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GROWTH PERFORMANCE OF GUAVA CUTTING UNDER DIFFERENT GROWING MEDIA AND PLANT CUTTING TAKING HEIGHT

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Abstract

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This study was conducted to explore the survival and growth performance of Guava cutting under different growing media and cutting height at Nursery Sanitation Project, University of Agriculture, Pakistan. In this experiment different growing media such as Peat moss:Sand:Sawdust (1:1:1), Silt, Top soil and Bagasse:Silt (1:1) and different cutting height (Bottom, Middle and Top) were evaluated by using single concentration of IBA (400 mg kg^{-1}). Results indicated that Silt media had recorded significantly higher number of roots (28.78±3.99), root length (24.95±5.00 cm), number of leaves (4.88±0.53), number of sprouts (3.79±0.64), shoot length (26.86±4.63 cm), sprouts length (19.09± 3.05 cm), stem diameter (5.30±0.65 mm), dry weight (139.25±14.92 mg), fresh weight of guava cutting (877.57±27.26 mg) and survival percentage (83.33±16.33%). Non-significant differences were observed with various cutting heights in terms of all parameters studied except stem diameter, while cutting from bottom showed highly significant differences in dry weight (146.48±8.93 mg), fresh weight (808.32±45.24 mg) and survival percentage (75.83±13.82%). Our data shows that silt media along with rooting hormone can increase root initiation and quality of root growth therefore, the results suggested that silt should be used as growing media.

Key words: guava; propagation; growing media; cutting height

Introduction

Guava (*Psidium guajava* L.) is an evergreen plant belonging to family Myrataceae and has been cultured since ancient times and commonly known as ‘‘Poor man’s apple’’. Guava produce two crops per year and grown throughout the country under diverse range of climatic conditions as well as cultivated throughout the world with the range from tropical to subtropical area (Smart et al., 2001). Guava fruit is a rich source of vitamins A, B_1, B_2 and vitamin C, and contains approximately 260 mg of vitamin C in 100 grams of guava fruit (Rahman *et al.,* 2003). Moreover, guava bears highly economic crop every year (Singh et al., 2000).

Guavas are commercially and traditionally propagated through seeds. Sexual propagation method yields a high percentage of plants and source of selection of several promising varieties but due to segregation and recombination of characters genetic purity is not maintained. Unique characteristics of certain variety cannot be multiplied or preserved through seed propagation and sexually propagated plants

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bear later than asexually propagated. Due to these hurdles it is difficult to standardize superior cultivars (Singh, 1996). To maintain quality of fruit and avoid segregation of economically superior tree in short time it obvious to use clonal propagation (Giri et al., 2004; Singh et al., 2004)

In fruit plant several vegetative propagation techniques e.g. air layering, stooling, root cutting have been proposed with changing success rate to increase the production and clonal multiplication (Mortan, 1987; Chandra et al., 2004). Success percentage varied due to technicalities involved regarding application of rooting hormones and media. Indeed, rooting through asexual methods of propagation is commonly used (Manica et al., 2000; Awan et al., 2012), however there is lack of proper information about guava cutting. Propagation by cuttings is a source of provision of true-to-type plants in one growing season from important trees (Tavares, 1994). There is different rooting behavior among different plant species, and some plants start rooting easily while some hardly rooted through cutting.

Auxins plays very important role to enhance success of propagation when applied to hardwood cuttings (Ljung, 2013), and increase the root initiation in plant. It has been reported that by applying root promoting hormones enhanced the growth performance of softwood cutting of guava (Hafeez et al., 1988). Shadparvar et al. (2011) mentioned that 4000 mg l^{-1} IBA treatment give maximum number of buds when planted in sand-perlite and peat-perlite bed. It has been previously reported that with IBA at 2500 ppm showed 98% success in hardwood cutting of guava (Prasad et al., 1988). Kilay and Gabr (1986) reported that semi-hardwood cutting of guava dipped in 10 ppm Alpha-Naphtholas + 2500 ppm IBA showed 81.4% rooting while poor rooting found in hardwood cutting.

Growing media should be considered an essential part of the propagation system because rooting competency depends on the type of medium used (Ingram et al., 1993; Chadha, 2007; Mehmood et al., 2013). Rooting medium directly effect on quality and percentage of rooting (Loach *et al*., 1988). The suitability of the rooting medium depends on the species, type of cuttings, growing conditions, season of the year and the cost effectiveness of the medium components (Macdonald, 1986; Hartmann et al., 2002). A use of good rooting media with rooting hormone will increase root induction (Leonardi et al., 2001).

The major problem in guava plantation is variability in propagation of plants by unreliable source by nurserymen (Singh et al., 2005). Guava production is affected due to poor quality seedlings and non-availability of quality planting material. For the establishment of guava orchard certified planting material is basic need to get quality produce (Singh et al., 2005). In the current scenario, when planting material is limited due to the huge expansion of acreage, it is obvious to standardize the propagation method. Moreover, in fruit plant long generation time required to make improvements through breeding. Therefore, experiment aimed at evaluating rooting and shooting competency of guava soft wood cutting in response of growth media and cutting taking height of plant that will increase successful establishment of clonal plants.

Materials and Methods

Selection of planting material

The proposed study was carried out during 2014-15 at Nursery Sanitation Project, University of Agriculture, Faisalabad. Highly productive and the phenotypically superior mother plant of Gola cultivar block (7-8 year-old) having excellent bearing, high fruit quality (fruit size and color of fruit), healthy and disease free plants were tagged as candidate plants for propagation at Post-Graduate Agricultural Research Station (PARS), Faisalabad.

Preparation of cuttings

Softwood cuttings of characterized plants of guava (Gola cultivar) were collected in the month of September from the Post-Graduate Agricultural Research Station (PARS), University of Agriculture, Faisalabad, Pakistan. The cuttings were collected from juvenile apical shoots of different heights of plants i.e. from bottom, middle and top of the canopy. The cuttings were prepared from apical shoots of 12 cm length and 1-1.5 cm diameter, with 2 to 4 nodes and carrying at least 2-4 pair of leaves. The bark on lower portion of these cuttings was wounded with the help of budding knife for the easiness during callusing process. After preparation, the basal portion of the cuttings was rapidly immersed in copper oxychloride (David Gray & Co. Ltd., Australia; 1 g per liter of water) solution to evade from any fungal infection for 10 min, subsequently cuttings were washed with distill water and treated with root promoting auxins at basal end (3-4 cm basal wounded portion). To avoid excessive water loss top (apical) cut was treated with paraffin wax. IBA treated cutting were planted in different rooting medias composed of Peat moss, Sand and Sawdust (1:1:1), Silt, Top Soil and Bagasse + Silt (1:1) by making a layer of 6 inches on surface for root induction and kept under white polyethylene sheet (Jilani Poly Industries (Pvt.) Ltd, Pakistan) non-misting low-tunnel. Elmore et al. (1997) disclosed that all rooting media should be sterilized under sunlight with polyethylene for fifteen days to kill the harmful pathogens. Cutting were irrigated with manual sprinkler each second day to maintain humidity. Relative humidity and temperature was approxi-

mately ranged between 70-85% and 18-25°C, respectively. Temperature and humidity were measured with Hygrometer device (Jumbo Display Hygrometer, USA). The experiment was performed in Completely Randomized Block Design (CRD) with two factors. All 540 cuttings were placed in twelve treatments by using three replications in a non-misting low-plastic tunnel. All cuttings were sown in 36 plots. Each replication contains 12 plots and each plot containing 15 cuttings. The cuttings were kept under low-tunnel for 90 days from mid-September to mid-December. To avoid any type of fungal growth cuttings were sprayed with mixed solution of Eliette ≅ 2.5 g/l (Fungicide) (Monheim am Rhein, Germany) after one month of planting.

Data collection and statistical analyses

After three months of planting, cutting were uprooted and data were recorded for shoot and root parameters, viz. number of sprouts per cutting, length of sprouting, stem diameter, shoot length, root length, leaves per cutting, roots per cutting, root fresh and dry weights and survival percentage. The collected data were statistically analyzed with Fisher analysis of variance (ANOVA) technique and the difference among the mean of treatments were compared with Tukey HSD test. Mean graphs were made by using Sigma plot v.10 (Systat Software, San Jose, CA).

Results and Discussion

Effect of rooting medium and cutting taking height on root induction, number of primary roots per cutting

Results obtained regarding roots per cuttings are presented in Table 1. Number of roots of guava softkwood cuttings was significantly affected by rooting media. Highest (28.78±3.73) number of roots per cutting was found in silt medium while lowest (18.04±3.48) number of roots per cutting was found in combination of bagasse + silt medium. Whereas cutting taking height did not show any significant difference on number of roots of guava cuttings. However, the interaction between the rooting media and cutting taking height shown the heights of root per cutting planted in silt and taking from the top of the plant. Results revealed that higher number of roots per cutting was obtained with silt medium may be due to neutral pH, which improve the drainage. Secondly reason may be other mediums (Peat moss + Sand + Sawdust, Top soil and Bagasse + Silt) have high water holding capacity that causes poor aeration. Perlite-silt (1:1 v/v) medium give highest rooting percentage (85%) but non-significant differences were observed with among other treatments (Mighani et al., 2010).

Regarding these observations silt medium holds low level of water and best for rooting cuttings. Oxygen deficiency induces rotting in cuttings and delay rooting process if humidity is higher (Erstad and Gislerod, 1994). Gislerod (1983) mentioned that media having low water retaining capacity is best choice in rooting cuttings. The lowest rooting number in guava cuttings was observed with bagasse + silt medium which can be due to high water holding capacity or may be due to the presence of some phytotoxic element in bagasse. However, the factor of cutting taking height of plant is non-significant irrespective of rooting media.

Root length (cm)

The results presented in (Table 2), shows that media had statistically significant effect on the root length of guava cuttings. The highest root length was observed in silt medium (24.95±5.00 cm) whereas the minimum length of root was observed in top soil (4.10±0.93 cm). However, mean comparison of Peat moss + Sand + Sawdust, Top soil and Bagasse + Silt treatments are non-significantly different from each other. Data presented regarding the cutting taking height of plant indicates that high root length was achieved by middle, top and bottom 10.15±8.83, 9.84±8.75 and 9.81±9.61 cm which are non-significantly different from each other. Ramtin et al. (2010) mentioned that longer roots are achieved in bed with lower water holding capacity which accords the observations of this study.

Table 1
Effect of cutting heights and different growing media on number of primary roots of guava cuttings

Rooting media	Height			Mean
	Bottom	Middle	Top	
Pm:S:Sd	23.25±1.39 ab	16.97±1.75 b	22.54±3.62 ab	20.92±3.73 B
Silt	26.36±5.81 ab	29.15±1.50 ab	30.84±1.28 a	28.78±3.99 A
Top soil	19.93±2.03 ab	24.54±7.97 ab	19.30±2.35 ab	21.26±5.46 B
Bagass : Silt	19.17±2.72 ab	17.52±1.04 b	17.43±5.10 b	18.04±3.48 B
Mean	22.18±4.47 A	22.04±6.57 A	22.53±6.16 A	

*Means having different letters differ significantly through Tukey HSD test; ± quantities show the standard deviation at p 0.05; Pm:S:Sd = Peat moss:Sand:Saw dust

Table 2
Effect of cutting heights and different growing media on root length (cm) of guava cuttings

Rooting media	Height			Mean
	Bottom	Middle	Top	
Pm:S:Sd	4.21±0.53 b	6.24±0.87 b	4.13±1.18 b	4.86±1.31 B
Silt	25.87±4.84 a	24.64±5.22 a	24.34±4.78 a	24.95±5.00 A
Top soil	4.61±0.80 b	4.92±1.20 b	5.47±0.34 b	4.10±0.93 B
Bagass : Silt	4.54±1.04 b	4.79±1.20 b	5.41±0.54 b	4.92±1.03 B
Mean	9.81±9.61 A	10.15±8.83 A	9.84±8.75 A	

* Means having different letters differ significantly through Tukey HSD test; ± quantities show the standard deviation at p 0.05; Pm:S:Sd = Peat moss:Sand:Saw dust

Number of leaves per cutting

The results of number of leave parameters of guava cutting are showed in Table 3. Significantly higher number of leaves was observed with cuttings planted in silt medium (4.88±0.53) compared to Peat moss + Sand + Sawdust, Top soil and Bagasse + Silt (4.18±1.00, 3.80±0.63 and 3.62±0.49), respectively. Higher number of leaves was observed with silt medium compare to others, whereas number of leaves per cutting did not differ significantly when used with various cutting taking height of plant irrespective of rooting media. Overall comparison of rooting media and cutting taking height indicates that highest number of leave per cutting was achieved from cutting grown in silt media and taking from bottom of plant. Olosunde et al. (2003) reported that good porosity of rooting medium promoting rapid absorption of nutrient leading to growth. The silt media produced significantly higher number of leaves compare to other media; this could be due to adequate drainage, aeration and low bulk density of media. Our results are in accords with results obtained by Adams et al. (2003) who achieved for *Dieffenbachia maculate* plants which needs porous and nutritious medium for seedling growth and establishment.

Number of sprouts per cutting

The results revealed from Table 4 that rooting media significantly affected the number of sprouts per cutting. Maximum number of sprouts of guava cutting was observed in silt (3.79±0.64) media and lowest was observed in Bagasse + Silt (1.79±0.35). Silt media showed significant difference from other media treatments but all other media (Peat moss + Sand + Sawdust, Top soil and Bagasse + Silt) treatments are not significantly different from each other. The results of this experiment on number of sprouts per cutting that develop new shoots regarding cutting taking height factor have not shown any significant difference. Rahimi et al. (2012) reported that higher number of shoots was observed with media coco peat-perlite (1:1 v/v) and IBA application of 2500 mg L^{-1}.

Shoot length (cm)

Data presented in Table 5 showed that, significant influence of rooting media on shoot length of guava cutting. The highest shoot length was achieved with silt medium (26.86±4.63 cm) whereas lowest shoot length was observed in B: S medium (13.92±1.72 cm). As a result, the treatment of rooting media silt was significantly superior form other media treatments. However, mean comparison of other three medias showed that high shoot length was observed with Peat moss + Sand + Sawdust, Top soil and Bagasse + Silt treatments which are non-significantly different from each other. Rahimi et al. (2012) reported that higher number of

Table 3
Effect of cutting heights and different growing media on number of leaves of guava cuttings

Rooting media	Height			Mean
	Bottom	Middle	Top	
Pm:S:Sd	4.67±1.04	4.04±1.03	3.84±0.70	4.18±1.00 AB
Silt	5.16±0.31	4.67±0.33	4.82±0.98	4.88±0.53 A
Top soil	4.29±0.68	3.43±0.40	3.68±0.42	3.80±0.63 AB
Bagass : Silt	3.87±0.42	3.44±0.42	3.55±0.52	3.62±0.49 B
Mean	4.50±0.82 A	3.90±0.80 A	3.97±0.85 A	

* Means having different letters differ significantly through Tukey HSD test; ± quantities show the standard deviation at p 0.05; Pm:S:Sd = Peat moss:Sand:Saw dust

Table 4
Effect of cutting heights and different growing media on number of sprouts of guava cuttings

Rooting media	Height			Mean
	Bottom	Middle	Top	
Pm:S:Sd	1.75±0.42 d	2.21±0.74 cd	2.82±0.59 abcd	2.26±0.64 B
Silt	3.81±0.54 ab	3.97±0.90 a	3.59±0.27 abc	3.79±0.64 A
Top soil	2.37±0.33 bcd	1.94±0.08 d	1.77±0.57 d	2.03±0.45 B
Bagass : Silt	1.94±0.21 d	1.88±0.16 d	1.55±0.46 d	1.79±0.35 B
Mean	2.47±0.89 A	2.50±0.99 A	2.43±0.95 A	

* Means having different letters differ significantly through Tukey HSD test; ± quantities shows the standard deviation at $p < 0.05$; Pm:S:Sd = Peat moss:Sand:Saw dust

shoots was observed with media coco peat-perlite (1:1 v/v) and IBA application of 2500 mg L^{-1}. Results presented regarding cutting taking have not shown significant influence on shoot length of guava cuttings.

Sprouting Length (cm)

Guava cuttings planted in silt medium were achieved significantly maximum length of sprouts (19.09±3.05 cm) over the Peat moss + Sand + Sawdust (6.29±2.46 cm), Top soil (4.79±2.39) and Bagasse + Silt (3.62±1.31 cm) treatments (Table 6). However, mean comparison of Peat moss + Sand + Sawdust, Top soil and Bagasse + Silt showed non-significant difference from each other. Results presented regarding cutting taking have not shown significant influence on sprout length of guava cuttings. The silt medium produces more sprouting length compare to all other media, this relates to what was observed by Adams et al. (2003) that good soil medium is basic resource for the production of healthy and successful plants.

Stem Diameter (mm)

It is clear from the Table 7 stem diameter was influenced by rooting media. The highest stem diameter of guava cuttings was observed in silt and Peat moss + Sand + Sawdust with means 5.30±0.65 and 4.93±0.68 mm, the lowest stem diameter was observed in media Top soil and Bagasse + Silt with means 4.14±0.58 and 4.24±0.61 mm. The silt medium produces more sprouting length compare to all other media,

Table 5
Effect of cutting heights and different growing media on shoot length (cm) of guava cuttings

Rooting media	Height			Mean
	Bottom	Middle	Top	
Pm:S:Sd	17.19±0.68 bc	12.39±0.88 c	16.52±2.88 bc	15.37±2.77 B
Silt	29.44±5.05 a	27.45±2.32 a	23.70±3.45 ab	26.86±4.63 A
Top soil	15.25±1.50 bc	12.86±0.65 c	14.67±2.50 c	14.26±2.01 B
Bagass : Silt	14.86±1.00 c	12.39±0.31 c	14.67±2.05 c	13.92±1.72 B
Mean	19.19±6.57 A	16.27±6.58 A	17.35±4.66 A	

* Means having different letters differ significantly through Tukey HSD test; ± quantities shows the standard deviation at p 0.05; Pm:S:Sd = Peat moss:Sand:Saw dust

Table 6
Effect of cutting heights and different growing media on sprouting length (cm) of guava cuttings

Rooting media	Height			Mean
	Bottom	Middle	Top	
Pm:S:Sd	5.07±3.00 b	8.15±1.92 b	5.64±0.03 b	6.29± 2.46 B
Silt	17.87±2.71 a	18.98±1.48 a	20.42±3.89 a	19.09± 3.05 A
Top soil	3.96±1.03 b	4.44±1.67 b	5.98±3.33 b	4.79± 2.39 B
Bagass : Silt	3.92±0.42 b	4.33±1.25 b	2.60±1.28 b	3.62± 1.31 B
Mean	7.71±6.22 A	8.98±6.19 A	8.66±7.40 A	

* Means having different letters differ significantly through Tukey HSD test; ± quantities show the standard deviation at p 0.05; Pm:S:Sd = Peat moss:Sand:Saw dust

Table 7
Effect of cutting heights and different growing media on stem diameter of guava cuttings

Rooting media	Height			Mean
	Bottom	Middle	Top	
Pm:S:Sd	4.66±0.34 ab	5.41±0.83 ab	4.72±0.47 ab	4.93±0.68 AB
Silt	5.03±0.44 ab	5.91±0.69 a	4.96±0.20 ab	5.30±0.65 A
Top soil	4.68±0.40 ab	3.96±0.39 b	3.78±0.50 b	4.14±0.58 B
Bagass : Silt	4.60±0.49 ab	3.96±0.78 b	4.17±0.24 ab	4.24±0.61 B
Mean	4.74±0.45 A	4.81±1.11 A	4.41±0.60 A	

* Means having different letters differ significantly through Tukey HSD test; ± quantities show the standard deviation at p 0.05; Pm: S:Sd = Peat moss:Sand:Saw dust

this relates to what was observed by Adams et al. (2003) that good soil medium is basic resource for the production of healthy and successful plants.

Root fresh and dry weights (mg)

Data regarding the root fresh and dry weights presented in Figure 1, media and cutting taking height had significant effect on root fresh and dry weight of guava cuttings. The high and low fresh and dry weights were achieved with cuttings taking from bottom and top, respectively. In the rooting media factor highest and lowest fresh and dry weights of guava cuttings were observed with cuttings planted in silt and Bagasse + Silt media, respectively. However, the interaction of media and cutting taking heights shows that maximum fresh and dry weight of roots was obtained in silt media with cutting taking from bottom of plant. These findings indicate positive correlation between the fresh and dry weight of the roots. Mighani et al. (2010) achieved high root fresh weight with cutting planted in perlite and silt-perlite medium, which is similar to our results.

Survival percentage (%)

It is evident from the Figure 2 that rooting media and cutting taking height significantly affected the survival percentage of guava cuttings. Highest (75.83%) survival percentage was achieved with cuttings taking from bottom of the plant, while minimum (58.33%) survival percentage of guava cuttings were found in cutting taking from middle of the plant. In the present study among rooting media highest (83.33%) survival percentage was found in cutting planted in silt media, while minimum (47.78%) survival percentage of guava cuttings was observed in Bagasse + Silt media. Significant effect of media on survival percentage might be due to porosity, aeration and less water holding capacity of which helps to produce more adventitious root and thereby increase the survival percentage. Our results are in agreement with Adams et al. (2003) who reported that nutritious and well

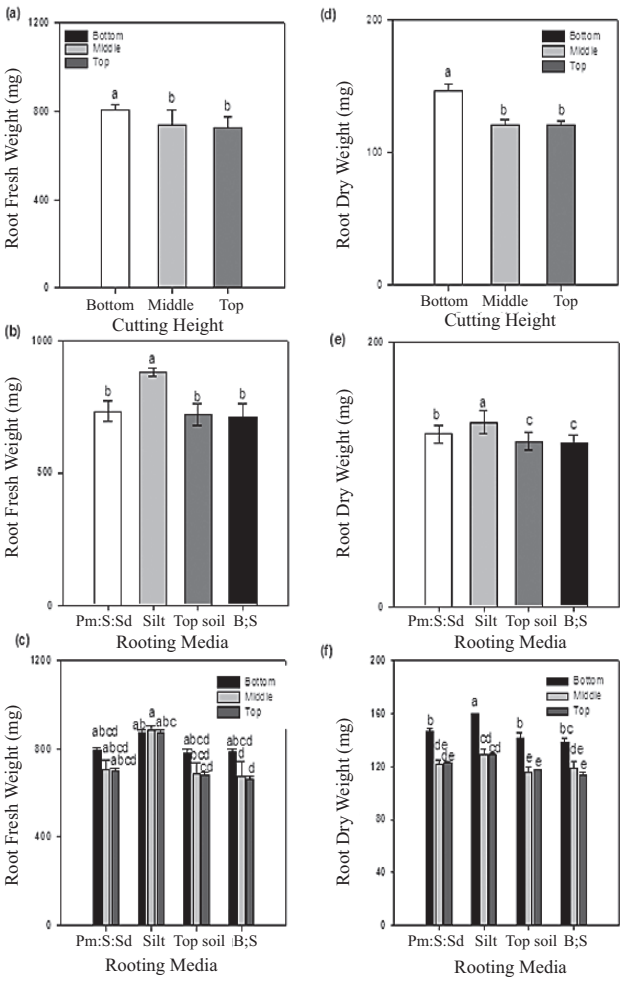

Fig. 1. Effect of different rooting media and cutting heights and their interaction on (a, b, c) fresh weight and (d,e, f) dry weight of guava cuttings.
Pm:S:Sd = Peat moss:Sand:Saw dust, B;S = Bagass;Silt

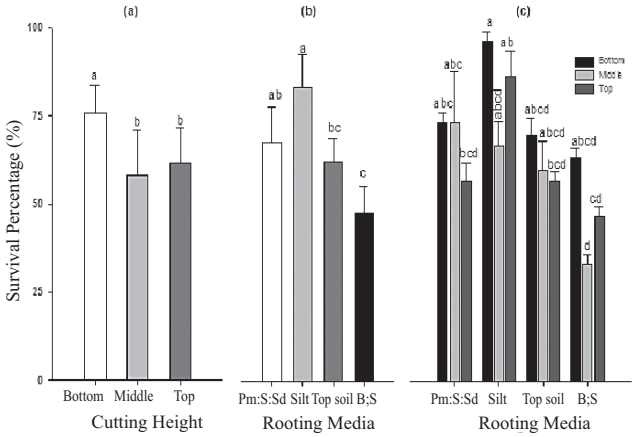

Fig. 2. Effect of different (a) cutting heights (b) growing media (c) and their interaction on survival percentage of guava cuttings.

Pm:S:Sd = Peat moss:Sand:Saw dust, B;S = Bagass; Silt

drained medium is good for growth and development of container grown *Dieffenbachia mucalata* plants.

Conclusion

On the basis of results revealed from the study, it is concluded that growing media significantly influenced the survival percentage and growth parameters of guava cutting. Among different growing media, silt media showed higher number roots, root and shoot length, sprouts and stem diameter regardless cutting height. However, highly significant difference regarding stem diameter, dry and fresh weight, and survival percentage was found in cutting from bottom height. Thus, silt is recommended as growing media along with IBA (400 mg kg^{-1}) for successful propagation of guava cutting.

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