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DEVELOPMENT OF YOUNG GRAFTED WALNUT PLANTS IN NURSERY

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Summary

The effect of a loamy alluvial soil deposit on the survival and growth of young grafted walnut plants was evaluated. The study was conducted during 2003–2005, involving one cultivar and four selections: Šeinovo (control), Ovčar, G-286, Elit and G-139. The survival percentage for the cultivar and selections at the end of the first and second growing seasons was 77.3% and 74.3% respectively. The average vegetative growth of walnut nursery plants was 14.3 cm at the end of the first year and 171.6 cm at the end of the second. The highest survival percentage at the end of the first and second growing seasons was obtained in cv. Šeinovo (85.3% and 82.3%) and the lowest in G-139 (73.4% and 70.2% respectively). Vegetative growth at the end of the first and second growing seasons was highest in G-286 (15.0 cm) and cv. Šeinovo (177.6 cm), respectively, and lowest in Elit, being 13.6 cm at the end of the first season and 165.5 cm at the end of the second.

Key words: *walnut, loamy alluvial deposit, grafted plants, cultivar and selection*

Introduction

Soil plays an important role in the cultivation of high-quality walnut nursery plants. Stanković and Jovanović (1983) report that nursery soil must be sufficiently deep and moist, as opposed to compact, stony, dry, podzolic, too moist, saline, strongly alkaline or considerably acid soils which do not provide a suitable growing environment for walnut plants. Jelenković (1983) underlines the need to use light-textured, warm, porous, loose, irrigatable soil for walnut nurseries. Cold, compact, heavy soils containing high ground water levels are not suitable for walnut nursery plants production. According to Kremenović (1984), permeable loose soils having favourable thermal and air regimes and a pH of 6.5-7.6 are most favourable for walnut.

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The objective of the present study was to evaluate the effect of a loamy alluvial soil deposit in the nursery on the survival and growth of grafted walnut plants.

Material and method

The experiments were conducted at the Fruit Research Institute Čačak during 2003-2005. One cultivar and four selections of walnut were used, including Šeinovo (control), Ovčar, Elit, G-139 and G-286. Walnut grafts were planted during the second ten-day period of May. A total of 30 grafts per cultivar/selection were used. A randomised block design (5 cultivars x 4 replications) was employed, totalling 600 nursery plants.

The physical and chemical properties of the soil used in this study suggested that the soil was a loamy alluvial deposit.

At the end of the first and second growing seasons, the number of survived walnut nursery plants was determined. At 20-day intervals upon shoot emergence, plant height was measured from the graft union upwards by a metre scale.

The obtained results were subjected to the Fisher's model of analysis of variance - ANOVA (Fisher, 1953). The significance of differences between the means of the control cultivar and the other selections at $p \leq 0.01$ and $p \leq 0.05$ significance thresholds was determined using Dunnett's test (Dunnett, 1955). The significance of differences between particular seasons, and interaction means were tested using the LSD test at $p \leq 0.05$. The results are presented in tabular form.

Results and discussion

According to its morphology and origin, the soil used in the study was alluvium. According to its physical and chemical properties, the soil was classified as a loamy alluvial deposit. This type of soil was relatively light in texture (Table 1) and slightly acid in reaction. The 0-20 cm soil layer had a good supply of humus (2.76%), P_2O_5 (17.80 mg/100 g air-dry soil) and K_2O (28.25 mg/100 g air-dry soil) and a moderate supply of N (0.13%). Their content decreased with increasing soil depth. The 0-100 cm soil layer (Table 2) contained on average 58.2% total sand and 41.8% physical clay. The content of other fractions over the profile depth was within the following narrow range: coarse sand 1.0-3.0%, fine sand 54.0-58.6%, silt 20.9-26.2% and clay 17.0-18.8%. These values were not homogeneous due to the effect of floodwaters of the West Morava River.

Table 1. Agrochemical properties of nursery soil – Fruit Research Institute Čačak

Depth, cm	pH in KCl	K_2O mg/100 g, air-dry soil	P_2O_5 mg/100 g, air-dry soil	Humus, %	N, %
0-20	6.35	28.25	17.80	2.76	0.13
20-40	6.28	12.60	7.40	1.50	0.06
40-60	6.25	9.25	3.95	1.30	0.05
60-80	6.20	8.85	3.10	1.30	0.05
80-100	6.23	8.25	3.00	0.97	0.04

Table 2. Physical properties of nursery soil – Fruit Research Institute Čačak

Depth, cm	Coarse sand, %	Fine sand, %	Silt, %	Clay, %	Total sand, %	Total clay, %
0-20	3.0	58.1	20.9	18.0	61.1	38.9
20-40	2.0	54.0	25.6	18.4	56.0	44.0
40-60	1.0	58.3	22.3	18.4	59.3	40.7
60-80	1.0	58.6	23.4	17.0	59.6	40.4
80-100	1.0	54.0	26.2	18.8	55.0	45.0

At the end of the first growing season (Table 2), a highly significantly greater number of survived walnut nursery plants and a highly significantly lower number of unsurvived nursery plants were observed in cv. Šeinovo than in the other selections. As for years, 2004 gave a highly significantly higher survival percentage (82.4%) as compared to 2003 (72.3%) and highly significantly lower number of unsurvived nursery plants (17.6%) as compared to 2003 (27.7%).

The highest walnut nursery plants survival rate at the end of the first growing season was obtained by cv. Šeinovo (79.9% - 2003 and 90.7% - 2004), followed by the selections G-286 (73.4% - 2003 and 82.7% - 2004), Ovčar (70.2% - 2003 and 81.9% - 2004), Elit (69.3% - 2003 and 78.6% - 2004), and G-139 (68.9% - 2003 and 77.9% - 2004). The number of unsurvived walnut plants showed the opposite tendency. At the end of the second growing season, the number of walnut nursery plants survivals in control cv. Šeinovo (Table 4) was highly significantly larger than in the other selections, whereas no significant difference was observed in number of unsurvived nursery plants.

A highly significantly lower number of walnut nursery plants survivals (68.6%) was obtained in 2004 as compared to 2005 (80.0%). No difference was observed in the number of nursery plants non-survivals between 2004 and 2005.

Table 3. Walnut nursery plants survival at the end of the first growing season

	Cultivar/Year	Number of walnut nursery plants survivals at the end of the 1st growing season (%)	Number of walnut nursery plants non-survivals at the end of the 1st growing season (%)
Cultivar (A)	Ovčar	76.0±0.92 **	23.5±0.55 **
	Elit	73.9±0.68 **	26.1±0.55 **
	G-139	73.4 ±0.92 **	26.6±0.47 **
	G-286	78.0±0.64 **	22.0±0.62 **
	Šeinovo	85.3±0.58	14.7±0.51
Year (B)	2003	72.3±0.47 b	27.7±0.47 a
	2004	82.4±0.43 a	17.6±0.42 b
ANOVA			
Cultivar (A)		**	**
Year (B)		**	**
A x B		**	**

- A and B represent cultivars and years, respectively.
- Asterisks in vertical columns represent significant differences between the means at $p \leq 0.05$ and $p \leq 0.01$ according to Dunnett's test and ANOVA (F-test) results; ns- non-significant
- The values designated with same small letters within columns for years and interaction means do not differ significantly at $p \leq 0.05$ according to Lsd test.

Walnut nursery plants survival at the end of the second growing season was highest in cv. Šeinovo (76.8% - 2004 and 87.8% - 2005), followed by the selections G-286 (70.0% - 2004 and 79.8% - 2005) and Ovčar (66.4% - 2004 and 78.7% - 2005), and lowest in Elit (66.2% - 2004 and 76.6% - 2005) and G-139 (63.4% - 2004 and 77.0% - 2005).

At the end of the first and second growing seasons (Table 5), cv. Šeinovo showed highly significantly greater plant growth as compared to Elit and G-139, whereas no significant difference was observed between cv. Šeinovo and the selections Ovčar and G-286.

At the end of the first growing season in 2003, the walnut plants exhibited highly significantly lower growth (12.5 cm) as compared to 2004 (16.2 cm). At the end of the second growing season in 2005, growth was found to be highly significantly lower (159.9 cm) than in 2004 (183.4 cm).

Walnut nursery plants growth at the end of the first growing season in 2003 was 12.9 cm in cv. Šeinovo, 12.5 cm in Ovčar, 11.9 cm in Elit, 11.6 cm in G-139 and 13.4 cm in G-286. In 2004, the growth was higher and ranged from 16.3 cm in cv. Šeinovo, 16.5 cm in Ovčar, 15.3 cm in Elit, 16.1 cm in G-139 to 16.7 cm in G-286. At the end of the second growing season during 2004, plant height of walnuts was as follows: Šeinovo – 186.1 cm, Ovčar - 186.6 cm, Elit – 178.9 cm, G-139 – 176.3 cm and G-286 – 189.1 cm. Plant height in 2005 was 169.1 cm in cv. Šeinovo, 162.4 cm in Ovčar, 152.1 cm in Elit, 157.1 cm in G-139 and 158.6 cm in G-286.

Table 4. Number of walnut nursery plants produced at the end of the second growing season

	Cultivar / Year	Number of walnut nursery plants survivals (%)	Number of walnut nursery plants non-survivals (%)
Cultivar(A)	Ovčar	72.5±0.99**	3.50±0.20ns
	Elit	71.4±0.81**	2.50±0.26ns
	G-139	70.2±1.02**	3.20±0.20ns
	G-286	74.9±0.96**	3.10±0.26ns
	Šeinovo	82.3±0.78	3.00±0.24
Year (B)	2004	68.6±0.54 b	3.70±0.17 a
	2005	80.0±0.59 a	2.42±0.13 a
ANOVA			
Cultivar (A)		**	ns
Year (B)		**	ns
A x B		**	ns

- A and B represent cultivars and years, respectively.
- Asterisks in vertical columns represent significant differences between the means at $p \leq 0.05$ and $p \leq 0.01$ according to Dunnett test and ANOVA (F-test) results; ns- non-significant
- The values designated with same small letters within columns for years and interaction means do not differ significantly at $p \leq 0.05$ according to Lsd test.

A comparison of the physical and chemical properties of the soil used in this experiment with the results obtained by other authors suggests that the soil type concerned is suitable for walnut plants cultivation. Korać (1987) reports that the most favourable soils are those containing 3% humus, 250-300 ppm K_2O , 80-100 ppm P_2O_5 and pH 7-7.5. Solar and Stampar (2004) determined the following soil content to be suitable for walnut production: 2-3% humus, 8-10 mg P_2O_5 per 100 g air-dry soil, 25-30 mg K_2O per 100 g air-dry soil and pH 6.6-7.5. Šapa (2002) recommends soils containing 2.5-3% humus, 250-300 ppm K_2O and 100-120 ppm P_2O_5 .

Given the lack of specified data on walnut nursery plants cultivation on a particular soil type, the results obtained in this study do not completely comply with those of other authors. Plant survival percentage in cv. Šeinovo was higher as compared to the results obtained by Bugarčić and Mitrović (1985), who reported the survival rate of 53.3 % and 48.3 % in cv. Šeinovo at the end of the first and second growing seasons, respectively. Elit exhibited higher survival at the end of the second growing season as compared to the survival rate of 64.0 % produced by Solar et al. (2001). The total number of nursery plants produced at the end of the second growing season was also higher as compared to the reports of 50.0 % - 60.0% obtained by Bugarčić and Mitrović (1985). According to Korać (1987), a realistic expectation is to produce 40.0-50.0% seedlings at the end of the second growing season.

Table 5. Vegetative growth of walnut nursery plants

	Cultivar/Year	Vegetive growth of walnut nursery plants at the end of the 1st growing season	Vegetive growth of walnut nursery plants at the end of the 2nd growing season
Cultivar (A)	Ovčar	14.5±0.69 ns	174.5±6.72 ns
	Elit	13.6±0.66 **	165.5±6.82 **
	G-139	13.8±0.75 **	166.7±5.58 **
	G-286	15.0±0.80 ns	173.8±8.52 ns
	Šeinovo	14.6±0.60	177.6±8.86
Year (B)	2003	12.5±0.39 b	
	2004	16.2±0.25 a	183.4±5.09 a
	2005		159.9±2.29 b
ANOVA			
Cultivar (A)		**	**
Year (B)		**	**
A x B		*	**

- A and B represent cultivars and years, respectively.
- Asterisks in vertical columns represent significant differences between the means at $p \leq 0.05$ and $p \leq 0.01$ according to Dunnett test and ANOVA (F-test) results; ns- non-significant
- The values designated with same small letters within columns for years and interaction means do not differ significantly at $p \leq 0.05$ according to Lsd test.

An analysis of the vegetative growth of nursery plants suggests that growth of cv. Šeinovo at the end of the first growing season was lower as compared to that of 21.6 cm obtained by Bugarčić and Mitrović (1985). However, at the end of the second growing season, cv. Šeinovo exhibited significantly higher growth as compared to the 168.4 cm produced by the said authors. Korać (1978) reported lower plant height in cv. Šeinovo in the first (13.29cm) and second (160.18 cm) growing seasons as compared to the results of the present study. Korać (1987) reported the average plant height of 10-25 cm and about 150 cm at the end of the first and second growing seasons, respectively. Stanisavljević and Mitrović (1997) obtained higher plant growth at the end of the first growing season, whereas the growth at the end of the second growing season was similar to the present results. Walnut plants height at the end of the first growing season was 23.4 cm in cv. Šeinovo, 24.1 cm in Ovčar, 11.2 cm in Elit, 17.6 cm in G-286 and 21.4 cm in G-139. Plant growth during the second growing season was reported to range from 187 cm - Ovčar, 185 cm - Šeinovo, 172 cm - G-286, 167 cm – G-139 to 152 cm - Elit. Elit produced higher growth in the second growing season as compared to the 120 cm obtained by Solar et al. (2001). In Romania, Achim and Botu (2001) reported nursery plants growth of 168-172 cm, in Hungary, Suvages (1990) of 150-250 cm and in Turkey, Ozkan et al. (2001) obtained 179.7-244.5 cm high nursery plants among different cultivars.

Conclusion

A walnut grafted plant has a good vegetative growth with very good lignification and a well developed root system in loamy alluvial soil.

The survival percentage of the cultivar and selections tested in this study was 77.3% at the end of the first growing season and 74.3% at the end of the second season.

The average vegetative growth of walnut nursery plants at the end of the first and second growing seasons was 14.3 cm and 171.6 cm respectively.

Walnut plants survival at the end of the first and second growing seasons was highest in cv. Šeinovo (85.3% and 82.3%) and lowest in G-139 (73.4% and 70.2% respectively).

Vegetative growth was highest in G-286 (15.0 cm) at the end of the first growing season and in cv. Šeinovo (177.6 cm) at the end of the second growing season. The lowest vegetative growth at the end of the first (13.6 cm) and the second growing seasons (165.5 cm) was observed in Elit.

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