

EFFECTS OF LIGHT, BANDING, AND IBA TREATMENTS ON ROOTING OF
LINDERA BENZOIN STEM CUTTINGS

A Capstone Paper

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by

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ABSTRACT

An experiment was conducted to assess whether various light and banding treatments could increase rooting in stem cuttings of *Lindera benzoin* L., a difficult-to-root woody plant. Stock plants were grown under one of three light conditions (light, shade, or etiolation) and emerging shoots received either a banding treatment with VELCRO® and varying concentrations of IBA in the form of Hormodin® (mfr. OHP, Inc.; Morrisville, NC) or received no band. Data on rooting percentage and number of roots per cutting were analyzed using logistic and Quasi-Poisson regression, respectively. Etiolated cuttings treated with VELCRO® without IBA had the highest rooting probability and number of roots; however, etiolated cuttings across all banding treatments had similarly successful results. Additionally, there were a number of significant differences in rooting probabilities and root numbers between banding treatments within the shade and light-grown groups.

BIOGRAPHICAL SKETCH

Caroline Stokes was born and raised in the greater Washington, DC area and is a lifelong appreciator of the natural world. For undergraduate, she attended Indiana University, where she earned a Bachelor of Arts in International Studies and Central Eurasian Studies with a certificate in Turkish. Following graduation, she worked in international education and international development for five years. While she found these pursuits to be noble, eventually she became unable to ignore her desire to work with plants instead and set about switching tracks to pursue a career in horticulture.

After taking science prerequisites and growing her skills through many horticultural volunteer opportunities, Caroline made her way to Cornell's Master of Professional Studies program in Integrative Plant Science. She has enjoyed taking courses in urban horticulture, plant propagation, and more while working on her Capstone project, of which this paper is the result, in the beautiful Finger Lakes region.

To Melissa, for encouraging me to take a hiatus from our regular life for a year to pursue my horticultural ambitions.

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I would also like to thank Julie Blaha and other employees from the Kenneth Post Lab for caring for my ever-growing collection of *Lindera* in the greenhouse. Many thanks as well to Dr. Lynn Johnson of the Cornell Statistical Consulting Unit for her assistance with the analysis of my data. Finally, thank you to all my family, friends, and Plant Science professors whose questions and curiosity about my project motivated me to make it better.

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LIST OF ABBREVIATIONS

IBA	Indole-3-butyric acid
NAA	1-Naphthaleneacetic acid
PAR	Photosynthetically active radiation

INTRODUCTION

There is great variability among woody plants in their response to asexual propagation techniques. While some species root readily from stem cuttings, others are much more difficult to propagate. For these difficult-to-root plants, a number of practices have been developed to stimulate root formation on stem cuttings, most notably full or localized etiolation or shading, application of synthetic growth regulators, and selection of stock plants with juvenile shoot growth. The optimum combination of pre-treatments for cuttings may vary by species and cultivar.

Several studies have suggested that etiolation, the growing of plants in the absence of light or under heavy shade, promotes developmental changes in differentiating stem tissues that may lead to increased rooting of stem cuttings. In 1923, Reid observed that growing camphor under light-excluding bags led to decreased lignification and cell wall thickness of etiolated shoots; Maynard and Bassuk (1996) also demonstrated delayed lignification and sclereid formation in potential rooting sites of *Carpinus betulus*. The positive effects of etiolation on rooting of stem cuttings have been observed in numerous taxa, including *Amelanchier alnifolia* (Nelson, 1987), *Acer grandidentatum* (Richards & Rupp, 2012), several *Quercus* species (Hawver & Bassuk, 2000), and certain *Rhododendron* cultivars (Apine et al., 2013). Cuttings taken from etiolated stock plants may be treated with a synthetic auxin, namely Indole-3-butyric acid (IBA) or 1-Naphthaleneacetic acid (NAA), to further promote rooting.

The level of light exclusion needed to achieve increased rooting may vary by species. Maynard and Bassuk (1992) found that stem cuttings of *Carpinus betulus* 'Fastigiata' displayed the best rooting response when stock plants were grown under 95% shade rather than complete (>99%) shade; likewise, increased rooting of cuttings has also been displayed in *Cotinus*

coggygia at 96% light exclusion (Pacholczak et al., 2005). Significantly improved rooting of cuttings has also been observed in plants grown in much lower shade levels, including *Juniperus horizontalis* grown at 50% and 70% irradiance, *Cornus alba* grown at 50% irradiance, and *Acer palmatum* ‘Atropurpureum’ grown at 40-50% irradiance (Hansen, 1997; Pacholczak et al., 2017; Behrens, 1988).

A complement or alternative to whole-plant etiolation or shading is banding, a procedure in which light is excluded from the portion of the stock plant shoot which will become the cutting base to create a localized etiolated zone. Opaque bands can be applied either to previously-etiolated shoots which are then allowed to “green up” in the light, or to light-grown shoots that are subsequently “blanched” by the band (Maynard & Bassuk, 1987). IBA is often added to the bands to promote rooting. Herman and Hess (1963) applied the blanching method to red kidney bean and *Hibiscus rosa-sinensis* by covering the bases of new shoots with black bands, taking cuttings at the shoot base, and dipping the blanched cuttings in IBA prior to rooting under mist. This procedure significantly increased root numbers in both species. Blanching followed by a quick dip in IBA has also been used to increase rooting percentage in softwood cuttings of apple rootstock (Sun & Bassuk, 1991), cherry rootstock (Gulen et al., 2004) and *Protea cynaroides* (Wu et al., 2006).

Maynard and Bassuk introduced a technique of banding shoots with squares of black, self-adhering hook-and-loop fasteners (such as those manufactured by the brand VELCRO®, Manchester, NH). Both sides of the open VELCRO® band are dipped in a talc IBA preparation and then are firmly pressed around the base of the stem so that the two sides adhere and the hooks are forced into the tender stems. This serves to lightly wound underlying stem tissue and facilitate the application of IBA, thereby increasing root formation (1985). Blanching with

VELCRO® dipped in IBA powder led to the highest rooting percentage among several taxa, including *Quercus robur*, *Quercus rubra*, and *Syringa vulgaris* cvs. Belle de Nancy and President Grevy (Maynard & Bassuk, 1987). Increased rooting of cuttings from shoots blanched with VELCRO® has also been observed in two-year-old greenhouse-grown seedlings of *Acer saccharum* (Richer et al, 2004).

In many cases, the combination of full etiolation plus banding leads to optimal rooting results. In apple rootstock Bramley's Seedling, complete shading of stock plants followed by banding with black tape significantly increased rooting percentages (Delargy & Wright, 1979). Maynard and Bassuk found that, compared to etiolation alone or banding alone, etiolation followed by banding with VELCRO® dipped in IBA led to the highest rooting in *Acer saccharum*, *Betula papyrifera*, *Carpinus betulus*, *Castanea mollissima*, *Quercus coccinea*, and several *Syringa reticulata* cultivars (1987, 1992). Similar results have been observed with *Corylus americana*, *Fagus sylvatica*, *Lindera benzoin*, *Magnolia sieboldii*, and *Pterostyrax hispida* (Bassuk et al., 1986; Lenze, 2020).

Propagule position and the cutting back of stock plants also play an important role in the rooting of stem cuttings. In a study of apple stock, Smith (1959) observed that cuttings of juvenile shoots from the seedling bases rooted better than those taken from mature fruiting branches. Additionally, Amissah and Bassuk (2009) found that severely pruning *Quercus bicolor* stock plants to 4 cm and allowing new epicormic shoots to form improved the rooting of subsequent cuttings and layers. These results are supported by the concept of the "cone of juvenility," which holds that the most physiologically juvenile tissues of a plant are in regions closest to the base. Cuttings taken from shoots arising from more juvenile regions produce more adventitious roots (Beyl & Trigiano, 2008).

Another area of discussion is whether the chronological age of stock plants can influence the rooting potential of cuttings. In cut-back stock plants of *Quercus ithaburgensis* (Eshed et al., 1996) and *Tectona grandis* (Husen, 2011), the rooting percentage of cuttings has been shown to decrease as the mother plant chronological age increases. However, Amissah and Bassuk observed no effect of stock plant age on the rooting of cuttings of *Quercus bicolor*, which was attributed to the severe cutback of plant stems to 4 cm above the soil surface (2004).

An appropriate subject for tests of root-stimulating factors of stem cuttings is *Lindera benzoin* L., Common Spicebush. *L. benzoin* is a dioecious shrub native to a large swath of North America from Maine west to Ontario and Kansas and south to Florida and Texas. Typically found in moist soils along streams and in the forest understory, *L. benzoin* grows 1.8 to 3.6 m tall and equally as wide with a loosely rounded form. Ornamental value is provided in the form of clusters of small, yellow flowers in the spring and bright scarlet, oval drupes in the fall (Dirr, 2009). Historically, *L. benzoin* has been propagated from seed due to low rooting percentages produced from cuttings. However, master's project research from Lenze (2020) provided preliminary evidence that rooting success could be improved through etiolation and banding treatments, a finding that this paper seeks to examine further.

METHODS

123 *Lindera benzoin* stock plants were left in an unheated polyhouse in Ithaca, New York (42° N, 76° W) from mid-October 2021 through late February 2022. The average ambient temperature ranged from -5.773 to 4.195° C (21.7 to 39.6° F) during this period. All plants were potted in soilless media (LM-111 All Purpose Mix; mfr. Lambert, Rivière-Ouelle, Québec) and were one of three distinct sizes: 5/8" caliper (Standard #3 pot), 1/4" caliper (Standard #1 pot), or

1/8" caliper (1/4 gallon pot). After four months, plants were moved to a greenhouse with 23.9 to 18.3° C (75 to 65° F) temperatures and 27% to 95% relative humidity. At the first sign of bud swell, the apical meristems of all plants were removed and plants of each size were trimmed to a uniform height (approximately 17.8 cm for the youngest plants, 25.4 cm for the intermediate plants, 33.0 cm for the largest plants).

Each stock plant was randomly assigned to one of three light treatments: full light, etiolation (>99% light exclusion), or shade (50% light exclusion). Relative light levels were determined using a LI-COR radiation sensor that measured Photosynthetically Active Radiation (PAR) in $\mu\text{mol s}^{-1} \text{m}^{-2}$. The plants to be etiolated were placed on a bench enclosed with a tent of black shade cloth topped with a layer of reflective cloth to prevent overheating. Plants in the shade group were placed on a bench under a tent of one layer of mesh shade cloth, while those in the light group were left under full natural light.

As shoots emerged and grew to 5-7 cm long, each was randomly assigned one of four banding and hormone treatments: no banding, banding with 3000 ppm IBA in talc, banding with 8000 ppm IBA in talc, or banding without IBA. Within the three light levels, roughly equal numbers of shoots received each treatment, with different shoots on the same plant often receiving varying treatments. The banding treatment involved firmly affixing a 2.5 cm square of VELCRO® around the base of each shoot. The VELCRO® bands either had no IBA applied or were coated in 3000 ppm IBA as Hormodin® 2 or 8000 ppm IBA as Hormodin® 3 (mfr. OHP, Inc.; Morrisville, NC) prior to applying to the shoot bases. A final group of shoots had no band applied (see Table 1 for a summary of treatments).

Table 1

Summary of Applied Light and Banding Treatments

Light Treatments	Banding Treatments
Light (100% PAR)	No band
Shade (50% PAR exclusion)	Band - IBA
Etiolation (>99% PAR exclusion)	Band + Hormodin® 2
	Band + Hormodin® 3

Note: Stock plants were each placed in one of the above light treatments. Emerging shoots were randomly assigned one of the above banding treatments.

Stock plants under the light and shade treatments remained on their respective benches for the duration of the experiment. Plants under the etiolation/black cloth treatment, however, were moved to the shade bench immediately after their shoots were treated to allow them to green up. On all plants, if any shoot grew longer than 10 cm, the apical meristem was trimmed in order to maintain uniform cutting length (Figure 1).

After three weeks from the initial banding treatment, shoots were excised from the mother plant directly below the VELCRO® band or equivalent location on light-grown plants. Bands were removed and bases of the cuttings were dipped in Hormodin® 3 (8000 ppm IBA) before being planted in trays filled with a perlite-LM 111 Mix (2:1 ratio by volume). Trays were placed on a mist bench with a layer of shade cloth overhead to prevent water stress, where they received 4 seconds of mist every 10 minutes. After seven weeks, each cutting was removed from its tray and assessed for rooting success, and, if rooted, number of roots.

Figure 1

Images Depicting Experimental Design and Procedure



Note: A. Arrangement of stock plants on bench. B. Stock plant with varying banding treatments applied to shoots. C. Shoot with band removed showing successful blanching of underlying tissue. D. Cuttings under intermittent mist.

STATISTICAL METHODS

Statistical analysis of the rooting data was carried out using RStudio statistical software. To determine the effects of light and banding treatments on rooting success, a generalized linear model with a binomial distribution and a logit link was fitted to the data (logistic regression). Data on the number of roots per cutting were analyzed using a Quasi-Poisson regression model, which was selected over a linear regression model to account for overdispersion. An alpha level of 0.05 was used to determine statistical significance.

Additionally, post-hoc testing was completed to assess the effect of band treatment on rooting within each light level. Z-tests were conducted to make pairwise contrasts of least-squared means by banding treatment. For instance, among etiolated plants, the least-squares means of unbanded cuttings versus cuttings treated with a band with Hormodin® 2 were compared to determine if one group rooted better than the other. P values were adjusted for multiple comparisons using the Tukey method. The difference within a pair was judged to be significant when $p < 0.05$.

RESULTS

A total of 476 cuttings were obtained from stock plants across all treatments, with 403 from the large plants and 73 from the medium plants. The number of cuttings obtained from the medium stock plants was lower than expected because 29 of 54 of the plants died after being moved to the greenhouse, potentially due to poor overwintering in the polyhouse. Therefore, data for cuttings from the medium plants were not included in this analysis due to inadequate sample size. Additionally, all of the smallest stock plants died after being moved to the greenhouse and

did not yield any cuttings. Thus, the data presented here only represent the 403 cuttings from the largest stock plant size.

Rooting Success

71% of total *L. benzoin* cuttings rooted, with notable variation by light and banding treatment group (Table 2). Rooting by overall light treatment was highest among cuttings from etiolated stock plants, followed by those from the shade- and light-grown plants, at 92%, 72%, and 60%, respectively. The highest rooting percentage by light and banding treatment occurred in etiolated cuttings treated with a band without IBA (96%), while the lowest percentage was in light-grown cuttings treated with a band without IBA (43%).

Table 2

Percent of Cuttings Rooted by Light and Banding Treatment

Light Level	Banding Treatment			
	No band	Band - IBA	Band + H2	Band + H3
Light	48%	43%	75%	78%
Shade	62%	67%	89%	70%
Etiolated	94%	96%	87%	91%

Note: H2 refers to Hormodin® 2 and H3 refers to Hormodin® 3. - means “without” and + means “with.”

Analysis of Deviance of the fitted binomial model showed that stock plant light level had a significant effect on the rooting of cuttings ($p < 0.05$). Band treatment and the overall interaction between band treatment and light were not significant (Table 3).

Table 3

Analysis of Deviance Results for Rooting Success of Cuttings

Variable	df	χ^2	P
Light	2	29.33	<0.0001
Banding Treatment	3	1.98	0.58
Light x Banding Treatment	6	10.38	0.11

Within each light treatment group, there were a number of significant differences in rooting probability based on banding treatment, as revealed by a pairwise comparison of least-squares means. In the light group, cuttings that received a band with Hormodin® 2 or Hormodin® 3 had a significantly higher probability of rooting than those receiving a band with no IBA. Also in the light group, cuttings treated with a band with Hormodin® 3 had a significantly higher probability of rooting than cuttings that did not receive a band. Additionally, the difference between cuttings treated with a band with Hormodin® 2 versus unbanded cuttings was nearly significant at $p = 0.05$ (Table 4).

In the etiolated group, there were no significant differences in rooting probability by banding treatment. This is reflective of the observed data, in which cuttings that had been etiolated displayed similarly high rooting percentages across all banding treatments (between 87 and 96%).

Table 4*Pairwise Contrasts of Rooting Probability by Band Treatment Within Each Light Treatment*

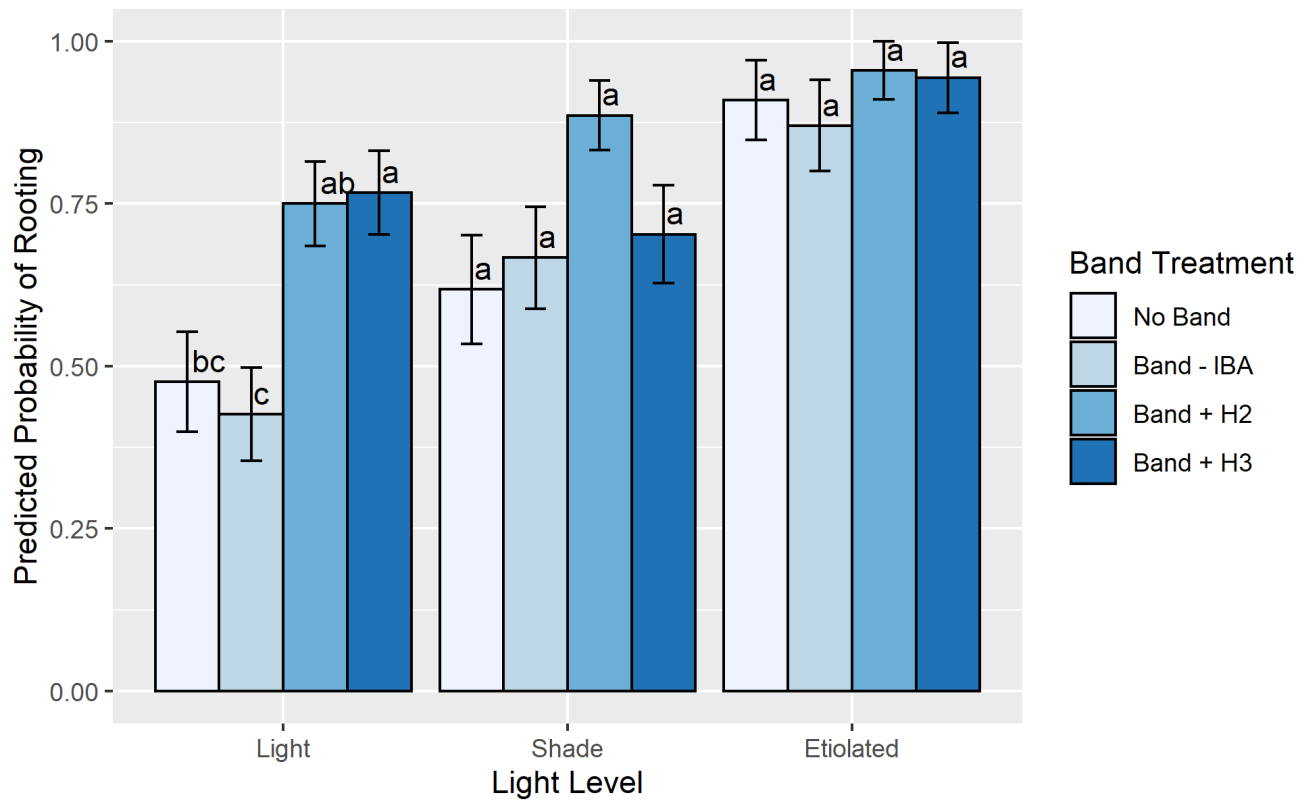
Light	Band Treatment Contrasts	Odds Ratio	SE	Z-Score	P
Light	Band + H3 / Band + H2	1.1	0.55	0.19	0.998
	Band + H3 / Band - IBA	4.5	2.08	3.21	0.007
	Band + H3 / No Band	3.6	1.72	2.71	0.034
	Band + H2 / Band -IBA	4.1	1.85	3.07	0.012
	Band + H2 / No Band	3.3	1.54	2.57	0.051
	Band – IBA / No Band	0.8	0.35	-0.48	0.964
Shade	Band + H3 / Band + H2	0.3	0.20	-1.85	0.250
	Band + H3 / Band - IBA	1.2	0.60	0.33	0.988
	Band + H3 / No Band	1.5	0.74	0.76	0.874
	Band + H2 / Band -IBA	3.9	2.47	2.21	0.146
	Band + H2 / No Band	4.8	3.06	2.46	0.067
	Band – IBA / No Band	1.2	0.62	0.43	0.974
Etiolated	Band + H3 / Band + H2	1.5	1.45	0.42	0.975
	Band + H3 / Band - IBA	0.5	0.60	-0.59	0.936
	Band + H3 / No Band	0.6	0.75	-0.42	0.975
	Band + H2 / Band -IBA	0.3	0.38	-0.96	0.773
	Band + H2 / No Band	0.4	0.47	-0.78	0.864
	Band – IBA / No Band	1.2	1.79	-0.15	0.998

Note: H2 refers to Hormodin® 2 and H3 refers to Hormodin® 3. - means “without” and + means “with.” A p value of < 0.05 indicates a significant difference in rooting probability between the two listed banding treatments. Odds ratios directly compare the predicted odds of rooting from the first listed banding treatment to the second.

A summary of the modeled probability of rooting by light and banding treatment is displayed in Figure 2. Overall, etiolated cuttings treated with a band without IBA had the highest predicted probability of rooting at 96%, while the lowest probability was in light-grown cuttings treated with a band without IBA (43%).

Figure 2

Predicted Probability of Rooting by Light and Band Treatment



Note: H2 refers to Hormodin® 2 and H3 refers to Hormodin® 3. - means “without” and + means “with.” Error bars represent calculated standard error. Within each light level, different letters represent significant differences in predicted mean rooting probability ($p < 0.05$, Z-tests with Tukey correction).

Number of roots

Across all treatment groups, cuttings yielded a mean of 18 roots per cutting. However, there were large differences across treatments: Plants that were grown under black cloth, shade, and light yielded a mean of 39, 16, and 11 roots per cutting respectively across all banding treatments. See Figure 3 for photos of rooting in light-grown versus etiolated cuttings. The highest mean number of roots per cutting was observed in etiolated cuttings treated with a band without IBA (50 roots), while the lowest number was seen in light-grown cuttings with no

banding treatment at (6 roots). See Table 5 for a summary of the mean number of roots per cutting across light and banding treatments.

Table 5

Average Number of Roots Per Cutting by Light and Banding Treatment

Light Level	Banding Treatment			
	No band	Band - IBA	Band + H2	Band + H3
Light	5.7	8.9	13.3	15.3
Shade	12.6	9.1	20.6	19.9
Etiolated	26.8	50.3	38.1	39.6

Note: Note: H2 refers to Hormodin® 2 and H3 refers to Hormodin® 3. - means “without” and + means “with.”

Figure 3

Images of Rooted Cuttings



Note: Examples of successfully rooted cuttings. Left cutting received etiolation and a band without IBA; right cutting received light and a band without IBA.

Light and band treatment were found to have a significant effect on number of roots per cutting at $p < 0.0001$ and $p = 0.0003$, respectively. The interaction between light and band treatment was also significant at $p = 0.019$ (Table 6). Shade and etiolation treatments were shown to have a significant positive effect on the number of roots per cutting, compared to light-grown plants. Additionally, band treatments with Hormodin® 2 and Hormodin® 3 had a significant positive effect on number of roots per cutting, relative to shoots that received no banding. Figure 4 displays the estimated number of roots per cutting by light and banding treatment based on the Quasi-Poisson regression model.

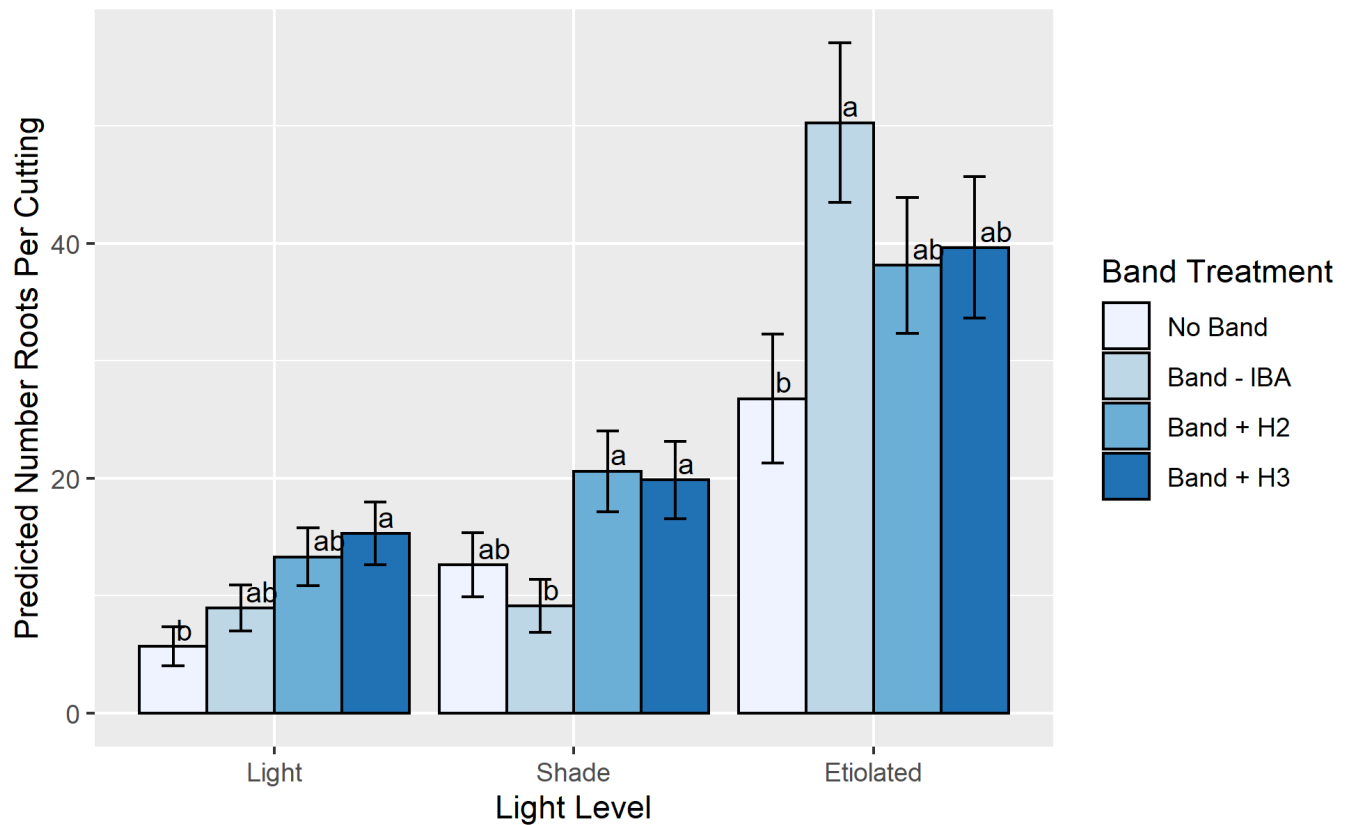
Table 6

Analysis of Deviance Results for Number of Roots Per Cutting

Variable	df	χ^2	P
Light	2	101.0	<0.0001
Banding Treatment	3	18.6	0.0003
Light x Banding Treatment	6	15.2	0.019

Figure 4

Predicted Mean Number of Roots Per Cutting by Light and Band Treatment



Note: H2 refers to Hormodin® 2 and H3 refers to Hormodin® 3. - means “without” and + means “with.” Error bars represent calculated standard error. Within each light level, different letters represent significant differences in predicted mean number of roots per cutting ($p < 0.05$, Z-tests with Tukey correction).

Additionally, pairwise contrasts of least-squares means showed that within each light condition, there were significant differences in the number of roots per cutting by banding treatment (Table 7). For shade-grown stock plants, cuttings treated with bands plus Hormodin® 2 or Hormodin® 3 had twice the predicted number of roots than cuttings treated with a band without IBA ($p = 0.03$ and 0.04 , respectively). In the light group, banding plus Hormodin® 3 was associated with an increase in roots compared to no banding ($p = 0.02$). Banding plus Hormodin® 2 also had higher predicted root numbers compared to no banding, though not

significant at $p = 0.07$. Among etiolated plants, cuttings treated with a band without IBA had significantly more roots than cuttings that were not banded ($p = 0.049$).

Table 7

Pairwise Contrasts of Number Roots/Cutting by Band Treatment Within Each Light Treatment

Light	Band Treatment Contrasts	Ratio	SE	Z-Score	P
Light	Band + H3 / Band + H2	1.1	0.29	0.55	0.948
	Band + H3 / Band - IBA	1.7	0.48	1.91	0.222
	Band + H3 / No Band	2.7	0.91	2.91	0.019
	Band + H2 / Band -IBA	1.5	0.43	1.39	0.509
	Band + H2 / No Band	2.3	0.81	2.45	0.066
	Band – IBA / No Band	1.6	0.57	1.24	0.600
Shade	Band + H3 / Band + H2	1.0	0.23	-0.16	0.999
	Band + H3 / Band - IBA	2.2	0.65	2.61	0.045
	Band + H3 / No Band	1.6	0.43	1.67	0.342
	Band + H2 / Band -IBA	2.3	0.67	2.723	0.033
	Band + H2 / No Band	1.6	0.48	1.79	0.277
	Band – IBA / No Band	0.7	0.24	-0.98	0.760
Etiolated	Band + H3 / Band + H2	1.0	0.22	0.18	0.998
	Band + H3 / Band - IBA	0.8	0.16	-1.17	0.646
	Band + H3 / No Band	1.5	0.38	1.54	0.413
	Band + H2 / Band -IBA	0.8	0.15	-1.36	0.523
	Band + H2 / No Band	1.4	0.36	1.39	0.506
	Band – IBA / No Band	1.9	0.46	2.57	0.050

Note: H2 refers to Hormodin® 2 and H3 refers to Hormodin® 3. - means “without” and + means “with.” A p value of < 0.05 indicates a significant difference in predicted mean number of roots per cutting between the two listed banding treatments. Ratios directly compare the predicted number of roots from the first listed banding treatment to the second.

DISCUSSION

These results provide evidence that it is possible to substantially increase the rooting percentage and number of roots per cutting of *Lindera benzoin* using etiolation, shading, and banding techniques. While etiolation led to the highest root counts and rooting probability across all banding treatments, shade and light grown plants displayed a number of significant differences in rooting probability and number of roots by banding treatment.

These findings should provide insight to commercial growers who wish to determine the best propagation method for *L. benzoin* based on their facilities, budgets, and labor constraints. Growers with the ability to etiolate their stock plants with a black cloth tent should note that there were no significant differences in predicted rooting probabilities among cuttings receiving different banding treatments. Even unbanded cuttings rooted as well as cuttings that received bands with and without IBA. As for the number of roots per etiolated cutting, bands without IBA led to the highest number, but all band treatments were predicted to yield 38 to 50 roots per etiolated cutting. Therefore, etiolation without banding or etiolation with a band without IBA are appropriate methods of propagating *L. benzoin* with relatively little effort. These techniques save the step of dipping bands in Hormodin® while still resulting in high success rates.

Conversely, if a grower plans to grow *L. benzoin* stock plants under sun or a shade cloth, the importance of banding and Hormodin® application increases. For instance, for light-grown stock plants, banding with Hormodin® 3 significantly increased both the predicted rooting probability to 77% and number of roots per cutting to 15.3, as compared to unbanded cuttings' 48% rooting probability and 5.7 roots per cutting.

In the near future, rooting data will be taken on a second round of cuttings (approximately 280) from the same stock plants. Analyzing these data will help to verify the

reliability of etiolation, shading, and banding treatments on the increased rooting of *L. benzoin* cuttings. Improved understanding of asexual propagation techniques will allow the horticultural industry to make more clonal selections for desirable ornamental traits and bring this underutilized plant to a wider market.

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