The feasibility of using combined soils in greenhouse conditions for growing Osteospermum

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Abstract. Periodically recurring droughts, unstable atmospheric moisture, and elevated air temperatures in summer are characteristic of the Orenburg region, which is part of the South Ural region. Of great scientific and practical importance at the present stage is the creation of soils that are optimal in terms of physical and chemical composition, giving high production results. The article presents the results of experimental data on the use of combined soils in greenhouse conditions in the Orenburg region when growing ornamental plants Osteospermum, for the purpose of decorative landscaping in urban areas, as one of the promising flower crops. In laboratory conditions, when constructing the soil, its chemical composition was carried out before sowing ornamental crops and after transplanting plants into open ground, in order to analyze the needs of plants for the mineral component of the soil and the possibilities of its reuse (secondary) for enriching the open soil of flower beds in urban conditions.

1 Introduction

Fertile soil is, first of all, an indicator of the qualitative development of any plant, but in modern conditions, this important renewable component of nature is found in limited volumes, since its formation requires a certain complex interaction of climatic and relief-forming conditions over a long period of time.

The lack of natural soil fertility, at present, can already be stopped due to constructed artificial soils. A variety of soils are formed from a basic base and accompanying inert physical and chemical components that represent a certain nutritional value for a particular plant, depending on economic needs - obtaining flowers or green mass.

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The main criterion when choosing structural soil components is the availability of the available local raw material base, which affects the cost of the finished product and the quality of the actual output. Therefore, one of the most important components of soils is organic waste, the disposal of which is still an unresolved problem in modern society, requiring close attention and a deep methodological approach to the implementation of this process.

At the first stages, among the many already tested methods of recycling organic waste, special attention should be paid to their use as the main and auxiliary components of combined nutrient soils used in greenhouses in Orenburg.

Engineered soils, with predetermined physicochemical parameters, are a promising alternative to traditional mineral substrates used in decorative floriculture, vegetable growing and nursery farming.

An analysis of a sufficient amount of literature data on this issue allows us to draw a conclusion about the effectiveness of using engineered soils, the basic basis of which are mineral and organic components, which in turn arouse interest not only among scientists and manufacturers of ready-made soil mixtures, but also have a response among consumers, those who directly apply these types of mixtures for the further production cycle, obtaining the final product. Artificially created soils for a specific plant organism are used for the most efficient growth of plants and the production of finished environmentally friendly products.

Currently, the agro-industrial complex of the Orenburg region has 10,628.5 thousand hectares of agricultural land, including 6,105.8 thousand hectares of arable land, but a significant part of the area is in fairly harsh soil and climatic conditions, has low natural soil fertility and almost half of the arable land is characterized by low humus content in the upper soil horizon [1-2].

About 2000 thousand hectares of arable land in terms of nutrient content have very low and low phosphorus (P) content, and 2500 thousand hectares are insufficiently provided with it, about 600 thousand hectares have very low and low potassium content (K), more than 700 thousand hectares of solonetzic or saline soils, therefore, using this soil in its pure form for greenhouse farming is highly impractical.

The dynamic decrease in the thickness of the humus horizon and the humus content in it is the result of constantly occurring erosion processes. The processes of water and wind erosion are actively manifested over large areas, which limits the yield of agricultural crops grown on these lands.

In the conditions of the sharply continental climate of the Orenburg region with characteristic dry winds in the summer, temperature increases up to + 35ºC, and low air humidity, obtaining high-quality seedlings of flower and ornamental plants used in landscaping is of great practical, production and economic importance.

In the Orenburg region, previously fertile steppe chernozem soils, as a result of many years of unregulated anthropogenic use, have been significantly degraded into already artificial agricultural landscapes, have reduced their natural productivity, have been subjected to secondary salinization, contain weed seeds and cannot be fully used as the basis of soil for growing flowers. crops with a closed root system in greenhouse conditions.

The intensification of greenhouse production is interested in the development and production of artificially created, highly productive soils based on environmentally friendly organic materials, which can fully ensure the cultivation of flower crops with given morphometric parameters that meet modern implementation standards [3].

The prospects of the resulting structural soil lie in the balance of its organomineral composition with an extremely low level of heavy metals, with a predetermined acidity required when growing ornamental flower plants using the example of *Osteospermum*.

2 Materials and methods

The balanced soil, experimental version, is intended for growing *Osteospermum* flower crops in greenhouses in the city of Orenburg with an open and closed root system, used for flower decoration of city flower beds. High infestation of greenhouse soils by diseases and pests, which manifests itself in the process of repeated use, significantly increases the costs of maintaining fertility and technologies are required that help reduce costs to create optimal conditions for growing flower crops and increasing their decorativeness.

The developed polycomposite soil based on large-tonnage waste, as a result of experimental use, is already showing positive results when used in greenhouses.

The sample soil was developed in the laboratory of the Orenburg State Agrarian University and tested on the basis of a greenhouse in Orenburg.

During the development process, we operated on the assumption that there are no specific proportions of the content of one or another component in the soil and everything depends on the place where the material was taken or the method of obtaining it and, most importantly, the purpose of creation, due to the lack of a unified classification of types of soil.

The main components of the soil are turf soil, river sand as the skeleton of the soil-soil mixture, horse manure, which is a source of humus - an organic substance formed during the decomposition of natural plant and animal residues.

Soil mixtures were obtained by artificial mechanical mixing of the main components, adding experimental samples of mineral fertilizers.

The composition of nutrient soils is determined by their content of micro- and macronutrients, biological characteristics, and the availability of nutrients for *Osteospermum* plants.

The artificial soil model was based on the inclusion of 70-85% of the total volume of substrates removed from natural resources, which is of important environmental and economic importance. An environmentally important component of the project for creating soil is the final level of waste hazard while simultaneously controlling fermentation, preventing the release of unpleasant odors and environmental pollution, obtaining fertile soil for growing ornamental trees, shrubs and flower plants.

The product (constructed soil) can be reused after growing flower seedlings in places with insufficiently fertile initial soil, and in places that initially do not have a fertile layer in the required volume, for landscaping work, landscaping urban areas and creating agricultural landscapes [4] .

The best nutrient soils for greenhouses should be highly fertile with good air permeability, water-holding and absorption capacity, free from pathogens and pests, toxic substances, with a soil solution pH of 5.5-6.5, with the best substrates containing 20-30% or more organic matter and 12-20% or more humus.

In a short-term production model experiment, a variant of a constructed artificial soil was used, where basic or basic fillers were used in a certain percentage to provide the physiological needs for growing healthy *Osteospermum* seedlings in a greenhouse complex.

Field studies were carried out in artificial greenhouse conditions using the method of vegetation experiments, in quadruple repetition.

An analysis of the physicochemical components of the model soil was carried out at the assessment and examination center of the Orenburg State Agrarian University. Studies of plant growth and their passage through the main phenological phases in experiments were carried out according to generally accepted methods and GOST [5].

3 Results and Discussion

For the experimental sample, the flower plant *Osteospermum* was chosen, which is a representative of the genus of evergreen perennials of the Asteraceae family, native to South Africa and in the arid climate of Orenburg, they most clearly show their excellent decorative qualities from June, and continues until the onset of stable frosts.

Blooming *Osteospermum* look great in group flower plantings, mixborders, preferring sunny and warm places.

This flower plant requires regular watering, and as the soil dries out, with severe atmospheric and soil drought, the plant falls into a kind of hibernation, stopping the formation of buds, but after watering *Osteospermum* comes to life and continues its growing season.

When grown in greenhouses on artificial soil, *Osteospermum* responded quite well to its physicochemical composition, showing noticeable powerful growth of vegetative and generative organs.

The composition of the experimental soil for growing *Osteospermum* in greenhouse conditions to obtain healthy seedlings is presented in Table 1, with the assigned name "Flower Rhapsody".

Table 1. Composition of the model constructed soil "Rhapsody of Flowers" for growing *Osteospermum*.

The main, basic element of soil	% content of basic components	Recommended base ratio
Sod land	30	1/2
River sand	25	1/3
Horse dung	35	1/3
Chicken droppings	10	1/5

The basic components and their ratio are selected in such a way as to provide high aeration, nutritional value, due to the balance of the main microelements, allowing the full growth potential of the Osteospermum plant to be revealed.

The use of river sand in the soil promotes its porosity, which makes the soil looser, thus enriching the root system of plants with moisture and air faster (Figure 1).

a b

Fig. 1. Constructed soil "Flower Paradise": a) prototype, b) *Osteospermum* seedlings.

The chemical composition of the constructed soil was carried out in order to analyze the needs of plants for the mineral component.

The basis for the correct organization of agrochemical services for ornamental and floral crop production in protected soil conditions should be based on the results of agrochemical analysis, which will contribute to the production of final products that meet environmental safety requirements with a minimum of costs for its production [6].

The vegetative growth of flower seedlings, the formation of powerful buds, and the development of leaf blades indicate a reliable stimulating effect of soil based on the use of organic and inorganic components.

Table 2 shows laboratory data on the chemical and organic composition of the "Rhapsody of Flowers" model soil. Water-soluble phosphorus (P_2O_5), which plays an important role in the processes of respiration and photosynthesis of plants, is determined within normal limits. Easily mobile potassium (K_2O_5), which is responsible for the full formation of buds, is within its normal range [7]. Acidity indicators - pH 6.1-6.5, humus content and moisture supply in the soil before sowing and after planting seedlings correspond to the permissible limits.

Table 2. Content of chemical and organic substances in the soil "Rhapsody of Flowers" before sowing *Osteospermum* and after planting seedlings in open ground.

Analysis results	Before sowing	After planting	Norm, MPC
Water-soluble phosphorus P_2O_5, mg/kg	59.16	112.07	30-300
Easily mobile potassium K_2O_5, mg/kg	43.24	51.96	30-90
Humus,%	5.76	5.74	1.-7.0
Moisture,%	49.13	61.09	60-80
pH	6.1	6.5	5.2-6.6
Ammonium nitrogenN-NH_4, mg/kg	13.32	13.85	2-10
Nitrate nitrogen N-NO_3, mg/kg	6.89	39.84	No more than 130
Ca, mg/kg	32.14	36.29	10-80
Mg, mg/kg	26.09	28.17	7-8
Na, mg/kg	2.14	2.29	0.5-3
Zn, mg/kg	0.15	5.27	23
Ni, mg/kg	0.019	0.046	4.0
Cr, mg/kg	0.031	1.018	6.0
Cu, mg/kg	2.59	2.29	3.0
Pb, mg/kg	0.004	0.0039	32
Mn, mg/kg	8.52	8.45	6.1-10
Co, mg/kg	0.0019	1.2	5.0
Cd, mg/kg	0.007	0.019	0.5
Fe, mg/kg	1.95	4.86	1.3-7.0

The limiting factor when deciding on the positive effect of the further use of the constructed soil is, first of all, not only the content of toxic elements (heavy metals) in the composition, but also the determination of the main nutritional elements necessary for the further growth and development of plants, in this case the formation decorative quality indicators.

The parameters of the content of ammonium nitrogen (N-NH_4) in the soil exceed the standard by more than three times, but it should be borne in mind that nitrogen (N) is the main element responsible for the rapid and powerful development of the plant and the growth of green mass, in addition, preventing the appearance of chlorosis on the leaves, which is fundamental when growing high-quality seedlings for landscaping purposes.

During the period of active vegetative growth and seedling development after picking, the need for nutrients increases sharply, which is associated with increased activity of metabolic processes in plants [8-10].

Timely use of ammonium sulfate (granular, crystalline) $(NH_4)_2SO_4$ has proven good results when growing seedlings on soil in a short-term model experiment when growing Osteospermum.

The weighted average survival rate of a flower crop after diving into boxes in a greenhouse was, respectively, 92.4%, 95.3%, 96.8%, 96.7%, with an average of 95.2%, which is assessed as a high indicator (Figure 2).

Fig. 2. *Osteospermum* seedlings before diving.

The vegetative growth of seedlings showed a significant stimulating effect of nutritious soil, the basis of which is their organic components.

4 Conclusion

The model soil "Rhapsody of Flowers", due to the harmonious proportions of its constituent components, has high aeration, looseness, water permeability and water-holding capacity in practical implementation.

The use of soil with high nutritional value is promising in decorative floriculture, when growing *Osteospermum* flower crops.

As a result of repeated use of waste soils when growing seedlings in greenhouses, the quality and fertility of soils in urbanized areas can be significantly improved.

When using waste soils in flower beds, the mechanical, chemical and physical properties of urban soils improve, which in turn has a positive effect on the growth and manifestation of the decorative qualities of flower plants.

Modern technologies for processing, separation and purification of organic waste open up wide possibilities for their use in decorative floriculture and make it possible to experimentally obtain artificial substrates or soils of different quality compositions and intended purposes for specific types of plants, fully revealing their growth and decorative potential.

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