

THE EFFECT OF SUBSTRATES ON DIFFERENT CHARACTERISTICS OF *PHILODENDRON ERUBESCENS* CUTTINGS

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ABSTRACT

Different substrates (BRT GreenMoss, perlite, white peat, coco coir, ASB Greenworld plant soil) were used during three cutting propagation trials of *Philodendron erubescens*, an ornamental climbing plant with attractive, large leaves. After examining morphological and physiological characteristics, I want to find the best substrates for the plants and ascertain the effects of substrates on the success of cutting propagation. As the results show, substrates, time of propagation and greenhouse temperatures also influenced certain parameters, especially shoot number. Warmer conditions (optimally 20-22 °C), optimal timing (cutting propagation: May, June, growing: summer) and effective substrates (BRT GreenMoss, ASB Greenworld plant soil or its combinations) resulted in the highest, largest values, mainly in the case of leaf length and width, shoot length, fresh green parts (leaves, shoots), total chlorophyll and carotenoid contents of leaves. Coco coir (and its mixture with BRT GreenMoss) also has positive effect on root and shoot development.

Keywords: *Philodendron*, cutting, substrates, plant characteristics

INTRODUCTION

Genus *Philodendron* is one of the largest groups belong to the *Araliaceae* family with almost 500 variably formed, epiphytic, hemiepiphytic or terrestrial species (BOYCE AND CROAT, 2012). The strong, robust climber *Philodendron erubescens* produces leathery, bright green leaves with reddish petiole and aerial roots on the nodes of the shoots. Leaves change shape as plants mature, young plants have smaller, heart-shaped ones, adult specimens develop larger, arrow-like leaves (ORLÓCI, 2014). *Philodendrons* can be propagated several ways (by seeds, micropropagation, etc.), and shoot cutting is one of the easiest and cheapest methods of multiplying climbing species, especially in nurseries (HAMRICK, 2003; JÁMBORNÉ AND DOBRÁNSZKI, 2005; TILLYNÉ MÁNDY AND HONFI, 2008). Well-drained, mildly acid (pH=6-6.5) soils are optimal for cutting propagation and growing of *Philodendrons* which usually contain peat plus other accessories for example peat+perlite or peat+sand (2:1) or 2:1:1 ratio of peat+tree bark+vermiculite (HAMRICK, 2003; MÁNDY ET AL., 2006). In this work, the aim was to find morphological and physiological differences between the rooted and survived cuttings and ascertain the effects of different substrates on the success of cutting propagation.

MATERIAL AND METHOD

Plant material, substrates, culture conditions

Cuttings of 10-15 cm in length with 2-3 leaves were collected from mother plants originated from previous micropropagation and acclimatization studies (ASZTALOS, 2012). Before planting soaked, cleaned cuttings were planted into containers of 9 x 9 cm size filled with every substrates (35 specimens per each group). The lower leaves were removed in order to avoid rot.

The first group was planted in 100% Novobalt white peat, BRT GreenMoss (rest on Sphagnum moss, originated from peat-moors of Finland – TILLY-MÁNDY AND HONFI, 2015), ASB Greenworld plant soil (henceforth: peat, BRT Moss, ASB soil), perlite, coco coir on 28th May 2015. Fifty-fifty percent combinations of BRT Moss plus the other 4 substrates were used for the second and third trials (which were started on 16th September 2015 and 3rd June 2016). The plants were grown in moderate greenhouse conditions without artificial lighting and with low heating during late autumn and winter, so the minimum temperature was only 6-12 °C during evenings of this period. In summertime, energy screen was used to avoid scorching of newly developed leaves and maintain optimal (20-22 °C) temperatures not more than 26-28 °C. As weekly (or during summer, daily) irrigation, heated (18-22 °C) tap water and as biweekly feeding, Substral fertilizer solution (NPK 6:3:6) were applied 2 months after planting of the cuttings.

Measurements of plant parameters

Three and a half months after starting, leaf width and length, length of shoots and roots, fresh weight of green parts and roots were measured, number of new shoots and roots were counted and physiological examinations (total chlorophyll, carotenoid content, peroxidase enzyme activity of leaves) were done.

For the determination of total chlorophyll and carotenoid content, 100 mg leaf sample was used (three times per group). Leaves were destructed by a dash of quartz sand and 10 ml acetone (80%). After one day cooling on +4 °C, absorbance of solution was measured by GeneSys VIS-10 (Thermo Fisher Scientific Inc., USA) spectrophotometer at 644, 663 and 480 nm wavelength. Leaf pigment contents ($\mu\text{g g}^{-1}$) were calculated by formula $(20.2 \times A_{644} + 8.02 \times A_{663}) \times V/w$ and $(5.01 \times A_{480})/w$; where V= volume of tissue extract (10 ml), w= fresh weight of tissue (0.1 g), A= absorbance (ARNON, 1949).

In case of assaying peroxidase (POD) enzyme activity, 3×150 mg leaf from every groups were homogenized in a refrigerated mortar with the use of 1.5 ml KH_2PO_4 (pH=6.5, 0.05 M). After centrifuging (4 °C, 20 minutes, 13500 rpm), separated extracts (without solid particles) were applied for spectrophotometric investigations (adjusted wavelength: 460 nm). For reaction, plant extracts (3 × 0.01 ml per group) were mixed with 1.7 ml $\text{C}_2\text{H}_3\text{NaO}_2$ (pH=4.5, 0.1 M), 0.03 ml H_2O_2 and 0.02 ml ortodiansidine (3,3'-dimethoxybenzidine) as chromogen reagent. Enzyme activity (U mg^{-1}) was calculated with formula $(\Delta A_1 \times \text{attenuation})/\epsilon$; where ΔA_1 = absorbance change/1 min, ϵ = 11.3: extinction coefficient of ortodiansidine (SHANNON ET AL., 1966; BLINDA ET AL., 1996). Three repetitions from every treatment were used for examinations of all biochemical parameters.

Data and statistical analysis

Data were evaluated by Ropstat statistical software (VARGHA, 2008). An analysis of variance (ANOVA) was conducted to calculate the statistical significance of all data presented. When significant differences between treatments were found, the means were separated by Tukey's test at $p < 0.1$, $p < 0.05$.

RESULTS

Leaf length and width

The use of 100% ASB soil resulted in the longest (190.17 mm) and widest (80.6 mm) leaves. In this (first) trial, significantly the shortest (133.34 mm) leaves were found on cuttings grown on perlite. In addition, significant differences were obtained if we compared results of the second and third trials (by the application of the same substrate

mixtures). In the latter case and because of the higher temperatures during growing time, plants developed considerably longer and wider leaves, especially on ASB soil + BRT Moss combination (185.91 mm length, 70.63 mm width). Mixing of perlite and BRT Moss eventuated the smallest leaves both in the second and third studies (Figure 1). In these cases, leaves were mostly shorter than 120 mm, narrower than 50 mm.

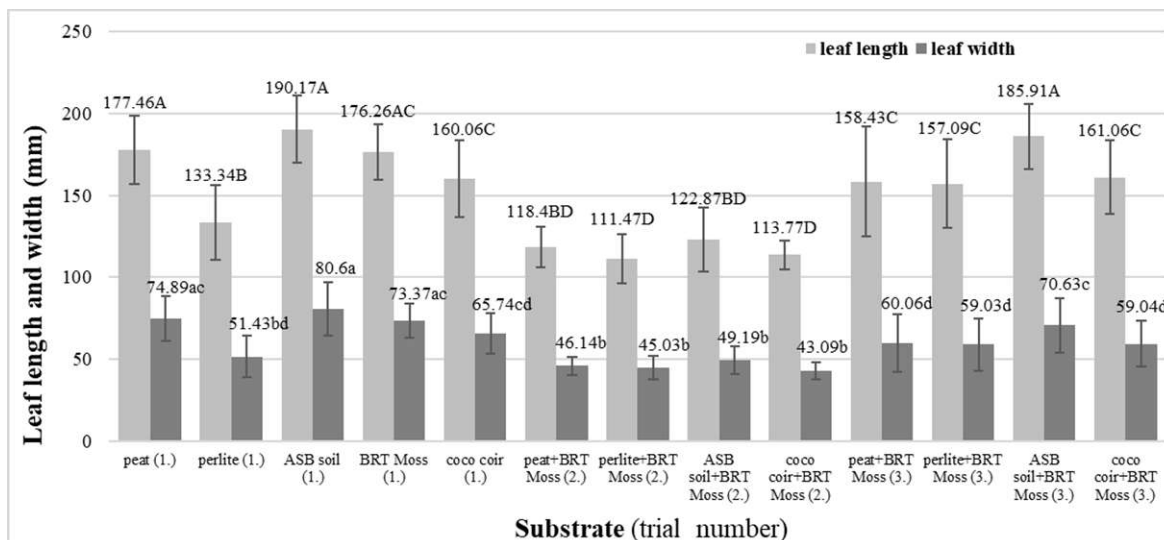


Figure 1. Leaf length and width of *Philodendron erubescens* cuttings. Means with different letter are significantly different by Tukey's test at $p < 0.1$, $p < 0.05$

Length of shoots and roots

The longest (147.26 mm) shoots were grown when ASB soil + BRT Moss mixture was used in the third trial. In almost every groups, significantly smaller shoot lengths were achieved excepting the result of 100% BRT Moss in the first study (135.49 mm). This latter agent was the best when pure soils (without mixing) were applied. In another trial with the same *Philodendron*, also BRT Moss resulted the highest plants during acclimatization, the last stage of their micropropagation (ÖRDÖGH AND VIZER, 2018). Lower growing temperatures (during the second experiment) and in the first trial, 100% perlite resulted in the shortest shoots.

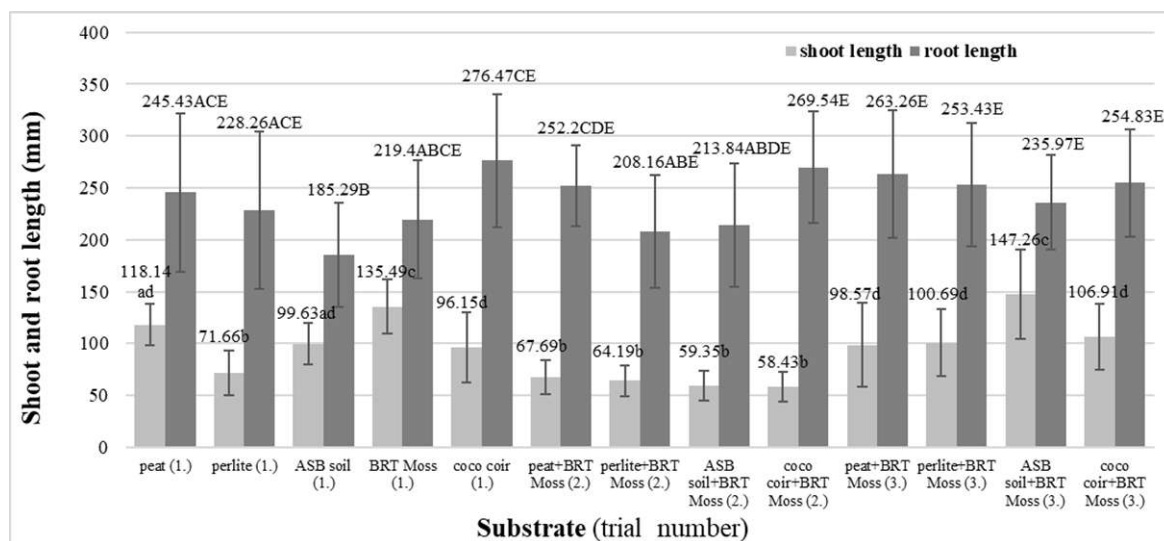


Figure 2. Shoot and root length of *Philodendron erubescens* cuttings. Means with different letters are significantly different by Tukey's test at $p < 0.1$, $p < 0.05$

The use of 100% coco coir and in the second trial, 50-50% coco coir + BRT Moss resulted in the longest roots (276.47 and 269.54 mm). Significantly shorter roots were developed in 100% ASB soil (first study) or in mixtures containing ASB soil or perlite in the second and third experiments (Figure 2). Probably, excessively dense, heavy (ASB soil) or easily drying, light weight substrates (perlite) were not optimal for the root elongation of these plants.

Number of shoots and roots

For producing more (12.56 and 14.8) roots, 100% coco coir or even more 50-50% ASB soil+BRT Moss (in the third study) were the best and 100% perlite or ASB soil the worst. The latter substrate similarly resulted in the smallest root values (number, length) during acclimatization of *Philodendron erubescens* (ÖRDÖGH AND VIZER, 2018). The most shoots (2.88 and 2.77) were achieved in the second study, especially when peat or coco coir was combined with BRT Moss (Figure 3). On the other hand, greenhouse temperatures also influenced the shoot number: in this experiment, lower night temperatures during autumn and especially winter (6-12 °C) inhibited shoot tip growing, therefore, more new shoots emerged from the lateral buds of the middle or basal parts of the cuttings.

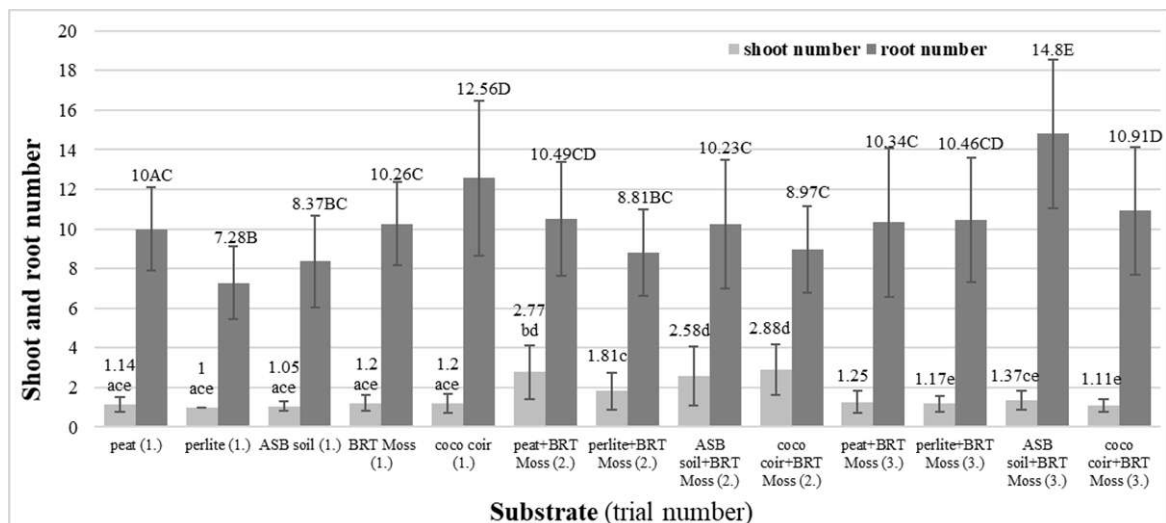


Figure 3. Shoot and root number of *Philodendron erubescens* cuttings. Means with different letter are significantly different by Tukey's test at $p < 0.1$, $p < 0.05$

Fresh green and root weight

As we can see on Figure 4, fresh green (leaves + shoot) weight values were larger than fresh root weights only in the first and third trials when warmer temperature resulted in considerably larger leaves and longer shoots. The shoot number did not influence the fresh green weight because of the relatively small size of the lateral, newly developed shoots. Furthermore, in all three trials, significantly the lowest values were obtained in the case of applying perlite (100% in the first or 50% perlite + 50% BRT Moss in the other two study) and the largest when pure ASB soil, BRT Moss or as mixtures, ASB soil + BRT Moss, coco coir + BRT Moss were used. Worthy of note that usually there was a positive coherence between fresh green weight and leaf sizes, shoot length.

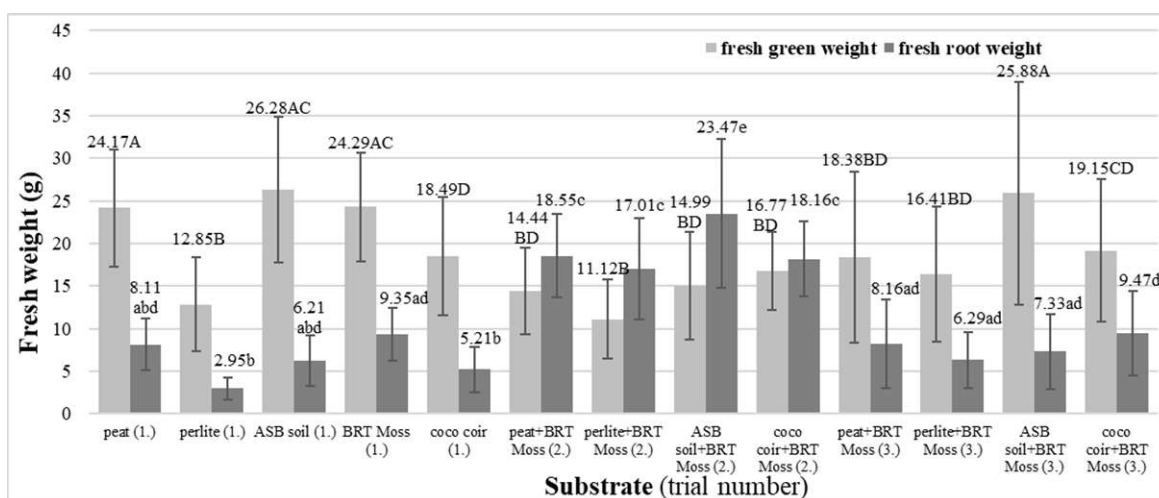


Figure 4. Fresh green and root weight of *Philodendron erubescens* cuttings. Means with different letter are significantly different by Tukey's test at $p < 0.1$, $p < 0.05$

Total chlorophyll and carotenoid contents of leaves

In the third experiment, 50-50% combination of BRT Moss and ASB soil resulted in the highest values: $4749.7 \mu\text{g g}^{-1}$ total chlorophyll and $95.67 \mu\text{g g}^{-1}$ carotenoid. If only pure substrates were used, 100% BRT Moss eventuated maximal pigment contents ($3550 \mu\text{g g}^{-1}$ and $75.23 \mu\text{g g}^{-1}$). The latter soil also eventuated the highest chlorophyll level when plantlets of the same species were acclimatized (ÖRDÖGH AND VIZER, 2018).

Temperatures also influenced leaf pigment contents. Significantly higher (and if we compare with the other two trial: mostly the highest) values were acquired in the third study, due to the warmer, optimal ($20\text{-}22^\circ\text{C}$) temperatures during growing period. Therefore, the lowest chlorophyll and carotenoid contents were determined in the second study, when air temperature often decreased below 15°C during especially winter (Table 1).

Table 1. Total chlorophyll and carotenoid content, peroxidase enzyme activity of leaves of *Philodendron erubescens* cuttings. Means with different letter are significantly different by Tukey's test at $p < 0.1$, $p < 0.05$

Trial number	Substrate	Total chlorophyll content ($\mu\text{g g}^{-1}$)	Carotenoid content ($\mu\text{g g}^{-1}$)	Peroxidase activity (U mg^{-1})
1.	100% peat	2276.3 AC	50.1 ac	0.0009 ace
	100% perlite	3451.7 BD	73.3 bd	0.0007 ace
	100% ASB soil	3181 ABD	67.07 abd	0.0023 bd
	100% BRT Moss	3550 BD	75.23bd	0.0005 ae
	100% coco coir	2746.7 ABCD	60.33 abcd	0.0012 acd
2.	50-50% peat + BRT Moss	2086 AC	51.23 ac	0.0009 acde
	50-50% perlite + BRT Moss	2214 C	56 ac	0.0015 cd
	50-50% ASB soil + BRT Moss	2942.7 B	75.5 bd	0.0019 d
	50-50% coco coir + BRT Moss	1959.3 C	50.9 c	0.0018 d
3.	50-50% peat + BRT Moss	3499.7 BD	74.47 bd	0.0004 e
	50-50% perlite + BRT Moss	3760 D	80.47 d	0.0004 e
	50-50% ASB soil + BRT Moss	4749.7 E	95.67 e	0.0003 e
	50-50% coco coir + BRT Moss	3225 D	70.07 d	0.0003 e

Peroxidase enzyme activity (POD) of leaves

The least stressed plants (with the lowest POD values: 0.0003-0.0004 U mg⁻¹) were grown in the third trial at higher temperatures. The same substrate mixtures with unfavourably lower temperatures resulted in higher enzyme activity (0.0009-0.0018 U mg⁻¹) in the second study. If we compared the effects of different substrates, 100% ASB soil and 50-50% ASB soil + BRT Moss, coco coir + BRT Moss (in the second experiment) enhanced these values (*Table 1*).

CONCLUSIONS

The highest morphological and physiological values were obtained when BRT Moss, ASB soil or their combinations were used as substrate for cutting propagation. Additionally, coco coir (and its admixture with BRT Moss) had positive effect on development of roots and shoots, but for producing larger sized plants (with faster growing and shorter duration time) warmer temperatures (optimally 20-22 °C) are recommended, especially during cool autumn and winter seasons. Accordingly, bottom or basal heat is preferable for the sake of better, successful rooting. As cheaper options, we can use other substrates (for example vermiculite, gravel or sand) as further accessories of different soil mixtures containing applicable agents (like BRT Moss, coco coir etc.), but more test is necessary to find the best substrates.

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