OptForests: Status information of the International European beech provenance trial Kamenski hrib/Straža 1996/1998 (Bu20-12)

N45° 47′ 46″ E15° 02′ 5″, Alt. 545m a.s.l.

Code	Provenance	Country	Altitude (m)
P01	Perche	F	205
P02	Bordure Man.	F	80
P05	08-Bretagne	F	180
P06	11-Plateaux du	F	600
P08	19-Pyreness Or.	F	670
P11	Heinerscheid	LUX	423
P13	Soignes	B	110
P14	Aarnink	NL	45
P15	Elspeet	NL	33
P17	Westfield 2002	GB	10
P21	Grasten, F.413	DK	45
P23	Torup	S	40
P27	Graf von Westf. (NW)	D	375
P31	Urach 12A13 (BW)	D	760
P32	Ebrach (BY)	D	406
P34	Oberwil	CH	530
P35	Hinterstoder	A	1250
P36	Eisenerz	A	1100
P37	Val di Sella	I	1150
P38	Bilowo 124a, 123 c	PL	250
P39	Jaworze	PL	450
P40	Tarnawa	PL	540
P43	Jawornik, 92b	PL	900
P46	Domazlice-Vyhl.	CZ	760
P48	Jablonec N.N.	CZ	760
P49	Brumov-Sidonie	CZ	390
P51	Horni Plana-Ce.	CZ	990
P53	Postojna Mašun	SI	1000
P54	Idrija-II/2, 14	SI	930
P55	Postojna Javorniki	SI	1040
P61	Tworylczuk, 180 F	PL	320
P63	06-Nord-Est Ma.	F	580
P64	Nizbor	CZ	480
P65	Koino, 105F	PL	400
P67	Bilowo 115, 116	PL	250
P69	Sucha	PL	400
P77	Val Fondillo	I	1145
P84	Topolcianky	SK	/

The European beech (*Fagus sylvatica* L.) provenance trial Kamenski hrib/Straža in Slovenia is a part of the second series of the international beech provenance trials launched by Institute of Forest Genetics and Forest Tree breeding at Grosshansdorf, Germany in 28 sites in 15 European countries with 61 provenances (1996/98). Seeds were harvested mainly in the year 1995. In spring of 1996 seeds were sown in the institute nurseries. Seedlings were labelled and lifted in autumn 1997 at an age of 1+1 and 2+0 and held during a winter in cold storage house in Hamburg. Plants were transported from Hamburg to collaborative institutions in European countries in the spring 1998 for trials establishment.

The aim of network of beech provenance trials established in years 1993/95, 1996/98 and 2005/07 using seed sources representing most of the species distribution range in Europe is to determine the site stability of economically important growth related phenological and morphological traits (survival, phenology), form (stem and branching habit), and yield (height and diameter), the variation in the time, adaptability and macro adaptation potential of populations to important site characteristics on a wide scale (von Wühlisch 2007) as well as (cit. Giannini, von Wühlisch, 2009: 104) "to make predictions of the future distribution range of beech forest ecosystems under the assumption of certain scenarios of climate change, based on the analysis of the reaction pattern of European beech populations of defined origin (progenies of natural beech stands) under changed climate situations in sets of pan European field trials".

The test site Kamenski hrib/Straža (N45° 47′ 46″ E15° 02′ 5″, Alt. 545 m a.s.l.) **is situated on the hilltop plateau in a mixed forest stand with 60% share in growing stock of *Fagus sylvatica*, 30% of *Abies alba* and 10% of *Picea abies***. A stand was clear-cut prior planting and the area was cleared. Tree stumps were left, and fence was erected. Ground rock material is limestone. Forest soils are eutric cambisols and haplic luvisols with good nutrient availability and average water capacity. The soils are usually deep, loamy to clayey, with a small skeleton, with shallow and humus accumulation horizon A, biologically active, fresh, good fertility and favourable for beech. Main climatic variables were determined as 6.3°C mean annual temperature and 1275 mm mean annual precipitation and based on 1971-2009 averages interpolated from the official weather stations in Novo mesto and Ambrus, both situated 20 km from the site. Late or early frosts can occur in the site from October till April. During winter, snow cover persists from 50 to 60 days (Figure 2).

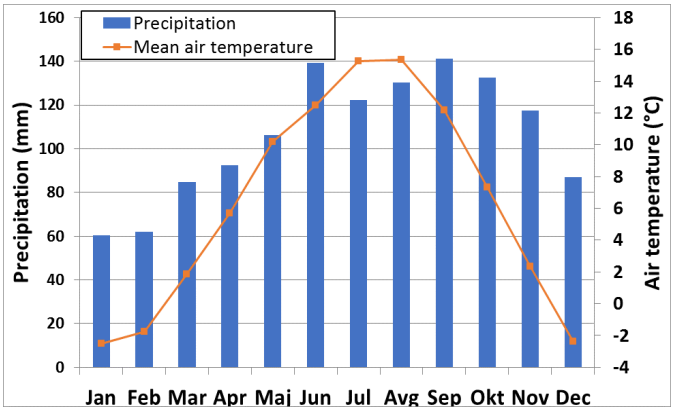

Fig.1: Location of the beech trial Kamenski hrib/Straža. Fig.2: Climate graph of the beech trial site.

The experiment in Slovenia was established in 1998 by the Slovenian Forestry Institute (SFI) in close cooperation with the Slovenian Forestry Service, Regional unit Novo mesto and the Forest Enterprise Novo mesto coordinated by Dr. Gregor Božič and Prof. Dr. Hojka Kraigher. Detailed plans of the international trial layout were made in collaboration with Dr. Hans Muhs, Dr. Georg von Wühlisch and Dr. Mirko Liesebach (Institute of Forest Genetics and Forest Tree breeding at Grosshansdorf, Germany). **A 1.3 ha trial is designed in three blocks divided into 31 plots of 10m × 10m. In each plot 50 plants of the same provenance were planted in 5 lines following a 1m × 2m spacing (5 rows by 10 seedlings).** Each provenance originally represented 150 individuals,4650 test seedlings in all were used. One border row with two years old beech seedlings with unknown provenances was planted around the trial. The trial was fenced to prevent game damage. **The experiment is planned for an observation period of 60 years.**

The planting was done between March 30th and April 3rd 1998 with two-year old seedlings planted in holes which were dug with a small machine cca. 30 cm deep (left). Each seedling was marked with a band and a pale (right). Photos: G. Božič

Data of the Kamenski hrib/Straža site one year after planting showed at age 3 the overall survival was 82 %. The best survival rates had provenances P37 (98%), P8, P51 and P54 (97%), P36 (95%). The poorest were P57 (27%) later determined as *Fagus orientalis* Lipsky and P11 (45%). Slovenian provenances Postojna Mašun (P53), Idrija-II/2, 14 (P54), Postojna Javorniki (P55) varied from 89-97%, Austrian 85-95%, Czech 83-97%, German 75-93%, Poland 65-95%, France 62-97%, The survival rate of provenances presented from Great Britain, Belgium, Netherlands, Sweden, and Switzerland varied from 73-93%.

In first years after establishment all dead trees were removed and replaces with additional planting obtained from the rest seedlings stock from the Hamburg nursery. Many of dead plants were replaced in spring 1999 with the three-year old seedlings except for the Bulgarian provenance Gramaticevo (P57) which was completely removed and replaced with new 150 seedlings of a Czech provenance (P65). The second time the provenance trial was additionally replanted after the massive attack of rodent animals (vole, mice) which occurred during the winter 1999/2000. The mortality rate was 40%. In autumn 2000 the trial was prepared for the reconstruction in the way agreed with the Institute of Forest Genetics and Forest Tree breeding, Germany. The plots were replanted in spring 2001 with five-year old seedlings. About 200 trees were obtained from the trial plots *in-situ* and 300 from the rest stock of the testing provenances in Hamburg nursery. Empty

plots were replanted with 7 new provenances (P05, P15, P38, P61, P63, P77, P84) transported from Hamburg nursery with 100 seedlings per provenance. In total 1192 seedlings were planted in spring 2001. Therefore, the design of provenance trial changed from originally planted 31 provenances to 38 provenances presented in 1 to 3 repetitions.

Consequences of the early snowstorm which happened at 26th of October 2012. Mainly late flushed provenances were seriously damaged while others survived without damage. Photo: G. Božič, October 2013.

The provenance trial is regularly managed and investigated by assessment and measurement of the phenological, and morphological traits, form, and yield obtained from all trees. Height measurements and survival assessment were done at almost yearly basis until 2009 and later in a few years intervals.

The genetic resources of beech in pan European scale were jointly analyzed in the frame of the COST Action E52 "Evaluation of Beech Genetic Resources for Sustainable Forestry" (2006-2010) which brings together all institutions holding field trials of the three series of the international European beech provenance trials established 1995, 1998, 2007, and all data harmonized (Robson *et al.* 2018). Main results from the Slovenian trial were published by Ivanković *et al.* 2008, Mátyás, Božič *et al.* 2009a, 2009b, Sinjur, Božič 2010, Wühlisch, G. von *et al.* 2010, Robson, Božič *et al.*

2011, Alìa, Božič *et al.* 2011 and Božič, Kraigher 2019. Current state of European beech gene pool and its conservation in Slovenia were published by Božič *et al.* 2011 and Westergren *et al.* 2010. Additionally types of ectomycorrhizae on seedlings and root growth dynamics of selected beech provenances in were studied by Westergren *et al*. 2004 and Železnik *et.al*. 2015, Železnik *et.al*. 2019.

In recent years, several different papers were published or submitted to different research journals describing the connection between radial growth, wood anatomy, root growth and genetics, i.e., provenances. The research done is a result of a fruitful cooperation between different departments and research institutions, two such papers are described briefly in the next paragraphs.

A comparison of radial increment and wood density from beech provenance trials in Slovenia and Hungary, 2022 (see References below): The study compares radial increment and wood density of beech provenances in the juvenile development stage from contrasting environments in Europe (Belgium, Slovenia, Czech Republic, Italy) planted at a mesic to wet site in Slovenia and a xeric site in Hungary. Existing data (past measurements of diameters and height) were combined with new measurements of tree height, diameter, dendrochronological and resistance drilling density measurements to assess differences in provenance radial growth. In order to study the differences in radial increment in more detail, two weather-wise contrasting years (2014 and 2017) were selected from the last decade, based on calculations of the 12-month Standardized Precipitation-Evapotranspiration Index. For most provenances, variation in tree-ring widths within the same provenance increased in unfavorable conditions. The difference between the provenances with the highest and lowest wood densities at both locations did not exceed 5%. The model results indicate that the Idrija (Slovenia) provenance probably has a higher median wood density than other studied provenances at both sites. Although the current study confirmed some differences in wood density between provenances and trial locations, the differences are negligible in practice due to their low magnitude and the fact that the analyzed trees were still juvenile. Beech provenances for planting in relation to changing weather should probably be chosen for their ability to survive more extreme weather events rather than to improve radial increment or wood density, especially as the differences in wood density of juvenile trees are relatively small.

Root growth dynamics of three beech (*Fagus sylvatica* L.) provenances, 2019 (see References below): Beech phenological and growth traits have been studied in large-scale international beech provenance trials, yet the growth and turnover of its fine roots (FR) has not been included among the observations. FR growth dynamics and FR architectural traits of three beech provenances in the international beech provenance trial Straza/Kamenski hrib, established in Slovenia in 1998, and from a natural beech regeneration site growing at its border, were studied from 2007 to 2010. We studied FR biomass using soil cores (SC), root production using ingrowth soil cores (IC), and root longevity using minirhizotrons (MR). Significant differences in FR biomass (live and dead) between the provenance P37 and other provenances were discovered in SC, FR biomass of P37 being significantly higher than FR biomass of latter, which could be connected with overall excellent growth performance of P37 due to favourable environmental conditions at trial. Values of specific root length (SRL) in IC varied significantly among P37 and P54. The turnover rates in IC were at the end of the experiment close to MR results. Median MR-based longevities of FR varied between 625 and 934 days. Survival curve of the slowest growing provenance (considering its aboveground characteristics) was significantly different from the other two, median longevities of the latter being higher. Death of FR, older than two years, occurred most likely in the winter. Our results suggest that there are significant differences in FR longevity among provenances, which might contribute to their adaptation to future environmental conditions. Furthermore, the calculated

annual C investment into FR growth per ha differs up to twofold between provenances, contributing to different C dynamics of their future stands.

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