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THE PHOSPHORUS ANALYZES IN NEEDLES OF CANADIAN DOUGLAS-FIR PROVENANCES

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Abstract: *Douglas-fir (Pseudotsuga menziesii Mir / Franco) is an indigenous and economically the most widespread species of conifers in Canada and North America. It is also the most common introduced species conifer in Europe.*

In Serbia testing of Douglas-fir, began setting up several provenance plots with seeds originating from Canada and North America. The research work carried out at the Institute of Forestry, conducting analysis in order to select the most adaptive and productive provenances for reforestation in Serbia. The seeds transfer of introduced species of trees include testing of all characteristic by provenance test. Genetic feature of trees species show in the new environmental, to confirm the selection of tree type for introduction. One of the methods of assessing the genetic variability of introduced species is the testing using provenance experiment.

The intensity effect of physiological processes of mineral nutrition of tree species is one of the most important indicators of its successful adaptation and production into new environment habitats.

This research analyzes the phosphorus content in the needles of Douglas-fir from different provenances originating from Canada.

Key words: Douglas-fir, seed transfer, provenances, phosphorus, needles,

ANALIZA FOSFORA U ČETINAMA DUGLAZIJE KANADSKIH PROVENIJENCIJA

Apstrakt: *Duglazija (Pseudotsuga menziesii Mir / Franco) je autohtona najrasprostranjenija i ekonomski najvažnija vrsta četinara u Kanadi i Severnoj Americi.*

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Takođe je najčešća introdukovana vrsta četinara u Evropi. U Srbiji istraživanje na duglaziji, počelo je postavljanjem nekoliko provenijeničnih testova sa semenom poreklom iz Kanade i Severne Amerike. Istraživački rad odvija se u Institutu za šumarstvo, sprovođenjem analiza kako bi se odabrale najvažnije adaptivne i produktivne provenijencije za pošumljavanja u Srbiji. Transfer semena introdukovanih vrsta drveća uključuju ispitivanje svih karakteristika metodom provenijeničnog testa. Genetska karakteristika stabala vrste, u novim životnim sredinama, treba da potvrdite selekciju stabla za introdukciju. Jedan od metoda procenu genetičke varijabilnosti uvedenih vrsta je testiranje pomoću provenijeničnog eksperimenta.

Efekat intenziteta fizioloških procesa mineralne ishrane vrsta drveća je jedan od najvažnijih pokazatelja njene uspešne adaptacije i proizvodnosti u nove životne sredine staništa.

Ovo istraživanje analizira sadržaj fosfora u četinama duglazije iz različitih provenijencija poreklom iz Kanade.

Ključne reči: duglazija, transfer semena, provenijencija, fosfor, četine

1. INTRODUCTION

Nutrient supply is one of the most important criteria when describing the condition of conifers and needle analyses are an efficient method of evaluating the nutrient situation of conifer stands (K. Stefan, F. Herman 1996).

The obstacles that introduced species must be overcome is survival in the new habitat. That means the typical environmental barriers are such as: seed germination, soil pH and nutrient availability.

The seeds transfer of introduced species of trees include testing of all characteristic by provenance test. Genetic feature of trees species show in the new environmental, to confirm the selection of tree type for introduction. One of the methods of assessing the genetic variability of introduced species is the testing using provenance experiment.

The process of introduction is justified only if the introduced species are better or at least the same potential as the native tree species.

Douglas-fir (*Pseudotsuga menziesii* Mir / Franco) is one of the most ecologically and economically important trees in western North America, and is planted as an exotic timber species in Europe, New Zealand, Australia and Chile. It has one of the widest natural ranges of any tree species, extending from the Pacific Coast to the eastern slope of the Rocky Mountains and from 19°N in Mexico to 55°N in western Canada (Hermann, R.K. 1987, Hermann and Lavender, 1990, Rehfeldt GE. 1979, 1982, 1983, 1989;).

Douglas-fir is Canada's largest conifer and the tree that first made British Columbia famous as a producer of exceptionally fine timber. It is found throughout the southern half of the province extending into south-western Alberta. The species reaches its northern limit near the Queen Charlotte Islands. It grows to its magnificent best on the coast in fairly deep, moist sites where it comprises about 10% of the forest. (Website: www.coastforest.org).

The introduction of exotic species is considered one of the most important supplement to the native ecosystem: contributing to the diversity and improve the productivity of wood mass. It's one of the reasons that in Serbia started researching

Douglas -fir as a very promising species of conifers. (Lavadinović, V., Koprivica, M. 1996 a, 2000, Lavadinović 2000, Lavadinović et al 2011)

The primary proces of phosphorous in the physiological processes in trees is the transfer of energy and regulation of metabolic processes, such as photosynthesis, synthesis of the primary and secondary chemical compounds (hydrocarbons, lipids, proteins, nucleic acids, etc).

This element enters phospholipids, which are the necessary components of membrane components in the cell, nucleic acids (RNA and DNA) and nucleoproteins Sarić, M. (1979):. Phosphorous enters phytic acid, the compound which most frequently occurs in seed. The phosphorous from phytic acid transforms during germination and incorporates into different compounds needed for the metabolism of young plants (Đukić M., Isajev, V.1991). It affects them indirectly, by stimulating the development of soil microorganisms, thereby accelerating the mineralization of the nutrients in the soil. Since this element is important for the numerous constituent and functional roles in the life processes of plants, the variability of quantitative and qualitative phosphorous content in plant organisms is used in plant breeding, as the indicator of the inter-individual and population variability (Mika, P.G *et al.*, 1990).

2. MATERIALS AND METHODS

Douglas- Fir seed was collected from the part of natural range in Canada. Collection of seeds from 14 provenances were imported by Canadian Forest Service. Table 1 presents the characteristics of geographic data provenance of Douglas-fir.

In the Institute of Forestry nursery, from the seed it was produced seedlings from which it where formed two experimental plots.

Table 1. Geographical characteristics of the tested Douglas-fir provenances

Provenance	Seed zone	Location	Latitude	Longitude	Altitude	
No.	Code					
1	03333	East Kootenay	Cranbrook	49° 25'	115° 20'	1050 m
2	00848	West Kootenay	Inonoaklin	49° 50'	118° 10'	671 m
3	30667	Shuswap Adams	Mann Creek	51° 35'	120° 10'	600 m
4	05227	East Kootenay	Gavia Lake tfl 14	50° 56'	116° 35'	1070 m
5	05226	East Kootenay	Nine Bay TFL 14	50° 58'	116° 32'	975 m
6	03356	Thompson Okanagan Arid	Trout Cr	49° 40'	119° 52'	884 m
7	03360	Thompson Okanagan Arid	Michell Cr	49° 54'	119° 37'	1035 m
8	01198	West Kootenay	Salmo	49° 15'	117° 30'	793 m
9	30460	Shuswap Adams	Mara LK	50° 48'	119° 00'	488 m
10	00278	Thompson Okanagan Arid	Monte Crk	50° 37'	119° 52'	701 m
11	03383	West Kootenay	Sheep Creek	49° 10'	117° 15'	1000 m
12	30461	Shuswap Adams	Cooke Creek	50° 38'	118° 49'	900 m
13	03389	West Kootenay	Benton Creek	49° 12'	117° 25'	933 m
14	05092	East Kootenay	Sun Creek	50° 08'	115° 52'	1000 m

Soil at one site, where the experimental provenance plots set, is the eutric cambisol , and the second plot it is vertisol. All plants of Douglas- fir were reared under identical site and identical stand conditions, and age of all the analyzed individuals are 12 years.

Both sites, where they placed the trials were flattened surface, without significant exposure and altitude are about the same.

For the determination of phosphorus in the soil at both sites were sampled taken needles of light from the upper third of the crown of Douglas -fir trees. Phosphorus content in the needles of Douglas -fir where determined by analysis of the ash after dry ashing at a temperature of 550 ° C and the translation of nutrition elements in chlorides. Determination was carried out by colorimetric method

Needles to determine the state of nutrition of Douglas- fir were collected during dormancy from the upper third of the tree canopy. Phosphorus content in the needles of Douglas -fir determined by analyzing the ash after burning dry colorimetric method. Linear regression analysis examined the effect of nutrition with phosphorus on the state of growth elements (mean diameter, mean height, basal area, volume and increment) studied provenances of Douglas fir. The amount of phosphorus available plants in the soil was determined with AL- method by Egner-Rihm (Džamić et al 1966).

3. RESULTS AND DISCUSSION

Based on the conducted studies, it can be concluded that conditions of phosphorous nutrition on eutric cambisol are considerably more favourable than the ones on vertisol. The difference in phosphorous nutrition is significant at $p < 0.01$. Nearly all Douglas-fir provenances cultivated on eutric cambisol had better phosphorous nutrition in comparison to the provenances cultivated on vertisol (Table 2, Graph 1). The exceptions are the Gavia Lake locality provenance, the East Kootenay seed zone, the code 05227, and the Salmo locality provenance, the West Kootenay seed zone, the code 01198. In both provenances cultivated on vertisol, slightly higher amounts of phosphorous were identified in comparison to the same provenances cultivated on eutric cambisol.

Tabela 2. *The content of calcium on different provenances in Douglas - fir needles*

No	Code	Locality	Vertisol		Cambisol Eutric	
			P	Z	P	Z
			%		%	
1	03333	Cranbrook	0.236	-0.299	0.245	-0.572
2	00848	Inonoaklin	0.237	-0.342	0.258	-0.986
3	30667	Mann Creek	0.209	0.546	0.267	-1.283
4	05227	Gavia Lake	0.216	0.344	0.213	0.423
5	05226	Nine Bay	0.222	0.134	0.246	-0.600
6	03356	Trout Creek	0.189	1.183	0.249	-0.715
7	03360	Michell Creek	0.206	0.662	0.272	-1.438
8	01198	Salmo	0.228	-0.050	0.206	0.654
9	30460	Mara Lake	0.215	0.353	0.257	-0.974
10	00278	Monte Creek	0.195	1.005	0.204	0.702
11	03383	Sheep Creek	0.165	1.939	0.221	0.175
12	30461	Cooke Creek	0.228	-0.048	0.257	-0.956
13	03389	Benton Creek	0.182	1.405	0.249	-0.692

14	05092	Sun Creek	0.172	1.732	0.299	-2.301
Average			0.207		0.246	
S			0.02341		0.02694	
min			0.165		0.204	
max			0.237		0.299	
T-value			4.074882			
P-Value			0.000192 The result is significant at $p < 0.01$			
For both populations	Average				0.227	
	S				0.03166	
	min				0.165	
	max				0.299	

Although all seedlings at both sites reared under identical site and stand conditions, the same type of soil and climate under identical conditions was found high variability among provenances of phosphorus content in the needles in both provenances were grown on eutric cambisol, and with provenance grown on vertisols.

All conditions that affect physiological processes in plants, and thus the adoption of nutrients from the soil were identical for all provenances, both at the site where the soil is vertisol, and at the site where the soil is Eutric cambisol. Therefore, the variability of phosphorus content in the needles of different provenances consequences of genetically inherited abilities of different provenances to exploit the potential of soil and achieve phosphorus nutrition.

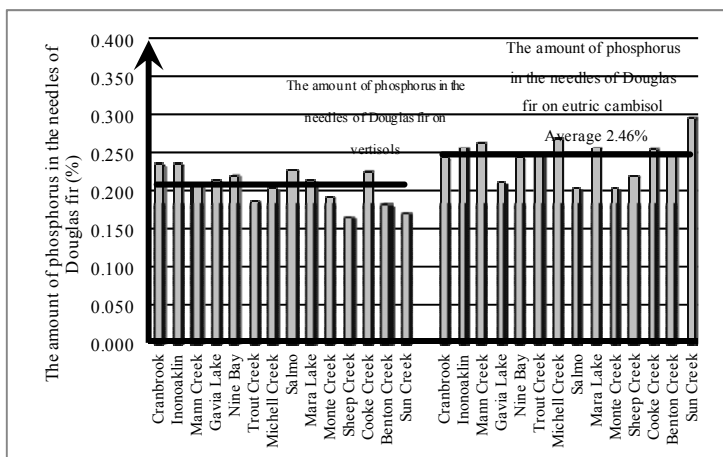


Figure 1. The amount of phosphorus in the needles of Douglas-fir on vertisol and eutric cambisol

The inter-provenance variability of phosphorus content in Douglas-fir needles is presented in Table 2 and Graph 2. The highest percentage representation of phosphorus in needles of Douglas-fir cultivated on vertisol (0.237%) was identified in the Inonoaklin locality provenance, the West Kootenay seed zone, the

code 00848, while the lowest percentage representation (0.165%) was determined in the Sheep Creek locality provenance, the West Kootenay seed zone, the code 03383.

Among the Douglas-fir provenances cultivated on eutric cambisol, the highest content of phosphorus was identified in the Douglas-fir needles of the Sun Creek locality provenance, the East Kootenay seed zone, the code 05092. The lowest representation of phosphorus in needles of Douglas-fir cultivated on eutric cambisol was identified in the Monte Creek locality provenance, the Thompson Okanagan Arid seed zone, the code 00278.

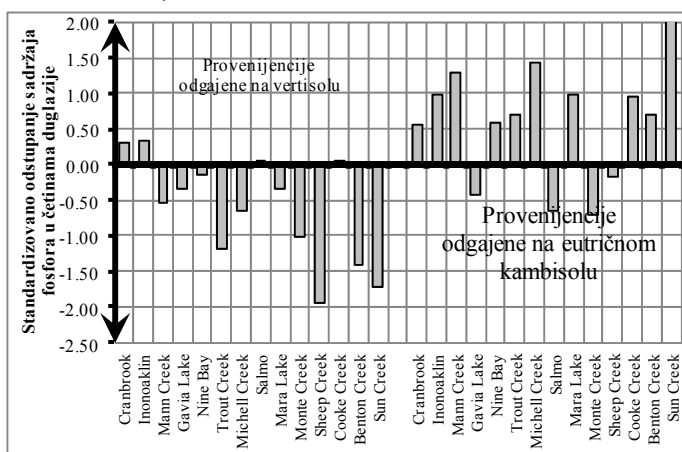


Figure 2. Standardized deviation of phosphorus content in the needles of Douglas-fir provenances

4. CONCLUSION

Based on the results of conducted analyses of phosphorus nutrition conditions in 14 Douglas-fir provenances of Canadian origin, it can be concluded that eutric cambisol provides far more favourable conditions for phosphorus nutrition than vertisol. Nearly all provenances cultivated on eutric cambisol assimilated a higher amount of phosphorus in comparison to the same provenances cultivated on vertisol.

Given the uniformity of conditions for soil nutrient assimilation in both provenance trial localities, it can be concluded that there are genetic specificities relating to calcium assimilation process. The inter-provenance variability of calcium content in Douglas-fir needles is an indicator of genetic pool specificity of different provenances with respect to calcium nutrition.

Based on the conducted study, it can be concluded that phosphorus content differences in Douglas-fir needles point out to a variability in the intensity of physiological processes in genotypes of different provenances. Given the fact that the Douglas-fir trees grew and developed in relatively small areas, with uniform general site and stand conditions, it can be concluded that needle phosphorus amounts are determined by different genotypes that constitute the genetic pool of studied Douglas-fir provenances.

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Summary

Among the provenance variability of phosphorus content in the needles of 14 Douglas-fir, from Canada, is presented in this research. Douglas-fir is an indigenous and economically the most widespread species of conifers in Canada and North America. It is also the most common introduced species conifer in Europe. The seeds transfer of introduced species of trees include testing of all characteristic by provenance test. Genetic feature of trees species show in the new environmental, to confirm the selection of tree type for introduction. One of the methods of assessing the genetic variability of introduced species is the testing using provenance experiment. Based on the results of conducted analyses of phosphorus nutrition conditions in 14 Douglas-fir provenances of Canadian origin, it can be concluded that eutric cambisol provides far more favourable conditions for phosphorus nutrition than vertisol. Nearly all provenances cultivated on eutric cambisol assimilated a higher amount of phosphorus in comparison to the same provenances cultivated on vertisol.

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Rezime

Međuprovenijenična varijabilnost sadržaja fosfora u četinama duglazije predstavljena je u ovom istraživanju. Duglazija je autohtona najrasprostranjenija i ekonomski najvažnija vrsta četinaru u Kanadi i Severnoj Americi. Takođe je najčešća introdukovana vrsta četinaru u Evropi. Transfer semena introdukovanih vrsta drveća uključuju ispitivanje svih karakteristika metodom provenijeničnog testa. Genetska karakteristika stabala vrste, u novim životnim sredinama, treba da potvrdite selekciju stabla za introdukciju. Jedan od metoda procenu genetičke varijabilnosti uvedenih vrsta je testiranje pomoću provenijeničnog eksperimenta. Na osnovu rezultata obavljenih analiza stanja ishrane fosforom 14 provenijencija duglazije poreklom iz Kanade može se konstatovati da eutrični kambisol obezbeđuje daleko povoljnije uslove za ishranu ovim elementom u odnosu na vertisol. Skoro sve provenijencije odgajene na eutričnom kambisolu su usvojile veću količinu fosfora iz zemljišta u odnosu na iste provenijencije odgajene na vertisolu.