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Performance of mulberry cultivars (*Morus* spp.) in response to different stem cuttings and fertilizers

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Abstract

The objective is to analyze techniques to form mulberry seedlings with different cutting sizes and forms of fertilization with N-P-K aiming a low production cost and an easy application in field. The experiment was carried out in a screened nursery, with a shading of 34%. The treatments were distributed in randomized blocks (RB) and compared in a 2x4x3 factorial design with five replications and 12 plants per plot. The factorial design consisted of two cutting lengths (10 and 20 cm) distributed in plastic tubes of 70 and 120 mL, four mulberry cultivars (IZ40, IZ10/1, Korin, and IZ3/2), and two types of fertilization: addition of 84 g of Osmocote® for each kilo of substrate, fertigation with aqueous solution containing 84 g of 14-14-14 N-P-K for each kilo of substrate, plus a control treatment (without fertilization). The commercial substrate Basaplant citrus® was used. 90 and 140 days after planting, assessments of percentage of rooting were carried out. At 140 days, shoot length (cm), number of shoots, number of leaves, root length (cm), and shoot and root green and dry matter were evaluated. The data obtained were evaluated using the Sanest software and Tukey test (P<0.05). Cuttings of 20 cm in length in tubes of 120 mL are recommended for the best formation of mulberry seedlings with the application of N-P-K fertilizer through fertigation. The cultivars showed different rooting potentials and shoot development. The best results are for Korin and IZ 10/1.

Keywords: mulberry; rooting; woody cuttings; seedling production; vegetative propagation.

Formação de mudas de amoreira (*Morus spp.*) em diferentes tamanhos de estacas e de adubação

Resumo

Objetivou-se estudar técnicas de formação de mudas de amoreira com diferentes tamanhos de estacas e formas de adubação com NPK visando baixo custo de produção e fácil aplicação no campo. O experimento foi realizado em viveiro do tipo telado, com sombreamento de 34%. Os tratamentos, distribuídos em um delineamento experimental de blocos ao acaso (DBC) foram comparados, em esquema fatorial do tipo 2x4x3 com 5 repetições e 12 plantas por parcela, a saber: dois comprimentos de estacas, 10 e 20 cm, distribuídas em tubetes plásticos de 70 e 120 mL, quatro cultivares de amoreira (IZ40, IZ10/1, Korin e IZ3/2) e dois tipos de adubação: adição de 84g de Osmocote® para cada quilo de substrato; fertirrigação com solução aquosa contendo 84g de NPK na formulação 14-14-14 para cada quilo de substrato e acrescido de um tratamento testemunha (sem adubação). Utilizou-se o substrato comercial Basaplant citrus®. Aos 90 e 140 dias após o plantio foram realizadas as avaliações da porcentagem de pegamento das estacas. Aos 140 dias, também, foram feitas avaliações do comprimento da parte aérea (cm), número de brotações, número de folhas, comprimento da raiz (cm), massas verde e seca da parte aérea e da raiz. Os dados obtidos foram avaliados por meio do programa Sanest e Teste de Tukey (P<0,05). Concluiu-se que para a melhor formação das mudas de amoreira são recomendadas estacas de 20 cm de comprimento em tubetes de 120 mL com a aplicação do adubo NPK através da fertirrigação. As cultivares apresentaram diferentes potenciais de enraizamento e desenvolvimento da parte aérea sendo os melhores resultados encontrados para a Korin e IZ 10/1.

Palavras-chave: amora; enraizamento; estacas lenhosas; produção de mudas; propagação vegetativa.

Introduction

Mulberry, a plant belonging to the family *Moraceae* and the genus *Morus*, traditionally used to feed silkworm caterpillars (*Bombyx mori* L.), produces fruits made up of phenolic compounds that have several properties, such as antioxidant and antimutagenic actions (HAIDA *et al.*, 2014). This crop has low production costs and requires little use of pesticides, making it an option for organic cultivation (ZENI *et al.*, 2017; PADILHA *et al.*, 2010).

Research related to seedling propagation methods is essential for professionals who own commercial nurseries and work with genetic improvement, as well as for rural entrepreneurs and processing industries, because it guides the formation of uniform and quality plantings. However, studies on mulberry (*Morus* sp.) are still scarce, especially regarding cutting length (YAMAMOTO *et al.*, 2013; BRANDÃO *et al.*, 2020).

The production of seedlings in tubes preserves the integrity of the root system in the nursery and improves the working conditions of workers (tubes suspended from the ground) (LIMA, 1986; VICHIATO, 1996), thus facilitating handling inside the nursery, transportation, and planting (CAMPINHOS JÚNIOR *et al.*, 1983). In addition, the use of tubes shortens the nursery period, anticipates planting in field, minimizes usage of substrate, avoids weeds, eliminates substrate purging, and eliminates root entanglement during the nursery phase, which continues in the field phase and may decrease the stability of future trees (GUIMARÃES *et al.*, 1998; BARBIZAN *et al.*, 2002).

Several studies on different species have shown, for forest restoration and for production of fruit plant seedlings, that large containers usually provide a better quality to seedlings (BOMFIM *et al.*, 2009). However, associating fertilization that meets the needs of seedlings using small containers may reduce costs in production, transport, and distribution in field, leading to the formation of high-quality seedlings, lower costs, and better yield in the planting operation, which decrease the costs of implanting an orchard (LIMA FILHO *et al.*, 2019; HAWERROTH *et al.,* 2013).

Modern fruit growing excels in obtaining high-quality seedlings. In this sense, fertilization with nutrients is essential to produce seedlings in nurseries aiming a rapid growth with vigorous, resistant, and rustic characteristics. Only thus can seedlings withstand the most varied conditions after planting in the field (GONÇALVES; BENEDETTI, 2005; BRUGNARA, 2018).

Primary macronutrients (N, P, and K) are usually added to the substrate in solid form, but they can also be supplied as a liquid (fertigation) (LANDIS *et al.*, 1989). The production of seedlings in tubes is a promising technique but still little investigated. It is necessary to verify its technical and economic viability. On the other hand, part of the substrates used for the production of seedlings do not contain all essential nutrients in adequate amounts for the growth and development of plants, which makes fertilization a necessary agronomic practice to obtain seedlings with an excellent quality. In addition, the frequent irrigation required for the production of seedlings considerably increases loss of nutrients by leaching, which requires replenishment in installments by leaf spraying or covering, or by fertigation (TEIXEIRA *et al.*, 2009). Usually, supplementing the substrate with nutrients for seedlings in tubes is usually done using slow-release fertilizers, such as Osmocote®, in order to reduce problems of excess solubility and losses due to nutrient leaching (BARBIZAN *et al.*, 2002; ALMEIDA *et al.*, 2019).

Given the above, the objective is to analyze techniques to form mulberry seedlings with different cutting sizes and forms of fertilization with N-P-K aiming a low production cost and an easy application to obtain vigorous and uniform seedlings in field.

Materials and Methods

The experiment was carried out in a screened nursery with 34% shading and benches suitable for tubes located at the Seedling and Seed Production Center of the Secretariat of Agriculture and Supply of the State of São Paulo, municipality of Marília, SP, Brazil.

The installation of the experiment consisted of preparing and filling tubes with the commercial substrate Basaplant citrus®, planting by stem cutting, burying about two thirds of the length inside soil, and following this experimental design: randomized blocks (RB) with five replications. The treatments were in a 2x4x3 factorial design with 12 replications, namely: two cutting lengths (10 and 20 cm), distributed in plastic tubes of 70 and 120 ml suitable for the production of eucalyptus and coffee seedlings, respectively; four mulberry cultivars: IZ40, IZ10/1, Korin, and IZ3/2; and two forms of fertilization: addition of 84 g of Osmocote® for each kilo of substrate, fertigation by applying an aqueous solution containing 84 g of 14-14-14 N-P-K for each kilo of substrate, plus a control treatment (without fertilization).

The stem cuttings of the four mulberry cultivars, from adult plants and healthy branches, with an average diameter between 1.0 to 1.5 cm, were harvested in field the day before planting. The branches were cut in two lengths taking into account the treatments proposed in this study. All cutting units, regardless of size, were collected with two leaves of an equivalent size. In all treatments, sprinkler irrigation was performed daily in a sufficient volume to maintain the substrate moisture.

The application of fertilizer was carried out weekly using an aqueous solution distributed in each tube using a graduated cylinder. In each tube, 5 mL of solution containing N-P-K were applied in a formulation 14-14-14, beginning 40 days after growth and the beginning of sprout development.

In evaluations, the rooting index was determined after 88 days of planting by the percentage of cuttings with leaves. After 140 days, sprouts were studied by measuring seedling height using a graduated ruler taking as a reference the distance from the neck to the apex of the plant (apical meristem). Then, the seedlings were removed from the tubes; the roots were washed and placed on absorbent paper to remove excess moisture; and then the main root length (cm) and the total mass (g) were evaluated.

The analyses of fresh and dry matter (in grams) of shoots and the root system were carried out in the laboratory of the Research and Development Unit of Marília/APTA. To obtain dry mass, the fresh samples were weighed and then placed in an oven with forced air circulation at 65°C for 72 hours; after cooling in ambient conditions, they were weighed, thus determining the weight of dry mass.

The data obtained were evaluated using the Sanest software. When the F value was significant, the treatment means were compared using the Tukey test ($P < 0.05$).

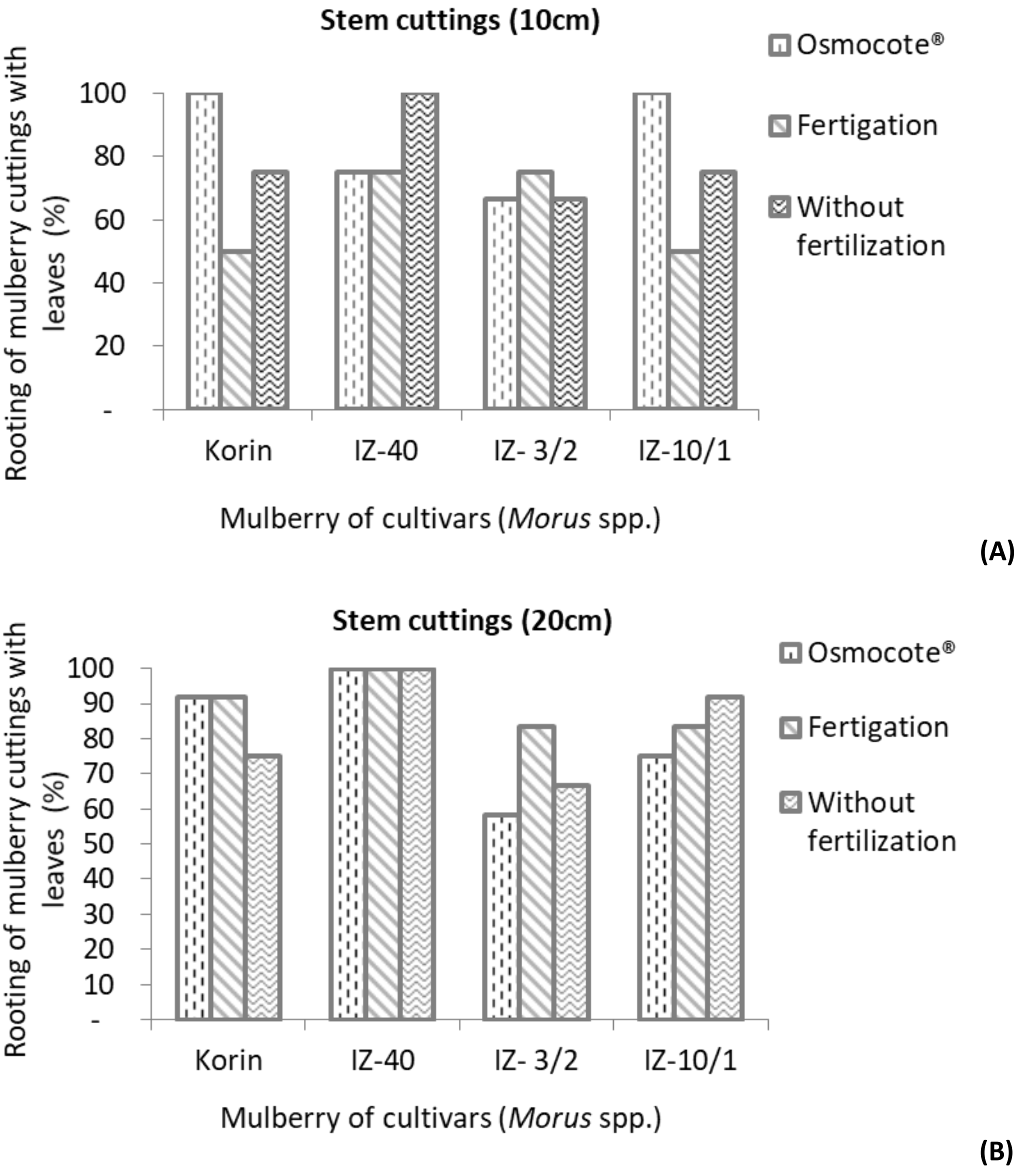
Results and Discussion

88 days after planting, most stem cuttings survived (Figure 1) and showed more than 60% of rooting index, mainly for cuttings with a length of 20 cm (Figure 1B). In 10-cm cuttings, fertilization with Osmocote® showed a better percentage of rooting in the cultivars Korin and IZ10/1 (100%), followed by the cultivars IZ40 and IZ3/2, with rates of 75% and 67%, respectively (Figure 1A). For the 20-cm cuttings, only the cultivar IZ40 reached 100% of rooting in all evaluated treatments (Figure 1B).

Okamoto *et al.* (2013) evaluated the cutting length and substrates in the production of mulberry seedlings and identified that cuttings with 20 cm in length had better rooting indexes compared to cuttings of 10 cm because the amount of reserves in the branch is proportional to the cutting size and this may contribute to the initial development of sprouting. However, this result is not directly related to the rooting of cuttings because the index is associated with other conditions represented mainly by the genetic potential (Okamoto *et al.*, 2005; Okamoto *et al.*, 2013).

At 140 days, there was a reduction in the rooting rates for all cultivars, both for lengths of 10 and 20 cm, as well as for all treatments evaluated (Figure 2). Only the cultivars Korin and IZ10/1 in the treatment with Osmocote® maintained 100% of stem cuttings with leaves and roots (Figure 2A). For the 20-cm length, only the cultivar IZ40 remained with a rooting index higher than 90% regardless of the treatment evaluated (Figure 2B).

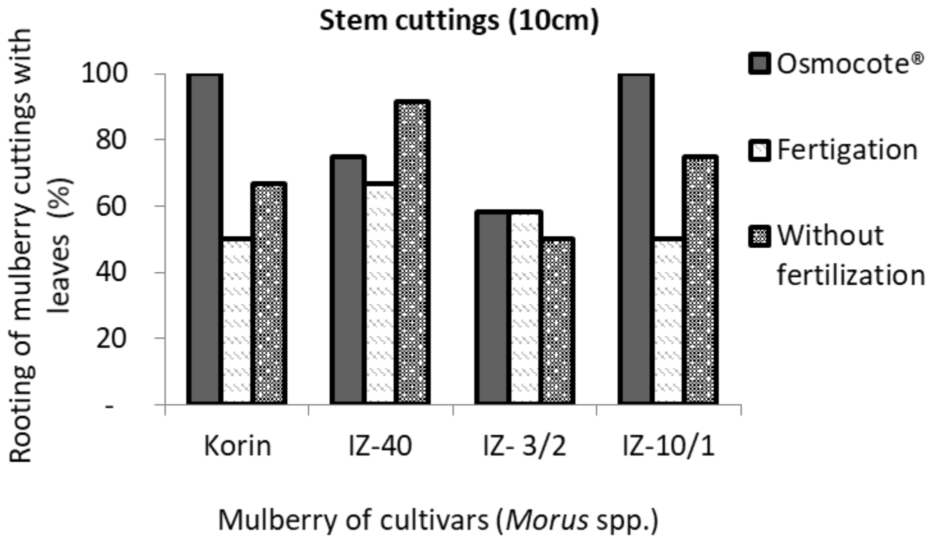
Figure 1. Percentage of rooting of mulberry cuttings with leaves (four cultivars), cut in two different lengths (10 and 20 cm), and fertilization (Osmocote®, fertigation and without fertilization) 88 days after planting.



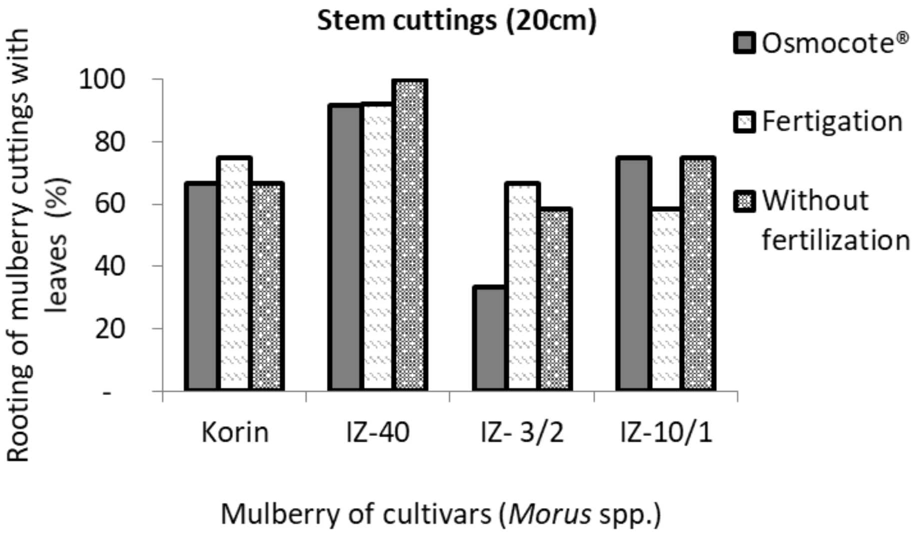
These results are in agreement with Teixeira *et al.* (2008) and Moreira *et al.* (2010). The authors, under controlled conditions with intermittent fogging, as is the case with seedling nurseries, reported that cuttings with 15 to 20 cm in length and a diameter between 4 and 10 mm showed good results of rooting in mulberries of the genus *Morus*.

In addition, in the cutting process, according to Villa *et al.* (2003), there are differences in the percentage of rooting between species and between cultivars. These differences can be attributed to internal conditions, such as hormonal reserves and genetic potential, in addition to external conditions, which justify the differences found between the cultivars evaluated in the present study (Figures 1 and 2).

Figure 2. Percentage of rooting of mulberry cuttings with leaves (four cultivars), cut in two different lengths (10 and 20 cm), and fertilization (Osmocote®, fertigation and without fertilization) 140 days after planting.



(A)



(B)

The analysis of variance showed significant effects of cultivars (C), cutting length (CL), and forms of fertilization (A) for most characteristics evaluated, except for root length of the studied cultivars; there were also effects of interactions for height, root length, shoot green and dry mass, and root green and dry mass, indicating that cutting length and forms of fertilization (Osmocote®, fertigation with N-P-K and without fertilization) influenced the behavior of these characteristics of the cultivars along the formation of seedlings (Table 1).

Table 1. Summary of analysis of variance (ANOVA) for height (A), root length (RL), shoot green mass (SGM), root green mass (RGM), shoot dry mass (SDM), and root dry mass (RDM) of mulberry cuttings.

Causes of variation	DF	A	RL	SGM	RGM	SDM	RDM
		MS					
Cultivars (C)	3	108.3966**	9.2201^{ns}	8.5701**	11.4056**	4.2832**	0.5512**
Cutting length (CL)	1	93.6333**	29.7008**	44.3496**	22.3603**	16.6210**	1.1732**
Fertilization (F)	2	160.1763**	32.7933**	9.5596**	2.2397**	2.0036**	0.0567*
C x CL	3	39.8691**	47.3405**	8.0532**	3.5043**	3.0251**	0.1276**
C x F	6	25.1196**	20.4626**	2.7146**	1.7049**	0.4382**	0.0563**
CL x F	2	9.8413^{ns}	10.3877^{ns}	0.365^{ns}	0.0324^{ns}	0.4068*	0.0575*
Treatment	23	47.2177	22.8853	6.3876	3.8035	2.1449	0.1738
Residue	69	6.4498	4.0611	0.7564	0.2272	0.0875	0.0168
CV (%)		34.75	24.8256	34.16	29.4082	26.81	48.50

MS = mean square; DF = degrees of freedom; C x CL = interaction between cultivars and cutting length; C x F = interaction between cultivars and types of fertilization; CL x F = interaction between cutting length and types of fertilization; CV (%) = coefficient of variation; **, * and ns, significant at 1% and 5% probability and not significant, respectively.

Planting cutting lengths (10 and 20 cm), as well as by the form of fertilization performed (Table 2), affected the sprouting heights of the cultivars studied. Regardless of cultivar, there was no difference between sprouting height in the cuttings of 10 cm.

However, the cultivars IZ 40 and IZ 10/1 had the highest heights when the cut was 20 cm, with values of 10.9 and 9.7 cm, respectively. The sprouting of the cultivar IZ 3/2 had the lowest height (4.0 cm) when formed by this same cutting size. Also, the fertilization with the solution containing N-P-K provided a greater plant height among the studied treatments, with the exception of the cultivar IZ3/2, which showed no differences between the forms of fertilization and the control treatment.

Unlike what Yamanishi *et al.* (2004) observed for papaya seedlings grown with two forms of fertilization (Osmocote® 14-14-14 and formulated 14-14-14 N-P-K) and three organic sources (humus, bovine manure, and Nutriplanta®), in the present test the fertilization with N-P-K in aqueous solution stimulated a greater height of mulberry seedlings in comparison to the formulation of Osmocote® 14-14-14.

In relation to the average size of cuttings studied in the assay, the cultivar IZ 40 had a high height of sprouting. Among the means of cultivars, the 20-cm long cuttings provided the highest heights.

Consistent with the sprouting height are the fresh and dry mass data, with no statistically significant differences between the cultivars studied and the 10-cm cuttings (Table 2). The cultivar IZ 3/2 obtained the lowest fresh and dry mass of sprout, resulting in values of 1.56 and 0.51 g, respectively, for cuttings of 20 cm. The means of fresh and dry masses were higher in the sprouts of cuttings of 20 cm.

Considering that the amount of reserves in the branch is proportional to the cutting size, this may have contributed to a better initial development of sprouting in 20-cm cuttings, which is in accordance with the technical recommendations of Tinoco *et al.* (2000) and Takahashi *et al.* (2009).

The form of fertilization was significantly different in the cultivars IZ10/1 and Korin for the production of green and dry mass, with emphasis on the application of fertilizer via fertigation compared to treatments with Osmocote® and without fertilization. Such data can be justified by the higher demand for nitrogen of the varieties IZ10/1 and Korin in comparison to the others, and the N-P-K formulation, which is soluble in water, makes this nutrient more readily available than Osmocote®, which is a slow-release fertilizer.

Fonseca *et al.* (1973), who studied the deficiency of macronutrients and boron in three varieties of blackberry, observed that nitrogen deficiency symptoms were the first to appear and that the varieties Calabreza and Fernão Dias were more susceptible to nitrogen and phosphorus deficiency than the variety Formosa. Vale *et al.* (2009) studied the growth curve and the macronutrient absorption rate of three mulberry cultivars (FM Shima-Miura, IZ 56/4, and Miura) and found that nitrogen was at a greater concentration in all cultivars and that the phosphorus was extracted in small quantities, with accumulations of 0.26, 0.46, and 0.27 g of P per plant at 115 days after plant rootage.

The best development of the root system in 10 cm cuttings was in the cultivar IZ 3/2, which presented 8.8 cm in length, followed by the cultivar Korin and IZ40, with 7.8 and 7.4 cm in length, respectively (Table 3). However, this same behavior did not occur in 20-cm stem cuttings. The cultivar IZ 3/2 had the shortest root length. On average, the cultivars showed a greater root length in cuttings of 20 cm compared to cuttings of 10 cm.

Table 2. Unfolding of the interaction between cutting length (CL) and forms of fertilization (A) for the variables height (cm) and fresh and dry mass (g) of the sprouts of four mulberry cultivars.

Parameter	IZ 40	IZ 10/1	Korin	IZ 3/2	Means of cultivars
			Sprout height (cm)		
C-10	7.3 bA	7.1 bA	5.7 bA	5.6 aA	6.4 B
C-20	10.9 aA	9.7 aAB	8.1 aB	4.0 aC	8.1 A
MSD = 1.84					
A1	7.5 bA	6.6 bAB	5.5 bAB	4.0 aB	5.9 B
A2	11.8 aA	12.5 aAB	9.3 aB	4.7 aC	9.6 A
A3	7.8 bA	6.0 bA	4.7 bC	5.6 aA	6.4 B
MSD = 2.71					
Means of factors	9.1 a	8.4 ab	6.9 b	4.8 c	
			Sprouting green mass (g)		
C-10	2.01 b	1.95 b	1.57 b	1.91 a	1.86 B
C-20	3.80 aA	4.18 aA	3.35 aA	1.56 bB	3.22 A
MSD = 0.71					
A1	*2.46 aA*	2.72 bA	1.75 bA	1.66 aA	2.15 B
A2	*3.41 aA*	4.10 a A	3.66 aA	1.49 aB	3.16 A
A3	*2.84 aA*	2.38 bA	1.98 bA	2.04 aA	2.31 B
MSD = 1.04					
Means of factors	2.91 a	3.06 a	2.46 a	1.73 b	
			Sprout dry mass (g)		
C-10	0.79 b	0.81 b	0.63 b	0.67 a	0.73 B
C-20	2.10 aA	1.82 aA	1.46 aB	0.51 aC	1.47 A
MSD = 0.21					
A1	1.26 bA	1.18 bA	0.74 bB	0.54 aB	0.94 B
A2	1.79 aA	1.68 aA	1.45 aA	0.50aB	1.35 A
A3	1.28 bA	1.09 bAB	0.94 bBC	0.68aC	1.00 B
MSD = 0.31					
Means of factors	1.44 a	1.32 a	1.04 b	0.59 c	

Means followed by the same lowercase letters in columns and uppercase letters in rows, if different, differ by Tukey test at 5% probability. C-10: 10 cm stem cuttings in 70 mL containers; C-20: 20 cm stem cuttings in 120 mL containers; A1: addition of 84 g of Osmocote® for each kilo of substrate; A2: fertigation with 84 g of 14-14-14 N-P-K formulation for each kilo of substrate; A3: without fertilization.

There was a greater root green and dry mass in the cultivar IZ40 in both cuttings sizes (Table 3). Comparing the results of dry and green root mass means obtained for cutting length (10 and 20 cm), there were higher values for the cuttings of 20 cm.

Table 3. Unfolding of the interaction between cutting length (CL) and forms of fertilization (A) for the variables length (cm) and root fresh and dry mass (g) of four mulberry cultivars.

Parameter	IZ 40	IZ 10/1	Korin	IZ 3/2	Means of cultivars
Root length (cm)					
C-10	7.4 aAB	6.3 bB	7.8 bAB	8.8 aA	7.6 B
C-20	8.8 aA	9.5 aA	9.8 aA	6.2 bB	8.6 A
MSD = 1.46					
A1	9.0 aA	8.1 aA	9.3 aA	8.6 aA	8.7 a
A2	7.8 aA	8.1 aA	9.0 aA	4.2 bB	7.07 b
A3	7.6 aA	7.6 aA	8.1 aA	9.6 aA	8.5 a
MSD = 2.14					
Means of factors	8.2 a	7.9 a	8.8 a	7.5 a	
Root green mass (g)					
C-10	1.62 bA	1.09 bB	1.19 bAB	0.83 aB	1.18 B
C-20	2.87 aA	2.49 aAB	2.13 aB	0.71 aC	2.05 A
MSD = 0.34					
A1	2.15 abA	1.77 bAB	1.36 bBC	0.84 abC	1.53 b
A2	2.60 aA	2.40 aA	2.13 aA	0.41 bB	1.88 a
A3	1.98 bA	1.20 cAB	1.49 bB	1.06 aB	1.43 b
MSD = 0.51					
Means of factors	2.24 a	1.79 b	1.66 b	0.77 c	
Root dry matter (g)					
C-10	0.27 bA	0.13 bB	0.16 bAB	0.09 bB	0.16 B
C-20	0.58 aA	0.38 aB	0.38 aB	0.10 aC	0.37 A
MSD = 0.09					
A1	0.48 aA	0.24 abB	0.19 bB	0.11 aB	0.94 b
A2	0.45 aA	0.36 aA	0.36 aA	0.04aB	1.35 a
A3	0.35 aA	0.18 bB	0.26 abAB	0.13aB	1.00 b
MSD = 0.14					
Means of factors	0.43 a	0.26 b	0.27 b	0.09 c	

Means followed by the same lowercase letters in columns and uppercase letters in rows, if different, differ by Tukey test at 5% probability. C-10: 10 cm stem cuttings in 70 mL containers; C-20: 20 cm stem cuttings in 120 mL containers; A1: addition of 84 g of Osmocote® for each kilo of substrate; A2: fertigation with 84 g of 14-14-14 N-P-K formulation for each kilo of substrate; A3: without fertilization.

Okamoto *et al.* (2013) evaluated different cutting lengths and substrates for the production of mulberry seedlings and highlighted that length is not the only factor that affects the success of seedling production, emphasizing that the genetic potential of cultivars is also important. Thus, such observations justify the better behavior of the cultivar IZ40 in the factors evaluated in this study.

Porto and Bosqueti (2017) also pointed out other factors that must be taken into account when establishing mulberry plants, such as the time between harvesting the branches and planting the cuttings and the way by which this material is stored. In some cases, mulberry branches, after being cut, are kept for days stored, usually improperly. In these cases, the branches lose nutritional reserves and mainly water, thus reducing vegetative capacity over time.

Also according to the authors, the immersion of the base of cuttings in water for a time before planting provides a significant improvement in the percentage of rooting. The practice of immersion in water can be applied to whole branches or cuttings already prepared for planting. Immersion should be carried out as soon as possible after cutting. In this research, all branches underwent the same preparation process up to planting, therefore this coefficient did not interfere with the results obtained in the experiment.

Vignolo *et al.* (2014) reported that, in vegetative propagation, rooting success depends on several factors. Among the factors that affect the formation of roots, the presence of leaves is a positive factor of this event, corroborating the event described by Dias *et al.* (2012).

Auxin affect cutting rooting, although auxin is not the only substance involved. In stem cuttings, the natural auxin produced in leaves and buds moves acropetally towards the bottom of the plant, increasing its concentration at the base of the cut, along with sugars and other nutritious substances.

Root formation apparently depends on an optimal level of auxin in relation to these substances (Pereira *et al.*, 2017). In this regard, the values found in this study for root length and production of green and dry mass did not suffer interference from the variation of production of natural auxin, since all units of cuttings, regardless of the size, were collected with two equivalent-sized leaves.

The forms of fertilization did not differ statistically regarding root length in most of the studied cultivars. However, following the observations found for shoots, the application of the readily soluble formulation provided a greater green and dry mass for the varieties IZ10/1 and Korin.

Finally, to determine the best form of fertilization for mulberry cultivars, it is necessary to take into account some factors such as the nutritional needs of the plant and the behavior of the source of N-P-K used.

According to Huett (1997), one of the benefits of using slow-release fertilizers compared to soluble fertilizers is the low loss of nutrients by leaching. Thus, Quiqui *et al.* (2008) concluded that the use of sources with slow-release of nutrients in eucalyptus seedlings allows a greater production of dry matter and a greater accumulation of nutrients in shoots compared to sources with rapid-release of nutrients when using formulations with equal N-P-K contents. On the other hand, considering the great demand for nitrogen presented by varieties of mulberry, as Fonseca *et al.* (1973) reported, further studies involving the form of fertilization with N-P-K for the production of mulberry seedlings are needed.

Conclusion

The results show that for the best formation of mulberry seedlings, cuttings of 20 cm in length and conducted in tubes of 120 mL are recommended.

The treatments with Osmocote® provide a good development of mulberry seedlings but are inferior to treatments with readily soluble N-P-K formulation (14-14-14) in relation to most characteristics analyzed for the cultivars IZ10/1 and Korin.

The cultivars show different rooting potentials and shoot development. The best results are for Korin and IZ10/1.

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