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Full Length Research Paper

Propagation of *ficus benjamina* and *bougainvillea spectabilis* using different media

Okunlola, A. Ibironke. and Akinpetide, Enitan O.

Department of Crop, Soil and Pest Management, the Federal University of Technology P.M.B 704 Akure, Ondo State, Nigeria.

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The growth media and propagule type that would facilitate root development of *Ficus benjamina* and *Bougainvillea spectabilis* using stem cuttings were assessed at the Ornamental Horticulture Nursery Section of the Department of Crop, Soil and Pest Management, Federal University of Technology, Akure from May to July, 2011. The experiments were laid out in a 7 x 2 factorial in Complete Randomised design (CRB) and replicated three times. The different media served as the first factor with 7 levels and the propagule types served as the second factor with 2 levels. The results from the experiment revealed that for *Bougainvillea* spp. the cuttings types had no adventitious root formation in all the media. The rooting of *F. benjamina* was higher in the hardwood compared to the semi-hardwood cuttings; with respect to media types, the longer root length was recorded in media with rice-husk mix, and cuttings in 100% topsoil produced more leaves while number of rooted cuttings were significantly higher in 50% topsoil + 50% river-sand and Topsoil+Riversand+Ricehusk. The most appropriate propagule type for *Ficus* is hardwood cutting and topsoil + Riversand+ Ricehusk was revealed to be the most appropriate media in terms of physical and chemical properties. There was no rooting observed in the cuttings of Bougainvillea for all the media types hence, the need for further research on the most appropriate media that would facilitate rooting of *Bougainvillea spectabilis.*

Key words: Ornamental plants, root development, stem cuttings, media, propagule types.

INTRODUCTION

Ficus benjamina and Bougainvilleas are amongst the ornamentals in high demand for beautification and landscape purpose in Nigeria. Bougainvilleas are characterized by colorful bracts which exhibit the best flowering performance during cool season months. The plants can be grown as specimen shrubs, hedges, pot crops, or climbing vines (Suxia *et al*., 2009). Besides its ornamental value in the landscape, bougainvillea is a pollution tolerant plant and can help in the mitigation of air pollution (Greenhouse gases) (Sharma *et al*., 2005; Kilshreshtha *et al*., 2009). They are also used as security barrier on fences because of their thorny nature (CP, 2007). It has been suggested that the reason bougainvillea is not commercially available is due to the difficulty encountered during propagation (Czekalski, 1989).

F. benjamina on the other hand is a versatile plant that looks attractive as a stand-alone specimen or as part of a mixed display. Larger specimens are especially useful as feature plants in shopping malls and similar open spaces. The smaller bush form is often used as hedge, being easily shaped by pruning (PIB, 2003).

The general practice of multiplication for most of the perennial ornamental plants is by the use of vegetative plant parts including stem, leaves, terminal buds and roots due to its simplicity and practicability (Ingram and Yeager, 2003). Vegetative propagation of ornamental plants through stem cutting is one of the cheapest methods available for multiplication in a developing country like Nigeria (Elgimabi, 2009; Okunlola, 2013). The four main types of stem cuttings are herbaceous, softwood, semi-hardwood and hardwood. These terms

Corresponding author. E-mail:okunlolaa1.hort@gmail.com

reflect the growth stage or age of wood of the stock plant which is an important factor influencing the rooting of a cutting (Welch-Keesey and Lerner, 2002).

Bougainvillea plants are generally propagated from stem cuttings or air-layering, but the root systems are extremely fine and fragile, with low rooting success, even during the cultivated seasons (Chakraverty, 1970). In *F. benjamina*, the success of propagation by stem cutting is very limited due to its low capacity for adventitious root formation limiting its commercial production by growers and nursery owners who have encountered difficulty and recorded very low survival rate in their propagation (Rzepka-Plevnes and Kurek 2001). In the nursery production industry, a variety of growing media are used worldwide, mixtures of the different proportions can however, give satisfactory plant growth if the physical, chemical and biological properties are considered when formulating the mix Handreck and Black, (1999), Shah *et al*. 2006.

In Nigeria, most of the peasant gardeners still use, mainly, topsoil for their planting operations even though it is bulky and heavy, very inconsistent in quality and environmentally unfriendly because it results in continuous depletion of the topsoil (Hall, 2003). There is therefore the need to encourage the use of composted organic biomass in agriculture in developing alternatives to soil media if the nursery business is to grow in Nigeria and compete considerably internationally. Horticulturists must therefore pay great attention to the quality of the plant materials used when composting the media especially for ornamentals that are of economic value whose demand necessitates that their difficult-to-root phenomenon be solved to ensure high performance and uniform quality of the species (Uzo, 1986; Davies *et al*., 1994; Kovar and Kuchenbuch, 1994).

To this end, the research aimed to investigate different growth media and stem cutting types that will enhance the rooting of *B*. *spectabilis* and *F.benjamina*.

MATERIALS AND METHODS

Study Site

The experiment was conducted in the nursery, the Ornamental Horticulture Section of the Department of Crop, Soil and Pest Management, The Federal University of Technology, Akure Ondo State, Nigeria from May to July, 2011. The state lies between 41 300 and 61 400 east of the Greenwich meridian and latitudes 501 450 and 80 north of the equator. It is located in the rainforest zone with two distinct seasons. The mean annual rainfall and number of rainy days in the year that the study was conducted were 1495.4mm and 110 days respectively. The mean daily maximum and minimum temperatures of the area in the year were 29 ^{0}C and 21^{0}C and the mean monthly maximum and minimum relative humidity were 83% and 65%.

Forest Topsoil from the top 0-15cm depth and river sand were collected from the floriculture garden. The soil was sieved to get rid of stones and other exogenous materials and also to improve aeration and porosity. The sieved soil was then pasteurized for three hours using a steam chamber. The river sand was thoroughly washed to reduce the silt content. Rice (*oryza sativa*) husks was obtained from Ogbese, a rice processing community in Ondo state, it was exposed to solar radiation (heat from the sun) for one week in order to kill pathogenic organisms.

The media formulation were; 100% Forest Topsoil ; 100% Riversand; 100% Rice husk; 50% Forest Topsoil +50% Riversand; 50% Forest Topsoil +50% Rice husk; 50% Riversand +50% Rice husk;50% Forest Topsoil +25% Riversand +25% Rice husk. They were mixed manually and composted over a period of three weeks to improve movement of water in the different media, dissolve nutrients, and oxygen in the media making it easy for plant roots to absorb.

The physical and chemical properties of the media were analyzed following procedures found in the FAO fertilizer and plant nutrition bulletin 19 (Motsara and Roy, 2008).

Perforated polythene bags of dimension 15 cm x 10 cm were filled with equal volumes of each media; before cuttings were inserted into the different media, they were moistened and allowed to settle overnight. A dibber was used to create a hole for the insertion of the cuttings.

Cuttings from healthy parent stock of *Ficus benjamina* and Bougainvillea were obtained from the floriculture garden of the Department of Crop, Soil and Pest Management, Akure, Ondo state, Nigeria.

Two types of cuttings; semi-hardwood (taken from partially mature wood) and hardwood cuttings (taken from dormant mature stems) were obtained from healthy parent stock. The length for each cutting of *F.benjamina* and *B. spectabilis* was 20 cm; at this length *F. benjamina* had 15-18 nodes while *B. spectabilis* had 2-4 nodes. All cuttings were obtained very early in the morning using a pair of multipurpose garden scissors. The semi-hardwood and hardwood cuttings were stripped of its lower leaves 2 cm from the base of cuttings. Before planting, all stem cutting types were dipped in 4% Sodium hypochlorite (JIK-household bleach) for disinfection. The cuttings were then inserted to about half its length in the rooting media maintaining the vertical orientation of the stem (ensuring that the cuttings are not upside down). After inserting the cuttings in an upright form, the medium was firmed around the cuttings. The cuttings were spaced adequately to allow all the leaves receive sunlight and then watered regularly. Emerging opportunistic weed seedlings were removed by regular handpicking throughout the duration of the experiment and the cuttings were sprayed with a systemic fungicide, Topsin-M 70% WP (Thiophanate-methyl. 70%); after they were set, to control disease incidence on the stem cuttings this was repeated four weeks after planting.

The experiment was laid out in a 7 x 2 factorial in Complete Randomised Design (CRD) and replicated three times. The different media served as the first factor with 7 levels as stated above and the stem cutting types as the second factor with 2 levels: semi-hard and hardwood stem cuttings. Data were collected on the following parameters: Days to sprouting**:** This was the number of days for the cuttings of Bougainvillea and *Ficus benjamina* to sprout beginning from (23) days after planting. Number of roots per cutting**:** This was the number of roots formed on each cuttings; evaluated at the end of the experiment. Number of rooted cuttings**:** this was the observed number of cuttings that had successfully rooted recorded at the end of the experiment. Root length per cutting**:** The root length was measured using meter rule from the point of attachment of the roots to the distal end of the stem cuttings. Number of leaves per cutting were taken at 4 weeks after propagation (WAP) and subsequently on weekly basis till the experiment was terminated.

Statistical Analysis

The counts data were transformed using the Arc Sin formula and then subjected to analysis of Variance (ANOVA) and the means were separated using the Duncan Multiple Range Test (DMRT). All analysis was conducted using the statistical package for social scientists (version 15).

RESULTS

The result showed that the water holding capacity varied (Table 1) among the media. Top-soil+Rice-husk had the highest water holding capacity of 285.54%, while River-sand had the lowest water holding capacity of 37.24%. Also, percentage air-porosity in 100% Rice-husk was lower than other media types. Among the media types, the highest air-porosity was recorded in the 100% River-sand.

Amongst the media, the lowest nitrogen content was observed in 100% River-sand (0.06) while 100% Rice-husk had the highest (0.88%) while Top-soil+Rice-husk followed closely at (0.74%) N. The pH of the media ranged from slightly acidic (4.09) to neutral (7.39), 100% river-sand had a pH (4.09) which is acidic, 50% forest topsoil+50% rice-husk had the highest pH (7.39) which is near neutral and 100% rice-husk also had near neutral pH (6.88). For organic matter, 100% Rice husk recorded the highest (24.33%) whereas 100% River-sand showed the lowest percentage of Organic matter (0.72) among all the media types.

The result from table 3 revealed that days to rooting of *F. benjamina* was higher in the hardwood compared to the semi-hardwood cuttings with respect to media types, 100% River-sand had the lowest value (2.11) for semi-hardwood while Topsoil+River-sand had the lowest value (3.45) for hardwood cuttings.

The effect of stem cutting and media type ($P \leq 0.05$) on leaf production from the 4th to the 8th (WAP) in (Table 4) revealed that topsoil + river-sand gave the highest number of leaves (2.413 and 2.613) respectively, and the lowest River-sand, and Rice-husk over the experimental period.

The effect of stem cutting and media type ($P \leq 0.05$) on leaf production as shown in (Table 5) revealed that there were significant differences in the number of leaves produced at each week after planting throughout the experimental period. Within and between (WAP), hardwood cuttings in 100% topsoil significantly gave the highest number of leaves from the 4th to 8th (WAP) at mean of (2.11 to 2.61).

The effect of stem cutting and media type ($P \leq 0.05$) on the number of roots formed on the different stem cutting types of *Ficus* spp. as shown in (Table 6) revealed that semi-hardwood cutting in 100% Rice-husk and hardwood cutting in River-sand+rice-husk recorded the highest number of roots (22 and 19) in counts and at mean of (2.18 and 2.12) respectively, which were significantly higher than in the other media types, for the semi-hardwood cuttings 100%River-sand had the lowest root number at mean of (0.67) and hardwood in Topsoil + ricehusk + riversand at mean of (0.22).

Table 7 revealed that semi-hardwood stem cutting in 100%Ricehusk and hardwood stem cutting in River-sand + rice-husk recorded the longest root length of 22.5cm and 24.3cm and at means of 19.47 and 23.97 respectively, while semi-hardwood and hardwood in Topsoil + ricehusk + riversand (0.00) showed less significance as there was no root formation.

The pie chart from (Figure 1) showed the percentage number of semi-hardwood stem cuttings of *Ficus benjamina* that survived and rooted at the end of the experimental period. It was observed that 12 out of 21 semi-hardwood stem cuttings rooted. Stem cuttings in 100%Ricehusk, 50% Forest Topsoil +50% Rice husk showed the highest percentage of survival at 25% respectively.

The pie chart from (Figure 2) showed the percentage number of hardwood cuttings of *Ficus benjamina* that survived and rooted at the end of the experimental period. It was observed that 15 out of 21 hardwood stem cuttings rooted. Stem cuttings in, 50% Riversand +50%Rice husk, 100%Forest Topsoil and 50% Forest Topsoil +50%Rice husk and 100%Ricehusk showed the highest percentage of survival at 20% respectively. However, stem cuttings in 50%Forest Topsoil +25%Riversand + 25%Rice husk showed 0% survival at the end of the experiment.

DISCUSSION

It was observed from the study that sprouting of *F. benjamina* was higher using hardwood compared to the semi-hardwood cuttings. It is well known that the success of rooting of the woody stem cuttings, in the majority of ornamental plants and fruit trees depends mainly on the physiological stage of the mother plant (Darwesh, 2000). Hardwood cuttings were taken from the fully mature stems; according to Leonard *et. al.,* (2005) the plant part's age affect success of rooting and old tissues have abundant carbohydrate food reserves. Tchoundjeu and Leakey (1996) also stated that larger cuttings store more carbohydrates. Wahab et al. 2001 also reported that

Table 1. Water capacity (%) and Percent air-porosity of the different media.

Media type	Water holding capacity (%)	Percent air-porosity (%)
River sand	37.24	63.07
Topsoil	106.80	44.00
Rice husk	178.88	36.81
Riversand+Topsoil	147.06	45.04
Topsoil+Ricehusk	285.54	38.93
Ricehusk+Topsoil+Riversand	161.39	40.60
Rice husk+ River sand	211.02	39.11

Table 2. Chemical properties of the different growth media.

Media type	P_H in H_2O 1:2	O/C (%)	O/M (%)	N (%)	P (mg/kg)	K^+	Na^+	Ca^{2+}	Mg^{2+}
						(CMol/Kg)			
River sand	4.09	0.42	0.72	0.06	6.98	0.07	0.05	0.80	0.50
Topsoil	6.75	4.38	7.57	0.57	26.14	0.58	0.44	3.90	2.60
Rice husk	6.88	14.13	24.33	0.88	16.7	0.72	0.13	5.78	1.38
Riversand+Topsoil	5.42	2.94	5.01	0.37	13.07	0.29	0.24	2.38	1.57
Topsoil+Ricehusk	7.39	9.36	15.95	0.74	21.42	0.63	0.29	4.84	2.01
Ricehusk+Topsoil+Riversand	6.41	6.66	8.335	0.40	14.2	0.36	0.187	2.82	1.04
Rice husk+ River sand	5.79	11.02	12.525	0.32	10.05	0.39	0.10	3.30	0.92

Table 3. Effect of media type and stem cutting on the rooting of Ficusbenjamina.

	Cutting types	
Media type	**Semi-hardwood**	**Hardwood**
Riversand	2.11b	3.45b
Topsoil	5.50a	5.00a
Riversand+Ricehusk	4.90a	5.22a
Topsoil+Ricehusk	4.96a	5.02a
Topsoil+Riversand	5.00a	5.38a
Ricehusk	4.86a	4.96a
Topsoil+Ricehusk+Riversand	5.06a	5.27a

*Means followed by the same letter in a row are not significantly different.

sprouting is mainly attributed to the stored carbohydrates in the cuttings used for sprouting.

The effect of stem cutting and media type on the semi-hardwood cuttings showed that all media types influenced early sprouting with an exception observed in semi-hardwood stem cutting in 100% River-sand this may be attributed to the fact that River-sand was too porous and could not keep enough humidity required by the cuttings.

Leaf production in the different media showed that semi-hardwood stem cuttings in 50%Topsoil+50%Riversand and 50%Topsoil+50%Ricehusk developed more leaves. The presence of sufficient nutrients in decomposed rice-husk and topsoil gave them an edge over other media. Awan *et al*. (2003), found similar results when they worked on response of olive hardwood cuttings to different growth media for propagation. They observed that the media with considerably higher organic matter content gave maximum number of leaves due to availability and release of essential nutrients which initiated early root development. The high organic matter content of rice-husk and the release and absorption of nutrients through decomposition also provided the other nutrients for absorption by the stem cuttings.

Table 4. Effect of media type on number of leaves of *Ficus benjamina*.

Media type	Semi-hardwood cutting (WAP)				
	4	5	6	7	8
Riversand	1.253ab	0.707b	0.998b	1.179ab	1.179ab
Topsoil	1.544ab	1.858ab	1.858ab	1.954ab	2.112ab
Riversand+Ricehusk	1.386ab	2.038ab	2.038ab	2.038ab	2.038ab
Topsoil+Ricehusk	1.915a	2.339a	2.339a	2.413a	2.476a
Topsoil+Riversand	1.544ab	2.481a	2.481a	2.613a	2.613a
Ricehusk	0.707b	1.941ab	1.858ab	1.954ab	2.029ab
Topsoil+Ricehusk+Riversand	1.566ab	2.187ab	1.858ab	2.112ab	2.271a

*Means followed by the same letter in a row are not significantly different

Table 5. Effect of media type and stem cutting on number of leaves for hardwood cuttings of *Ficus benjamina*.

Hardwood cutting (WAP)					
Media type	B	5	6	7	8
Riversand	0.998b	1.386ab	1.559ab	1.655ab	1.954ab
Topsoil	1.598ab	2.413a	2.481a	2.481a	2.613a
Riversand+Ricehusk	1.386ab	2.016a	2.016a	2.196a	2.196a
Topsoil+Ricehusk	1.171ab	2.160a	2.244a	2.327a	2.327a
Topsoil+Riversand	1.171ab	1.386ab	1.483ab	1.566ab	1.650ab
Ricehusk	0.707b	2.000a	2.064a	2.244a	2.445a
Topsoil+Ricehusk+Riversand	1.095ab	1.774ab	2.112a	2.112a	2.187a

*Means followed by the same letter in a row are not significantly different.

Table 6. Effect of stem cutting and media type on number of roots of *Ficus benjamina* at 12WAP.

	Stem cutting type	
Media type	Semi-hardwood	Hardwood
Riversand	0.676b	1.374ab
Topsoil	0.809ab	1.687ab
Riversand+Ricehusk	0.746ab	2.127a
Topsoil+Ricehusk	1.578ab	1.817ab
Topsoil+Riversand	0.731ab	0.858bc
Ricehusk	2.185a	1.885ab
Topsoil+Ricehusk+Riversand	1.199ab	0.224c

*Means followed by the same letter in a row are not significantly different.

The number of rooted cuttings were significantly higher in 50% topsoil + 50% river-sand and Topsoil+Riversand+Ricehusk for hardwood cuttings; and 100% topsoil, 50%Riversand+50% Top soil, 50%topsoill+50% rice-husk and 100% Top soil for Semi-hardwood cuttings.

Due to the high water retaining capacity of the media and high organic matter content this enabled these media to have high available nutrient capacity thus encouraging enough uptake of water and nutrients by the stem cuttings for root development. Water needs to be available in the media since cuttings don't have roots it becomes more difficult for them to take up water easily. If they lose water faster than they take it up, then the cuttings could wilt and die. The results were also similar to the findings of Shah *et al*. (2006) with leaf mold medium which had maximum number of leaves as a result of the high organic matter content which increased

Table 7. Effect of stem cutting and media type on root length of *Ficus benjamina* at 12WAP.

	Stem cutting type	
Media type	**Semi-hardwood**	**Hardwood**
Riversand	3.60b	13.73abc
Topsoil	3.40b	8.20cd
Riversand+Ricehusk	5.40b	23.97a
Topsoil+Ricehusk	14.70ab	22.20ab
Topsoil+Riversand	3.97b	4.13cd
Ricehusk	19.47a	11.80bc
Topsoil+Ricehusk+Riversand	3.53b	0.00d

*Means followed by the same letter in a row are not significantly different.

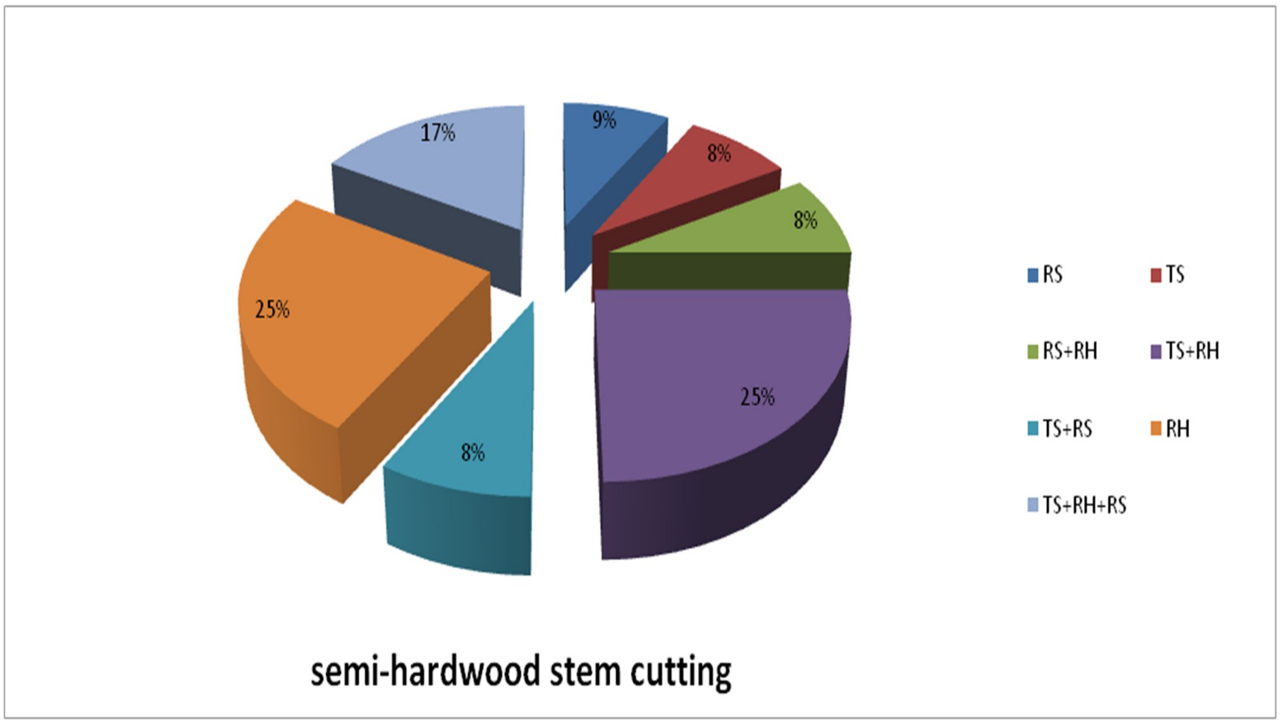

Figure 1. Effect of media type and stem cutting on the percentage survivalof *F. benjamina*.

the water and nutrient holding capacity of the medium. In addition, the high nitrogen content of Rice-husk played a vital role in vegetative growth of the plants, as this was observed in media mixes which had rice-husk as The longer root length recorded in media with rice-husk mixture may be due to easy translocation of water and minerals to the above ground parts of the cuttings considering the fact that it also contains the combination of both river sand and top soil Caron *et al.,*(2000). Also, better aeration potential and drainage capacity/porosity component. The lower pH also made more nutrients available for absorption by the cuttings. Handreck and Black (1999) reported that the coniferous shrubs and trees prefer lower pH levels about 5.0-5.5.

enabled development and spreading of roots (Olabunde and Fawusi, 2003; Puri and Thompson, 2003).A study on rooting performance in *Vitellaria paradoxa* by Yeboah and Amoah (2009) showed that high aeration in rooting media is responsible for promoting metabolic activities and enhancing root initiation. Consequently, the type of

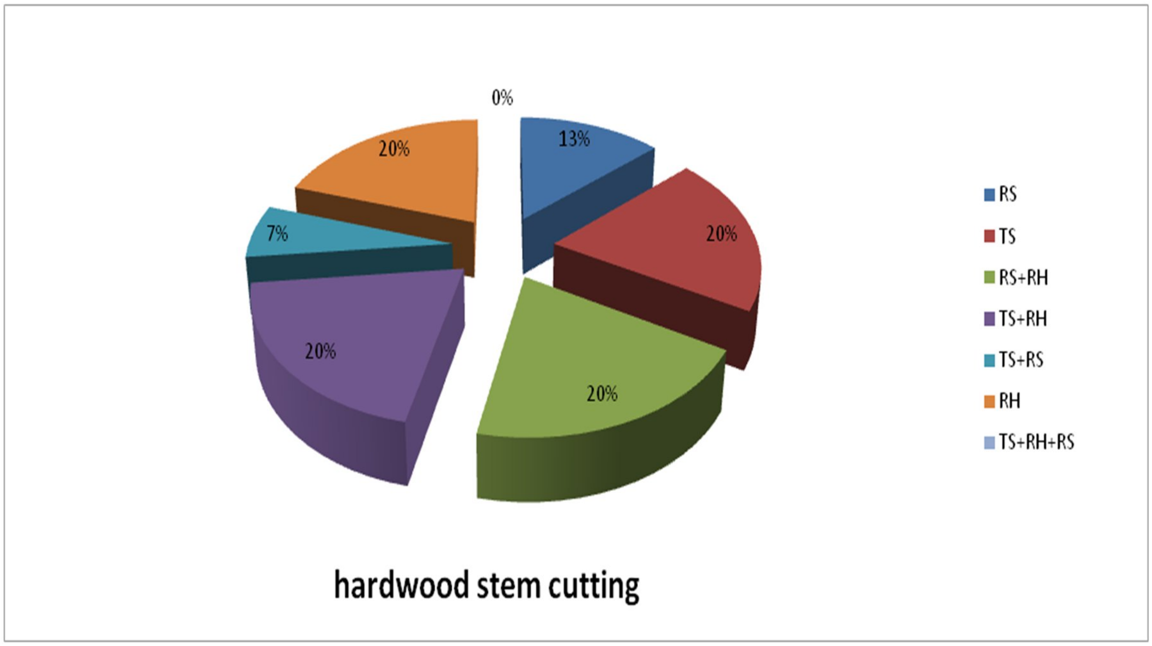

Figure 2. Effect of media type and stem cutting on the percentage survival of *F. benjamina.*

rooting media used can have a major influence on the rooting capacity of cuttings.

In addition, the high water holding capacity of the medium was efficiently utilized by the cuttings in combination with available nutrients from the decomposition of the organic matter which made the roots travel longer distances in the medium to absorb the nutrients and water. Studies conducted by Shah *et al*. (2006) on the effect of different growing media on Ficus (Amstel Queen) cuttings revealed that leaf mold medium gave the maximum number of roots because of the availability of essential nutrients at the surface of the medium for effective absorption so as to produce more roots.

Among the different media, hardwood stem cuttings in 100% topsoil also produced more leaves than the other media and stem cutting type probably because the hardwood stem cuttings had greater exposed surface area that resulted in the natural accumulation of auxins. This stimulated cell division which resulted in the formation of callus and root primordia to absorb water and nutrients from the medium for early root growth and subsequent vegetative growth (Hartmann *et al*., 2002). The high water holding capacity of the different media was efficiently utilized by the stem cuttings in combination with available nutrients from the decomposition of the organic matter for shoot growth. The pH of the 100% topsoil also promoted the early root growth and that further promoted the development of the leaves as *Ficus benjamina* thrives best in acidic soils.

There was no rooting observed in the cuttings of Bougainvillea for all the media types. It is suggested that the rooting of Bougainvillea maybe enhanced through the use of growth stimulants (hormones) as propagation through stem cuttings and media types had no significant effect on its rooting.

CONCLUSION

The results from the study reveal that *Ficus* spp. can be easily propagated using hardwood cuttings; Top soil+Riversand+Ricehusk is the best media mix for root formation and growth of *F*. *benjamina*. There was no rooting observed in the cuttings of Bougainvillea for all the media types hence, there is need for further research on the most appropriate media and rooting hormone that would facilitate rooting of *Bougainvillea spectabilis.*

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