirements for this product in all respects.

4. Practical relevance and implementation results

"Stimulin" was tested on various crops in different regions of Russia, the Republic of Kazakhstan, as well as in China. The effect of the agrochemical on the yield of soybean, wheat, buckwheat, barley was studied in the Altai Territory [13]. The combination of seed treatments and vegetative plants with the “Stimulin” preparation in recommended doses provided an increase in yield by 8–35%.

Preparation was tested on watermelons in China. "Stimulin" did not affect the quality of the fruit, but the total yield increased by 25.1% [14].

The study of the fungicidal properties of "Stimulin" was conducted on sea buckthorn (Hippophae rhamnoides L.), the main causative agent of diseases and the cause of drying out of which is the fungus Fusarium. The antifungal effect of Stimulin was comparable to the chemical fungicide “Raxil”. [15].

5. Conclusion

The test results showed that the plant protection product created on the basis of birch effectively increases the yield of main agricultural crops, exhibits pronounced fungicidal properties and is completely harmless to human and environment. The production and use of such products will contribute to environmentally safe agriculture.

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