

**PHENOLOGICAL VARIABILITY OF CERTAIN SILVER FIR POPULATIONS
(*ABIES ALBA*, MILL.) IN BOSNIA AND HERZEGOVINA**

**Fenološka varijabilnost nekih populacija obične jele (*Abies alba*, MILL.) u Bosni i
Hercegovini**

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Abstract

Within this research phenological observation of leafing process on the trees in nine silver fir provenances was conducted. The trees are located in the area of „Krivaja“ management unit in section 86, department a, site „Delimusa“, spreading at the surface of 32,5 ha.

The aim of this research is to determine the intra population and inter population variability of phenological features of nine fir provenances.

Phenological researches were made in the period from 16 March to 23 May 2015. The following four phases were observed: A – winter bud, B – bud swelling, C – bud eruption and D – open bud.

Results of research show that there is no statistically significant difference in the length of the phases between individual provenances.

Keywords: *silver fir, phenology*

Introduction - Uvod

Silver fir (*Abies alba* Mill.) is one of the most significant types of conifers in Bosnia and Herzegovina from both economic and ecological perspective as it may be found at the area of 562.237 ha (Uščuplić 1992; Ballian and Čabaravdić 2005). According to Fukarek (1970), the main area of silver fir in Bosnia and Herzegovina is along the inner part of Dinarides and it can also be found in multiple separate, big and small units beyond this area.

In the past one hundred years the natural areas of silver fir has significantly reduced. The reasons for this are frequent loggings. During the procedures of logging, attention was not paid to regenerating fir and these areas were afforested with spruce, considering that manipulation of fir seeds has been somewhat difficult in all phases of planting material production. Research of silver fir variability features are conducted with the purpose of improving and preserving the gene pool and dominating this

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economically significant but severely endangered type of coniferous tree. This type has a narrow ecological valence and it is sensitive to contamination caused by anthropogenic effects.

The aim of this research is to determine the intra population and inter population variability of phenological features of nine fir provenances. There have not been any researches of phenological variability of silver fir in Bosnia and Herzegovina so far.

In neighbouring Croatia, Ivanković et al. (2008) conducted a research on leafing variability in silver fir provenances. The research was conducted at experimental provenances in Brloško site and the results showed statistically significant differences between provenances.

MATERIAL AND METHODS - *Materijal i metode*

Within this research, in spring 2015 we conducted phenological observation of leafing process on the trees in nine fir provenances. The trees are located in the area of „Krivaja“ management unit in section 86, department a, site „Delimusa“, spreading at the surface of 32,5 ha.

The section belongs to 1221 management class – forest of beech and fir with spruce at a deep sour and brown terrain at siliceous substrates. According to the typological classification that has been conducted in BiH within forest inventory process in the period from 1964 to 1968 (Matić et al. 1971), pedological and typological maps were made for this area.

According to the pedological classification, the terrain at which experimental surface has been built is a distric cambisol at an undivided volcanogenic sedimentary formulation – feature 2008-II. The experimental surface was lifted at 970 m above sea level and the terrain exposition is northern. Terrain inclination stretches within the interval from 10 to 20 degrees.

Starting material for conducting the experiment originates in nine sites in Bosnia and Herzegovina (Bosanski Petrovac, Bugojno, Fojnica, Konjic, Olovo-Klis, Olovo-Palež, Pale, Prozor and Sokolac), in the sites located between 850 and 1,300 m above sea level. The northernmost provenance is Bosanski Petrovac, while the southernmost is in Herzegovina region (Prozor).

Table 1: Basic features of populations for the establishment of the test

Tabela 1: Osnovne karakteristike populacija za osnivanje testa

No.	Population	Soil type	Geological and petrographic base	Altitude (m)	Exposition	Terrain inclination (%)
1.	Sokolac	Calcic cambisol, calcic melanosols	Limestone	940	S-W	13
2.	Prozor	Calcic melanosols, luvisol	Limestone moraine	1.300	N-E	5-10
3.	Bosanski Petrovac	Rendzina, Calcic cambisol, pseudogley	Dolomite	900	N	2
4.	Fojnica	Distric cambisol	Rhyolite	1.010	-	-
5.	Olovo-Palež	Calcic cambisol, luvisol	Limestone	960	N-E	12
6.	Olovo-Klis	Calcic cambisol, luvisol	Limestone	850	N-W	13
7.	Bugojno	Rendzina, Calcic cambisol	Dolomite and limestone	1.090	N-W	10-25
8.	Konjic	Calcic cambisol, calcic melanosols	Buxy limestone	1.030	E-EN	10-22
9.	Pale	Distric cambisol, calcic melanosols	Werfenian shales, sandstones, limestone	1.200	N-E	20

Phenological variability of certain Silver fir populations (Abies alba, Mill.) in Bosnia and Herzegovina



Figure 1: Map of researched populations
Slika 1: Karta istraživanih populacija

Phenological researches were made in the period from 16 March to 23 May. The following four phases were observed: phase A – winter bud, phase B – bud swelling, phase C – bud eruption and phase D – open bud.

We observed 386 trees in total (B. Petrovac 50, Bugojno 46, Fojnica 53, Konjic 41, Olovo-Klis 25, Olovo-Palež 50, Pale 36, Prozor 43 and Sokolac 42 trees).



Figure 2: Phenophase D

Slika 2: Fenofaza D

RESULTS AND DISCUSSION - *Rezultati i diskusija*

Entering of certain provenances in these phases is fairly uniform, with the exception of provenances Prozor (the southernmost), Bosanski Petrovac (the northernmost) and Pale which enter phase C with slight delay. However, considering that these provenances are located in different parts of Bosnia and Herzegovina and at different altitudes, delayed entering into certain phases may be attributed to their geographical position. Considering that phenological phases depend on whether conditions as well, it is necessary to continue researches of fir provenances at the experimental surface.

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Provenance	16.03.	23.03.	30.03.	16.04.	23.04.	29.04.	06.05.	15.05.	23.05.
1	A	A	A	B	B	C	C	C	D
2	A	A	A	B	B	C	C	C	D
3	A	A	A	B	B	C	C	C	D
4	A	A	A	B	B	C	C	C	D
5	A	A	A	B	B	C	C	C	D
6	A	A	A	B	B	C	C	C	D
7	A	A	A	B	B	C	C	C	D
8	A	A	A	B	B	C	C	C	D
9	A	A	A	B	B	C	C	C	D

Legend:

Phase	A	B	C	D

Figure 3: Phenophases by dates and provenances

Slika 3: Fenofaze po datumima i provenijencijama

The length of different phenophases is also uniform in provenances and no major discrepancies (Table 2).

Table 2: Descriptive indicators of the length of phenophases

Tabela 2: Deskriptivni pokazatelji dužine trajanja fenofaza

Phenoph.	Proven.	N	Mean	Std. Dev.	Minimum	Maximum
A	1	42	19.43	4.984	10	22
	2	43	18.65	5.446	10	22
	3	50	17.68	5.818	10	22
	4	53	19.06	5.212	10	22
	5	50	19.60	4.849	10	22
	6	25	18.64	5.499	10	22
	7	46	20.70	3.776	10	22
	8	41	20.83	3.605	10	22
	9	36	20.67	3.825	10	22
	Total	386	19.45	4.915	10	22
B	1	42	24.57	6.601	18	38
	2	43	27.49	6.706	18	38
	3	50	27.92	8.290	18	38
	4	53	24.42	8.165	18	38
	5	50	24.08	6.114	18	38
	6	25	26.16	8.285	18	38
	7	46	23.48	6.387	18	38
	8	41	24.24	5.063	18	38
	9	36	23.33	5.575	18	38
	Total	386	25.07	7.018	18	38
C	1	42	16.48	4.920	9	23
	2	43	13.65	4.134	9	23
	3	50	14.20	4.499	9	23
	4	53	16.77	6.477	9	23
	5	50	16.36	5.134	9	23
	6	25	15.24	5.142	9	23
	7	46	15.70	3.558	9	23
	8	41	13.93	3.320	9	23
	9	36	16.61	4.753	9	23
	Total	386	15.46	4.876	9	23
D	1	42	7.52	3.480	5	13
	2	43	8.21	3.385	5	13
	3	50	8.20	3.429	5	13
	4	53	7.75	3.216	5	13
	5	50	7.96	3.574	5	13
	6	25	7.96	3.470	5	13
	7	46	8.13	3.810	5	13
	8	41	9.00	3.661	5	13
	9	36	7.39	3.475	5	13
	Total	386	8.02	3.490	5	13

Table 3: Analysis of phase length variance

Tabela 3: Analiza varijanse dužine trajanja faza

Phenophase	Source of variation	Sum of Squares	df	Mean Square	F	Sig.
A	Between Groups	412.497	8	51.562	2.187	0.028
	Within Groups	8887.067	377	23.573		
	Total	9299.565	385			
B	Between Groups	1022.592	8	127.824	2.687	0.007
	Within Groups	17937.657	377	47.580		
	Total	18960.249	385			
C	Between Groups	543.235	8	67.904	2.973	0.003
	Within Groups	8610.682	377	22.840		
	Total	9153.917	385			
D	Between Groups	71.777	8	8.972	0.732	0.663
	Within Groups	4618.057	377	12.249		
	Total	4689.834	385			

Variance analysis (table 3) has shown that there is no statistically significant difference in the length of phases between individual provenances ($F_{izr} < F_{tab}$, Sig. < 0.05)

Ivanković et al. (2008) observed three phases: winter bud, bud swelling and open bud. Phenology observations were conducted once a week from 17 April to 24 May resulting in detection of significant differences in leafing in simple fir provenances. Eastern provenance or provenances in the area between rivers Sava and Drava start leafing earlier than provenances located in Gorski Kotar – western provenances.

CONCLUSIONS - *Zaključci*

Entering of certain provenances of silver fir originating in Bosnia and Herzegovina in phenophases is fairly uniform.

Provinces Prozor, Bosanski Petrovac and Pale enter phase C with a delay.

Variance analysis shows that there is no statistically significant difference in the length of the phases between individual provenances ($F_{izr} < F_{tab}$, Sig. < 0.05)

Phenological phases depend on weather conditions as well so it is necessary to continue with phenological researches of fir at the experimental surface.

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SAŽETAK

U ovom radu istraživana je fenološka varijabilnost obične jele (*Abies alba*, Mill.) na stablima devet provenijencija iz Bosne i Hercegovine na eksperimentalnoj plohi kod Olova. Posmatrano je ukupno 386 stabala (Provenijencija B. Petrovac 50 stabala, Bugojno 46 stabala, Fojnica 53 stabla, Konjic 41 stablo, Olovo-Klis 25 stabala, Olovo-Palež 50 stabala, Pale 36 stabala, Prozor 43 stabla i Sokolac 42 stabla).

Cilj istraživanja je utvrđivanje unutarpopulacijske i međupopulacijske varijabilnosti fenoloških svojstava devet provenijencija jele.

Fenološka osmatranja vršena su u periodu od 16.3. do 23.5. 2015. godine, a posmatrane su četiri faze: A - zimski pup, B - bubrenje pupa, C – probijanje pupa i D - otvoreni pup.

Rezultati istraživanja pokazuju da je ulazak pojedinih provenijencija u fazu dosta je ujednačen, osim što provenijencije Prozor (koja je najjužnija), Bosanski Petrovac (koja je najsjevernija) i Pale kasnije ulaze u fazu C (Slika 3). Analiza varijanse pokazuje da ne postoje statistički značajne razlike u dužini trajanja pojedinih faza između provenijencija.

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