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Stocktype effect on field performance of Austrian pine seedlings

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Abstract

Austrian pine (*Pinus nigra* Arnold) seedlings are one of the most produced planting material in Serbian nurseries. In this study we compared a field performance of two container stocktypes, one usually used (2+0 produced in Plantagrah I) and one recently introduced (1+0 produced in Hiko V120 SS). The trial was established at planting site Vlaško polje (East Serbia), at altitude of 840 m a.s.l., one year following the total destruction of previous pine plantation by ice. One-year-old Austrian pine seedlings produced in Hiko containers show similar initial height and root collar diameter at planting time as two-year-old seedlings produced in traditionally used Plantagrah I containers. There was no vegetation control at field trial during the first growing season. At the end of the first growing season, taller (15.6 cm) and more slender (H/D=4.5) 1+0 seedlings from Hiko containers survived at higher rate, and shorter (10.9 cm) and more stocky seedlings 2+0 produced in Plantagrah I grow in height at higher rate. Seedlings taller at the planting time kept their advantage in size after the first growing season at the field. We found that both stocktypes can be used in operational planting programs on sites with lack of vegetation control.

Keywords

Stocktype; Container seedling; Austrian pine; Field performance

Contents

1 Introduction

According to the National Bureau of Statistics (2015), more than quarter of total afforestation in Serbia is done by coniferous, mostly by Norway spruce (*Picea abies* (L.) Karst.) and Austrian pine (*Pinus nigra* Arnold). Due to Austrian pine ability to survive and grow on harsh sites, plantations are founded on a significant area of over 100,000 ha for the period from 1961 to 2007 (Ranković 2009). Almost all forest nurseries in Serbia

produce Austrian pine seedlings, but technology of producing is different and it is affected by nursery equipment. The most significant producer of forest seedlings in Serbia is PE "Srbijašume", with more than 7,500,000 seedlings of Austrian pine were produced in the last five years and 43% was produced in some type of container.

Production of containerized seedlings in Serbia started on mid 1970s and until today it has become common method for the production of forest seedlings. In Serbian nurseries mostly used container types are Plantagrah, Jukosad, Pirosad and Nisula rolls (Isajev et al. 1999), but in the last decade Hiko containers (BCC, Sweden) were introduced. Seedlings production in containers has many advantages in comparison to bareroot seedlings production, as fast growth and extended planting season. Containerized seedlings survive in higher rate than bareroot seedlings after field planting (Grossnickle and El-Kassaby 2016), but experiences from Serbia are opposite (Ivetić 2015). The reason for low field performance of containerized seedlings can be found in nurseries. The quality of container seedlings is not defined by current Serbian standard and many nurseries do not follow protocols for seedling production in containers.

In this study we compared a field performance of two container stocktypes, one usually used (2+0, produced in Plantagrah I) and one recently introduced (1+0, produced in Hiko V120 SS), in lack of vegetation control.

2 Material and methods

The trial was established at planting site Vlaško polje (East Serbia, 43°41'49"N; 22°04'16"E), on a slope (15° - 20°), facing northeast, 840 m a.s.l., on rendzic leptosl. Two stocktypes of Austrian pine seedlings were planted in manually prepared planting holes with 20-30 cm diameter and depth, at distance 2 x 2 m on March 2016. Previous plantation of Austrian pine was totally destructed by ice on winter 2014/2015. The planting site was prepared by manually removing of obstacles. Seedlings were produced in two different nurseries which belong to the system of PE "Srbijašume". One year old seedlings (1+0, Hiko V120 SS) were produced in nursery "Barje" (Pirot, East Serbia) equipped by mechanical line for filling and seeding of containers (BCC, Sweden). Two years old seedlings (2+0, Plantagrah I) were produced in nursery "Ribnica" (Kraljevo, Central Serbia) where all operations were performed manually. The most important characteristics of used containers are shown in Table 1. There was no vegetation control at field trial during the first growing season.

Table 1. Characteristics of Plantagrah I and Hiko V120 SS containers.

	Plantagrah I	**Hiko V-120 SS**
Cross section	Polyedric hexagon	Square
Volume of cell (cm^3)	120	120
Depth (mm)	120	110
Diameter et the top (mm)	40	40
Plant density (N/m^2)	660	526
Material	Solid plastic	Solid plastic
Drainage hole	One on the bottom	Side slit and open bottom
Inner wall	Slick	Slick

Total of 240 seedlings were measured for height and root collar diameter at two times, after planting in March (H1 and D1) and at the end of first growing season in

November 2016 (H2 and D2). The height was measured as the distance between the root collar and base of terminal bud of dormant seedlings, with an accuracy of 0.1 cm. The diameter was measured at or near the root collar; with an accuracy of 0.1 mm. An increment percent relative to the initial values of height and diameter was calculated as (H2/H1)x100)-100 and (D2/D1)x100)-100. Correlation between initial values and values measured at the end of first growing season is determined by coefficient of determination (r^2). Survival of seedlings was recorded during the second measurements and it is calculated as percentage of the number of living individuals from the total number of outplanted seedlings. Roller's sturdiness coefficient was calculated using measured values of height and root collar diameter as height/diameter ratio (Roller 1977).

3 Results

At planting, one-year-old Hiko seedlings were taller (H1=15.6 cm), but with equal root collar diameter (D1=3.5 mm) compared to two-year-old Plantagrah seedlings had average height (H1=10.9 cm and D1=3.6 mm). After the first growing season on the field, Hiko seedlings maintained the advantage in height (H2=25.1 cm) and grow more in diameter (D2=5.7 mm) compared to Plantagrah seedlings (H2=22 cm and D2=5.3) and those differences are significant (one-way ANOVA, $p<0.05$). The Hiko seedlings were more slender (4.6) than Plantagrah seedlings (3.1) at planting time (Figure 1), but survived at higher rate (Table 2).

Table 2. Mean values of initial height (H1), diameter (D1), height/diameter ratio (H1/H2) and height (H2), diameter (D2), height/diameter ratio (H2/D2) after the first growing season on the field (standard deviation), ANOVA ($p<0,05$), and seedlings survival of different stocktypes (%).

Stocktype	H1 (cm)	D1 (mm)	H1/D1	H2 (cm)	D2 (mm)	H2/D2	S (%)
1+0 Hiko 120 SS	15.6 (3.8)	3.5 (0.8)	4.6 (1.5)	25.1 (4.9)	5.7 (0.9)	4.5 (1)	90
2+0 Plantagrah I	10.9 (3.7)	3.6 (1)	3.1 (0.9)	22 (5.1)	5.3 (1.3)	4.3 (1)	75
p values	0.0000	0.3439	0.0000	0.0000	0.0099	0.1581	

Figure 1. One-year-old seedling (Hiko VS 120 SS, left) and two-year-old seedling (Plantagrah I, right) after field planting.

Height after the first growing season on the field is more affected by initial height (30% and 38%) than diameter (1% and 10%) for both stocktypes. Initial diameter show weak influence on the observed attributes after the first growing season on the field at one-year-old Hiko seedlings, while at two-year-old Plantagrah seedlings this effect is stronger (23% on height and 25% on diameter). Initial height/diameter ratio does not have influence on the diameter after the first growing season on the field and influence on the height and height/diameter ratio is weak at both stocktypes (Table 3).

Table 3. Coefficient of determination (R^2) between values of initial morphological attributes height (H1), diameter (D1) and height to diameter ratio (H1/D1) and same morphological attributes (H2, D2 and H2/D2) after the first growing season on the field.

STOCKTYPE		**1+0**			**2+0**	
MORPHOLOGICAL ATTRIBUTE	**H2**	**D2**	**H2/D2**	**H2**	**D2**	**H2/D2**
H1	0.30	0.01	0.17	0.38	0.10	0.08
D1	0.01	0.04	0.00	0.23	0.25	0.01
H1/D1	0.08	0.00	0.08	0.04	0.00	0.15

Two-year-old Plantagrah seedlings grow on higher rate in height while one-year-old Hiko seedlings growth uniformly on height and diameter (Figure 2). One-year-old hiko seedlings showed equal increment of height and diameter after the first growing season at field. Two-year-old Plantagrah seedlings have doubled their height, but diameter increment was much lower (Table 2).

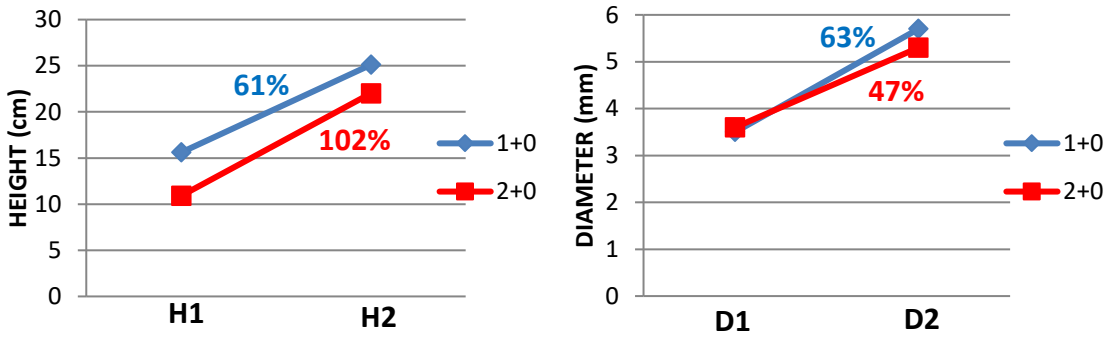

Figure 2. Height and diameter increment of different stocktype seedlings during the first growing season after field planting.

4 Discussion

Afforestation programs in Serbia usually include different stocktypes of *Pinus nigra* and seedlings survival vary from site to site. The average survival of *Pinus nigra* bareroot seedlings is about 80%, while container seedlings survive at the lower rate (Ivetić 2015). In this study, taller and slander seedlings survive at higher rate, opposite to previous findings for pines on droughty sites (Tuttle et al. 1988; Van Den Driessche 1991; McTague and Tinus 1996; Ivetić et al. 2016a). The reason for survival of taller and more slender seedlings at higher rate can be found in environmental conditions with lack of vegetation control when height can be consider as an advantage (Puertolas et al. 2003; Cuesta et al. 2010; Pinto et al. 2011; Villar-Salvador et al. 2012).

Initial size of one-year-old Hiko seedlings was larger, while two-year-old Plantagrah seedlings show similar values relative to *Pinus nigra* seedlings of different proveniences and stocktypes reported by Ivetić and Škorić (2013) and Kolevska and Trajkov (2012). The difference of seedlings initial heights, between stocktypes is statistically significant but not for initial diameter. Morphological attributes of seedlings can be affected by container type (Dominguez-Lerena et al. 2006; Selektović et al. 2011; Ivetić and Škorić 2013), but characteristics of used containers are similar and we do not expect significant differences between seedlings. Main difference between the containers is drainage hole which can provide better drainage, aeration and root cutting at Hiko seedlings (Annapurna et al. 2004). On the other hand, seedlings were grown for one additional year in Hiko container and one year more in Plantagrah I container which indicate possibility to root deformation, but not observed in this study. Higher growth density promote higher and more slander seedlings (Dominguez-Lerena et al. 2006), but this is not confirmed in this study. Nursery practice overall and fertilization, as one of most important cultural practice in container nursery, can result in great differences between seedlings (Landis 1989), which is probably the main reason for the one-year-old Hiko seedlings greater initial size than two-year-old Plantagrah seedlings.

5 Conclusion

Better survival of one-year-old Hiko seedlings (90%) is result of site condition and lack of vegetation control, where their height is advantage. We found that both stocktypes can be used in operational planting programs on sites with lack of vegetation control, but priority should be given to taller seedlings. Larger seedlings kept their advantage in size after outplanting, despite a higher rate of height growth of shorter seedlings.

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