Application of a vermicomposter containing biostimulant for pine tapping

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Abstract The issues of biotechnological development of economics have become rather topical in recent years. Scientific papers in the field of environmental economics, namely in the field of the forest sector, are of particular interest. The main component of the forest industry bioeconomics development is the increase in the volume of forest resources management. Rubber tapping (tapping) is the main form of natural resource management of pine plantations. During the analysis of the resources, it was found that the development of an alternative biological stimulant of animal origin for tapping is needed to be developed for its further application, and its efficiency of the maximum pine resin yield should be assessed. A 1% aqueous extract of the vermicomposter of Black Soldier Fly (Hermetia illucens L.) was used as the main active component of the experimental biostimulant. At the test area, where the studies were conducted, trees involved in tapping procedure included ones, on which the stimulant was tested, and those trees, where ordinary tapping was carried out without the use of the stimulant; the latter ones were considered to be a control group. In the course of studies, it was found that the biostimulant based on the vermicomposter of Black Soldier Fly led to the excess of the resin yield per centimetre of face in comparison with the control group. Also, no negative effect of the biostimulant on the pine forest condition was revealed.

1. Introduction

Recently, the interest to the issues of the economic development in the field of forest sector biotechnology have aroused significantly. This is one of the most dynamically developing and investment-attractive industries, which enables sustainable investment and economic growth of a state. In a broad sense, bioeconomics is the production and consumption of products obtained from raw materials being a result of natural biological processes. The process is based on the transformation of renewable biological resources into industrial, food and other products with high value added, so the main component of the forest industry bioeconomics development is the increase in the volume of forest resource management.

Rubber tapping, as the main form of natural resource management, is one of the common and effective ways of intravital use of pine plantations. Extracted in the process of tapping resin is a raw material for the production of rosin and turpentine used in paper, paint and varnish, medical, rubber and other industries. Until the end of the sixties of the last century, resin was extracted without the use of chemical stimulants. In the future, the chemical action that enhances the resin release and prevents
blockage of the resin passages, became a common technological technique. Physiologically active chemical stimulants (sulfuric acid, chloride lime, hydrochloric acid) were mainly used, and despite their high efficiency, they had serious drawbacks, both in technical side and in technological basis. With the use of 50% sulfuric acid, the yield of pine resin increased up to 128%, and with the use of 20% hydrochloric acid - up to 115% [1]. However, despite high efficiency, chemical stimulants destroy plant tissues of a tree, affect metabolism, growth, condition and vital activity, which leads to the fall of the stand [2, 3].

In the future, the development of forest chemical production resulted in the appearance of non-aggressive stimulants based on natural, mostly plant origin (extract of fodder yeast, birch sap). They were causing less damage to the plant tissues of trees, but with their use, the yield of pine resin had increased only by 32-52% [4]. However, it is of high necessity to take into account that, despite less damage to plantations, the collection and preparation of organic stimulants is a very laborious process, so the question about finding and using biological stimulants in forest tapping arose. We have not found stimulants of animal origin in the practice of tapping. In this regard, the purpose of our study is to develop an alternative biological stimulant of animal origin with the further possibility of its application in practice and to assess its effectiveness of the maximum yield of pine resin.

As the main active component of the biostimulant, the vermicomposter of Black Soldier Fly (Hermetia illucens L.) was used. Wide popularity in bioeconomics was obtained by the insect due to highly efficient bioconversion of different organic solid wastes as well as high nutrition of the larvae applicable for further feeding of farm animals and aquaculture. However, this is not the full potential use of the Fly.

The vermicomposter (or biohumus) is a product of larva’s activity; it is an environmentally friendly fertilizer obtained as a result of eating and digestion of solid biological waste by larvae. The vermicomposter is rich in humic acids; it contains a balanced complex of minerals and organic substances and other biologically active components that enable to obtain environmentally friendly agricultural products [5 - 7].

Biohumus made of insects showed itself in good advantage in agriculture. Due to its composition, it increases the plant resistance to diseases and pests, as well as it has natural insecticides, repellents and fungicides, thanks to which biohumus has a detrimental effect on a number of pests and pathogens of agricultural crops. It protects the plant at all stages - from a seed growing to winter storage of the crop.

The use of biohumus in conditions of protected and open ground increases seed germination, stimulates the development of a powerful root system, the growth of stems, leaves, the accumulation of plant biomass, their flowering, fruiting. Biohumus has a phytoncide effect. The use of biohumus in conditions of protected ground allows to reduce the level of infection of vegetable crops with bacteriosis, late blight, powdery mildew, drying, Septoria blight, Alternaria blight.

The use of biohumus stimulates the survival of seedlings, rooting of cuttings of fruit, berry, decorative plants, increases the bushiness, branching of flower crops, the number of inflorescences, prolongs their flowering period, promotes the growth and development of lawn grasses. Soaking of infected cabbage and tomatoes seeds in an aqueous infusion of biohumus reduces the infection of seeds with fungi of Alternaria, Penicillium and Aspergillus genera by 2.0 - 2.3 times, and with pathogens of the black-footed polypore (Royoporus badius) - by 3 times. Watering infusion of biohumus decreases the number of gall eelworms by 5 - 10 times. The death of cabbage moth caterpillars increases by 5 times, of sod webworm caterpillars - by 7 times. The death of caterpillars and nematodes is caused by the presence of chitin-destroying bacteria in the biohumus as well as Actinomycetales, which produces a toxin with high insecticidal effect. Adding biohumus to the soil repels the onion fly (Delia antiqua) and lesser bulb fly (Euemerus strigatus), suppresses the infectious potential of pathogens, heals the soil from the black-footed polypore (Royoporus badius), noble rot (Botrytis cinerea), Sclerotinia timber rot, the pathogen of wilting.

When growing potatoes, Phytophthora is not noticeable. Prevalence of the infection on potato is reduced by 2 times at a dose of 20-30 g of biohumus per a seed-spot; higher doses have showed almost
the same result. The infestation of tubers with Rhizoctonia reduces, depending on the dose of biohumus, by 1.5-4.0 times. [8]

However, as practice shows, the most economically expedient is the use of biohumus for the production of low-capacity nutrient soils, the profitability of which in crop production can exceed 200%. We decided to consider the insect biohumus from the point of view of the forest industry bioeconomics in the field of natural resource management during the production of pine resin and develop a biostimulant based on this biohumus.

2. Methods

Research on the approbation of an experimental biostimulant for tapping was carried out in a pine stand of myrtillus-type forest of the 6th allotment of the 81st quarter of the Afanasiev forest district of the Verkhnetoyemsky forest district of the Arkhangelsk region. The average diameter of the trees involved in the tapping was 26 cm. The work on the creation of the biostimulant was carried out in the laboratory by the staff of the Landscape Architecture and Artificial Forest Department of NARFU named after M. V. Lomonosov. As a biostimulant it was used 1% aqueous extract of Black Soldier Fly vermicomposter.

On the studied test area of the Verkhnetoyemsky forest district there was industrial cutting of Scotch pine stand (Pinus sylvestris L.) carried out, i.e. face width conformed to the "Regulations of resin harvesting" [9] and was changing depending on a tree trunk diameter. Year of tapping – the 2nd (i.e., the height of the face sitting – 1 metre). Category of tapping – II, streaking interval – 5 days. The number of streaks applied – 5. One-side face – single on the tree.

The trees on which the stimulant was tested and the trees on the control, where usual tapping was carried out without the use of the stimulant, were involved in the work alternately: one tree was applied with the stimulant after making a streak, the next tree was left without the stimulant, and so on throughout the test area. The stimulant was applied to the face streak with a manual home pulverizer. All the trees involved in tapping were set with containers of different colours (green containers - for trees with the stimulant, yellow ones - for the control trees). As a result, the total number of treatment trees amounted to 196 PCs.

At the end of the work with each tree, the face width was measured and data on the collection of resin were defined. The results were statistically processed using STATISTICA, version 10, StatSoft, Inc., 2011 with the calculation of arithmetical mean values and standard deviation.

3. Research results

Assessment of the efficiency of the developed biostimulant for tapping pine based on the vermicomposer (biohumus) was conducted through a comparative analysis of statistical indicators of resin yield and the average value of the face width of the treatment trees (table 1).

Table 1. Data of the comparative analysis of pine trees with biostimulant and without biostimulant.

| The studied indicators / tree category | Stimulant | Control |
|--------------------------------------|-----------|---------|
| Sum of face width values             | 5298      | 4736    |
| Number of trees, pcs                 | 101       | 95      |
| Average face width                   | 52.46±0.699 | 49.85±0.959 |
| Total quantity of resin obtained, kg | 17.8      | 13.2    |
| Resin yield from the face, g         | 176.2     | 138.9   |
| Resin yield from the face streak, g   | 35.2      | 27.8    |
| Resin yield per centimetre of the face, g | 0.671    | 0.558   |

Based on the research, it was established that according to all the studied indicators (table 1), the biostimulant based on Black Soldier Fly biohumus has a significant impact on the resin yield during pine tapping. However, it is necessary to take into account that the average face width on the trees
with the stimulant and on the control trees has different values, so it is necessary to calculate the resin yield per centimetre of the face, which will reflect the effectiveness of the biostimulant during pine tapping. As a result, we get a percentage ratio, which indicates that pine resin yield when using the biostimulant is 20% higher than in case with control trees. Also the studies revealed no negative consequence after usage of the experimental biostimulant on pine forest; no tree fall or plantation activity/condition degradation was revealed.

According to our research and resources, the experimental biostimulant based on the Fly’s biohumus is inferior to already existing organic stimulants in terms of the effectiveness. However, from the point of view of forest industry bioeconomics, this is another way of using renewable biological resources to increase the volume of forest resource use. This is especially topical for our country, considering the fact that Russia has a high natural resource potential, but bioeconomics is only at the stage of formation. Based on these data, we consider it possible to use advanced biostimulant based on Black Soldier Fly biohumus in the practice of pine tapping and continue the study of its effectiveness with testing different concentrations of active substance on the forest.

4. Conclusion

For the first time, the biostimulant based on the biohumus of Black Soldier Fly larvae was used in the tapping practice.

The biostimulant based on Black Soldier Fly biohumus provides the excess of resin yield per centimetre of face by 20%, in contrast to the control trees.

In the course of studies, no negative consequences after the use of the experimental biostimulant on pine stands were revealed.

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