Phytotesting and environmental assessment of soil in the greenhouse complex

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Abstract. Greening the urban environment is a necessary element for improving the quality of life of the population, which requires the use of significant amounts of seedlings of flower-ornamental plants. Soil condition in greenhouse complexes does not always meet the requirements, which causes low yield and quality of grown plants. Phytotesting and assessment of ecological quality of soil in greenhouse complex were carried out through research of oxidative enzymes activity. The control of the level of toxicity and chemical contamination of soil is necessary for the development of measures to reduce and prevent changes in the soil and biotic environment. The comprehensive study of soil has revealed factors affecting its quality and suitability for growing flower crops. Dynamic changes in biological indices are recorded during phytotest of soil, as well as during control of level of enzymatic activity of oxidative enzymes. An average and low level of phytotoxicity of the studied soil is established, as well as inhibition of activity of enzymes: catalase, ascorbatoxidase, peroxidase. The soil survey in the greenhouse complex showed that for rapid diagnosis of its condition it is possible to use both phytotest of samples, to carry out analysis of the level of activity of oxidative enzymes.

1. Introduction
The main tasks that need to be solved in greenhouse farms, first of all, how to avoid its depletion, how to prevent its infection with pathogens and pests [1]. Usually, for greenhouses, soils are formed from several components, most often turf soil, peat, manure and mineral fertilizers. The soil created has certain agroecological characteristics, which are expressed by certain quantitative and qualitative parameters, the most important of which are biological indicators, which determine both the availability of its nutrients and its environmental safety. The quality of soil used in greenhouse complexes for growing plants is the basis for obtaining better and disease-resistant seedlings of flower plants [2].

The environmental survey of the soil should be based not only on the level of its provision with basic food elements, but should also include an analysis of the level of its infection and toxicity. At the same time, enzymatic activity of oxidative and hydrolytic enzymes is described as the most sensitive and significantly less variable characteristic, compared to microbiological indices. The use of enzymatic activity indicators as an additional diagnostic indicator for the study of soil in greenhouse and greenhouse areas is well founded, as it provides comprehensive information both on the level of nutrient supply and on the level of pesticide contamination [3].

2. Object and methods of research
The object of the study was soil fruit, selected in the greenhouse complex of the city of Krasnoyarsk. The soil fruit composition is determined by the following components in combination (1:1:1): soil, sheet
superstructure and sand. The scheme of the experience included the following options: 1 variant (control) - soil, without seedlings; 2 variant - soil under the seedlings of roses of "Concord" variety; 3 variant - soil under the seedlings of roses of Karina variety; 4 variant - soil under the seedlings of calla of Little Jam variety; 5 variant - soil under the seedlings of roses of the Golden Times variety; 6 variant - soil under the seedlings of chrysanthemums of Davin variety; 7 variant - soil under the seedlings of chrysanthemum of Neptune variety. The prepared soil fruit was treated with the biological fungicide Trichocin. The drug was introduced before landing and after planting the seedlings. Then 1-2 times with an interval of 1.5-2 months during the growing period to suppress fusariosis and root rot. The acidity of the soil runt solution was pH 5-6. A cress salad test culture was used for phytotest. The methodology for laying down the experience is presented in the workshop [4, 5].

Additional diagnostics of the studied soils were carried out using activity indices of oxidative enzymes. The catalase enzyme activity was determined by Johnson and Temple (1964) titration with 0.1 N potassium permanganate solution, activity expressed in ml of 0.1 N KMnO₄ g⁻¹ soil in 20 minutes, peroxidase by the Svistyan method in Chunderova modification (1978) and expressed in mg of purpurghallin in 24 hours. Ascorbatoxidase activity was determined by titration and expressed in mg dehydroascorbic acid/g soil per hour [6, 7].

3. Research results and discussion
In greenhouse complexes, fungicides and insecticides are used to control the level of diseases and the number of pests of flower seedlings, so an important step in the primary ecological assessment of the soil fruit is to control the level of its phytotoxicity. Phytotoxicity is determined by obtaining a water extract of soil fruit and growing a test plant on it. The principle of obtaining a response of a test object is based on detection of signs of inhibition of growth of test-culture seedlings and reduction of values of morphological characteristics of seedlings, in particular, length of above-ground and underground part of the plant. Analysis of germination energy and germination of cress lettuce test culture seeds during germination on a water extract showed that on average the values varied in the range from 41 to 91%, which characterizes the average, weak and very weak level of phytotoxicity (table 1).

Table 1. Germination energy and germination of seeds test - cultures (water extract), assessment of phytotoxicity.

| Experiment variants | Germination energy,% | Seed germination test-cultures for day 7,% | Phytotoxicity levels timate |
|---------------------|---------------------|------------------------------------------|-----------------------------|
| 1. soil (control) without seedlings | 87.0±1.1 | 91.0±1.7 | Very weak |
| 2. soil under seedlings of roses of Concord variety | 48.0±2.0 | 51.0±1.5 | average |
| 3. soil under the seedlings of roses of Karina | 41.0±0.8 | 46.0±0.6 | average |
| 4. soil under seedlings of Little Jam grade calla | 55.0±3.7 | 57.0±4.2 | average |
| 5. soil seedling of roses of a grade of the Golden Times | 53.0±0.8 | 59.0±1.7 | average |
| 6. soil under crop chrysanthemum of Davin variety | 69.0±3.7 | 75.0±6.8 | weak |
| 7. soil under crop chrysanthemum of Neptune class | 55.0±1.1 | 57.0±1.5 | average |

The differences are reliable and correspond to the level of significance p ≤ 0.05. Of the variants presented in table 1, the gradation - weak toxicity, refers only to the experimental version of the soil runt selected under the seedlings of the chrysanthemums class Davin, at the same time the germination was 75%.

The average toxicity level is set in all other test variants where the germination values of the test culture seeds varied from 46 to 59%. This phytotoxic effect of the soil and its components can be due...
both to the accumulation of phytotoxic forms of microorganisms and to the use of excess doses of mineral fertilizers, residual amounts of herbicides. Phytotoxic substances are generally known to be derivatives of phenols, quinones, polypeptides and other compounds entering the soil as a result of pesticide loading. Therefore, this requires measures to improve the ecological and biological state of the soil fruit used in this greenhouse complex. The control version of the soil is not toxic.

The lowest germination indicators of cress lettuce seeds – 46%, recorded in soil images taken under the seedlings of roses of Karina variety. The absence of phytotoxicity in the initial control soil used to obtain seedlings of different flower cultures proves the values of germination energy and germination in the control - 87 and 91%, respectively.

The program of studying the level of phytotoxicity of soil is usually supported by data on measuring the length of the main root of the seedlings of the test - culture, as the most informative indicator, which is established according to the data of researchers [2].

The evaluation of the length of the main root of the seedlings of the test culture showed that the minimum values were recorded when growing the seeds of the test culture in the soil under the seedlings of kall of the Little Jam variety, as well as in the soil under the seedlings of roses of the Concord variety and in the soil under the seedlings of roses of the Golden Times variety - 4.7, 5.1 and 5.9 cm, respectively. The maximum values of the root length of the cress lettuce seedlings are established in the initial soil (without seedlings of flowering plants), as well as in the soil selected under the seedlings of roses of Karina variety and under the seedlings of chrysanthemum of Davin variety, respectively. In this case, the root length is 1.2-1.5 times greater than in other experimental variants (figure 1).

**Figure 1.** Average length of the main root test of culture, cm: 1 - soil (control) without seedling; 2 - soil under seedling of roses of a grade Concorde; 3 - soil under seedling of roses of a grade Karina; 4 - soil under seedling a grade calla Litl Jem; 5 - soil under seedling of roses of a grade of the Golden Times; 6 - soil under seedling of chrysanthemums of a grade of Davin; 7 - soil under seedling of chrysanthemums of a grade Neptune.

In general, phytotesting of soil fruit samples, carried out by growing the test - culture of cress salad on water extract showed very medium and weak level of toxicity, in the initial control version its absence was established. No significant inhibition of germ root development was observed either, except for the 2nd and 4th experimental variants, in particular the soil fruit under the seedlings of "Concord" rose and the soil fruit under the seedlings of "Little Jam" grade calla. It is possible that the development delay is due to the lack of mineral nutrition elements, or to toxic substances in the drawing.
determine soil fertility level, characterize the degree of agroecosystems disturbance caused by natural and anthropogenic factors [3]. The initial level of catalase enzyme in the control version was 0.24 ml 0.1 n solution KMnO₄ per 1 g of dry soil in 20 minutes, while in all variants under the crop seedlings this indicator is reduced [6].

The activity of this enzyme is most intensively reduced to 0.14, 0.18 values and 0.17 ml 0.1 n solution KMnO₄ per 1 g of dry soil in 20 minutes respectively in soils under the seedlings of Concord rose, Little Jam grade calla and Neptune class chrysanthemum, respectively. The data are consistent with table 1 on phytotoxicity levels, which may indicate contamination of the soil with excess pesticides used. In the remaining test samples no reliable differences were found and the values ranged from 0.19 to 0.22 ml 0.1 n KMnO₄ per 1 g of dry soil in 20 minutes (table 2). Thus, the nature of change of activity of enzyme of a catalase defined decrease in level of this enzyme, in all samples of the studied soil with seedling of flower cultures and revealed the most intensive decrease in samples: the soil which is selected under grade rose seedling Karina and under grade calla seedling Litl Jem that proves presence in them of microbial toxicosis and toxicity of a water extract of soil in the last sample.

Similar to the level of activity of catalase enzyme, the activity of other oxidative enzymes ascorbatoxidase and peroxidase is reduced, with the lowest values also recorded in the soil variant selected under the seedlings of roses of Concord variety to 1.56 mg of dehydroascorbic acid per 1 g of soil and 0.55 mg of purpurgalline per 1 g of soil.

Table 2. Indicators of soil oxidative enzymes activity.

| Experiment variants                      | Catalase, ml 0.1 N. KMnO₄ g⁻¹·20 min⁻¹ | Ascorbateoxidase, mg acid g⁻¹·1 h⁻¹ | Peroxidase, mg purpurgallin g⁻¹·24h⁻¹ |
|------------------------------------------|----------------------------------------|-----------------------------------|-------------------------------------|
| 1. soil (control) without seedlings      | 0.24±0.001                             | 2.54±0.08                         | 1.70±0.009                          |
| 2. soil under seedlings of roses of Concord variety | 0.14±0.008                             | 1.56±0.07                         | 0.55±0.02                           |
| 3. soil under the seedlings of roses of Karina | 0.19±0.009                             | 2.42±0.04                         | 1.40±0.04                           |
| 4. soil under seedlings of Little Jam grade calla | 0.18±0.013                             | 1.73±0.09                         | 1.22±0.03                           |
| 5. soil seedling of roses of a grade of the Golden Times | 0.20±0.011                             | 2.01±0.09                         | 1.65±0.02                           |
| 6. soil under crop chrysanthemum of Davin variety | 0.22±0.001                             | 2.15±0.09                         | 1.58±0.04                           |
| 7. soil under crop chrysanthemum of Neptune class | 0.16±0.009                             | 0.29±0.005                         | 0.75±0.023                           |

To create flower compositions in different parts of the city, it is necessary to use a significant amount of flower crop seedlings obtained in greenhouse complexes. As a result of constant operation of the soil, without its replacement in the greenhouse, its compaction takes place, accumulation of residual amounts of pesticides, increase in the number of pests and phytopgenic microorganisms.

These factors contribute to plant death, reduce the yield of seedlings quality, so in the greenhouse it is necessary to control the quality of the soil fruit constantly. Expensive methods do not always allow this to be done. In addition, the diagnosis of the condition of the soil is also important for the control of safety, used plant protection agents.

4. Conclusion

Thus, phytotestation of the water extract of the test soil showed the presence of a medium and weak degree of phytotoxicity of the test soil taken under the seedlings of flowers. Differences in the length of the main root of the test culture also determined toxicity in soil variants under the seedlings of the Concord rose and under the seedlings of the Little Jam kall.
There is a low activity of the catalase enzyme in samples taken under the seedlings of Little Jam calla flowers and Davin chrysanthemum, which may indicate contamination of the soil with excess pesticides. Analysis of peroxidase activity and ascorbotoxidase enzyme activity in these samples is minimal, which requires measures to reduce the level of contamination. The soil survey in the greenhouse complex revealed that both phytotest of samples and analysis of oxidative enzymes can be used for rapid diagnosis of its condition.

References
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