EVALUATION OF PROPAGATION TECHNIQUES FOR TEA (*Camellia sinensis* var. Sinensis)

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ABSTRACT

Tea is alternative beverage to coffee with important benefits to human health and wellness and role in agroforestry system. There has been no initiative on propagation and technologies which could also be applied in indigenous tea and edible shrubs. Therefore, a study was conducted at Bureau of Plant Industry-Baguio from May 2011 to May 2013 to determine suitable medium, effective plant part, the interaction effects of medium and plant part and economics of rooted cuttings production. Softwood, semi-hardwood and hardwood cuttings and their combinations with rooting hormone were stuck in sand and coco coir under a rooting chamber.

Coco coir favored the rooting of cuttings with higher rooting percentage and earlier initiation of roots. Semi-hardwood cuttings with rooting hormone noted the highest percent survival and rooting, produced highest number and longest roots in shortest period than other plant parts. Further, semi-hardwood cuttings with rooting hormone stuck in coco coir had the highest percent rooting, produced the highest number and longest roots in the shortest time. Semi-hardwood cuttings with rooting hormone stuck in sand registered the highest percent survival.

Semi-hardwood cutting with rooting hormone sticking in coco coir is recommended as propagation technique for tea giving a return on investment of 125.26% in nine months.

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RATIONALE

Tea was introduced in the country before 1905, and was occasionally planted in Baguio and Benguet province (Quizumbing, 1951). There are two varieties of *Camellia sinensis* namely: sinensis and assamica. Sinensis can reach 10 feet tall and thrives best in cool high mountains while Assamica is taller, 65 feet high and grows best in lower elevations in moist tropical regions; and there are hybrids of these two varieties. Tea requires a soil pH of 5 to 6, and planted 3 feet apart in a semi-shaded or sunny area and can produce leaf yield for 50 to 100 years.

Tea (*Camellia sinensis*) is known as alternative beverage to coffee. However, due to health and wellness trend, it is believed to alter the preference of middle and high-income Filipinos and this was supported by a demand of ready to drink tea (Euromonitor International, 2011) and mushrooming stalls selling local and imported teas in the local markets. In the Cordilleras, indigenous teas are processed by some groups in a very small scale and sold in local stores.

Tea could also play an important role in agroforestry system especially on sustainable upland development and sloping agricultural land technology suited in the mountainous areas of the country. Developing the industry could help regreen denuded areas which indirectly helps mitigate environmental degradation while providing additional livelihood for the community.

As an initial step, propagation is very important in tea development. Initial study was conducted in BPI-Baguio by Delizo and Ferrer (1995) and identified sand as the best medium for rooting tea. Also, it was found that coco coir is the best medium for rooting semi-hardwood coffee (Galacio and Ayban, 2004) and geranium (Jose, 2002) stem cuttings. According to Mudge, Muaja, Itulya and Ochieng, 1995, cutting is extensively practiced and economical with advantages of uniform population, higher leaf yield and quality (Hamid et. al, 2006). Hamid et. al, (2006) and Hajra (2001) found that vegetative propagation through single node leaf cutting from selected mother bushes is reliable and economic method. Further, Bonheure (1990) stated that tea cuttings should be taken from the primary shoots that were not plucked for 2 to 3 months at the middle portion which is neither too soft nor too hard for faster rooting and higher percent survival.

The Bureau of Plant Industry-Baguio has a collection of tea that could serve as mother plants. Hence, the study was conducted and the resulting technology could be applied to other indigenous teas and edible shrubs with similar agronomic characteristics.

OBJECTIVES

1. To determine the suitable rooting medium for tea cuttings;
2. To determine the effective plant part of tea for rooting;
3. To determine the interaction effects of medium and plant part for the rooting of tea; and
4. To determine the economic analysis of rooted cutting production for tea.

METHODOLOGY

Tea (*Camellia sinensis* var. sinensis) branches which are strong and vigorous were selected from disease-free, three months pruned mother plants (Fig. 1). The cutting was cut in slanting position, consisting of a single node whole leaf in the first and second trial, and half leaf in the third trial to lessen transpiration.

Fresh coco coir which was previously exposed under rain and washed sand were thoroughly prepared in a rooting chamber and drenched with a fungicide ready for sticking. After one day, stem cuttings with and without hormone were stuck in the different media. Stem cuttings with hormone treatment were dipped in rooting hormone (IBA + Vit. B_1 + ANAA) solution (10 ml/1 gallon water) for 15 minutes then stuck into the different media. The same media were also utilized for the second and third trials upon drenching with fungicide.

The first and second trials were carried out in a rooting chamber provided with plastic roofing alone, and additional net roofing for the third trial for higher percent survival. Watering was done every other day to provide moisture to the stuck cuttings while weeding and spraying were done as need arises. Further, the stuck cuttings were regularly monitored for rooting and occurrence of insect pests and diseases. The design was 2x6 factor factorial in RCBD with three replications. Twelve cuttings represented one treatment in a replication.

The treatments were as follows:

Factor A. Rooting media (M)

M_1-Sand
M_2-Coco coir

Factor B. Plant Part (P)

P_1-Softwood - taken just below the two expanded leaves from terminal shoot; light green leaves and stem that can be bent without breaking

P_2-Semi-hardwood - taken below the softwood cutting; green leaves and stem that will break upon bending
P_3-Hardwood - taken below the semi-hardwood cutting; brown stems and green leaves
P_4- Softwood with rooting hormone
P_5- Semi-hardwood with rooting hormone
P_6- Hardwood with rooting hormone

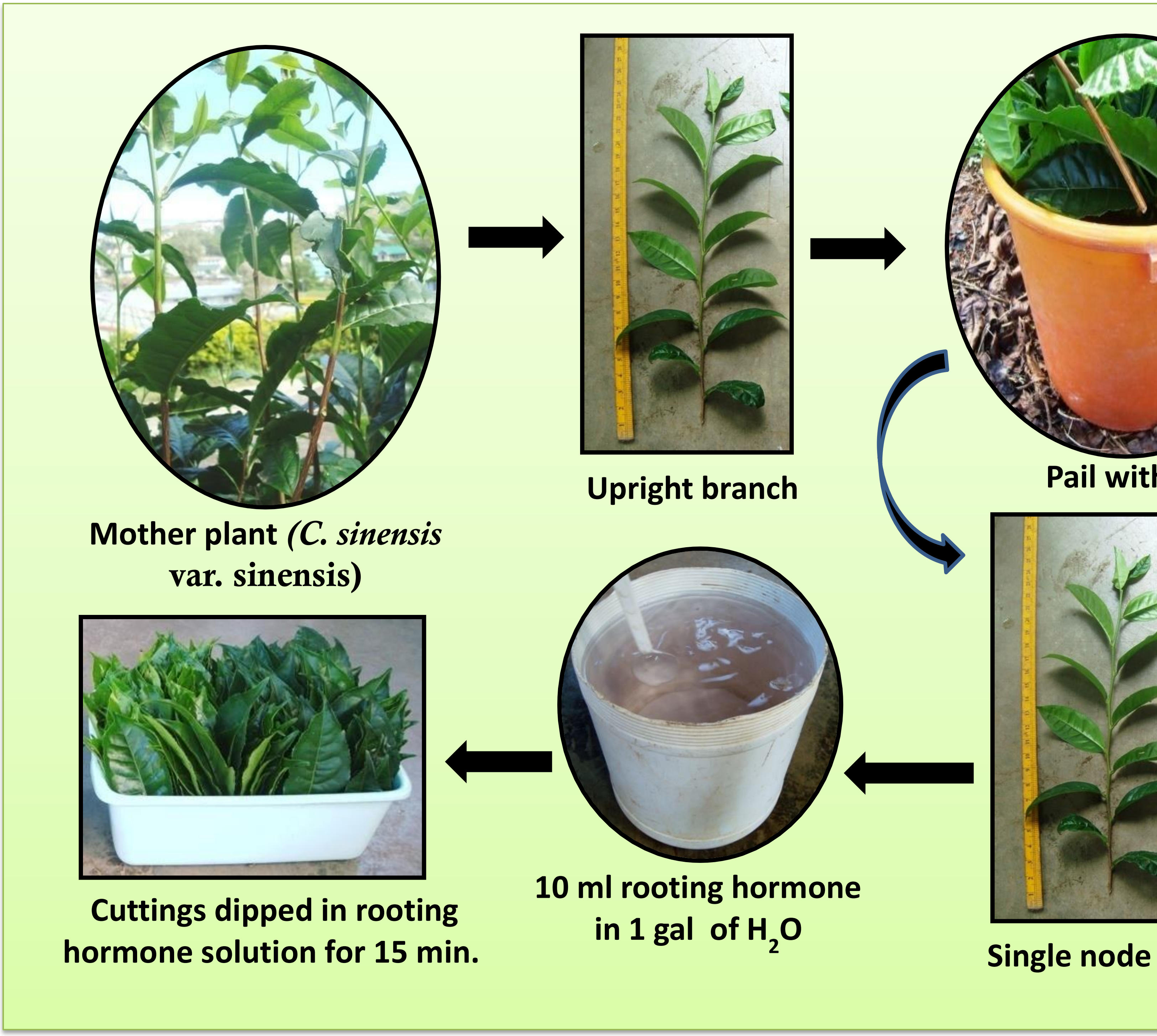
The data gathered were as follows:

1. Percent survival. Cuttings that survived were counted and computed in percent.
2. Percent Rooting. Cuttings that produced roots were also counted and computed in percent.
3. Number of roots. Roots produced by the cuttings were counted.
4. Length of roots (cm). Roots produced by cuttings were measured from the base to the tip of the longest root.
5. Days to root initiation. Days were counted after sticking to rooting.

Statistical Analysis

Data were analyzed through Analysis of Variance (ANOVA) and further analyzed through Duncan's Multiple Range Test (DMRT) for the difference between treatments means. Cost of production and return on investment (ROI) were also computed for the production of 1,000 pots rooted semi-hardwood, single node cuttings stuck in coco coir.

Fig. 1. Procedure in obtaining tea cuttings up to sticking into the different media


Mother plant (C. sinensis var. sinensis)
Upright branch
Pail
Single node
10 ml rooting hormone in 1 gal of H_2O
Cuttings dipped in rooting hormone solution for 15 min.

RESULTS AND DISCUSSIONS

Percent Survival

Medium. Table 1a shows that tea cuttings stuck in sand and coco coir had comparable percent survival in the three trials.

Plant Part. Semi-hardwood cuttings with rooting hormone had consistently higher survival in the first two trials with an average of 70.02% followed by hardwood cuttings with 66.62% while softwood cuttings was the lowest with average of 35.00%. This conforms to the findings of Bonheure (1990) that semi-hardwood cutting has higher percent survival compared to softwood cutting. The low survival of softwood cuttings could be due to the soft leaves that easily wilted under warm weather that reached up to 28 and 31.20 ^{o}C (Appendix table 2) for the first and second trial, respectively.

In the third trial softwood cuttings with rooting hormone had the highest survival with 89% but other plant parts with or without hormone were comparable except hardwood cuttings with rooting hormone with the lowest survival of 81.45%. The provision of net roofing aside from plastic that screened the heat of the sun favored the higher percent survival.

Table 1a. Percent survival as affected by medium and plant part

Treatment	**1st trial**	**2nd trial**	**Average (1 & 2)**	**3rd trial**
Medium				
Sand	48.78^{a}	57.22^{a}	53.00	85.91^{a}
Coco coir	48.89^{a}	58.88^{a}	53.88	87.33^{a}
ANOVA	*	*	*	*
Plant Part				
Softwood	30.00^{d}	40.00^{d}	35.00	88.92^{a}
Semi-hardwood	44.67^{c}	50.00^{c}	47.33	86.11^{a}
Hardwood	61.67^{a}	71.57^{a}	66.62	87.50^{a}
Softwood w/ rooting hormone	41.67^{c}	51.66^{c}	46.66	89.00^{a}
Semi-hardwood w/ rooting hormone	65.00^{a}	75.05^{a}	70.02	86.65^{a}
Hardwood w/ rooting hormone	59.00^{b}	60.02^{b}	59.51	81.45^{b}
CV (%)	13.26	15.35		9.23
ANOVA	**	**		**

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Means with the same letter in a column do not differ significantly at 5% level by DMRT

Interaction. Semi-hardwood cuttings with rooting hormone stuck in sand significantly registered the highest survival in the first and second trial with average of 72.29% while the lowest was obtained from softwood cuttings stuck in sand with 30% (Table 1b). In the third trial, semi-hardwood cuttings stuck in sand had the highest survival of 94.44% while the lowest was hardwood cuttings stuck in sand with 74.99%.

Third trial had higher percent survival than the first and second because of the provision of net roofing aside from the plastic sheet which screened and reduced the heat of the sun, and the trimming of the tea leaves which reduced transpiration leading to reduced wilting and drying of the stem cuttings.

Table 1b. Percent survival as affected by the interaction of medium and plant part

Treatment	**1st trial**	**2nd trial**	**Average (1 & 2)**	**3rd trial**
Sand				
Softwood	30.00^{e}	30.00^{f}	30.00	88.89^{a}
Semi-hardwood	46.00^{d}	36.67^{fe}	41.33	94.44^{a}
Hardwood	66.67^{b}	66.67^{ab}	66.67	83.33^{b}
Softwood + Rooting Hormone	26.67^{e}	26.65^{f}	26.66	89.32^{a}
Semi-hardwood+Rooting Hormone	73.33^{a}	71.25^{a}	72.29	84.43^{b}
Hardwood + Rooting Hormone	50.00^{cd}	51.00^{dc}	50.05	74.99^{c}
Coco coir				
Softwood	30.00^{e}	30.10^{f}	30.05	88.88^{a}
Semi-hardwood	43.33^{d}	54.35^{de}	48.84	77.77^{b}
Hardwood	56.67^{c}	55.67^{bc}	56.67	91.66^{a}
Softwood + Rooting Hormone	56.67^{c}	57.67^{bc}	57.67	88.88^{a}
Semi-hardwood + Rooting Hormone	56.67^{c}	58.67^{bc}	57.67	88.87^{a}
Hardwood + Rooting Hormone	50.00^{cd}	52.00^{dc}	51.00	87.91^{a}
CV (%)	13.26	15.35		9.23
ANOVA	**	**		**

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Percent Rooting

Medium. Tea cuttings in coco coir consistently had higher rooting percentages in the first two and third trials with an average of 37.33 and 48.78%, respectively, compared with cuttings in sand with rooting of 28.22 and 18.31%, in order (Table 2a). This was may be because coco coir is more porous and softer than sand suitable for rooting.

Plant Part. Semi-hardwood cuttings with rooting hormone had the highest percent rooting with average of 45.83% for the first two trials and third trial with 43.91% (Table 2a). Softwood cutting was noted with the lowest percent rooting with average of 17.40% and 22.21% for the first two trials and third trial, respectively. It was observed that cuttings with rooting hormone had higher rooting percentage than cuttings without rooting hormone which means that rooting hormone had enhanced the rooting of the stem cuttings. Further, semi-hardwood cuttings without rooting hormone had intermediate percent rooting of 34.17 and 38.89% which is higher than softwood and hardwood cuttings, may be because it has enough inherent hormone for rooting.

Table 2a. Percent rooting as affected by medium and plant part

Treatment	**1st trial**	**2nd trial**	**Average (1 & 2)**	**3rd trial**
Medium				
Sand	32.56^{b}	23.88^{b}	28.22	18.31^{b}
Coco coir	41.33^{a}	33.33^{a}	37.33	48.78^{a}
Plant Part				
Softwood	20.00^{d}	15.00^{e}	17.50	22.21^{c}
Semi-hardwood	41.67^{b}	26.67^{c}	34.17	38.89^{ab}
Hardwood	36.66^{c}	21.67^{d}	29.16	23.61^{c}
Softwood w/ rooting hormone	33.34^{c}	28.33^{c}	30.83	41.40^{a}
Semi-hardwood w/ rooting hormone	48.34^{a}	43.33^{a}	45.83	43.91^{a}
Hardwood w/ rooting hormone	41.67^{b}	36.67^{b}	39.17	32.43^{b}
CV (%)	11.93	9.69		10.23
ANOVA	**	**		**

Means with the same letter in a column do not differ significantly at 5% level by DMRT

Interaction. Among the treatments, semi-hardwood cuttings with rooting hormone stuck in coco coir registered the highest percent rooting with average of 54.83% while the lowest was obtained from softwood cuttings stuck in both media and softwood cuttings with rooting hormone stuck in sand with 15% for the first two trials (Table 2b).

In the third trial, softwood and semi-hardwood cuttings with rooting hormone stuck in coco coir noted the highest rooting percentage both with 66.67% while lowest was from hardwood cuttings in sand with 11.02%. Other treatments had lower percent rooting with average ranging from 13.88 to 63.33%. Higher percent rooting may be attained in a longer period.

Table 2b. Percent rooting as affected by the interaction of medium and plant part

Treatment	1st trial	2nd trial	Average (1 & 2)	3rd trial
Sand				
Softwood	20.00[d]	10.00[e]	15.00	13.88[de]
Semi-hardwood	43.00[bc]	23.33[cd]	33.16	19.44[d]
Hardwood	35.33[c]	23.33[cd]	29.33	30.55[c]
Softwood + Rooting Hormone	20.00[d]	10.00[e]	15.00	16.13[de]
Semi-hardwood + Rooting Hormone	40.00[bc]	20.00[d]	30.00	21.14[d]
Hardwood + Rooting Hormone	36.67[c]	26.67[c]	31.67	11.02[de]
Coco coir				
Softwood	20.00[d]	10.00e	15.00	30.55[c]
Semi-hardwood	40.00[bc]	20.00[d]	30.00	63.33[a]
Hardwood	37.99[c]	10.00[e]	23.99	16.67[de]
Softwood + Rooting Hormone	46.67[b]	36.67[b]	41.67	66.67[a]
Semi-hardwood + Rooting Hormone	56.67[a]	53.00[a]	54.83	66.67[a]
Hardwood + Rooting Hormone	46.67[b]	38.67[b]	42.67	53.84[b]
CV (%)	11.93	9.69		10.23
ANOVA	**	**		**

Means with the same letter in a column do not differ significantly at 5% level by DMRT

Number of roots

Medium. Table 3a shows that tea cuttings stuck in sand produced more roots in the first two trials with 4 compared to cuttings in coco coir with 3 roots but this was a reverse in the third trial. This was may be because in the first two trials, cuttings are enhanced to root in sand which easily gets warm during warm weather than coco coir. However in the third trial where heat from the sun was reduced through the provision of net roofing aside from plastic, favored the production of more roots in cuttings stuck in coco coir.

Plant Part. Semi-hardwood cuttings with or without rooting hormone produced the most number of roots with 4 to 5 in the three trials and the lowest was taken from softwood and hardwood cuttings with or without rooting hormone with 2 to 3 roots (Table 3a and Fig. 2). The most number of roots was may be due to enough inherent hormones responsible for rooting, and the production of side shoots for photosynthesis in semi-hardwood cuttings which was not observed in softwood and hardwood cuttings.

Table 3a. Number of roots as affected by medium and plant part

Treatment	1st trial	2nd trial	Average (1 & 2)	3rd trial
Medium				
Sand	4^{a}	4^{a}	4	3^{b}
Coco coir	3^{b}	3^{b}	3	4^{a}
Plant Part				
Softwood	2^{c}	2^{c}	2	3^{ab}
Semi-hardwood	4^{b}	3^{b}	4	4^{a}
Hardwood	3^{b}	3^{b}	3	3^{ab}
Softwood w/ rooting hormone	2^{c}	2^{c}	2	3^{ab}
Semi-hardwood w/ rooting hormone	5^{a}	4^{a}	5	4^{a}
Hardwood w/ rooting hormone	5^{b}	3^{a}	4	3^{ab}
CV (%)	13.36	19.35		14.32
ANOVA	**	**		**

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Interaction. Observation shows that for the first two trials, semi-hardwood and hardwood cuttings without rooting hormone stuck in sand, hardwood cuttings with rooting hormone in sand and semi-hardwood cuttings with rooting hormone in coco coir produced the most number of 5 roots while least number was noted in softwood in coco coir with 1 root (Table 3b). In the third trial the three plant parts with or without rooting hormone stuck in coco coir produced more and comparable number of roots (4 to 5) and lesser roots were produced from cuttings with or without rooting hormone stuck in sand with 2 to 3 roots.

Table 3b. Number of roots as affected by the interaction of medium and plant part

Treatment	1st trial	2nd trial	Average (1 &2)	3rd trial
Sand				
Softwood	3^b	3^b	3	2^b
Semi-hardwood	5^a	5^a	5	2^b
Hardwood	5^a	5^a	5	3^b
Softwood + Rooting Hormone	1^c	2^b	2	3^b
Semi-hardwood + Rooting Hormone	3^b	3^b	3	3^b
Hardwood + Rooting Hormone	5^a	4^a	5	2^c
Coco coir				
Softwood	1^c	1^c	1	5^a
Semi-hardwood	2^b	2^b	2	5^a
Hardwood	1^c	2^b	2	5^a
Softwood + Rooting Hormone	3^b	3^b	3	4^a
Semi-hardwood + Rooting Hormone	5^a	5^a	5	4^a
Hardwood + Rooting Hormone	3^b	3^b	3	4^a
CV (%)	13.36	19.35		14.32
ANOVA	**	**		**

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Length of roots

Medium. In the first two and third trials, coco coir significantly favored the growth of roots with respective average lengths of 1.76 and 1.63 cm compared with cuttings in sand with average root length of 0.86 and 0.96 cm (Table 4a). This was may be because coco coir is porous and softer that roots can easily penetrate, and as coco coir decomposes can release nutrients that serve as organic fertilizer enhancing the growth of roots and the cuttings.

Plant Part. Semi-hardwood cuttings with rooting hormone remarkably produced the longest roots with an average of 2.72 and 1.94 cm and the shortest were obtained from softwood (0.21 cm) and semi-hardwood cuttings (1.02 cm) for the first two and third trials (Table 4b and Fig. 2). Other plant parts with or without rooting hormone produced shorter roots with lengths ranging from 0.26 to 1.93 cm, in order. The production of longer roots in semi-hardwood cuttings could be due to the treatment of rooting hormone which enhanced the growth of roots, and this means that semi-hardwood is suited for propagation compared with other plant parts.

Table 4a. Length of roots as affected by medium and plant part

Treatment	**1^{st} trial**	**2^{nd} trial**	**Average (1 & 2)**	**3^{rd} trial**
Medium				
Sand	0.84^{b}	0.88^{b}	0.86	0.96^{b}
Coco coir	1.82^{a}	1.70^{a}	1.76	1.63^{a}
Plant Part				
Softwood	0.22^{d}	0.20^{c}	0.21	$1.05b^{c}$
Semi-hardwood	0.34^{d}	0.40^{c}	0.37	1.02^{bc}
Hardwood	0.23^{d}	0.29^{c}	0.26	1.19^{b}
Softwood w/ rooting hormone	2.11^{b}	2.24^{b}	2.17	1.29^{b}
Semi-hardwood w/ rooting hormone	3.23^{a}	2.21^{a}	2.72	1.94^{a}
Hardwood w/ rooting hormone	1.86^{c}	2.00^{b}	1.93	1.26^{b}
CV (%)	11.82	13.78		5.38
ANOVA	**	**		**

Means with the same letter in a column do not differ significantly at 5% level by DMRT

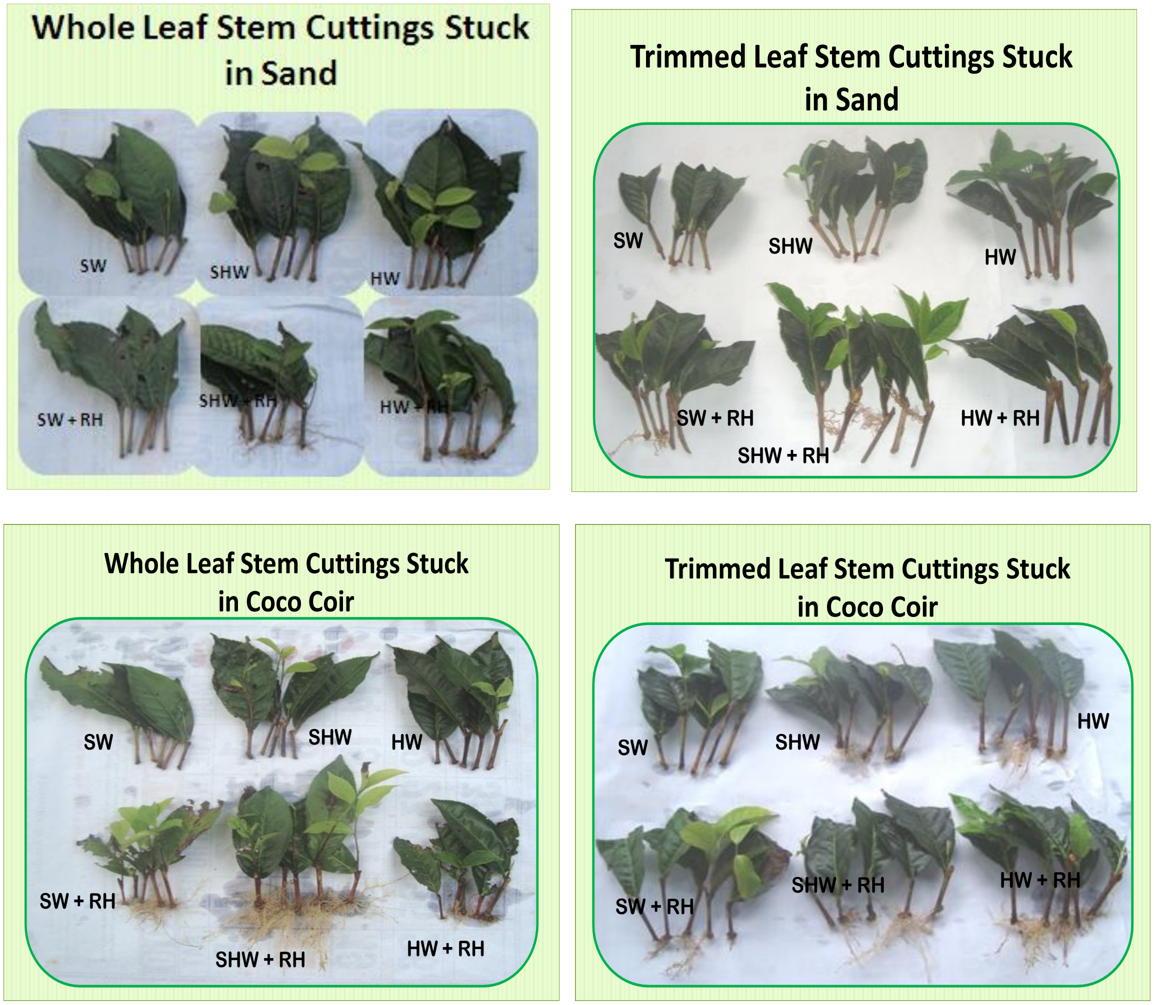
Interaction. Among the treatments, semi-hardwood cutting with rooting hormone in coco coir produced the longest roots with average of 3.85 and 2.97cm followed by hardwood cuttings with rooting hormone in coco coir with 1.94 and 2.40 cm for the first two and third trials, respectively (Table 4b). The shortest roots were obtained from hardwood and semi-hardwood cuttings in sand with 0.42 cm and 0.43 cm. Other treatments produced shorter roots.

Table 4b. Length of roots as affected by the interaction of medium and plant part

Treatment	**1st trial**	**2nd trial**	**Average (1 & 2)**	**3rd trial**
Sand				
Softwood	0.30^{e}	0.30^{ef}	0.30	1.02^{b}
Semi-hardwood	0.47^{e}	0.50^{e}	0.48	0.43c
Hardwood	0.32^{e}	0.35^{ef}	0.33	0.60^{c}
Softwood + Rooting Hormone	1.06^{d}	1.07^{d}	1.06	1.31^{b}
Semi-hardwood + Rooting Hormone	2.10^{c}	1.07^{d}	1.58	1.92^{ab}
Hardwood + Rooting Hormone	1.76^{c}	1.77^{c}	1.76	0.45^{c}
Coco coir				
Softwood	0.13^{e}	0.10^{f}	0.11	1.08^{b}
Semi-hardwood	0.20^{e}	0.19^{ef}	0.19	1.61^{ab}
Hardwood	0.13^{e}	0.13^{f}	0.13	1.77^{ab}
Softwood + Rooting Hormone	3.15^{b}	3.12^{b}	3.13	1.26^{b}
Semi-hardwood + Rooting Hormone	4.35^{a}	3.36^{a}	3.85	2.97^{a}
Hardwood + Rooting Hormone	1.95^{c}	1.93^{c}	1.94	2.40^{ab}
CV (%)	11.82	13.78		5.38
ANOVA	**	**		**

Means with the same letter in a column do not differ significantly at 5% level by DMRT

Fig. 2. Tea cuttings from different plant parts stuck in sand and coco coir



Days to rooting

<u>Medium</u>. There were significant differences on the number of days from sticking to rooting as affected by medium (Table 5a). Coco coir favored the production of roots earlier at an average of 150 and 135 days for the first two and third trials compared to sand at 155 and 144 days. This was may be because coco coir is softer and porous and when decomposing holds more moisture favorable for the initiation of roots earlier compared with sand that is hard and easily dries.

<u>Plant Part</u>. Among the plant parts, semi-hardwood cutting with rooting hormone was noted the earliest to initiate roots at an average of 136 days (first two trial) and 131 days (third trial) while the latest to root were softwood and hardwood cuttings both at 165 days (first two trials) and softwood cuttings at 144 days for the third trial (Table 5a). The treatment of

rooting hormone in semi-hardwood cuttings enhanced the earlier production of roots and earlier initiation of roots means earlier transplanting into pots and earlier turn over. This finding coincides with Bonheure (1990) who stated that tea cutting which is not too soft nor too hard has faster rooting.

Table 5a. Days to rooting as affected by medium and plant part

Treatment	1st trial	2nd trial	Average (1 &2)	3rd trial
Medium				
Sand	164[a]	146[a]	155	144[a]
Cococoir	160[ab]	139[b]	150	135[b]
Plant Part				
Softwood	177[a]	153[a]	165	144[a]
Semi-hardwood	172[a]	151[a]	162	143[a]
Hardwood	177[a]	153[a]	165	141[a]
Softwood w/ rooting hormone	151[b]	133[b]	142	141[a]
Semi-hardwood w/ rooting hormone	140[c]	132[b]	136	131[c]
Hardwood w/ rooting hormone	154[b]	133[b]	144	137[b]
CV (%)	11.82	12.75		9.35
ANOVA	**	**		**

Means with the same letter in a column do not differ significantly at 5% level by DMRT

Interaction. Table 5b shows that semi-hardwood cutting with rooting hormone stuck in coco coir was earliest to initiate roots at an average of 125 days (first two trials) and 128 days (third trial) while the latest were softwood and hardwood cuttings in coco coir both at 168 days and semi-hardwood and hardwood with rooting hormone in sand both at 150 days, respectively. This also coincides with the study of Galacio et. al (2008) who found that coffee *Arabica* cuttings plus rooting hormone rooted earlier in coco coir.

Table 5b. Days to rooting as affected by the interaction of medium and plant part

Treatment	**1st trial**	**2nd trial**	**Average (1 & 2)**	**3rd trial**
Sand				
Softwood	175[a]	151[a]	163	145[a]
Semi-hardwood	171[ab]	149[a]	160	150[a]
Hardwood	175[a]	151[a]	163	148[a]
Softwood + Rooting Hormone	161[b]	145[b]	153	140[b]
Semi-hardwood + Rooting Hormone	150[b]	145[b]	148	132[c]
Hardwood + Rooting Hormone	153[c]	135[c]	144	150[a]
Coco coir				
Softwood	180[a]	155[a]	168	144[a]
Semi-hardwood	177[a]	154[a]	166	136[b]
Hardwood	180[a]	155[a]	168	134[c]
Softwood + Rooting Hormone	142[d]	121[d]	132	142[ab]
Semi-hardwood + Rooting Hormone	130[c]	120[d]	125	128[d]
Hardwood + Rooting Hormone	155[c]	132[c]	144	130[c]
CV (%)	11.82	12.75		9.35
ANOVA	**	**		**

Means with the same letter in a column do not differ significantly at 5% level by DMRT

Return on Investment

The production of 1,000 pots rooted single node semi-hardwood stem cuttings sticked in coco coir costs PhP 6,437 yielding a gross and a net income of PhP 14,500 and PhP 8,063, respectively, giving a return on investment of 125.26% in nine months period (Table 6 and Appendix Table 1).

CONCLUSION

Coco coir medium is suitable and favorable for rooting of single node cuttings for having higher percent rooting and longer roots in shortest period. Likewise, semi-hardwood cutting with rooting hormone is effective for rooting for its high survival and rooting percentage and production of the most number and longest roots at the shortest time.

Semi-hardwood cuttings with rooting hormone stuck in coco coir was the best interaction effect noting the highest percent rooting and producing of the most number and longest roots at a shortest period, resulting to a faster turn over and gave a computed return on investment of 125.26% in nine months.

RECOMMENDATION

1. Coco coir is recommended for sticking single node tea stem cuttings for higher percent rooting and faster rooting.

2. Semi-hardwood cutting with the treatment of rooting hormone is effective for tea multiplication to obtain high survival, high percent rooting and faster rooting for faster turn over.

3. Multiplication of tea through semi-hardwood, single node cuttings with rooting hormone and sticking in coco coir is the best technique and profitable giving a return on investment of about 125.26% in nine months.

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APPENDICES

Appendix Table 1. COST AND RETURN ANALYSIS (Rooted single node semi-hardwood with rooting hormone stuck in coco coir (1000 Pots)

I. Cost of Production*

A. Labor Cost		
Operation/Activity	**Man Days** (Php 250/man day)	**Amount (PhP)**
1. Bed/media Preparation	0.5	125
2. Sticking/maintenance	12	3,000
3. Soil media preparation & potting	1.5	375
4. Net/plastic sheet installation	1	250
Sub-Total	**15**	**3,750**
B. Cost of Inputs	**Number/Unit Price**	
1. Rooting hormone	1bottle (60 ml)@ 70/bot	70
2. Sprinklers	1 pc @ 150/pc	150
3. Net	12 sq. m @18 /sq. m	216
4. Plastic sheet	2.5 kg (6 sq.m) @ 155/kg	387
5. Pail	1 @ 100/pc	100
6. Tray	1 pc @ 50/pc	50
7. Water for irrigation	24 drums @ 26/drum	624
8. Plastic pot	1000 pcs @ 0.50/pc	500
9. Coco coir	1 sack	250
10. Compost	1 sack	75
11. Rice hulls	1 sack	25
Sub-Total		**2,447**
C. Land rent	12sq. m @ 20/sq.m/yr	**240**
GRAND TOTAL		**6,437**

* Cost of labor, supplies and materials are based on 2012 prices

II. Economic Analysis

A. Total Cost of Production = Php **6,437**
B. Gross Returns =
C. Net Income =Gross Income – Total Cost of Production
D. Return on Investment (%) **=** $\frac{\text{Gross Income – Total Cost of Production}}{\text{Total Cost of Production}}$ X 100

Tea cuttings	**% Survival**	**% Rooting**	**Price (PhP)**	**Gross Return (PhP)**	**Net Income (PhP)**	**ROI (%)**
1000 pcs	680 pcs (68%)	580 pcs (58%)	25	14,500	8,063	125.26

Appendix Table 2. Air temperature during the trial period

Month	**Temperature (^oC)**	
First Trial	Minimum	Maximum
May	17.5	28.0
June	17.5	26.6
July	17.2	25.3
August	17.3	25.6
September	17.1	25.3
October	16.8	25.8
Second Trial		
January	14.00	28.40
February	12.40	29.80
March	12.80	30.20
April	14.20	30.40
May	16.40	31.20
June	16.20	29.60
Third Trial		
January	15.80	25.90
February	15.93	27.46
March	15.99	25.84
April	18.18	28.78
May	18.36	26.80
June	18.61	26.42