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Full Length Research Paper

Stem cut: An alternative propagation technology for rubber (*Hevea brasiliensis*) tree species

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Rubber tree is known to be the white gold tree species in Mindanao Philippines due to its high priced latex product. It is a seasonal tree which has problems on seed propagation thus; stem cut rubber was tested for sprouting and rooting potentials as affected by stem parts and levels of alpha naphthalene acetic acid (ANAA). The experiment employed a split-split plot design in lay-out and data analysis. The results indicate that at 75 days of observation, brown stem cut rubber significantly gave higher rate of survival (74%) as compared to 41% in green stem cut. No ANAA (control treatment) was significantly lower in survival rate of 48.3% compared with 65.8 and 58.3% in 1 tbsp/3 lit. H_2O and 1 tbsp/1 lit. H_2O, respectively with no interaction effects observed. Brown stem part significantly performed better than the young stem parts (green stem cut) as affected by the levels of ANAA. Lower concentration of ANAA (1 tbsp/3 lit. H_2O) gives better sprouts and rooting potentials as compared to the control treatment and higher concentration of the growth hormone with interaction effects. This indicated that older stem part and lower level of ANAA application would mean greater potential of propagating rubber tree through stem cut technology, thus alternative propagation technology during seed off year in rubber would be addressed.

Key words: Stem cut, sprout, rooting potentials, survival rate, soaking time, levels of ANAA.

INTRODUCTION

The common rubber (*Hevea brasiliensis)* tree is an indigenous tree in Amazon, Brazil. It is a tropical tree that grows best at temperatures of 20 to 28°C with annual rainfall of 1,800 to 2000 mm. Prime growing area of rubber tree is 10 degrees in latitudes from the equator, but it is also cultivated in the Philippines particularly in Mindanao Island. It is a light demanding tree species and requires moist soil. Rubber tree is relatively insensitive to soil type, but higher production and disease resistance can be on highly fertile soil.

H. brasiliensis grows satisfactorily up to 600 meters asl, but it tends to be pruned to damage by strong winds. In plantations, it may grow up to 20 to 30 m (IRRDB, 2005). It is a material having industrial, technologies and domestic uses. While it is considered a minor crop in the Philippines, it has high export potentials and is rated as one of the most profitable agro-industrial ventures (Phil. Recommend for Rubber, 1977).

Rubber tree is initially grown for its latex but it provided timber for the highly profitable downstream furniture industry (Mohamad, 1998). It is a seasonal tree species which means that there are years when said plants do not bear fruits (seed-off year). With this reason, rubber nurserymen/planters could hardly provide means of producing planting materials. Hence, this research attempts to find alternative methods of mass propagation of rubber planting materials by trying to determine the growth success of stem cut rubber as influence by stem parts and levels of alpha naphthalene acetic acid (ANAA). Vegetative propagation provides the best opportunity to multiply valuable trees for cultivation (Mialoundama et al., 2002). Results of this study may help

Figure 1. Map showing the study site inArakan, Cotabato Philippines.

Figure 2. Stem cut rubber parts.

rubber planters and nurserymen to cope with the shortage of rubber planting materials during off seasons.

Seedlings of *H. brasiliensis*are raised in nursery for almost a year before transplanting to the field. Stem cut propagation technology for rubber tree will shorten this time of nursery management besides, it help minimize cost and effort of producing planting materials by utilizing tree parts in mass propagation during seed-off year or even during peak season of rubber trees by recycling/utilizing the stems being cut after budding successes. Result of this study will contribute on the development of the rural community rubber farmers/planters who cannot afford to buy high cost budded rubber planting materials. It is assured that stem cut will inherit all the characteristics of the tree source (prototype) thus, successful stem cut propagules will not be budded anymore.

The study generally aimed to propagate rubber tree through stem cut. Specifically it sought to:

1. Determine the sprouting and rooting potentials of stem cut rubber as influence by stem parts (brown and green) and levels of alpha naphthalene acetic acid (ANAA).
2. Find out the survival rate of the stem cut rubber
3. Determine the number of roots that will be developed
4. Measure the length of the sprout and longest root developed
5. Relate the rates of the growth hormones with the growth characteristics that appears such as number of stem that produces sprouts, number of roots develop, length of sprout and longest roots developed

MATERIALS AND METHODS

Study on the success of stem cut rubber as alternative propagation technology was conducted in CFCST Doroluman Arakan Cotabato (Figure 1) from July 17 to October 2, 2011 to determine the potential of stem cut rubber tree in producing sprouts and roots. One hundred eighty stem cut (green and brown stem) at 1foot length (Figure 2) were used in the study. Stem cut were soak in water with ANAA at different levels such as 1tbsp/litH_2O and 1tbsp/3litH_2O including control treatment (no application). After soaking at decided number of hours (0 hours as control, 6 and 12 h treatment), stem cut were planted on a used poly bag soil filled with sandy clay soil with a ratio of 1:2. The experiment is arranged in a split-split plot design using stem parts as main plot treatment, soaking time as subplot and levels of ANAA as sub-subplot treatment replicated three times.

RESULTS

Survival rate

Table 1 shows that at 75 days of observation, brown cut rubber significantly had higher survival rate of 74% as compared to 41% in green cut stem parts. The levels of ANAA also shows significant variations. The control treatment is significantly lower in survival (48.3%) compared with 65.8% and 58.3% in 1tbsp/3 lit. H_2O and 1tbsp/1lit. H_2O, respectively. Figure 3 shows the cuttings in 75 days after planting.

Sprouting

The stem cut parts in 17 days after planting reported to

Table 1. Survival of stem cut rubber after 75 days as affected by stem parts and levels of ANAA.

Parameter	Treatment	Percent
Stem Part	Green	40.67[a]
	Brown	74.00[b]
	No Application	48.30[a]
Levels of ANAA	1 tbsp/1 lit.H_2O	58.30[ab]
	1 tbsp/3 lit.H_2O	65.80[b]

Mean with common letter subscript are not significantly different at 1% level.

Figure 5. 45 days after planting.

Figure 3. The cuttings in 75 days after planting.

Table 2. Sprouting growth potentials of stem cut rubber as affected by stem parts.

Stem part	Day			
	17	45	60	75
Green	6.2667a	5.8000[a]	5.0000[a]	4.0667[a]
Brown	3.8000[b]	8.0667[b]	7.4667[b]	7.4000[b]

Mean with common letter subscript are not significantly different at 1% level.

Figure 4. 17 days after planting.

significantly affects sprouting growth. The green stem parts significantly performed better compared to brown stem parts in the early growth stage. However, after 45 days to 75 days, the trend reversed, brown stem parts significantly performed better than the green stem (Table 2). Figures 4 and 5 show the stem cut after 17 and 45 days respectively.

Levels of ANAA significantly affect sprouting success. At 17 days, the control treatment (no application) significantly lower in growth (3.083 sprouts) compared to 5 and 7 sprouts in 1tbsp/lit.H_2O and 1tbsp/3lit.H_2O respectively. The trend continued up to 75 days only that the control treatment did not significantly varied with 1tbsp/lit.H_2O (Table 3).

Length of sprout produced

Table 4 shows the length of sprout measured after 75 days. The brown stem part reported to be significantly longer in length of 12.7 cm compared to the green parts of only 5.76 cm. This implies that brown stem cut grows faster in length up to 75 days (Table 4).

In terms of the effect of ANAA on sprout length, the two treatments did not vary significantly with the control treatment. This implies that the level of ANAA did not affect the growth of sprout in terms of length.

Rooting growth potentials

The number of roots developed did not vary as influenced by stem parts. However, root length and number of secondary roots significantly differed. The brown stem cut significantly was longer in length (6.67cm) compared to 4.65 cm in green stem cut (Table 5).

Brown stem cut also significantly higher in number of secondary roots developed (8.95) compared to only 5.4 in green stem cut.

The effect of ANAA levels on the root growth of stem cut rubber is reported to be significant in terms of number of roots and length of roots but not to number of secondary

Table 3. Sprouting growth potentials of stem cut rubber as affected by levels of ANAA.

Level of ANAA	Day			
	17	45	60	75
Control	3.083[a]	6.083[a]	5.167[a]	4.83[a]
1 tbsp/lit.H2O	5.000[b]	7.500[b]	7.250[b]	5.83[ab]
1 tbsp/3lit.H2O	7.000[b]	7.500[b]	6.330[ab]	6.58[b]

Mean with common letter subscript are not significantly different at 1% level.

Table 4. Length of sprout measured after 75 days as affected by stem parts and levels of ANAA.

Parameter	Treatment	Mean
Stem part	Green	5.7644[a]
	Brown	12.700[b]
Levels of ANAA	No application	9.733[a]
	1 tbsp/1 lit.H_2O	9.436[a]
	1 tbsp/3 lit.H_2O	8.778[a]

Mean with common letter subscript are not significantly different at 1% level.

Table 5. Rooting growth potentials of stem cut rubber as affected by stem parts.

Stem part	Number of root	Length of root (cm)	Number of Secondary root
Green	2.0	4.65[a]	5.4[a]
Brown	2.24	6.66[b]	8.95[b]

Means with the same letter are not significantly varied at 5% level.

roots. The 1 tbsp/3 lit.H_2O has significantly higher number of roots developed (4.4) and has longer roots (9.125cm) compared to the 1tbsp/lit.H_2O and the control treatment which are not significantly varied from each other (Table 6). Figure 6 shows the uprooted plants with root system and sprouts developed.

Effect of soaking time

No significant effect have been observed in the survival rate, sprouting and rooting potentials of stem cut rubber as influenced by time of soaking. This implies that soaking hours will not affects the growth success of stem cut rubber.

Table 6. Rooting potentials of stem cut rubber as affected by levels of ANAA.

Level of ANAA	Number of root	Length of root (cm)	Number of secondary root
No application	2.22[a]	7.389[a]	7.286[a]
1 tbsp/1 lit.H_2O	2.84[a]	7.632[a]	8.867[a]
1 tbsp/3 lit.H_2O	4.4[b]	9.544[b]	9.125[a]

Mean with the same letter subscript are not significantly different at 5%.

Figure 6. Uprooted plants with root system and sprouts developed.

Relationship of the number of sprout developed per collection days with stem parts, levels of ANAA and time of soaking

Pearson's correlation analysis reported that cut stem parts of the rubber is negatively related to the number of sprouts emerged 45 days after planting (DAP), 60 DAP and 75 DAP. The same findings with the levels of ANAA was found (Table 7).

On the other hand, time of soaking is positively related with the number of sprouts emerged in all collection days. The implication of the negative relationship in the levels of ANAA with number of sprouts emerged can be due to over dosage. As the level of ANAA application increased, growth of sprout seems to decline. The finding of the study clearly state that 1tbsp/3litH_2O is significantly better than 1tbsp/litH_2O in terms of sprout and root growth potentials of rubber tree species.

Scatter plot of the relationships of stem parts, levels of ANAA and time of soaking

The following scatter plots will explain the relationship of the three factors (stem parts, soaking time and rate of ANAA) with sprouting and rooting growth of Stem cut rubber (Figure 7).

Table 7. Pearsons' Correlation Analysis for stem parts, levels of ANAA, soaking time and number of sprouts emerged in various collection days after planting (DAP).

Parameter	Stem part	ANAA level	Soaking time	17 DAP	45 DAP	60 DAP	75 DAP
Stem Parts	1.0000						
ANAA level	0.0000	1.0000					
Soaking time	0.0000	0.6429**	1.0000				
17 DAP	0.4134*	-0.3554	0.0329	1.0000			
45 DAP	-0.4553*	-0.0608	0.1181	0.0946	1.0000		
60 DAP	-0.050**	-0.2113	0.0255	0.1406	0.6926**	1.0000	
75 DAP	-0.627**	-0.1609	0.0905	0.0516	0.7230**	0.8201**	1.000

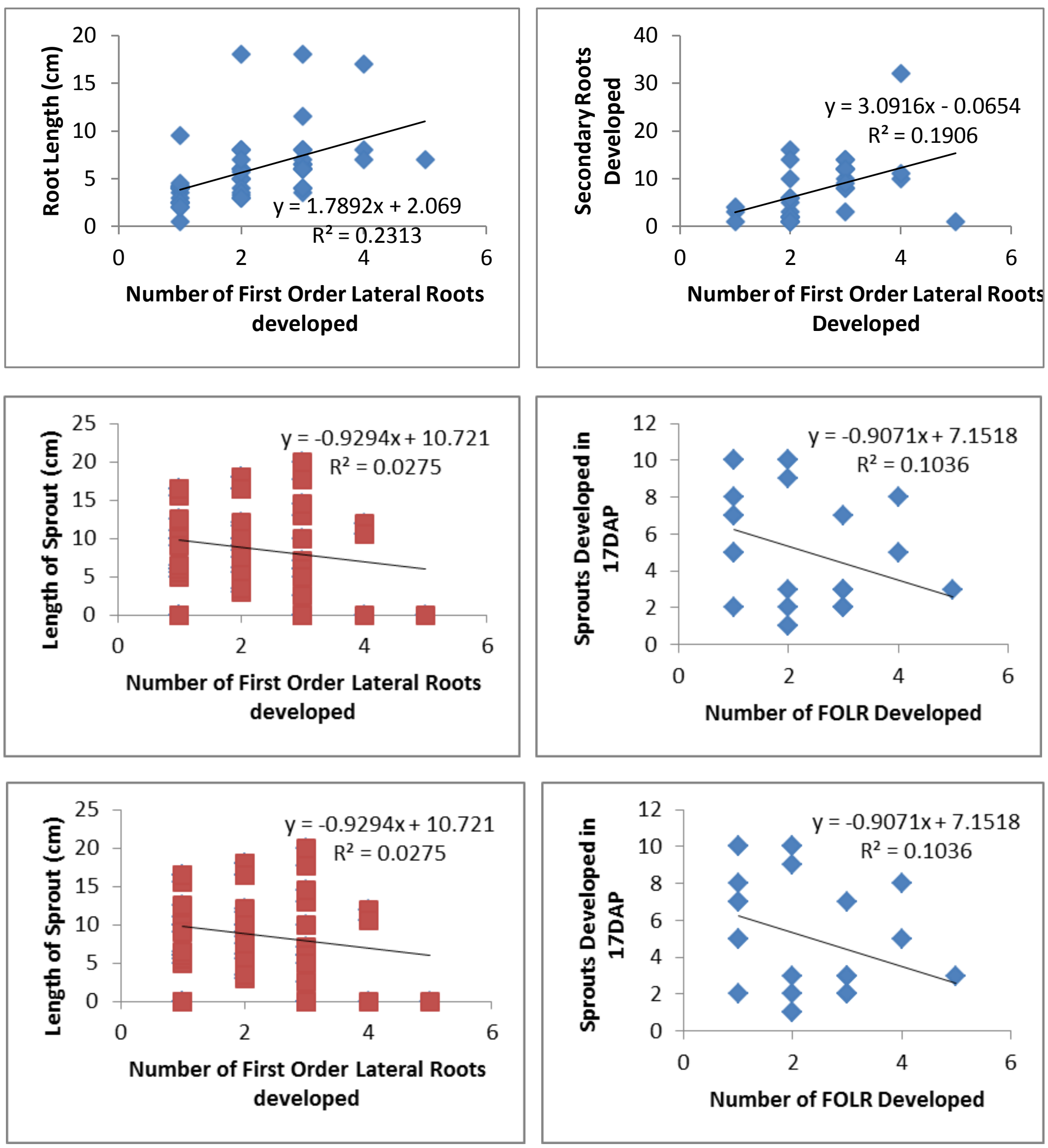

Figure 7. Scatter plots showing relationship of the three factors (stem parts, soaking time and rate of ANAA) with sprouting and rooting growth of stem cut rubber.

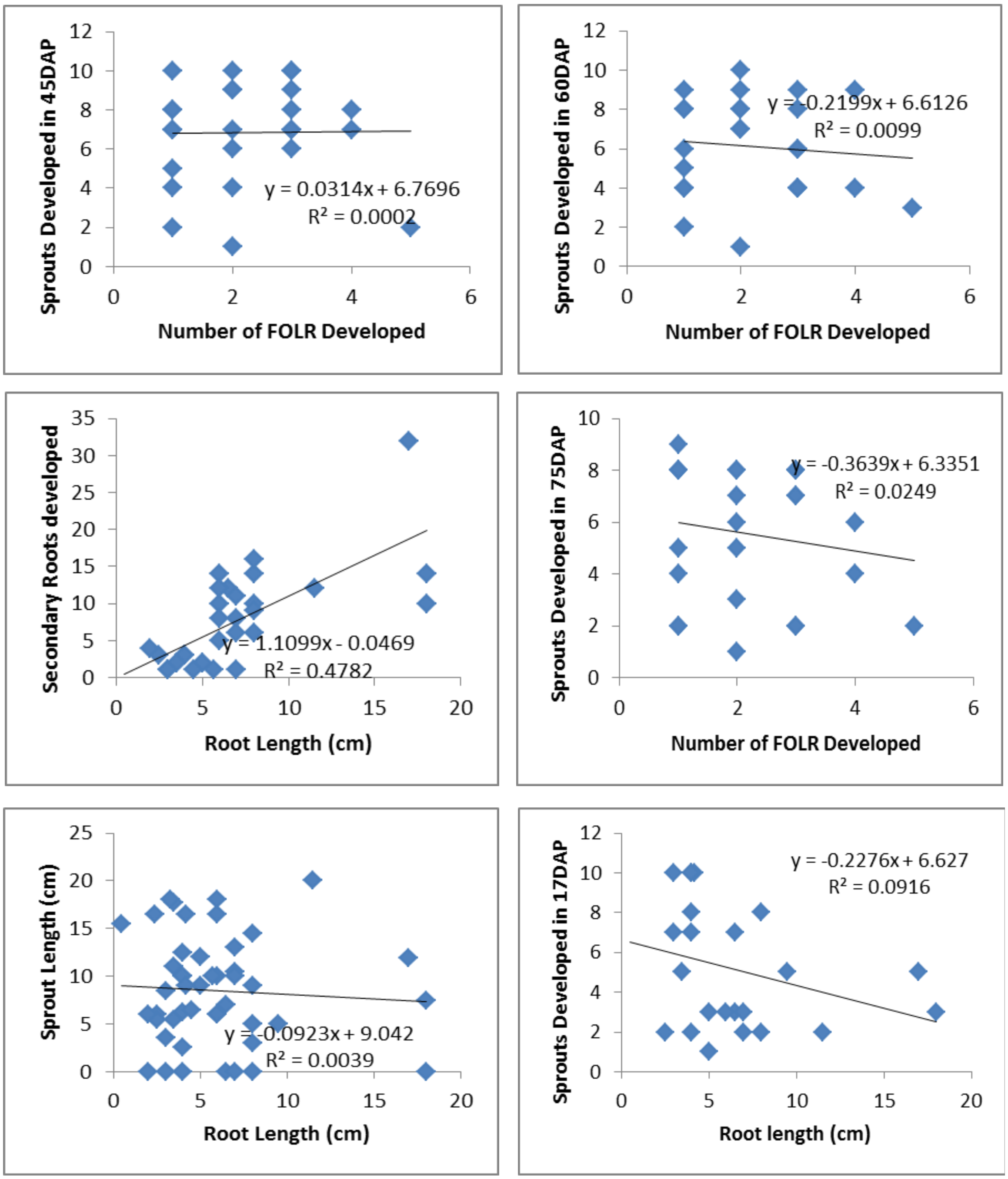

Figure 7. Contd. Scatter plots showing relationship of the three factors (stem parts, soaking time and rate of ANAA) with sprouting and rooting growth of stem cut rubber.

DISCUSSION

The length of rubber stem cut used in the study is 1 foot in length without considering the visible bud eye of the stems. One study shows that single node stem cuttings are better planting materials for successful survival and of large plum. There could be differences in aeration between media; or even the pH of the media. Small responses of large sour plum cuttings to hormone application could be due to high supplements of endogenous auxins in the shoots of the cuttings and these might interact negatively with the applied NAA

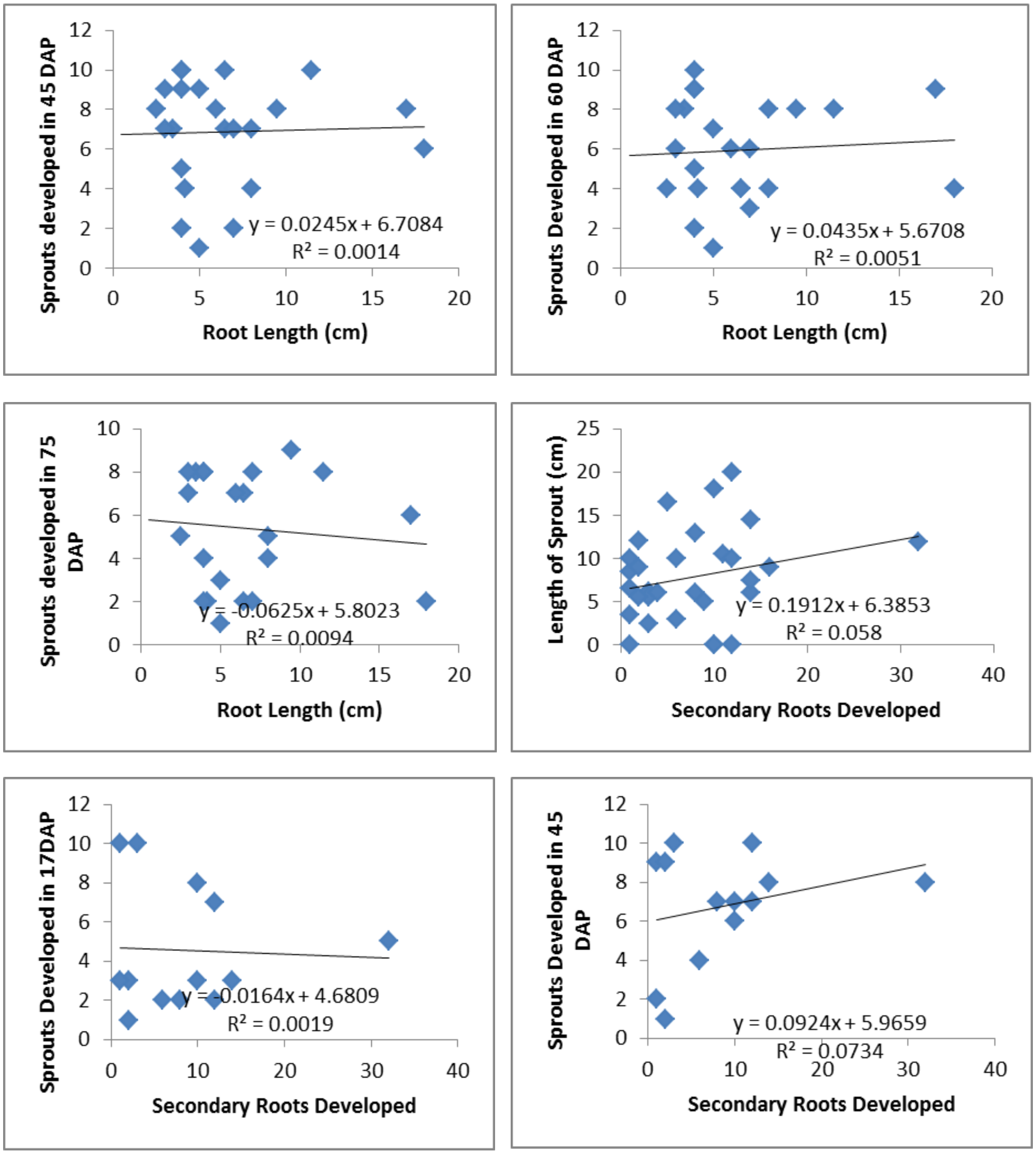

Figure 7. Contd. Scatter plots showing relationship of the three factors (stem parts, soaking time and rate of ANAA) with sprouting and rooting growth of stem cut rubber.

hormones (Owuor et al., 2009).

Rooting ability of stem cuttings depends on several factors. The purpose of treating the cuttings, with auxin is to increase the percentage of rooting (Ullah et al., 2005). Rooting was relatively insensitive to different NAA concentrations. The good rooting and survival of cuttings in sawdust may be explained by the high water retention of sawdust (Mialondou et al., 2002) and faster initiation of root formation by NAA hormone application. With the present study, 1tbsp/3litH_2O survived significantly and performed better as compared to 1tbsp/litH_2O. Among the exogenous rooting hormones, alpha naphthalene acetic acid (ANAA) has been found to be reliable in rooting of cuttings. According to Hartmann et al. (1997), there are

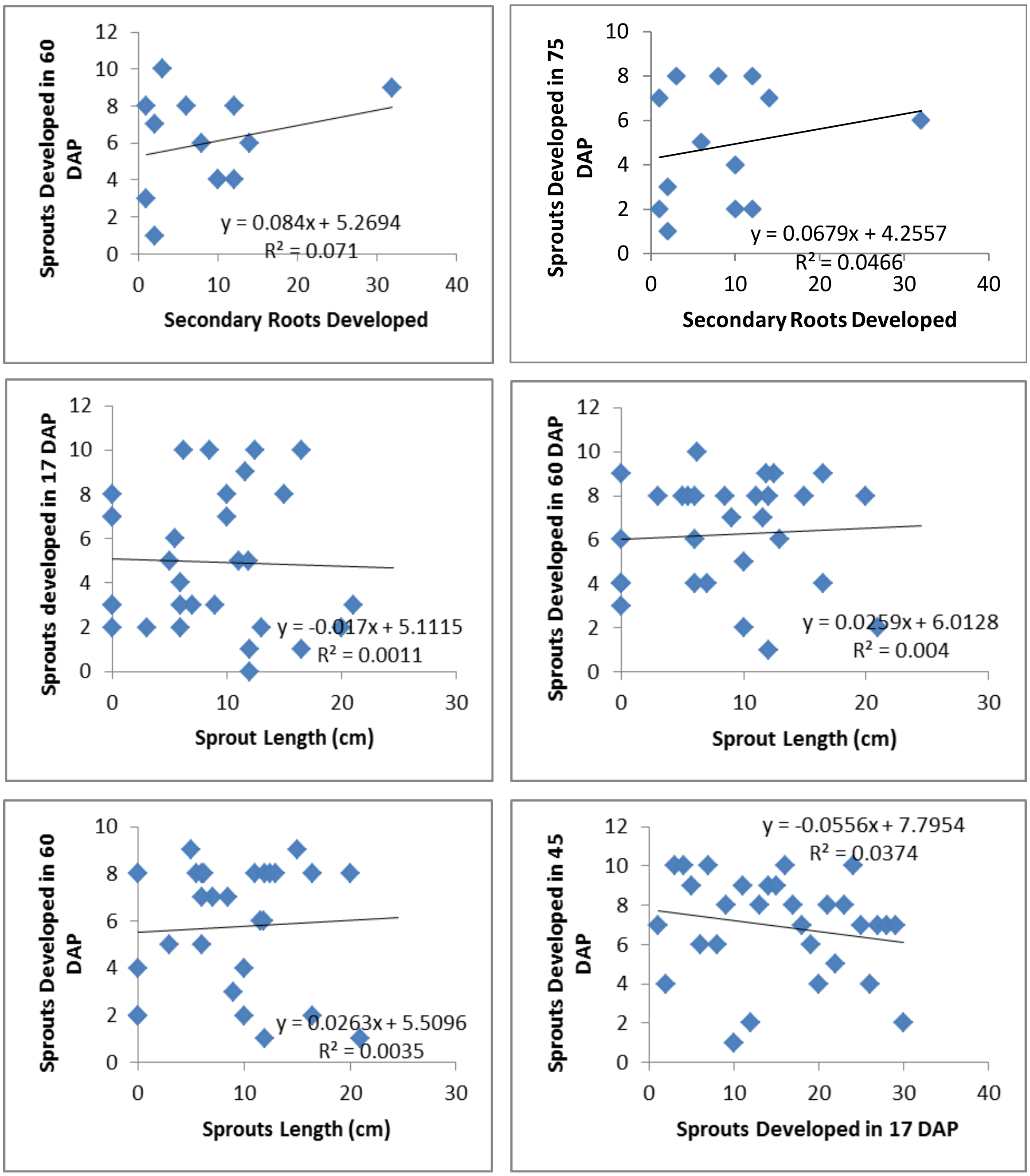

Figure 7. Contd. Scatter plots showing relationship of the three factors (stem parts, soaking time and rate of ANAA) with sprouting and rooting growth of stem cut rubber.

compounds within stem cuttings such as phenolics that interact with auxins to promote rooting, and increase root length. Some species tend to root better in certain substrates with or without hormone treatment, and this is linked to their hydromorphic or xeromorphic status (Mialondou et al., 2002).

The findings of Blythe et al. (2004) generally showed that, with increasing auxin concentration in the plugs, treatments first provided a root-promoting response of the lower stem tissue of the cuttings and suppression of shoot development, then a phytotoxic response of the lower stem tissue and some root-promoting

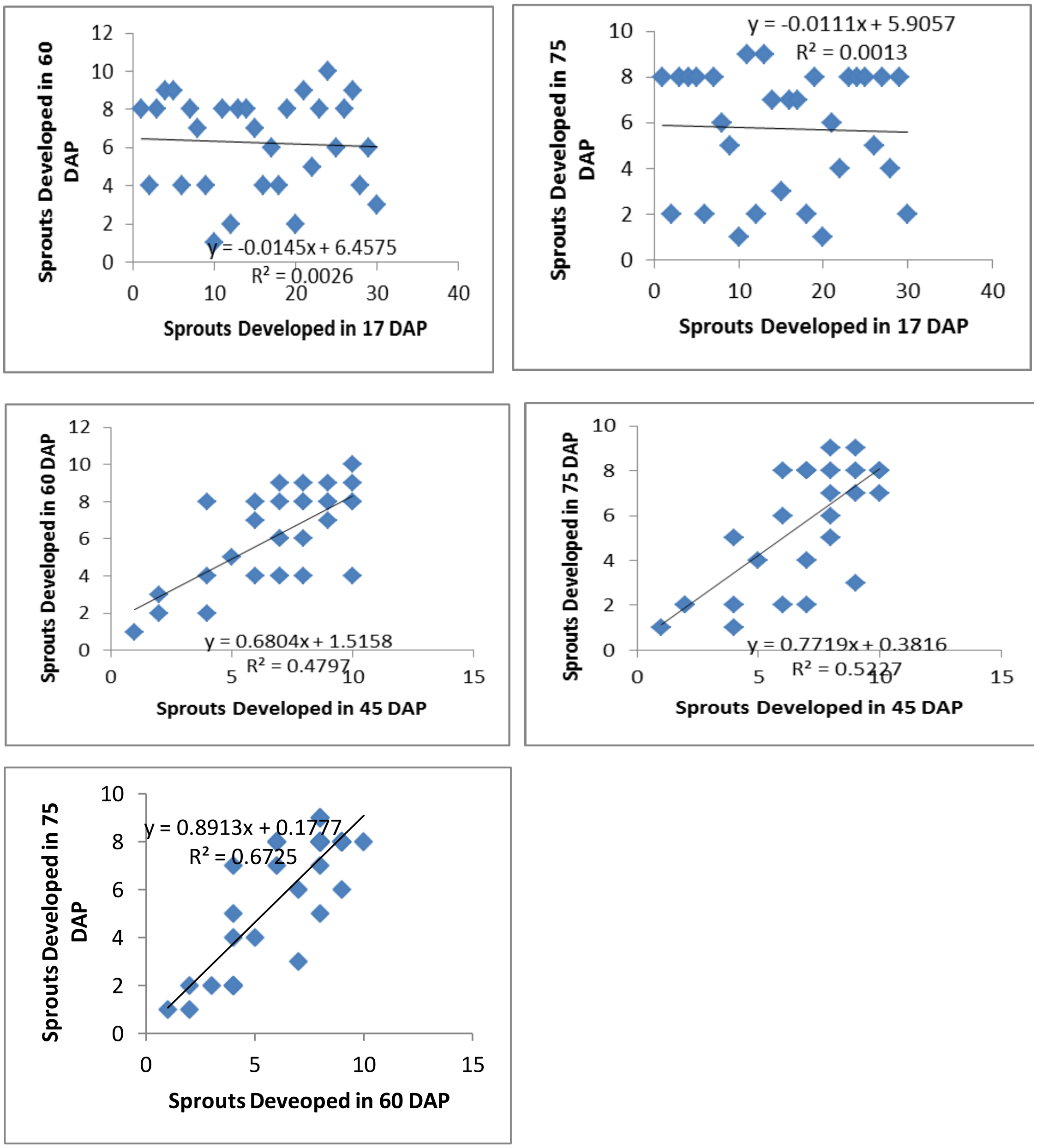

Figure 7. Contd. Scatter plots showing relationship of the three factors (stem parts, soaking time and rate of ANAA) with sprouting and rooting growth of stem cut rubber.

response of the upper stem tissue, and then a phytotoxic response by all stem tissue. The auxin NAA has previously been shown to be phytotoxic when applied at elevated rates to *Oxalis* plants as a foliar spray (Holt and Chism, 1988).

Vegetative propagation provides the best opportunity to multiply valuable trees for cultivation (Mialoundama et al., 2002). Cuttings propagated in sawdust with hormone treatment produced long and slender roots (Owuor et al., 2009). Application of ANAA hormone tended to increase the rate of root growth. Similar findings were reported by Ofori et al. (1996) while rooting Miliciaexcelsa. Other factors could interact with media to affect root growth and development . Roots of the cuttings grown in sand media were short, coarse and brittle, while when media such as mixture of sand: sawdust were used, the cuttings had well branched “slender” and flexible root types, which were suitable for transplanting. The findings also agree well with the findings of Hartmann and Kester (1983). The observations could be explained by the high moisture holding capacity and good aeration of the sawdust media. Pure sawdust has been found to have high moisture holding capacity and also a lower air/water ratio than coarse and fine sand in the propagation of *Nauclea diderrichii* cuttings (Leakey, 1990). Accordingly to Mohinderpal (1995), 1000 ppm of IBA treatment applied as basal dip in 1 to 2 cm diameter hardwood cuttings collected from healthy vigorously growing branches where in terminal portion of leaves is excised and branches are made into 15 to 20 cm long cuttings and then planted in nursery beds under 50 to 60% shade. The per cent of rooting is low.

On the other hand, hardwood cuttings treated with IAA or IBA 100 ppm in dilute water solution by basal dip method for 24 h gave profuse rooting (Sunil and Verma, 1996).

Researchers have proved that stem cuttings of chirpine can be rooted with the help of auxin under mist conditions (Bhatnagar, 1977). About 12 to 15 cm long cuttings taken from the lateral branches of six year old plants of chirpine in the month of July, treated with 50 mgl^{-1} water solution of IAA and planted under mist are reported to root 100% (Shamet and Handa, 1996). To encourage growth of branch blasts, the apical portion of chirpine plants is excised in the beginning of April. Within a month, about 4 to 6 cm long branch blasts are produced near the cut end. These are collected and planted under mist. Rooting occurs on more than 60 per cent cuttings within about 6 weeks. The percentage of rooted cuttings can be increased to as high as 90% by girdling the side shoots followed by the treatment with growth promoters, and using these side shoots for vegetative propagation.

Conclusion

Based from the result of the study, sprouting and rooting success of stem cut rubber particularly the brown/older part performed and survived significantly better and higher with the green/younger stem parts. While lower concentration of ANAA (1tbsp/3lit.H_2O) perform better as compared to the control treatment. Time of soaking did not affect the sprouting and rooting growth of stem cut rubber. These findings can be used as guide when propagating rubber trees through stem cut.

Recommendations

Testing of other growth hormones should be done to better understand their effects. The foregoing study only proves that older stem cut rubber performed better than green or younger parts. It also proves that lower concentration of ANAA (1tbsp/3litH_2O) responded better than higher concentrations of 1tbsp/litH_2O.

This finding will be further validated when conducting another trials with additional parameters and treatments such as different watering frequency, varied temperature of shading intensity, soil medium, length of cuttings, varietal source, other growth hormones, time of collecting cuttings, position of planting, and age of tree source. Take note that, plant grown through cuttings would be genetically identical to the parent plant from which the original cutting was taken. This is not necessarily so when plants are grown from seed. Cuttings are the most widely used technique for reproducing "prototype" plants. Therefore, it is highly recommended to have a follow up study and test the on field performance of successful cuttings in the particular study considering its growth and latex production.

REFERENCES

Blythe EK, Sibley JM, Tilt KM (2004). Cutting propagation of foliage crops using a foliar application of auxin. Scientia Hort. 103:1:31-37.

Hartmann HT, Kester DE (1983). Plant propagation, rinciples and practices. Prentice Hall International, London.

Hartmann HT, Kester DE, Davies FT, Geneve RL (1997). Plant propagation: Principles and practices. 7th ed. Prentice Hall, Upper Saddle River, NewJersey.

Holt JS, Chism WJ (1988). Herbicidal activity of NAA (1-naphthaleneacetic acid) on creeping woodsorrel (*Oxalis corniculata*) in ornamentals. Weed Sci. 36:227-233.

IRRDB (2005). The International Rubber Research and Development Board. Proceedings of Sympossium on physiological and molecular aspects of the breeding of Hevea

Leakey RRB (1990). Naucleadiderriochi: rooting of stem cuttings, clonal variation in shoot dominance, and branch plagiotropism. Trees 4:164-169.

Mialoundama F, Avana ML, Youmbi E, Mampouyl PC, Kopguep F, Tsobeng AC, Abega J (2002). Vegetative propagation of Dcrodesedulis (G. Don) H.J Lam by marcots, cuttings and micropropagation. Forests Trees Livelihoods 12:85-96

Ofori, DA, Newton AC, Leakey RRB, Grace J (1996). Vegetative propagation of Milicia excels by leafy stem cuttings: effects of auxin concentration, leaf area and rooting medium. For. Ecol. Manag. 84:39-48.

Owuor B, Musyimi D, Ocaidoand M, Asimwe J (2009). Vegetative propagation of the large sour plum (*Ximeniacaffra*Sond) by rooting of plagiotropic stem cutting. ARPN J. Agric. Biol. Sci. 4:1.

Sunil P, Swamy SL (1996). Geographical variation in rooting ability of stem cuttings of *Azadirachtaindica* and *Dalbergiasisso*. Genetic Resource and Crop Evolution. 46(1):29-36, DOI 10.1023/A:1008609407987. http//springerlink.

Ullah T, Wazir FU, Ahmad M, Analoui F, Khan MU (2005). A breakthrough in guava (Psidiumguajava L.) propagation from cutting. Asian J. Plant Sci. 4:238-243.