

## REVIEW



on a thesis for acquiring of a scientific degree “Doctor of Sciences” in the domain of higher education 6. Agricultural Sciences and Veterinary Medicine, professional field 6.5. Forestry, scientific specialty Forest plantations, breeding and seed production

**Author of the thesis:** Assoc. Prof. Krasimira Nikolova Petkova – Tsokova, Ph.D.

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**Topic of the thesis:** “Potential for adaptation of Douglas Fir and Common Beech provenances to climate change.

**Reviewer:** Assoc. Prof. Velichko Georgiev Gagov – University of Forestry, Forestry, Forest genetics, tree breeding and seed production (retired).

Appointed as a member of the scientific jury with an order № 636/28.11.2019 of the Rector of UF.

### 1. Brief presentation of the author

Assoc. Prof. Krasimira Nikolova Petkova – Tsokova, Ph.D. graduated in the UF in 1981 and worked in Agrolesproject in the field of forest management planning until 1988. Then, after a competition, she was appointed as Assistant professor in the Department of Silviculture. In 1990 she defended her Ph.D. thesis and in 2001 she became Associate Professor, a position she holds until today.

### 2. Relevance and importance of the scientific problem

Establishment of production and experimental plantations in the forestry practice is related the regeneration of forests and enlargement of their area. The introduction is one of the opportunities for enrichment of species composition in the forests, increasing their productivity, wood quality, tolerance to the atmospheric pollution and adaptation of species to the changing ecological factors, including climate change. The regulatory mechanisms in the nature contribute to the adaptation to the environmental changes, which in natural conditions take long period of time and many generations. Without the active intervention of experts, in many places today there could be no forests, performing their specific functions.

There are still unknown factors affecting the dynamics of the forest populations, for promoting their regeneration, for enlargement of forest territories and improvement from the point of view of tolerance, productivity and wood quality. In this aspect the importance and relevance of the reviewed work should be evaluated, with its main objective – to reveal the potential of genetic adaptation of Douglas fir (*Pseudotsuga menziesii* (Mirb.) Franco), which is not an autochthonous species in Bulgaria, and to assess inheritance of different traits of the

Beech (*Fagus sylvatica* L.) of its natural area of distribution in Europe, under climate change and as affected of other environmental factors.

### **3. State of the art and interpretation of the literature survey**

Usually, the studies in a given area start as a succession of the previous studies, after thorough analysis of their results. In this respect, the work of the author of thesis deserves high evaluation, for the analysis and interpretation of 355 published references. As a result of the analysis, the author concludes that Douglas fir is one of the economically important tree species in the world. Hence, a logical question to the author: what is the reason for this statement?

I have a critical remark to the literature survey: a substantial part of the cited references concerning Douglas Fir are not directly related with the studies in the thesis and could be omitted. The detailed review of the literature concerning the problems of the Douglas Fir in its autochthonous populations and provenance tests is much wider than necessary for the purpose of the thesis. All scenarios about the climate change: optimistic, realistic and pessimistic, are described into too many pages, and finally, it is concluded that they are uncertain, approximate and cannot serve as a necessary background for the future establishment and management of the forests in Bulgaria. As a whole, if the part "1.1. Climate change and tree species" would be omitted the thesis would be improved. The part 1.2. "Provenance tests with the Beech" is written purposefully in relation to the author's studies. This part also contains additional facts of educational character, which could be omitted.

The other sections of the literature review related to studies on the phenological characteristics of Douglas Fir and Beech, the growth, productivity and reaction of individual provenances in the context of climate change are presented in an appropriate form. The overall evaluation of the literature survey is positive. The interpretation of significant references related to the author's studies is done with precision and competence for both species. This is an essential prerequisite for the quality of the studies carried out, from the establishment of the experiments to the analysis of the results.

### **4. Objective, tasks, hypotheses and methods of study**

The most frequently applied approaches for analysis of the reaction of seedlings of tree species to climate change are the "transfer analysis" and "universal response function". These approaches are adopted by the author for achieving the objective, to evaluate the potential for adaptation of individuals of different autochthonous provenances of Douglas Fir and Beech, planted in provenance tests, to the future climate change.

Seven main tasks are set for achieving the objective set.

Due to the specific characters of the tree species, with their long life cycle, the success of the studies and achieving of satisfying results of the tasks depends mainly on the selecting of appropriate objects and applying there of well-grounded research methods.

New and modern methods for studies in provenance tests are applied in the investigations, measurements and data processing performed.

The phenotypic characteristics of needles and development of the terminal bud are determined according to 5-point scale of Kleinschmitt et al. (1974) – method applied in similar studies in the Experimental Station for breeding and seed production in Teisendorf (Germany). Round-year measurements of the temperatures and relative humidity are performed with a special Logger.

The scale of Kleinschmitt et al. (1974) is ocular and hardly applicable, due to the color nuances. This concerns also the formation of the terminal bud and lignification of the terminal shoot both in the Douglas fir and Beech.

Height growth assessment is based on measurement of 10 heights of the central diameter classes, with subsequent calculation of mean values. The average diameter is determined by means of the basal area of the trees in experimental plots. The mechanical stability is calculated only for the provenances in one of provenance tests for Douglas Fir.

The use of Ellenberg coefficient for comparison among the beech provenances is correct. The same coefficient is used for calculation of the mean ecological distances, indicating the effect of climate on the seedlings in the provenance tests, each one containing provenances with different level of adaptation.

Successfully, R - software is applied for statistical estimation of data, with the packages stats and agricole, and visualization of the results is done with the graphical functions of R – ggplot 2.

The following statistical analyses are applied: ANOVA for studying the effect of factors “provenance”, “group of provenances”, and “replication” on the survival, height and diameter growth of Douglas Fir provenances. One-way ANOVA is applied in the studies of Beech. The same analysis is applied for testing the effect of “group of provenances” on the bud flushing. For beech provenances, in the nursery and in the test in Varbitza the effect of the factor “provenance” on the phenological phases “flushing” and “autumnal” leaves coloration”. Two-factor ANOVA is applied successfully for detecting of differences in the mean height of seedlings of different provenances of Beech.

The following variant of regression analysis is applied: univariate linear regression model, second power linear regression model (represented graphically as parabola),

generalized regression model with different functions, and non-linear logistic model, applied to the average date of the different phenological phases.

The correlation analysis is used for determining of the effect of altitude on the stem model and the effect of factor stand density on the degree of windthrow damages.

The new methods developed for the studies are applied successfully for estimation of some indicators used for characterizing of populations in relation to the necessity of their transfer and introduction from one place to another.

The provenance tests established could be used as sources of seeds adapted to the new conditions, after reaching the reproduction phase and proper evaluation of their adaptation to the new environmental conditions. This approach can be applied to all forest tree species.

### **5. Presentation of the results obtained**

The opportunities for large-scale research in Douglas Fir are limited, as there are no autochthonous populations, and only two experimental provenance test have been established, under the scientific guidance of the author of the dissertation. These provenance tests are located in the Western Balkan Mountains (UOGS Petrohan and DGS Berkovitsa). For the Beech, also under her leadership, three provenance experiments were established in Vidin (Western Stara planina) and in Varbitsa and Kipilovo (Eastern Stara planina). The characteristics of the 54 seed samples used to produce seedlings and to establish the provenance tests of Douglas Fir are done unnecessarily detailed, without specifying whether they refer to individual populations or single parent trees. Most likely these are samples of individual trees, which is confirmed to some extent by the great similarity of the data in the table for the characteristics of the samples in terms of longitude, latitude and altitude. During the period since the establishing of the first provenance test in Petrohan and its thinning, there were serious problems with the survival of the seedlings, caused by the fungi *Rhabdocline pseudotsugae* and *Phaeocryptopus gaumanii*. The number of seedlings affected and killed by these pathogenic fungi has increased significantly. Snow damage and felling of a number of trees during the thinnings could also lead to some measurement errors and to decreasing the accuracy of the results. In the second provenance test, the number of surviving seedlings is significantly higher.

The thesis contains unnecessarily detailed description of the entire technological process, which includes the preparation of the nursery area for sowing, cultivation of seedlings in the nursery, the preparation of the areas for provenance trials and planting of the seedlings. This applies to both Douglas and Beech.

## **6. Discussion of the results and references**

The results of the studies carried out using parametric and non-parametric statistical methods prove the significant effect of the factors "group of provenances" and "provenance" on the height growth. The results of the studies are presented in the attached tables, illustrated very well with graphs and charts.

An evaluation is done of the phenological and morphological traits of the seedlings of different provenances, and their survival over a relatively long period of time. Height and diameter growth, stem volume and productivity are determined, together with the mechanical stability coefficient of the provenances in the oldest trial in Petrohan.

The results obtained of phenological observations in Beech refer to seedlings in the nursery and in the provenance trials. Periods of flushing and autumn leaf coloration are determined. The relationship between phenophases and the geographical coordinates of the provenances has been established. Height growth of beech provenances in nurseries and in the provenance trials in Varbitsa and Kipilovo are evaluated. Based on these data, the Ellenberg coefficient (EQ) and the eco-distance ( $\Delta E$ ) were determined and reported.

The conclusions drawn from the results are original and specific and relate to studies of the two species under the respective environmental conditions. Some of the conclusions, which are confirmatory, are presented in the main text. Interesting is also the conclusion 12, which is completely in line with the assessment of the Common Beech from Bulgaria in all provenance trials in Europe. I have the following questions to the conclusions:

1. Do you not find that those listed under Nos. 4 and 6 contradict to each other?
2. Conclusion No. 7. What is the specificity of the phenological phases of the Bulgarian beech provenances? How they run and how do they differ from foreign provenances? Do the results allow to conclude that Bulgarian Beech provenances are ecologically determined phenotypes? Based on what phenotypic traits is this possible?

## **7. Contributions of the thesis**

The 14 contributions specified in the thesis are classified as contribution of scientific, of methodological and of applied character. I think it is difficult to make such discrimination in similar studies.

### **7.1. Scientific contributions**

To this group of contributions, I have the following questions:

1. What are the reasons for the earlier start of vegetation period in the continental provenances of Douglas Fir in comparison with the later start in the coastal ones?

2. Can the regression models for the relationships between the height growth and the main climate factors, developed and applied in the thesis, be applied to other tree species.

3. What is the evidence that, with age, the slowest-growing provenances of Douglas retain their rank?

4. What is an ecologically determined phenotype?

5. Which relationship in beech is more pronounced, the one between the average date of flushing and autumn leaf coloration with geographical coordinates, or that between the average date of flushing and autumn coloration with altitude of provenance?

6. What are the reasons for the higher survival rate of continental provenances of Douglas Fir than the coastal ones?

#### **7.2. Scientific and applied contributions**

My question to the scientific contribution referred to in point 3 is related to the possibility of its application - what it is and where is possible?

#### **8. Assessment of the degree of the personal participation of the author in the contributions.**

The contributions made by the author to the thesis are her personal work and are the result of a long, in-depth research work in Bulgaria, and participation in many high-level international research projects.

#### **9. Critical remarks and questions.**

In the text of the review, I have made a number of critical remarks which, in essence, cannot have a negative impact on the high assessment of the quality of the scientific level of the dissertation. They are mainly related to unnecessarily detailed descriptions of certain types of activities, related to the establishment of experiments in the nursery and in the forest.

#### **10. Publications and citations.**

The list of published articles and citations in Appendix 2 to the general documentation is extremely meticulous, as is generally the case with the work of Dr. K. Petkova, so that it can safely be attached to the review without analyzing it. There are 13 papers published related to the thesis, 2 of them in journal with Impact factor. These papers are cited 38 times in the scientific literature.

#### **11. Assessment of the publications related to the thesis: number, where they are published. Reflections in the scientific field – used and cited by other authors.**

Papers are usually accepted for publication after objective and precise peer reviews. Therefore, I consider that the articles published by the author are of high scientific value, especially since most of them have been reported and discussed at international symposia.


The presented abstract is written by the author and reflects the structure and content of the thesis.

**CONCLUSION:**

Based on the scientific research methods applied by the author, on the precisely performed experiments, the careful analysis and discussion of the results and conclusions drawn, scientific and applied by the dissertation doctor, different research methods, correctly performed experiments, summaries made and conclusions drawn, I believe that the submitted thesis meets the requirements of the Act for Development of the Academic Staff in the Republic of Bulgaria and the respective Rules of the University of Forestry, which allows me to evaluate it POSITIVELY.

Therefore, I can propose to the Scientific Jury to vote positively for awarding Assoc. Prof. Krasimira Nikolova Petkova – Tsokova, Ph.D., with the scientific degree “Doctor of Sciences” in the domain of higher education 6. Agricultural Sciences and Veterinary Medicine, professional field 6.5. Forestry, scientific specialty Forest plantations, breeding and seed production

Date: 12.02. 2020  
Sofia

Reviewer:   
/Assoc. Prof. Velichko Gagov, Ph.D./