

Propagation of plum rootstocks by hardwood cuttings

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Summary: Vegetative propagation by hardwood cuttings is a very simple and cheap method for production of plum rootstocks. The aim of this study was to examine if this propagation technique is suitable for practice of three plum rootstocks and find the time or period when the percent of rooted cuttings is maximal. Based on our results, hardwood cuttings of the rootstocks tested have the rooting potential acceptable for practice, however, for Fehér besztercei in the previous literature leafy cuttings are recommended. Fehér besztercei reached 74.0% rooting, cuttings of Sainte Julien GF 655/2 rooted in as high percentage as 78.3%, and Marianna GF 8-1 had 88.3% rooted cuttings. Rooting potential of hardwood cuttings depends on more factors, one of them can be their dissimilar sensitivity for the diverse environmental circumstances at the different propagating dates, affecting through the internal biochemical changes that can be in relation with the differences in their dormancy.

The cuttings of Marianna GF 8-1 take root easily, but in some years the conditions were less favourable for reaching maximal rooting. For taking cuttings the period from the beginning of October until December was optimal. For Fehér besztercei the optimal date of cutting collection was around the end of October, but in some years the rooting in the middle of December was also high. Sainte Julien GF 655/2 definitely rooted best in October. The treatments with different IBA concentrations in two years affected differently the rooting percentage. The rooting of Marianna GF 8-1 and Sainte Julien GF 655/2 is barely influenced by the different hormone dose in both years. Hardwood cuttings of Fehér besztercei rooted definitely better when treated with 2000 ppm IBA in comparison to untreated ones, while in 2001-2002 there was no difference between 2000 and 4000 ppm.

Key words: vegetative propagation, rooting, dormant season, Sainte Julien GF 655/2, Marianna GF 8-1, Fehér besztercei, time of cutting, IBA treatment

Introduction

Vegetative propagation by hardwood cuttings is a very simple and cheap method for propagation of plum rootstocks, but Hungarian nurserymen still do not use it. Propagation by hardwood cuttings is widely used for commercial propagation of fruit tree rootstocks, but not in Hungarian nurseries. The success of hardwood cuttings is influenced by many factors, one highly important of them is the timing of collection. Some authors found two peaks in the seasonal rooting trend: one at the beginning and one at the end of dormant season (Howard, 1980; Bassuk & Howard, 1981; Hartmann et al., 1990), but others experienced only one (Fadl & Hartmann, 1967; Guerriero & Loreti, 1975). It is not clear yet which parameters are the most determinant, but besides the environmental factors, the internal processes inside the stock plant might have an important role, the phenological and biochemical state of the stock plants influence the rooting (Bassuk & Howard, 1981; Loreti et al., 1985; Gur et al., 1988; Guskov et al. 1988). Some researchers suggest, that the presence of buds is necessary for the formation of root initials (Fadl & Hartmann, 1967; Hartmann et al., 1990), through producing some biochemical components that are essential for root formation. These components are formed only in active buds, but not during the endodormancy, when the rooting is minimal. The optimal date for successful propagation depends on the species and the cultivar.

Many researchers worked on the application of the hardwood method for plum rootstocks (Loreti et al., 1985; Howard & Ridout, 1991; Howard, 1994). According to literature (Howard, 1987; Guerriero & Loreti, 1975), the best time for collecting plum cuttings is the fall. Erbil (1997) reached maximal rooting of GF 655/2 in the period of 5–20 November; also Kracikova (1996; 1999) emphasized the importance of the right choice of propagating dates, and reached 71.5% maximal rooting. Cuttings of the same cultivar, collected in February, rooted as high percentage as 80.67% in the experiments of Uzunov (1987) if treated with 1000 ppm IBA. For the propagation of the growth reducing apricot rootstock, Fehér besztercei (*Prunus domestica*) the method by leafy cuttings is recommended (Nagy, 1980), but in previous trials the establishing rate was never above 50% (Magyar, 2003).

The aim of this study was to examine the propagation method by hardwood cuttings. The optimal time of cutting collection and different concentrations of hormone treatment are also studied.

Material and method

In the experiment, hardwood cuttings of three plum rootstocks were collected throughout three dormant seasons in 3–4 weeks intervals, and after cold storage, planted into field conditions in the following spring.

Plant material

Hardwood cuttings of the following three plum rootstocks were taken:

- 'INRA Marianna GF 8-1' is a vigorous *Prunus munsoniana* WIGHT & HEDRICK x *Prunus cerasifera* EHRH. hybrid, that roots easily.
- 'INRA Sainte Julien GF 655/2', medium vigorous *Prunus insititia* JUSL., which seems to be promising for Hungarian conditions.
- 'Fehér besztecei', *Prunus domestica* L., medium vigorous rootstock, recommended for apricot trees.

The Hungarian rootstock Fehér besztecei was elected for this experiment, to test its propagation by hardwood cuttings. The INRA Sainte Julien GF 655/2 is also a new rootstock for Hungarian commercial orchards, and no data are published about propagation results by hardwood cuttings in Hungarian conditions. Neither for Marianna GF 8-1, for which propagation by hardwood cuttings is widely used in West-Europe.

The diameter of the cuttings collected was 7–8 mm, prepared to the length of 20–25 cm from the basal part of the shoot.

Dates of cutting collection

Cuttings were collected in three-four weeks intervals:

- In the first propagating season, 1997–1998: October 20, November 26, December 15, January 28, and February 26.
- In the second season, 2000–2001: October 25, November 08, November 29, December 18, January 10, January 31, February 21.
- In the third season, 2001–2002: September 19, October 08, October 29, November 19, December 10, January 07, January 28, February 18.

The same experiment was carried out also in 1998–1999 hardwood cutting season, but due to the non-optimal technical conditions in this period, the data is not presented here.

Treatment of the cuttings

After fungicide treatment, the cuttings were put into cold storage for one day to desiccate. The next day they were treated with rooting hormones, dipped into indole-butyric acid (IBA) dissolved in alcohol for five seconds. In the first year only 2000 ppm solution was used, because most authors advice this concentration (Nahlawi & Howard, 1972; Nahlawi & Howard, 1973; Reighard et al., 1990; Howard & Ridout, 1994; Nicotra & Damiano, 1975). In the second season 2000 ppm and 4000 ppm, and in the 2001–2002 propagating season 2000 ppm and 4000 ppm treatment and an untreated control were set up. After treatment, the cuttings were put into cold storage into wet perlite until planted in April into field conditions. The number of rooted cuttings was recorded in October after lifting the plants. The number of rooted cuttings were recorded in October, also the quality of the roots and the quantity of shoot growth.

Statistical analysis

The results were assessed by one-way analysis of variance with the Duncan's multiple range test at a level of LSD=5%.

Results

1. Potential rooting capacity

Potential rooting capacity of hardwood cuttings was calculated using the data of treatments resulting maximum rooting in the season. The results varied by rootstocks and years (Table 1). Comparing the average rooting results through rootstocks achieved in the various years, no significant differences were found between the average through years (63.93–74.93%). With the applied propagating technology the absolute maximum of rooting ability of Fehér besztecei was 74.0%, that of GF 655/2 was 78.3%, and 88.3% for GF 8-1. This means that all of these cultivars have the potential of high percentage rooting. Our results confirm the data published by other authors: Kracikova (1996) & Uzunov (1987) achieved similar percentages with the Sainte Julien GF 655/2.

On the average of the three years' data, the Hungarian cultivar Fehér besztecei reached maximal rooting around

Table 1 Potential rooting capacity reached in the years of the hardwood cuttings treated with 2000 ppm IBA

Rootstocks	Potential rooting capacity (%)							Mean ⁴	
	1997–1998		2000–2001		2001–2002				
Fehér besztecei	74.0	(Oct. II.)	71.7	(Oct. III.)	52.5	(Oct. III.)	66.07	a	
St. Julien GF 655/2	46.0	(Oct. II.)	78.3 ¹	(Oct. III.)	67.5 ²	(Oct. III.)	63.93	a	
Marianna GF 8-1	64.0	(Dec. II.)	88.3	(Oct. III.)	72.5	(Nov. II.)	74.93	a	
Mean ³	61.33	a	79.43	a	64.17	a			

¹ 4000 ppm

³ SD = 22.48

² untreated

⁴ SD = 27.35

The dates in brackets are indicated in decades. The different letters mean a significant difference among the data.

66.07 %, the Sainte Julien GF 655/2 around 63.93 %, and the Marianna GF 8–1 had an average maximal rooting about 74.93 %. These results are acceptable for practice. Based on these results the hardwood cuttings can be recommended instead of leafy green cuttings.

2. Timing of cutting collection

The comparison of rooting capacity of hardwood cuttings taken at different dates showed a strong effect of timing, which is varied by rootstocks also.

In the first season (1997–1998) hardwood cuttings of Fehér besztercei showed highest rooting capacity in the middle of December (74.0%). 50.0% rooting was achieved at the end of November, but in January and February it was very low (2.0%; 6.0%). In the second season (2000–2001) the highest rooting percentages were found at the end of October: 71.7 %, but also the seasonal pattern of rooting showed a rise at the end of the dormant season, with 55.0% rooting at the end of February. In 2001–2002, the cuttings collected in the third decade of October rooted best, 52.5% stayed alive. From the middle of September until the middle of November, the results were not significantly different (27.5%; 45.0%), but from the beginning of December the rooting was definitely lower (25.0%–7.5%). In general the best rooting could be achieved at the end of October (22.0%–71.7%), but in some years the end of November or the middle of December was also an optimal period for cutting collection with the rooting percentage as high as 74.0%. The cause of the presence or absence of the peak in the rooting ability in December might be the different weather conditions throughout the dormant season or just before the cutting collections. Usually the rooting dropped to a minimum after December, except in 2000–2001 (Figure 1).

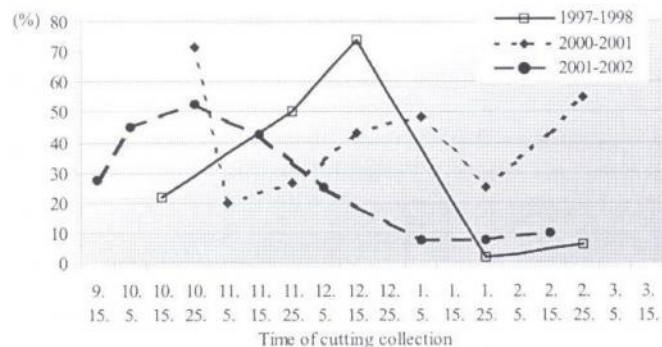


Figure 1 Rooting percentages (%) of Fehér besztercei hardwood cuttings, treated with 2000 ppm IBA.

The highest rooting percentage of the hardwood cuttings of GF 655/2 in the 1997–1998 propagating season was 46.0%, when the material was collected in the middle of October and treated with 2000 ppm IBA. Not significantly, but a lower-rate rooting was found in the middle of December (26.0%) and at the end of February (28.0%). At the end of November and January the rooting dropped to

14.0% and 6.0%, respectively. The best rooting of the whole experiment took place if the cuttings were collected in the period between the end of October and the end of November in 2000 (71.7%–65.0%). In the same season, from the middle of December the cuttings showed a significantly lower rooting potential: 40.0–23.3%. The propagating season of 2000–2001 was the most successful period for rooting the hardwood cuttings of GF 655/2; almost 50% of the cuttings took on the average of all dates. In the last season the best results could be achieved at the end of October, 47.5% rooted at this time, but in the middle of November the significantly not different 37.5% result was obtained. From December, the rooting percentage dropped to a very low rate (2.5%). It is clear, that the best rooting can be achieved in the end of October (46.0%; 78.3%; 67.5%), but in some years other periods may give satisfactory results. Such as cutting collection in November was also good concerning rooting in 2000 (65.0 %) (Figure 2).

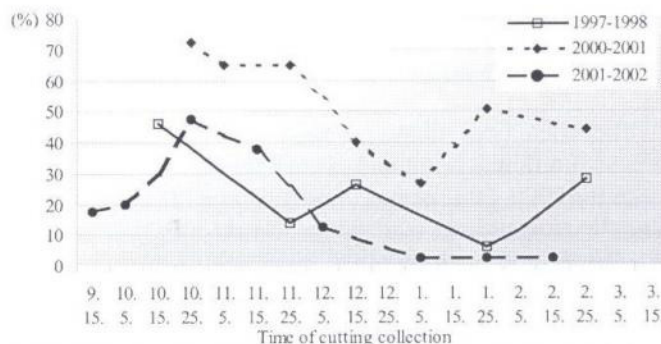


Figure 2 Rooting percentages (%) of St. Julien GF 655/2 hardwood cuttings, treated with 2000 ppm IBA.

Marianna GF 8-1 roots very easy, also without any treatment with rooting substances, but according to literature 2000 ppm IBA is usually applied (Nahlawi & Howard, 1972; Nahlawi & Howard, 1973; Reighard et al., 1990; Howard & Ridout, 1994; Nicotra & Damiano 1975). In 1997–1998 propagating season, the best results were found between the middle of October and the middle of December (46.0%–64.0%). In the second half of the hardwood-cutting period, the rooting was poorer (26.0%–24.0%). In the following propagating season (2000–2001) at the end of October, in the middle of December, and at the beginning of January the highest rooting results of the whole experiment were found: the rooting was above 80%. In this term, the rooting did not drop under 50%. In the last propagating season, the best rooting percentages were in October and November (52.5%; 70.0%; 72.5%). In the second decade of February the rooting was very weak, only 7.5% of the cuttings survived (Figure 3).

The optimal date of hardwood cutting collection can be around the end of October for Fehér besztercei, but in some years the cuttings collected in the middle of December may give satisfactory rooting results as well. This woody propagation material of Sainte Julien GF 655/2 definitely

roots best if assembled in October. For the easy-rooting cultivar, Marianna GF 8-1, the period from the beginning of October until December can be optimal for taking the cuttings, but in some years this term can be longer, even in January the rate of rooting can be also high.

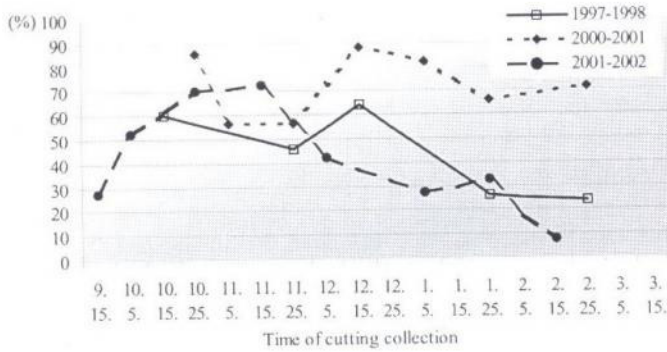


Figure 3 Rooting percentages (%) of Marianna GF 8-1 hardwood cuttings, treated with 2000 ppm IBA.

3. Effect of hormone treatments

There are two winter propagating seasons, where the effects of different hormonal treatments could be compared.

In the 2000–2001 period of propagation the optimal time for collecting cuttings of Fehér besztecei was at the end of October. This was the only time when significant differences occurred between the results of the 2000 and 4000 ppm treatments of IBA, the lower concentration turned to be better. On the rest of the dates the rooting percentages were significantly similar. This phenomenon could be observed also in the following hardwood cutting season, when the dissimilarities between the untreated and treated cuttings were categorical only in the first, better-rooting period of the season. The 2000 and 4000 ppm IBA improved the rooting of cuttings collected on different dates, but the comparison of two concentrations showed hardly differences, so the 2000 ppm treatment can be recommended to improve the rooting of hardwood cuttings (Figure 4–5).

On the average the propagation of the cultivar Sainte Julien GF 655/2 was more successful with the lowest concentration of IBA both years. The discrepancy in rooting results was remarkable only at the beginning of November and at the end of January in the first rooting season, and on 19th September and 7th January in the 2001–2002 period. In the second season the dissimilarity occurred between the rooting of the untreated and treated cuttings, and no significant differences could be proved between the 2000 and 4000 ppm IBA treatment (Figure 6–7).

Cuttings of Marianna GF 8-1 rooted almost following the same pattern in the two seasons. On the first date in the 2000–2002 propagating period the 2000 ppm IBA was more effective, and the following term the significant difference was observed on three dates (in the middle of November, the first decade of January and on 18th February), but it is varied which was the better. This proves the practical propagation technique, when applied rooting substances are not used (Figure 8–9).

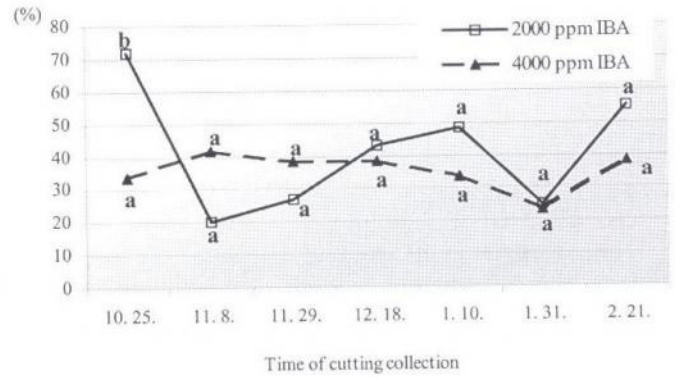


Figure 4 Rooting percentages (%) of Fehér besztecei hardwood cuttings in 2000–2001 treated with different concentrations of IBA.

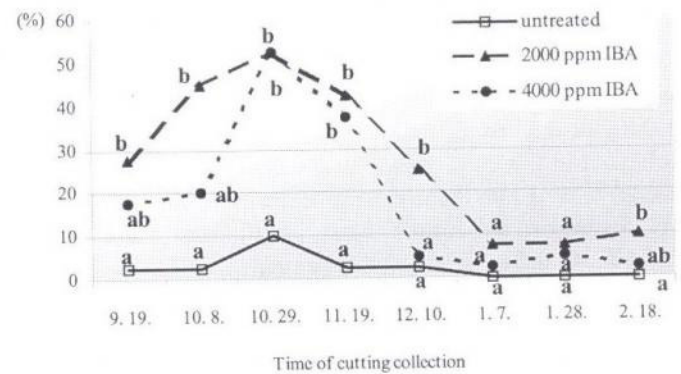


Figure 5 Rooting percentages (%) of Fehér besztecei hardwood cuttings in 2001–2002 treated with different concentrations of IBA.

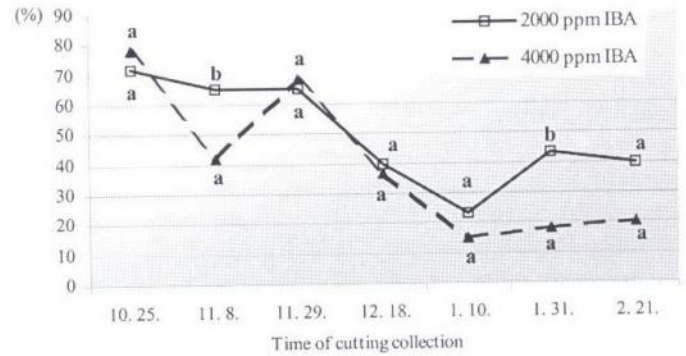


Figure 6 Rooting percentages (%) of Sainte Julien GF 655/2 hardwood cuttings in 2000–2001, treated with different concentrations of IBA.

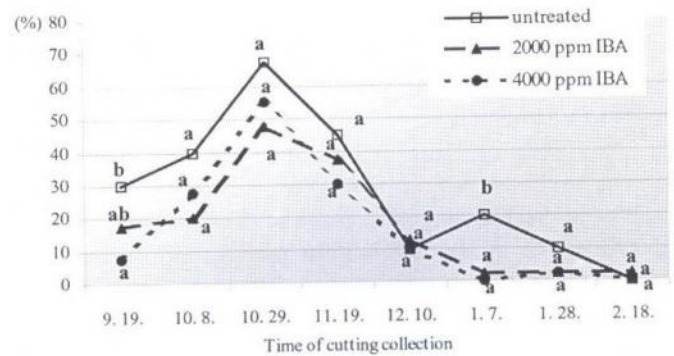


Figure 7 Rooting percentages (%) of Sainte Julien GF 655/2 hardwood cuttings in 2001–2002, treated with different concentrations of IBA.

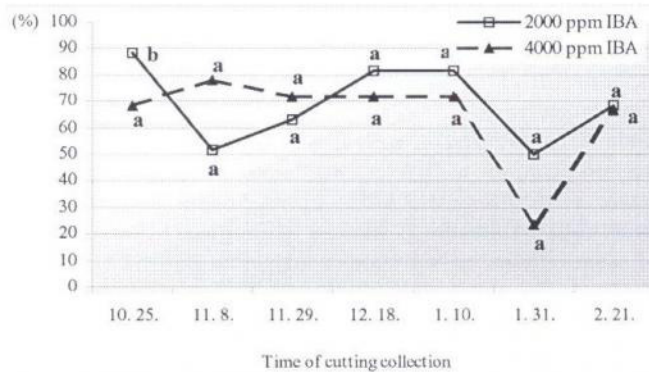


Figure 8 Rooting percentages (%) of Marianna GF 8-1 hardwood cuttings in 2000–2001, treated with different concentrations of IBA.

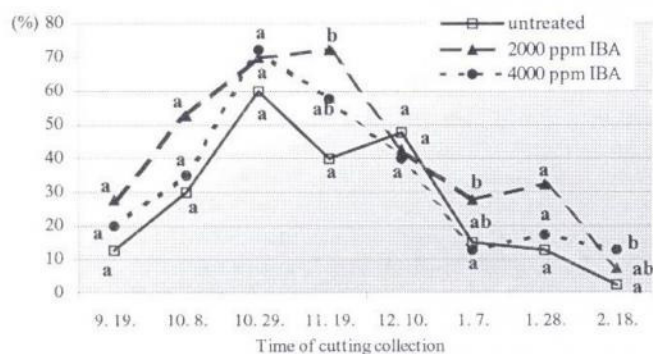


Figure 9 Rooting percentages (%) of Marianna GF 8-1 hardwood cuttings in 2001–2002, treated with different concentrations of IBA.

Conclusions

Based on results of three rootstocks propagation we can conclude that all of these cultivars have the potential of rooting in high percentage. The maximal rooting capacity of the three different rootstock cultivars showed no significant differences, in this experiment the absolute maximal rooting of Fehér besztercei was 74.0%, that of GF 655/2 was 78.3%, and 88.3% for GF 8–1.

However, the seasonal rooting ability of these cultivars' hardwood cuttings followed different patterns. The cause of this phenomenon could be their dissimilar sensitivity for the diverse environmental circumstances on the different propagating dates during the four years, affecting through the internal biochemical changes that can be in relation with the differences in their dormancy. The rooting percentage did not increase significantly just before bud break every year, as Howard (1987) found. Our results only partly proved that the cuttings collected in the middle of the dormant season do not root in high percentages (Hartmann et al., 1990), because the overall highest rate of rooting of Fehér besztercei happened in the middle of December. Other researchers advice this period also for propagation, when the vernalization was not fully completed (Guerrero et al., 1975). For Fehér besztercei the optimal date of hardwood cutting collection can be around the end of October, but in some years the cuttings collected in the middle of December

may give satisfactory rooting results as well. Finding the reasons or the causes of the rooting peak in December needs further examinations. This woody propagation technique of Sainte Julien GF 655/2 definitely works best if the material is assembled in October. The cuttings of Marianna GF 8-1 root easily, but some years the conditions could be less favourable for reaching maximal (almost 100%) rooting. The period from the beginning of October until December can be optimal for taking the cuttings, but in some years, this term can be longer, even in January the rate of rooting can be also high. Similar results can be expected every year, but the maximum of rooting can be on different dates, maybe due to the diverse environmental and internal biochemical factors, that are under further examination.

The optimal IBA treatment for the cuttings of Fehér besztercei was 2000 ppm. From this experiment, it seems that GF 655/2 roots best if not treated with any rooting hormone. This statement requires further studies, as it was studied only in one season. Our results confirm the practical propagation technique, when applied rooting substances are not used in the multiplication of Marianna GF 8–1.

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