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Blackberry and raspberry seedlings growth under the soilless cultivation system

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ABSTRACT

The objective of this study was to evaluate the growth of micropropagated blueberry and raspberry seedlings under conventional and soilless cultivation systems. Seedlings of two blackberry cultivars (Xavante and Tupy) and two raspberry cultivars (Heritage and Fall Gold) were submitted to two cultivation systems: the conventional system and the soilless system. Under the conventional system, they were kept in polyethylene bags containing H. Decker® substrate and were irrigated with nutritive solution every 15 days. Under the soilless system, they remained in plastic flowerpots containing sand and were irrigated with nutritive solution daily. In regards to shoot length, the Xavante, Tupy, Heritage and Fall Gold cultivars showed the best results under the soilless cultivation system. As for number of lateral shoots, the Xavante, Heritage and Gold Fall showed significant results under the soilless system, unlike the cultivar Tupy, which showed better results under the conventional system. The soilless cultivation system is suitable for the development of the blackberry 'Xavante' and 'Tupy' and the raspberry 'Heritage' and 'Fall Gold' mini-cuttings.

Key words: Propagation, soilless, conventional system, nutritive solution.

INTRODUCTION

Fruit plants from temperate climate comprise several species, including small fruit, in which the interest of the global consuming market has increased due to their antioxidant properties and substances capable of fight off free radicals (Salgado 2008).

Despite all information about the possible explorations of these species, studies about them in Brazil are scarce. In addition, research investments to define a production system with specific culture practices for these species are still very limited. Thus, knowledge about propagation methods and seedlings formation may be the first step towards the expansion of these cultures in Brazil, becoming important research areas to be followed (Affonso 2014).

Among the promising alternatives for fruit species seedlings production are the soilless cultivation systems such as hydroponics and substrate cultivation. Nascimento et al. (2011) and Casarin (2015) found that such systems can be adopted in the propagation of blueberry (*Vaccinium* sp.) and olive trees (*Olea europaea* L.), respectively.

Hydroponics is a soilless cultivation technique that uses a nutritive solution with all the necessary nutrients for plant development and growth with the aid of inert substrates. In this sense, fruit plants seedlings production under this system is new and may become a viable alternative, with great potential mainly for the production of seedlings, since it allows for early production, adequate supply of mineral nutrients, conditions for plant development, pests and diseases control and, most importantly, better work environment quality. In addition, the use of soilless cultivation systems combined with vegetative propagation, such as micro-cuttings, was tested in Southern Brazil to obtain better quality and more fruit plant species with propagation limitations (Schuch and Peil 2012).

The objective of this work was to evaluate the growth of micropropagated blackberry and raspberry seedlings under conventional and soilless cultivation systems.

MATERIALS AND METHODS

The experiment was conducted in a metallic agricultural greenhouse covered with a low-density polyethylene film (150 μm thick), positioned in the North-South direction, from January to December 2014, in the county of Pelotas - RS.

During the seedlings production period, greenhouse environment management included natural ventilation and the daily opening of the lateral windows between 8 am and 5 pm. The greenhouse remained closed during days with low temperatures, strong wind, strong rains and/or high external environment relative humidity

During the first experiment with a totally randomized experimental design, arranged in a 2x2 factorial scheme, two levels were evaluated for the cultivar factor (Xavante and Tupy) and two levels for the cultivation systems (conventional and soilless), resulting in four treatments and four replications. Each replication included eight seedlings.

During the second experiment with a totally randomized experimental design, arranged in a 2x2 factorial scheme, two levels were evaluated for the cultivar factor (Heritage and Fall Gold) and two levels for the cultivation systems (conventional and soilless), resulting in four treatments and four replications. Each replication included eight seedlings.

Micro-cuttings from the blackberry (Xavante and Tupy) and raspberry (Heritage and Fall Gold) cultivars, originated from micropropagation, were rooted in Sampack® articulated plastic bags with 250 mL of vermiculite and coconut fiber substrates.

Under the conventional system, seedlings were kept in 15 x 20 cm black polyethylene bags with H. Decker® substrate, grown 0.10 x 0.10 m apart on a one-meter high wood counter. Under this system, nutritive solution was provided every 15 days.

Under the soilless system, seedlings were placed in 80 x 20 x 25 cm plastic flowerpots. Inside the flowerpots, a 5 cm layer of gravel for drainage and a 20 cm layer of coarse sand were placed for drainage purposes. Seedlings were transplanted to flower beds in an eight seedlings per bed proportion, distributed in two 0.10 x 0.10 cm apart lines and were irrigated with nutritive solution daily.

This nutritive solution was introduced by Sommer (2015) and contains macronutrients and micronutrients formulated according to the needs of blackberry and raspberry cultures.

Assays were carried out in the beginning of the experiment and at 30, 60, 90 and 120 days. They evaluated the survival percentile, aerial part length (cm), number of lateral shoots and lateral shoots average length (cm). Aerial part and root fresh and dry weights were verified in the last assay.

Results were submitted to the ANOVA analysis of variance. Means, when significant, were compared by the Tukey test ($p<0.05$). Regressions among variables were established and considered significant at $p<0.05$.

RESULTS AND DISCUSSION

For the shoot length and survival rate variables, there was no significant effect on any of the tested cultivars. They all showed a survival rate of 100% and all the surviving plants grew roots and aerial parts.

The analysis of variance showed an interaction between cultivation days and cultivation systems for aerial part length, number of lateral shoots and length of the first lateral shoot variables for the Xavante and Tupy blackberry cultivars.

In regards to the aerial parts of the Xavante and Tupy cultivars, the soilless system showed results that were more significant, with an increasing linear response due to the increase in number of cultivation days, reaching 3.8 and 4.25 cm of length, respectively (Figures 1A and 1B). It also provided nutritive solution, more nutrients and, consequently, seedlings vegetative growth. Nascimento et al. (2011) also observed a significant difference for aerial part height when using the soilless system, with more significant results for blueberry (*Vaccinium myrtillus* L.) seedlings growth.

As for number of lateral shoots, significant results were obtained for the Xavante cultivar under the conventional system, where the maximum efficiency point occurred at 88 days of cultivation, with 1.67 shoots per plant (Figure 1C). For the Tupy cultivar, the soilless system presented the most representative results, with an increasing linear response due to the increase in number of cultivation days, with 1.06 shoots per plant (Figure 1D).

Number of lateral shoots showed little variation during the 120 days period, probably due to the pattern established by the system for the mini-cuttings, with around four yolks. However, these results differ from those of Affonso (2011), where no significant effect was observed for number of secondary shoots during the growth of Cattley guava (strawberry guava or cherry guava) under the soilless system.

For the first lateral shoots length, there was a difference between the tested systems for the Xavante cultivar (Figure 2A), whereas for the Tupy cultivar, the system of flowerpots presented the most representative results (1.8 cm of length), probably due to the cultivar's intrinsic characteristics (Figure 2B).

For Cappellaro (2013), the secondary shoots height variable showed significance for both soilless and NFT (Nutrient Film Technique) systems, where olive (*Olea europaea* L.) seedlings growth was analyzed under different soilless cultivation systems.

In regards to the second lateral shoots length variable, results for the Xavante cultivar were more significant for the soilless system, with an increasing linear response in function of the increase in number of cultivation days, reaching 1.85 cm of length, while the Tupy cultivar showed no significant difference for the tested treatments (Figure 2C). Nascimento et al. (2011) also found a significant difference for average shoot growth while the soilless system showed results more significant for blueberry seedlings growth. These results differ from Affonso (2011), in which no significant effect was found for the secondary shoots length of Cattley guava (*Psidium cattleyanum*) seedlings grown under the soilless system.

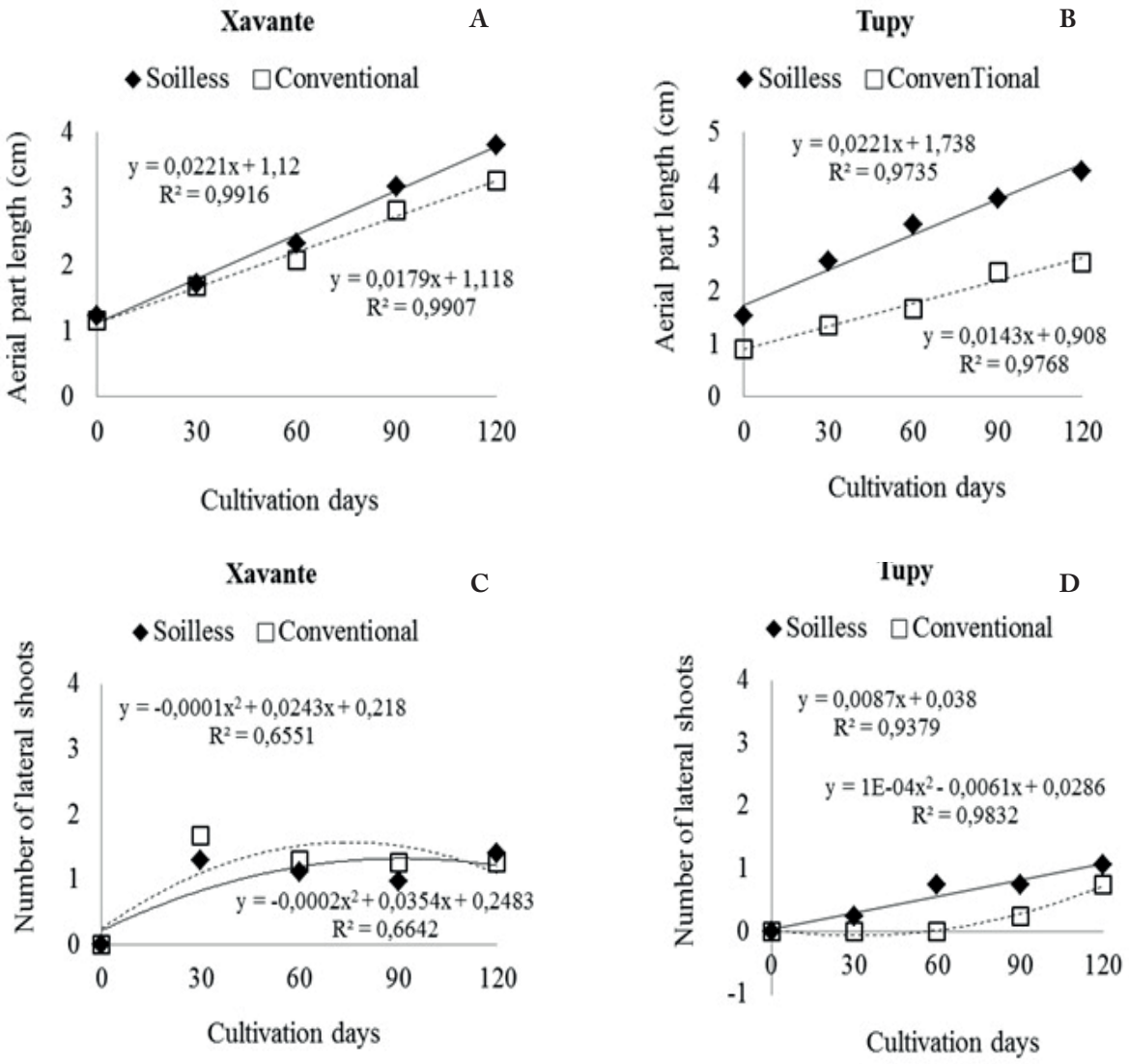

Figure 1. Aerial part length of 'Xavante' seedlings in function of cultivation days under the soilless and conventional systems. Pelotas, RS – 2014 (A). Aerial part length of 'Tupy' seedlings in function of cultivation days under the soilless and conventional systems. Pelotas, RS – 2014 (B). Number of lateral shoots of the Xavante seedlings in function of days of cultivation under the soilless and conventional systems. Pelotas, RS – 2014 (C). Number of lateral shoots of the Tupy seedlings in function of cultivation days under the soilless and conventional systems. Pelotas, RS – 2014 (D).

In regards to the 'Xavante' cultivar, expressive results were obtained for aerial part fresh weight and aerial part dry weight under the flowerpots system, with 22.43 g and 7.03 g, respectively (Table 1). As for the 'Tupy' cultivar, the flowerpots system also presented the best results for the same analyzed variables, with 15.06 g and 6.34 g, respectively (Table 1). Affonso (2011) found no significant difference for the same variables between the tested cultivation systems, being the general mean of 9.83 for fresh weight and 2.35 for dry weight. For the root dry weight variable in the Xavante cultivar, the flowerpot system showed significant results under the flowerpot system, with 9.31g (Table 1). These results were possible due to the system's daily provision of nutrients thus meeting the demands of the culture more consistently.

In the 'Heritage' and 'Fall Gold' raspberry cultivars, the analysis of variance showed an interaction between cultivation days x systems for the aerial part length, number of lateral shoots, first lateral shoot length and second lateral shoot length variables.

For the aerial part length, in both 'Heritage' and 'Fall Gold' cultivars, greater lengths were observed under the soilless system, reaching 75.22 and 13.38 cm, respectively (Figures 3A and 3B). These results show the superiority of the soilless system in meeting the demands of the culture more consistently, as mentioned before. Ristow (2009) obtained different results when testing micropropagated seedlings growth in different substrates, verifying ar around 18 cm of length for the greater shoot length with the Plantmax® substrate at 90 days of cultivation.

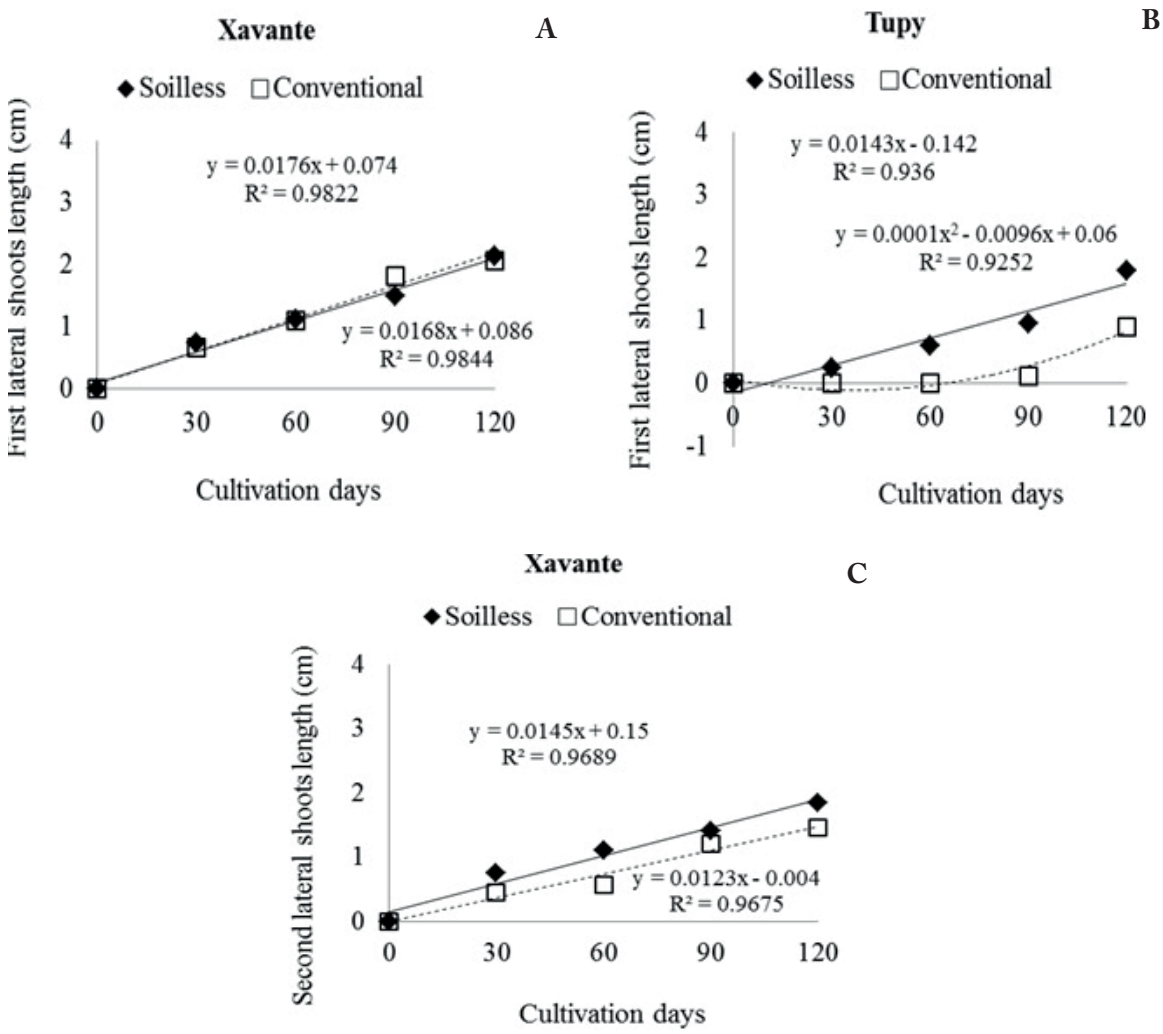

Figure 2. First lateral shoots length of Xavante seedlings in function of cultivation days under the soilless and conventional systems Pelotas, RS – 2014 (A). First lateral shoots length of Tupy

Table 1. Aerial part fresh weight (g) root fresh weight (g), aerial part dry weight (g) and root dry weight (g) from the Xavante and Tupy blackberry cultivars under soilless (SH) and conventional (C) cultivation systems.

Cultivar	MMFPA		MMFR		MMSPA		MMSR	
	SH	C	SH	C	SH	C	SH	C
Xavante	22.4 a[1]A[2]	7,79nsB	1.5,88a ns	15.39a ns	7.03ns A	.2,68ns B	.9,31aA	7.28aB
Tupy	15.06 bA	7.94nsB	6.,55 b ns	9.86 b ns	6.34ns A	2.85ns B	3.92 b ns	4.63 b ns

[1]Lower case letters in the column differ significantly at the 5% significance level by the Tukey test. 2Upper case letters in the line differ significantly at the 5% significance level by the Tukey Test. nsnot significant at the 5% significance level by the Tukey Test.

In regards to number of lateral shoots, for both the 'Heritage' and the 'Fall Gold' cultivars, the best results were obtained by the soilless system, with an increasing linear response in function of the increase in cultivation days (Figures 3C and 3D). Tomaz et al. (2014), using the soilless system to develop peach (Prunus persica) rootstocks obtained shoots height in a shorter time compared to traditional rootstock development methods. However, for the Cattley guava culture, the soilless system showed no difference against the conventional system.

For the first lateral shoots length, the 'Heritage' cultivar showed more representative results under the soilless system , with an increasing linear response in function of the increase in cultivation days (Figure 4A). For the Fall Gold cultivar, the flowerpot system results were more significant, since there was a quadratic response in function of number of cultivation days with 7.6c m o maximum shoots length (Figure 4B). These results are favorable, since number of shoots and average shoots length are important parameters when plants are destined to clonal garden formation, where they will determine plant propagation potential. According to Nascimento et al. (2011), considerable results were found when testing blueberry seedlings under the soilless system.

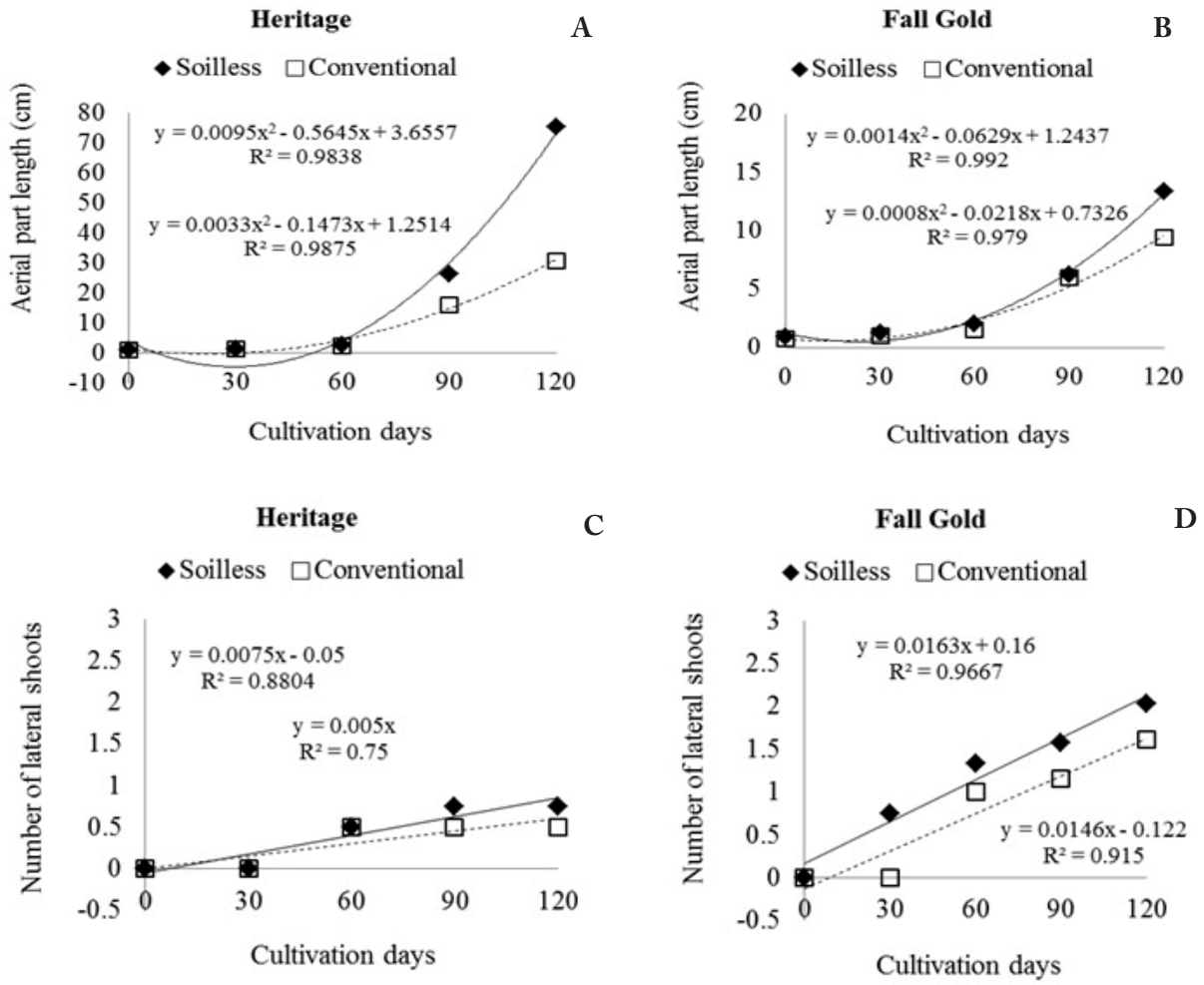

Figure 3. Aerial part length of 'Heritage' seedlings in function of cultivation days under the soilless and conventional systems. Pelotas, RS – 2014 (A). Aerial part length of 'Fall Gold' seedlings in function of cultivation days under the soilless and conventional systems. Pelotas, RS – 2014 (B).
Number of lateral shoots of 'Heritage' seedlings in function of days of cultivation under the soilless and conventional systems. Pelotas, RS – 2014 (C). Number of lateral shoots of 'Fall Gold' seedlings in function of cultivation days under the soilless and conventional systems. Pelotas, RS – 2014 (D).

In regards to the second lateral shoots length, the best results for the 'Heritage' cultivar were verified under the soilless system, with an increasing linear response in function of the increase in the number of cultivation days (Figure 4C). For the 'Fall Gold' cultivar, the flowerpot system also provided better results; however, there was a quadratic response in function of number of cultivation days, where shoots reached 6.8 cm of length (Figure 4D). According to Cappellaro (2013), the secondary shoots height variable was favorable under both soilless and NFT (Nutrient Film Technique) systems, where olive seedlings growth was analyzed under different soilless cultivation systems.

The soilless system showed better results in regards to aerial fresh weight and aerial dry weight for the 'Heritage' cultivar, with 61.45 g and 23.51 g, respectively (Table 2). As for the 'Fall Gold', the best results were obtained from the flowerpot system, for the same analyzed variables, with 47.70 g and 12.17 g, respectively (Table 2). According to Nascimento et al. (2011), the soilless system also showed better results over the conventional system for the same variable analyzed for the blueberry culture.

For the 'Fall Gold' cultivar root fresh weight and dry weight, the flowerpot system showed better results, with 56.25 g and 44.90 g, respectively (Table 2). However, Affonso (2011) found no significant difference for the same variables between the tested cultivation systems, with the general mean of 9.83g for fresh weight and 2.53g for dry weight.

These results show the superiority of the soilless system over the conventional system since it makes the daily supply of nutrients possible and meets the demands of the blackberry and raspberry cultures more consistently (Figures 5A, 5B, 5C and 5D).

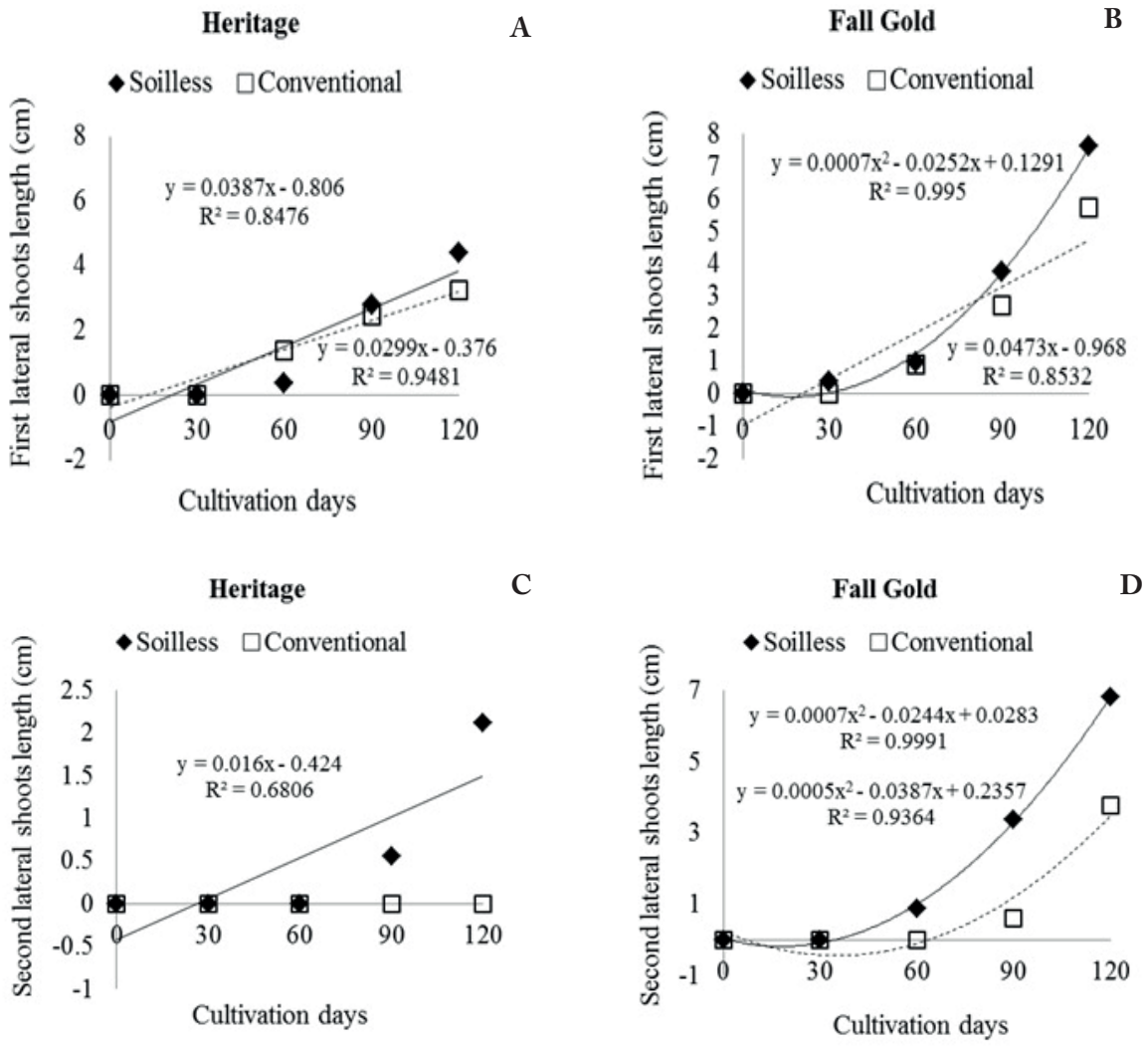

Figure 4. First lateral shoots length of 'Heritage' seedlings in function of cultivation days under the soilless and conventional systems. Pelotas, RS – 2014 (A). First lateral shoots length of 'Fall Gold seedlings in function of cultivation days under the soilless and conventional systems. Pelotas, RS – 2014 (B). Second lateral shoots length of 'Heritage' seedlings in function of cultivation days under the soilless and conventional systems. Pelotas, RS – 2014 (C). Second lateral shoots of 'Fall Gold' seedlings in function of cultivation days and under the soilless and conventional systems. Pelotas, RS – 2014 (D).

Table 2. Aerial part fresh weight (g) root fresh weight (g), aerial part dry weight (g) and root dry weight (g) from the Heritage and Fall Gold raspberry cultivars under soilless (SH) and conventional (C) cultivation systems.

Cultivar	MMFPA		MMFR		MMSPA		MMSR	
	SH	C	SH	C	SH	C	SH	C
Heritage	6.,45a[1]A[2]	15.39aB	40.66ns	41.27a ns	23.51aA	5.28aB	30.67b ns	22.39a ns
Fall Gold	6.,45a1A2	15.39aB	40.66ns	41.27a ns	23.51aA	5.28aB	30.67b ns	22.39a ns

[1]Lower case letters in the column differ significantly at the 5% significance level by the Tukey test. 2Upper case letters in the line differ significantly at the 5% significance level by the Tukey Test. nsnot significant at the 5% significance level by the Tukey Test.

Figure 5. Seedlings from the 'Xavante' (A) and 'Tupy' (B) blackberry; and 'Heritage' (C) and 'Fall Gold' (D) raspberry, at 120 days of cultivation under the soilless cultivation system. Pelotas, RS – 2014.

CONCLUSION

The soilless cultivation system is adequate for the development of the 'Xavante' and 'Tupy blackberry mini-cuttings and the 'Heritage' and 'Fall Gold' raspberry mini-cuttings. .

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