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Effect of Leaf Segments and Potting Media on Plant Performance of *Sansevieria trifasciata* Hort. ex Prain Grown under *Ex vitro* Conditions

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ABSTRACT

The present study was conducted to investigate the vegetative propagation of *Sansevieria trifasciata* under *ex vitro* conditions. The experiment was conducted at the net house to select the best leaf segment among apical, middle and bottom portions of leaves and also to evaluate their performance in different potting media. Leaf segments were taken from apical, middle and bottom portions and planted in soil: compost at 1:0, soil: compost at 1:1 and soil: compost at 1:2 ratios. After 90 days, number of shoots per cutting (>1cm), number of shoot buds (<1cm), length of longest shoots, leaf area, fresh weight of shoots, dry weight of shoots, number of roots, length of longest root, fresh weight of roots and dry weight of roots were recorded. The result indicated that leaf segments and potting media showed the significant influence on number of days taken to emerge shoots, leaf area, number of roots per segment, longest shoot length, longest root length, fresh weight of shoot, fresh weight of roots, dry weight of shoot, dry weight of roots among the tested treatments. Apical segment of leaf was the best to produce higher number of shoots while bottom portion of leaf was more suitable to produce longest root. Among the potting media, shoot formation was quicker in soil: compost at 1:1 than that in other potting media.

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Introduction

Sansevieria trifasciata (snake plant) is a perennial herb that occurs in the certain tropical parts of the world. *Sansevieria* species are one of the major foliage ornamentals mainly due to the variegated and mottled leaves (Bos, 1998). The erect and stiff leaves of *Sansevieria* are used in artistic flower arrangements. *Sansevieria* is a source of white strong elastic fibre commonly used in the manufacture of rope, fine matting, bowstring and clothing (Abral and Kenedy, 2015). It is a popular foliage plant and grown commercially. The plant also eliminates considerable amounts of benzene, formaldehyde, trichloroethylene and toluene (Deborah, 2019). *S. trifasciata* can be reproduced by seeds, leaf segments and rhizomes. Leaf segments and rhizomes grow rapidly to form dense thickets (Arnold, 2004).

Leaves are most often used for plant propagation. Leaves are cut into appropriate long segments and placed in soil to form a new shoot. In conventional agriculture, inorganic fertilizers are used to increase crop yield however it reduces soil fertility. Animal manures alone or in combination with crop residues can be used as a substitute of chemical fertilizer as stated by Mandal et al. (2007). In agriculture, utilization of organic manure is recommended for maintain the productivity of problem soils, reducing the usages of chemical fertilizer and minimizing environmental problems (Xiao et al., 2006). According to the literature survey, organic manure improves the soil texture, water holding capacity and drainage thus it helps to boost the growth and development of horticultural crop. This study was done to select suitable leaf segment to produce higher number of shoots and also to find out the best potting medium to produce better plant production of *S. trifasciata* in Eastern region of Sri Lanka.

Materials and Methods

Experiment was conducted at the net house of Crop Farm, Eastern University, Sri Lanka, during the period of 2014-2015. In this experiment, leaf sections were taken from apical (L_1), middle (L_2) and bottom (L_3) portions and they were planted in different potting media (soil:compost at 1:0, 1:1 and 1:2 ratios). They were nine treatments which were arranged in a Randomized Complete Block Design. Soil and compost were collected and they were mixed separately into 1:0, 1:1 and 1:2 ratios for preparing the potting media P_1, P_2 and P_3 in order. Each potting medium was filled into polybags to a depth of two third and labelled.

Healthy juvenile leaves of snake plant with similar long were selected and they were cut off at the soil level with a very clean sharp knife. The collected leaves were cut into three segments (about 15 cm) namely apical (L_1), middle (L_2) and bottom (L_3) sections. Potting media were wetted and allowed to drain before placing the cutting into it. Apical, middle and bottom leaf segments were placed vertically into each polybag containing P_1, P_2 and P_3 potting mixtures (Table 1). Compost contains 0.87% N, 0.82% P_2O_5, 0.79% K_2O (Seran and Imthiyas, 2016). The leaf segments were placed about two cm into the potting media. The leaf cuttings were placed into the potting media in accordance the growth direction of leaves. Polybags with leaf segments were maintained in a net house under lightly shaded (50%) conditions. Watering was done occasionally using sprayer to keep the soil slightly moist and weeding was done at once in a month. And cuttings were checked for the rotting of the base.

Table 1 Treatments used in this experiment

Treatment codes	Treatments	
	Potting medium (v/v)	Leaf segment
P_1L_1	Soil:Compost (1:0)	Apical
P_1L_2	Soil:Compost (1:0)	Middle
P_1L_3	Soil:Compost (1:0)	Bottom
P_2L_1	Soil:Compost (1:1)	Apical
P_2L_2	Soil:Compost (1:1)	Middle
P_2L_3	Soil:Compost (1:1)	Bottom
P_3L_1	Soil:Compost (1:2)	Apical
P_3L_2	Soil:Compost (1:2)	Middle
P_3L_3	Soil:Compost (1:2)	Bottom

Number of days taken to emerge shoots was recorded to each leaf segment until three months from the beginning. After three months, leaf cuttings with newly emerged shoots were removed carefully without damaging the roots and they were washed to remove the media. Number of shoots per cutting (>1 cm), number of shoot buds (<1 cm), length of longest shoots, leaf area, fresh weight of shoots, dry weight of shoots, number of roots, length of longest root, fresh weight of roots and dry weight of roots were recorded. The data obtained were analysed by using SAS software. The mean comparisons between treatments were done by using Tukey's test at 5 % significant level.

Results and Discussion

The objectives of the study were to find out the best portion of leaf segments of *Sansevieria* and potting medium under *ex vitro* condition useful for vegetative propagation. It includes high shoot production and rooting of shoots as well as *ex vitro* plantlet survival (Hartmann et al., 2002). Therefore three different types of leaf segments (apical, middle and bottom) were placed in three different potting media.

Number of Days Taken to Emerge Shoots

There was a significant variation (P<0.01) among the treatments (Table 2). While increasing the rate of compost, there was statistical variation in the days of emerging shoots. Compost application showed the influence on number of days taken to emerge new shoots from leaf segments. There was no any significant variation on different leaf segments placed in same potting medium. The mean value of number of days to emerge shoots was relatively low to apical portion, this result is close conformity with several findings. The amount of cytokinin existing in apical portion is higher than other two portions of the leaves (Zubo et al., 2008). Cytokinin has the great effect on shoot bud initiation from leaf cuttings (Hartmann et al., 2002). Therefore, internal mechanisms present in the leaves possess the ability for the emergence of shoots.

Number of Shoot/s per Segment

The result of the experiment showed that there was no significant difference (P>0.05) between the segments of leaves on number of newly emerged shoots and number of shoot buds developed (Table 2). However, higher mean value of newly emerged shoot (>1 cm) was recorded with apical segment grown in P_2 potting medium (Figure 1, Table 2). The apical region of leaves normally receives more light than the basal region during the entire plant life. Medina et al. (1994) reported that increasing leaf age of *Ananas comosus* determined strong variations in nitrogen content. Zubo et al. (2008) stated that in freshly detached leaves, the content of cytokinin in basal segments was half the content in the middle and upper portion of leaves. The ratio of low auxin and high cytokinin favours adventitious bud formation (Hartmann et al., 2002). The result of the experiment was supported by Zubo et al. (2008).

Figure 1 Apical leaf segment of *Sansevieria* plant at 90 days after planting in potting medium P_2 (soil: compost at 1:1 ratio)

Leaf Area and Number of Leaves Per Shoot

Leaf area was highest with the P_2 potting medium (soil: compost at 1:1 ratio) and lowest in the P1 potting medium (soil: compost at1:0 ratio). Result from the study showed that there was no any significant influence on leaf area of different leaf segments (apical, middle and bottom) planted in the same potting medium (Table 3). However, it was found that there were significant (P<0.05) differences in the leaf area of the newly developed shoots from apical and middle leaf sections those grown in different potting media. Because of the higher available nutrition, number of leaves and leaf area was higher in the shoot of middle portion than the apical portion. There was no any statistical variation in the number of leaves per newly formed shoot among the treatment (Table 3). Leaf area of newly developed shoots of middle segment was higher than the apical segment (Figure 2). The mean number of shoots at the middle portion was lower while comparing with an apical portion (Table 2).

Number of Roots Per Segment

This result showed that the number of roots per segment was increased with the amount of compost added to the soil (Table 3). Among the leaf segments, the higher number of roots was observed in apical (L_1) segment and lowest number of roots was noted in bottom segment (L_3). Popp et al. (2003) showed that there is an increase of carbohydrate and organic solute concentrations from the basal portion to the top portion of the leaves of *Ananas comosus.* The higher number of roots was observed in apical segment due to higher amount of carbohydrate content in apical portion. Hartmann et al. (2002) reported that carbohydrates translocated from the leaves are one of the important factors for root development.

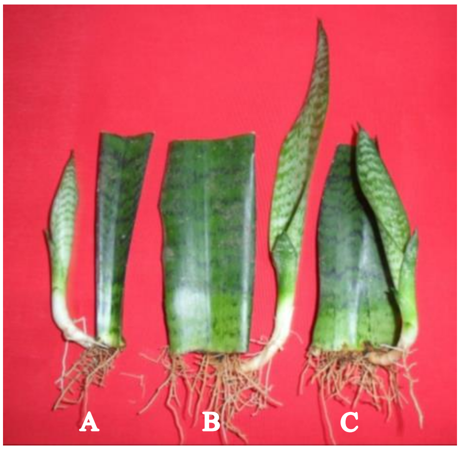

Figure 2 Leaf segments of *Sansevieria* plant at 90 days after planting in potting medium P_3
(soil: compost at 1:2 ratios) (A: Bottom segment of a leaf; B: Middle segment of a leaf; C: Apical segment of a leaf)

Table 2 Effect of leaf segments and potting media on number of days taken to emerge shoots from leaf segment and number of shoot/s per leaf section

Treatments	Number of days taken to emerge new shoots	Number of shoot /s (>1 cm) per leaf segment	Number of shoot buds (<1 cm) per leaf segment
P_1L_1	$72.67±1.33^{abc}$	1.00±0.00	0.67±0.33
P_1L_2	$74.67±1.86^{ab}$	1.00±0.00	0.33±0.33
P_1L_3	$78.67±2.60^{a}$	1.00±0.00	1.33±0.33
P_2L_1	$67.00±2.52^{bdc}$	2.33±0.88	0.67±0.67
P_2L_2	$69.67±0.67^{abcd}$	1.00±0.00	0.00±0.00
P_2L_3	$72.33±2.33^{abc}$	1.00±0.00	0.67±0.33
P_3L_1	$62.00±1.53^{d}$	1.33±0.33	2.00±1.15
P_3L_2	$64.33±2.60^{dc}$	1.00±0.00	0.33±0.33
P_3L_3	$70.67±1.76a^{bcd}$	1.00±0.00	0.67±0.33
F test	**	ns	ns

ns – no significant, ** P<0.0; P1: soil:compost (1:0), P2: soil:compost (1:1), P3: soil:compost (1:2); Apical (L_1), middle (L_2) and bottom (L_3) leaf segments; All the values are expressed as mean ± standard error. Means with the different letters within a column indicate significant differences based on Tukey's test at α = 0.05.

Table 3 Effect of leaf segments and potting media on leaf area and number of leaves per newly developed shoot and number of roots per leaf segment

Treatment code	Leaf area (cm^2)	Number of leaves per shoot	Number of roots per segment
P_1L_1	$6.58±0.46^{c}$	1.00±0.00	$17.33±1.76^{ab}$
P_1L_2	$7.03±0.59^{c}$	1.00±0.00	$12.33±1.20^{bc}$
P_1L_3	$7.16±1.51^{c}$	1.00±0.00	$8.67±1.45^{c}$
P_2L_1	$16.89±2.95^{ab}$	1.33±0.33	$17.67±0.88^{ab}$
P_2L_2	$20.43±0.97^{a}$	2.00±0.00	$15.33±1.33^{abc}$
P_2L_3	$13.11±2.02^{abc}$	1.00±0.00	$9.00±1.15^{bc}$
P_3L_1	$15.76±0.52^{ab}$	1.67±0.33	$23.00±3.46^{a}$
P_3L_2	$18.24±2.22^{ab}$	1.67±0.33	$18.00±2.65^{ab}$
P_3L_3	$10.99±2.11^{bc}$	1.33±0.33	$8.00±2.00^{bc}$
F test	**	ns	**

F test** P<0.01, ns – not significant, All the values are expressed as mean ± standard error. Means with the different letters within a column indicate significant differences based on Tukey's test at α = 0.05.

Mamba and Wahome (2010) stated that rooting geraniums in the potting mixture of garden soil, compost and sand resulted in more number of roots per cutting as compared to garden soil alone. The type of rooting medium and their characteristics are most important for the quality of rooted cuttings (Khayyat et al., 2007). They also attributed the improved root formation and growth in *Epipremnum aureum* Engler cuttings rooted in medium mixtures containing leaf mould and sand to better aeration, drainage and water holding capacity. In this study, the highest root formation was observed in the mixture of compost and sand which enhanced the root formation of cuttings.

Longest Shoot Length

There was significant difference ($P<0.05$) in longest shoot length among the treatments (Table 4). Middle leaf segments in compost added media were significantly different in the shoot length from bottom leaf portions. Longest shoot length was observed in P_3 potting medium; in this, the longest shoot length of middle segment was higher (14.60 cm) than others. Due to the higher partitioning of nutritious to the shoot of middle portion of a leaf and also due to the higher compost level, the shoot length of middle section in P_3 potting medium is higher compared to others. El-Naggar and El-Nasharty (2009) stated that potting medium and nutritional requirements are the most significant factors affecting growth of ornamental plants. Mamba and Wahome (2010) reported that the higher shoot height was obtained from geranium cuttings rooted in the potting mixture of garden soil, compost and sand than in cuttings rooted in sand.

Longest Root Length

Longest root length was observed in bottom segment of the leaf and lowest root length was observed in apical section of the leaf (Table 4). The effect of different treatments on root length was significantly different ($P<0.01$) among the treatments. Cuttings are naturally wounded when excised from stock plants. Wounded tissues are stimulated into production of root primordial due to a natural accumulation of auxin and carbohydrate in the wounded area.

Fresh Weight of Shoot and Root

The result showed the treatment P_1L_1 was significantly different ($P<0.05$) from P_3L_2 treatments on the fresh weight of shoot (Table 5). Highest fresh weight of shoot was observed in middle segment (L_2) of a leaf. In the present result of the study, the mean value of shoot length, number of leaves per shoot and leaf area was highest to middle portion therefore the fresh weight of shoots was also highest to middle segment.

There was a significant variation ($P<0.01$) on fresh weight of roots among the treatments (Table 5). Roots of apical leaf segment showed the highest fresh weight and roots of bottom segment showed the lowest number of fresh weight. In the result of the study, the highest number of roots was observed in apical segment as the reason fresh weight of roots was highest in apical segment.

Table 4 Effect of leaf segments and potting media on shoot length and root length

Treatment code	Longest shoot Length (cm)	Longest root Length (cm)
P_1L_1	7.00 ± 0.25^{b}	6.87 ± 1.10^{ab}
P_1L_2	6.33 ± 0.68^{b}	8.70 ± 0.59^{ab}
P_1L_3	7.13 ± 0.20^{b}	9.40 ± 1.24^{a}
P_2L_1	11.17 ± 0.60^{ab}	5.60 ± 0.81^{b}
P_2L_2	12.63 ± 3.38^{a}	5.80 ± 0.12^{b}
P_2L_3	9.63 ± 0.59^{b}	6.10 ± 0.38^{ab}
P_3L_1	12.07 ± 0.47^{ab}	5.37 ± 0.58^{b}
P_3L_2	14.60 ± 2.74^{a}	5.77 ± 0.43^{b}
P_3L_3	9.40 ± 0.31^{b}	5.83 ± 0.44^{b}
F test	*	**

F test * -P<0.05, **-P<0.01, ns – not significant, All the values are expressed as mean± standard error. Means with the different letters within a column indicate significant differences based on Tukey's test at α = 0.05.

Table 5 Effect of leaf segments and potting media on fresh weight of shoot and fresh weight of roots of cuttings

Treatment code	Fresh weight of shoot (g)	Fresh weight of roots (g)
P_1L_1	1.30 ± 0.08^{b}	0.67 ± 0.03^{a}
P_1L_2	1.44 ± 0.08^{ab}	0.59 ± 0.02^{ab}
P_1L_3	1.41 ± 0.09^{ab}	0.41 ± 0.11^{b}
P_2L_1	2.76 ± 0.40^{ab}	0.58 ± 0.02^{ab}
P_2L_2	3.10 ± 0.95^{ab}	0.45 ± 0.04^{ab}
P_2L_3	2.45 ± 0.68^{ab}	0.38 ± 0.07^{b}
P_3L_1	2.70 ± 0.22^{ab}	0.69 ± 0.02^{a}
P_3L_2	3.96 ± 0.95^{a}	0.44 ± 0.02^{b}
P_3L_3	2.19 ± 0.32^{ab}	0.39 ± 0.02^{b}
F test	*	**

F test* -P<0.05, F test** -P<0.01; All the values are expressed as mean± standard error. Means with the different letters within a column indicate significant differences based on Tukey's test at α = 0.05.

Table 6 Effect of leaf segments and potting media on dry weight of shoot and dry weight of roots

Treatment code	Dry weight of shoot (g)	Dry weight of roots (g)
P_1L_1	0.105±0.001[b]	0.088±0.001[a]
P_1L_2	0.121±0.012[b]	0.074±0.001[abc]
P_1L_3	0.112±0.001[b]	0.055±0.012[abc]
P_2L_1	0.230±0.041[ab]	0.086±0.001[a]
P_2L_2	0.263±0.093[ab]	0.072±0.012[abc]
P_2L_3	0.198±0.061[ab]	0.050±0.013[bc]
P_3L_1	0.224±0.012[ab]	0.086±0.001[a]
P_3L_2	0.338±0.045[a]	0.056±0.014[ab]
P_3L_3	0.183±0.013[ab]	0.047±0.001[c]
F test	*	**

F test* -P<0.05, F test** -P<0.01; All the values are expressed as mean ± standard error. Means with the different letters within a column indicate significant differences based on Tukey's test at α = 0.05.

Dry Weight of Shoot and Root

Treatment P_3L_2 showed the significant difference (P<0.05) on dry weight of shoot from P_1L_1, P_1L_2 and P_1L_3 (Table 6). Shoots emerged from the middle segment of the leaves showed the highest value, the value also increased with the amount of compost added to the soil. The same trend of effect of leaf segments and potting media on fresh weight of shoots was observed in soil alone and other potting media. Compost improves soil nutrients and retains soil moisture. As the mean value of shoot length, number of leaves per shoot and leaf area increase, more light is intercepted and photosynthesis rate enhanced, resulting in high dry matter production. The result of the experiment showed that there was significant difference (P<0.01) in dry weight of roots between the treatments. Among the treatments, dry weight of roots was higher in apical segment.

Conclusion

Growth performances of different leaf segments of *Sansevieria trifasciata* were assessed in three potting media for the period of three months. From this study, it could be concluded that apical leaf segment could be suitable for numerous shoot production and it took less days to emerge shoots, middle leaf portion could be appropriate for the production of shoot with higher leaf area, dry matter and longest shoot length while bottom leaf portion could be used for the production of shoots with longest root length. Among the potting media, soil: compost at 1:1 could be better to produce shoots quicker and responsible to produce higher leaf area than other potting media.

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