Plant Propagation from cuttings using rooting solutions by foliar methods

Joel Kroin
Hortus USA Corp.
support@hortus.com
rooting-hormones.com

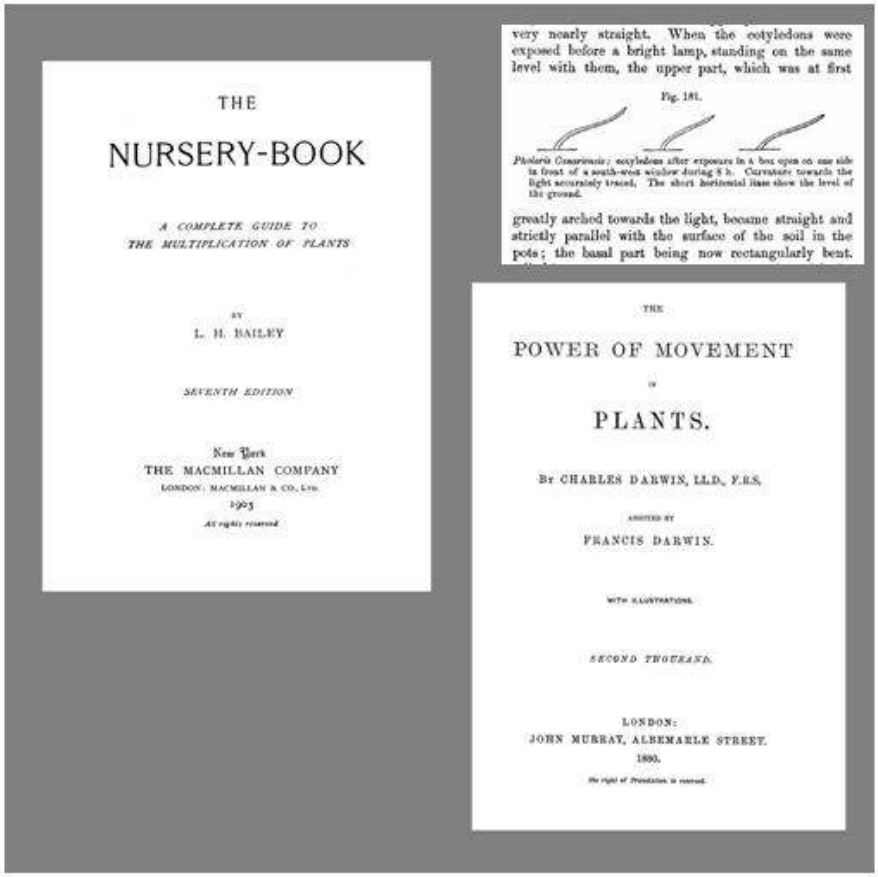
Presented at the International Plant Propagator's Society
Eastern Regional Meeting, Cleveland OH, October 17, 2009

Plant Propagation from cuttings using rooting solutions by foliar methods
including

- **how foliar methods work**
- **methods and rates**
- **when and when not to use foliar methods**

Methods to apply rooting solutions to the leaves of plant cuttings will be discussed.
Using readily available equipment, these methods assure all cuttings are properly treated using minimum labor and materials.

I have never completely read a whole book on plant propagation nor even read a complete chapter. I did however read a popular book on nursery management. Written in '96 the writer explains that the best way to propagate plants is to use it's natural reproduction ability. Perhaps you have this popular book, the Nursery Book, written by Liberty Hyde Bailey, not in 1996 but rather 1896, more than 120 years ago.



THE

NURSERY-BOOK

A COMPLETE GUIDE TO
THE MULTIPLICATION OF PLANTS

BY
L. H. BAILEY

SEVENTH EDITION

New York
THE MACMILLAN COMPANY
LONDON: MACMILLAN & CO., Ltd.
1903
All rights reserved

very nearly straight. When the cotyledons were exposed before a bright lamp, standing on the same level with them, the upper part, which was at first

Fig. 181.

Phalaris Canariensis: cotyledons after exposure in a box open on one side in front of a south-west window during 8 h. Curvature towards the light accurately traced. The short horizontal lines show the level of the ground.

greatly arched towards the light, became straight and strictly parallel with the surface of the soil in the pots; the basal part being now rectangularly bent.

THE

POWER OF MOVEMENT

IN

PLANTS.

BY CHARLES DARWIN, LL.D., F.R.S.

ASSISTED BY

FRANCIS DARWIN.

WITH ILLUSTRATIONS.

SECOND THOUSAND.

LONDON:
JOHN MURRAY, ALBEMARLE STREET.
1880.

The right of Translation is reserved.

Bailey did not discuss plant rooting substances since scientists had not yet identified them.

Contemporaries of Bailey, Darwin and other scientists, identified the polar transport of natural substances from the apex top part of the plant downward.

- The above diagram shows Darwin's illustrations in his 1880 book 'Power of Movement in Plants'.

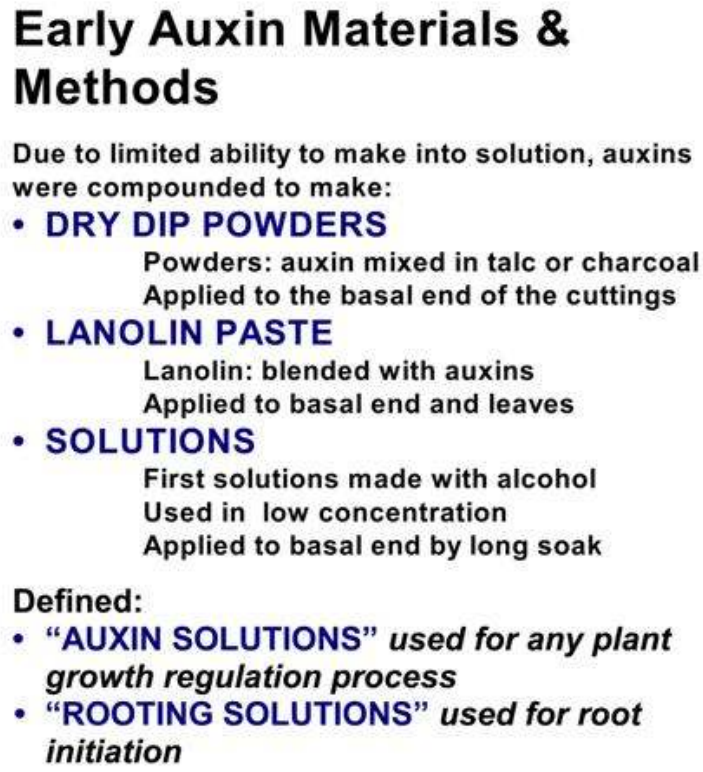
It was not until 1934, Thimann and Went identified the substance to be IAA, Indole-3-acetic acid, a plant growth regulator, now called an auxin.

• Scientists identified substances related to IAA

IAA is unstable and degrades rapidly in the presence of light and heat. bio-simulators of IAA that are more stable include:
• IBA, Indole-3-butyric acid
• NAA, Naphthalene acetic acid

The scientists found that auxins had "free" and "bound" states.

• **"Free auxins",** are available immediately and move within the plant in polar transport
They can move from leaf tips and continue downward through the plant system.
Free Auxins are present when auxins are dissolved in water.
• **"Bound auxins"** are variable in their ability as plant growth regulators.
They have limited ability to move in the plants' system
Bound Auxins are found in compounds like dry powders rooting hormones and lanolin pastes.



EARLY AUXIN APPLICATION METHODS

From the early 1930's, researchers were limited in the auxin material that they had at hand. Auxins, as produced are difficult to make into solutions, therefore, other compounds were made"

- **Auxin Dry Dip Powder compounds**
  - Powders were made with auxins blended with talcum powder or powdered charcoal.
  - These are applied to the basal end of the cuttings.
- **Auxin Rooting Solutions**
  - Used by basal long soaks.
  - Early auxin rooting solutions, made up using alcohol, were made in low concentration
  - After 1939, tablets made by Rhizopon, in Holland, allowed auxin solutions to be made using water.
  - These solutions were used for plant rooting and other plant growth regulation operations.
- **Auxin Lanolin Pastes**
  - Used by application to the basal end and also to plant leaves

Early Auxin Materials & Methods

Due to limited ability to make into solution, auxins were compounded to make:

- **DRY DIP POWDERS**
  - Powders: auxin mixed in talc or charcoal
  - Applied to the basal end of the cuttings
- **LANOLIN PASTE**
  - Lanolin: blended with auxins
  - Applied to basal end and leaves
- **SOLUTIONS**
  - First solutions made with alcohol
  - Used in low concentration
  - Applied to basal end by long soak

Defined:

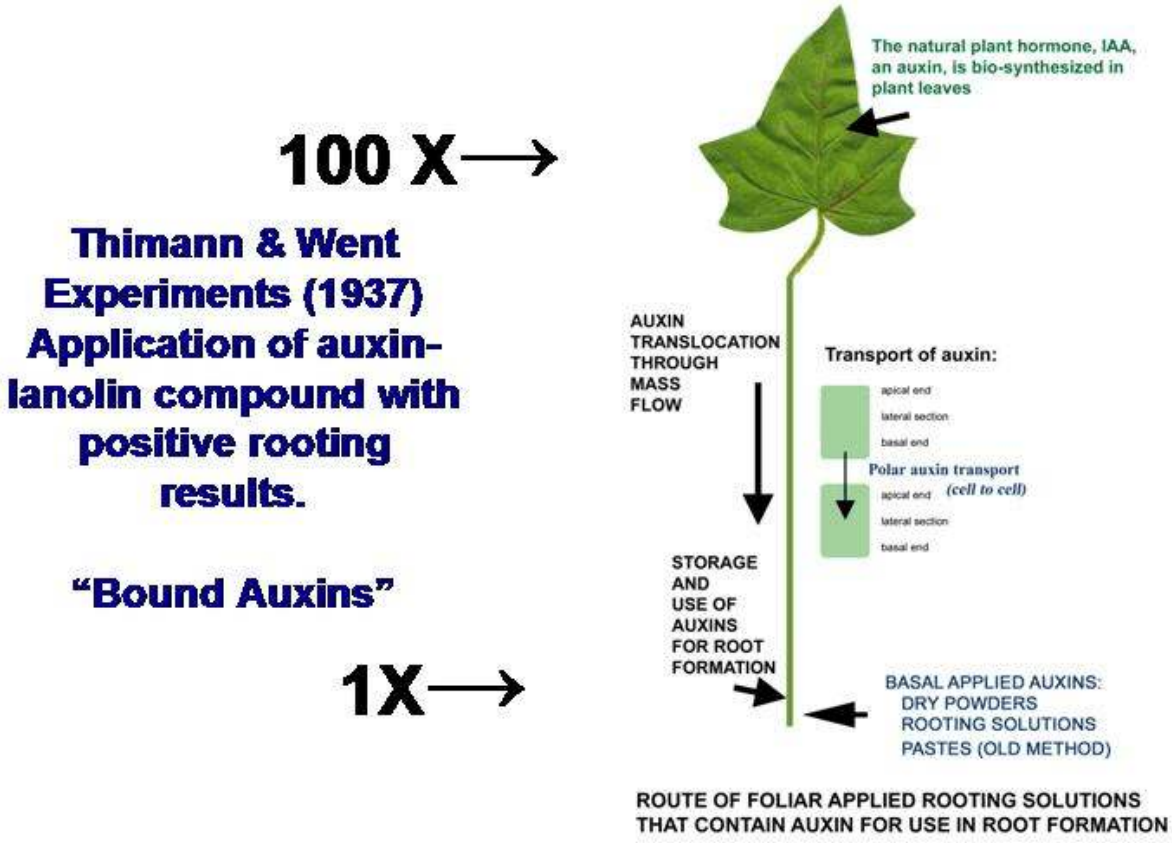
- **"AUXIN SOLUTIONS"** ***used for any plant growth regulation process***
- **"ROOTING SOLUTIONS"** ***used for root initiation***

IAA is manufactured by plants during photosynthesis in leaves.
The plant transports IAA, and other auxins

In polar transport auxins move

- Cell to cell
- From the leaf to the basal end
- They accumulate in high concentration at the basal end.

The relative auxin distribution is shown in the diagram from Thimann's book



Thimann and Went, in their 1937 book Phytohormones, discuss trials on plants

They applied lanolin-auxin compounds to various parts of the plant.

Application to the apex and also to the basal end both had positive rooting effects.

"When auxin is applied to the apex, the lowest concentration needed to produce localized roots in this way is about 100 times that needed to produce roots at the base".

Thimann and Went did prove auxin applied to leaves induced root formation

Their compound had ‘Bound Auxins' that are difficult to translocate. Therefore, they needed concentrations higher than basal application

Some Auxin Effects on Plants

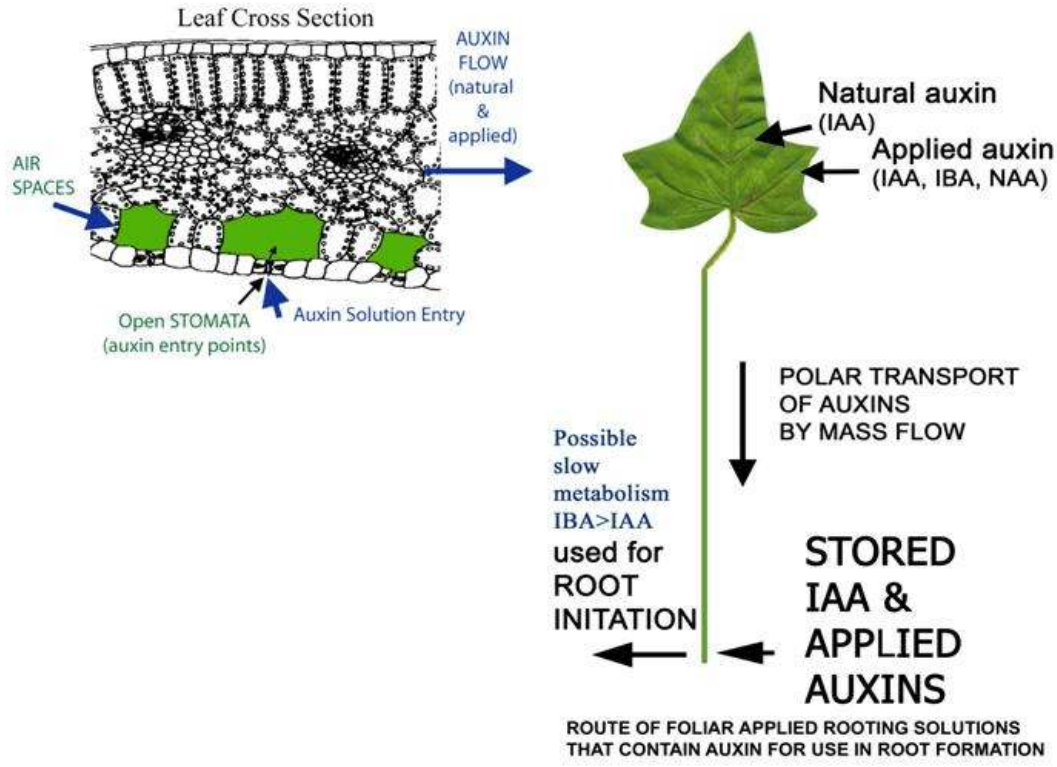
- Induce Cell Enlargement
  Increase root and stem length
- **INDUCE CELL DIVISION**
  Assists in root formation
- Induce Root Formation
- Induce Apical Dominance
- Effect Stem and Leaf Growth
- Tropic Responses: Bending
- **LEAF SENESCENCE**
  Delays leaf drop
- **LEAF AND FRUIT ABSCISSION**
  Promotes leaf and fruit drop
- Induce Fruit Setting and Growth
- Promote Flowering in Some Plants
- Promote Growth of Growth of Flower Parts
- Sometimes Excess Auxin Inhibits Growth

From early studies by Thimann and Went and the researchers including those at the Boyce Thompson Institute observed the many effects that auxins have on plants

In 1985, Kees Eigenraam was the technical advisor for Rhizopon bv in Holland.
Kees knew that Rhizopon auxin rooting products, made into aqueous auxin solutions

Applied to the leaves of plants

- Regulate fruit
- Regulate Flower drop.



Observation on foliar applied auxins are

- Leaves have stomata, pores that allow the plant to transpire gases, oxygen, carbon dioxide, and liquids.
- Under the stomata are air spaces.
- Applied auxin solutions enter the leaves through the stomata
- The auxin solutions enter the air spaces,
- Aqueous auxin solutions contain ‘free auxins'.
- The auxin solutions are carried in the plant’s vascular system just like the natural auxin

Kees found that aqueous auxin solutions applied to leaves had a positive effect on root initiation. The aqueous solutions have free auxins; they are able to translocate through the plant.
As was seen in the previous diagram, the auxins are accumulated at the basal end. Since the auxins accumulate, the rate necessary for root formation when auxin solutions are applied to the leaf may be lower than rates required by basal application.

- If 100 parts of 1 ppm IBA in are applied to a large leaf area, when they accumulate at the basal end they become one part of 100 ppm IBA, assuming no losses

Doing trials at Dutch greenhouses, Kees developed two methods of foliar application.
THE TOTAL IMMERSE METHOD
THE SPRAY DRIP DOWN METHOD

In 1994 I visited Kees in Holland where we visited several growers who used these methods.

Total Immerse Method

- The cuttings are TOTALLY IMMERSED in an IBA water based rooting solution for five seconds.
- Use a basket (optional).
- The cuttings are STUCK in media.
- The cuttings require no further treatment.
- Dispose of solution after use.

Workers doing sticking do not individually treat the cuttings. The cuttings are all treated uniformly.

Useful for small production lots and large homogenous lots.

Using the **TOTAL IMMERSE METHOD**

- Use a basket (optional)
- Use a IBA water based rooting solution
- The cuttings are TOTALLY IMMERSED in the rooting solution (for five seconds)
- The cuttings are STUCK in media
- The cuttings require no further treatment

Useful for

- Small production lots.
- Large homogenous lots taken from a large parent stock.

To avoid cross contamination of pathogens, the rooting solution should be disposed after four to five hours of use or minimum every day.

Some of the growers we visited were pot rose and hedera growers.

The Dutch growers Totally Immersed the cuttings in the rooting solution, drained, then stuck.
The solutions were made with Rhizopon AA water Soluble Tablets containing IBA

In this photo the ivy are treated in the immersion tank having a drain tray.
The dip basket is not shown

Spray Drip Down Method

- The cuttings are STUCK in media
  The cuttings are SPRAYED with an IBA water based rooting solution until liquid drips off the leaves.
- Use a tank type sprayer: hand, backpack or hydraulic.
  Do not use booms or proportional mixers.
- The cuttings require no further treatment.

Misters are turned on after the leaves dry or after about 45 minutes.

There is no cross contamination. The solution is used one time. The unused solution can be kept for several days or weeks in normal temperature and light.

The workers doing sticking do not individually treat the cuttings. The cuttings are all treated uniformly.

The second method is the **SPRAY DRIP DOWN METHOD**

- The cuttings are stuck in media.
- The rooting solution is sprayed onto the cuttings until the liquid drips off the leaves.
- Minimum labor skills are required, and, no PPE is needed since cuttings are untreated.
- Tank mix sprayers are used, hand, backpack or hydraulic.
  - Boom sprayers do not provide good control.
  - Proportional mixers do not provide consistent mixing.
- One skilled operator can treat large production areas in a few minutes.
- Misters can be turned on after the rooting solution dries on the leaves or 30 to 45 minutes.
- In hot conditions spraying is done early in the morning while the temperature is cool and the stomata are open.
- The rooting solution is used once, therefore, there is no cross contamination caused by the treatment.

The Total Immerse and Spray Drip Down methods are labor saving

- The workers doing sticking do not individually treat the cuttings.
- The cuttings are all treated uniformly

We visited Lyraflor greenhouses, then one of the world's largest chrysanthemum rooting stations, They used robots.

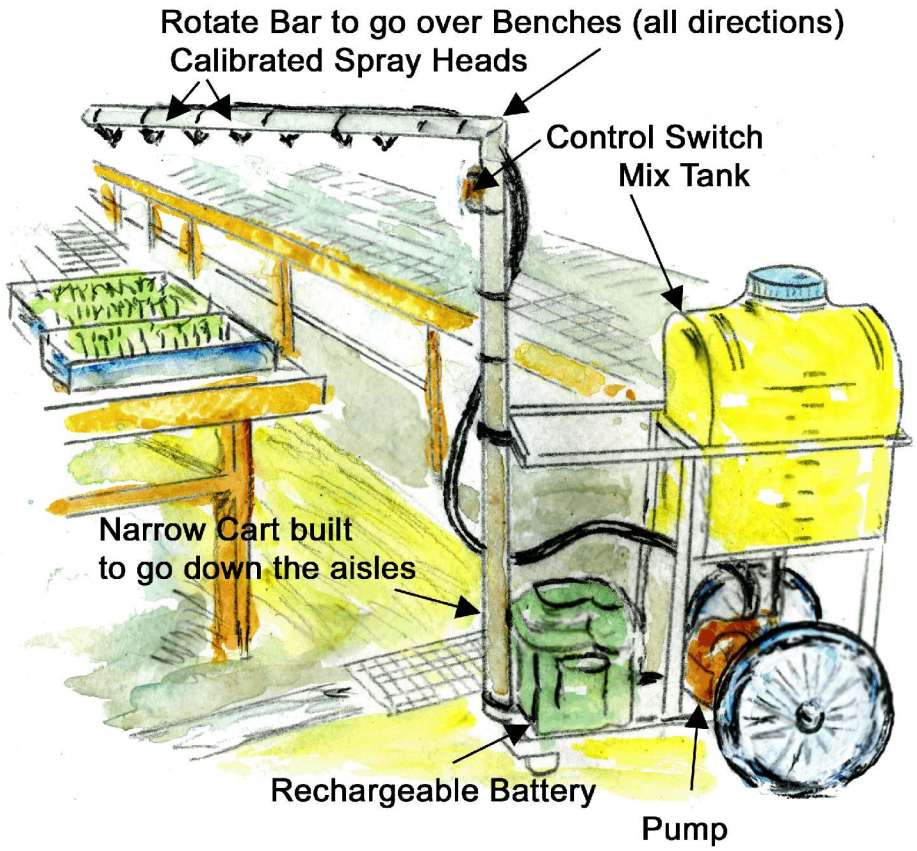
- The robots placed the trays of cuttings in the propagation house.
- The robot then sprayed the rooting solutions on the cuttings.

So, I just said not to use booms. These are not ordinary booms.
These are sprayers which were is optically controlled to provide uniform spraying on each cutting

Soon after my Holland trip, in the US, Kees and I visited the **Yoder Brothers** chrysanthemum Florida stock plant facilities. At that time they used rooting solutions by basal quick dip. We introduced them to foliar application.

Soon after their Yoder-Greenleaf Perennials growers in Lancaster PA did foliar trials on their perennial plant cuttings. They kept computerized record on thousands of trials. They adopted the Spray Drip Down Method using Hortus IBA Water Soluble Salts. Here we see the propagation manager putting flags on each production lot indicating the rooting solution rate to be applied. The flags are removed as the cuttings are treated.

A few years later Sam Drahn at **Bailey Nurseries** developed a program using the Spray Drip Down Method on woody ornamental plant cuttings using Hortus IBA Water Soluble Salts. The Bailey trials were innovative since the technique had previously mostly been used on annual and perennial cutting.



Custom Built Cart Used to Apply Rooting Solutions by the Spray Drip Down Method

Yoder and Bailey Nurseries developed spray methods suited for their operations.

- Both companies do sticking all day and spray the next work day, even after a weekend.

Shown here, the Yoder-Greenleaf Plants, Lancaster facility, made a **spray cart**.

- The spray arm at the top swivels to allow spraying on either side of the aisles.
  As the cart is moved down the aisles, the operator controls the spay so that all the cutting are treated.

As you saw in the earlier photo, the flags are removed as the cuttings are treated

Bailey Nurseries plant their cuttings in beds or pots.

- They spray the cuttings using a hydraulic sprayer

Trial Rates

Rates can be lower for juvenile cuttings

TRIAL RATES FOR CUTTING TYPES	Solution rates in ppm IBA - When made with water soluble IBA
Tender Perennials, Annuals and Tropical Plant cuttings	80-250
Winter Hardy cuttings:	
Perennials	250-1500
Woody Ornamentals	350-1500

Source: *Rates used by US and Dutch growers including Yoder Brothers, Aris Green Leaf Plants, and Bailey Nurseries when using solutions made with Rhizopon AA Water Soluble Tablets and Hortus IBA Water Soluble Salts.*

Yoder produce **PERENNIAL PLANTS**, Bailey produce **WOODY ORNAMENTAL PLANTS**

- They each started trials at relatively high rates: 1500 to 2000 ppm IBA as Hortus IBA Water Soluble Salts.
- Over time they found satisfactory results using lower rates.
- Comparing the perennial to woody rates I was surprised that the target rates are almost the same; winter hardy perennial plant cuttings and woody ornamental plant cuttings need a range from about 350 to 1500 ppm IBA.

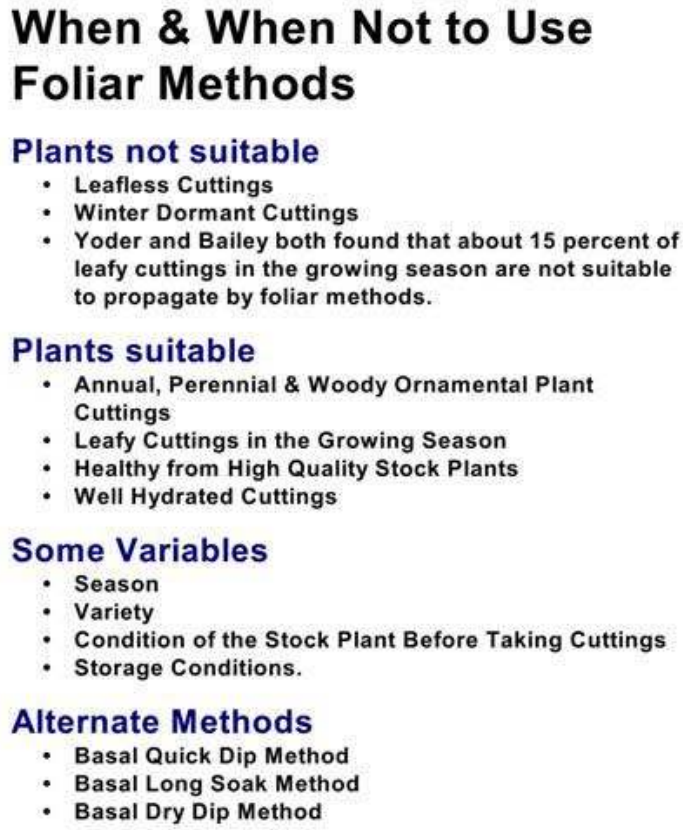
ANNUAL PLANT grower use much lower rates than those used for the hardy plant cuttings

- Annual plant cuttings and Tropical plant cuttings, those plants that are not hardy or short season, target rates are from 80 to 300 ppm IBA.
- While higher rates will not cause permanent damage to the cuttings, they might get leaf curl or leaf spotting.

These effects are not permanent as the new leaf growth will be normal and there will be a high root mass. The effect is likely not caused by the rooting solution. Rather, the cuttings had inadequate stock plant preparation. They might not have had enough light while growing and before taking cuttings to assure adequate stored carbohydrates.

SLOW TO ROOT CUTTINGS, planted in trays or pots, can use the be sprayed, using Spray Drip Down Method, to improve root formation.

- Spray rates are similar to initial rates by the Spray Drip Down Method.
- To bring young rooted plants up to a uniform standard, Dutch growers use the spray drip down method using Rhizopon AA Water Soluble tablets at about 50-100 ppm IBA



When not to use foliar methods

• Plants not suitable to be treated by foliar methods are leafless cuttings and winter dormant cuttings.

• Yoder and Bailey both found that about 15 percent of leafy cuttings in the growing season are not suitable to propagate by foliar methods.

• Suitability of plants is variable based upon reasons such as the season, variety, condition of the stock plant before taking cuttings, and storage conditions.

• Sometimes the plants are better propagated by basal methods such as the Basal Quick Dip, Basal Long Soak, and the Basal Dry Dip Method.

Successful Plant Propagation

Liberty Hyde Bailey

For successful propagation use the full potential of the plant itself.
Only use stock plant that are "vigorous, free from disease or blemishes, and that possess the characteristics of that variety.
"These "first class" plants are well grown, mature, and of the proper age for propagation.

Kees Eigenraam

Mother plants only produce "easy-to-root" cuttings when they are biologically and physiologically young.

L. H. Bailey was correct to say

- *When propagating plants you must use the full potential of the plant itself.*
- *Whatever propagation method he suggested to use,*

his goal is to use a stock plant that "is vigorous, free from disease or blemishes, and that possesses the characteristics of that variety. These first class plants are well grown, mature, and of the proper age for propagation.

Kees Eigenraam says,

- *Mother plants only produce "easy-to-root" cuttings when they are biologically and physiologically young*.

Bailey and Eigenraam are correct to select

- Select the very best plants,
- Take cuttings at the proper time

The result will be to achieve successful propagation.

Propagation on Plants Using Foliar Applied Rooting Solutions

- **Plants produce natural root forming substances, auxins, in leaves**
- **Leafy plants in the growing season can accept auxin rooting solutions through their leaves though open stomata**
- **The natural and applied auxins move in polar transport, from leaves to the basal end where they are used for root initiation**
- **The SPRAY DRIP DOWN & TOTAL IMMERSE METHODS are useful to apply rooting solutions to leaves**

In summary

- Plants produce root forming substances in their leaves
- When enhanced by additional bio-simulators of the auxins
- Applied to leaves in aqueous solutions they enter the plant trough pores, the stomata.
- The auxins can travel together by polar mass flow to the basal end of cuttings where they are stored
- In slow release they work together to induce new roots

The Spray Drip Down and Total Immerse Methods have been shown to be useful to apply these auxins

Acknowledgments

Kees Eigenraam
President, Rhizopon Bv, Holland
He Developed Foliar Methods to Apply Rooting Hormones to Induce Roots

Sam Drahn
Researcher, Bailey Nurseries
He Did Landmark Studies on Woody Ornamental Plants

The Plant Propagators at Green Leaf Plants (formerly Yoder Brothers)
They Did Extensive Trials on Perennial Plants

I thank

Kees Eigenraam
President of Rhizopon
Kees is responsible for developing foliar methods to apply rooting hormones to induce roots.

Two researcher teams have done practical research on foliar applications:

Sam Drahn
Researcher of Bailey Nurseries
Sam did landmark studies on woody ornamental plants.

The Propagation Team at Green Leaf Plants and Yoder Brothers
Green Leaf Plants (formerly Yoder-Greenleaf Plants) in Lancaster PA
This team did extensive research on perennial plant cuttings