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VEGETATIVE PROPAGATION OF *Coffea arabica* L. USING SOFTWOOD CUTTINGS

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SUMMARY

The success of quickly capitalizing on and locking in hybrid vigor, improved flavor, and disease resistance in a coffee breeding program will depend on the ability to vegetatively propagate the identified hybrids. This study was conducted to find a simple and reliable method of vegetatively propagating coffee using softwood cuttings. The coffee cultivars, 'Catuai' and 'Typica' at the HARC Kunia Substation were stumped. Single node cuttings and shoot tips with two to three pairs of leaves were prepared from 2- to 3-month regrowth vertical shoots. The cuttings were dipped in commercial plant growth regulators for one second, inserted into media consisting of half perlite and half vermiculite, and placed under an intermittent fine misting system set at short intervals in the HARC Maunawili greenhouse. The system also had a bottom-heating mat set at 85°F. Plant growth regulators included DIP'N GROW [1.0% indole-3-butyric acid (IBA) and 0.5% 1-naphthalenacetic acid], Hormdin 3 (0.8% IBA), and Hormex 3 (0.3% IBA). The rooting percentage from these treatments averaged 28 percent, and varied from 0 to 100 percent. The best rooting percentage was obtained from untreated single node cuttings. The method was subsequently used to clone selected coffee trees from Hawaii coffee farms. The rooting percentage of four selected trees of 'Guatemalan' ('Typica') hybrid from Dole's Waialua Coffee farm averaged 83 percent and ranged from 68 to 98 percent.

INTRODUCTION

New F_1 hybrids and heterozygous genotypes of *Coffea arabica* L. with disease resistance, high yield, and good cupping quality characteristics require vegetative propagation to perpetuate their genetic makeup and to establish uniform plantings.

Several vegetative propagation methods, including grafting, budding, girdling, layering, rooting of hard and softwood cuttings, and tissue culture (Wellman, 1961; Nagai and Mai, 1996) have been tested and employed for *Coffea* species in many coffee growing countries. Some methods, such as grafting, budding, and tissue culture, need skilled persons to follow the procedures, while others, such as rooting of softwood cuttings, can be mastered easily with little training. Percentage of success in rooting cuttings varied from 0 to 90 percent and the time required from two to more than six months. Owing to uncontrolled experimental conditions, these results were inconsistent. More recently, the highest rooting success of Ruiru 11

(*C. arabica*) cuttings was 50 percent with combinations of different cutting materials, media, and plant growth regulators (Wamatu and King'oro, 1992). Ruiru 11 is a widely planted coffee hybrid variety in Kenya because it is resistant to coffee leaf rust (*Hemileia vastatrix*) and coffee berry disease (*Colletotrichum coffeanum*) and is high yielding.

Our objectives are to establish a simple and reliable vegetative propagation method using softwood cuttings, to facilitate the Hawaii coffee breeding program, and to explore the feasibility of commercial planting using vegetatively propagated seedlings.

MATERIALS AND METHODS

Two major coffee varieties grown in Hawaii, 'Catuai' (Red and Yellow) and 'Guatemalan' ('Typica'), were used for the experiment. The 'Catuai' cultivars are intraspecific hybrid progeny selections from the cross between 'Mundo Novo' and 'Caturra'. The method of rooting softwood coffee cuttings followed the techniques developed for *Leucaena* hybrids at HARC and the University of Hawaii at Manoa (Sun et al., 1998).

Eleven-year-old trees at the HARC Kunia Substation were stumped to 2-ft in height in May 1997. After two to three months regrowth, new vertical growth shoots from 12- to 20-inches in length were collected and cuttings were prepared at the HARC Maunawili Experiment Station. The third, fourth, fifth single node cuttings (from the shoot tip), and shoots with two to three pairs of leaves were used. Each single node cutting included one node with a trimmed pair of leaves. The two end cuts were right above the nodes. Lateral shoots (plagiotrophic) of the shoot cuttings and single node cuttings were also trimmed. The lower two pairs of leaves of the shoot cuttings were also cut in half. The cuttings were dipped in plant growth regulators for one second, then immediately placed into media (1 part vermiculite: 1 part perlite). Black plastic seedling trays with 72 holes were used to hold the cuttings. After trays with cuttings were placed on the bench under mist, the cuttings and media were drenched with fungicide solution (Dithane M45 1.5%, ROHM and HAAS Company).

A misting bench with heating mats (Olson Products Inc., Ohio, USA) set up to 85° F at the bottom, was used to facilitate rooting of the cuttings. Misting was set at 5-seconds, with 8-minute intervals during the day, and 12-minute intervals during the night. Atomizing nozzles with fine droplets were used for misting. In order to keep the rooting benches clean during rooting period, fallen leaves and rotten cuttings were taken away regularly and fungicide (Dithane M45 1.5%) was applied every two to three weeks.

The experiment was established with a total of 279 cuttings of shoot tips and single nodes from 'Catuai' and 'Guatemalan' ('Typica') varieties on 4 August 1997. Three plant regulators, DIP'N GROW (1% Indole-3-butyric acid [IBA] and 0.5% 1-Naphthalenetic acid, Astoria-Pacific, Inc.), Hormdin 3 (0.8% IBA, MSD-AGVET of Merck & Co., Inc.) and Hormex 3 (0.3% IBA, Brooker Chemical) were used for the experiment.

After 2.5 months, the cuttings were checked for rooting and the rooted cuttings were transplanted into pots and kept under mist for one month. The potted cuttings were then moved to outside nursery benches for hardening. After 1.5 months of hardening, the plants were ready for field transplanting. The mean monthly temperature in the HARC Maunawili Experiment Station greenhouse ranged from 72-75°F, day length ranged from 11- to 13-hours, and the mean monthly solar radiation ranged from 150 to 250 cal m^{-2} day^{-1}.

RESULTS AND DISCUSSION

The cuttings initiated new shoots (or buds) within two to three weeks. At 1.5 months after planting, the cuttings started developing root systems. Rooting percentages from the experiment are presented in Table 1. The best rooting result was 100 percent and 59 percent from single node cuttings of 'Guatemalan' ('Typica') and 'Catuai', respectively. Overall, the single node cuttings had a higher rooting percentage than shoot tips with two to three pairs of leaves. The treatments with plant growth regulators did not improve rooting percentage of coffee cuttings, which is in accordance with the earlier findings (Singh-Dhaliwal and Torres-Sepulveda, 1961; Valicek and Wahaishi, 1988).

This method was subsequently used to clone the selected coffee trees from Hawaii coffee farms. Without plant growth regulator treatment, the rooting percentage of four selected trees of 'Guatemalan' ('Typica') hybrid from Dole's Waialua Coffee farm averaged 83 percent and ranged from 68 to 98 percent (Fig. 1).

The rooted cuttings were planted in the field at HARC Maunawili Substation in March 1998. We have not seen any disadvantages of growth from cuttings, compared with plants propagated from seed. However, as expected, plagiotrophic growth and early flowering occurred in all rooted cuttings prepared from lateral shoots. Dominant growth of extra-axillary (lateral) bud shoots from the vertical shoot cuttings was observed. These problems can be corrected by using cuttings only from vertical shoots and by spraying coffee propagation hedges for cuttings with chlorflurenol-methylester to induce vertical shoots (Stemmer et al., 1982).

The cloning technique developed in this study is simple and reliable. It has been successfully employed to vegetatively propagate individual selected trees from Hawaii coffee farms. The method can be deployed to facilitate the Hawaii coffee breeding program and to propagate outstanding coffee trees for large scale field testing.

Table 1. Percentage of coffee cuttings rooted under different plant growth regulator treatments after 10 weeks in the misting system.

Treatments		Catuai			Guatemalan (Typica)		
Plant regulator†	Cutting	Inserted No.	Rooted No.	%	Inserted No.	Rooted No.	%
DIP'N & GROW	Shoot	25	2	8	20	0	0
	Single node	25	14	56	30	9	30
Hormdin 3	Shoot	20	1	5	17	0	0
	Single node	30	15	50	33	3	9
Hormex 3	Shoot	20	0	0			
	Single node	30	13	43			
Control	Shoot	3	1	33	2	0	0
	Single node	37	22	59	2	2	100

†: DIP'N GROW: 1% Indole-3-butyric acid (IBA) and 0.5% 1-Naphthalenetic acid (liquid); Hormdin 3: 0.8% IBA (powder); and Hormex 3: 0.3% IBA (powder).

Fig. 1. **Above:** The coffee cuttings of selected Dole's Waialua Coffee tree, OA12 'Guatemalan' ('Typica') hybrid after 10 weeks in misting.

Below: The rooted cuttings from lateral single node (left), vertical single node (middle), and vertical shoot tip (right).

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