Studies on Stem Cuttings of Kiwi (*Actinidia chinensis* PL. CV Bruno)

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ABSTRACT

The work was carried out to study the effects of some auxins and boron in the rooting of kiwi (Actinidia chinensis Planch cv Bruno) stem cuttings.. These cuttings were treated on the base individually with H_2O; NAA 300 mg.L^{-1}; IBA 300 mg.L^{-1}; NAA 300 mg.L^{-1} + Boron; IBA 300 mg.L^{-1} + Boron; NAA 0,5%-talc and IBA 0,5%-talc. After the treatments, the cuttings were placed in styrofoam trays with vermiculite under moist conditions for 120 days. The evaluation of auxin and boric acid effects were made by observing rooted stem cuttings percentage; reducing and total sugar analysis (g/100 g of dry matter); and tryptophan analysis (in µg/100 mg of dry matter). The effects of such treatments were observed during four seasons of the year. The results showed that summer season was the best for rooting. Use of IBA or NAA in the cuttings showed to be unnecessary.

Key words: *Actinidia chinensis*, NAA, IBA, boron, rooting

INTRODUCTION

Kiwi multiplication is generally carried out through sexual reproduction and by vegetative propagation using stems and roots for new plants. The propagation for stem cuttings is the usual method for the multiplication of that species (Bosman & Uys, 1978). In the multiplication through hardwood cuttings low rooting percentage were observed. On the other hand, in the propagation for semihardwood cuttings up to 90% of rooting were observed. Thus, this method could be used for fast multiplication of that species (Bosman & Uys, 1978).

Hartmann *et al*. (1997) reported that the auxins stimulated and speeder up the cutting's rooting. Lewis (1980) emphasized a metabolic relationship between the boron, phenolic composites and peroxidases/IAA-oxidases, which interacted with each one and with the auxins. The relation between boron, auxin and peroxidase/IAA-oxidase activity are contradictory. For example, lack of boron increased the peroxidase activity in many tissues, but reduced in some other tissues (Dutta & Mc Ilrath, 1964). The IAA-oxidase activity was also reported to be increased by boron (Parish, 1968).

Some authors related the influence of the season on the cutting's rooting. The variation in the rooting capacity was attributed to the plant growth phases (Mercado Flores & Kester, 1966) and to the cuttings biochemical state (Basu *et al*., 1973).

The purpose of the work was to study the effect of auxins and boron in the rooting of kiwi stem cuttings, aiming at the posterior new plant production.

MATERIAL AND METHODS

Cuttings of semihardwood kiwi (*Actinidia chinensis* Planch cv Bruno) branches were used with two nodes and two leaves cut in half with approximately 10 cm of length. Approximately,

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1 cm of cuttings base was treated with IBA 0.5% - powder and NAA 0.5% - powder in the talc form. The IBA at 300 $mg.L^{-1}$ was dissolved in alcohol and the solution was completed with distilled water. For the treatments with auxins plus boric acid, the latter was dissolved in the solution of NAA or IBA at 150 mg/ml. After that, 2.5 cm of the cuttings base was immersed in these solutions for approximately 24 hours.

The combinations between auxins and boric acid were carried out through the following treatments: H_2O (control); NAA 300 $mg.L^{-1}$; IBA 300 $mg.L^{-1}$; NAA 300 $mg.L^{-1}$ + B; IBA 300 $mg.L^{-1}$ + B; NAA 0.5%-powder and IBA 0.5%-powder.

After the treatments, the cuttings was placed in styrofoam trays with vermiculite and placed under moist conditions for 120 days. The evaluation of auxins and boric acid effects on the rooting of kiwi stem cuttings was carried out through the followings: the rooted cuttings percentage; b. reducing and total sugars analysis (g/100 g of dry matter) and c. tryptophan analysis (µg/100 mg of dry matter).

The biochemical evaluations was carried out in cuttings' samples before being placed in the rooting medium and after, at the time of the evaluation same them.

All the seven treatments was tested during 4 different times (months), corresponding to spring, summer, autumn and winter. This was carried with a purpose to select the best havest time for the cuttings' collect of kiwi branches, aiming at higher rooting success.

The determination of reducing and total sugars was carried by the Somogy-Nelson method (Nelson, 1944) for dry samples. The method for the tryptophan determination was as described in the Plant Biochemistry Laboratory of the CENA/USP (Kersten, 1990).

The entirely randomized design with 7 treatments at each season with 2 replications was utilized. Each parcel had 16 cuttings. The results for rooted cuttings percentage were been submitted to the variance analysis (F test) at the time of summer, autumn and winter (data transformed into arc sen $\sqrt{(x/100)}$) and the averages were compared through the Tukey test with 5% of probability. The data for spring time not analyzed due to the high number of null values.

RESULTS AND DISCUSSION

The results of kiwi cv Bruno cuttings' rooting percentage are shown in Table 1. The branches' cuttings collected in the spring had lower rooted cuttings indicating to be unfavorable period for the collection and the cuttings production. Kiwi cuttings collected in the summer that had not received treatment (control) had the highest rooting percentage. Cuttings that had received treatment with 300 IBA $mg.L^{-1}$ + B showed high rooting percentage. Boron addition to the auxins solutions increased the rooting percentage at this time of evaluation.

The treatment with NAA 300 $mg.L^{-1}$ + B showed higher percentage of rooted cuttings, in the autumn collect but without significance difference. Control cuttings and those treated with IBA 0.5%-powder were the most effective treatments in the rooting of kiwi branches cuttings collected in the winter. Morever, it also did not produced cuttings with high rooting potentiality.

Lawes & Yes (1980) reported fast roots formation in cuttings collected in the summer similar observation were made by Poves (1982). Costa & Baraldi (1983) and Vitagliano *et al*. (1983) observed low rooting percentage in cuttings collected in the summer. In the present work, however the best time of kiwi branches collect for the cuttings production was the summer.

The boron addition had influence in the rooting percentage increase only in the cuttings of branches collected in the summer. In the attempt to discover the action of boron in the rooting of cuttings, some works have been carried out. Gauch & Dugger (1953) considered the existence of a direct control of the carbohydrate movement for boron, claiming that this forms a ionizable complex boron-sacarose, facilitating the carbohydrate transport through the membranes, being translocated quickly for the places where celular development and elongating occur.

Some authors reported that the roots in stem cuttings of plants are initiated by the auxin requiring growth or being this, extremely increased for boron (Middleton *et al.*, 1980). According to Esau (1965), the roots originate endogenously from pericycle or the endoderm, together to the vascular cambium, where the boron has its primary role activating the meristematics cells (Lewis, 1980). In the present work, boron addition influenced positively in the rooting process of kiwi branches cuttings collected during the summer.

It was not possible to differentiate the effectiveness between NAA or IBA on the rooting. Aparently, the two auxins behaved similarly.

Table 1. Rooting percentage average of kiwi (*Actinidia chinensis* Pl. cv Bruno) stem cuttings collected during four seasons.

Treatments	Seasons				
	Spr.	Sum	Aut.	Win	x
H_2O	10,0	55,6 a	17,5	23.1	26,6
NAA 300mg.L^{-1}	0	11,1 ab	12,5	3.9	6,9
IBA 300mg.L^{-1}	0	11,1 b	20,0	3.9	8,8
NAA 300mg.L^{-1}+B	0	44,4 ab	25,0	7.7	19,3
IBA 300mg.L^{-1}+B	0	50,0 ab	17,5	0	16,9
NAA 0,5%-pó	0	11,1 ab	15,0	7.7	8,5
AIB 0,5%-pó	7,5	33,3 ab	22,5	23.1	21,6
x	2,5	31,3	18,6	9.9	-
F	-	6.39*	0.65	0,80	
C.V.		23.3	21.6	82.6	

* significance to the 5% probability
average followed by same letter in the column did not differ significantly for the Tukey test

Table 2. Reducing sugars contents (g/100 g of dry matter) in kiwi (*Actinidia chinensis* Pl. cv Bruno) stem cuttings before and after the branches treatments' collected during four seasons.

Treatments	Seasons				
	Spr.	Sum	Aut.	Win	x
before treatments	0.93 Cb	0.64 Cc	1.57 Be	5.37 Aa	2.13
H_2O	1.91 Aa	1.65 Bab	3.62 Ab	1.20 Cbc	2.10
NAA 300mg.L^{-1}	2.00 Ba	1.46 Cb	3.20 Abc	0.99 Dc	1.91
IBA 300mg.L^{-1}	1.91 Ba	1.76 BCab	2.89 Acd	1.49 Cb	2.01
NAA 300mg.L^{-1}+B	2.00 Ba	1.70 BCab	4.18 Aa	1.46 Cbc	2.33
IBA 300mg.L^{-1}+B	1.91 Ba	1.50 Cb	4.57 Aa	1.49 Cb	2.37
NAA 0,5%-pó	1.91 Ba	2.00 Ba	2.57 Ad	1.46 Cbc	1.98
AIB 0,5%-pó	2.00 Aa	2.00 Aa	1.11 Be	1.16 Bbc	1.57
x	1.82	1.59	2.96	1.83	-
F treatments (T) = 22.79*		F season (S)= 273.25*		F T x S = 106.43*	
C.V. (%) = 7.31					

* significance to the 5% probability
average followed by same letter in the column did not differ significantly for the Tukey test

Results with the treatments with NAA 0.5%-powder and IBA 0.5%-powder showed that these growth regulators had been more effective in solution. In the talc form, the IBA was more effective than the NAA.

The results for content of reducing and total sugars in the kiwi cuttings before and after the treatments are shown in Tables 2 and 3, respectively. During winter higher amount of reducing and total sugars were observed, before of the rooting cuttings beginning process. Results showed that after the rooting process, increase in the content of reducing and total sugars occurred during the spring, summer and autumn cuttings. In contrast, in cuttings during the winter a reduction in their concentration was observed, indicating perhaps, consumption of those substances. Therefore, these observations indicated that the auxins treatments increased reducing and total sugars in the cuttings, possibly for leaves transport or conversion.

According to Veierskov *et al*. (1976), the auxin has an important role in the roots initiation. Other substances also showed important performance, mainly the sugars. The relation between auxins and carbohydrates in the roots development seems complex; however, the auxin can influence directly in the basal carbohydrates accumulation as well as due to increase of its concentration, conditions that induce the rooting (Altman & Wareing, 1975).

The content of reducing and total sugars, apparently, had not influenced in the rooting percentage improvement. The content of reducing and total sugars, in cuttings of autumn and winter, more had been raised previously to the rooting process; however, at those seasons not presented high rooting percentage.

According to Hess (1969) the carbohydrates do not increase the rooting reply, but they are a source of carbon and energy for the synthesis of other essential substances for the roots formation. According to Brutsch (1971) the carbohydrates availability in the cuttings was, probably the factor that determines the rooting potential in the *Carya illinoensis* (Wang.) C. Koch cuttings. During the development of the primordium root, the content of free sugars in the cutting bases many time, increased due to starch hydrolysis or had to the increase of the basipetal sugars transport, or both (Altman & Wareing, 1975). The endogenous or exogenous auxin increases starch hydrolysis (Davis & Potter, 1981).

The results for tryptophan content in kiwi cuttings are presented in Table 4. It can be seen that tryptophan contents reduced in

Table 3. Total sugar average contents (g/100 g of dry matter) in kiwi (*Actinidia chinensis* Pl. cv Bruno) stem cuttings before and after the branches treatments' collected during four seasons.

Treatments	Seasons				
	Spr.	Sum	Aut.	Win	x
before treatments	2.93 Bb	2.22 Cb	1.89 Cf	6.00 Aa	3,26
H_2O	2.22 Bc	0.90 Cd	5.99 Ad	1.32 Ce	2.61
NAA 300mg.L^{-1}	3.52 Bab	1.38 Ccd	9.80 Aa	1.79 Ce	4.12
IBA 300mg.L^{-1}	3.52 Bab	3.70 Ba	9.80 Aa	2.48 Ccd	4.88
NAA 300mg.L^{-1}+B	3.82 Ba	1.58 Dc	4.80 Ae	2.60 Cc	3.20
IBA 300mg.L^{-1}+B	3.82 Ba	1.69 Cbc	9.01 Ab	3.52 Bb	4.51
NAA 0,5%-pó	3.52 Bab	4.00 Ba	8.14 Ac	1.90 Cde	4.39
IBA 0,5%-pó	3.40 Bab	1.47 Dcd	5.19 Ae	2.87 Cc	3.23
x	3.35	2.12	6.83	2.81	-
F treatments (T) = 144.34*	F season (S)= 1970.22*		F T x S = 170.45*		
C.V. (%) = 19.54					

* significance to the 5% probability average followed by same letter in the column did not differ significantly for the Tukey test

Table 4. Tryptophan average contents (mg/100 g of dry matter) in kiwi (*Actinidia chinensis* Pl. cv Bruno) stem cuttings before and after the branches treatments' collected during four seasons.

Treatments	Seanos				
	Spr.	Sum	Aut.	Win	x
before treatments	0.1125 Aa	0.1120 Aa	0.1040 Aa	0.1025 Aa	0.1078
H_2O	0.0055 Bb	0.0040 Bb	0.0125 ABbc	0.0200 Abc	0.0105
NAA 300mg.L^{-1}	0.0155 ABb	0.0090 Bb	0.0165 ABb	0.0280 Abc	0.0173
IBA 300mg.L^{-1}	0.0080 Bb	0.0070 Bb	0.0090 Bbc	0.0225 Abc	0.0116
NAA 300mg.L^{-1}+B	0.0045 Bb	0.0010 Bb	0.0010 Bc	0.0290 Abc	0.0089
IBA 300mg.L^{-1}+B	0.0045 Bb	0.0025 Bb	0.0045 Bbc	0.0340 Ab	0.0114
NAA 0,5%-pó	0.0050 ABb	0.0135 ABb	0.0035 Bbc	0.0170 Ac	0.0098
IBA 0,5%-pó	0.0060 Bb	0.0020 Bb	0.0110 Bbc	0.0325 Ab	0.0129
x	0.0202	0.0189	0.0203	0.0357	-
F treatments (T) = 430.44*		F season (S)= 47.36*		F T x S = 4,32*	
C.V. (%) = 19.54					

* significance to the 5% probability average followed by same letter in the column did not differ significantly for the Tukey test

all the studied seasons and treatments. Tryptophan content in the cuttings of branches collected at the 4 different seasons did not differ significantly. It was also observed, that independent of the treatments during the process of roots initiation the reduction in tryptophan content was higher in the cuttings of branches collected during the spring, summer and autumn when compared with the those collected during the winter.

Singh (1981) suggested tryptophan as the precursor in the indolacetic acid biosynthesis. Middleton *et al*. (1980) and Jarvis & Booth (1981) reported that the exogenous application of indol-butyric acid to the cuttings base increased the level of indolacetic acid in leaves.

Samish & Spiegel (1957) noted high percentage of tryptophan and total protein in grapevine cuttings (*Vitis vinifera* L.), suggesting that the auxins addition occurred, from the accumulated tryptophan.

CONCLUSION

The results on the kiwi (*Actinidia chinensis* Planch. cv Bruno) stem cuttings rooting process showed summer as the best season for cuttings' without necessity of auxin treatments.

RESUMO

O presente trabalho teve como objetivo, estudar o efeito de auxinas sintéticas e do boro, sobre o enraizamento de estacas caulinares de kiwi (*Actinidia chinensis* Planch. cv Bruno). As estacas continham dois nós com aproximadamente 10 cm de comprimento, contendo 2 folhas cortadas ao meio. As bases das estacas receberam os seguintes tratamentos: control (H_2O); NAA 300 mg.L^{-1}; IBA 300 mg.L^{-1}; NAA 300 mg.L^{-1} + B; IBA 300 mg.L^{-1} + B; NAA 0,5%-pó e IBA 0,5%-pó. Após os tratamentos as estacas foram plantadas em bandejas de enraizamento contendo vermiculita pura e colocadas em câmara de nebulização por 120 dias até a coleta das mesmas. Para a avaliação do efeito das auxinas e boro, foram realizadas as seguintes observações: 1. porcentagem de estacas enraizadas; 2. análise de açúcares redutores e açúcares totais (em g/100 g de matéria seca); 3. análise de triptofano (em µg/100 mg de matéria seca). Além disso, foram verificados o efeito dos tratamentos em quatro épocas, que corresponderam às estações do ano (primavera, verão, outono e inverno). Através dos resultados obtidos no processo de enraizamento de estacas caulinares de kiwi (*Actinidia chinensis* Planch. cv Bruno), conclui-se ser o verão a melhor época de coleta dos ramos para a produção das estacas sem a necessidade do tratamento com auxinas.

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