

*Genetika a šlechtění lesních dřevin*

# Forest Tree Seed Orchards in Serbia

Professor Dr. Vasilije Isajev,

Faculty of Forestry, Belgrade University, Serbia



evropský  
sociální  
fond v ČR



EVROPSKÁ UNIE



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INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

**MENDELOVA UNIVERZITA V BRNĚ  
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**Professor Vasilije Isajev – BELGRADE UNIVERSITY,  
SERBIA**



**THE PROGRAM OF ESTABLISHMENT AND UTILIZATION  
OF SERBIAN SPRUCE, AUSTRIAN PINE, SCOTS PINE,  
PENDUCULATE OAK AND BALCAN MAPLE, SEED  
ORCHARDS INCLUDE:**

- (A) CHANGES OF POPULATION STRUCTURE COMPARED  
TO CLONAL ORCHARDS, AND**
- (B) SPECIFICITY AND MOSAICNESS OF SITE CONDITIONS  
IN SPACE AND TIME.**

**THE NUMBER OF SUBPOPULATIONS, REPETITIONS,  
AND THE NUMBER OF GENOTYPES CREATE THE  
CONDITIONS FOR THE FUNCTION OF THE  
RECOMBINATION SYSTEM.**

# SEED ORCHARD OF FOREST TREES IN SERBIA

## Clonal seed orchards:

species: *Quercus robur* L.  
YEAR OF ESTABLISHING: 1988  
total area: 7 ha  
number of genotypes: 86  
number of ramets: 2520

species: *Picea abies* /L./ Karst  
YEAR OF ESTABLISHING: 1986  
total area: 1,5 ha  
number of genotypes: 30  
number of ramets: 2300

## Generative seed orchard:

species: *Picea omorica* /Panč/ Purkyne  
YEAR OF ESTABLISHING: 1987  
total area: 3 ha  
number of half-sib lines: 50

species: *Pinus nigra* Arnold  
YEAR OF ESTABLISHING: 1991  
total area: 3 ha  
number of half-sib lines: 40

species: *Acer heldreihii* Orph. ex Boiss  
YEAR OF ESTABLISHING: 1992  
total area: 2,5 ha  
number of half-sib lines: 30

species: *Pinus silvestris* L  
YEAR OF ESTABLISHING: 2011  
total area: 09 ha  
number of half-sib lines: 40

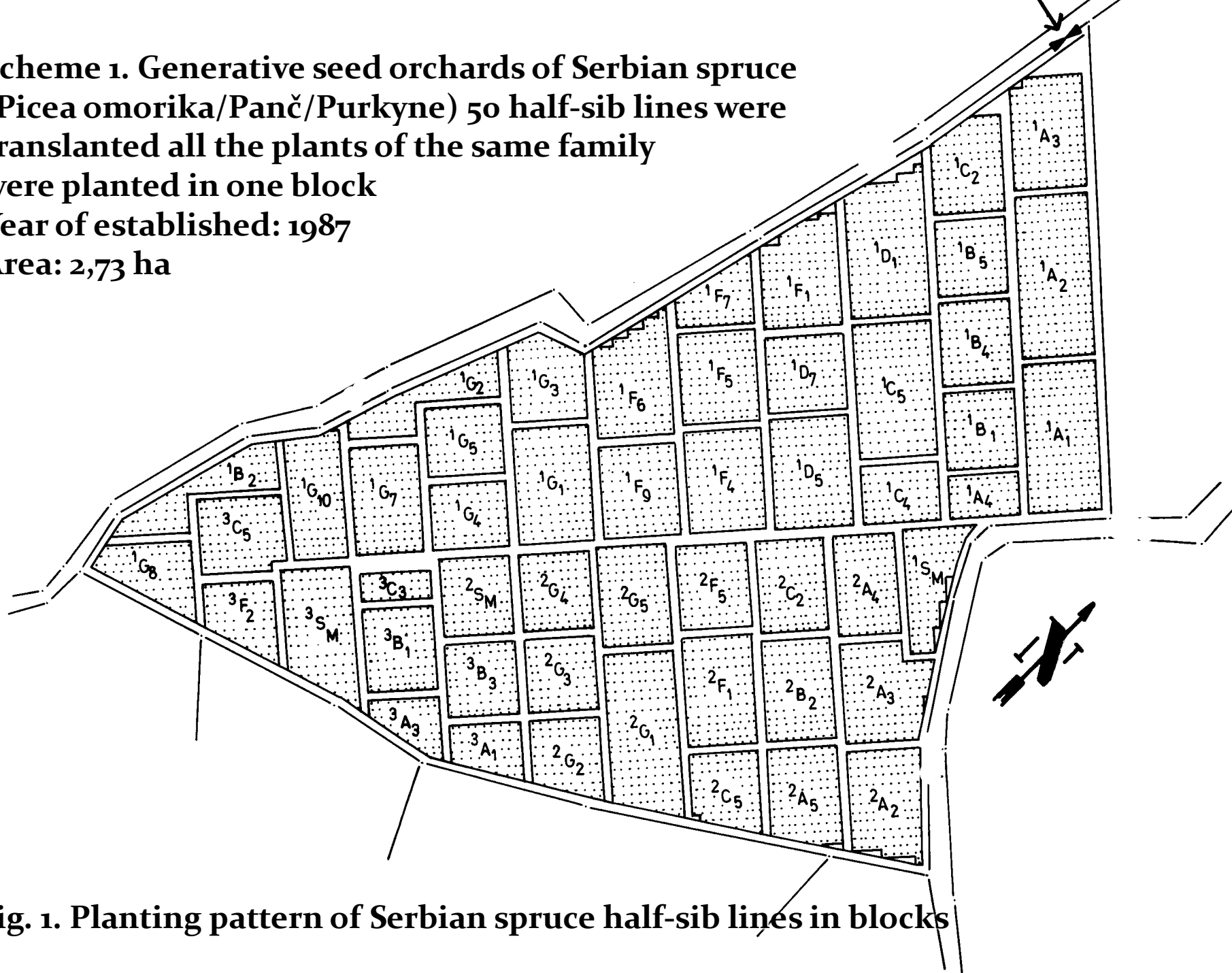
# **SERBIAN SPRUCE SEED ORCHARD**

# **METHOD**

**SERBIAN SPRUCE SEED ORCHARD WAS ESTABLISHED ON THE AREA OF 2.73 HA WITH 5959 PLANTS IN 50 HALF-SIB LINES, BASED ON THE PLANTING PATTERN WHERE PLANTS OF THE SAME FAMILY ARE PLANTED IN ONE BLOCK, DIAGRAM 1, FIG. 1. THE SITE IS *QUERCETUM FRAINETTO-CERRIS* S.L., ALTITUDE 360 M.**

**THREE BASIC TYPES OF REPRODUCTION ARE PROVIDED: INBREEDING, OUTBREEDING AND UNIPARENTAL.**

**Scheme 1. Generative seed orchards of Serbian spruce (*Picea omorika*/Panč/Purkyne) 50 half-sib lines were transplanted all the plants of the same family were planted in one block**  
**Year of established: 1987**  
**Area: 2,73 ha**



**Fig. 1. Planting pattern of Serbian spruce half-sib lines in blocks**



**PLANTING PATTERN OF SERBIAN SPRUCE HALF-SIB LINES IN  
SEED ORCHARD "GODOVIK"**





**GENERATIVE SEED ORCHARD OF SERBIAN SPRUCE AT LOCALITY POČIVALNIK,  
REPUBLICA SLOVENIA, *ISAJEV*, 1989. GOD.  
PLANT PATTERN ALIKE AS IN SERBIA**



## **A DEGREE OF GENETIC CONTROL OF PHENOTYPE EXPRESSION IN DIFFERENT SERBIAN SPRUCE PHENOGROUPS WAS TESTED BY THE USE OF MOLECULAR MARKERS**

**THE TOTAL GENOME *DNA* WAS ISOLATED FROM 10–20 gr OF OVEN DRY PLANT TISSUE. *DNA* ISOLATION WAS BASED ON THE MODIFIED PROTOCOL FOR *RAPID* ISOLATION OF SMALL *DNA* QUANTITIES FROM THE FRESH LEAF TISSUE (DOYLE & DOYLE 1987).**

**BASED ON THE RESULTS OF THE ANALYSIS OF ALLELE POLYMORPHISM OF THE MITOCHONDRIAL GENOME, IT CAN BE CONCLUDED THAT THERE IS A DEGREE OF GENETIC CONTROL OF PHENOTYPE EXPRESSION IN DIFFERENT SERBIAN SPRUCE PHENOGROUPS. THIS FORM OF INTRASPECIFIC VARIATION COULD BE EXPLAINED BY THE ADAPTIVE-ECOLOGICAL PHENOMENA, WHOSE GENETIC DETERMINATION HAS NOT BEEN COMPLETELY EXPLAINED YET. CONSEQUENTLY, THE HYPOTHESIS ON THE GENETIC DETERMINATION OF THE SPECIFIC PHENOGROUP TRAITS IS FULLY JUSTIFIED, (MILOVANOVIĆ & ISAJEV, 2007 ).**

# DISCUSSION

**BY THE CATEGORY AND GENETIC CONSTITUTION, THE SEEDS AND SEEDLINGS OBTAINED FROM SERBIAN SPRUCE SEED ORCHARD ORIGINATE FROM:**

**A. FREE POLLINATION OF HALF SIBS LINES:**

- (I) 50 TYPES HALF-SIB LINES, INTRA-LINE TREES,
- (II) 200 TYPES INTER-LINE HYBRIDS OF BORDERING FAMILY ORDERS.

**B. CONTROLLED POLLINATION:**

**C) 50 SELF-FERTILIZING LINES, -**

**D) 223 INTRASPECIFIC HYBRIDS, AND**

**E) INTERSPECIFIC HYBRIDS - WITH SPRUCE (*PICEA ABIES* KARST.), HONDO SPRUCE (*PICEA AJANENSIS* FISCH) AND OTHER COMPATIBLE SPECIES.**

# **AUSTRIAN PINE SEED ORCHARD**

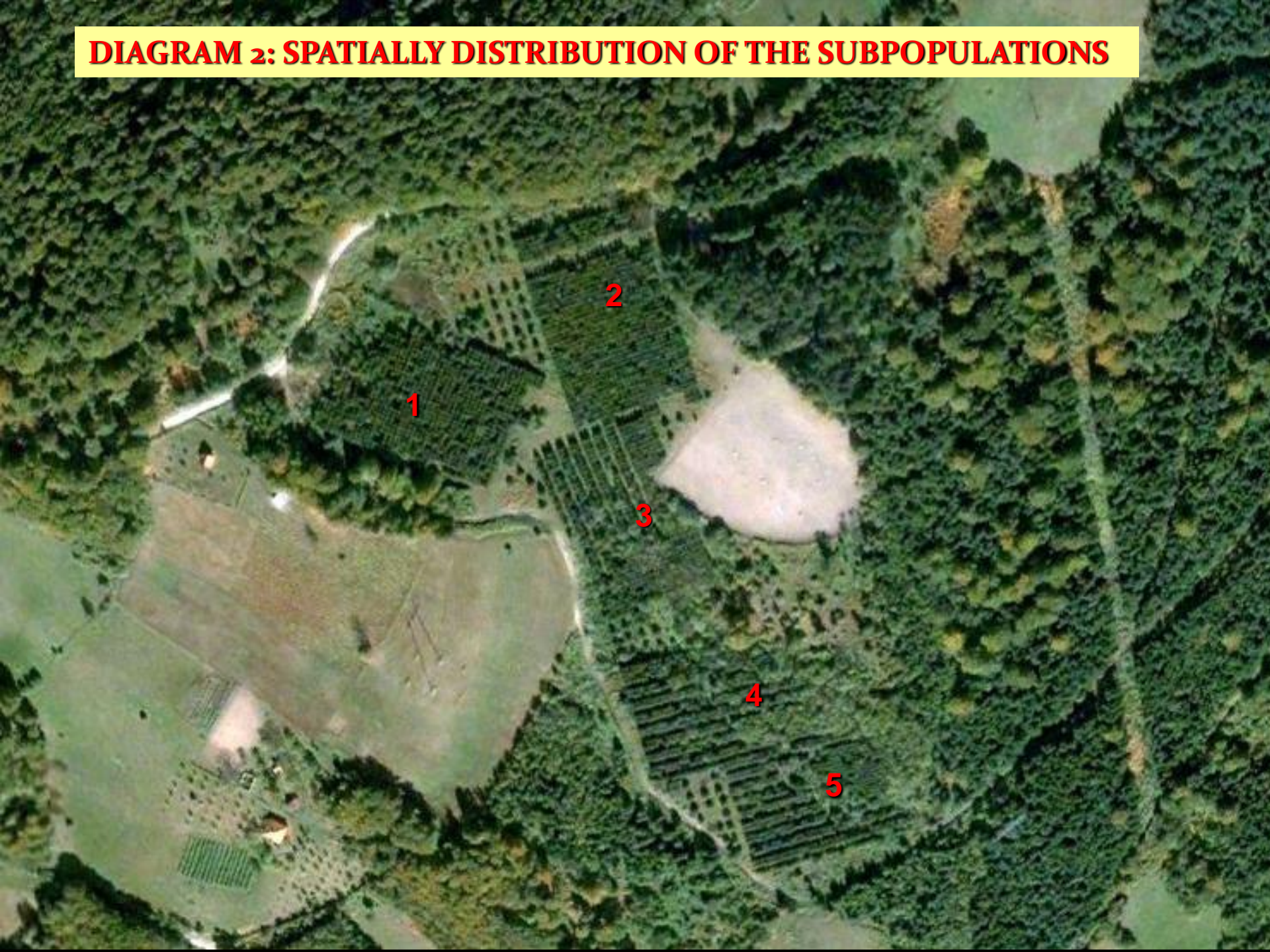
**AUSTRIAN PINE SEED ORCHARD WAS ESTABLISHED AT THE ALTITUDE OF 810 m a.s.l., ON THE SITE *FAGETUM MONTANUM* RUD., s.l.**

**SEED ORCHARD HAS A METAPOPOPULATION STRUCTURE, I.E. IT CONSISTS OF SIX MORE OR LESS RELATED SUBPLANTATIONS (DIAGRAM 2).**

**IN THE SUBPLANTATIONS, EACH HALF-SIB LINE IS REPRESENTED IN GROUPS OF 9 SEEDLINGS WITH THREE REPETITIONS AND PLANTING DENSITY 2 X 2 M (3 X 9 = 27).**

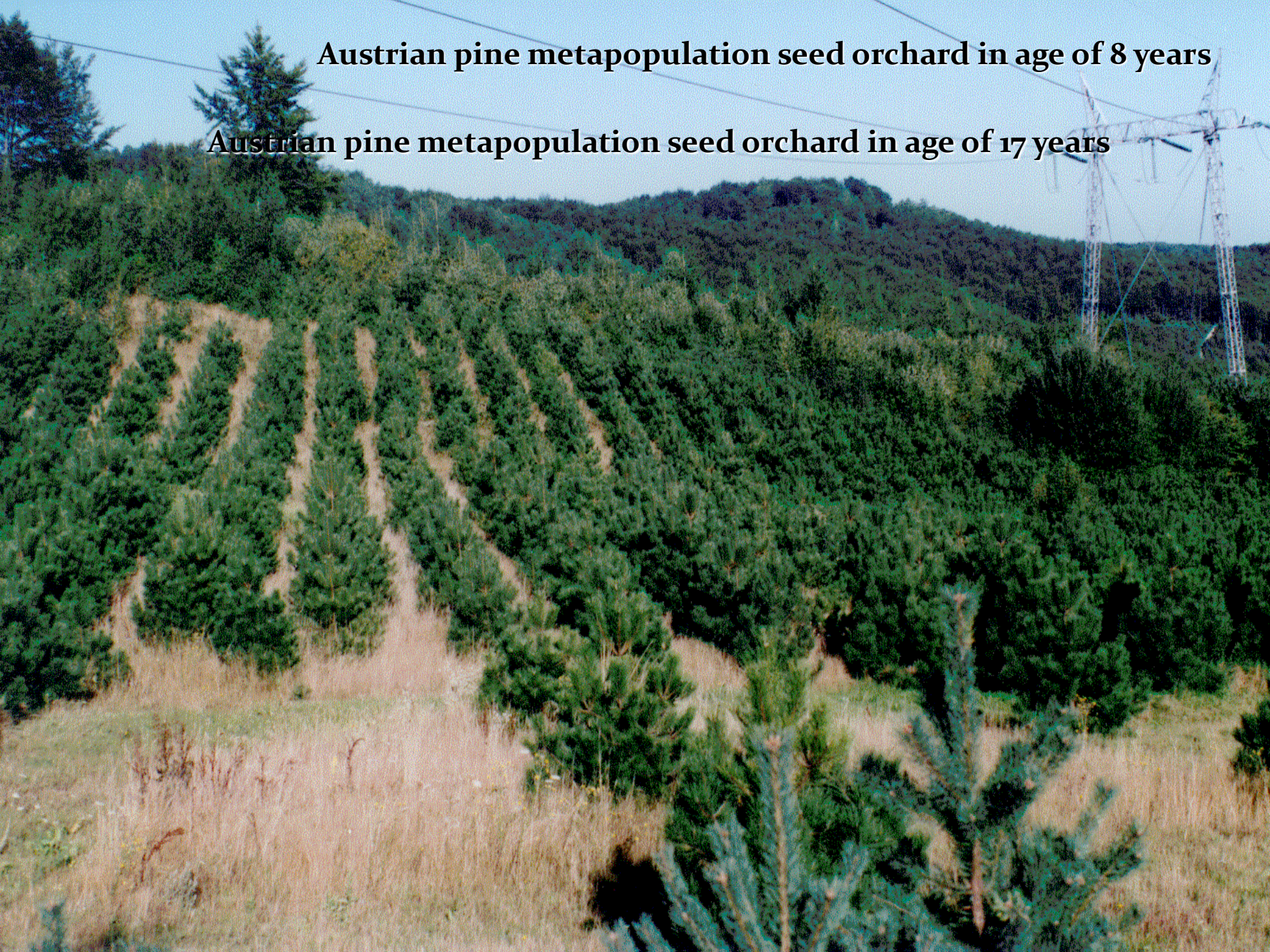
**THE FIRST REPETITION IS SYSTEMATIC, THE SECOND ONE IS RECIPROCAL TO THE FIRST ONE AND THE THIRD REPETITION IS NON-SYSTEMATIC – ALTOGETHER 5 SUCH BLOCKS, I.E. SUBPLANTATIONS (DIAGRAM 3). THE FIVE SUBPLANTATIONS**

**DIAGRAM 2: SPATIALLY DISTRIBUTION OF THE SUBPOPULATIONS**



**Austrian pine metapopulation seed orchard in age of 8 years**

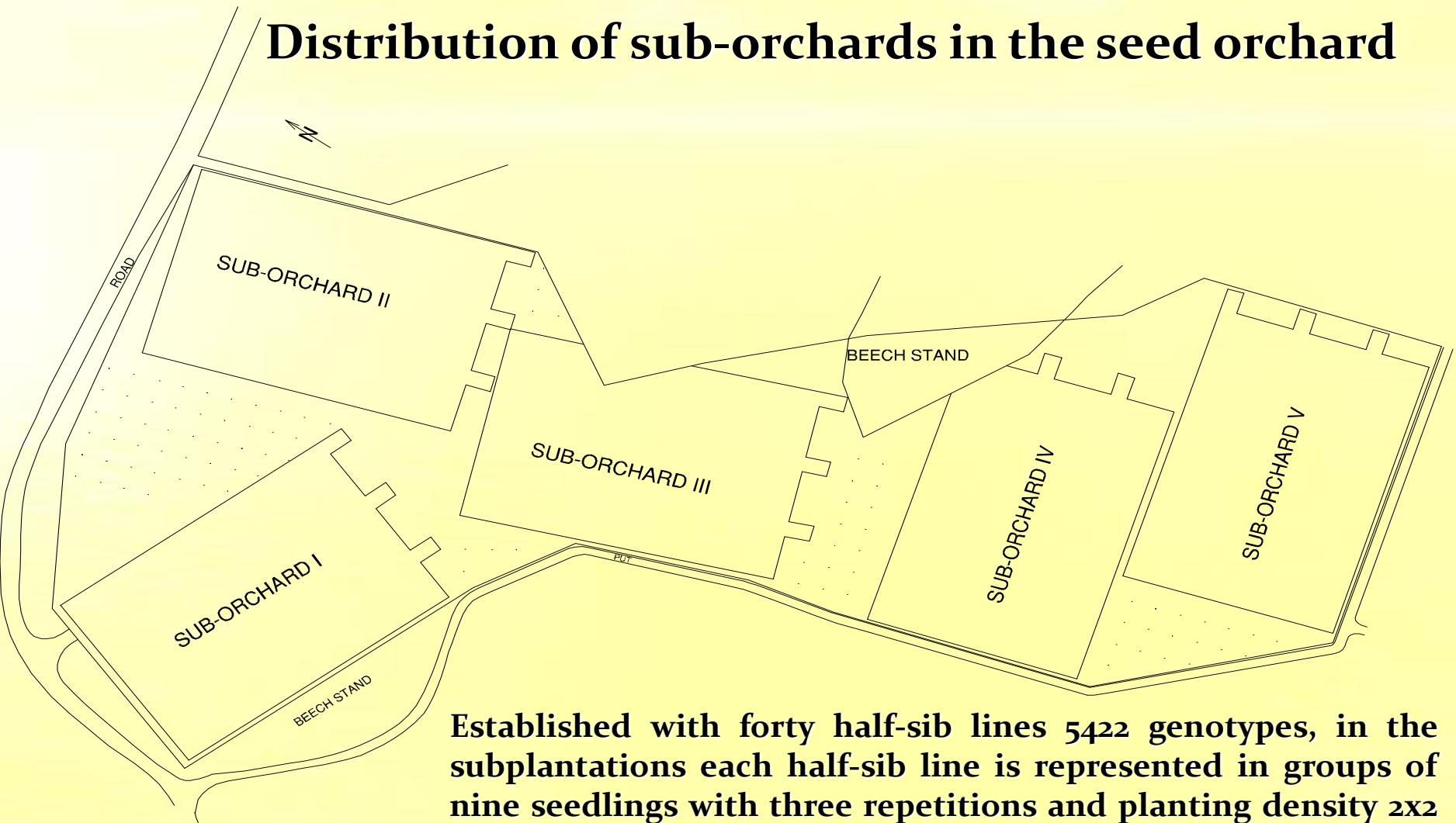
**Austrian pine metapopulation seed orchard in age of 17 years**



# Generative seed orchard of Austrian pine (*Pinus nigra* ssp. *gočensis* var. *illyrica*) metapopulation structure

R 1:1500

## Distribution of sub-orchards in the seed orchard

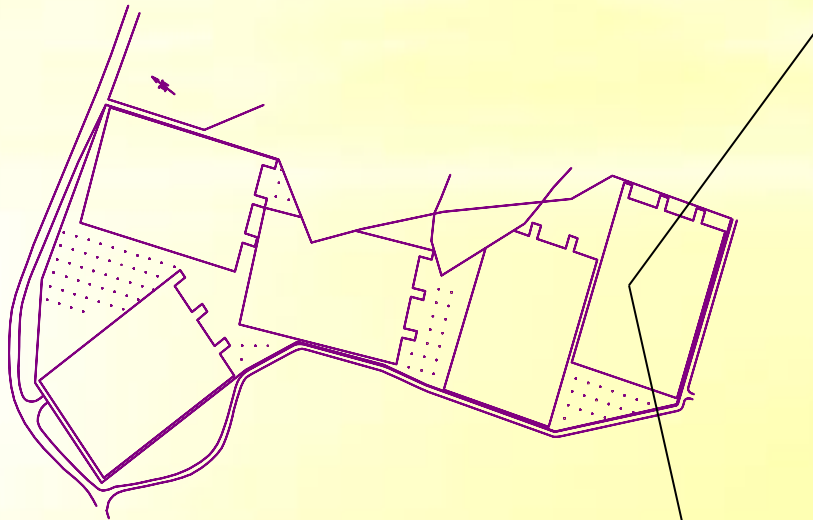


Established with forty half-sib lines 5422 genotypes, in the subplantations each half-sib line is represented in groups of nine seedlings with three repetitions and planting density 2x2 m

Year of established: 1991, Area: 2,70 ha



# Plant pattern in the subpopulation with 40 half-sib lines:



	← I →										← II →										← III →									
1	1	1	14	14	14	27	27	27	13	13	13	26	26	26	40	40	40	17	17	17	11	11	11	39	39	39				
1	1	1	14	14	14	27	27	27	13	13	13	26	26	26	40	40	40	17	17	17	11	11	11	39	39	39				
1	1	1	14	14	14	27	27	27	13	13	13	26	26	26	40	40	40	17	17	17	11	11	11	39	39	39				
2	2	2	15	15	15	28	28	28	12	12	12	25	25	25	39	39	39	10	10	10	33	33	33	36	36	36				
2	2	2	15	15	15	28	28	28	12	12	12	25	25	25	39	39	39	10	10	10	33	33	33	36	36	36				
2	2	2	15	15	15	28	28	28	12	12	12	25	25	25	39	39	39	10	10	10	33	33	33	36	36	36				
3	3	3	16	16	16	29	29	29	11	11	11	24	24	24	38	38	38	1	1	1	37	37	37	35	35	35				
3	3	3	16	16	16	29	29	29	11	11	11	24	24	24	38	38	38	1	1	1	37	37	37	35	35	35				
3	3	3	16	16	16	29	29	29	11	11	11	24	24	24	38	38	38	1	1	1	37	37	37	35	35	35				
4	4	4	17	17	17	30	30	30	10	10	10	23	23	23	37	37	37	9	9	9	40	40	40	34	34	34				
4	4	4	17	17	17	30	30	30	10	10	10	23	23	23	37	37	37	9	9	9	40	40	40	34	34	34				
4	4	4	17	17	17	30	30	30	10	10	10	23	23	23	37	37	37	9	9	9	40	40	40	34	34	34				
5	5	5	18	18	18	31	31	31	9	9	9	22	22	22	36	36	36	7	7	7	20	20	20	32	32	32				
5	5	5	18	18	18	31	31	31	9	9	9	22	22	22	36	36	36	7	7	7	20	20	20	32	32	32				
5	5	5	18	18	18	31	31	31	9	9	9	22	22	22	36	36	36	7	7	7	20	20	20	32	32	32				
6	6	6	19	19	19	32	32	32	8	8	8	21	21	21	35	35	35	5	5	5	25	25	25	29	29	29				
6	6	6	19	19	19	32	32	32	8	8	8	21	21	21	35	35	35	5	5	5	25	25	25	29	29	29				
6	6	6	19	19	19	32	32	32	8	8	8	21	21	21	35	35	35	5	5	5	25	25	25	29	29	29				
7	7	7	20	20	20	33	33	33	7	7	7	20	20	20	34	34	34	19	19	19	13	13	13	28	28	28				
7	7	7	20	20	20	33	33	33	7	7	7	20	20	20	34	34	34	19	19	19	13	13	13	28	28	28				
7	7	7	20	20	20	33	33	33	7	7	7	20	20	20	34	34	34	19	19	19	13	13	13	28	28	28				
8	8	8	21	21	21	34	34	34	6	6	6	19	19	19	33	33	33	14	14	14	30	30	30	26	26	26				
8	8	8	21	21	21	34	34	34	6	6	6	19	19	19	33	33	33	14	14	14	30	30	30	26	26	26				
8	8	8	21	21	21	34	34	34	6	6	6	19	19	19	33	33	33	14	14	14	30	30	30	26	26	26				
9	9	9	22	22	22	35	35	35	5	5	5	18	18	18	32	32	32	27	27	27	31	31	31	24	24	24				
9	9	9	22	22	22	35	35	35	5	5	5	18	18	18	32	32	32	27	27	27	31	31	31	24	24	24				
9	9	9	22	22	22	35	35	35	5	5	5	18	18	18	32	32	32	27	27	27	31	31	31	24	24	24				
10	10	10	23	23	23	36	36	36	4	4	4	17	17	17	31	31	31	4	4	4	38	38	38	18	18	18				
10	10	10	23	23	23	36	36	36	4	4	4	17	17	17	31	31	31	4	4	4	38	38	38	18	18	18				
10	10	10	23	23	23	36	36	36	4	4	4	17	17	17	31	31	31	4	4	4	38	38	38	18	18	18				
11	11	11	24	24	24	37	37	37	3	3	3	16	16	16	30	30	30	3	3	3	22	22	22	21	21	21				
11	11	11	24	24	24	37	37	37	3	3	3	16	16	16	30	30	30	3	3	3	22	22	22	21	21	21				
11	11	11	24	24	24	37	37	37	3	3	3	16	16	16	30	30	30	3	3	3	22	22	22	21	21	21				
12	12	12	25	25	25	38	38	38	2	2	2	15	15	15	29	29	29	6	6	6	15	15	15	23	23	23				
12	12	12	25	25	25	38	38	38	2	2	2	15	15	15	29	29	29	6	6	6	15	15	15	23	23	23				
12	12	12	25	25	25	38	38	38	2	2	2	15	15	15	29	29	29	6	6	6	15	15	15	23	23	23				
13	13	13	26	26	26	39	39	39	1	1	1	14	14	14	28	28	28	8	8	8	12	12	12	16	16	16				
13	13	13	26	26	26	39	39	39	1	1	1	14	14	14	28	28	28	8	8	8	12	12	12	16	16	16				
13	13	13	26	26	26	39	39	39	1	1	1	14	14	14	28	28	28	8	8	8	12	12	12	16	16	16				
40	40	40																27	27	27				2	2	2				
40	40	40																27	27	27				2	2	2				
40	40	40																27	27	27				2	2	2				

**The first repetition**

– I systematic pattern;

**The second one**

– II reciprocal;

**The third one**

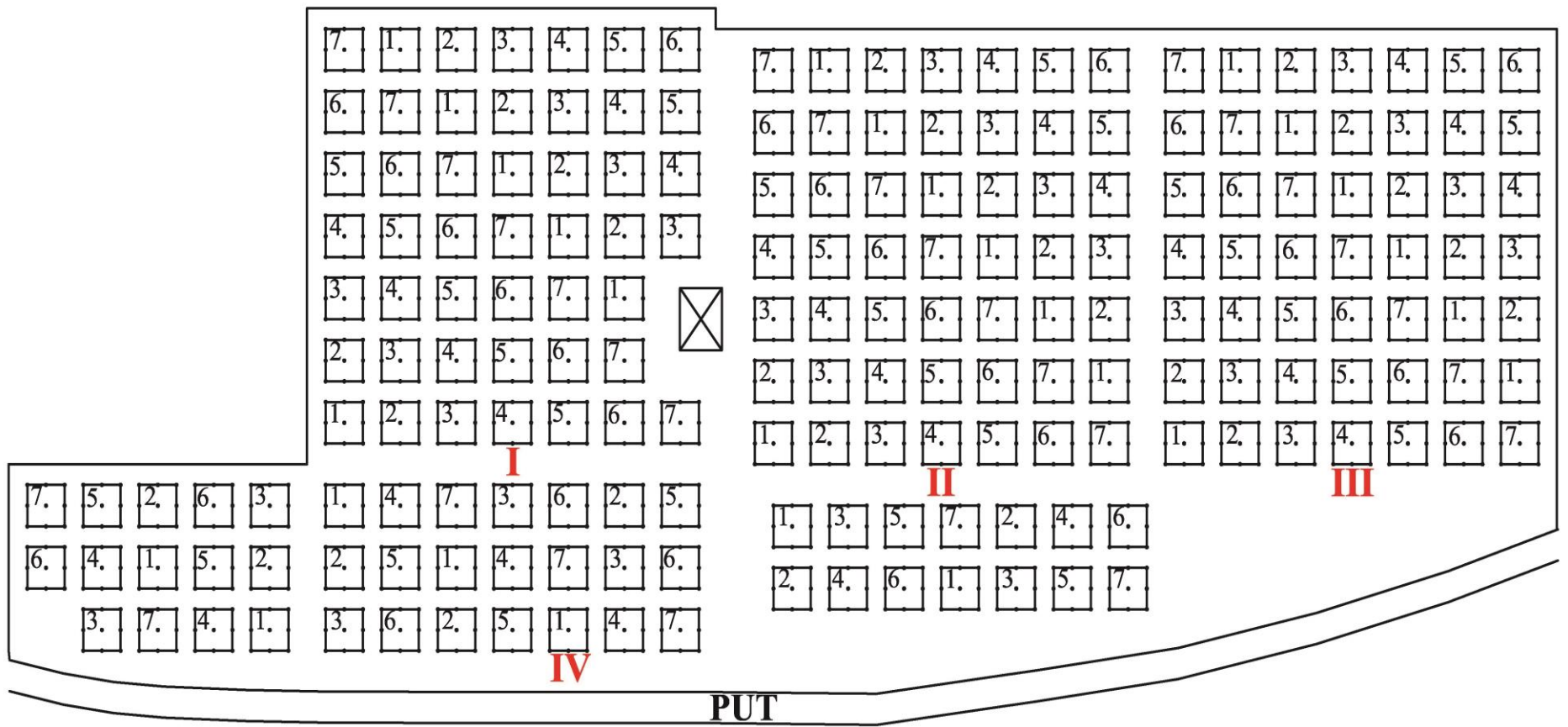
– III random.

# **SCOTS PINE SEED ORCHARD**

**SCOTS PINE SEED ORCHARD WAS ESTABLISHED AT THE ALTITUDE OF 810 m a.s.l., ON THE SITE *FAGETUM MONTANUM* RUD., s.l.**

**SEED ORCHARD HAS A METAPOPOPULATION STRUCTURE, I.E. IT CONSISTS OF FOUR MORE OR LESS RELATED SUBPLANTATIONS (DIAGRAM 2).**

# GENERATIVE SEED ORCHARD OF SCOTS PINE (*Pinus sylvestris* L.) METAPOPOPULATION STRUCTURE, Lučić A., 2011.god



# PLANT PATTERN IN THE SUBPOPULATION WITH 40 HALF-SIB LINES:



13	7	26	40	16	2	24
23	31	12	27	30	22	20
5	9	1	22	25	5	6
14	25	34	30	9	35	39
38	15	3	39	4	23	18
11	35	17	6	33	29	36
36	4	10	29	1	14	31
28	24	37	21	34	11	27
	2	18	10	19	28	7
	16	20	37	8	26	21
	32	8	38	3	13	40
	33	19	32	12	17	15

I BLOCK

**BY THE ESTABLISHMENT OF THE AUSTRIAN PINE METAPOPOPULATION SEED ORCHARD, THE ANALYSIS OF THREE PRINCIPAL MECHANISMS OF THE CONSERVATION OF GENETIC VARIABILITY OF THE FIRST GENERATION, WERE PROVIDED.**

- (A) GENETIC AND DEVELOPMENT MECHANISMS THAT PREVENT THE DIRECT SELECTION OF GENES BY COMBINING THEIR EFFECTS ON THE PHENOTYPE.**
- (B) REGULATION MECHANISM, I.E. THE REGULATION OF THE SIZE OF THE GENE COMPLEX OF SELECTED SEED FROM GENERATION TO GENERATION, BY CROSSING;**
- (C) ECOLOGICAL MECHANISMS, EXPRESSED IN DEPENDENCE ON ENVIRONMENTAL DIVERSITY IN SPACE AND TIME, WHICH OFTEN LEADS TO THE NEUTRALIZING OF SELECTION PRESSURES.**

## **CONCLUSIONS**

**THE REPRODUCTION OF HALF-SIB LINES IN SEED ORCHARDS OF SERBIAN SPRUCE AND AUSTRIAN PINE IS NOT A SIMPLE PROPERTY, IT IS IN THE FUNCTION OF INTERNAL AND EXTERNAL CONDITIONS.**

**REPRODUCTION CONSISTS OF BOTH THE PROCESSES WHICH DETERMINE VARIABILITY, AND THE PROCESSES WHICH ENSURE THE STABILITY OF GENOTYPES. THE BALANCE BETWEEN THESE TWO PROCESSES IS DETERMINED BY THE RECOMBINATION SYSTEM,**

**THE OPEN RECOMBINATION SYSTEM IS CHARACTERIZED BY A HIGH LEVEL OF OUTBREEDING, HIGH HETEROZYGOSITY AND BY ABUNDANCE OF INTRAPOPULATION TYPES OF POLYMORPHISM.**

**THE CONCEPT OF FREE POLLINATION PRESUMES THAT ALL FEMALE AND MALE GEMETES OF ALL GENOTYPES OF THE POPULATION COMBINE WITH EQUAL PROBABILITY; THE COMBINATIONS OF GAMETES ARE EFFECTED ON RANDOM BASIS.**

**CLONAL SEED ORCHARD PEDUNCULATE OAK (*Quercus robur* L.)**





**1968-1979 – PHENOTYPE SELECTION 86 PLUS TREES OLDER THAN 110 YEARS  
SELECTION PARAMETRES: DIMENSION, STRAIGHTNESS, BRANCHING AND  
MICROSPHAERA RESISTANCE**

**1979-1985 – ESTABLISHMENT OF CLONAL SEED ORCHARD  
4 VARIETIES**

***Q. ROBUR VAR. PRAECOX***

***Q. ROBUR VAR. TYPICA***

***Q. ROBUR VAR. TARDIFLORA***

***Q. ROBUR VAR. TARDISSIMA***



**-GENERATIVE SEED ORCHARD WAS ESTABLISHED IN 2000**

**-127 HALF-SIB PROGENIES (85 + 52)**

**7 X 5 M → 7 X 10 M AFTER THINNING VARIETY SPLIT PLOT**

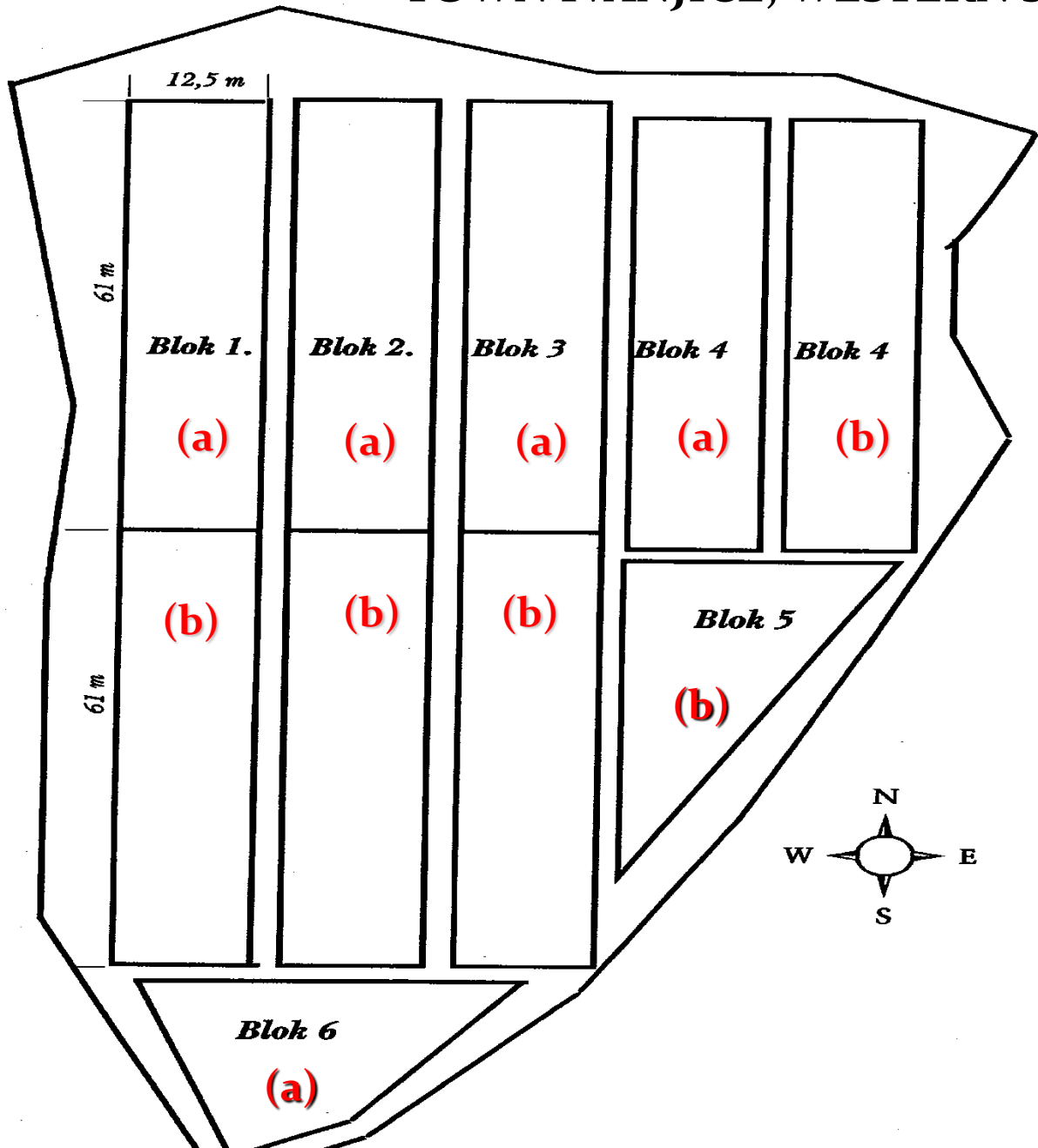


Variety	% of progenies
<i>praecox</i>	15
<i>typica</i>	30
<i>tardiflora</i>	40
<i>tardissima</i>	15

**SEED ORCHARD OF BALKAN MAPLE (*Acer heldreihii* Orph. ex Boiss ) WAS ESTABLISHED WITH TWENTY HALF-SIB LINES, 1200 GENOTYPES, IN THE SIX BLOCKS;**

**EACH HALF-SIB LINE IS REPRESENTED IN GROUPS OF NINE SEEDLINGS WITH THREE REPETITIONS AND PLANTING DENSITY 2X2 M YEAR OF ESTABLISHED: 1996, AREA: 2,70 ha, *Isajev V., 1996.***

# GENERATIVE SEED ORCHARD OF BALKAN MAPLE (*Acer heldreihii*) LOCALITY TOWN IVANJICE, WESTERN SERBIA



ESTABLISHED OF 40 HALF-SIB LINES.

**(a)** 20 MOTHER TREES SELECTED IN ALTITUDE OF 1000 M, AND

**(b)** 20 MOTHER TREES SELECTED AT ALTITUDE OF 1600 M

PATERN OF PLANTING SEEDLINGS WAS RANDOMISED



**THANK YOU FOR ATTENTION**



