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Comparison of seedling quality between autochthonous and poplar clones

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Abstract

Autochthonous poplar species were neglected during the intense establishment of plantations using various selected clones. This paper presents the results of seedlings quality comparison of two autochthonous poplars and three clones of poplar (129/81, I-214 and PE 19/66) in order to determine capabilities for mass production of autochthonous poplar seedlings. The seedlings of clone 129/81 have the largest diameter and height, and the seedlings of black poplar shows the smallest values. Seedlings of gray poplar have similar values as seedlings of clone PE 19/66, except diameter on 1 m above the ground. Clone I–214 shows least values relative to seedlings of other two clones. The results obtained in this study indicate the possibility of mass production of autochthonous poplar seedlings. Considering that the seedlings are used primarily for the purposes of conservation, the existing manufacturing technology, as well as the applicable standards of quality seedlings, which are used for highly productive clones of poplar, should be adapted to the production of a large number of genotypes.

Keywords

Black Poplar; Gray Poplar; Poplar Clones; Seedling Quality

Contents

1 Introduction

Poplar plantations in Europe account for 4% of the total plantation and cover a total of 940,200 ha (Coaloa and Nervo 2011). Plantation forestry in Serbia is based almost exclusively on poplars - poplar plantations are established on 40,000 ha (Ivetić and Vilotić 2014). Poplar clones constitute only 0.3% of the total number of trees in the forest fund, but in a total volume account for 1.7% and 3.7% in a total volume

increment (Banković et al. 2009). According to the Statistical Office of the Republic of Serbia in 2015, 359,000 poplar seedlings have been planted on 415 ha, which is about 25% afforested area in that year (Statistical Office of the Republic of Serbia 2016a). Also, from 2011 to 2015, about 16% of total cut trees was poplar (Statistical Office of the Republic of Serbia 2016b).

Poplar seedlings in Serbian nurseries are produced in accordance with the Italian school of seedling production in the system "rooting beds-nursery" (Žufa 1961). Height is marked as a basic measure of seedling quality (Rončević et al. 2002).

Autochthonous species were neglected during the intense establishment of plantations using various poplar clones. Grey poplar (*Populus x canescens* L.) is marked as rare in the forest fond of Serbia (Banković et al. 2009), while black poplar (*Populus nigra* L.) is considered endangered due to the presence of the American and Euramerican black poplar, which creates a basis for the obtaining of hybrid progeny (Cagelli and Lefèvre 1995). In addition to this, local black poplars habitat is further narrowed since a significant part of poplar habitat has been modified for the purpose of agricultural production, urbanization, flood control and others (Vietto and Chiarabaglio 2004). Several international projects have been started with the aim of examining variability in natural populations of poplars, as well as their conservation (Lefèvre et al. 1998, 2001). Restoration of habitats and reforestation with autochthones poplars are active in many European countries (Vietto et al. 2008; Smulders et al. 2008; Maksimović and Devetaković 2016).

This paper presents the results of seedlings quality comparison of two autochthonous poplars and three clones of poplar (129/81, I-214 and PE 19/66) in order to determine capabilities for mass production of autochthonous poplar seedlings.

2 Material and method

The experiment was carried out in the nursery "Žarkovac" in Kovin, which belongs to SE "Vojvodinašume" - FE "Banat" Pančevo. The nursery (44°43’50” N, 20°59’18” E) is located on an altitude of 70.1 to 74.1m a.s.l, without clearly expressed exposure. The terrain is flat and there is no threat of erosion. Due to the proximity of the Danube River, alluvium soil dominates in the nursery.

The texture of the soil in the nursery was loamy sand (Table 1), which predetermines a small amount of available water capacity and a low level of nutrient adsorption. These characteristics indicate a more frequent irrigation during the vegetation period with lower irrigation rates, as well as the addition of artificial fertilizers in small quantities, nitrogenous fertilizers in particular (2004).

The soil in the nursery "Žarkovac" is very poorly provided with organic substances. Content of total nitrogen is good, but content of potassium is medium and phosphorus is weak (Table 2). According to these indicators, as well as taking into consideration physical characteristics of the average soil sample, it is necessary to add small doses of organic and mineral fertilizers. Organic fertilizers (blown, aged manure) in an amount of 15 to 20 m^3 per hectare should be added every second year. For optimal growth of poplar seedlings, it is necessary to add 40-70 kg/ha of nitrogen, 70 kg/ha of phosphorus and 70 kg/ha of potassium every year.

For seedlings production we used cuttings obtained from: registered mature trees (RS-3-4-pni-00-691) for *Populus nigra* and stolbads in nursery "Žarkovac" for clones I-214, PE 19/66, 129/81 and *Populus x canescens*.

Table 1. Granulation and texture of average soil sample.

	Granulation %						
Sample	**Rough Sand > 0,2 mm**	**Fine sand 0,2-0.02 mm**	**Powder 0,02-0,002 mm**	**Colloidal Clay <0,002 mm**	**Total Sand >0,02 mm**	**Total Clay <0,02 mm**	**Texture class**
1	2,2	75,8	14,6	7,4	78,0	22,0	Loamy sand
2	3,6	74,9	13,2	8,3	78,5	21,5	Loamy sand
3	13,3	71,9	9,9	4,9	85,2	14,8	Loamy sand
4	7,2	77,3	9,9	5,6	84,5	15,5	Loamy sand
5	21,1	65,3	8,7	4,9	86,4	13,6	Loamy sand
6	5,5	79,2	10,5	4,8	84,7	15,3	Loamy sand
Average	8,8	74,1	11,1	6,0	82,9	17,1	Loamy sand

Table 2. Granulation and texture of average soil sample.

Sample	**pH μ H_2O**	**Humus %**	**$CaCO_3$ %**	**N %**	**P_2O_5 mg/100g**	**K_2O mg/100g**
1	8,1	1,31	15,89	0,129	5,6	10,6
2	8,1	1,14	15,47	0,136	5,2	7,8
3	8,0	0,60	15,91	0,125	5,2	12,8
4	8,2	0,33	16,30	0,122	5,2	13,4
5	7,9	0,24	15,91	0,119	5,6	11,8
6	8,0	0,87	14,70	0,125	4,4	11,0
Average	8,0	0,75	15,69	0,126	5,2	11,2

Cuttings were obtained manually by garden pruner (each cutting have three healthy buds) and planted on March 2016th. Weed control was provided five times during growing season (hilling), and tearing of laterals was performed four times. Fertilization was carried out with artificial fertilizer NPK 15-15-15 (400 kg/ha) and later with nitrogen fertilizers (250 kg/ha). Treatment with insecticide Agara®, against leaf beetle (*Melasoma populi* Stephens, 1834), was performed twice (April and July), while copper oxychloride as prevention of *Marssonina brunnea* (Ell. & Ev.) Magnus in May.

Root collar diameter (D) and diameter at a height of 1m (D1) were measured by digital caliper with an accuracy of 0.1 mm. Height (H) was measured by a telescopic ruler with an accuracy of 0.1 m. Random sampling included 250 seedlings. Measurements were taken in March 2017.

Seedlings are classified into height classes in accordance with applicable regulations (2009), with the exception that seedlings with a height below 2.0 m (instead of 1.8 m) are considered useless. The height classes were:

I class > 3.0 m
II class – H 2.5 – 3.0 m
III class –2.0 – 2.5 m
IV class < 2.0 m.

3 Results

The highest values of seedling diameter and height have seedlings of clone 129/81, on the other hand black poplar shows the least values (Table 3). Seedlings of gray poplar have similar values as seedlings of clone PE 19/66, except D1. Clone I – 214 shows least values relative to seedlings of other two clones.

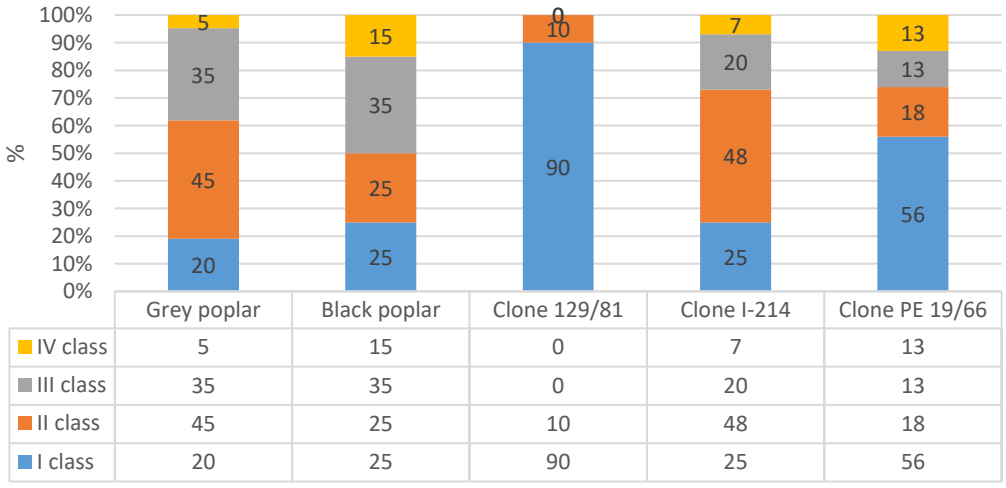
Differences between values of height and diameters for two autochthonous poplars (Black and Grey poplar) and three clones (129/81, I-214 and PE 19/66) are statistical significant (Table 4).

Table 3. Mean values (MV), Standard deviation (SD), minimal (MIN) and maximal (MAX) values of height (H), root collar diameter (D) and diameter on 1m of height (D1) for seedlings of two autochthonous poplar (Black and Grey poplar) and three clones (129/81, I-214 and PE 19/66). Mean values followed by different letters are of a statistical significant difference.

Poplar (N=251)	H (cm)				D (mm)				D1 (mm)			
	MV	SD	MIN	MAX	MV	SD	MIN	MAX	MV	SD	MIN	MAX
black	255.9^{a}	55.82	150.0	346.0	18.6^{ab}	4.23	11.2	27.2	12.2^{a}	3.2	4.2	17.8
gray	287.6^{ab}	17.7	250.0	312.0	20.0^{ab}	2.19	16.1	24.5	13.7^{ab}	1.8	10.2	16.6
129/81	345.0^{b}	30.9	294.0	399.0	34.2^{c}	4.5	27.6	41.0	23.3^{c}	2.7	18.0	28.1
I-214	271.0^{a}	46.7	132.0	395.0	20.8^{a}	4.8	8.6	33.9	13.3^{a}	3.9	3.2	24.0
PE 19/66	290.4^{a}	65.4	131.0	389.0	23.3^{b}	6.8	9.2	37.5	17.3^{b}	5.3	5.9	25.6
Average	284.2	57.7	131.0	399.0	22.6	6.65	8.6	41.0	15.6	5.3	3.2	28.1

Table 4. Analysis of variance (One-Way ANOVA) of height (H), root collar diameter (D) and diameter at 1 m of height (D1) for seedlings of two autochthonous poplars (Black and Grey poplar) and three clones (129/81, I-214 and PE 19/66).

	SS	df	MS	SS	df	MS	F	p
H	111332.8	4	27833.20	720624.8	246	2929.369	9.50143	0.000000
D	3465.0	4	866.26	7605.4	246	30.916	28.01948	0.000000
D1	2261.3	4	565.32	4657.3	246	18.932	29.86078	0.000000



	Grey poplar	Black poplar	Clone 129/81	Clone I-214	Clone PE 19/66
IV class	5	15	0	7	13
III class	35	35	0	20	13
II class	45	25	10	48	18
I class	20	25	90	25	56

Figure 1. Percentage of the quality class for seedlings of two autochthonous poplars (Black and Grey poplar) and three clones (129/81, I-214 and PE 19/66).

In addition to the largest value of height and diameter, seedlings of clone 129/81 show the best quality structure. 90% of the seedlings of clone 129/81 were classified into the first class, while the remaining 10% belong to class number 2 (Fig. 1). Seedlings of clone PE 19/66 have a satisfactory quality of structure - 56% of seedlings belong to the first class and 13% are deemed useless. Seedlings qualitative structure of autochthonous poplar is comparable to seedlings of clone I-214. However, the total first and second class of I-214 seedlings exceeds 70%, while the gray poplar seedlings slightly higher than 60%, and black poplar seedlings are only 50%.

4 Discussion

Seedlings of autochthonous poplars were the subject of a small number of studies because their economic value was insignificant. The authors do not know results of grey poplar quality seedlings, but values of height and diameter are similar with previous research on black poplar seedlings (Maksimović 2015). A small percentage of autochthonous poplar seedlings, which can be used for afforestation, can be explained by the technology of production which is not adapted to the studied species. However, these results point to the inadequate provisions of the regulations about production and use of reproductive materials of poplar (2009), which is based on the results of testing the quality of seedlings of high yielding clones of poplar. Considering the fact that the reproductive material of autochthonous poplars will not be used in productive forests, but for biodiversity conservation programs, and that there is a strong influence of genotype on the dimensions of seedling aged 1/1 (Maksimović 2015), the existing regulations should be extended and adapted to autochthonous species. The values of height and root collar diameter are similar with previous research (Rebić 2016), but it is significantly higher from the results reported by (Todorović 2016) for seedlings of the same age, but grown on deposol and planting cuttings late. The negative impact on the survival and growth of clone I-214 seedlings due to planting cuttings late has previously been shown (Andrašev et al. 2007).

Clone 129/81 showed the best results in terms of total values and quality structure 1/1 old seedlings. However, comparative testing of clone 129/81 and PE19/66 on different types of soil showed higher values of diameter, while height was similar (Orlović et al. 2006). The authors reported that clone PE 19/66 has the highest increment on optimal soil types (humofluvisol and fluvisol of loamy form), compared with the rest of the clones tested. The dominance of clone PE 19/66 in height and diameter values compared to the 129/81 and the three other tested clones was confirmed at the age of 11 years old on reclaimed gley soil (Rončević et al. 2011).

The results obtained in this study indicate the possibility of mass production of autochthonous poplar seedlings. Considering that the seedlings are used primarily for the purposes of conservation, the existing manufacturing technology, as well as the applicable standards of quality seedlings, which are used for highly productive clones of poplar, should be adapted to the production of a large number of genotypes.

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