RESPONSE OF COFFEE (*Coffea robusta* L.) STEM CUTTINGS TO VARYING LEVELS AND DIPPING TIMES OF SEAWEED CONCENTRATE UNDER MODIFIED CONDITION

[1]Eric Randy R. Politud* and [1]Leslie Gwen A. Augusto

Abstract

Mass production of coffee stem cuttings could be enhanced using rooting hormones. This study was conducted to determine the response of coffee stem cuttings to levels and dipping times of seaweed concentrate under modified condition. Conducted at the Horticulture Nursery of MOSCAT in Claveria, Misamis Oriental, the study was laid-out in a 4 x 4 factorial arrangement in Completely Randomized Design (CRD) and replicated 3 times. Stem cuttings dipped in 0.5 tbsp/1 liter H_2O produced the first shoot, dipped at 1.5 tbsp/1 liter H_2O with longest root (1.95cm), 2 tbsp/ liter H_2O with 2.17 roots and 1.24 shoots, dipped in 0.5 tbsp/liter H_2O with 2.42 leaves and 1.5 tbsp/liter H_2O produced (0.83 shoot). Stem cuttings dipped at 5 minutes produced first shoot and longest root, most number of roots and leaves. Those dipped at 25 minutes produced the longest shoot and dipped in 35 minutes produced the most number of shoots. No significant interaction effects were found between the 2 factors except for the longest shoot. The best combination was on the interaction between 2 tbsp/liter H_20 and 25 minutes, producing the longest shoot (1.53). The least was obtained between 0.5tbsp/li H_20 with 5 minutes and 1.5tbsp/Li H_20 with 25 minutes (0.80 shoot). Thus, dipping the coffee stem cuttings between 1.5 to 2 tbsp seaweed concentrate / liter H_20 for 5, 25 and 35 minutes had the best growth performances of the cuttings.

Key words: coffee stem cuttings, dipping time, interaction effect, levels of seaweed concentrate, modified condition

*Corresponding Author: Eric Randy R. Politud, erpolitud@yahoo.com

1.0 Introduction

Coffee (*Coffea robusta*) is a shrub that requires tropical and subtropical conditions to grow. While this plant is native to Africa and Asia, it may be grown indoors or outdoors. The coffee shrub may be grown from seeds; however, it may take four years before its fruit to be established. Coffee may also be grown from stem cuttings as long as the cuttings are propagated and specific steps are taken (Manila Bulletin, 2005).

Coffea robusta and *C. canephara*, known locally as 'kapeng' Robusta is more popular variety among growers and it is widely cultivated in the highland of Cavite. The robusta plant is characterized by a large umbrella – shaped growth. The leaves are thinner and have more wavy margins than excelsa coffee leaves but are thicker, bigger and have less wavy margins than the leaves of Arabica. Its leaf axil flowers only once. Unlike other varieties, it may flower every year or every other year. The berries are borne in heavy clusters, smaller than the arabica but the pulp and parchment are almost thin. Coffee can also be propagated asexually. Cloning the coffee propagation is a part of a plant that is made to reproduce an offspring which carries all the qualities of its parents (Abellanosa and Pava, 1991; www.trendsandspot.com/tag/health-benefits-of-coffee/).

According to Fernandez (1993), vegetative propagation using plant cuttings applies to many crops. This method allows the production of clones or plants which are considered "duplicates" of the parent plants genotypically, and usually also phenotypically. Just like other vegetative propagation methods, it is advantageous where a plant does not produce seeds. The seeds are sterile, or whenever seeds are not available. The use of clonal chamber where cuttings are propagated can enhance their rooting formation.

According to Ruck (2006), applying seaweed concentrate into the vegetative and reproductive growth as a foliar spray or a root drench at transplanting, improved both the vegetative and reproductive growth of marigolds. Particular significance is that the overall production of seeds (fruits) was increased by as much as 50% in some instances. Very low concentrations of seaweed concentrate were not always effective, while the higher dosages decreased vegetative growth.

Seaweed concentrate is a unique natural organic concentrate manufactured from freshly harvested seaweed, *Ecklonia maxima*, through exposure to heat or dehydration. This cell burst technique ensures that the delicate growth regulators are released in their natural active form. Seaweeds are a natural, biologically balanced plant growth stimulant. It contains auxins at 11.3 mg/L and cytokines, which are plant growth regulators. It improves rooting system and uptake of soil nutrients and fertilizers strengthens overall plant growth producing healthier crops with less disease problems and greatly improving crop yield. Overall crop performance is improved due to their effect on the plant growth, protein and carbohydrate production, prolonged chlorophyll production and photosynthesis (ZAGRO Corporation, 2009).

In the locality of Claveria, coffee production is known to farmers and its climatic condition is suitable for coffee production, however, shortage of planting materials has always been experienced by these farmers. Introducing this seaweed concentrate as natural and unique rooting hormone is another consideration to hopefully help answer the need of shortage.

Thus, this study aimed to determine the response of

[1]Misamis Oriental State College of Agriculture and Technology

coffee stem cuttings to varying levels and dipping times of seaweed concentrate under modified condition.

.

2.0 Research Methodology

This study was conducted at the Horticulture Laboratory area of the Misamis Oriental State College of Agriculture and Technology (MOSCAT), Claveria, Misamis Oriental, Philippines from November 2011 to January 2012. The materials used in this study were: 144 stem cuttings (lateral) of coffee, seaweeds concentrate, tap water, 144 pcs. of empty disposable cups, ruler, pencil, covers cellophane, sand/gravel, tablespoon, beaker, woods/nails, watch, bamboo, hand sprayer, container, pruning-sheer and thumb tacks.

This study was conducted using a 4 x 4 factorial arrangement in Completely Randomized Design (CRD) with three (3) replications and three (3) samples of cuttings per combination. Factor A was the application level of seaweeds concentrate and Factor B was the dipping times.

One (1) cutting was planted in each disposable cup. These 3 cups were comprised 1 group of treatment combinations with an alleyway distance of 7.62 cm. The width of the set-up is 228.6 cm (2.4384 sq m) and the length with 127cm (1.2192 sq m). The total area was 355.6 cm (3.6576 sq m).

Selection and Cutting. One hundred forty four (144) coffee stem cuttings having two nodes from the sized lateral shoots were prepared and selected. One leaf on the stem was removed. The second leaf was cut halfway.

Preparation for the Germination Box and the Containers. The boxes were made for the planting containers. The stem cuttings were placed in disposable cups and the sand was mixed with gravel thoroughly. Holes in the center bottom of the cup were made so that water cannot be stacked-up in the cup. The disposable cups with the sand/gravel were poured with watered to avoid drying. The tablespoon, container, plastic cover, seaweed concentrate were prepared for the liquid media.

Preparation of Liquid Media. All the liquid media formulated for all the treatments used were also prepared. Seaweed concentrates were prepared according to different levels at 0.5tbsp, 1tbsp, 1.5tbsp and 2tbsp mixed with 1 liter H_2O. Stem cuttings were dipped on different durations of 5, 15, 25, and 35 minutes in each treatment combination.

Preparation for Planting and Modified Chamber. The lateral cuttings having 2 nodes were planted in the wooden boxes with moist sand. The planting distance between cuttings was 3 inches by 3 inches apart (7.62 cm). The whole set-up was covered with a tent made of plastic cellophane to seal in moisture.

Placement and Growth. The whole set-up was placed in a moderate shade. The covered cellophane was opened when watering was done, and removed as soon as cuttings began to root and grow.

Care and Maintenance. Watering was done regularly or as the needed. Cultivation of the growing media in each disposable cup was done to facilitate proper aeration of the cuttings.

Data Collection. A collection of all the data was done after 45 days.

Data Gathered. Among the data gathered in the study were: number of days to first shoots initiation, length of longest root, length of longest shoot, number of roots, the number of shoots produced, number of leaves produced.

Statistical Analysis. The Analysis of Variance (ANOVA) using 4 x 4 factorial arrangement in Completely Randomized Design (CRD) was used to solve for the level of significance. The Tukey Test was used to determine significant differences among treatment means.

3.0 Results and Discussion

Days to First Shoot Initiation. Table 1 shows the mean number of days to first shoot initiation of coffee stem cuttings in response to varying levels of seaweed concentrate and dipping times. Statistical analysis showed that there were no significant differences in the number of days to first shoot initiation regardless of varying levels of seaweed concentrate and dipping times. Likewise, no interaction effects were observed between the application levels and dipping times to seaweed concentrate.

It was observed, however, that among the levels of seaweed concentrate, stem cuttings applied with 0.5tbsp/liter H_2O produced shoot at 2.92 days, while those applied with 1.5 tbsp/liter H_2O lately produced shoot after 3.67 days. Cuttings dipped at 5 minutes produced shoot earlier time at 3 days after dipping. The best combination therefore, is 0.5tbsp/liter H_2O of seaweed concentrate and dipped the cuttings in 15 minutes.

According to Ruck (2006) that very low concentration of seaweed concentrates were not always effective, while higher dosages decrease vegetative growth. The modified condition of which the cuttings were exposed hastened the formation of shoots earlier because the heat build-up inside activates the cells to shoot formation (Hartman and Kester, 1997). With Factor A and B having no significant differences on the treatment means; both factors had no interaction effect as well. Dipping the cutting at varying levels of seaweed concentrate at varying dipping times had no bearing or effects on the number of days to first shoot initiation.

Length of Longest Root. The mean length of longest root produced was not influenced by both application levels of seaweed concentrate and varying dipping times. There was no interaction effect noted on both factors (Table 1). In Factor A, the longest root produced came from the application levels of 1.5tbsp/liter H_2O

Table 1. Mean number of days to first shoot initiation, longest root and number of roots of coffee stem cuttings in response to different levels and dipping times of seaweed concentrate.

Factors		No. of Days to First Shoot Initiation	Longest Root (cm)	Number of Roots
Levels of Seaweed Concentrate (A)	0.5 tbsp/liter H_2O	2.92	1.86	1.92
	1 tbsp/liter H_2O	3.58	1.79	2.08
	1.5 tbsp/liter H_2O	3.67	1.95	2.08
	2 tbsp/liter H_2O	3.58	1.44	2.17
Dipping Times (B)	5 minutes	3.00	2.02	2.83
	15 minutes	3.17	1.96	1.42
	25 minutes	3.92	1.42	1.67
	35 minutes	3.67	1.65	2.33
F-test	*A*	*ns*	*n.s*	*n.s*
	B	*ns*	*n.s*	*n.s*
	A x B	*ns*	*n.s*	*n.s*
c.v. (%)		*19.14*	*14.30*	*13.24*

n.s- non-significant

with 1.95cm, which differed from the rest of the levels exhibiting to more or less similar length of root produced from 1.86cm to 1.44cm. The application level of 2tbsp/liter H_2O produced the shortest roots with 1.44cm.

In Factor B, the cuttings dipped in 5 minutes with 2.02cm had the longest root, followed by those dipped in 15 minutes with 1.96cm and 35 minutes with 1.65cm. Those dipped in 25 minutes had the shortest root produced with 1.42cm. This might be due to ages of cutting which were not at the same maturity. Both factors had no significant effects in terms of the length of root produced.

Number of Roots. The number of roots produced by stem cuttings dipped at varying levels of seaweed concentrate at different dipping times is presented in Table 1. Regardless of the varying levels and dipping times, statistical analysis showed no significant differences among treatment means. No significant interaction effects were, likewise, observed between the two factors.

The number of roots was not affected by the levels of seaweed concentrate. However, result showed the most number of roots produced when cuttings were dipped in 1tbsp/liter H_2O and 1.5tbsp/liter H_2O of seaweed concentrate with 2.08, while the least was in 0.5tbsp/liter H2O with 1.92. For the dipping times, cuttings dipped in 5 minutes had the most number of roots with 2.83. The least was obtained by those cuttings dipped at a duration of 15 minutes with 1.42 roots produced.

Length of Longest Shoot. Table 2 reveals the mean length of longest shoot produced by the stem cuttings in response to varying levels of seaweed concentrate and dipping times. Statistical analysis showed no significant differences among treatment means observed in cuttings applied with varying levels of seaweed concentrate and as well as the dipping times. There were interaction effects observed between the two factors.

Regardless of the varying levels of seaweed concentrate, stem cuttings dipped in 2tbsp/liter H_2O obtained the longest shoot with 1.24cm, while the least was on cutting dipped in 0.5tbsp/liter H_2O with 1.03cm. For factor B, cuttings dipped in 25 minutes garnered the longest shoot with 1.22cm long, while the shorted shoot was obtained on cuttings dipped within 15 minutes with 1.02 cm long. However, combining the two factors

Table 2. Mean length of longest shoot (cm) of coffee stem cuttings in response to levels and dipping times of seaweed concentrate

Factor A (Levels of seaweed concentrate)	Factor B (*Dipping times*), (A x B)				
	5 minutes	15 minutes	25 minutes	35 minutes	^{ns}(A)
0.5 tbsp/liter H2O	0.80^{b}	0.90^{b}	1.30^{ab}	1.13^{ab}	1.03
1 tbsp/liter H2O	1.10^{ab}	1.07^{ab}	1.23^{ab}	1.03^{b}	1.11
1.5 tbsp/liter H2O	0.97^{b}	1.17^{ab}	0.80^{b}	1.40^{a}	1.08
2 tbsp/liter H2O	1.50^{a}	0.93^{b}	1.53^{a}	1.00^{b}	1.24
^{ns}(B)	1.09	1.02	1.22	1.14	

*Means of same column followed by common letters are not significantly different at 5% using Tukey Test. ^{ns}(A), ^{ns}(B), *(A x B), c.v. 8.56%*

revealed significant differences in their interaction effects. The two factors had a bearing on the length of shoots.

Among the best combinations were obtained by stem cuttings dipped in 2tbsp/liter H_2O of seaweed concentrate for 25 minutes which produced 1.53cm long, followed by those in 2tbsp/liter H_2O in 5 minutes with 1.5cm long. Such are not significantly different from each other. While among the lowest combinations were obtained by those dipped in 1.5tbsp/liter H_2O in 2 minutes with 0.8cm long, 0.5tbsp/liter H_2O in 15 minutes with 0.9cm and 1.5 tbsp/liter H_2O in 5 minutes with 0.97 cm long. They are, however, statistically different from those with the best combinations. This implies that treatment means of various combinations are statistically different from each other. Both factors showed significant effects on the formation of longest shoot produced by coffee stem cuttings.

Number of Leaves. Table 3 shows the mean number of leaves produced by coffee stem cuttings at varying levels of seaweed concentrate and dipping times. Statistical analysis showed no significant differences observed among treatment means, regardless of varying levels and dipping duration. No interaction effects were observed between the two factors.

It was, however, observed that coffee stem cuttings dipped at 0.5 tbsp/liter H_2O produced the most number of leaves at 2.42, while the least was obtained by those being dipped at 1tbsp and 1.5tbsp/liter H_2O with both 1.58. For the dipping times, cuttings dipped in 5 minutes showed the most number of leaves at 2.25 with the least on the cutting dipped in 35 minutes 1ith 1.67.Some leaves of the different treatment were not produced causing a high coefficient of variation at 120.49%.

Number of Shoots. The number of shoot produced was significantly affected by the application levels of seaweed concentrate but not with dipping times. However, no interaction effect was observed between the two factors (Table 3).The highest number of shoot produced was observed on the cuttings dipped in 1.5tbsp/liter H_2O with 0.83, and such were statistically different from those being dipped in 0.5tbsp/liter H_2O and 1 tbsp/ liter H_2O, while for the dipping times, cuttings dipped in 35 minutes obtained the most number of shoot with 0.92, while 0.75 shoot was produced from cuttings dipped at 5, 15 and 15 minutes. It was observed that the higher the levels of seaweed concentrate, the greater the change for shoot to produce more. Seaweed concentrate is a hormone that enhances shoot formation of stem cuttings (Zagro, 2005). Regardless of the levels of seaweed concentrate and dipping times which the cuttings were subjected to, still they have no bearing as to their interaction for the production of shoots.

4.0 Conclusion

Dipping coffee stem cuttings to concentration levels between 1.5 to 2 tbsp/L H_2O for 5, 25 and 35 minutes of seaweed concentrate would enhance formation of shoots and some other growth parameters of coffee stem cuttings.

Acknowledgement

The authors gratefully acknowledge the financial support of Ms. Gilda M. Echem of 1020 Apt A, 15th Ave., Northwest, Largo City, Florida, USA 33770 for this publication. Such support will always be cherished by the authors for the rest of their lives.

Table 3. Mean number of leaves and shoots produced in coffee stem cuttings in response to different levels and dipping times of seaweed concentrate

Factors		Number of Leaves	Number of Shoots
Levels of Seaweed Concentrate (A)	0.5 tbsp/liter H_2O	2.42	0.75[b]
	1 tbsp/liter H_2O	1.58	0.75[b]
	1.5 tbsp/liter H_2O	1.58	0.83[a]
	2 tbsp/liter H_2O	2.08	0.83[a]
Dipping Times (B)	5 minutes	2.25	0.75
	15 minutes	2.00	0.75
	25 minutes	1.75	0.75
	35 minutes	1.67	0.92
F-test	*A*	*n.s*	*
	B	*n.s*	*n.s*
	A x B	*n.s*	*n.s*
c.v. (%)		*20.49*	*3.46*

Means of same column followed by common letters are not significantly different at 5% using Tukey Test.
n.s - non-significant

References

Abellanosa, A.L. &. Pava, H. (1991). *An introduction to crop science.* Central Mindanao University, Musuan, Bukidnon, Philippines Publication Office. pp 71-87.

Fernandez, P.G. (ed.). (1993). *Recalcitrant seeds and intermediates.* Agroforestry Seeds Circular No. 3, 22-26.

Hartmann, H.T. & Kester, D. (1997). *Plant propagation:principles and practices.* New Jersey Partice- Hall, Inc., 211-313.

Manila Bulletin (2005). *Coffee is healthy*. Vol.386.

Ruck, K. (2006). "Can kelp extract (KELPAK) be useful in seaweed mariculture?". *Journal of Applied Phycology, 18 (3-5), 315–321.* doi:10.1007/s10811-006-9030-1.

Zagro Corporation (2010). *Sea weeed concentrate*. 108 Benavidiz St. Legaspi Village Makati City.

www.trendsandspot.com/tag/health-benefits-of-coffee