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Full Length Research Paper

Vegetative and Rooting growth response to different stem cutting types and soilless media

kwame V. mijad, Owusu Tyson and Mpiani kubi Young

Department of Horticulture, Faculty of Agriculture, College of Agriculture and Natural Resources, University of Ghana, Accra, Ghana.

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Studies were carried out at the Department of Horticulture, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana, to determine the rooting and vegetative growth responses of different stem cutting types (heel and straight) of *Ixora coccinea* and *Ficus benjamina* cv. „Starlight" to different soilless media formulations over a 10-week period. Two experiments of a 2 × 6 factorial in randomised complete block design, replicated three times, were used. The different media formulated were 100% topsoil (control), 100% palmix (palm waste that is, bunch, fibre and mill mud), 50% teak sawdust + 50% coconut coir, 50% palmix + 50% coconut coir, 50% palmix + 50% teak sawdust and 50% palmix + 25% teak sawdust + 25% coconut coir. The study revealed that 50% teak sawdust + 50% coconut coir was the best soilless medium, in terms of physical and chemical properties, and produced the highest number of leaves (2.59) in *I. coccinea*. Also, 50% palmix + 25% teak sawdust + 25% coconut coir medium had more survived cuttings (1.13) and produced the longest root (1.05 cm) per cutting in *F. benjamina* cv. „Starlight". The heel stem cutting produced higher number of leaves (2.32), eight weeks after planting, in *Ixora coccinea* while straight stem cuttings produced more leaves (2.49) in *F. benjamina* cv. „Starlight" four weeks after planting.

Keys words: *Ixora coccinea*, *Ficus benjamina* cv. „Starlight", media effect, stem cutting types.

INTRODUCTION

A revolution, according to McGregor and Stice (2008), is occurring in the export of horticultural products from developing countries since overall, high value products (including horticulture, livestock, fish, and organic products) now make up 66% of all developing country agricultural exports. It is common to find people associating the purchase of flowers with luxury. Koshioka and Amano (1998) reported that, with increased prosperity in Japan, the amount of cut flowers purchased per household increased. Globally, horticulture has become a lead sector for poverty reduction in developing countries. The value of world production of floriculture products is estimated at approximately €100 billion and around 10% of this production enters international trade. Leonhardt (2006) projected trade in floriculture products to increase by 3.5% annually to 2012.

About half of the existing nurseries in Ghana were set up in the recent past (Ellis et al., 2003), an indication that the industry is growing more in recent times. Ornamental plants such as *Ixora coccinea* and *Ficus benjamina* cv. „Starlight" are in high demand for landscaping, bouquets-making and wreath as well as cut flowers in Ghana. Yet, these economically important ornamental plants have a low genetic and physiological capacity for adventitious root formation and, therefore, limit their commercial production. Such ornamental plants have been popularly termed as "difficult-to-root". Economically, the demand for these ornamentals necessitates that the difficult-to-root phenomenon should be solved. Since the growth medium

*Corresponding author. E-mail: kwame_vj@gmail.com

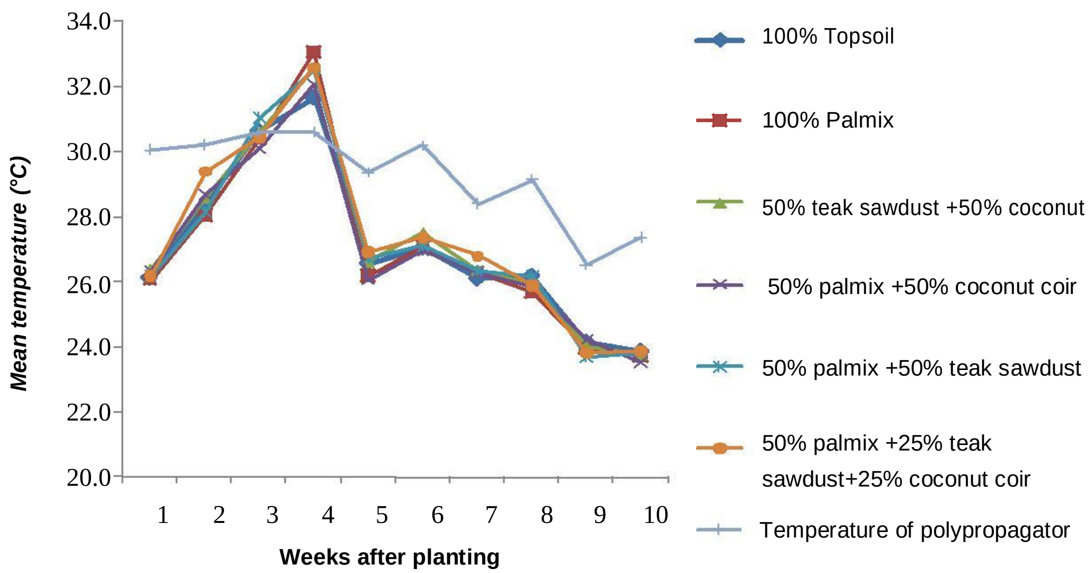

Figure 1. Mean media and poly-propagator temperature over time.

relates to every cultural practice in the production of nursery crops in containers, the selection and preparation of the medium is extremely important and could pay great dividends in terms of plant growth and quality (Hall, 2003). There is no universal or ideal rooting mix for cuttings. An appropriate propagation medium depends on the species, cutting type and propagation system (Longman, 2002). To this end, different soilless media and stem cutting types need to be explored to optimise the rooting of the ornamentals. Thus the objective for this research was to determine the most appropriate soilless rooting and growth medium for promoting rooting and also to determine the best stem cutting type that would facilitate root development in *I. coccinea* and *F. benjamina* cv. „Starlight".

MATERIALS AND METHODS

The rooting and vegetative growth responses of different stem cutting types of "difficult-to-root" *I. coccinea* and *F. benjamina* cv. „Starlight" to different soilless media were carried out at the Department of Horticulture, KNUST, Ghana.

I. coccinea L. is a common flowering shrub native to Asia. It is a dense, multi-branched evergreen shrub belonging to the family Rubiaceae. It is propagated by cuttings and can grow to reach a height of 6m with a rounded architecture. The glossy, leathery, oblong leaves are about 10cm long and are carried in opposite pairs or whorled on the stems. The leaves are bronzy when young later turning to a glistering dark green. Small tubular, scarlet flowers in dense rounded clusters 5 to 15 cm across are produced almost all year long. It bears dark red stone fruits crowned by four sepals. It thrives well in full sun in moist but well-drained acid soil and can tolerate some shade. There are numerous named cultivars differing in flower colour (yellow, pink, orange, white) and plant size (Gilman, 1999).

The starlight weeping fig belongs to the family Moraceae and is a new variegated form of durable green weeping fig. It is a large evergreen shrub with slender-pointed green leaves broadly margined with creamy-white. It requires moist but well-drained loamy soil and will grow in most soil types. It tolerates a wide range of pH and attains a height of 2.5 m (Hessayon, 1998).

Two 2 × 6 factorial experiments in randomised complete block design (RCBD), replicated three times, were used. The different experiments using either of the two selected difficult-to-root ornamental plants (*I. coccinea,* and *F. benjamina* cv. „Starlight") were set up. Two different stem cutting types (heel and straight) of 1.4 cm stem diameter for both *I. coccinea,* and *F. benjamina* cv. „Starlight" were tested in six soilless media formulations (100% topsoil -control, 100% palmix (palm waste that is, bunch, fibre and mill mud), 50% teak sawdust + 50% coconut coir, 50% palmix + 50% coconut coir, 50% palmix + 50% teak sawdust and 50% palmix + 25% teak sawdust + 25% coconut coir). Both stem cutting types used for the experiment were taken from 3 year old stock plants. Three cuttings per treatment were inserted into perforated dark polythene bags of dimension 15 × 10 cm filled with the required medium and put under poly-propagator of dimension 1.5 × 0.6 × 0.6 m to create the microclimate conditions for rooting the cuttings. Each set of treatment was then watered with 200 ml of water fortnightly. Temperature of media, humidity of poly-propagator, days to sprouting, number of survived cuttings, number of rooted cuttings, root length per cutting and number of fully developed leaves per cutting were recorded. All data collected were square-root transformed before being analysed using Analysis of Variance (ANOVA) in Statistix statistical package. Differences between treatment means were separated using the least significant difference (LSD) test at 5% probability level.

RESULTS AND DISCUSSION

Temperature of media and poly-propagator

Temperature values taken for the duration of the experiments in the media were similar over the 10-week period (Figure 1). The temperature in the poly-propagator ranged between 26.0 and 31.0°C and that of the various

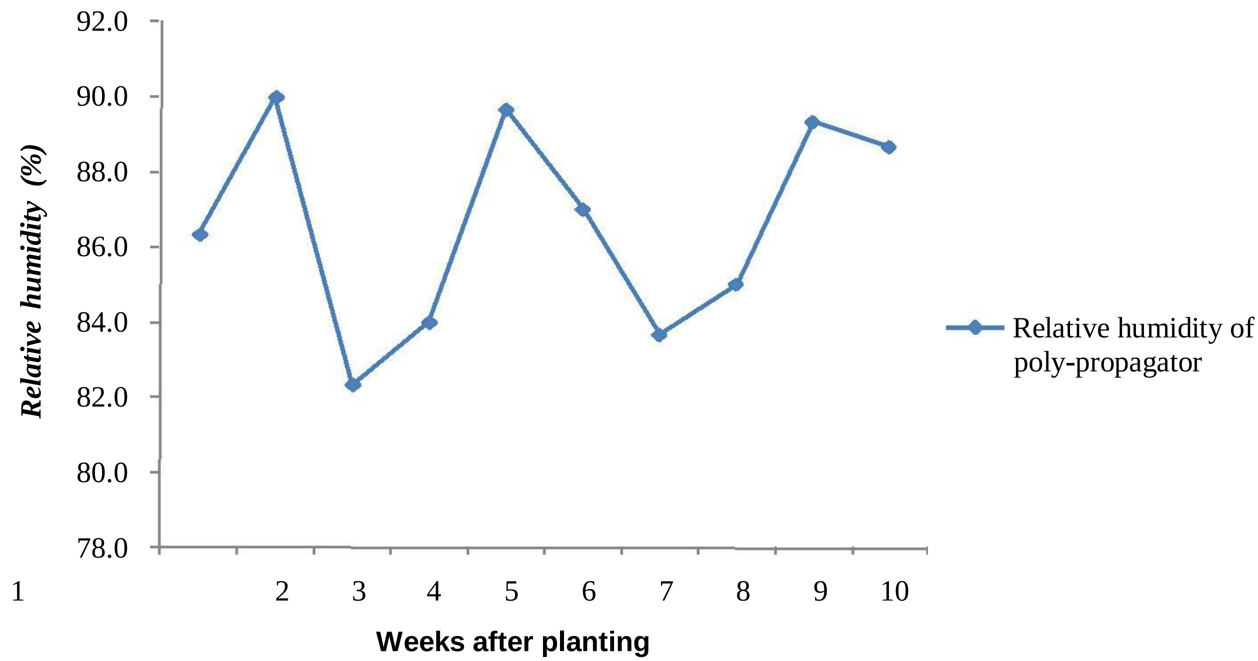

Figure 2. Relative humidity in poly-propagator over time.

media ranged from 23.0 to 34.0°C (Figure 1). Temperature was higher than that in the poly-propagator recorded across the media in the 4th week. By the 2nd, 5th and 9th week temperature of the different media had declined to that of the 1st week and below that of the poly-propagator. Further temperature decreases were observed up to the 10th week across the media and the poly-propagator. The different media recorded higher temperature values in the 4th week due to the low relative humidity conditions in the poly-propagator as a result of intense sunshine thereby trapping more heat. However, as the relative humidity in the ploy-propagator increased due to moderate rainfall from the 5th week of experimentation, the temperatures in the media dropped due to transpiration allowing temperatures in the poly-propagator to increase.

Relative humidity of poly-propagator

The relative humidity within the poly-propagator (Figure 2) ranged from 82.0 to 90.0%. There were fluctuations in the relative humidity in the poly-propagator over time. High relative humidity of 90.0% was recorded in the 2nd week while the minimum relative humidity was recorded in the 3rd week. This was a result the low intensity of sunshine in the 2nd, 5th and 9th week of experimentation thereby allowing the poly-propagator to dissipate heat from the transpiration of the cuttings but in the 3rd week the low relative humidity recorded was a result of the high temperature in the surrounding atmosphere.

Sprouting, survival and rooting of *I. coccinea* propagules

The different media, stem cutting types and their interactions did not significantly affect the number of days to sprouting, survived cuttings, rooted cuttings and the root length (cm) of the propagules. However, in terms of trend, the soilless medium 50% teak sawdust + 50% coconut coir contained more survived cuttings (1.57) with more roots (0.79) and longer root length (1.11 cm) than the other media. Among the stem cuttings, the heel stem cuttings had more survived cuttings (1.43), with more roots (0.79) and longer root lengths (0.98 cm) than the straight stem cutting. This observation was probably due the fact that the carbohydrate reserve in the heel cuttings was more than in the straight cuttings (Sadhu, 1989; Hartmann et al., 2002).

Leaf production of *I. coccinea* propagules

There was significant stem cutting by media interaction (P=0.0055) in leaf production (Table 1) only at the 4th week after planting. Heel stem cutting in 100% topsoil produced the greatest number of leaves (2.63), significantly different from the other treatment combinations. Among the soilless media, heel cuttings in 50% teak sawdust + 50% coconut coir produced significantly higher number of leaves (1.72) (Plate 1) than the other soilless media and stem cutting treatments. This was as a result of the extra carbohydrates

Table 1. Stem cuttings by media interaction effect on number of leaves of *I. coccinea* propagules at 4 weeks after planting.

Media	Stem cuttings		
	Straight stem	Heel stem	Means
100% Topsoil	1.17	2.63	1.90
100% Palmix	0.88	0.71	0.79
50% Teak sawdust+50% Coconut coir	1.00	1.72	1.36
50% Palmix+50% Coconut coir	0.71	1.05	0.88
50% Palmix+50% Teak sawdust	0.71	0.71	0.71
50% Palmix+25% Teak sawdust+25% Coconut coir	1.10	0.88	0.99
Means	0.93	1.28	

Lsd (0.05) media = 0.44; cuttings = 0.26; medium × cuttings = 0.23.

from the attachment on the heel cutting which made the wounded site heal quickly (Sadhu, 1989; Hartmann et al., 2002)., callused and form root primordial to absorb water, high nitrogen and high organic matter from 100% topsoil and 50% teak sawdust + 50% coconut coir that promoted its early vegetative growth. Among the soilless media, the pH of the 50% teak sawdust + 50% coconut coir also promoted the early root growth and that further promoted the development of the leaves as *I. coccinea* thrives best in acidic soils. High poly-propagator than media temperatures for the first 3 weeks kept the relative humidity high in the poly-propagator which prevented the cuttings from drying up thus enhanced the early shoot growth of the heel stem cuttings in the 100% topsoil and the 50% teak sawdust and 50% coconut coir.

From the 5th to the 10th week there were no significant interactions in leaf production. Significant differences were only observed in the main effects of media and stem cutting types. In the 5th week, there were significant (P=0.0022) differences among the media in the production of leaves (Figure 3). From the 6th week to the 10th week, leaf production was significantly highest in 100% topsoil as compared to the other media. Among the soilless media, leaf production in 50% teak sawdust + 50% coconut coir was significantly different than the others. Over the period, the least leaf production was observed in 50% palmix + 50% teak sawdust. Cumulatively, at the end of the 10-week period, the highest number of leaves (3.11) was observed in 100% topsoil whereas the minimum number of leaves (1.43) was found in 50% palmix + 50% teak sawdust. Among the soilless media the 50% teak sawdust + 50% coconut coir recorded an average number of leaves of 2.40 followed by 50% palmix + 25% teak sawdust + 25% coconut coir which recorded 2.36 leaves.

The production of more leaves in 100% topsoil can be attributed to the fact that the supply of nitrogen was in abundance for utilization by the cuttings because no decomposition of organic matter took place. It also had sufficient water holding capacity and air-porosity which enhanced the uptake of oxygen and nutrients by the stem cuttings for root development and onward plant growth. Among the soilless media and as an alternative to the 100% topsoil, the 50% teak sawdust + 50% coconut coir produced the second highest number of leaves because it had high organic matter content with increased water holding capacity, a pH of 5.7 that favoured the root growth in *I. coccinea* since it is an acid-loving (Gilman, 1999; Uchida and Hue, 2000) plant by also supplying the other held nutrients in the media. The 50% palmix + 50% teak sawdust produced the least number of leaves because it had low organic matter and consequently less available nutrients for the cuttings to use for leaf formation. The high pH value of the 50% palmix + 50% teak sawdust medium also did not favour the growth of the stem cuttings of *I. coccinea*.

Among the stem cutting types there were significant differences in leaf production between the straight and heel stem cuttings in the 6th week (P=0.0119), 7th week (P=0.0499) and 8th week (0.0318) after planting (Table 2). Heel stem cuttings produced 1.3 times more leaves than the straight stem cuttings at each of these periods because healed its wounds and rooted more quickly due to preformed root initials than the straight stem due to extra carbohydrates from the piece of the previous season‟s growth (Hartmann et al., 1990; Evans and Blazich, 1999). It also had a bigger surface area which enabled the absorption of nutrients and the natural accumulation of auxins that stimulated cell division resulting in the formation of callus and root primordial for the absorption of water and nutrients from the medium for early root growth (Evans and Blazich, 1999).

Sprouting, survival and rooting of *F. benjamina* cv. „Starlight‟ propagules

The different media did not significantly affect the root length of cuttings in *F. benjamina*. However, the 50% palmix + 25% teak sawdust + 25% coconut coir medium recorded the longest root length of 1.44 cm (Plate 2). There were no significant differences in the stem cutting

Plate 1. Leaf developments of heel stem cuttings in 50% teak sawdust + 50% coconut coir of *I. coccinea*. Scales on figures?

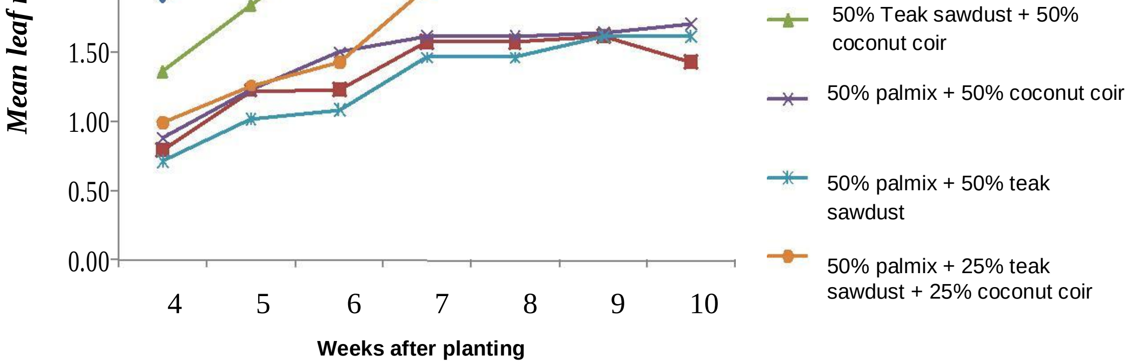

Figure 3. Effect of media on number of leaves of *Ixora coccinea* propagules over time. Lsd bars are at p=0.05.

Table 2. Effect of stem cuttings on number of leaves of *Ixora coccinea* Propagules at 6, 7 and 8 weeks after planting (WAP).

Treatment	6WAP	7WAP	8WAP
Straight stem	1.46	1.79	1.79
Heel stem	1.98	2.25	2.32
Lsd (0.05)	0.39	0.46	0.47

Plate 2. Rooted heel stem cuttings in 50% palmix + 25% teak sawdust + 25% coconut coir in *F. benjamina* cv. „Starlight" scales

types and the stem cutting by media interaction of *F. benjamina* in the number of days to sprouting, number of stem cuttings that survived, number rooted and also the root length per cuttings. Straight stem cuttings however sprouted earlier (2.98 days) and had more survived cuttings (0.85) with more roots (0.82) of longer root lengths (1.06 cm).

There were significant differences between the media in the number of days to sprouting, number of stem cuttings that survived and number rooted (Table 3). Cuttings in the 50% palmix + 50% coconut coir medium significantly (P=0.0361) sprouted earlier (2.92) than in the other media. 50% palmix + 25% teak sawdust + 25% coconut coir contained significantly (P=0.0009) more survived cuttings (1.13) than the other soilless media and the 100% topsoil. The number of rooted cuttings was significantly (P=0.0407) affected by the different media. More rooted stem cuttings (1.05) were observed in 50% palmix + 25% teak sawdust + 25% coconut coir than the 100% topsoil. The early sprouting observed in the 50% palmix+50% coconut coir compared to the late sprouting in 100% topsoil was probably due to the high medium temperatures from the 1st to 4th week coupled with the higher poly-propagator temperatures and relative humidity which promotes quick sprouting. The 50% palmix+25% teak sawdust+25% coconut coir had more survived cuttings and rooted cuttings than 100% because it rooted earlier, its high water holding capacity and air-porosity ensured that the rooted cuttings utilized the stored nutrients from the decomposition of the high organic matter for absorption at the of the surface medium for early growth than the stem cuttings in 100% topsoil.

Leaf production of *F. benjamina* cv. „starlight" propagules

There were significant stem cuttings by media interaction (P=0.0336) in the number of leaves produced in the 8th

Table 3. Effect of media on number of days to sprouting, number of survived cuttings and number of rooted cuttings of *F. benjamina* cv. „Starlight" propagules.

Media	Days to sprouting	Survived cuttings	Rooted cuttings
100% Topsoil	3.13	0.71	0.71
100% Palmix	2.95	0.71	0.71
50% Teak sawdust+50% coconut coir	3.02	0.79	0.79
50% Palmix+50% Coconut coir	2.92	0.79	0.79
50% Palmix+50% teak sawdust	2.97	0.88	0.88
50% Palmix+25% teak sawdust+25% coconut coir	2.97	1.13	1.05
Lsd (0.05)	0.13	0.23	0.22

Table 4. Stem cuttings by media interaction effect on number of leaves on *F. benjamina* cv. „Starlight" propagules at 8 week after planting.

Media	Stem cuttings		
	Straight stem	Heel stem	Means
100% Topsoil	0.71	0.71	0.71
100% Palmix	0.71	0.71	0.71
50% Teak sawdust+50% coconut coir	0.71	0.71	0.71
50% Palmix+50% coconut coir	0.71	1.18	0.94
50% Palmix+50% teak sawdust	1.71	0.71	1.21
50% Palmix+25% teak sawdust+25% coconut coir	0.71	0.71	0.71
Means	0.88	0.79	

Lsd (0.05) Media = 0.41; cuttings = 0.23; media × cuttings = 0.58.

Table 5. Stem cuttings by media interaction effect on number of leaves on *F. benjamina* cv. „Starlight" propagules at 9week after planting.

Media	Stem cuttings		
	Straight stem	Heel stem	Means
100% Topsoil	0.71	0.71	0.71
100% Palmix	0.71	0.71	0.71
50% Teak sawdust+50% coconut coir	0.71	0.71	0.71
50% Palmix+50% coconut coir	0.71	1.00	0.85
50% Palmix+50% teak sawdust	1.79	0.71	1.25
50% Palmix+25% teak sawdust+25% coconut coir	0.71	0.71	0.71
Means	0.89	0.76	

Lsd (0.05) media = 0.36; cuttings = 0.21; media × cuttings = 0.52.

week (Table 4). Straight stem cuttings in 50% palmix + 50% teak sawdust produced more leaves (1.71) than the heel stem cuttings in the same medium as well as straight and heel stem cuttings in 100% topsoil (0.71). Whereas in the 9th week, straight stem cuttings in 50% palmix + 50% teak sawdust continued to significantly (P=0.0138) produced 1.79 more leaves than the heel stem cuttings in 50% palmix + 50% coconut coir which produced 1.00 leaves (Table 5). The higher leaf production recorded for straight stem cuttings in 50% palmix + 50% teak sawdust compared to the heel stem cuttings in 100% topsoil in the 8th and 9th weeks after planting could be attributed to the fact that there were more roots on the straight stem cuttings. These straight stem cuttings effectively used the available nutrients in the medium which were supplied as a result of the high organic matter content and thus resulting in the development of the leaves. The high medium and poly-propagator temperature and relative humidity also promoted faster leaf development on the straight stem

Table 6. Effect of stem cuttings on number of leaves of *Ficus benjamina* cv. „Starlight" propagules at 4and 6 weeks after planting (WAP).

Stem cuttings	4WAP	6WAP
Straight stem	2.49	1.34
Heel stem	1.90	0.84
Lsd (0.05)	0.56	0.43

cuttings.

For the stem cutting types, only on the 4th and 6th week after planting did significant differences in leaf production exist between the heel and straight cuttings. The straight stem cutting produced significantly (P=0.0404) 2.49 more leaves than the heel stem cutting (1.90) in the 4th week and the trend was maintained in the 6th week when the straight stem cutting produced 1.34 leaves which was significantly (P=0.0241) more leaves than the heel stem cutting of 0.84 leaves (Table 6). The reason why the straight stem cuttings had more leaves than the heel stem cuttings was through early sprouting and thereafter early root growth thus using more of the available nutrients that was provided in the media to further develop more leaves. Although most of the stem cuttings died during the experimental period, heel stem cuttings were the worst affected. This resulted in the straight stem cuttings having a higher number of survived and rooted cuttings. The number of leaves was however low in the 6th week because the most of leaves dropped on both stem cuttings due to disease incidence.

Conclusion

In conclusion, for stem cutting propagation, 50% teak sawdust+50% coconut coir was the best medium in terms of physical and chemical properties. It also produced the highest number of rooted cuttings and root lengths followed by 50% palmix+25% teak sawdust+25% coconut coir. Heel stem cuttings produced more leaves than the straight stem cuttings in Ixora coccinea but for Ficus benjamina cv. „Starlight", straight stem cuttings produced more leaves.

It is therefore, recommended that the 50% teak sawdust+50% coconut coir and 50% palmix+50% coconut coir and their variations should be experimented using other difficult-to-root ornamental plants to confirm its use as the best soilless medium for most difficult-to-root ornamental plants.

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