The Effects of Honey on Root Generation in Plant Cuttings

[1]Wayne Stokes III, [2]Susmita Mukherjee, [3]Sonali Paul, [4]Rajiv Narula*

[1,4]Department of Science, State University of New York in Canton (N.Y.) -13617, USA. [2,3]Department of Biotechnology, University of Engineering and Management, Newtown Kolkata

*Corresponding Author - narular@canton.edu

Abstract

Plant propagation through cuttings has been practiced for a long time by plant enthusiasts. It is rapid, simple, and cheaper than other asexual or sexual methods (seeds) of plant propagation. One gets greater uniformity (clones) of plants and desired traits are not lost. Also, the plant reaches maturity at an earlier age. Several rooting hormones and media have been tested for effective propagation of plant cuttings. The development of quick roots without infection and necrosis in the plant cuttings is the key to success for propagation. In our experiments, we tested raw, unpasteurized honey and store bought pasteurized honey as growth media to support rooting in different plant specimens. Raw, unpasteurized honey solution proved to be an inexpensive and successful medium to propagate plants from cuttings.

*Key words:*Plant propagation, Rooting hormones, Necrosis, Unpasteurized honey

I. INTRODUCTION

Propagation through cuttings, as defined by the University of Maine, is the process in which a cutting is severed from the parent plant in order to regenerate itself, thereby forming an independent and complete new plant. (Plant Propagation - Cooperative Extension: Garden & Yard). Propagation through cuttings is both useful and efficient, with many species being easier to reproduce through cuttings than through seed. Propagation through cuttings is also useful due to it being a form of asexual reproduction. This allows for the multiplication of a specimen that possesses unique or desirable traits that one wishes to preserve.

The first, basic goal of any propagation via plant cuttings is for the cutting to begin developing roots. This allows the plant to once again absorb water and nutrients from its environment. If a specimen does not develop roots within a timely manner, the eventual death of the specimen is guaranteed [4]. As a result, encouraging a cutting to develop roots as soon as possible not only increases the chance of survival, but will ultimately lead to larger, more robust specimens. It is equally important in a retail setting, as cuttings that root quickly can be sold sooner and will often be more attractive to the buyer, as an early rooting brings minimum stress to the plant and encourages strong, healthy growth sooner.

Several products and methods have been created with the purpose of encouraging plant cuttings to develop roots faster than they would without said aide. Often, this product consists of some form of

rooting hormone in the form of gels or powders, which are applied to the area of desired root generation [3]. However, natural forms of this aide are said to exist, and are said to work for several reasons.

There are several articles that speak to the positive effects of honey as a root stimulant. According to the Asian Pacific Journal of Natural Biomedicine, honey offers an antibacterial environment, becauseit is viscous and provides a protective barrier to prevent infection, yet maintaining a moist wound environment that promotes healing [2]. It is also said to have antifungal properties, as reported in an article in Medical Mycology [1]. It is due to these protective and antifungal properties that honey is accepted as a "natural" option for decreasing the time needed for root development in plant cuttings. Cuttings are often vulnerable to both fungal and bacterial infections, and supposedly benefit from being treated with a honey solution.

The objective of this research was to test the effectiveness of honey in promoting root generation, when applied on a regular basis as a solution. Due to the proven antifungal antibacterial effects, it is believed that, when a honey solution is used to water plant cuttings, the cuttings will produce roots sooner than specimens who receive no honey.

II. MATERIALS & METHODS

Selection and preparation of plant species and cuttings: In this experiment, six different plant species were collected for testing. There was a wide diversity in the selected plant species with respect to morphology, growth habits and patterns, and growth environments. The species are the Rose Geranium (*Pelargonium graveolents*),the Jade plant (*Crassula ovata*), the Christmas Cactus (*Schlumbergerarusselliana*), China rose (*Hibiscus rosa-sinensis*), English Ivy (*Hedera helix*), and Periwinkle (*Vincapacifica*). Cuttings were taken from each plant in the fashion appropriate for the root development of each species. For the Hibiscus, *V. pacifica*, *H. helix*, and *P. graveolens*, stem cuttings were taken. For *Schlumbergera* and *C. ovata*, whole leaves were taken as cuttings. Cuttings were planted in groups of three, resulting in nine specimens of each plant total.

The planting medium: These cuttings were planted in pots filled with long fibered sphagnum moss, and were kept in basins filled with ¼ inch of water to prevent the media from drying out. Due to *Schlumbergera's*and*C. ovata's* vulnerability to rot, they were kept in a growing medium consisting of a 2:1:1 ratio of peat, perlite, and washed sand.

The honey solution: The honey solution was made by boiling 2 cups of distilled water, followed by mixing in one tablespoon of honey. Two batches of this solution were made, one using raw honey, the other using pasteurized honey. A control was established by a set of each plant that was not watered with the honey solution but with regular water. The variable consisted of watering the cuttings with the honey solution every seven days, with one set of plants being watered with the pasteurized honey, and

the other with the raw honey.

Growth conditions and measurements: All specimens were kept under a fluorescent light ballast with a 16-hour light cycle. The average mass of each cutting set was taken, with the interest of how much mass is gained/ lost by the specimen set. When measuring the mass, all cuttings must be carefully removed and cleaned of all medium, allowing for a more accurate reading. The average mass is measure in grams to a maximum of three significant figures. Afterwards, the longest root of the specimen set was measured with a 12-inch ruler, with centimetres being the unit of measurement. The total number of cuttings that display visible roots was also recorded. Each week, the difference in both average masses and root lengths are calculated. The data is recorded for a 5-week period, with each of these values being measured on the same day, every seven days.

III. RESULTS & DISCUSSION:

The following tables summarize the average mass of cuttings, difference in mass, root length, increase in root length, and number of cuttings with root development for the various cuttings from different plant species treated with raw, unpasteurized honey solution, solution from store bought honey, and control (water).

Raw, Unpasteurized Honey

Table 1.1

Plant Species	**Date**	**Avg Mass of Cuttings (g)**	**Difference in Mass (g)**	**Root Length (cm)**	**Increase in Root Length (cm)**	**Number of Cuttings with Root Development**
Pelargonium graveolens	11/6/2017	4.49	0	0	0	0
	11/13/2017	4.72	0.23	2.2	2.2	3
	11/20/2017	4.79	0.07	2.7	0.5	3
	11/27/2017	5.41	0.62	5.8	3.1	3
	12/4/2017	5.93	0.52	6	0.2	3

Table 1.2

Plant Species	**Date**	**Avg Mass of Cuttings (g)**	**Difference in Mass (g)**	**Root Length (cm)**	**Increase in Root Length (cm)**	**Number of Cuttings with Root Development**
Crassula ovata	11/6/2017	5.54	0	0	0	0
	11/13/2017	5.58	0.04	1.8	1.8	2
	11/20/2017	5.59	0.01	1.9	0.1	2
	11/27/2017	7.26	1.67	5.5	3.6	3
	12/4/2017	7.16	-0.1	7.1	1.6	3

Table 1.3

Plant Species	Date	Avg Mass of Cuttings (g)	Difference in Mass (g)	Root Length (cm)	Increase in Root Length (cm)	Number of Cuttings with Root Development
Schlumbergera russelliana	11/6/2017	1.8	0	0	0	0
	11/13/2017	1.83	0.03	0.9	0.9	3
	11/20/2017	1.9	0.07	1.1	0.2	3
	11/27/2017	3.55	1.65	6.2	5.1	3
	12/4/2017	3.26	-0.29	3	-3.2	3

Table 1.4

Plant Species	Date	Avg Mass of Cuttings (g)	Difference in Mass (g)	Root Length (cm)	Increase in Root Length (cm)	Number of Cuttings with Root Development
Hibiscus rosa - sinensis	11/6/2017	2.27	0	0	0	0
	11/13/2017	1.58	0.69	0	0	0
	11/20/2017	1.55	0.03	0	0	0
	11/27/2017	1.02	0.53	0.9	0.9	3
	12/4/2017	1.06	0.04	1.4	0.5	4

Table 1.5

Plant Species	Date	Avg Mass of Cuttings (g)	Difference in Mass (g)	Root Length (cm)	Increase in Root Length (cm)	Number of Cuttings with Root Development
Hedera helix	11/6/2017	1.49	0	0	0	0
	11/13/2017	1.53	0.04	1.9	1.9	1

	11/20/2017	1.58	0.05	2.1	0.2	2
	11/27/2017	1.78	0.2	4.1	2	3
	12/4/2017	1.94	0.16	4.5	0.4	3

Table 1.6

Plant Species	**Date**	**Avg Mass of Cuttings (g)**	**Difference in Mass (g)**	**Root Length (cm)**	**Increase in Root Length (cm)**	**Number of Cuttings with root development**
Vincapacifica	11/6/2017	1.4	0	0	0	0
	11/13/2017	1.34	0	0	0	0
	11/20/2017	1.35	0.01	0.1	0.1	1
	11/27/2017	1.16	-0.19	0.2	0.1	1
	12/4/2017	1.94	0.78	1.1	0.9	2

Store Honey

Table 2.1

Plant Species	**Date**	**Avg Mass of Cuttings (g)**	**Difference in Mass (g)**	**Root Length (cm)**	**Increase in Root Length (cm)**	**Number of Cuttings with Root Development**
Pelargonium graveolens	11/6/2017	2.87	0	0	0	0
	11/13/2017	2.6	-0.27	0	0	0
	11/20/2017	2.67	0.07	0.1	0.1	1
	11/27/2017	2.75	0.08	2.5	2.4	2
	12/4/2017	2.5	-0.25	3.2	0.7	2

Table 2.2

Plant Species	**Date**	**Avg Mass of Cuttings**	**Difference in Mass (g)**	**Root Length (cm)**	**Increase in Root Length**	**Number of Cuttings with Root**

		(g)			(cm)	Development
Crassula ovata	11/6/2017	2.99	0	0	0	0
	11/13/2017	2.96	-0.03	1.7	1.7	1
	11/20/2017	2.98	0.02	1.82	0.12	1
	11/27/2017	3.39	0.41	5.2	3.38	2
	12/4/2017	3.28	-0.11	6	0.8	2

Table 2.3

Plant Species	**Date**	**Avg Mass of Cuttings (g)**	**Difference in Mass (g)**	**Root Length (cm)**	**Increase in Root Length (cm)**	**Number of Cuttings with Root Develoment**
Schlumbergera russelliana	11/6/2017	2.85	0	0	0	0
	11/13/2017	2.57	-0.28	0	0	0
	11/20/2017	2.58	0.01	0.1	0.1	1
	11/27/2017	3.26	0.68	2	1.9	3
	12/4/2017	3.65	0.39	3.5	1.5	3

Table 2.4

Plant Species	**Date**	**Avg Mass of Cuttings (g)**	**Difference in Mass (g)**	**Root Length (cm)**	**Increase in Root Length (cm)**	**Number of Cuttings with Root Development**
Hibiscus rosa-sinensis	11/6/2017	1.42	0	0	0	0
	11/13/2017	1.34	-0.08	0	0	0
	11/20/2017	1.08	-0.26	0	0	0
	11/27/2017	0.85	-0.23	0	0	0
	12/4/2017	0.64	-0.21	0	0	0

Table 2.5

Plant Species	Date	Avg Mass of Cuttings (g)	Difference in Mass (g)	Root Length (cm)	Increase in Root Length (cm)	Number of Cuttings with Root Development
Hedera helix	11/6/2017	1.2	0	0	0	0
	11/13/2017	1.11	-0.09	0	0	0
	11/20/2017	1.11	0	0	0	0
	11/27/2017	1.18	0.07	0	0	0
	12/4/2017	1.27	0.09	0.32	0.32	2

Table 2.5

Plant Species	Date	Avg Mass of Cuttings (g)	Difference in Mass (g)	Root Length (cm)	Increase in Root Length (cm)	Number of Cuttings with Root Development
Vincapacifica	11/6/2017	0.97	0	0	0	0
	11/13/2017	0.7	-0.27	0	0	0
	11/20/2017	0.7	0	0	0	0
	11/27/2017	0.62	-0.08	0	0	0
	12/4/2017	0.37	-0.25	0	0	0

Control

Table 3.1

Plant Species	Date	Avg Mass of Cuttings (g)	Difference in Mass (g)	Root Length (cm)	Increase in Root Length (cm)	Number of Cuttings with Root Development
Pelargonium graveolens	11/6/2017	4.56	0	0	0	0

	11/13/2017	4.33	-0.23	0	0	0
	11/20/2017	4.28	-0.05	0	0	0
	11/27/2017	3.85	-0.43	1.5	1.5	2
	12/4/2017	3.43	-0.42	2.2	0.7	2

Table 3.2

Plant Species	**Date**	**Avg Mass of Cuttings (g)**	**Difference in Mass (g)**	**Root Length (cm)**	**Increase in Root Length (cm)**	**Number of Cuttings with Root Development**
Crassula ovata	11/6/2017	1.32	0	0	0	0
	11/13/2017	1.31	-0.01	0.5	.5	1
	11/20/2017	1.42	0.11	0.7	0.2	1
	11/27/2017	1.48	0.06	1.5	0.8	2
	12/4/2017	1.68	0.2	2	0.5	2

Table 3.3

Plant Species	**Date**	**Avg Mass of Cuttings (g)**	**Difference in Mass (g)**	**Root Length (cm)**	**Increase in Root Length (cm)**	**Number of Cuttings with Root Development**
Schlumbergera russelliana	11/6/2017	1.64	0	0	0	0
	11/13/2017	1.55	-0.09	1.2	1.2	1
	11/20/2017	1.55	0	1.2	0	1
	11/27/2017	1.82	0.27	2.4	1.2	3
	12/4/2017	2.18	0.36	3.5	1.1	3

Table 3.4

Plant Species	**Date**	**Avg Mass of Cuttings (g)**	**Difference in Mass (g)**	**Root Length (cm)**	**Increase in Root Length (cm)**	**Number of Cuttings with Root Development**
Hibiscus	11/6/2017	1.21	0	0	0	0

rosa-sinensis						
	11/13/2017	1.37	0.16	0	0	0
	11/20/2017	1.11	-0.26	0	0	0
	11/27/2017	1.11	0	0	0	0
	12/4/2017	0.77	-0.34	0	0	0

Table 3.5

Plant Species	**Date**	**Avg Mass of Cuttings (g)**	**Difference in Mass (g)**	**Root Length (cm)**	**Increase in Root Length (cm)**	**Number of Cuttings with Root Development**
Hedera helix	11/6/2017	1.96	0	0	0	0
	11/13/2017	1.87	-0.09	0	0	0
	11/20/2017	1.87	0	0	0	0
	11/27/2017	1.83	-0.04	0.4	0.4	1
	12/4/2017	1.67	-0.16	0	0	0

Table 3.6

Plant Species	**Date**	**Avg Mass of Cuttings (g)**	**Difference in Mass (g)**	**Root Length (cm)**	**Increase in Root Length (cm)**	**Number of Cuttings with Root Development**
Vincapacifica	11/6/2017	1.24	0	0	0	0
	11/13/2017	0.89	-0.35	0	0	0
	11/20/2017	0.87	-0.02	0	0	0
	11/27/2017	0.89	0.02	0	0	0
	12/4/2017	0.6	-0.29	0	0	0

The charts 1.1-1.6, 2.1-2.6, and 3.1-3.6 depict the growth patterns of each species, being the set watered with the raw honey solution, pasteurized honey, and the control, respectively. The average mass, the difference in mass between values, the root length, the difference in root length values, and the number of cuttings that had developed visible roots were all recorded.

Fig. 1 – The experimental set-up

This serves as the setup for all cuttings, with all of them being fitted under the light ballast an equal distance from the lights.

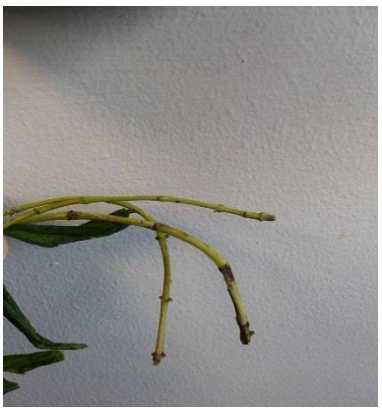

Figure2

Figure3

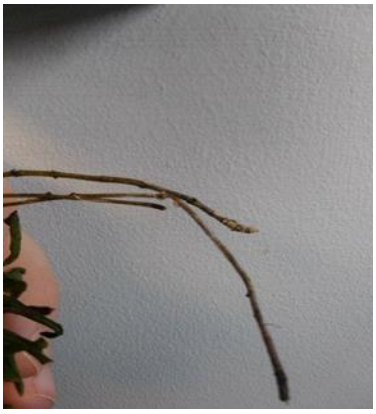

Figure4

Figures 2-4 depict the varying levels of necrosis found throughout several plants, with *V. pacifica* being the example in this photograph. Pictured from left to right is the raw honey specimen, the pasteurized honey specimen, and the control specimen.

IV. CONCLUSION

From our experiments it was concluded that raw, unpasteurized honey served as an effective medium to promote root development in plant cuttings. Several factors come into play when considering which aide was better, or if, in fact, they were beneficial. Firstly, one must consider how many cuttings took root, as accelerated root development is the focal point of this experiment. Considering both the number of cuttings that developed roots by the end of the experiment, and the rate in which these cuttings began to grow them, the cuttings treated with unpasteurized honey was the most successful. Not only did the specimens treated with unpasteurized honey develop roots more quickly, they also often had more specimens that had developed roots by the end of the experiment. All of the pasteurized honey specimens were less successful with some showing necrosis and no root development. The only exception to this was the Hibiscus, as no Hibiscus specimens developed roots by the end of the experiment in store bought pasteurized honey solution, but showed no necrosis as well. However, measuring the Hibiscus's development for an additional 2-3 weeks may have given different results.

The average mass of each specimen set was measured as a general indicator of the overall health and growth rate of the plant. A specimen set that was losing mass was wilting and losing water, while an increase in mass shows both root development and the intake of water. This can be inferred do to the fact that all plants need to be able to take in water and nutrients to develop growth beyond a certain point. This is only possible through the development of roots. However, some roots are not yet visible, but can still take in water. This can be observed in the Hibiscus specimens treated with unpasteurized honey, as they did begin to gain mass, in the first few days despite no roots being visible yet. Once again, the cuttings treated with unpasteurized honey were most successful in this endeavour, and not only did they gain mass more quickly, they also on an average gained the most weight in the experiment time.

Regarding actual root length, the cuttings treated with unpasteurized honey were once again the most successful. The group not only developed roots more quickly, but had also, on average, developed the longest roots by the end of the experiment. It should also be known that many of the pasteurized honey and control sets had begun experiencing various levels of necrosis. This is seen in the V. pacifica specimens, as depicted in Figures 2-4. The cuttings treated with unpasteurized honey had experienced little to no necrosis, while both the raw and pasteurized honey sets display several noticeable patches of black tissue.

There is one major reason as to why the cuttings treated with unpasteurized honey were more successful than both the control and the pasteurized honey regarding growth success. In a concentrated form, the high sugar content of unpasteurized honey makes it an inhospitable environment for bacteria to thrive. Unpasteurized honey also has several antioxidant properties and nutrients that aid in plant development and growth. Some of these beneficial properties could be missing in store bought pasteurized honey, which promoted necrosis and no root development. As predicted, most necrosis was seen in the control specimens. Due to the lack of beneficial properties of honey in control specimens, increase in bacteria made it more difficult for the cuttings to take root, and encouraged rot amongst the specimens. As it stands, using honey for root development is very effective and can be used in commercial nurseries and laboratories, and also by gardeners who would like to propagate plants. This experiment can be repeated with even greater precision and few changes to make the experimental set up easier. It could certainly be repeated by dipping the plant cuttings in raw honey (rather than a honey solution) and then keeping the cuttings in a moist environment. Primarily, changes in the setting would be beneficial. Due to the lack of closed areas and heavy traffic, exact mass measurements were not possible. Also, there was fluctuation in both the temperature and the humidity of the environment. While it may not change the outcome, using a scale in a more stable environment, paired with keeping specimens in an area with regulated temperature and humidity may give a clear, more precise view on the effectiveness of each honey. However, the possibility of honey being effective for root development in plant cuttings is an important conclusion which can help individuals and researchers in the field of plant propagation.

REFERENCES:

[1] Irish, J., Carter, D. A., Shokohi, T., & Blair, S. E. Honey has an antifungal effect against Candida species. Medical Mycology, 44(3), 289–291. 2006.

[2] Mandal, M. D., & Mandal, S. Honey: its medicinal property and antibacterial activity. Asian Pacific Journal of Tropical Biomedicine, 1(2), 154–160. 2011.

[3] Sherwood, M. A. . P. D.. Plant Breeding and Propagation. Salem Press Encyclopedia of Science. 2018

[4] Wortman, S. E. and Mamo, M. Developing a Holistic Framework for Learning Outcomes Assessment: A Case Study in Plant Propagation. NACTA Journal, 62(4), 353–358. 2018.