STATEMENT

on a dissertation thesis for obtaining the educational and scientific degree "Doctor" in the field of higher education 6. Agricultural Sciences and Veterinary Medicine, professional field 6.1 Plant Growing, scientific specialty "Ornamental Plants"

Author of the dissertation thesis: MARIA PETKOVA GROZEVA, doctoral student in an independent form of study at the Department of Horticulture, Agricultural University, Plovdiv

Title of the dissertation thesis: TYPOLOGY AND METHODS FOR NOISE PROTECTION THROUGH THE USE OF GREEN PLANTATIONS IN AN URBAN ENVIRONMENT

Reviewer: Assoc. Prof. Dr. Katya Spasova Uzundzhalieva, Institute of Plant Genetic Resources "K. Malkov" – Sadovo, field of higher education 6. Agricultural Sciences and Veterinary Medicine, professional field 6.1 Plant Growing, scientific specialty "Breeding and Seed Production of Cultivated Plants", appointed as a member of the scientific jury by Order No. RD-16-776/23.06.2026 of the Rector of the Agricultural University.

1. Relevance of the problem.

Sustainable development of the modern city is an extremely complex, multilayered task that has long gone beyond the boundaries of traditional engineering planning. Its ultimate goal is to preserve the ecological balance in the places we inhabit and to protect citizens' right to a favorable and healthy living environment. However, the pursuit of intensive economic growth, construction and mobility in large agglomerations generates one of the most aggressive and pervasive pollutants of modern society – anthropogenic traffic noise.

In Bulgaria, and in particular under the conditions of the Sofia agglomeration, which is the focus of the study, there is a lack of a comprehensive, scientifically validated applied toolkit linking the dendrological composition and spatial architecture of plantations with specific quantitative calculations of the attenuation effect. The present dissertation thesis is aimed at filling this significant scientific and applied gap. This determines the relevance and innovativeness of the problem developed in the dissertation thesis.

2. Aim, tasks, hypotheses and research methods.

The aim of the present dissertation thesis is to develop a scientifically based concept encompassing spatial-functional typological models and methodological guidelines for the establishment of highly effective green noise-

protection screens, as well as to quantify the phytoacoustic potential of a specific reference assortment of tree and shrub species under the actual environmental conditions of the Sofia agglomeration.

In connection with this aim, the following tasks have been set:

1. Systematization and detailed analysis of the physico-biological mechanisms of propagation, absorption and scattering of sound waves through plant masses.

2. Conducting systematic instrumental in situ monitoring at selected control points along the main street network of Sofia.

3. Experimental determination and quantitative measurement of the influence of the seasonal factor (phenological phases of leafing and dormancy) on the insulation capacity of deciduous and coniferous belts.

4. Performing a multicriteria dendrological analysis and assessment of the ecological plasticity and gas resistance of priority species under conditions of anthropogenic stress.

5. Development of digital phytoacoustic models and creation of an original Constructive Typology of phyto-screens (Type 1, Type 2 and Type 3) for practical application.

The experimental work on the topic was carried out in the territory of the Sofia agglomeration (covering 19 permanent systematic control points and additional specialized locations within the project case studies) during the doctoral study period.

The studied material encompasses existing tree and shrub vegetation used to form linear protective structures. Within the study, the selection of target dendrological material was strictly adapted to the specifics of the temperate continental climate, local soil conditions and the orography of the Sofia Valley. The species were classified on the basis of their ecological plasticity.

• Adaptability to urban stress: Taxa capable of tolerating severe soil sealing, compaction and winter salting were prioritized (e.g. Robinia pseudoacacia and Acer negundo).

• Temporal dynamics of screening: Fast-growing pioneer species (Populus x canadensis) were integrated to achieve early protection within shortened periods (3–5 years), combined with long-lived climax species (Quercus robur) to form a sustainable structural framework.

• Phenological dynamics: The timing of leaf emergence and leaf fall is a determining factor. It is essential to include evergreen taxa (Picea abies, Pinus nigra), which serve as an acoustic buffer during the winter period, when, due to temperature inversions, sound propagation is most intensive.

The empirical part of the present dissertation thesis focuses on a detailed analysis of the acoustic environment in the Sofia agglomeration through a series

of precise instrumental in situ measurements. The instrumental measurements in Stage 1 (at the edge of the roadway) confirm the presence of a persistently high-energy noise background. The average equivalent levels (LAeq) range from 72.4 dB(A) to 73.2 dB(A) at most locations, which clearly exceeds the critical threshold of acoustic comfort.

3. Illustration and presentation of the obtained results.

The dissertation thesis is 210 pages long and contains 29 tables and 30 figures, which indicates good visualization in the presentation of the obtained results.

4. Discussion of the results and literature used.

To ensure logical consistency and scientific objectivity, the structure of this chapter and the presentation of the results strictly follow the methodological algorithm of the study. This algorithm proceeds through four consecutive and conceptually cumulative stages:

1. Diagnostic and analytical stage (Field studies) – The first stage covers instrumental measurement and comprehensive analysis of the existing situation (Status quo).
2. Experimental stage (Project case studies and spatial modeling).
3. Validation stage (Practical verification through implemented projects).
4. Synthesis and scientific contribution (Modeling and typologization).

A rationale was provided for the selection of plant species for noise insulation purposes in an urban environment, and a comprehensive assessment matrix was constructed on the basis of four key factors – acoustic density, gas resistance, edaphic plasticity and phenological stability.

The list of cited literature contains 157 sources, of which 35 are in Cyrillic and 122 in Latin script.

5. Contributions of the dissertation thesis.

Based on the results obtained from the theoretical studies conducted within the present research, three scientific-theoretical and three scientific-practical conclusions have been formulated.

Scientific-theoretical conclusions:

1. Physico-biological mechanism of phyto-screens: It has been established that plant belts do not function solely as a linear physical barrier analogous to conventional engineering structures.
2. Structural dependence and the imperative of biodiversity: Monocultural plantations demonstrate limited effectiveness and greater vulnerability.
3. Phenological paradox and seasonal dynamics of protection: Empirical data from Sofia revealed a drastic dependence of effectiveness on the phenological phase.

Practical conclusions:

1. Spatial imperative and functional zoning: The rule of "close protection" has been confirmed. The green barrier realizes its maximum potential when positioned at a distance of 6.0–10.0 meters from the source.

2. Effectiveness of the "Green Shield" in a residential environment: The design solution for the "Botevgrad" Residential Complex demonstrated that a multilayer structure is necessary to achieve actual acoustic comfort in zone "Жс".

3. Economic and spatial optimization through vertical greening: The "Technopolis" case study (with 512 linear meters of implemented vertical greening) demonstrates that in industrial zones (Смф), biological screens are the most cost-effective alternative.

Scientific contributions

1. Definition of the physico-biological mechanism: It has been scientifically demonstrated that phyto-screens function as a complex system for the dissipation of sound energy through the synergy of absorption, diffraction and micro-reverberation.

2. Demonstration of seasonal (phenological) dynamics: The "phenological collapse" in acoustic effectiveness of entirely deciduous masses during the winter period has been quantitatively measured and demonstrated.

3. Development of a Mathematical Model of Acoustic Transfer: A model has been created for the quantitative calculation of Insertion Loss.

Scientific and applied contributions

1. Creation of an original Constructive Typology: Three spatial-functional models of phyto-screens have been developed and validated (Type 1: Aerodynamic, Type 2: Checkerboard, Type 3: Combined).

2. Construction of a Comprehensive Selection Matrix: A specialized matrix has been developed for the selection of priority tree and shrub species for Zone 6.

3. Validation in a real urban environment: The technical-economic and landscape effectiveness of biological solutions has been demonstrated at critical infrastructure sites (the "Technopolis" Shopping Complex, "Botevgrad" Residential Complex).

6. Critical comments and questions.

I have no questions or critical comments.

7. Published articles and citations.

Two articles related to the dissertation thesis have been published, in which the doctoral student is the first and sole author.

The submitted abstract accurately reflects the structure and content of the dissertation thesis.

CONCLUSION:

Based on the various research methods learned and applied by the doctoral student, the correctly conducted experiments, and the summaries and conclusions drawn, I consider that the presented dissertation thesis meets the requirements of the Academic Staff Development Act and the Regulations of the Agricultural University for its implementation, which gives me grounds to assess it **POSITIVELY**.

I therefore take proporse that the esteemed Scientific Jury also vote positively and award MARIA PETKOVA GROZEVA the educational and scientific degree "Doctor" in the scientific specialty "Ornamental Plants".

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