

Original Research Article

EFFECTS OF DIFFERENT ROOT INDUCING AGENTS ON CUTTING PROPAGATION OF TEA (*Camellia sinensis*)

ABSTRACT

Aims: In commercial cultivations, vegetative propagation through rooting of cuttings is common, and IBA based rooting hormone is often used. However, due to the need for non-chemical alternatives in organic cultivations, organic rooting substances have become increasingly important. Hence considering this, an experiment was conducted to investigate the effectiveness of different root inducing agents on the propagation of tea cuttings.

Study design: The experimental units were arranged in a completely randomized design.

Place and Duration of Study: The experiment was conducted in a special project nursery belongs to TSHDA (Tea Small Holding Development Authority) in Beralapanathara GN division of Pasgoda divisional secretariat in Matara, Sri Lanka.

Methodology: The nodal cuttings were pre-treated with six different root inducing agents including water (control), *Aloe vera* gel, coconut water, honey charcoal mixture, potato juice and rooting hormone (0.3% IBA). Each treatment was replicated four times with 20 cuttings in each. Cuttings' survival percentage, rooting percentage, number of roots, root length, fresh and dry weights of the ~~root-roots~~ were evaluated during three phases as 2nd, 4th and 6th week. The data were statistically analyzed using SAS statistical package and treatment means were compared using DMRT at a 5% significance level.

Results: The results revealed that there were significant differences between the treatments on cutting performances. The cuttings treated with rooting hormone showed the highest values in rooting percentage (55.8%), sprouting percentage (72.3%), during the 4th week and root length (2.1cm) and root dry weight (0.254g) during the 6th week. Moreover, coconut water and ~~aloe~~ *Aloe vera* gel showed ~~not-no~~ significant higher values in most of the measured variables compared to the rooting hormone.

Conclusion: Therefore, it can be concluded that coconut water and ~~aloe~~ *Aloe vera* gel can be considered as alternative rooting substances to the chemical-based rooting hormone for organic tea cultivations.

Keywords: [*Aloe vera gel, Camellia sinensis, IBA, Propagation*]

1. INTRODUCTION

The tea plant (*Camellia sinensis* (L.) O. Kuntze), is a woody-perennial plant of which the tender shoots are used to make the end product. Tea is a popular healthy beverage worldwide and ranks next to water. The Asian countries, mainly China, India and Sri Lanka generate more than half of the world tea production. It is an important revenue source for tea producing countries both in terms of earning foreign exchange and generating employment in the community (Trixie and Gunasekare, 2012).

Nurseries are the beginning of a planned plant production program and are needed to raise healthy, vigorous and uniform plants suitable for field planting. This can only be achieved by proper nursery operations. In a nursery, the time spent by the plant is money spent in maintenance. Reducing time will lower the cost of production. If nursery plants are healthy and vigorous, they will succeed in the field and reach production stage earlier. These twin objectives will be served if

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procedures are evolved to obtain good quality uniformly grown plants in the shortest possible time (Kathiravetpillai and Kulasegaram, 1986).

Conventionally, propagation of shoots are obtained from mother bushes and, about 250 mother bushes are needed to obtain cuttings to plant a hectare (Kathiravetpillai and Kulasegaram, 1986). Therefore, nurserymen face difficulties in obtaining cuttings for raising plants. Furthermore, growers find it is difficult to transport large numbers of plants to fields manually as bagged plants are bulky and heavy and require vehicles. There is another unacceptable practice some growers adopt and that is: obtaining their cuttings from New Clearings, bushes rested from plucking, 'Tipping' fields etc. Such methods would only give poor cuttings and thereafter poor quality plants which in turn would result in poor Re-Planted Clearings (Seneviratne, 2017).

There are some findings on rooting of cuttings using *Aloe vera* gel, coconut and king coconut water, honey and charcoal mixture, Apple cider, vinegar, potato juice and cinnamon powder but there are very less number of scientific researchers did to found the effectiveness of these rooting agents for tea cuttings. Most researchers compare different natural hormones on vegetative propagation of different plants only. But specially do not based on tea cuttings. The research is to select the most effective naturally available which gives rapid and high quality root formation of cutting nodes of tea in the tea nursery. Hence considering this, an experiment was conducted to investigate the effects of different root inducing agents on propagation of tea cuttings.

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2. MATERIAL AND METHODS

The experiment was conducted in a special project nursery belongs to TSHDA (Tea Small Holding Development Authority) in Beralapanathara GN division of Pasgoda divisional secretariat in Matara, Sri Lanka. Experiment was designed with six treatments with four replicates where each replicate had 10 cuttings. Experimental units were arranged in a completely randomized design (CRD) manner. The treatments were as follows;

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- T1 – Water (Control)
- T2 - *Aloe vera* gel (100%)
- T3 - Coconut water (100%)
- T4 - Honey and charcoal mixture (1:1)
- T5 – Potato juice (100 g potato in 100 ml of water)
- T5 – Rooting hormone (0.3% IBA)

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Only single node cuttings from the suitable shoots were selected and cuttings were taken from the middle portion of the shoot leaving the apical tender portion of, and basal mature portion; and cuttings with axillary flower buds, over grown shoots and damaged mother leaf were discarded. For single node cuttings upper cut was made on the shoot closer to axillary buds without damaging it and the second cut was made 2-4 cm below the node. Potting media was prepared using Top soil that (Citrus, Guatemala, kekilla cultivated land soil were used) and in 7 inch height and 5 inch width polythene containers were used for potting nursery and it was selected with 150 gauge thick polythene containers. Plants were kept in a shade house and manual irrigation was practiced only in sunny days daily in the morning and manual weeding was performed when any weed observed.

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Plant growth data such as cutting survival %, rooting %, sprouting %, root number, root length (cm), root fresh (g) and dry weight (g) were collected at 2 weeks interval. Collected data were analyzed using ANOVA and means were separated using DMRT at 5% significant levels.

3. RESULTS AND DISCUSSION

3.1 Survival percentage

It was found that, there were no significant differences among the treatments on survival percentage at 2nd week. But, there were significant differences at 4th and 6th weeks after planting. The higher values in survival percentage was observed in application of rooting hormone and cuttings dipped in coconut water. Those were followed by aloe-vera gel, honey and charcoal mixture and potato juice respectively. The lowest value in survival percentage was obtained in the control treatment.

In an experiment on *Parkia biglobosa*, Dunsin et al. (2014) employed honey as an alternative application to induce rooting. Honey had a lower cutting mortality rate than the control. Honey can be used to treat *Hemigraphis* cuttings,

according to Firth (2018), and it resulted in a higher rate of rooting and heavier roots. Honey is commercially utilized as rooting, according to several sources (Nair et al., 2018). It has been claimed that, in addition to growth regulators and hormones, sucrose is a major factor in roots (Abo et al., 2018). It is obvious that oligosaccharides deposited in plant cell walls have a favorable influence on root induction and growth (Mehrabani et al., 2016).

Table 1. Effects of difference root inducing agents on survival rate of tea cuttings

Treatments	2 nd week	4 th week	6 th week
T1 – Water (Control)	100a	56.5d	30.0d
T2 – Aloe vera gel	100a	80.3b	78.0bc
T3 – Coconut water	100a	90.0a	90.0a
T4 - Honey and charcoal mixture	100a	65.0c	70.0bc
T5 – Potato Juice	100a	68.0c	68.5c
T6 – Rooting Hormone	100a	92.8a	92.8a
Sig.	ns	*	*

Means followed by same letter in a same column not significantly different at 5% significance level due to DMRT. '*' represents significant and 'ns' not significant.

3.2 Rooting percentage

There was no rooting observed at 2nd week of planting. Based on the above table, it was revealed that there were significant differences between the treatments on rooting percentage at 4th and 6th week after planting of cuttings. The highest rooting percentage at 2nd week was observed in cuttings applied with rooting hormone and it was followed by application of ~~aloe~~ *Aloe vera* gel and coconut water. The higher values in rooting at 6th week was observed in the treatments where applied with rooting hormone, coconut water and ~~Aa~~ *Aloe vera* gel respectively. The lowest value in rooting was observed in the cutting ~~where applied s in~~ water and maintained as the control.

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According to Rout (2006), after 3 weeks of potting medium transfer, Tea cuttings treated with nutrient solution without growth regulators showed little response in root development. Most nodal cuttings treated with growth regulators produced root initiation 14 days after being transferred to potting medium. IBA-treated nodal cuttings had a better rooting response than NAA and IAA-treated nodal cuttings. Cuttings treated with 75 ppm IBA had the highest percentage of rooting and the most roots per cutting. Ibiroinke (2017) investigated IBA, Coconut water, and Tetracycline and discovered that coconut water treatment had a substantial influence on *Murrayya* cutting rooting. The primary type of auxin found in coconut water is Indole-3-acetic acid, which is found in plants (Wu et al., 2009).

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Table 2. Effects of difference root inducing agents on rooting percentage of tea cuttings

Treatments	2 nd week	4 th week	6 th week
T1 – Water (Control)	0	0.00d	29.8d
T2 – Aloe vera gel	0	32.3b	75.3ab
T3 – Coconut water	0	30.5b	80.8ab
T4 - Honey and charcoal mixture	0	20.5c	68.5b
T5 – Potato Juice	0	15.8c	50.4c
T6 – Rooting Hormone	0	55.8a	84.5a
Sig.	ns	*	*

Means followed by same letter in a same column not significantly different at 5% significance level due to DMRT. '*' represents significant and 'ns' not significant.

3.3 Sprouting percentage

It was revealed that, no sprouting was observed at 2nd week and there were significant differences between the treatments on sprouting percentage at 4th and 6th week. The highest sprouting percentage was observed in rooting hormone application during 4th week. It was followed by the other application methods respectively. The higher values in sprouting during 6th were observed in rooting hormone and coconut water application. Those were followed by ~~aloe~~ *Aloe vera* gel, honey and charcoal and potato juice which did not show significant sprouting percentage.

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Usman et al. (2015) employed coconut water at concentrations of 25 percent, 50 percent, and 100 percent to treat *Massularia acuminata* Bullock ex Hoyl single node stem cuttings. They discovered that coconut water is more effective than IBA and NAA in terms of sprouting percentage and callus formation. Cuttings treated with coconut water had more leaves than IBA and NAA. Massoud et al. (2017) observed that Rosemary cuttings treated with Honey, Yeast extract, and Coconut Milk demonstrated 5.90 percent rooting percentage.

Table 3. Effects of difference root inducing agents on sprouting percentage of tea cuttings

Treatments	2 nd week	4 th week	6 th week
T1 – Water (Control)	0	0.0c	0.0c
T2 – Aloe vera gel	0	40.8b	62.5b
T3 – Coconut water	0	30.3b	85.8a
T4 - Honey and charcoal mixture	0	42.5b	60.4b
T5 – Potato Juice	0	35.8b	55.8b
T6 – Rooting Hormone	0	72.3a	90.0a
Sig.	Ns	*	*

Means followed by same letter in a same column not significantly different at 5% significance level due to DMRT. '*' represents significant and 'ns' not significant.

3.4 Number of roots

The above table indicated the effects of different root inducing agents on propagation of Tea cuttings. It was revealed that, there were significant differences between the treatments on number of roots. Higher values in number roots were observed during the 6th week where the cuttings treated with rooting hormone, coconut water and honey, charcoal mixture. Lowest root numbers were recorded in the cuttings treated with water, which was maintained as the control. Cuttings with a large number of roots will have a better chance of establishing themselves. Natural hormones are important in boosting the quantity of roots in cuttings. Faster cutting growth will be aided by an increase in the number of roots. Many studies have shown that natural compounds can increase the quantity of roots in horticulture crops.

Salicylic Acid, found in *Aloe Vera vera* and cinnamon powder, aids in the rooting of cuttings. *Aloe vera* has been shown to root *Vitex diversifolia* semihard wood cuttings better than IBA (Shidiki et al., 2019). *Aloe vera leaf extract* contains GA3 16 mg/100gm fresh weight, IAA 0.6 mg/100gm fresh weight, ABA 3.1 mg/100gm fresh weight, Glucose 3 g/100g, Protein 1.0 mg/g are and all phytohormones and nutrients found in *aloe vera leaf extract*. Aloe plant extracts have been shown to contain almost 75 biologically active components, including several forms of salicylic acid, minerals, sugar, vitamins, saponins, lignins, and amino acids. This encourages cell survival and growth (Dagne et al., 2000).

Table 4. Effects of difference root inducing agents on number of roots of tea cuttings

Treatments	4 th week	6 th week
T1 – Water (Control)	0.0c	2.3c
T2 – Aloe vera gel	4.5b	10.4b
T3 – Coconut water	6.5a	13.5a
T4 - Honey and charcoal mixture	6.0a	12.3ab
T5 – Potato Juice	2.0b	6.0c
T6 – Rooting Hormone	8.3a	14.0a
Sig.	*	*

Means followed by same letter in a same column not significantly different at 5% significance level due to DMRT. '*' represents significant and 'ns' not significant.

3.5 Rooting length

It was found that, there were significant variations observed between the treatments on root length of Tea cuttings. Not significant higher values were not observed during 4th week were observed in the treatments applied with rooting hormone and coconut water. The lower values were recorded in honey, charcoal mixture and application of water. Further, highest root length was recorded where the cuttings treated with rooting hormone and it was followed by coconut water and aloe vera gel.

Aloe vera gel is said to contain IAA and could be utilized as an alternative hormone (El Sherif, 2017). *Aloe vera gel* contains growth hormones such gibberellin and salicylic acid, which help the plant growth (Sahu et al., 2013). Many people have discovered that applying *Aloe vera gel* on cuttings helps them grow longer roots. *Dracaena purplecompacta* L. was studied using coconut water extract for propagation by softwood canes and cuttings for vegetative reproduction

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(Agampodi *et al.*, 2009). The effect of coconut water on adventitious root formation was validated in this investigation. Coconut Water extracts and natural IAA were tested in five different concentrations. For comparison, they performed another series of treatments with the same dose of real IAA rooting hormone. Dunsin *et al.*, (2014) found that cuttings of *Parkia biglobosa* treated with Moringa leaf extract had the largest root length compared to control, honey, and coconut water treatments.

Table 5. Effects of difference root inducing agents on root length (cm) of tea cuttings

Treatments	4 th week	6 th week
T1 – Water (Control)	0.31c	0.51d
T2 – Aloe vera gel	0.75b	1.75b
T3 – Coconut water	0.98ab	1.85b
T4 - Honey and charcoal mixture	0.38c	0.85c
T5 – Potato Juice	0.58b	0.95c
T6 – Rooting Hormone	1.24a	2.14a
Sig.	*	*

Means followed by same letter in a same column not significantly different at 5% significance level due to DMRT. '*' represents significant and 'ns' not significant.

3.6 Root Fresh Weight

There were significant differences between the treatments on root fresh weight of Tea cuttings. Not significant higher root values were recorded during the 4th and 6th weeks in the treatments where applied with rooting hormone, coconut water and aloe vera gel respectively. The lowest was found in the cuttings treated with water.

Rawat *et al.*, (2020) reported that an experiment on *Rosmarinus officinalis* revealed that the highest fresh weight of roots per cutting was recorded 60 days after cuttings were planted with the application of 750 ppm IBA, which was statistically at par with IBA 1000 ppm and IBA 500 ppm and was superior to IAA treated cuttings. Untreated cuttings had the smallest fresh weight of roots per cutting (control). Similarly, at 90 DAP, IBA with a concentration of 750 ppm had the maximum fresh weight of roots per cutting, which was superior to other treatments as well as control. Cuttings treated with various doses of plant growth regulators aid in the mobilization and translocation of primary metabolites, resulting in improved root development and nutrient uptake. Padekar *et al.* (2018), Watane *et al.* (2018), and Siddiqua *et al.* (2018) all reported similar findings.

Table 6. Effects of difference root inducing agents on root fresh weight (g/cutting) of tea cuttings

Treatments	4 th week	6 th week
T1 – Water (Control)	0.80c	1.12d
T2 – Aloe vera gel	2.12a	2.94a
T3 – Coconut water	1.98ab	3.00a
T4 - Honey and charcoal mixture	1.74b	2.42b
T5 – Potato Juice	1.24b	1.58c
T6 – Rooting Hormone	2.24a	3.14a
Sig.	*	*

Means followed by same letter in a same column not significantly different at 5% significance level due to DMRT. '*' represents significant and 'ns' not significant.

3.7 Root Dry Weight

It was revealed that, there were significant differences among the applied treatments on root dry weight of tea. Higher values in root dry weights were recorded during the 4th week on the cuttings treated with rooting hormone, coconut water and aloe Aloe vera gel. The significant highest root dry weight was recorded during the 6th week in the rooting hormone application and it was followed by coconut water and Aloe vera gel. The lowest dry weight was observed in the control treatment where water was used as a treatment.

A study on *Pelargonium graveolens* by Rawat *et al.*, (2020), indicated that, under 750 ppm IBA, the maximum dry weight of roots per cutting was reported at 60 DAP, which was statistically comparable to IBA 1000 pp and T2 IBA 500 ppm, and was superior to other treatments as well as control. However, with the 750 ppm IBA, which was superior to all other

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treatments, the largest dry weight of roots per cutting was recorded, whereas it was the lowest in untreated cuttings (control). Cuttings treated with IAA had a lower dry weight of roots. Tanuja et al. (2017) found similar results. IBA treatment is also superior to IAA treatment, according to Yesiwas et al. (2015) also discovered that at 1000 ppm IBA concentration, the maximum root dry weight in stem cuttings of rose of Natal Break rootstock was attained.

Table 7. Effects of difference root inducing agents on root dry weight (g/cutting) of tea cuttings

Treatments	4 th week	6 th week
T1 – Water (Control)	0.003b	0.007d
T2 – Aloe vera gel	0.135a	0.235b
T3 – Coconut water	0.140a	0.240b
T4 - Honey and charcoal mixture	0.010b	0.125c
T5 – Potato Juice	0.008b	0.130c
T6 – Rooting Hormone	0.150a	0.254a
Sig.	*	*

Means followed by same letter in a same column not significantly different at 5% significance level due to DMRT. "*" represents significant and 'ns' not significant.

4. CONCLUSION

Based on the present findings, it was observed that application of rooting hormone on Tea cuttings showed superior values in most of the measured variables. Further application of coconut water and *Aloe vera* gel also showed nearly similar values ~~not significant values~~ in several measured variables. It can be concluded that, coconut water and *Aloe vera* gel can be used as an alternative to the IBA based rooting hormone in organic tea cultivations.

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