

PHYTONCIDAL PROPERTIES OF FORESTS PLANTATIONS OF SCOTS PINE (*Pinus sylvestris* L.) OF USMAN FORESTS (RUSSIAN FEDERATION)

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Abstract: *Environmental degradation increases the risk of various diseases, leading individuals and society as a whole to rely on natural healing resources from forest ecosystems. For this reason, biologically active plant communities have been established as special-purpose forests, especially in urban agglomerations. The aim of this study is to investigate the phytoncidal activity of forest crops of white pine (*Pinus sylvestris* L.) under different conditions of temperature and relative humidity. The subject of the research includes complexes established for the preservation and promotion of children's health, which are located in specially protected natural areas of the Usman Oblast (Russian Federation). The research method included the analysis of the effect of average temperature and humidity on the phytoncidal activity of pine stands using multiple regression analysis. The results show that the activity of phytoncides is influenced not only by air temperature, but also by relative humidity. In particular, the lower the humidity and the higher the air temperature, the stronger the phytoncidal activity of boron. The phytoncidal activity of white pine forest crops decreases at the beginning of the growing season (March, 2024), but later during the flowering period (April and May, 2024) there is a slight increase in activity. A gradual increase in the activity of phytoncides is observed from the beginning of the phenological phase of flowering of white pine.*

Key words: *Phytoncides, white pine, Usmansky district, forest plantations*

Introduction

The current environmental situation forces a person and society as a whole to think about their further existence without causing damage to health. Unfortunately, in recent years, the living environment of the human population has had a negative impact on its health and vital functions. The quality of media (water, air, soil) largely depends on various components and chemical compounds. The concentration of pollutants exceeding the limit values is a determining condition for disrupting the development and functioning of natural ecosystems, the vital functions of living organisms and the human population. It has been noted time and again that forests provide important health benefits to people, affecting their physical, psychological and social well-being. Forest plantations are planted to create more favorable

conditions for the functioning of medical institutions, such as sanatoriums and nature resorts, as well as children's camps, for the prevention and restoration of health. These artificial plantations have the status of special-purpose forests. To date, measures to improve the environment with the use of biologically active plant communities are a priority. The range of woody and shrubby plants with certain phytoncidal properties, their structural relationships for landscaping urban agglomerations is being actively studied [1,2,3]. The presence of parks, gardens, squares and other green spaces in urban conditions is a necessary condition for maintaining human health. It is obvious that walks in the fresh air, especially in forest park areas, help to strengthen the immune system, increase the body's stress resistance. This once again proves the need to create, restore and protect the plantings of the urban environment [4]. The topic of the impact of plant communities, and specifically forest ecosystems, on human health, is relevant, especially in connection with the rehabilitation period after serious and serious diseases. The study of the phytoncidal activity of plants and the effect of biologically active substances formed by them on harmful organisms is an urgent area of scientific activity. The main sanitary and hygienic property of phytoncides is the ability to destroy pathogens. Phytoncides have the ability to stimulate the growth of microorganisms-antagonists to microorganisms that are pathogenic for plants, and also participate in various processes of plant life [5].

Phytoncidal properties of plants are actively used for disinfection of closed rooms, for the purpose of medical photo design [6,7]. The positive effect of phytoncides on the human immune system is evidenced by the works in which the inhalation effect of phytoncides of forest plantations on the immune status of people was studied [8]. Inhalation of volatile fractions of phytoncides was carried out in a concentration corresponding to the background one. Analysis of experimental data showed that the inhalation effect of natural forest substances for one month stimulates the immune status of a person. At the same time, the functional state of the human body improves, mental performance increases, and the body's resistance to infections increases [6]. Forest landscapes on the territory have a huge aesthetic, emotional impact, have a strong life-affirming and balancing effect on the human psyche, help to accelerate the recovery process, due to the ionization of the air and phytoncides. Visiting recreation areas also contributes to an increase in physical activity, raises vitality [9].

However, it should be remembered that along with positive properties (inhibition of pathogenic bacteria and microorganisms), phytoncides can also have an adverse effect on the human body. For example, pine phytoncides, along with the ability to effectively relieve coughing, irritate people suffering from cardiovascular diseases. Pollen formed during flowering causes attacks of suffocation in people with bronchial asthma [10]. The conducted complex of studies of volatile secretions of flowering forest plants indicates their ability to cause significant hemodynamic changes in humans, expressed in a decrease in blood pressure, an increase in pulse, a decrease in respiratory rate and a decrease in arterial blood oxygen saturation. At the same time, a certain trend is revealed: the greater the saturation of the air with phytoncides of flowering plants, the more pronounced the nature of hemodynamic shifts and undesirable subjective sensations. Changes in hemodynamic indicators under the influence of volatile secretions of forest plants are short-term, functional, the

symptoms completely disappear a day after contact with these plants [11]. The study of the mechanisms underlying the links between the plant community and human health contributes to solving the main health issues associated with various types of diseases [12].

The purpose of the work was to show the phytoncidal activity of pine plantations located on the territory of children's health complexes and in specially protected natural areas. The results of the work are necessary to optimize the management of forests of this group to achieve a favorable effect on recreation conditions and health recovery [13]. Similar studies were carried out jointly with our colleagues in the Republic of Srpska, where forest cultures of black pine (*Pinus nigra* Arn.) planted near the resorts of Serbian Toplica and Slatina were studied [13,14]. The purpose of the research was to determine how much the phytoncidal ability of Scots pine depends on abiotic factors, specifically on the temperature and relative humidity of the atmospheric air.

Object of research

The object of the research is a part of the territory of the Somovsky forestry, which is part of the state nature reserve of federal significance "Voronezh" (Fig. 1), located in the north-western part of the region, covers the territory of two municipalities: the Novousmanskyy municipal district and the urban district of the city of Voronezh. The forest was formed on the left-bank sandy terraces of the Voronezh River. Forest plantations of the Somovskoye forestry of the Voronezh region belong to the forest-steppe zone and to the forest-steppe region of the European part of the Russian Federation. These forests have a great sanitary and health value, which is characterized by the amount of oxygen released, biologically active substances, as well as dust absorption [15]. Since the relief of the Voronezh Region is flat, there are no significant climatic changes associated with it, except for a slight increase in the amount of precipitation on the slopes facing the wind source (windward slopes). The climate of the study area is temperate continental with warm summers and cold winters. The altitude to which the sun rises at noon varies from about 15° on December 22 to almost 62° on June 22: the higher the sun rises above the horizon, the more solar energy enters, and consequently the air temperature rises. Most cloudy days are observed in December, the least in July. The bulk of precipitation falls in the warm period of the year (60–70%). Snow cover is about 20 cm thick on average: 16-20 cm in the south of the region, 19-30 cm in the north. Winds in summer prevail from the northwest, in autumn and winter from the southwest and in spring from the southeast. In the warm season, dry winds are possible, bringing heated air masses with low humidity, causing drought. On average, there are up to 5 dry periods lasting 9–10 days per year [16].

The soils in the study area are poor in humus, nitrogen and ash substances. The following types of soils are mainly present here: in pine conditions – light gray forest, slightly podzolized, dry and fresh sandy soils; in suburbs – gray forest sod, weakly and medium podzolized, sandy loam, depending on the relief – from dry to wet; in gentle depressions between the dune hills and in the lower part of the slopes of the watershed there are gray and dark gray forest, sandy loam [17].

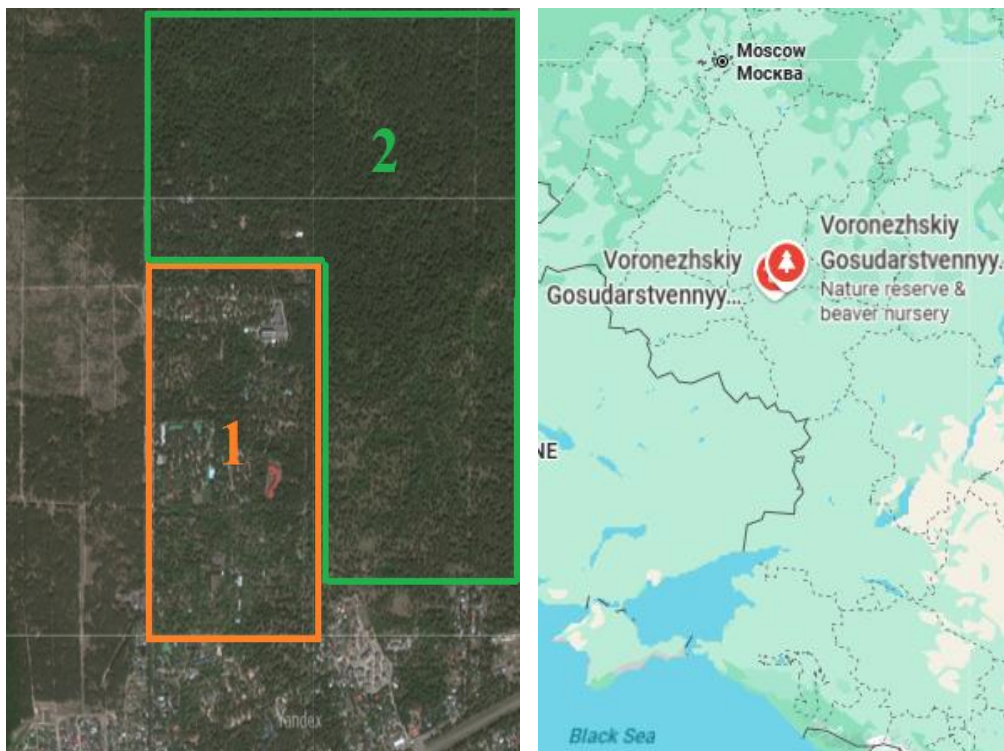


Figure 1. Satellite image of the study area (1 – children's health camps, 2 – forest area)

Method of research

In the course of our work, we analyzed data on the average daily temperature and average daily humidity. Next, the data obtained were processed. In the calculations, the equation of multiple regression of the phytocidal activity of Scots pine from the data of meteorological indicators was used [3]:

$$f = -46,85 + 4,18t - 0,031t^2 - 0,03tV + 0,007V^2,$$

f – Phytocidal activity, 1/min;

t – Air temperature, °C;

V – The humidity of the air, %.

Results and discussions

As a result of the analysis of the data obtained, it was proved that with the change of climatic conditions, namely with the increase in atmospheric air temperature, the phytocidal properties of coniferous plantations increase. For calculations, we used the data obtained during the beginning of the growing season and for comparison – during the beginning of the phenological phase of flowering of Scots pine (*Pinus sylvestris* L.). The results are presented in the graphs: dependence of phytocidal activity on abiotic factors during the beginning of the vegetation of Scots pine and dependence of phytocidal activity on abiotic factors during the beginning of the vegetation of Scots pine (*Pinus sylvestris* L.).

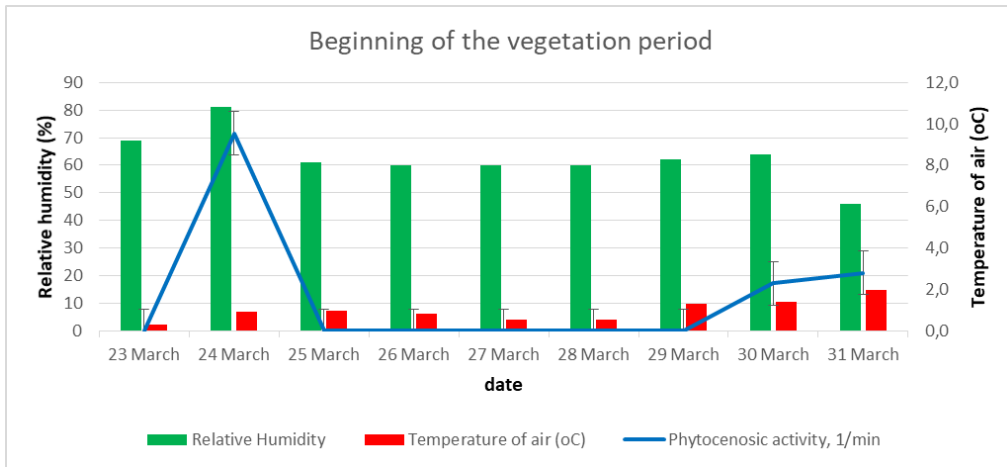


Fig. 2. Graph of phytoncic activity dependence on abiotic factors during the beginning of the vegetation of Scots pine (*Pinus sylvestris* L.)

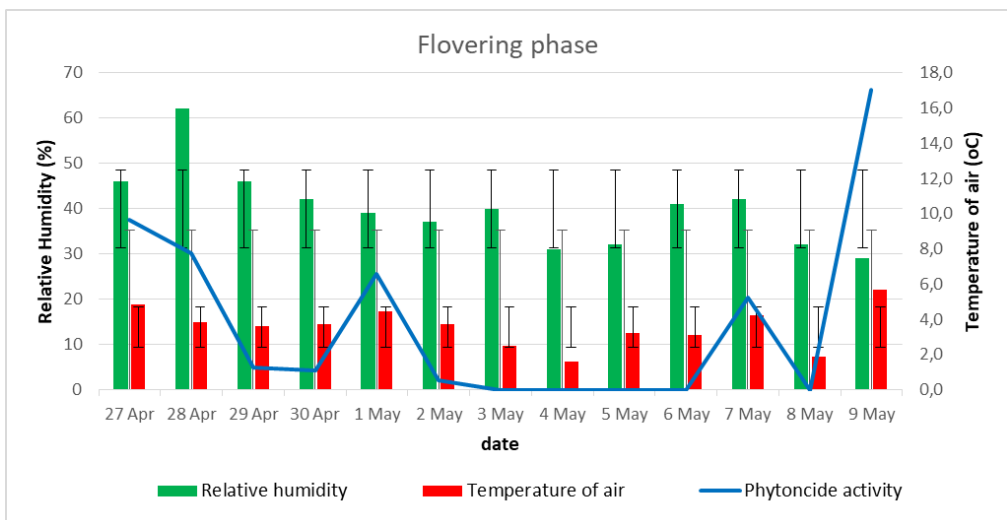


Fig. 3. Graph of the dependence of phytoncic activity on abiotic factors during the flowering period of Scots pine (*Pinus sylvestris* L.)

Analysis of the graphs showed that phytoncic activity directly depends not only on temperature, but also on humidity: the lower the humidity and the higher the temperature, the stronger the phytoncic activity of Scots pine. An increase in phytoncic activity is observed from the moment of the phenological phase of flowering of Scots pine (*Pinus sylvestris* L.).

Conclusions

Research shows that with an increase in air temperature and a decrease in relative air humidity in white pine stands during the growing season and at the time of flowering, there is an increase in phytoncidal activity of white pine stands and trees. The data obtained are necessary for further research in the fields of forest management and forest regulation, as well as for the formation, preservation and introduction of tree species with pronounced phytoncidal properties. This will improve the visual effect, will help to ensure their resistance to the negative effects of abiotic factors, have a positive effect on air purity, and the production of oxygen, the release of essential oils.

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FITONCIDNE OSOBINE ŠUMSKIH KULTURA BIJELOG BORA (*Pinus silvestris* L.) USMANSKE ŠUME (RUSKA FEDERACIJA)

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Sažetak: Degradacija životne sredine povećava rizik od raznih bolesti, što dovodi pojedince i društvo u cjelini da se oslanjaju na prirodne ljekovite resurse iz šumskih ekosistema. Iz tog razloga, biološki aktivne biljne zajednice su uspostavljene kao šume posebne namjene, posebno u urbanim aglomeracijama. Cilj ove studije je da se istraži fitoncida aktivnost šumskih kultura bijelog bora (*Pinus silvestris* L.) pod različitim uslovima temperature i relativne vlažnosti. Predmet istraživanja obuhvata komplekse osnovane za očuvanje i promociju zdravlja djece, koji se nalaze u posebno zaštićenim prirodnim područjima Usmanske oblasti (Ruska Federacija). Metoda istraživanja obuhvatila je analizu uticaja prosječne temperature i vlažnosti vazduha na fitoncidnu aktivnost borovih štandova koristeći višestruku regresijsku analizu. Rezultati pokazuju da na aktivnost fitoncida utiče ne samo temperatura vazduha, već i relativna vlažnost. Konkretno, što je niža vlažnost i viša temperatura vazduha, to je jača fitoncida aktivnost bora. Fitoncida aktivnost šumskih kultura bijelog bora smanjuje se na početku vegetacije (mart, 2024), ali kasnije tokom perioda cvjetanja (april i maj, 2024) dolazi do blagog povećanja aktivnosti. Postepeno povećanje aktivnosti fitoncida uočeno je od početka fenološke faze cvjetanja belog bora.

Ključne reči: Fitoncidi, bijeli bor, Usmanski okrug, šumske plantaže

