The increase of the potential agricultural landscapes fertility through the use of non-traditional organic fertilizers

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Abstract. In modern conditions of economic crisis, the use of mineral and organic fertilizers has sharply decreased, which leads to the soil fertility degradation and the microbial cenosis structure simplification. In this regard, there is a growing interest in the use of non-traditional fertilizers, including those obtained from wood vegetation wastes. The purpose of the research is to study the possibility of using waste oil from coniferous trees as fertilizers and growth stimulants for grain crops. The object of the research is soft spring wheat variety of Siberian selection “Krasnoyarskaya-12”. Recording was performed using generally accepted methods and existing State Standards. The influence of fir water on the germination energy, germination capacity and infection of soft spring wheat “Krasnoyarskaya-12” seeds was determined by the wet chambers method using paper rolls, as well as Petri dishes according to State Standard 12044-93. Statistical processing of the obtained data was performed by the method of dispersion and correlation analysis. The obtained results and the conducted chemical analysis of fir needles, peat and water solution of needles showed a fairly high content of nitrogen, phosphorus and potassium. Therefore, the use of waste products in the production of fir oil as non-traditional organic fertilizers requires targeted research and can be a very promising agricultural approach.

1. Introduction

Currently, the agriculture intensification and the anthropogenic impact increase on soil leads to a progressive decrease in soil fertility due to the insufficient use of organic and mineral fertilizers [1,2,3,4,5], as well as to the violation of crop rotation due to the predominance of grain crops [6,7].

The current economic situation dictates the necessity to focus on regional resources of agrochemical raw materials [8,9,10]. The content of organic matter in soil depends on the amount and composition of incoming organic residues, the rate of their humification and mineralization [11,12,13,14]. The problem of recycling accumulated wood waste in the Krasnoyarsk territory is acute, and therefore there is a need to study the use of this raw material.

The purpose of the scientific research is to study the possibility of using waste oil from coniferous trees as fertilizers and growth stimulants for grain crops.

The object of the research is soft spring wheat variety of Siberian selection “Krasnoyarskaya-12”.
2. Research methodology

Laboratory studies were carried out in the Krasnoyarsk scientific-research institute of agriculture and in the Krasnoyarsk state agrarian university. Field experiments were laid in the fields of a separate division of the Krasnoyarsk scientific-research institute of agriculture in Minino village [15].

Recording was performed using generally accepted methods and existing State Standards [16, 17]. Statistical processing of the obtained data was performed by the method of dispersion and correlation analysis [18].

Fir needles, peat, and fir water were examined. The study of the fir water influence on the germination energy, germination capacity and infection of seeds of soft spring wheat “Krasnoyarskaya-12” was carried out by various methods. Germination energy, germination capacity and seed infection were determined by the wet chambers method using paper rolls and Petri dishes according to State Standard 12044-93.

3. Experimental base, research progress

As a result of the conducted research, the organic mixture of peat and fir needles that was heat-treated when receiving fir oil, as well as the aqueous solution remaining during this production were studied as the organic fertilizers and the plant growth stimulants.

The chemical analysis of peat, fir needles and water solution showed a fairly high content of nitrogen, phosphorus and potassium (table 1).

| Variety | Material     | Acidity | pH | Nitrogen of nitrates | Phosphorus mobile | Potassium exchangeable |
|---------|--------------|---------|----|-----------------------|-------------------|------------------------|
| Wheat   | fir needles  | 4,6     | 50 | 414                   | 250               |                        |
|         | peat         | 6,1     | 12 | 83                    | 290               |                        |
|         | fir water    | 5,1     | 10 | 53                    |                   |                        |
|         | soil         | 6,7     | 9  | 65                    | 250               |                        |

(Data was received by T. A. Snytkova and A. A. Kryuchkov, Krasnoyarsk scientific-research institute of agriculture)

Despite the high content of nitrogen, phosphorus and potassium in the studied samples, the plants cannot use these substances, perhaps because of their high concentration, available only by chemical methods. It is probably necessary to continue the study to identify the necessary concentration to an affordable level.

Microbiological assessment shows that a mixture of peat+needles can provoke the development of microbial toxicosis; fir water, on the contrary, reduces soil contamination. Fir water reduces the biological activity of soil less strongly than the peat+needles complex (table 2).

| Experiment variant | Germination capacity of test culture seeds for 7 days, without substrate, % | Germination capacity of test culture seeds for 7 days, with substrate, % | Assessment of toxicity level |
|--------------------|--------------------------------------------------------------------------------|---------------------------------------------------------------------|-----------------------------|
| 1. wheat (control) | 76                                                                               | 72                                                                  | average                     |
| 2. wheat (fir solution) | 60                                                                          | 28                                                                  | High degree                 |

(Data was received by Fomina N.V., Krasnoyarsk state agrarian university)
The study of the fir water influence on the germination energy, germination capacity and infection of seeds of soft spring wheat “Krasnoyarskaya-12” was carried out by various methods. Germination energy, germination capacity and seed infection were determined by the wet chambers method using paper rolls and Petri dishes according to State Standard 12044-93.

In the version with paper rolls, the seeds were pre-soaked for 24 hours in an undiluted solution of fir water, as well as solutions with dilutions of the original 10, 100, 1000 times. Distilled water was used as a control. After a day, treated with fir water, the seeds of each of the variants (in 3 repetitions of 100 seeds) were laid out on wet filter paper, were rolled into rolls and grown in a tray at a temperature of 25°C for 7 days. After that, the number of sprouted seeds and seeds with symptoms of fungal and bacterial infection was calculated.

Similar variants of seed treatment (undiluted solution of fir water, solutions with dilutions 1/10, 1/100, 1/1000, control-distilled water) were taken to study the effect of fir water on the energy of wheat germination using wet chambers in Petri dishes. To do this, the studied solutions were poured 10 ml into Petri dishes with seeds in an amount of 25 pcs. in each, in 4 repetitions. Seeds were placed in solutions for 3 days. After that, the germination energy was recorded.

4. Results
In the experiment with rolls, the initial solution of fir water reduced the laboratory germination of wheat seeds by almost 2.5 times compared to the control (table 3). The solutions with dilutions on the contrary significantly increased it by 11.6-15.3%. Infection of seeds in all variants of the experiment was at the control level. Due to the ambiguity of the experiment results on the influence of fir water on the germination of wheat, conducted by the method of rolls, another study of seeds in Petri dishes was conducted.

Table 3. Influence of fir water on germination and infection of wheat “Krasnoyarskaya -12” seeds (roll method), on seed germination energy (in Petri dishes, for 3 days).

| Indicator                  | Control          | Initial solution | Dilutions 1/10 | Dilutions 1/100 | Dilutions 1/1000 |
|----------------------------|------------------|------------------|----------------|-----------------|------------------|
| Germination capacity, %    | 61.7±0.7         | 27.0±3.1         | 73.7±2.0       | 73.3±1.9        | 77.0±1.5         |
| Infection, %               | 95.0±0.6         | 98.0±1.0         | 98.0±1.0       | 92.2±2.0        | 93.7±0.9         |
| Germination energy, %      | 24.0±2.2         | 0.0              | 0.0            | 21.3±1.6        | 24.0±0.8         |

(Data was received by N.V. Neshumaeva H.B. Krasnoyarsk scientific-research institute of agriculture)

Based on the data obtained from this experiment, it was found that the initial solution of fir water, as well as its dilution by 10 times, completely suppresses the seeds germination capacity. Infection of seeds in all variants of the experiment, including control, was equal to 100%.

**Crop capacity.** In a stationary control experiment, wheat “Krasnoyarskaya-12” formed grains of 2.8 t / ha without fertilizers; the use of ammonium nitrate increased the crop capacity by an average of 0.3 t / ha, (HCP50= 0.1 t / ha). Wheat sown with seeds soaked in fir water (stimulant) formed the same crop capacity as the control.

In the micro-field experiment (seeds soaked in ordinary water and sown without fertilizers) the ear grain content was 39 pcs. in the control, weight of grain per one ear was 1.6 g. The ear grain content of wheat sown without fertilizers, the seeds were soaked in pine seeds, made up of 31 pcs., the weight of grains in 1 ear was 1.5 g. In the variant sown on fertilized ammonium nitrate background, the seeds were soaked by fir water, the ear grain content was 43 pcs., with a mass of 1.7 grams.

Model experiment. “Krasnoyarskaya-12” wheat was sown in vessels with peat + lime, poured with clean and fir water, the control was a vessel with soil. After 4 days, wheat sprouts appeared on the
control, and within 7 days, 80% of the seeds sprang up. In the experimental variant (peat), there were no seedlings; there were wheat seedlings in the variant with plain water and peat.

Model experiment has shown that the direct use of preparations from peat, fir and fir water for grain crops does not lead to an increase in crop capacity.

5. Conclusions
The initial solution of fir water and its dilution 1/10 completely suppressed the germination capacity of wheat “Krasnoyarskaya-12” seeds. Dilutions of 1/100 and 1/100 had no effect on the germination energy. Treatment of wheat seeds with fir water in the studied concentrations did not reveal a significant difference in the indicators of their infection with fungal and bacterial diseases.

Despite the high content of nitrogen, phosphorus and potassium found in the study samples, plants cannot use these substances. It is necessary to continue research, to study more deeply and to test in the field the possibility of using accumulated at sawmills wood waste as an organic fertilizer. Utilization of organic materials of various origins can bring real benefits in terms of improving the environmental situation and increasing the efficiency of agriculture.

The use of organic mixtures of peat and fir needles that were heat-treated in fir oil production as plant growth stimulators, as well as the aqueous solution remaining in this production may prove to be a very promising agricultural approach in the zonal aspect with the use of non-traditional organic materials as fertilizers.

Acknowledgements
The article was prepared with the support of the Krasnoyarsk regional science foundation as part of the project N 2020020705956.

References
[1] Avdyukova T V 2017 Soil fertility status of arable land in the Eastern zone of the Krasnoyarsk territory Agriculture 1 25-9
[2] Butyrin M V 2017 Dynamics of the main indicators of arable soil fertility in the Irkutsk region Agriculture 4 9-14
[3] Zhulanova V N 2012 Soil monitoring of agricultural land in the Central Tuva basin Izvestiya TACA 6 122-30
[4] Simakova S A 2018 State of soil fertility in the South-West of the Altai territory Achievements of science and technology in agriculture 32(1) 13-7
[5] Sergeev A P 2017 State of arable soil fertility in the southern zone of the Krasnoyarsk territory Achievements of science and technology in agriculture 31(4) 17-21
[6] Surin N A 2011 Adaptive potential of varieties of grain crops of Siberian selection and ways to improve it (wheat, barley, oats) Krasnoyarsk scientific-research institute of agriculture — Novosibirsk 708 p
[7] Aksenova Yu V, Shpedt A A, Krasnitsky V M et. al 2018 Assessment of soil resources of the Omsk region Agriculture 3 14-8
[8] Mukina L R 2001 Efficiency of organic-zeolite-phosphate fertilizers and top-dressing in plant nutrition Materials of the all-Russian scientific and practical conference, Krasnoyarsk 208-16
[9] Melnikov A I 2018 State and dynamics of agrochemical indicators of arable land in the kulundinsky zone of the Altai territory Achievements of science and technology in agriculture 32(5) 11-4
[10] Savich V I, Zhulanova N V, Kashchenko V S et. al 2012 Agroecological evaluation of Tuva soils (Moscow: Russian state agrarian university-Moscow Timiryazev Agricultural academy) 440
[11] Khlystov I A 2015 Carbon and nitrogen of organic compounds of the soil in the conditions of pollution by emissions of a copper smelter Bulletin Of KrasSAU, Krasnoyarsk 5 17
[12] Alkhimenko R V 2017 Monitoring the state of arable soils in the Western and Central territorial districts of the Krasnoyarsk territory Achievements of science and technology in agriculture
31(6) 10-4

[13] Shpedt A A 2013 Assessment and optimization of organic matter of soils of agricultural lands of the Krasnoyarsk territory (Krasnoyarsk: Krasnoyarsk state agrarian university) 239

[14] Fedorova E A et. al 2016 State of soil fertility, dynamics of application of mineral and organic fertilizers, balance of nutrition elements and humus in the Northern zone of the Omsk region Achievements of science and technology in agriculture 30(7) 38-40

[15] Dospekhov B A 2011 Methodology of field experience (M.: Agropromizdat) 315

[16] Dospekhov B A 1987 Practicum on agriculture (M.: Agropromizdat) 383

[17] Alexandrova L N 1986 Laboratory and practical classes in soil science (L.: Kolos) 350

[18] Tomilov V P 1987 On statistical processing of field experiment data (M: Agriculture) 48–51