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Parameters that Influence Rooting and Survival of Peach Cuttings

G. Bartolini,[1] P. Pestelli,[1] L. Tazzari,[1] and M. A. Toponi[2]

Abstract

To obtain a better understanding of the factors limiting the survival rate of self rooted cuttings in peach (*Prunus persica* L. Batsch) after transplantation, some studies were performed. First, was examined the influence of shoot orientation and side, on the stock plants and the diameter of the shoots from which the hardwood cuttings were been taken. The results indicated that cuttings made from plagiotropic south-facing shoots, and, in general, the cuttings with a 6-10 mm diameter show higher rooting values in comparison with smaller diameters. In a second experiment performed with material chosen with the parameters just defined we studied the effect on the cutting of basal heating (14 and 42 days) in combination with or without any previous cold treatment (90 days at 4°C) of the shoots. The cold and basal heating treatments may enhance the rate and amount of rooting. The survival of the rooted cuttings can be facilitated avoiding any trauma during transplanting. The carbohydrate analyses indicate that the 6-10 mm diameter shoots contain a higher amount of soluble carbohydrates compared to the cuttings coming from cold treated shoots.

Introduction

For peach (*Prunus persica* L. Batsch), as for many other species, seasonal variations in rooting have been noted (9, 18, 19). These seasonal variations may be the result of natural nutritional and/or physiological environmental factors (15, 17). These factors are able to influence the intrinsic conditions of the stock plant in different ways and influence the success or failure of the rooting of cuttings (11). Among these factors are the quality and intensity of light (8, 11, 24). The expression of these features varies from species to species (1).

A number of researches have investigated the effect temperature of the soil and air (20), the CO_2 supply (23) and the mineral nutrition of the stock plants on rooting. Some studies have shown that, depending on the plant studied, a vigorous stock plant growth is not necessarily associated with good root formation of the cuttings (2).

In three cultivars of peach, Marini (22) showed that rooting of semihardwood cuttings were influenced both by the position of the shoots on the stock plant and by their diameter, however subsequent survival data were not reported.

The carbohydrate availability in stock plants and cuttings has been studied extensively (26). Even if the levels of carbohydrates affect rooting, no direct effect has yet been demonstrated in peach (3, 12).

Survival of self-rooted peach cuttings after transplantation is the factor most limiting its propagation; a high percentage of newly rooted cuttings develop necrotic areas at the base (5, 13, 14). Various techniques were used successfully with some herbaceous and woody plants to promote and facilitate rooting and survival of the peach cuttings. Among these are: treatment of the cuttings by dipping in water, basal heating, cold storage and girdling and wounding, etc. (5, 6, 9, 12, 16). Different substrates (21) and various gaseous treatments on the soil (23) have also been used. However, problems related to rooting and survival have not yet been resolved because in some cases the range of variability is very high and the results aren't easy to repeat.

In order to resolve the difficulties with rooting and survival we focused our efforts

[1]Institute for the Propagation of Woody Plants. C.N.R. Via Ponte di Formicola 76 - 50018 Scandicci (FI)-Italy

[2]Institute of Plant Biochemistry and Ecophysiology. C.N.R. Km 29.300 Via Salaria, Monterotondo Scalo, (Roma) Italy.

on the influence of the stock plant and nursery practices.

The objectives of this research were to evaluate the role played by orientation, side and diameter of peach hardwood cuttings on rooting and to determine the relationship with the carbohydrate content of the shoots.

Materials and Methods

Influence of habit of stock plants. Shoots were taken from 10-year-old peach stock plants, cv Fertilia I grown in fields near Florence, Italy. Each year trees are pruned in winter so that 1-year-old vegetative branches can be obtained the following autumn. The material for the present experiment was gathered in mid-October 1996 choosing randomly a block of trees to taken shoots on basis of their orientation, orthotropic (vertically oriented) and plagiotropic (horizontally oriented); by their side, north or south; and by their diameter, 3-6 mm or 6-10 mm.

For each eight these (120 cuttings), ten 30-cm long cuttings of twelve replicates, and 20 cuttings for the carbohydrate analyses were taken (total 140 cuttings). The basal end of each cutting was dipped in 2000 mgl^{-1} IBA (Merck) 25% in hydroalcoholic solution for 5 sec. Control cuttings, other eight these (120 cuttings), were prepared without IBA treatment with only 25% hydroalcoholic solution. All the cuttings were placed randomly into a perlite bed having basal heating at 18-20°C and moistened by mist (10 s every 4 h).

After 45 days, the percentage of cuttings which had rooted and the total root length (root number x root length/cutting) were recorded. The experiment was a 2x2x2 factorial in a completely randomised design, results were analysed using Tukey's test ($P \leq 0.05$).

A 1-cm sample of the basal end of cuttings, 20 randomly chosen, was taken at the moment of collection and at the end of the basal heating treatment to evaluate the soluble carbohydrate levels of the 8 different theses.

Influence of cold treatment and basal heating. For the second experiment, peach shoots were collected in mid-October from the same block of trees as the first experiment and the choice of samples was based on the results obtained in the first experiment.

At the moment of collection, the shoots, plagiotropic-south-facing, 6-10 mm, were subdivided into two groups: the first was comprised of shoots which were immediately made into cuttings for rooting; the second group was stored in polyethylene bags for 90 days in a climatic cabinet at 4°C to be studied the following January. Cuttings 30 cm long and 6-10 mm in diameter from both groups, before rooting, were treated dipping the basal ends into a 2000 mgl^{-1} IBA in 25% hydroalcoholic solution for 5 sec, while the controls consisted of samples from the two groups that had undergone the same procedures at the same times but without any IBA treatment.

The experimental protocol called for 12 replicates, the 10 cuttings (120 cuttings), for each of the 4 combinations was cold storage/basal heating. The cuttings were randomly placed in a perlite bed in the greenhouse with air temperature of 2-10°C in winter and 5-15°C in spring. Cuttings were moistened by mist (10 s every 4 h). Basal heating (18-20°C) was maintained for 14 days, when the first signs of rooting occurred, and for 42 days when rooting was complete (4). After 14 or 42 days, both rooted and unrooted cuttings were transplanted with care into soil under a PVC tunnel.

Data of rooting percentage and total root length were recorded at the end of the basal heating periods (14 and 42 days). Survival of all transplanted cuttings was recorded in July. Data were analysed with analysis of variance and using Tukey's test ($P \leq 0.05$).

Soluble carbohydrate analyses. Soluble carbohydrate analyses were carried out on 1-2 cm samples taken from the basal end of the 20 cuttings from the two experiments.

The samples were freeze-dried at –50°C, stored at –20°C and subsequently ground. Extracts of the carbohydrates were removed 3 times, every 24-h, at room temperature, using ethanol (75%) at pH 7. The extract was filtered through a BIO-REX 5 (BIO-RAD). It was analysed 3 times using HPLC

Table 1. Rooting of peach cuttings as affected by shoot orientation, side of the shoot and shoot diameter (collected in mid-October 1996 and treated with IBA).

Orientation	Shoot Side	Diameter (mm)	Rooting (%)	Total root Length/cutting(mm)
Orthotropic			73.1 b[z]	19.0 a
Plagiotropic			79.9 a	16.1 b
	North		70.7 b	16.3 b
	South		82.2 a	18.8 a
		3-6	66.3 b	12.0 b
		6-10	86.4 a	23.1 a
		Interactions		
Orthotropic	North	3-6	59.5 d	12.6 cd
		6-10	78.0 c	21.4 b
	South	3-6	73.0 c	15.0 c
		6-10	82.0 bc	26.9 a
Plagiotropic	North	3-6	55.0 d	10.1 d
		6-10	90.5 ab	21.2 b
	South	3-6	79.0 c	10.3 d
		6-10	95.0 a	22.9 b

[z]Mean separation within columns by Tukey's test ($P \leq 0.05$).

(Perkin-Elmer), with a Waters Sugar-Pak 1 column, water as mobile phase; flow rate was 0.5 ml/min: temperature was 90°C. A refractive index detector (LC-30 RI) was employed. Sucrose, glucose, fructose, sorbitol and prunasin (cyanogenetic glucoside) were identified according to retention times of sugar standards (25).

Results

The cuttings that had not been treated with IBA did not root. Plagiotropic shoots

Table 2. Soluble carbohydrate content ($mg.g^{-1}$ D.W.) in peach shoots (mid-October 1996).

			Total sol. Carbohyd.	Sucrose	Glucose	Fructose	Sorbitol	Prunasin
Shoot orientation (1)								
Orthotropic			124.3 a[z]	23.4 b	10.6 a	20.6 b	69.7 a	133.6 a
Plagiotropic			123.9 a	26.5 a	9.5 a	23.2 a	64.8 a	100.6 a
Shoot side (2)								
North			116.1 a	24.0 a	8.2 b	19.8 b	64.0 a	101.1 a
South			132.1 a	25.9 a	11.8 a	23.9 a	70.5 a	133.1 a
Shoot diameter (3)								
3-6 mm			140.9 a	26.6 a	10.2 a	24.8 a	79.2 a	144.6 a
6-10 mm			107.4 b	23.3 b	9.9 a	18.9 b	55.3 b	89.6 b
Interactions								
Orthotropic	North	3-6	64.4 bc[z]	12.2 bcd	4.5 bc	9.8 cd	37.8 b	56.3 bc
		6-10	50.6 c	11.0 d	3.4 c	9.0 d	27.6 c	50.9 bc
	South	3-6	79.9 a	12.1 bcd	7.8 a	12.5 b	47.5 a	119.2 a
		6-10	53.1 c	11.4 cd	5.4 b	9.8 cd	26.4 c	40.7 cd
Plagiotropic	North	3-6	65.0 abc	13.6 ab	4.4 bc	11.6 bc	35.5 b	60.6 b
		6-10	51.6 c	11.1 d	4.1 c	9.2 d	27.1 c	34.3 d
	South	3-6	72.1 ab	15.2 a	3.6 c	15.7 a	37.5 b	52.9 bc
		6-10	58.9 bc	13.0 bc	6.7 a	9.8 cd	29.3 c	53.2 bc

[z]Mean separation within columns by Tukey's test ($P \leq 0.05$).

with diameters ranging from 6 to 10 mm rooted best (Table 1). Northern (90.5%) vs. southern exposure (95%) had little influence on success.

Either the orientation or side of shoots did not affect the total carbohydrate content (Table 2). Thin shoots had higher total carbohydrate content than thick shoots. Therefore, even if the smaller diameter samples had a reduced rooting value, they had a statistically significant higher level of total soluble carbohydrates when comparing north vs. south.

A comparison between Table 1 and 2 shows that a low concentration of carbohydrates, particularly sorbitol, were related to elevated rooting. The 42-day basal heating treatment strongly stimulated rooting and total root length, compared to the 14-day basal heating period, although the survival was lower than that of the 14-day treatment (Table 3). In both cases, no cold treatment preceding basal heating stimulated rooting percentages significantly.

The reduced rooting with cold treatment may be able to decrease the extent of trauma and allow for the repairing of the damage caused by transplanting: thus, it may influence survival. The data support our unpublished data. In addition this type of rooting response in hardwood cuttings has previously been reported (4, and data unpublished).

Conditions for rooting and root growth, even under different environments, may led to a better survival rate, if the period of basal heating (between 14 and 42 days) and cold treatment are varied. To confirm this hypothesis further study is needed to determine if the type of storage procedure is an important factor.

Until the 42nd day of basal heating with no cold storage, total soluble carbohydrates and sorbitol and prunasin diminished (total carbohydrates dropped from 61.6 to 28 mg x g^{-1} d.w.), mainly during the first 14 days (Table 4). Even when cuttings received basal heating after cold storage, soluble carbohydrates were higher in cuttings without cold treatment (from 78.8 to 15.5 mg x g^{-1} d.w.) and the amount diminished more drastically. These results are in accord with others obtained by Veierskov (26) and Bartolini et al. (7) in *Vitis*.

Discussion and Conclusions

The variations in rooting and survival of cutting and total carbohydrate concentration found in the different experimental combinations indicate that the physiological and morphological conditions of the shoot on the stock plant may play important roles in the rooting and survival of the cuttings.

The rooting response most likely indicates and confirms that the shoot diameter is more important than its characteristics on the stock plant (22). The hypothesis that a site of carbohydrate accumulation within the plant favours better rooting was not supported by our data. In our experimental conditions, rooting was better in sample cuttings with low carbohydrate levels, collected in mid-October, than in those collected at the same time but whose shoots had higher carbohydrate levels.

To obtain a large number of good quality plants with a high survival rate follow-

Table 3. Survival of rooted peach cuttings treated with IBA (2000 mgl^{-1}) after different periods of cold storage (4°C) and basal heating (18°C).

	Cold storage (days)			
	mid-October 1996		mid-January 1997	
	0	0	90	90
	Basal heating (days)		Basal heating (days)	
	14	42	14	42
Rooting (%)	48.3 b[z]	95.8 a	0.0 d	34.0 c
Root number/cutting	3.1 c	11.5 a	0.0 d	9.2 b
Root length (cm)/cutting	0.5 c	3.7 a	0.0 c	1.9 b
Total root length (cm)/cutting	1.5 c	42.6 a	0.0 d	17.5 b
Survival (%)	58.3 a	40.0 b	2.5 c	8.3 bc

[z]Mean separation within rows by Tukey's test ($P \leq 0.05$).

Table 4. Soluble carbohydrates and prunasin (mg g^{-1} D.W.) in peach cuttings treated with IBA (2000 mgl^{-1}) after different periods of cold storage (4°C) and basal heating (18°C).

	Cold storage (days)					
	0	0	0	90	90	90
	Basal heating (days)					
	0	14	42	0	14	42
Sucrose	12.0 a[z]	8.5 b	9.0 ab	1.5 c	13.4 a	5.8 b
Glucose	5.5 b	8.7 b	7.7 b	21.8 a	8.3 b	2.8 c
Fructose	5.4 bc	10.8 b	7.3 bc	20.1 a	9.6 b	3.9 c
Inositol	3.0 b	0.0 b	0.0 b	19.4 a	0.0 b	0.0 b
Sorbitol	35.7 a	7.1 cd	4.0 d	16.0 b	11.3 bc	3.0 d
Total soluble carboh.	61.6 b	35.1 cd	28.0 d	78.8 a	42.6 c	15.5 e
Prunasin	24.6 a	6.2 c	3.9 cd	21.0 a	16.3 b	2.3 cd

[z]Mean separation within rows by Tukey's test ($P \leq 0.05$).

ing transplanting a high percentage of rooting is not essential.

Survival is improved by providing the cuttings with basal heat that can stimulate root primordia formation. Cuttings should be transplanted when the roots are not yet visible or are only a few mm long (14 days), thus avoiding traumas to the cutting root system.

In our experimental conditions, when cold storage of the cuttings was considered as a single factor, it did not appear to favour sample survival. This treatment, nevertheless, increased the possibilities of rooting and survival. It may provide practical opportunities for transplantation of self-rooted peach cuttings. However, this procedure can be accomplished only after appropriate conditions for cold and basal heating treatments are more fully explored and defined.

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Pecan Scion Cultivar Effects on Freeze Susceptibility of the Rootstock

S. SANDERLIN

Abstract

Unusual freezes occurred in 3 of 5 years following planting of a pecan orchard. Observations on the damage caused by these freeze events are reported. In one freeze event, scions of cultivar 'Pawnee' were less susceptible to being killed by moderately low temperatures than were nine other cultivars or ungrafted 'Elliott' seedlings. The 'Pawnee' scion appeared to impart some resistance to freeze damage to its rootstock.

Introduction

Cold injury to pecan trees has been reported from freezes during the fall, winter, and spring (3, 7, 11, 12, 15, 16). Differences in cultivar response to early fall freezes has been in the form of tree death or injury to the limbs and the trunk (3, 12, 15, 16). Even though fall freeze damage occurs frequently (14), few published reports document the damage. Reports of damage caused by severe winter freezes are more frequent (2, 7, 9, 14, 17). Reports of damage to pecan trees induced by early fall freezes have been made from Oklahoma, Alabama, and New Mexico (3, 12, 16). Some of the more freeze susceptible cultivars reported include 'Mahan,' 'Desirable,' 'Wichita,' 'Kiowa,' 'Mohawk,' 'Houma,' and 'Melrose.'

Cultivar susceptibility to cold temperatures varies with specific weather conditions, tree size, crop load, nutritional sta-