Research on *Picea pungens* Vegetative Seedlings Propagation

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ABSTRACT

In forest nurseries, seedlings are obtained through vegetative methods, in order to faithfully transmit traits from the parent plants to the offspring. Grafting was used as vegetative propagation method for obtaining ornamental trees, decorating through beautiful colored specimens as well as by their boosting flowering and fructification, traits that might be put in good used by territorial planning. The current research aimed to study the production of *Picea pungens* var. *argentea* saplings using the side-veneer-grafting method. Grafting was performed on spruce rootstocks of two categories of age (two years and three years), and respectively for three categories of diameter (4 mm, 6 mm and 8 mm). It was noted that the successful grafting percentage varied depending on the diameter of the rootstock. Thus, it appeared that the best grip was recorded for the two years rootstocks of small size (M1-90%), followed by M2 and M3 with a grip percentage of 85%, while for the seedlings of three years, lower values were recorded: M1-83%, M2-80% respectively M3-72%.

Keywords: nursery, *Picea abies*, *P. pungens* var. *argentea*, rootstock, scion, vegetative propagation

INTRODUCTION

Blue spruce is primarily native to the central and southern Rocky Mountains of the western United States (Fechner, 1980), being very decorative, frequently used in landscapes and private gardens (Șofletea and Curtu, 2001)

Blue spruce (*Picea pungens*) is also called Colorado blue spruce, Colorado spruce (Peattie, 1950), silver spruce, épinette bleue (Canadian French) and pino real (Spanish) (Taylor, 1993). It is a slow-growing, long-lived tree of medium size; because of its symmetry and color, is planted extensively as an ornamental (Fechner, 1985; Schaeffer and James, 1986). Because blue spruce is relatively scarce and the wood is brittle and often full of knots, it is not an important timber tree (Strong, 1978).

It is a high tree, it can have about 30 meters or even 50 meters sometimes in native areas. Have a grey bark, deeply wrinkled and split, the crown has no regular branches (Burns and Honkala,

1990; Taylor, 1993). The needles are green-bluish or white-silvery, being cultivated especially the trees with green-bluish needles (*Picea pungens* var. *glauca*), variety obtained by selection from the European gardeners (Rubțov, 1958), and the cultivar with white-silvery needles (*Picea pungens* var. *argentea*).

The species does not sprout from the stump or root, but the development of epicormic branches on the trunk is common. Grafting and air-layering have been practiced successfully for many years to perpetuate desired horticultural varieties (Frohlich, 1957; Lyon, 1983; Mergen, 1958; Ravenstein, 1957; Wells, 1953). Success has also been achieved through the rooting of hardwood or greenwood stem cuttings, especially in sand-peat-soil media, or hydroponically (Kirkpatrick, 1940; Savella, 1965; Sherwood, 1968; White, 1975).

Picea pungens is one of the exotic conifer species that reach the fructification in Romanian parks and green spaces, the biggest problem is

getting varieties of this species seedlings. And this because, although at the beginning the obtained specimens have the color of the parental variety, with the passage of time the color disappears (Rubțov, 1958; Hill, 1989). So, the vegetative propagation remains the only possible way in order to obtain the specimens capable to keep a long period the needles' color.

Grafting is a basic tool for horticulturists and also has been used widely in forestry for clone preservation and seed orchard establishment (Zobel and Talbert, 1984).

Methods of grafting are numerous and they were covered in many texts, among others Bailey, 1891; Dormling, 1964; Hartmann and Kester, 1983; Hartmann and Kester, 2002; Stănica *et al.*, 2002; Smith, 2007.

At conifers the side-veneer-grafting method is the most frequently applied (Teuscher, 1962; Leiss, 1987; Enescu *et al.*, 1994; Carpenter, 1998; Lupescu, 2003; Smith, 2007; Mazăre, 2010). With *P. pungens*, this grafting method is practiced in greenhouse, during august-september or december-march periods (Hartmann and Kester, 2002; Iliescu, 2002). The veneer grafting was recommended in alder, aspen, oak, Douglas-fir, larches, pines and spruces (Wright, 1976).

The present papers aims to study the production through vegetative methods of saplings of *Picea pungens* var. *argentea*, using side-veneer-grafting method (side plywood), on two categories

of rootstocks, of 2 and 3 years and on 3 categories of diameters, of (M_1), 6 mm (M_2) and 8 mm (M_3).

MATERIALS AND METHODS

Researches location

The research was conducted in the Nursery Mihai Viteazu, Forest Department Turda, Cluj-Napoca Forest Department, Romania. The nursery has a modern conservatory fully equipped, that produces seedlings through the use of generative and vegetative methods (cuttings, grafting, layering, etc.).

Biological material

To carry out the research, side-veneer-grafting was carried onto rootstocks spruce, *Picea abies* L., aged two and three years and produced in the section of forest seedlings destined for afforestation work.

All the rootstocks used were grouped into three size categories: small, medium and large (M_1 – small, 4 mm; M_2 – medium, 6 mm; M_3 – large, 8 mm) both copies of the second year (Fig. 1) as well as samples of the third year (Fig. 2).

Rootstocks of three years undergoing a cycle 1+2+1, namely one year in the greenhouse, two years in nursery pots in the season before grafting and respectively those of two years, which undergo 1+2, meaning one year in the greenhouse, a relapse year in the nursery. The seedlings were transplanted to pots in spring, the year before grafting, before vegetation. Bedding was made in

Fig. 1. Grafting two years rootstocks

Fig. 2. Grafting three years rootstocks

pots with a diameter of 9 cm in normal soil mixture consisting of black soil, humus and peat.

Before grafting, rootstocks were verified through a survey. This survey consisted of extracting the seedlings from the container, observing if the tips of the roots are bleached; another criterion being the size and the shape of the buds. Also, grafting can be done when the buds are bigger and they start to dry.

Harvesting of the grafts took place on the day of grafting for avoiding their dehydration, the grafts were collected from Mihai Viteazu Nursery, where mother-specimens were silver spruce saplings with a maximum height of 1 m, thus harvesting being made on specimens grafted in previous years (Fig. 3). Grafts length was of about 10 cm, so that after trimming they remain of 7-8 cm. Both the grafting and the rootstock must have the same size for the procedure to be successful, so after the unification of the two partners to ensure their contact cambial zone (Blada and Panea, 2011). In terms of thickness were chosen grafts about 1/3 thinner than the thickness of the rootstock in the grafting point, resulting in 120 grafts, out of which 60 for 2 years rootstocks and 60 for 3 years rootstocks.

Grafting method

The grafting method applied was side vents grafting (side plywood). Initially rootstocks were cleaned on the portion where grafting will occur. Grafts were obtained by shortening annual increases with scissors, being used only terminal increases (Fig. 3). After determining the length of

the graft, the needles from the base were removed. The operation is recommended to be done carefully so as not to injure the graft. Graft was made in a simple wedge-shaped. Before the incision is made on the rootstock, it was disinfected using a gauze pad or a cloth soaked in alcohol. The same was done with the grafting knife before each grafting. From the rootstock came off a strip of the same length as the one of the graft, removing the bark and a very small portion of wood. The graft was positioned at the base of incision on the rootstock and its annexation took place, so that the cambial zones of the two partners coincide, then following the conjunction of the partners with biodegradable plastic-foil. Regarding the incision, both on the grafts and the rootstock, this must be done with a single hand movement, and not from two or three moves (Mazăre, 2014).

After grafting, the saplings were reduced about 30% in the first phase, this reduction was made in order to stimulate the production of phloem and xylem of the graft and rootstock. The reduction was made of rootstock crown, following that during the year another 50% of the crown to be reduced progressively. The final nipping of the rootstock is done in the spring of the following year at the same moment with planting the grafted seedlings in the nursery.

Statistical analysis

Within the research work, three evaluations were done (C1 two months after grafting, C2 at four months, C3 at six months after grafting) by visual observations, for all six classes of rootstock

Fig. 3 Harvesting the grafting from the field nursery

small (M1 - 4 mm), medium (M2 - 6 mm) and large (M3 - 8 mm), of two and three years respectively. Within the study, it was determined the scion diameter, 5 cm above the grafting joint, by direct measurement with callipers (Fig. 4).

For interpreting the results regarding grafting efficiency, expressed in the number of successful grafts, the data obtained from the measurements were statistically processed through the method of variation, using the 't' test.

RESULTS AND DISCUSSION

The characters of the rootstocks were analyzed through the middle of the grafted diameter (mm) for rootstocks of two and three years. The first observation regarding the success of the grafting for two years rootstocks showed that the diameter of the grafted area had different values, the amplitude of variation ranging from 4.76 mm in size M₁ (small size) respectively 8.83 mm M₃ (large size), the average of the experience being of 6.81 mm. Compared with the experience

average, high values of the diameter of the grafted area were recorded for saplings of large size (8.83 mm), respectively 6.84 mm, medium size, and low values were recorded for the diameters category M₁ (small size - 4.76 mm) (Tab. 1).

At the time of the measurements (C₁ - read 1), reported to the success percentages, were recorded significantly positive results for the diameter category M₃.

Within the results obtained regarding the diameter of 3 years rootstocks, the variation amplitude varied between 5.19 mm and 9.15 mm, and the average of the experience for the studied diameter category was of 7.30 mm (Tab. 1).

Analyzing the variability coefficients for two and three years rootstock it is possible to conclude that diameter variability is smaller for all the three categories of sizes.

At the second read (C₂), the analysis of the variation highlights the differences statistically assured between the diameter categories of rootstocks, revealing the existence of high genetic

Fig. 4. Measurement of the grafting point

Tab. 1. Summary of results on the diameter of two and three years rootstocks (mm)

Diameters category	Two years rootstocks			Three years rootstocks		
	Average	Signif.	CV%	Average	Signif.	CV%
M ₁ - small, 4 mm	4.76	ooo	6.23	5.19	ooo	5.02
M ₂ - medium, 6 mm	6.84	-	5.18	7.55	-	5.15
M ₃ - large, 8 mm	8.83	***	3.66	9.15	***	3.74
Average (Control)	6.81	-	5.02	7.30	-	4.64

*, **, *** / 0, 00, 000 Significance for P<0.05, 0.01 and 0.001 (*, **, *** positive; 0, 00, 000 negative)

variability. For two years rootstocks, the diameter of the grafting areas had different values, being recorded a variation amplitude between 6.46 mm for the category M_1 and 9.67 mm for M_3 , the average being 8.01 mm. Three years rootstocks showed a variability with an amplitude between 5.86 mm and 9.72 mm, the average being of 7.87 mm, registering positive significant differences for the M_3 diameter category. The variation coefficients calculated for the diameters of the rootstocks were lower for all experimental variants (Tab. 2).

At the third read (C_3) of the diameter of grafting areas, it was noticed that the variation

amplitude ranges between 7.01 mm and 10.25 mm, the average being of 8.49 mm for two years rootstocks. For three years rootstocks, amplitude variation is between 6.33 mm and 10.14 mm, with an average of 8.38 mm. Significant superior value were recorded for the third size (M_3) for both categories of rootstocks, and inferior values were recorded for the first size (M_1). The variability coefficients had low values for both two years and three years rootstocks, the average being of 4.89% respectively 5.16% (Tab. 3).

Tab. 2. Summary of results on the diameter of two and three years rootstocks (mm)

Diameters category	Two years rootstocks			Three years rootstocks		
	Average	Signif.	CV%	Average	Signif.	CV%
M_1 – small, 4 mm	6.46	ooo	6.57	5.86	ooo	4.86
M_2 – medium, 6 mm	7.89	-	4.40	8.03	-	6.30
M_3 – large, 8 mm	9.67	***	3.69	9.72	**(*)	4.32
Average (Control)	8.01	-	4.89	7.87	-	5.16

*, **, *** / 0,00,000 Significance for $P < 0.05$, 0.01 and 0.001 (*, **, *** positive; 0,00,000 negative)

Tab. 3. Summary of results on the diameter of two and three years rootstocks (mm)

Diameters category	Two years rootstocks			Three years rootstocks		
	Average	Signif.	CV%	Average	Signif.	CV%
M_1 – small, 4 mm	7.01	oo	6.87	6.33	ooo	6.45
M_2 – medium, 6 mm	8.29	-	4.38	8.61	-	5.21
M_3 – large, 8 mm	10.25	**	3.71	10.14	**	4.43
Average (Control)	8.49	-	4.99	8.38	-	5.36

*, **, *** / 0,00,000 Significance for $P < 0.05$, 0.01 and 0.001 (*, **, *** positive; 0,00,000 negative)

Fig. 5. Average of variability coefficient CV%

Analyzing the average of variability coefficients for both categories of rootstocks was observed that CV% values are small, with a value below 10%, which indicates the fact that the experiment is homogeneous, the lowest values being recorded at two years rootstocks (Fig. 5).

After the statistical processing of data regarding rootstocks diameter, in terms of both types of seedlings (year two, respectively year three), it was noted that the vigor of growth is higher for second year seedlings, third size (M_3 -seedlings with 8 mm diameter). This achievement is possible because the young seedlings are characterized by a higher growth.

Within the results obtained on the percentage of success (Fig. 6), it can be observed that the smaller the rootstock diameter, the higher are the grip changes and the yield.

In the same context, analyzing the influence of rootstock thickness on the success of the grafting process, experimental results show

that the success percentages of grafting increase with the decrease in diameter of its thickness to average diameter of 4 mm that has the best grip percentage.

The best grip was recorded for two years rootstocks, small size (M_1 -90%), followed by M_2 and M_3 with a grip percentage of 85%. Three years rootstocks have lower values, M_1 -83%, M_2 -80% respectively M_3 -72% (Fig. 7).

This is due to the fact that at this diameter grafting can be done under appropriate conditions and cell division process is emphasized (Blada and Panea, 2011). However, if the grafting on the rootstock with the diameter under optimal size is required the application of agro-technical fertilization measures backed by completing soil water deficit if necessary in conjunction with the maintenance of appropriate phytosanitary level so that the plants can grow until falling within the optimal categories of diameters, those categories that create prerequisites for successful grafting.

Fig. 6. Grip percentage on rootstocks of two and respectively three years (%)

Fig. 7. Average percentage of grip on analyzed rootstocks (%)

CONCLUSION

The reproduction of the silver spruce through vegetative methods has a series of advantages, consisting in the fact that the characters faithfully transmit from mother-plant to offspring plant, and the increases are higher.

According to the results obtained (statistically verified), in order to achieve the highest percentages of success and increases in diameter, especially in the area of grafting, it is recommended to choose side vents grafting using as rootstocks spruce seedlings (*Picea abies*) from cultures of two years, with diameters of 4 mm or more, but not more than 6 mm.

The silver spruce seedlings (*Picea pungens* var. *Argentea*) obtained through this technique of grafting, retained the silver appearance of the needles and achieved higher growth, being recommended for green spaces and sometimes even for winter trees (especially those produced in containers).

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