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Response of natural rooting substances on leaf cuttings of two cultivars of ZZ plant (*Zamioculcas zamiifolia*)

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ABSTRACT

The present investigation on "Multiplication of ZZ (Zamioculcas zamiifolia) cultivar leaf cutting using different natural rooting substances" was carried out during the year 2021-2022 at Horticultural Farm, School of Agricultural Sciences and Rural Development, Medziphema, Nagaland. The experiment was laid out in completely randomized design with 12 treatments C_1- ZZ Super Nova and C_2- ZZ Raven, and different natural rooting substances (T) viz., Control (T_0), Honey (T_1), Cinnamon powder (T_2), Aloe vera gel (T_3), Apple cider (T_4), Coconut water (T_5)and replicated thrice. The leaf cutting of two cultivars (Super Nova and Black Raven) were dipped in different prepared natural rooting substances, Honey, Cinnamon, Aloe vera, Apple cider, Coconut water and control, and planted in coarse sand. Early rhizome initiation (45.54 days), root initiation (52.09 days), number of roots at 75 and150 DAP (4.46 and 8.04), length of primary root at 75 and 150 DAP (1.88cm and 3.65cm), rate of root growth at 75 and 150 DAP (71.76% and 86.55%), diameter of rhizome at 90, 120 and 150 DAP (0.93cm, 2.10cm and 2.49cm) days to shoot bud emergence (182.76) and shoot length at 45 days after emergence (2.31cm) were recorded in C_1(Super Nova). While T_5 (Coconut water) exhibited the highest values in all the growth characters viz. rhizome initiation (46.50 days), root initiation (50.73 days), number of roots at 75 and 150 days after planting (5.33 and 8.73), length of primary root at 75 and 150 DAP (2.45cm and 4.93cm), rate of root growth at 75 and 150 DAP (78.59% and 89.44%), diameter of rhizome at 90, 120 and 150 DAP (1.05cm, 2.10cm and 2.46cm) days to shoot bud emergence (182.20) shoot length at 45 days after emergence (3.09cm). The leaf cutting of ZZ Super Nova grows much faster than ZZ Black Raven when given with same soil and climate condition.

***Keywords*:** *Aloe vera, apple cider, cinnamon, coconut water, honey, leaf cutting, multiplication, Zamioculcas zamiifolia*

INTRODUCTION

Zamioculcas zamiifolia, known by several common names such as African cootie, aroid palm, arum fern, cardboard palm, emerald frond, and ZZ plant, is a stemless tropical herbaceous perennial native to submountain and lowlands forests of eastern Africa (Chen *et al.*, 2002). It was discovered in the year 1905 (Mayo *et al.*, 1998) and the only species belonging to the genus *Zamioculcas* (Chen *et al.*, 2005). *Zamioculcas* has thick, fleshy petioles supporting attractive dark green and glossy alternate pinnate leaflets. Petioles arise from succulent rhizomes that can range from 0.4 to 10 cm in diameter. Mature plants can form a short yellow-brown flowering spadix at the base of the plant, but inflorescences do not have ornamental value. The roots of ZZ are rich in steroid, triterpenoid, flavonoid, and polyphenolic. The extract is also a source of antioxidants and the juice is used to treat ear-ache by Malawian people meanwhile the roots are used for treating gastric problems by Sukuma people in Tanzania. The locals also use the entire plant to treat the inflammatory condition–*Mshipa*. The leaves of the plants are also used by the shamans in the jungles of Ghana to cure stomach ailments (Rini *et al.*, 2018).The potential for *Zamioculcas* to become a popular foliage plant exists because it has naturally dark green glossy foliage, limited disease, insect pests, and it performs well in low light and dry conditions also improves air quality which helps enhance cognitive function (Lopez *et al.*, 2009). However, the ZZ plant grows

very slowly. Starting with leaflet cutting, it takes a year or more to reach a saleable size.

ZZ plants can be propagated asexually by rhizome division, leaflet cutting, and petiole cutting. To propagate from a leaflet cutting, an individual leaflet is directly inserted into rooting medium or large leaflets may be cut horizontally in half to two pieces to increase the number of propagules and propagated by sticking the basal cut end into the rooting media. The main objectives of study were to see the effect of natural rooting substances on rooting, rhizome, and shoot growth of *Zamioculcus zamiifolia* cultivars. Natural root promoting substances are cheap and safe to use as an alternative for rooting of horticultural crops. They are environment friendly and can be used as a substitute for synthetic plant growth hormones like IBA (Sherif *et al.*, 2017).

Natural rooting substances can be utilised for the propagation of hardwood and softwood cuttings of horticultural crops. They are sustainable, cost effective, and environment-friendly and improve crop growth and quality. They increase sustainability of the soil and make it more productive. Synthetic growth regulators have restrictions in some countries including European Union. In this regard, the use of natural rooting hormones is highly significant in propagation of horticultural crops (Pacholczak *et al.,* 2016). Hence there is a need of utilizing alternative hormone for the propagation of cuttings.

MATERIALS AND METHODS

The field experiment was conducted at the Horticulture Farm, SASRD, Medziphema, Nagaland. The institution is located at 25°45'43" N latitude and 93°53'04" E longitude at an elevation of 305 m above mean sea level. Medziphema falls under sub-tropical region with humid and moderate temperature having medium to high rainfall. The temperature varies from 31-7°C during winter to 34-13°C during summer and average maximum RH of 79-92% and minimum of 38-64%. The annual rainfall of experimental site was ranges from 200 cm to 300 cm. The experiment was laid out in completely randomized design (factorial) with three replications and two factors. Treatment consists of (i) Two cultivars (C) of zz plant; C_1- ZZ Super Nova and C_2- ZZ Raven, and different natural rooting substances *viz*., Control (T_0), Honey (T_1), Cinnamon powder (T_2), *Aloe vera* gel (T_3), Apple cider (T_4) and Coconut water (T_5). Healthy mother plant of ZZ cultivars, Super Nova and Black Raven were procured from a reliable commercial nursery named as 'Zapzeer Nursery' in Assam. The Super Nova ZZ plant is a cultivar that is a very well-known house plant, not only for its attractive, exotic looking foliage but for being borderline indestructible. The ZZ (Black Raven) first appeared in a South Korean nursery in 2006. Hyuk Jin Lee, a nursery owner, and ZZ plant grower noticed when one of his plants sent out a single dark-colored branch this mutation appeared naturally and when propagated, the same characteristics carried over to next generations. The Black Raven plants are slow-growing plant, which can grow up to 2-3 feet tall. ZZ leaf cuttings were taken from a healthy mother plant having matured shoot, dense leaf growth and glossy look. Healthy and matured leaves were cut with the petiole from the mother plant with the help of sharp Blade. Transparent plastic disposal cup of 60 ml was used for planting/ propagation of leaf cuttings. Coarse river bed sand, being sterile was used as rooting medium. The rooting media were moistened with water and leaf cuttings were inserted into the media in upright position, leaving most of the leaf exposed and pressed firmly to the media. After that, the planted cuttings were kept under a poly house for further growth of rhizome and root. The potting mixture was prepared by mixing top soil, sand and Farm Yard Manure in the ratio of 1:1:1, after removing all the grasses and foreign materials. Thereafter, the rooted cuttings were transplanted to the polybag from disposal cup with the potting mixture filled in a poly bag of 4 ×6 inch in size. Then the rooted leaves with rhizome were transplanted in the field after 75 days of planting in polybags. Proper care was taken during transplanting to avoid injury to the root.

The length of the root growth was calculated by the following formula and represented in percentage:

$$\text{Growth rate} = (L_t - L_0)/L_t \times 100$$

L_t= length at the end of time, L_0= initial root length

The survivability percentage of the leaf cutting for both the cultivars (Black Raven and Super Nova) was calculated by the following formulae and expressed in percentage.

Plant survival rate (%) = Number of remaining plant/numbers of plant originally×100

Mean data obtained during the period of investigation were statically analyzed by the analysis of variance method (Gomez and Gomez, 1984). The significance of the different source of variance were tested by error mean square, using Fisher Snedecor 'F' test of probability at 0.5% level of significance.

RESULTS AND DISCUSSION

Days to rhizome initiation

The results pertaining days to rhizome initiation of ZZ (*Zamioculcas zamiifolia)* leaf cutting are presented in (Table 1, Fig. 1A.). It was observed that the days to rhizome initiation varied significantly in both the cultivars, where C_1 (Super Nova) took minimum days (45.54) to rhizome initiation, while rhizome initiation in C_2 (Black Raven) was observed after 56.28 days of planting the leaf cuttings. The difference in days to rhizome initiation may be attributed to several factors including genetic factor as well as the interaction of the varieties with the climatic condition. The present findings are in conformity with the results of (Benedetto *et al.,* 2020) who stated that the difference among the cultivars is a varietal trait and is probably governed by genetic makeup. Further, analysis of the data showed that there was a significant variation among the natural rooting substances with respect to days to rhizome initiation as shown in (Table 1). It was found that ZZ leaf cuttings treated with T_5 (coconut water) initiates rhizome formation earlier (46.50 days), which was at par (47.97 days) with T_1 (honey). The maximum number of days (55.80) to rhizome initiation was noted in control. The present results are in agreement with the findings of Davies, (2004) who noted that coconut water contains auxins and gibberellins and stimulate the cambial activity, thereby causes formation of large xylem and phloem. Similarly, Agele *et al.* (2010) stated that coconut water promotes root formation and shoot emergence in stem cuttings of various species. The interactions between cultivars and natural rooting substances failed to evoke any significant effect on days to rhizome formation.

Days to root initiation on rhizome

The analysis of the data on days to root initiation varied significantly in the studied cultivars, represented in (Table 1, Fig. 1B.). The minimum number of days (52.09) to root initiation was recorded in C_1 (Super Nova), while C_2 (Black Raven) took the maximum days (60.47) to root initiation. The variation may be due to genetic makeup of the individual cultivars. The spongy mesophyll cell of black leaves receives lesser light than those of green leaves of *O. planiscapus* 'Nigrescens' which might have attributed to slow down the growth rate. Further critical examination of the results presented in (Table 1) showed a significant difference among the natural rooting substances. ZZ leaf cutting dipped in T_5 (coconut water) took minimum days (50.73) to root initiation followed by T_1 (honey) and T_4 (apple cider) which took 53.17 days and 51.77 days respectively to initiate root. While the maximum number of days (61.17) to root initiation was noted in T_0 (control). The present result corroborates with the finding (Hartmann and Kester, 2007) who opined that coconut water enhances the hydrolysis and translocation of carbohydrates resulting in root initiation and a greater number of roots per cuttings. Similarly, (Ibironke, 2016) also stated that bougainvillea, cuttings treated with coconut water showed significant effect on root emergence and root growth. Honey is a natural source of vitamins such as vitamin A and vitamin B_1, which might have attributed to the initiation of rooting in cuttings. The interactions between cultivars and natural rooting substances were found to cause an appreciable impact on days to root initiation. The minimum days to root initiation (46.20) was recorded in C_1T_5 while C_2T_0 took the maximum days (65.07) to root initiation.

Fig. 1:
A. Rhizome initiation **B. Root initiation** **C. Number of roots**

Table 1: Effect of natural rooting substances on days to rhizome initiation, root initiation onrhizome, emergence of shoot bud, shoot length at 45 days afteremergence and survivability of *ZZ* cultivar leaf cuttings

Treatments	Days to Rhizome initiation	Days to Root initiation on rhizome	Emergence of shoot bud (Days)	Shoot length at 45 days after emergence	Survivability (%)
C_1	45.54	52.09	182.76	2.26	100%
C_2	56.28	60.47	194.13	2.31	100%
SEm(±)	**0.23**	**0.18**	**1.10**	**0.02**	
CD	**0.67**	**0.53**	**3.20**	**0.06**	
T_0	55.80	61.17	196.00	1.54	100%
T_1	47.97	53.17	180.27	2.96	100%
T_2	53.97	59.30	192.60	1.60	100%
T_3	50.53	57.53	188.90	1.91	100%
T_4	50.70	55.77	190.70	2.63	100%
T_5	46.50	50.73	182.20	3.09	100%
SEm(±)	**0.33**	**0.26**	**1.55**	**0.03**	
CD	**0.95**	**0.75**	**4.53**	**0.08**	
Interaction (CxT)					
C_1T_0	50.13	65.07	189.87	1.55	100%
C_1T_1	42.67	57.60	174.13	2.90	100%
C_1T_2	49.27	63.53	187.27	1.68	100%
C_1T_3	45.20	62.07	183.33	1.75	100%
C_1T_4	45.00	59.27	184.67	2.70	100%
C_1T_5	41.00	55.27	177.27	3.01	100%
C_2T_0	61.47	57.27	202.13	1.54	100%
C_2T_1	53.27	48.73	186.40	3.01	100%
C_2T_2	58.67	55.07	197.93	1.51	100%
C_2T_3	55.87	53.00	194.47	2.07	100%
C_2T_4	55.50	52.27	196.73	2.55	100%
C_2T_5	52.00	46.20	187.13	3.18	100%
SEm(±)	**0.56**	**0.44**	**2.69**	**0.05**	
CD	**NS**	**1.29**	**NS**	**0.14**	

C= Cultivars, T= Natural rooting substances

Table 2: Effect of natural rooting substances on rhizome size (cm), root length, number of roots and rate of root growth of *ZZ* cultivar leaf cuttings

Treatments	Diameter of rhizome (cm)			Length of primary root (cm)		No. of root sper cutting		Rate of root growth (%)	
	90DAC	120 DAC	150 DAC	75DAP	150 DAP	75DAP	150DAP	75DAP	150DAP
C_1	0.93	2.10	2.49	1.88	3.65	4.46	8.04	71.76	86.55
C_2	0.82	1.52	1.76	1.83	2.82	4.36	7.15	70.43	82.55
SEm(±)	**0.02**	**0.07**	**0.06**	**0.10**	**0.17**	**0.18**	**0.23**	**1.50**	**0.72**
CD	**NS**	**0.19**	**0.16**	**0.29**	**0.51**	**0.52**	**0.67**	**4.39**	**2.10**
T_0	0.76	1.42	1.80	1.23	2.56	3.17	6.33	59.22	80.24
T_1	0.91	2.03	2.34	2.11	3.99	5.10	8.53	76.16	86.92
T_2	0.84	1.65	1.93	1.62	2.94	3.91	6.82	67.73	82.33
T_3	0.81	1.76	2.00	1.82	3.18	4.43	7.00	71.40	83.94
T_4	0.89	1.91	2.22	1.91	3.48	4.50	8.17	73.49	84.42
T_5	1.05	2.10	2.46	2.45	4.93	5.33	8.73	78.59	89.44
SEm(±)	**0.32**	**0.25**	**0.25**	**0.14**	**0.25**	**0.25**	**0.32**	**2.13**	**1.02**
CD	**0.94**	**0.73**	**0.72**	**0.41**	**0.72**	**0.73**	**0.94**	**6.21**	**2.97**
Interaction (CxT)									
C_1T_0	0.83	1.61	2.19	1.21	2.81	2.87	6.60	58.67	82.18
C_1T_1	0.97	2.35	2.69	2.15	4.45	5.40	9.27	76.57	87.96
C_1T_2	0.91	1.98	2.32	1.82	3.34	3.96	7.00	71.63	84.79
C_1T_3	0.87	2.09	2.33	1.88	3.59	4.47	7.00	73.92	85.91
C_1T_4	0.97	2.11	2.51	1.82	4.05	4.47	8.93	72.17	87.14
C_1T_5	1.02	2.46	2.89	2.41	5.80	5.60	9.47	77.60	91.29
C_2T_0	0.69	1.23	1.41	1.24	2.31	3.47	6.07	59.77	78.30
C_2T_1	0.85	1.70	1.98	2.07	3.54	4.80	7.80	75.75	85.87
C_2T_2	0.77	1.98	1.53	1.45	2.55	3.87	6.63	63.83	79.87
C_2T_3	0.75	1.42	1.66	1.72	2.78	4.40	7.00	68.88	81.96
C_2T_4	0.81	2.11	1.94	1.99	2.92	4.53	7.40	74.80	81.70
C_2T_5	1.07	1.73	2.04	2.49	4.05	5.07	8.00	79.57	87.60
SEm (±)	**0.06**	**0.16**	**0.14**	**0.24**	**0.42**	**0.43**	**0.56**	**3.68**	**1.76**
CD	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

DAC= days after cutting, DAP= days after planting

Days to emergence of shoot bud

The data on days to emergence of shoot bud are depicted in Table 1. The result showed a significant difference between cultivar. The minimum days (182.76) to shoot bud emergence was noted in C_1 (Super Nova), while C_2 (Black Raven) took maximum days of 194.13 for shoot bud emergence. The variation in shoot bud emergence might be due to the genetic makeup of the cultivars. Apparently, the variation in vegetative characters was attributed to genetics factor whose performance will be varied over a wide range of environmental conditions (Srilatha *et al.,* 2015). Further, perusal of the data showed a significant influence on shoot bud emergence among the different natural rooting substances, perented in Tables 1. The earliest shoot bud initiation (182.20 days) was noticed in T_5 (coconut water), which was at par (180.27 days) with T_1 (honey), while the slowest shoot bud initiation (196 days) was recorded from T_0 (control) treatment. Coconut water contains urea diphenyl which has activities of cytokinins thereby increases growth and differentiation of cells affecting cell division leading to better shoot growth. The increase in rate of shoot initiation may also be due to auxin effect on the cell wall, turgor and osmotic pressure and water permeability which causes cell enlargement resulting in enhanced vegetative

growth (Taiz and Zeiger, 2006). Prathibha *et al.* (2018) reported that in *Zamioculcas zamiifolia*, enhanced shoot initiation and shoot growth was observed in cuttings treated with cytokinin and NAA and even multiple shoot formation was observed. The interaction effect between cultivars and natural rooting substances on shoot bud emergence was found to be non-significant.

Shoot length at 45 days after emergence

The data regarding shoot length at 45 days after emergence are shown in (Table 1). It is evident from the result that the cultivar had significant impact on the shoot length. It was observed that C_1 (Super Nova) recorded the maximum shoot length (2.31 cm), while C_2 (Black Raven) recorded the minimum shoot length (2.26 cm) at 45 days after emergence. Differences in growth may be due to nature of cultivars, changes in any phenotypic character like color, shape or size of flower and chlorophyll variegation in leaves which can impact the character of plant (Datta *et al.,* 2006). Further, examination the data showed that different natural rooting substances evoked a significant difference on shoot length at 45 days of emergence, presented in (Table 1). The maximum shoot length (3.09 cm) was recorded in cuttings treated with T_5 (coconut water), which was at par (2.96 cm) with T_1 (honey), while the least shoot length (1.54 cm) was observed in T_0 (control) at 45 days after emergence. The best result was observed in cuttings treated with coconut water, which may be due to increased number of roots which probably drive more nutrients and water from the soil and enhanced photosynthesis which ultimately resulted in more growth (Singh and Singh, 2005). Moreover, coconut water contains urea diphenyl which has activities of cytokinins thereby increases growth and differentiation of cells affecting cell division leading to longer shoot. The increase in shoot length may also be due to auxin effect on the cell wall, turgor and osmotic pressure and water permeability which causes cell enlargement resulting in enhanced vegetative growth (Taiz and Zeiger, 2006). Comparable finding was observed by (Ogunsiji *et al.,* 2022) in *Ceiba petandra* L., cuttings. The interactions between the cultivars and different natural rooting substances were found to cause an appreciable impact on the shoot length after 45 days of emergence. The highest shoot length (3.18 cm) was observed in C_1T_5 and least shoot length (1.51cm) was recorded in C_2T_2.

Survivability percentage

All the cuttings displayed 100 % survivability, represented in (Table 1). The growth of adventitious roots and rhizome of ZZ plant leaflet cutting during propagation is largely determine by the carbohydrates reserve in the source and the photosynthesic capacity of the cuttings after root emergence.

Diameter of rhizome

Thorough scanning of the data pertaining to the effect of cultivars on the diameter of rhizome at 90, 120 and 150 days after planting presented in Table 2, it was apparent that the cultivars did not have any significant response on growth of rhizome at 90 days after planting. However, a significant effect was noted at 120 and 150 days after cutting. Out of the two cultivar, C_1 (Super Nova) recorded the maximum diameter (2.10 and 2.49 cm) of rhizome while C_2 (Black Raven) exhibited the least (1.52 and 1.76 cm) diameter at 120 and 150 DAP, respectively. Benedetto *et al.* (2020) opined that significant difference in growth rate among clones is known to occur and the difference tends to increase during plant development. Further analysis of data showed that the natural rooting substance had significant impact on the rhizome growth, presented in Table 2. However, it was observed that the cutting dipped in T_5 (coconut water) induced larger rhizome diameter size (1.05, 2.10 and 2.46 cm) at 90, 120 and 150 DAP, which was at par with T_1 (honey), which recorded 0.91, 2.03 and 2.34 cm at 90, 120 and 150 DAP, respectively. The maximum rhizome size on all dates of observation was observed with coconut water treated leaf cutting which might be due to maximum number of roots which probably drive more nutrients and water from the medium which ultimately resulted in more growth (Singh and Singh, 2005) of rhizome. Moreover, coconut water contains urea diphenyl which has activities of cytokinins thereby increases growth and differentiation of cells affecting cell division (Taiz and Zeiger, 2006).The

interaction effect between cultivars and natural rooting substances on the rhizome size was found to be non-significant.

Length of primary root

It was evident from the data given in Table 2 that there was a significant variation in the length of primary root between the cultivars. The root length was maximum (1.88 and 3.65 cm) in C_1 (Super Nova), while C_2 (Black Raven) recorded the minimum root length (1.83 and 2.82 cm) at 75 and 150 days after planting respectively. Cultivars difference may be due to nature of cultivar, changes in any phenotypic character like color, shape or size of flower and chlorophyll variegation in leaves can impact the character of plant (Datta *et al.,* 2006). Further examination of the data revealed that the maximum root length was observed in leaf cuttings treated with T_5 (coconut water) with (2.45 and 4.93 cm), which was at par (2.11 and 3.99 cm) with T_1 (honey) at 75 and 150 DAP respectively whereas the minimum primary root length (1.23 and 2.56 cm) was recorded in T_0 (control) at 75 and 150 DAP, respectively, presented in Table 2. The increase length of root treated with coconut water may be due to the presence of auxins and cytokinins in coconut water which stimulates the formation of masses of undifferentiated cells (callus) and also increased the carbohydrate metabolism and metabolite translocation (Karunarathna and Kumuthini, 2016). The present findings are in line with the result of Richard (2015) who reported that in *Rhizospora stylosa,* highest root length was observed in samples treated with coconut water. The interactions between cultivars and natural rooting substances failed to reach the level of significant effect on the length of primary root at 75 and 150 days after planting, respectively.

Number of roots per cutting

The data pertaining to number of roots per leaf cutting at 75 and 150 DAP as influenced by cultivars are presented in Table 2, Fig. 1 C. The number of roots per cutting was found to be maximum (4.46 and 8.04) in C_1 (Super Nova), while the least number of roots (4.36 and 7.15) was observed in C_2 (Black Raven) at 75 and 150 days after planting, respectively. The variation in number of roots might be due to the genetic makeup of the cultivars. Apparently, the variation in growth characters was attributed to genetic factor whose performance will be varied over a wide range of environmental conditions (Srilatha *et al.,* 2015). Further, scanning of the data showed a significant influence on number of roots among the natural rooting substances. The maximum number of roots (5.33 and 8.73) per cuttings was recorded in T_5 (coconut water), which was found to be at par (5.10 and 8.53) with T_1 (honey) at 75 and 150 DAP respectively whereas the minimum number of roots (3.17 and 6.33) per cuttings was recorded in T_0 (control) at 75 and 150 DAP respectively, depicted in (Table 2). Coconut water contains auxins and gibberellins which stimulates the cambial activity and leads to formation of larger xylem and phloem which influence formation and growth of roots, (Davies, 2004). Comparable results were observed by Bamigboye *et al.* (2016) who reported that in *Dioscoreophyllum cumminssi* and Serendipity Berry plant sample treated with coconut water showed highest number of roots. Abo *et a.,* (2018) reported that besides growth regulators and hormones, another main criterion affecting rooting phenomenon is sucrose which is in high concentration in honey. The interactions between cultivars and natural rooting substances did not show any significant effect with respect to number of roots per cutting on both days of observation.

Rate of root growth

It was evident from the data Table 2, that the cultivars had a profound effect on the rate of root growth. The rate of root growth was maximum (71.76% and 86.55%) in C_1 (Super Nova) while C_2 (Black Raven) recorded minimum root growth (70.43% and 82.55%) at 75, 150 days after planting (DAP) respectively. Cultivars difference may be due to nature of cultivar, changes in any phenotypic character like color, shape or size of flower and chlorophyll variegation in leaves can impact the character of plant (Datta *et al.,* 2006). Further examination of the data showed a significant effect on the rate of root growth among the different rooting substances. The highest rate of root growth (78.59% and 89.44%) was observed in cuttings treated with T_5 (coconut water), followed by T_1

(honey), exhibiting a root growth percentage of 76.16 and 86.92% respectively at 75 and 150 DAP. The minimum rate of root growth (59.22% and 80.24%) was recorded in T_0 (control) treatment at 75 and 150 DAP, presented in (Table 2). Coconut water contains auxins and gibberellins which together stimulates the cambial activity, causing formation of larger xylem and phloem, (Davies, 2004). Comparable results were reported by Richard (2015) in *Rhizospora stylosa*, where the highest root length was observed in samples treated with coconut. Karunarathna and Kumuthini (2016) also reported that cuttings of Ixora treated with coconut water recorded highest root length. The interaction effect between cultivars and different natural rooting substances on the rate of root growth rhizome size was found to be non-significant on both days of observation.

CONCLUSION

Out of both cultivars, it can be inferred from the present research work that the leaf cutting of ZZ cv. Super Nova grows much faster than ZZ cv. Black Raven for all parameters from rhizome initiation, root initiation, root length, rhizome size, shoot emergence, shoot length, root growth and root number even when given with same soil and climatic condition. In case of natural rooting substances used in the experiment, coconut water was considered to be the best in respect of rhizome initiation and root and shoot growth.

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