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Vegetative flowerpot for measurements of studied plants in the conditions of the diverse condensation of the soil in the roots system

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ABSTRACT

Patent pending modified vegetative flowerpot enables, except typical observation lead in objects this type, the experimental study of plant responses to soil heterogeneity constituting a natural feature of the root growth center. In cultivation fields variability of soil properties is conditioned by natural and anthropogenic processes associated with the technique of cultivation and fertilization. In designed flowerpot using its two movable parts can observed conditions around the root system of the cultivation plant's under different condensation of soil caused by rides of agricultural machinery and localized fertilization. The design of the invention also allows optimal dispensing water into the ground soil by controlled drying and irrigation, which maintains proper conditions of humidity developing plants.

Konstrukcja i zastosowanie wazonu wegetacyjnego do pomiarów rozwoju roślin w warunkach zróżnicowanego zagęszczenia gleby w obrębie systemu korzeniowego

Słowa kluczowe: wazon wegetacyjny, nawożenie, zagęszczenie gleby

STRESZCZENIE

Opatentowany, zmodyfikowany wazon wegetacyjny umożliwi eksperymentalne badanie reakcji roślin na zróżnicowany skład granulometryczny gleby, stanowiący naturalną cechę ośrodka wzrostu korzeni. Na polach uprawnych zmienność właściwości gleby uwarunkowana jest procesami naturalnymi i antropogenicznymi związanymi z techniką uprawy i nawożeniem. W zaprojektowanym wazonie, wykorzystując jego dwie ruchome części, można prześledzić warunki rozwoju systemu korzeniowego rośliny uprawnej wzrastającej przy zróżnicowanym zagęszczeniu gleby spowodowanym m.in. przejazdami maszyn rolniczych czy zlokalizowanym nawożeniem. Rozwiązanie konstrukcyjne wynalazku pozwala także na optymalne dozowanie wody do podłoża glebowego poprzez kontrolowane osuszanie i nawadnianie zapewniające odpowiednie warunki wilgotności rozwijającym się roślinom.

1. INTRODUCTION

Vegetation vases are usually used in research in the field of agricultural chemistry, ecology, soil science, farming and breeding and plant physiology.

Mostly used in solving problems related to:

• knowledge of transformations nutrients in the soil and the determination the uptake rate by test plants,

• preliminary assessment of the effectiveness the new fertilizers based on the reaction test plants,

• the use of non-conventional sources of soil enrichment in organic matter and nutrients in crop production,

• initial recognition the degree of contamination the soil and its remediation capabilities.

Well-known are the advantages of pot experiments, which include:

• low cost of setting up and conducting the experiment,

• full control of soil moisture, which is one of the most important factors strongly differentiating results,

• providing as possible, the same environmental conditions to apply of these factors combination,

• the possibility analyzing the variety factors, including the use of vegetation in different doses, which strong contaminated environment, by complete control,

• easy treatment (thermal, chemical) substrates used in the experiments after the completion of the experiment.

The essence of vegetation experiments is the observation of plant response to the test factor in the possible homogeneous conditions. The cultivation of plants is particularly important to optimize fertilization, which translates into higher yields while maintaining good quality characteristics of biomass. Effective selection of fertilizers doses affects for the profitability of agricultural production.

In this context, the growing research conducted on the response of plants under controlled conditions, has a deep sense of social, economic and environmental [1-4].

In the patent [5] the vegetative flowerpot is described in which solution depends on placing three containers placed one within the other, the first container is filled with soil substrate, in which a plant is planted or sown seeds.

The first container has capillary holes in the bottom, which excess water flows into the free space formed between it and the second container fulfilling the role of the water tank. In the upper port of a larger reservoir are located holes for aeration. Both tanks are placed in the third, the largest, which is formed chassis of the vegetative flowerpot. The water used for irrigation, which will not be taken up by the plant as a result of transpiration or stopped by the soil substrate, flows by gravity through holes in the bottom and enters to the space formed between the first and second bottom of the containers.

From the space of the tank water can be drained through the capillary tube outside the vegetative flowerpot [6].

Another way to supply vegetative flowerpot in water was described in the work [7]. It involves placing in the vegetative flowerpot flexible tube with capillary holes used for watering plants and tube and air filter to aerate the soil. The vegetative flowerpot construction proposed by [7] is also provided with a water filter at the bottom of the container with activated carbon and is covered with a grid opening in the bottom for the discharge of excess water through the drain valve.

The first two cited solutions only allow drainage of excess water used for irrigation. In case excess of moist soil didn't show the solution the drying process. The excess of moist soil may affect the state of decay within the root system and thus impair the growth of the test plants.

Although in the embodiment of the vegetative flowerpot [7] includes irrigation and soil aeration, but technical equipment inside of flowerpot occupy a significant volume, which may hinder the crops.

In none of these solutions is not possible to modify and replace part of structure the soil substrate without disturbing tested plants nor a test of soil compaction around the root system affecting the growth of roots and aboveground parts of the plant.

2. VEGETATIVE FLOWERPOT

The new construction of vegetative flowerpot is presented.

The compartments on the side walls of vegetative flowerpot are placed air nozzles and on the inner walls are the double nozzle arrangement irrigation [8] in order to avoid the above difficulties.

Vegetative flowerpot has movable lower part, which allows modify the grain size composition of the soil which reflects the uneven density within the rhizosphere soil according to conditions found in field crops.

Vegetative flowerpot has a conical shape on an inner side surface provided as 120^o three longitudinal, vertical plates 2 with the air nozzles 3. Air nozzles are supplied with compressed air at

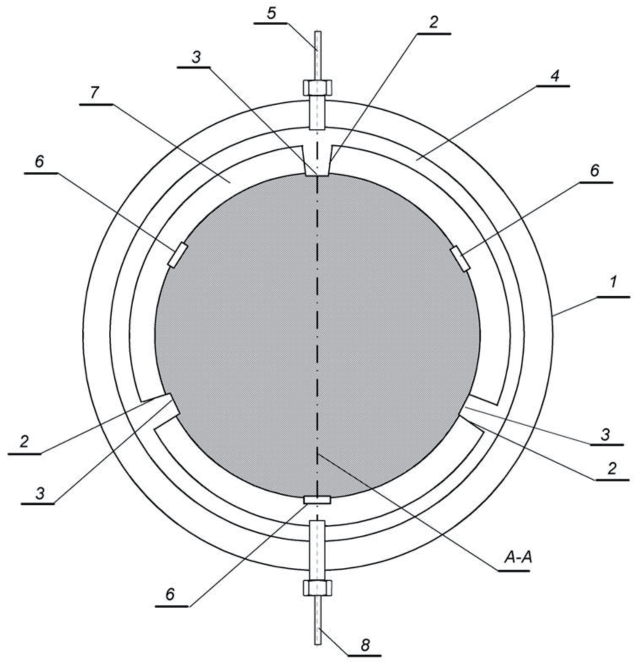

Figure 1 The diagram of vegetative flowerpot (view of the top)
1 – vegetative flowerpot, 2 – vertical plate, 3 – air nozzle, 4 – air chamber, 5 – connector of compressed air, 6 – upper irrigation nozzle, 7 – upper water chamber, 8 – connector of water chamber

a slight excess pressure through an air chamber 4 to the side wall around the vegetative flowerpot. Compressed air is supplied through the connector 5. The three upper irrigation nozzles 6, also settled at 120° on the inner surface side of the vegetative flowerpot, are supplied with water from the upper water chamber 7 through the connector 8.

Scheme vegetative flowerpot in cross-section is shown in Figure 2. The three lower irrigation nozzles 9 are placed below the upper irrigation nozzle (the plane along which the cross-section was made in Figure 1 has been selected by capital letters AA).

These nozzles are supplied with water from the lower chamber 10 through the connector 11.

The connector 12 serves to drain excess water from the lower chamber. The detachable lower part 13 of vegetative flowerpot is connected by threaded connection with gasket 14 with a vase. Both parts of the vegetative flowerpot separates perforated diaphragm 15. In this way, used in the experiment, upper soil basis 16 (highly concentrated, with increased resistance, due to e.g. agricultural treatments) is separated from the lower soil basis 17 placed in the removable bottom part of the vegetative flowerpot. At the bottom of the removable bottom part of the vegetative flowerpot is provided in porous plate 18 which serves to drain excess water from the bottom of the vase through the connectors 19 and 20.

Figure 3 shows method of supplying water and air to vegetative flowerpot. Air is supplied to the vegetative flowerpot through the connector 5 and the valve 21. Vegetative flowerpot is supplied with water by the connector 11 and valve

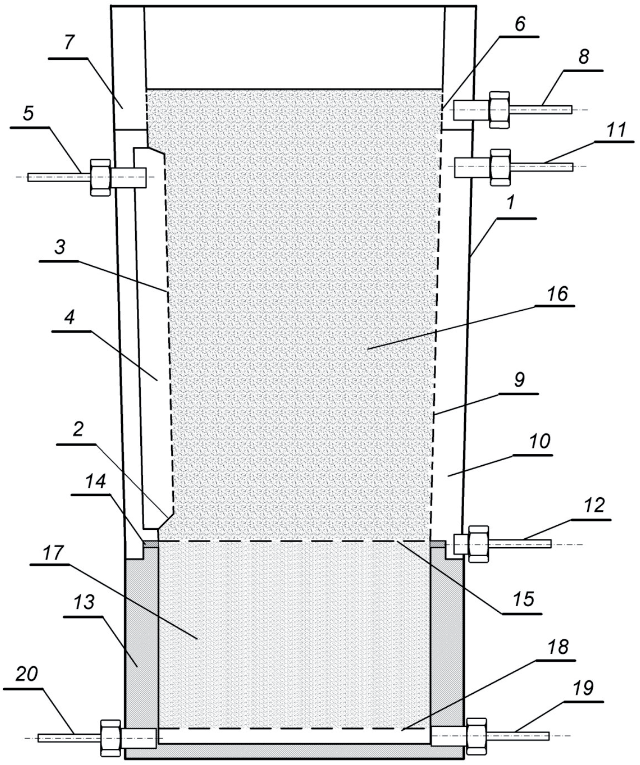

Figure 2 The diagram of vegetative flowerpot in transverse cross-section (the surface, along which the section has been executed which on Figure 1, has been noted the great letters of alphabet A-A)
1 – vegetative flowerpot, 2 – vertical plate, 3 – air nozzle, 4 – air chamber, 5 – connector of compressed air, 6 – upper irrigation nozzle, 7 – upper water chamber, 8 – connector of upper water chamber, 9 – lower irrigation nozzle, 10 – lower water chamber, 11 – connector of lower water chamber, 12 – connector for draining of excess water from lower water chamber, 13 – detachable lower part of vegetative flowerpot, 14 – connector with gasket, 15 – perforated diaphragm, 16 – upper soil basis, 17 – lower soil basis, 18 – porous plate, 19, 20 – connector

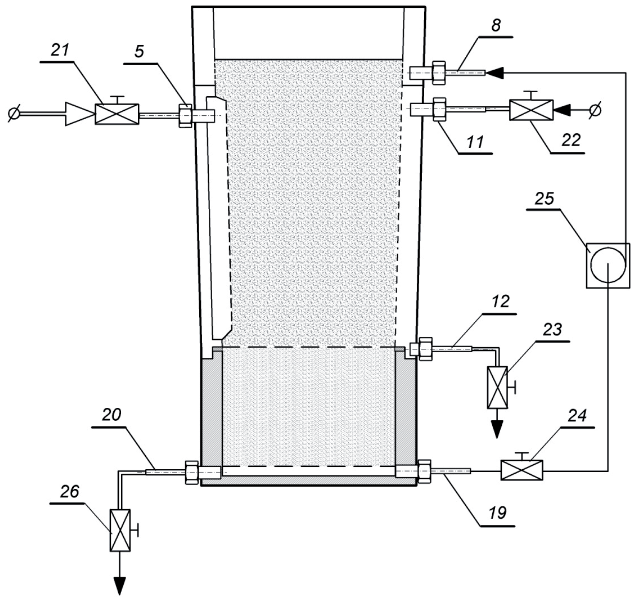

Figure 3 The diagram of water and air supply of vegetative flowerpot
5 – connector of compressed air, 8 – connector of upper water chamber, 9 – lower irrigation nozzle, 11 – connector of lower water chamber, 12 – connector for draining of excess water from lower water chamber, 19, 20 – connector, 21 – compressed air valve, 22 – water supply valve, 23 – valve for draining of excess water from lower water chamber, 24 – valve for pump water supply, 25 – pump, 26 – valve for draining of water

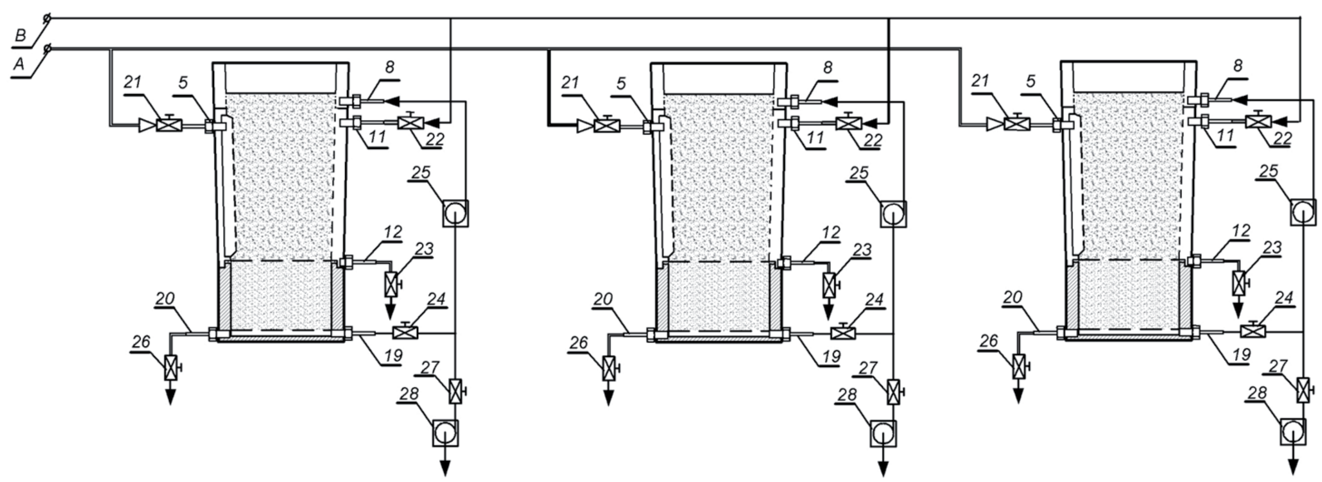

Figure 4 The diagram of water and air supply of vegetative flowerpot unit
A – compressed air track, B – water supply track, 27 – valve for water sampling, 28 – pump for water sampling. Other marks, as in Figure 3

22, the surplus is drained through connector 12 and valve 23.
Excess water from the bottom of the vegetative flowerpot can be recycled to the upper irrigation nozzle – connector 19, valve 24, pump 25 and the connector 8 and discharged to the outside through the connector 20 and valve 26.
Vegetative flowerpot construction allows to be compiled into groups (Figure 4), which can be used in applied experimental combinations. Then they can be connected to a compressed air path A and path B of water supply. This makes it easier to perform measurements with a number of test plants (many variants of the experiment).
Samples of water from the leachate can be downloaded through the valve 27 of the pump 28. The design of the invention allows both to dispense water into the ground soil and drying soil through the air, which allows you to keep a constant humidity of the soil substrate.
Placing the air nozzles at the ends of the internal compartments of vegetative flowerpot allows aerate and dry the internal volume of the soil substrate.
Dosing of water through the lower irrigation nozzles disposed on the inner walls of the vase inflicts, that in soil appears a gradient of water flow directed axially into the flowerpot.
Eventually excess water with dissolved minerals is recycled to the upper irrigation nozzles, which allows for re-use by the test plant. The movable lower part of the vegetative flowerpot makes it easy to modify (as needed) the size distribution of the soil medium, without disturbing the root system of the studied plants. Vegetative flowerpot maintains the same conditions of plant growth, precise dosage of water, and provides a solid collection of filtrates for next the physical-chemical studies.
Vegetative flowerpots can be combined to form vegetative cells.

3. THE INFLUENCE OF SOIL COMPACTION WITHIN A ROOT SYSTEM ON THE GROWTH OF ROOTS AND THE ABOVEGROUND PARTS OF PLANTS

The main purpose of the designed vegetative flowerpot is use to determine the effect on growth and underground parts of the plant:
• localized fertilization,
• improvers soil of variety substances (e.g. hygienized municipal sludge, other sediments),
• compaction of the soil around the root system,
• collection of water and nutrients in a controlled conditions.
Precise determination of the ability of the plant to take water and nutrients in the conditions of uneven density of soil and localized fertilization is essential in the development of agrotechnical works [2-4, 9].
These studies are also relevant to the design and functioning of growth models in variety conditions of plants cultivation.
From the literature it is known that both the mechanical resistance changes occurring within the soil rhizosphere and the surface of contact between the soil and the roots are factors strongly modifies the nutritional uptake [1, 2, 9].
The root structure, size, height and spatial distribution, affects the aboveground parts growth of the plant.
Improper use of fertilizer can affect both stimulating and inhibiting effect on growth, morphology, structure, roots and uptake efficient of water and nutrients [4, 5, 10, 12].
In this context, the natural soil heterogeneity refers to a portion of the surface usually richer in organic matter, characterized by a higher content of nutrients with a lower bulk density relative to the lower levels poorer of backlog mineral soil with a higher density.
For soils, the heterogeneity in the distribution of nutrients is similar, however, the modification of bulk density, which varies locally under the influence of agrotechnical operation and crossings of agricultural equipment [11].
As we know, overcrowding (<1.50 $Mg \cdot m^{-3}$) is particularly bad in the first period of root growth and effects on the subsequent vegetation in laboratory conditions [3, 4].

4. CONCLUSION

Vegetative flowerpot of the proposed design beside to the typical observations of objects of this type, enables experimental study of plant responses to soil heterogeneity constituting a natural feature of medium root growth.
In the case of soils with low anthropogenic impact, e.g. the forest, can use a variant associated with the natural variability of the morphology soil profile.

Depending on the purpose of the study, at the top of the vase could place the soil with organic levels (organic and mineral), at the bottom for the example from bedrock.

Designed vegetative flowerpot also allows for a classic study of plant responses to stress relief associated with the introduction of severe factors increase on environment under controlled humidity and homogeneous soil material.

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