[OH] Article Review Request

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Elfarisna Elfarisna:

I believe that you would serve as an excellent reviewer of the manuscript, "Evaluation of sustainable propagating media – an environmentally benign way of pot production of Sansevieria trifasciata (Prain).," which has been submitted to Ornamental Horticulture. The submission's abstract is inserted below, and I hope that you will consider undertaking this important task for us.

Please log into the journal web site by 2023-05-31 to indicate whether you will undertake the review or not, as well as to access the submission and to record your review and recommendation.

The review itself is due 2023-06-14.

Submission
URL: https://ornamentalhorticulture.emnuvens.com.br/rbho/reviewer/submission?submissionId=2607&reviewId=4054&key=HzNaT3

Thank you for considering this request.

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"Evaluation of sustainable propagating media – an environmentally benign way of pot production of Sansevieria trifasciata (Prain)."

Abstract

Sansevieria trifasciata (Prain). (Commonname: Snake plant; Family: Asparagaceae) by habit is an evergreen perennial, popular indoor ornamental foliage plant. Barring its ornamental importance(s), it also has multifaceted usefulness i.e. for fibre yielding and indoor air filter purposes. Considering its cultural significances, easy mode of propagation (leaf cuttings) and for evaluation of the viable, organic growth medium which may be alternative of soil, we have carried outthe present study. The treatments comprised of 8 different compositions of growing substrate *viz.,*S_1M_1 – Red soil (Control), S_1M_2 – Coconut wood chips, S_1M_3 - Coir pith, S_1M_4 - Vermicompost, S_1M_5 - Coir pith + Coconut wood chips (1:1; w/w), S_1M_6 – Coconut wood chips + Vermicompost (1:1; w/w), S_1M_7 – Coir pith + Vermicompost (1:1; w/w), S_1M_8 – Red soil + Coconut wood chips + Coir pith + Vermicompost (1:1:1:1; w/w). Observations on pH, EC (Electrical Conductivity), nutrient status of growing medias and other morphological parameters (like number of leaves, shoot length, shoot weight, plant height), root characters (root length and number of primary roots, root weight) had been evaluated. The treatment combinationS_1M_8yielded the optimum soil health indicators like pH [5.79], EC [0.94 dSm^{-1}], nitrogen [1.7%], phosphorous [9.43%], potassium [1.4%], organic carbon [9.38%] which potentially impacted their growth. Thistreatment combinationhad recorded maximum plant height (22.45cm), number of leaves (6), shoot length (13.17cm), shoot weight (13.76g), root numbers (27.83), root length (10.69cm), root weight (3.81g), and early shoot emergence (80 DAP). The control group's outputs were not mention worthy. Summarily, the experimental output could endorse the utilization of the aforementioned organic media combination for pot culture of *S. trifasciata* (Prain). This merely not reduces the non-sustainable usages of soil but could also efficiently facilitate its growth.

Ornamental Horticulture - Editorial Team

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Dear Dr. Petterson Baptista da Luz Ok. I will review the manuscript. Thank you Best Regards Elfari

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Dr. Petterson Baptista da Luz
I have sent the manuscript that I have corrected in the online journal system Ornamental Horticulture Journal. Here I attach a manuscript that has been corrected

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U BalasTeruskan

Evaluation of sustainable propagating media – an environmentally benign way of pot production of *Sansevieria trifasciata* (Prain).

Abstract

Sansevieria trifasciata (Prain) by habit is a tropical, evergreen, perennial plant popular as indoor ornamental foliage as well as fiber yielder and natural indoor air filter plant. Considering the importance(s) of this crop and the principles of sustainability, we had aimed here to evaluate its optimum organic growth media which may be the alternative of soil. Leaf cutting is the conventional asexual propagation component for this plant. Red soil, coconut wood chips, coir pith, and vermicompost had been used, as organic growing substrates, in sole and combination forms. Observations on physio-chemical properties of the growing media and their subsequent impact on *S. trifasciata*'s growth and biomass characteristics had been recorded. The treatment combination of S_1M_8 (Red soil + Coconut wood chips + Coir pith + Vermicompost (1:1:1:1; w/w)) yielded the optimum soil health indicators like pH [5.79], EC [0.94 dSm^{-1}], nitrogen [1.7%], phosphorous [9.43%], potassium [1.4%], organic carbon [9.38%] which had resulted in maximum plant height (22.45cm), number of leaves (6), shoot length (13.17cm), shoot weight (13.76g), root numbers (27.83), root length (10.69cm), root weight (3.81g), and early shoot emergence (80 DAP). S1G7 (Coir pith + Vermicompost (1:1; w/w)) and S1G6 (Coconut wood chips + Vermicompost (1:1; w/w)) both the growing media may be considered as second best propagating media. The outcomes of other treatments are not mention worthy. Summarily, the experimental output could endorse the utilization of the aforementioned eco-friendly components, in combination, for pot culture of *S. trifasciata* (Prain). This will merely not reduce the non-sustainable usages of soil but could also efficiently facilitate its production.

Keywords: Propagation, organic, growing media, sustainable, ornamental, indoor plant.

Introduction

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Foliage plants are majorly used for interior decorations. Currently, more than 500 species are grown as foliage plants. India has the largest market share in the foliage industry. The foliage plants production in India were 91.27 MT and export value were Rs.33.22 lakhs from 2020 to 2021 (APEDA, 2022).Snake plant *(Sansevieria spp*., Family Asparagaceae), is one of the popular foliage plants, a perennial herb by habit, found in dry tropical and subtropical parts of the world, possess great economic importance ornamentally as well as ecologically i.e. as natural air purifiers (Sokhal and Narayan, 2020, Li and Yang, 2020, Chrysargyris*et al*., 2019) and also for diversified value-added products like photo-stabiliser (Li*et al*.,2020 and Siswanto*et al*., 2020), fibre source, and folk medicines (Maroyi, 2019 and Thu*et al*., 2021).It is a potential source of white strong elastic fibre commonly used in the manufacture of rope, fine matting, bowstring, and clothing(Srinivasan *et al*., 2020).

*S. trifasciata*is generally reproduced by seeds, leaf segments, and rhizomes. 'Leafcutting' is the conventional mode ofitspropagation (Henley, 1982, Sarmast et al., 2009, Rosawanti, 2016). Growth and development of the plants are aided by substrates which may be of organic origin (compost, poultry feathers, tree bark, peat) or inorganic (mineral wool, vermiculite, and clay).Severalrecent stringent environmental legislations have motivated ~~the~~ plant growers and researchers too to concentrate on sustainableproduction system.Itimplies the need of further exploration of sustainable, eco-friendly propagation media of this valuable foliage plant since propagation is a vital part of plant production.Recently, very few studies had been conducted on pot 'growing media',is the media containing materials to provide optimum nutrition, physical support and arable conditiontoaidplants to grow, ~~of~~ this crop.Okunlola et al. (2018~~) had~~ utilized sawdust, rice hull, sand, and soil to evaluate the suitable rooting substrate for the same species of *Sansevieria*whileSeran (2019) ~~had~~ studied the impact of compost and soil of varied proportions on growth performance during leaf cutting-based propagation of our target foliage.Gruda (2019) ~~had~~

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experimented on appropriate growing media of *S. cylindrica* Bojer ex Hook.using organic substrates.

Sustainability circumferences both the ethos of mitigation of environmental pollution and use of natural resources resiliently. Environmental sustainability is a vital aspect of sustainability but targeting the high yield parameter, the indiscriminate usages of inorganic growing media have crossed the threshold of environmental tolerance and consequently contributed to the environmental pollution. In this backdrop, the identification of novel organic propagating media for the pot production of the target foliage efficiently, to lower ~~down~~ the reliance on natural resources, may be the prudent and timely approach.

Although, ~~the~~ soil is one of the renewable resources but the requirement of prolonged time for its reformation has considered it as 'limited' natural resource (Okunlola*et al.*,2018). Collaterally, since the last few decades, the surge on the sustainability measures on diversified aspects is also the stimulatory factor for framing this experiment. Except these, the insufficient literatures on the study of apposite sustainable propagating substrates and the importance(s) of the target foliage are the supplemental rationale behind conducting this investigation. We have aimed here, to minimize the despoiling and pervasive utilization of soil and to identify the optimum, eco-friendly pot substrate for its propagation.

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Materials and methods

Experiment condition and setups

The experiment was conducted under naturally shaded condition. The experimental plot is geographically located at 10°32'27.0‖ North latitude and 79°25'40.2‖ East longitude. The average maximum and minimum temperature were 31°C and 26°C respectively. The average relative maximum and minimum humidity is 79% and 62% respectively. There was eight treatments which were arranged in a Completely Randomized Design (CRD) with three replications.

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Experimental materials

Selections of the leaves for preparation of the cuttings were based on the thickness and colour of the unit; the thick, healthy, disease free and bright coloured leaves were selected. The leaves were cut at a 45° angle (approximately 2.5 cm above the top of the soil)from the apical portion using a sharp pair of scissors. Each end of the leaves was marked by permanent marker for easy identification of planting base. The *Sansevieria* leaf cuttings were stored in a warm, humid and aerated area for a few hours.

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The constituents employed as propagating media(s) were locally available red soil (control), ~~the~~ naturally decomposed coconut wood chips, coir pith, and vermicompost. The treatments comprised of 8 different compositions of propagating substrates *viz.,* S_1M_1 – Red soil (Control), S_1M_2 – Coconut wood chips, S_1M_3 - Coir pith, S_1M_4 - Vermicompost, S_1M_5 - Coconut wood chips + Coir pith (1:1; w/w), S_1M_6 – Coconut wood chips + Vermicompost (1:1; w/w), S_1M_7 – Coir pith + Vermicompost (1:1; w/w), S_1M_8 – Red soil + Coconut wood chips + Coir pith + Vermicompost (1:1:1:1; w/w).

Substrates were filled in earthen pots, followed by planting of excised cuttings. Watering at 4 to 5 days intervals and intercultural operations had been carried out as and when required. The pots had been kept throughout the experimental trial under ~~the~~ naturally shaded condition.

Physio-chemical analysis of propagating media

No nutrients were added to the substrate, so as to assess the growth and performance of *S.trifasciata* with the available nutrients in the medium. Nutrient status (Nitrogen (N), Phosphorous (P), Potassium (K)) of the media and soil pH, Organic Carbon (OC), Water Holding Capacity (WHC), and Electrical Conductivity (EC) had also been analysed.The available N in the media was estimated by alkaline potassium permanganate method (Subbaiah and Asija, 1956), the available P was estimated calorimetrically using KlettSummerson calorimeter with red filter at 600

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nm (Olsen *et al*., 1954), the available K in the soil was estimated using Flame Photometer (Hanway and Heidal, 1952), the available organic carbon were estimated using chromic acid wet oxidation method (Wahley and black, 1934).Water holding capacity of the medias were analyzed by oven drying method. The pH of the growing mediaswas determined using a pH meter (Jackson, 1973), the EC of the media were estimated by conductivity bridge (Jackson, 1973).

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Evaluated plant growth and biomass features:

The parameters of days taken from planting to root and shoot emergence(days),a number of primary roots, root length(cm.), fresh root and shoot weight(g), shoot length(cm.), leaf number, and plant height (cm.) had been measured and recorded.Data on plant height and a number of fresh leaves emerged had been registered ~~after~~ 14-19 weeks after shoot emergence.

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Statistical analysis

The collected data were subjected to analysis of variance (ANOVA) using SPSS 10.0 statistical package. The treatment means were compared by Duncan's new multiple range test (DNMRT) at a 5% probability level.

Results

Of eight (8) propagation media, used for *S.trifasciata* production, first four (4) media (i.eM_1, M_2, M_3, and M_4) ~~were~~ consisted of single components while the remaining four (4) (i.e M_5, M_6, M_7, and M_8)were the combination media (Table 1). The detailed account on the nutritional status and physio-chemical properties of the employed media has been furnished below.

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Nutrient level& physical-chemical properties of the propagating substrates

Nitrogen (N) content: The utmost N content of 1.7% had been found in M8 (Red soil + Coconut wood chips + Coir pith + Vermicompost) while M3 (Coir pith, S_1M_4 - Vermicompost) and M6 (Coconut wood chips + Vermicompost)media may be considered as second best regarding 1.24 and 1.03% respectively of N content enrichment. The remaining media found insignificant in this aspect (Table 1).

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Phosphorus (P) content: Results in Table 1 proves the high P content of 9.3% of vermicompost (M4) media. The combined media i.e M8 (Red soil + Coconut wood chips + Coir pith + Vermicompost) found to be contained 9.43% of P may be due to the synergistic effect of all the media components.

Potassium (K) content: It is evident from Table 1 that M8 (Red soil + Coconut wood chips + Coir pith + Vermicompost) and M3 (Coir pith, S_1M_4 - Vermicompost) media contained highest of 1.4 and 1.2% of K content followed by M6 (Coconut wood chips + Vermicompost) media of 0.96%.

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Organic Carbon (OC) content: In this aspect, the antagonistic interaction impact had been evidenced in almost all the combination media ofM6 (14.40%) (Coconut wood chips + Vermicompost), M7 (13.75%) (Coir pith + Vermicompost) and M8 (9.38%) (Red soil + Coconut wood chips + Coir pith + Vermicompost). The highest OC content of 24% had been found in M3 (Coir pith) followed by M5 (17%) (Coconut wood chips + Coir pith) media (Table 1).

Water Holding Capacity (WHC): M5 (Coconut wood chips + Coir pith) and M2 (Coconut wood chips) – these two-growth media had exhibited the highest of 298.08 and 268.18% ~~of~~ moisture holding capacity respectively (Table 1).

pH: Almost all the growing media found to contain the acceptable range of pH viz. 5.5-7.5 except control media (M1- Red soil; 4.1 pH) (Table 1.)

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Electrical Conductivity (EC): The acceptable EC values had been obtained only in M8 (0.94 dS m^{-1}) (Red soil + Coconut wood chips + Coir pith + Vermicompost) and M4 (1.05dS m^{-1}) (Vermicompost) media. The high EC values of 3.14, 2.2 ad 2.01 dS m^{-1}had been found in M6 (Coconut wood chips + Vermicompost), M5 (Coconut wood chips + Coir pith) and M2 (Coconut wood chips) media respectively while M3 (Coir pith) and M7 (Coir pith + Vermicompost) media had shown 0.24 and 0.6 dS m^{-1} EC respectively which were below the threshold (Table 1).

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Effect of the propagating substrates on *S.trifasciata's* growth characteristics

Root emergence

The results tabulated in Table 2, revealed that S1M8 growing media caused the early (15days from DoP) root emergence followed by S1M6, S1M7 and S1M2 (21 days from DoP for each growing media). The maximum duration of 41 days had been registered under control condition (S1M1).

Shoot emergence (days)

The range of duration from root to shoot emergence was 2.2-3.1 months. Significant differences ($p<0.05$) were recorded on this parameter. The minimum no. of days of 80days (2.2 months) had been documented in the case of S1M8 media while the maximum no. days of 101days (3.1 months) in the case of S1M3 media. Except S1M8, S1M6, S1M2 and S1M7 media had also facilitated shoot emergence within 86, 87 and 88 days. Hence, all these 3 media may be considered as second best. Other treatment media including control had been found ineffective.

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Shoot length

The maximum shoot length of 13.17cm followed by 11.25 and 10.21cm, on 19th WAP (4.3 months), had been recorded in the case of S1M8, S1M6 and S1M2 growing media respectively. The shoot length were almost more than double on the 19th WAP over the 14th WAP (3.2 months) regarding all the growing media used except control (S1M1) (Table 2) but the influential role of S1M8, S1M7, S1M6 and S1M2 growing media on shoot elongation was evidenced. Barring the aforementioned, the other growing media failed to prove their effect.

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Plant height

S1M8 growing media had resulted in attaining the maximum plant height of 22.45cm followed by 20.31cm in S1M6 growing media. Except these two, S1M7 (15.29cm), S1M2 (18.35cm) and S1M4 (12.331cm) had also influenced the plant height to some extent. The results obtained from other growing media are not mention-worthy (Table 2).

Root length

The maximum root length of 10.69 am had also been obtained by S1M8 while 9.85 and 8.48cm of root length had been recorded in the case of S1M6 and S1M2 growing media respectively. The outcomes of other growing media were insignificant.

Effect of the propagating substrates on *S.trifasciata*'s biomass characteristics

Number of leaves

S1M8 and S1M6 growing media both ~~had~~ yielded a maximum number of leaves of 6 and 5nos respectively (Table 2) on 19th WAP while S1M2 growing media, in this regard, may be considered as second best one (no. of leaves 4 on 19th WAP). Here, S1M7 (no. of leaves 3.66 on 19th WAP) did not show its efficacy while other growing media, as usual, had shown their ineffective impacts. The impact of growing media on the rate of leaf emergence, over the duration of 1 month, was obscure (Table 2) except, for S1M8 growing media (2-fold increase in leaf nos on 19th WAP over 14th WAP).

Shoot weight

The same trend had been also evidenced here; more clearly S1M8, S1M6 and S1M2 had caused the maximum fresh weight of 13.76, 10.37 and 9.62g respectively in shoots while the least had been documented in S1M3 (2.80g) S1M5 (3.58g) (Table 2).

Number of primary roots

The implication of S1M8 (27.83 nos.), S1M6 (23.16 nos.) and S1M7 (2.16 nos.) growing media on the emergence of no. of primary roots which consist of tap, basal and lateral roots, of *S. trifasciata* had been found optimum. Control and S1M3 growing media had the least influence on this aspect (Table 2).

Root weight

Maximum fresh root weight of 3.81g (S1M8) followed by 2.82, 2.75 and 2.1g had been found in S1M6, S1M2 and S1M7 growing media respectively. Other growing media had been found insignificant. Any inter-relationship, whether or not, b/w number of primary roots, root length and weight is existing, is obscure.

Discussion

The importance of the employed foliage and the need of using sustainable eco-friendly propagating media, to attain the sustainability goals, were the impetus to carry out this investigation. This research finding clearly showed that propagating substrates play an essential role in the production of quality plantlets in terms of yield with improved plant growth characteristics. Functions of growing media include anchoring of plants and reservoir of nutrients and water. Proper potting mixtures of optimum chemical and physical characteristics promote plant growth and development.

The highest N:P:K content in M8 propagating media ~~had~~ significantly influenced the production rate along with improved plant growth and biomass characteristics, may be owing to the cumulative impact of all propagating components used for this experiment.

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Since, the key target of our experiment was the production; in other words, the propagation of *S. trifasciata* using organic growth components, hence, the emergence of roots from the propagating components (here, apical leaf cuttings) ought to be considered as one of the cardinal parameters. As the propagating media S1M8 had taken least number of days from planting-to-root emergence, so, the synergistic interaction effect is undeniable. According to Fageria (2001), P and K both play vital role in root emergence and growth duo while it is evident from Table 1 that M8 media contained utmost percentage of P and satisfactory percentage of K and N contents. Furthermore, several researchers (Wilkinson et al., 1999, Terman et al., 1977, Adams, 1980) had reported about the positive interaction between N and P. The presence of both of these nutrient components acts symbiotically; more elaborately, the nitrification process of N content and the subsequent release of H^+ cations cause the enhancement in solubility of P content while also consequence in marked on increase in P absorption, uptake and translocation (Fageria, 2001).This view is in concurrence of the obtained result.

Coconut wood chips, the coarsely broken parts of coconut shell while coir pith is the fine powdered form of coconut husk (Cresswel, 1992). Both contain the high C:N ratio ranged from 58:1 to 112:1 (Prabhu and Thomas, 2002). The use of raw coco-residues may often cause the development of toxic symptoms (yellowing of leaves) on plants, hence, use of bio-degraded forms not only cause the transformation of nutrients from complex to ready-to-use form for the plants (Khayyat *et al*., 2007; Riaz *et al*., 2008) but also contain low lignin, polyphenols and C:N ratio (Murphy, 1998, Yau and Murphy. 1998) which may be beneficial to subside the inhibitory impact of coco-residues. As reported by Nagarajan et al. (1985) the C:N ratio of coir pith of 24:1 or less may be used for agricultural purposes which had found true by the obtained result (Table 1). In general, the total porosity in coir pith is >94% (by volume) with high air content, ranges from 24-89% (by volume) and total WHC of <30% (Abad et al, 2005) while in case of coconut wood chips, the WHC is >60% as reported by Rabbani et al. (2020). According to the obtained data (Table 1)

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Commented [O360]: find the latest library the combination of coir pith and coconut wood chips (M5) media had showed maximum WHC (54.39% more over M1) followed by coconut wood chips (M2) (48.94% more over M1) and coir pith (M3) (32.16% more over M1)media but the reason of showing low WHC of combined media (i.e M8) is unknown. High lignin content and low cellulose make coir pith resistant to bio-degradation and good source of carbon (Savithri and Khan, 1994) which is evident from Table 1 but surprisingly, the M8 growing media showed antagonistic interaction impact. Whatsoever, any effect of OC content and WHC of the growing substrates on the root emergence had not been found.

The humus, macro and micronutrients rich vermicompost (the excreta of earthworms) not only augment the physical properties (Adhikary, 2012) of propagating substrates but also upgrades the chemical properties (like cation exchange capacity [CEC]) of them (Mahmud et al., 2018, Delgado and Gomez, 2016). In case of other combination treatments, especially M7 (Coir pith + Vermicompost) and M6 (Coconut wood chips + Vermicompost), the nutritional values of vermicompost had been found ineffective to shorten the number of days from planting-to-root emergence. P is a vital component for root initiation and growth; its high amount had been found in M4 (vermicompost) growth media but in combination with Coconut wood chips(M6) and Coir pith (M7),the antagonistic interaction impacthad been observed may be due to the abiotic factors(temperature, and light intensity), physio-chemical features of growth media (aeration, moisture, and pH) and physiological factors (rate of transpiration, respiration, age of cuttings, and selection of species) (Fageria, 2001).

According to Ding et al. (2018) the optimum EC value for *Sansevieria*growth ranges from 1-1.6 dS m^{-1}while other researchers (Kevin and Black, 2002; Selvaraj *et al*., 2009) had stated that the EC range of 0.75 – 2.0 $dSm^{-1}$is best for maximum nutrient availability of plants. The EC value of 0.94dSm-1in M8 media (Table 1) had proved the sufficient ions' interactions which consequently had caused the root emergence.

Except for M8 growing media, M6 and M7 had taken less number of days from root-to-shoot emergence (Table 2). Beyond the fact of moderate NPK content in these two (2) growing media, the organic matter, another vital factor which facilitates the photosynthetic process to build sugars usually used for plant growth (Hussain et al., 2017), optimum pH and WHC might had influenced the shoot emergence. On the contrary, the highest and low EC in M6 and M7 growing media respectively had arisen the doubt concerning mobilization of nutrients from growing media to plant. As we know that EC is an index of salt concentration (Ding et al., 2018) and indicates the electrolyte concentration available in the root zone (Nemali and Van lersel, 2004) since the adsorption and absorption mechanisms take place at the root site followed by ions interaction at the sub-cellular level. According to Signore et al. (2016) and Samarakoon et al. (2006) high EC value hinders nutrient uptake by enhancing the osmotic pressure of solutes and consequences into nutrient~~’s~~ discharge in the surrounding environment while low EC results in nutritional deficiencies and slow growth rate. Hence, in this experiment, notwithstanding ~~of~~ the abnormal values of EC, which may be owing to the congenial environmental factors, the noticeable growth and biomass characteristics in *Sansevieria* had been obtained but further in-depth study on the exact physiological process is needed. The maximum nutrient availability could be obtained in media with a pH of 5.5 – 6.5 (Kevin and Black, 2002; Selvaraj *et al*., 2009) while for *Sansivieria* it ranges from 5.5-7.5 (Henley, 1982).

Vermicompost is rich in NPK. According to Am-Euras (2009), one (1) kg of vermicompost contains 2.3, 1.85-2.25, and 1.55-2.25% of N, K, and P respectively while also considered as reservoir of other micro-nutrients, soil microbes, plant growth hormones, enzymes, etc. but the nutritional profile of the vermicompost media (Table 1) used for our experiment contains only high P content and optimum EC value. The synergistic interaction effect had been found only in combination with coconut wood chips and coir pith. Chen et al. (2006) ~~had~~ used pine bark, peat, vermicompost, and coir dust based growth media for the propagation of *Chlorophytum comosum*

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and found the best outcomes in terms of root development and other growth aspects in combined media.

In all the evaluated parameters, M6 and M7 both of these growing media showed a positive impact. The maximum number of leaves had been counted in S1G8, S1G7, and S1G6 growing media (Table 2). The optimum aeration, available N content (Khayyat *et al*., 2007; Riaz *et al*., 2008), optimum organic content (causes higher protein synthesis) (Sosamma *et al*., 1998) and physiological mechanisms (increased production of photosynthates) (Eapen, 2005) may contribute to the higher rate of leaf production. An Increased number of leaves, in Lilium Asiatic hybrid 'Navona', on media amended with vermicompost had been reported by Moghadam *et al*. (2012) while the same result had been also recorded in Gladiolus (Anjana and Singh, 2015). According to Tyagi and Kumar (2006), ~~the~~ improved growth and flowering parameters (like plant height, shoot weight, plant spread, number of flowers per plant, flower diameter, weight, and yield of flowers) had been found in African marigold which were grown in vermicompost based growing media. The microbiologically-active nature, low C:N ratio, high porosity, optimum WHC and nutrient enrichment (a readily available form of nitrates, exchangeable phosphorus, soluble potassium, calcium, magnesium, etc.) are the reasons which improve the physical properties of growing media (Dominguez, 2004, Kahsnitz, 1992; Hidalgo and Harkess, 2002; Hidalgo *et al*., 2006, Edwards and Burrows, 1988; Orozco *et al*., 1996, Tomati *et al*., 1990) and the subsequent yield. Appropriate texture, prevention of compaction, and macro-porosity of the growing media – ~~these~~ play vital roles in the rapid multiplication of roots (Handreek and Black, 2007, Eleni *et al*., 2001). These could be easily obtained in coco residue based media while the results, in respect of the number of roots and its weight and length, of the current experiment could endorse this view. Several researchers reported that in *Epipremnum aureum* Lindl. and Andre (Khayyat *et al.,* 2007), Golden Pothos (Reghuvaran and Rabindranath, 2014), *Osteospermum* sp. (Nowak, 2004) and *Impatiens* sp. (Smith, 1995), the number of roots were higher in medium containing cocopeat. Optimum dry

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Commented [O370]: find the latest library and fresh root weight and length had been registered in S1G8 media. Shirol *et al*. (2001) in dwarf poinsettia (*Euphorbia pulcherrima)* recorded maximum root development with vermicompost and sand while Nerlich *et al*. (2021) and Hwang *et al*. (2000) recorded noteworthy root characteristics in tomato which had been grown on carbonized chestnut wood chips based media. Here, the cumulative effect of all the media components might had caused the quantitative and qualitative improvement of emerged roots. The Addition of inorganic growth-promoting substances with organic ones can effectively enhance the growth and biomass attributes (Gao *et al*., 2010). The growth rate, in terms of shoot length and emergence of new leaves had been found insignificant in between 14-16WAP which may be for non-optimal source of nutrients and consideration of short span of documenting data while 19WAP almost double measurements/counts over the 14WAP counts had been obtained regarding the said parameters. Hussain et al. (2017) ~~had~~ used coconut compost for propagating *Caladium bicolour* but did not find satisfactory output being using coco-based residues alone as a growth substrate while recommended this substance as one of the essential components in combination treatment. Okunlola et al. (2018) had also investigated the impact of eco-friendly growing media on root development in the same species of *Sansevieria*. They ~~had~~ found the best outcomes in the combination of topsoil, sawdust, rice hull, and sand media, not in any single component-based growth media. A few other ornamental members of Asparagaceae family had been also employed for the evaluation of suitable organic substrates for their growth. For example, Valle et al. (2008~~) had~~ used the combination of sand, waste pulp, and earthworm compost as growing media and found a 20.4% improvement over the control (9.5%) in growth and biomass features of *Agave angustifolia*.

In this study, late emergence of the shoot, least plant height, shoot length, and leaf number had been found in S_1M_1 (Red soil; control) (Table 1). Wang *et al*., (2016) stated that red soil is generally rich in iron alumin~~i~~um hydroxides with a strong fixation capacity of phosphate, low pH and organic matter content, and poor nutrient availability. These may be the reasons of getting low

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growth-related outputs in the current study. In S1M2 (coir pith) also ~~the~~ unsatisfactory outcomes had been obtained which might ~~had~~ have been due to the immobilization of soluble nitrogen as stated by Cresswel (1992).

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Conclusion

Results of this study reveal~~s~~ that the combination of Red soil, coconut wood chips, coir pith, and vermicompost (1:1:1:1) may be recommended as the ideal organic potting mixture for the production of *S. trifasciata*. The identification of these eco-friendly growth substrates will be beneficial to minimize the dependence on and irrational usages of soil, a non-renewable resource (for human purposes). Furthermore, may also facilitate the production of quality plantlets of this ornamentally and ecologically valuable tropical foliage plant. Further endeavour on an exploration of suitability of other diversified qualitatively more upgraded organic components for successful propagation of *Sansivieria* may be ventured targeting to promote the soilless production of *Sansivieria* to fulfil the sustainability goal.

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Author contribution

All authors contributed equally for the manuscript.

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Table 1. Physio-chemical properties of the propagating media used for *S. trifasciata*

Treatments	Nutrients status of the substrate at the time of planting (%)				WHC (%)	pH	EC(dS/m)
	N	P	K	OC			
M_1	0.5^{cd}	$0.\ 138^{d}$	0.2^{cd}	0.05^{g}	18.25^{h}	4.1^{d}	0.47^{b}
M_2	0.0042^{e}	0.00001^{f}	0.03^{e}	10^{d}	268.18^{ab}	5.68^{a}	2.01^{c}
M_3	1.24^{b}	0.06^{e}	1.20^{a}	24.0^{a}	176.24^{c}	6.6^{b}	0.24^{b}
M_4	0.0095^{e}	9.3^{a}	0.0074^{f}	3.5^{f}	21.35^{g}	6.8^{b}	1.05^{b}
M_5	0.63^{c}	0.03^{e}	0.61^{c}	17^{b}	298.08^{a}	7.61^{b}	2.2^{c}
M_6	1.03^{b}	1.08^{c}	0.96^{b}	14.40^{c}	28.27^{f}	7.82^{b}	3.14^{de}
M_7	0.624^{c}	4.68^{b}	0.60^{c}	13.75^{c}	49.43^{d}	6.7^{a}	0.6^{ab}
M_8	1.7^{a}	9.43^{a}	1.4^{a}	9.38^{de}	39.27^{e}	5.79^{a}	0.94^{a}
SE(m)	0.017	0.049	0.086	0.164	2.484	0.080	0.026
SE(d)	0.024	0.070	0.121	0.232	3.513	0.113	0.037
C.D	0.052	0.149	0.259	2.466	7.512	0.241	0.078

OC- Organic carbon; EC- Electrical conductivity, WHC-Water Holding Capacity,M_1 – Red soil (Control), M_2 – Coconut wood chips, M_3 - Coir pith, M_4 – Vermicompost, M_5 - Coir pith + Wood chips (1:1), M_6 – Coconut wood chips + Vermicompost (1:1), M_7–Coir pith + Vermicompost (1:1), M_8 – Red soil + Coconut wood chips + Coir pith + Vermicompost (1:1:1:1). Means in a column bearing different letters have significant difference ($P \leq 0.05$) among no. of days of shoot emergence. Similar letters containing data are statistically at par.

Table 2. Effect of different propagating media on *S. trifasciata*'s plant growth and biomass attributes.

Trts.	Evaluated growth & biomass characteristics											
	No. of days to shoot emergence	Shoot length (cm) (WAP)			Fresh shoot weight (g)	Leaf number (WAP)			Plant height (cm)	Number of primary roots	Root length (cm)	Fresh root weight (g)
		14	16	19		14	16	19				
S_1M_1	-	0^g	0^f	0^g	0^g	0^d	0^d	0^e	3.4^h	9.16^f	3.40^f	0.73^d
S_1M_2	87^b	3.82^c	6.51^b	10.21^c	9.62^{bc}	2.33^b	3^b	4^b	18.35^c	$21b^c$	8.48^c	2.75^b
$S_1 M_3$	101^{cd}	0.1^f	1.34^e	3.36^f	2.80^f	0^d	1.33^c	2.33^d	5.61^{fg}	9.23^f	3.55^f	0.75^d
$S_1 M_4$	90^c	2.17^d	4.60^d	7.68^d	4.29^d	2.33^b	3^b	3.33^c	12.31^e	18.16^d	5.48^e	1.5^c
$S_1 M_5$	100^{cd}	0.53^e	1.44^e	4.11^e	3.58^e	0.66^c	1.66^c	2.66^d	7.48^f	15.46^e	4.58^e	1.42^c
S_1M_6	86^b	4.91^b	7.13^a	11.25^b	10.37^b	3^a	4^a	5^a	20.31^b	23.16^b	9.85^b	2.82^b
$S_1 M_7$	88^b	3.16^{cd}	5.31^c	9.19^{cd}	7.91^c	2^b	3^b	3.66^{bc}	15.29^d	20.16^c	6.46^d	2.1^b
$S_1 M_8$	80^a	5.11^a	7.86^a	13.17^a	13.76^a	3.33^a	4^a	6^a	22.45^a	27.83^a	10.69^a	3.81^a
SE(m)	1.445	0.097	0.287	0.141	0.423	0.236	0.289	0.236	0.177	0.177	0.249	0.033
SE(d)	2.043	0.138	0.406	0.199	0.598	0.333	0.408	0.333	0.250	0.250	0.352	0.046
C.D	4.369	0.295	0.869	0.426	1.280	0.713	0.873	0.713	0.535	0.535	0.753	0.099

S_1-*S.trifasciata*, M_1 – Red soil (Control), M_2 – Coconut wood chips, M_3 - Coir pith, M_4 – Vermicompost, M_5 - Coir pith + Wood chips (1:1), M_6 – Coconut wood chips + Vermicompost (1:1), M_7–Coir pith + Vermicompost (1:1), M_8 – Red soil + Coconut wood chips + Coir pith + Vermicompost (1:1:1:1), WAP-Weeks after planting. Means in a column bearing different letters have significant difference (P≤0.05) among no. of days of shoot emergence. Similar letters containing data are statistically at par.

Figure 1. Effect of different propagating media on *S. trifasciata*'s plant growth on 19th Week after planting. S_1-*S. trifasciata*, M_1 – Red soil (Control), M_2 – Coconut wood chips, M_3 - Coir pith, M_4 – Vermicompost, M_5 - Coir pith + Wood chips (1:1), M_6 – Coconut wood chips + Vermicompost (1:1), M_7–Coir pith + Vermicompost (1:1), M_8 – Red soil + Coconut wood chips + Coir pith + Vermicompost (1:1:1:1)

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