

## عوامل مؤثر در باززایی گیاهان از قلمه

○ 1- شرایط محیطی و فیزیولوژیکی گیاهان مادری  
(عدم تنش، تاریک رویی، افزایش دی اکسید کربن، مواد غذایی معدنی، طوقه برداری)

○ 2- بازجوان سازی و آماده سازی گیاهان مادری  
(نگهداری قلمه ها، آبشویی برای حذف بازدارنده\_ها)

○ 3- شرایط محیطی حین ریشه زایی  
(روابط آبی، نور، فتوسنتز، محیط کشت)



## Etiolation and Banding

**Etiolation** is the exclusion of light to plant tissue. New growth lacks chlorophyll therefore stem and leaf color is white to yellow.

Difficult-to-root cuttings often show improved rooting after etiolation.



Cut branches of paw paw (*Asimina*) being etiolated for cutting propagation.

The entire stock plant can be covered with black plastic to exclude light as new growth emerges.

After etiolation, cuttings are removed from the plant and rooted under mist.



Black-out tents can be used to cover stock plants to generate etiolated stems. Image courtesy of B.H. Howard.

Etiolation can have dramatic effects of difficult-to-root woody plants.

However, the process is can be labor intensive and is only commercially viable on valuable cultivars.

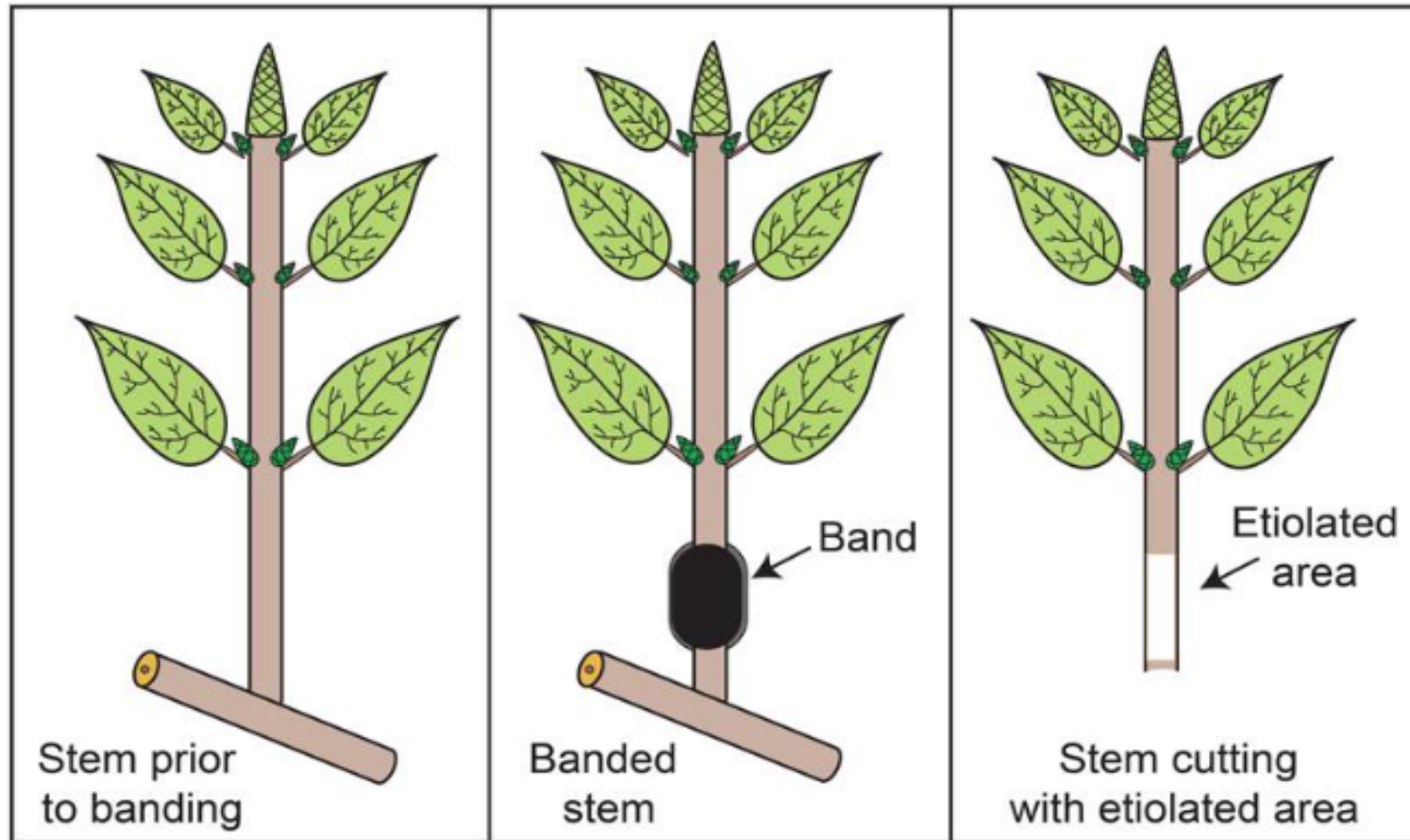


The impact of etiolation on a difficult-to-root lilac cultivar. Image courtesy of B.H. Howard.





It involves placing a self-adhesive black (opaque) band around the base of the stem while it is still attached to the stock plant to exclude light.



Cartoon depiction of banding a stem to create an etiolated area on the cutting.



Localized etiolation uses banding materials such as black tape or black Velcro.

It takes about four weeks to etiolate the stem.

After etiolation, cuttings are removed from the plant and rooted under mist.



Paw paw stem covered with black tape.

After etiolation, cuttings are removed from the plant and rooted under mist.



Redbud stem covered with a Velcro strip.



# 1- شرایط محیطی و فیزیولوژیکی گیاهان مادری

## ○ قلمه گیری در صبح (گیاه شاداب)

تاریک رویی حذف نور به طور کامل است  
پاتاریکی نور را به صورت موضعی حذف می کند  
سایه دهی رشد گیاه در شرایط نور کاهش یافته است.

○ تاریک رویی حساسیت ساقه به اکسین را افزایش می دهد، با تغییر در مواد فنولیکی همراه است، باعث تغییراتی تشریحی در بافت شاخه می شود که ممکن است پتانسیل آغازیدن سرآغاز ریشه را به دلیل سلول های پارانشیمی تمایز نیافته افزایش دهد، تولید لیگنین کاهش می یابد

○ کاهش در میزان نیتروژن گیاه مادری و کاهش رشد و تجمع کربوهیدرات، انتخاب شاخه های قوی با کربوهیدرات فراوان، هر نوع بستن ساقه انتقال کربوهیدراتها و هورمون ها را مسدود میکند



## ۲- بازجوان سازی و آماده سازی گیاهان مادری

- قابلیت تولید ریشه نابجا در قلمه با افزایش سن گیاه پس از کاشت بذر و یا به عبارت دیگر تغییر مرحله گیاه از نونهالی به بلوغ کاهش می یابد (افزایش تولید بازدارنده ها، کم شدن مقدار مواد فنولیک)
- تولید شاخه از ریشه و تهیه قلمه از آنها
- تولید شاخساره از محل تورم تنه
- پیوند شکل های بالغ روی نونهال و تیمار دمایی (تبدیل به گیاه نونهال)
- حلقه زنی، طوقه برداری، هرس شدید، تاریک رویی، محلول پاشی جیبرلین، کشت بافت و ....







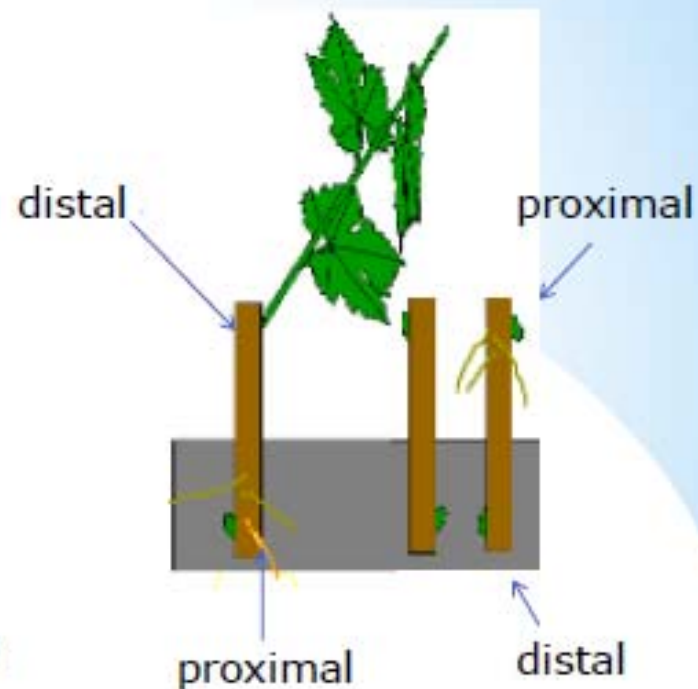
**Polarity** - A cutting has different properties in opposite ends

**Buds and leaves** -  
Affect root formation

**Plant Growth**

**Hormones** - influence  
root initiation

Auxins - natural IAA  
(Indole-Acetic Acid)



- وجود حداقل یک جوانه روی قلمه برای تولید ریشه ضروری است.
- یک قلمه بدون جوانه حتی اگر با مواد سرشار از آکسین تیمار شئد، ریشه نمیدهد
- در نخودفرنگی حذف جوانه پس از ۴ روز در تشکیل ریشه اختلالی ایجاد نکرد.

- اگر قلمه چوب سخت در اواسط زمستان در دوره استراحت جوانه ها گرفته شود، جوانه هیچ اثر محرکی روی ریشه دهی ندارد. (برخلاف اول پاییز و آخر زمستان)



➤ اثر برگها بر تولید کربوهیدرات ها و کمک به تشکیل ریشه ثابت شده است.

➤ برگها و جوانه ها تولید کننده های هورمون آکسین هستند

➤ پیوند بخش برگدار یک کلون آسان ریشه زا روی یک کلون سخت ریشه زا و استفاده از این ترکیب به عنوان قلمه موجب تولید آسان ریشه شد.

ماده پیشنهادی به عنوان ریزوکالین:

- مواد اختصاصی مانند اورتو دی هیدروکسی فنل
- مواد غیر اختصاصی مانند اکسین
- آنزیم های اختصاصی که در بافت های خاص مانند پریسیکل یا لایه زاینده تولید می شوند مانند پلی فنل اکسیداز





## مراحل تشکیل و نمو ریشه

○ 1- مرحله آغازیدن: تشکیل مریستم ریشه

الف: مرحله فعال اکسین، نیاز مرتب به اکسین  
ب: مرحله غیرفعال اکسین: عدم نیاز به اکسین

○ 2- مرحله رشد و طولیل شدن ریشه: عدم واکنش به اکسین



# Auxins

IBA – Indole-butyric acid

NAA – Napthalene acetic acid



Indole-butyric acid

Napthalene acetic acid

Liquid concentrate

Willow water  
IBA, Salicylic acid



Powder

Indole-butyric acid



Cytokinins – greatest effect on buds and shoots from leaf cuttings



High auxin to cytokinin ratio favors **rooting**  
High cytokinin to auxin ratio favors **shoot/bud**

- گونه هایی که سایتوکنین فراوانی دارند مشکل تر از آنهایی که سایتوکنین آنها کم است ریشه دار می شوند.
- معمولا به کارگیری سایتوکنین ها از آغازیدن ریشه در قلمه های ساقه جلوگیری میکند ولی اثر سایتوکنین در آغازیدن ریشه به مرحله خاص آغازیدن و غلظت دارد.
- اثر تحریکی آنها بر ریشه زایی می تواند به بازجوان سازی و جمع آوری کربوهیدرات ها مربوط باشد.
- افزودن سایتوکنین با غلظت زیاد به قلمه های برگ تشکیل جوانه نابجا را به حداکثر میرساند ولی کیفیت ریشه ها را کاهش می دهد





## Factors affecting success with cuttings:

- Nutrients in mother plant
- Immature material
- Water stress
- Lateral and terminal shoots
- Flowering or vegetative growth
- Seasonal timing



- جیبرلین ها در غلظت زیاد از تشکیل ریشه نابجا جلوگیری می کنند
- کند کننده های رشد شاخساره برای افزودن ریشه زایی استفاده می شوند

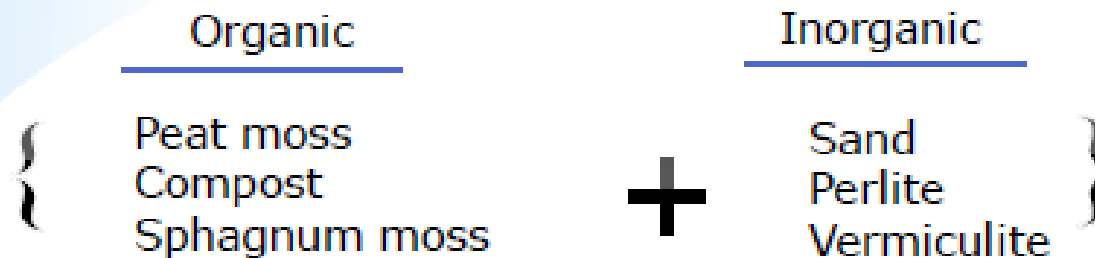
مکانیسم اثر کندکننده های رشد:

- جلوگیری از تولید جیبرلیک اسید
- کاهش رشد شاخساره و رقابت
- اتیلن می تواند روی تشکیل ریشه اثر افزایشی یا کاهش دهنده داشته باشد یا بی اثر باشد.



# Factors affecting success with cuttings:

- Rooting medium



- Wounding (sanitize tools)
- Treating with auxins
- Enclosures
- Bottom heat
- Care after rooting



# TYPES OF STEM CUTTINGS

Segments of stems containing buds are used to produce new plants. There are several types:

**Softwood**○

**Semi-hardwood**○

**Hardwood**○

**Herbaceous**○





**Hardwood cuttings are taken in the dormant season when tissues are fully matured and lignified through their entire length. This may be after leaves have dropped in deciduous species.**

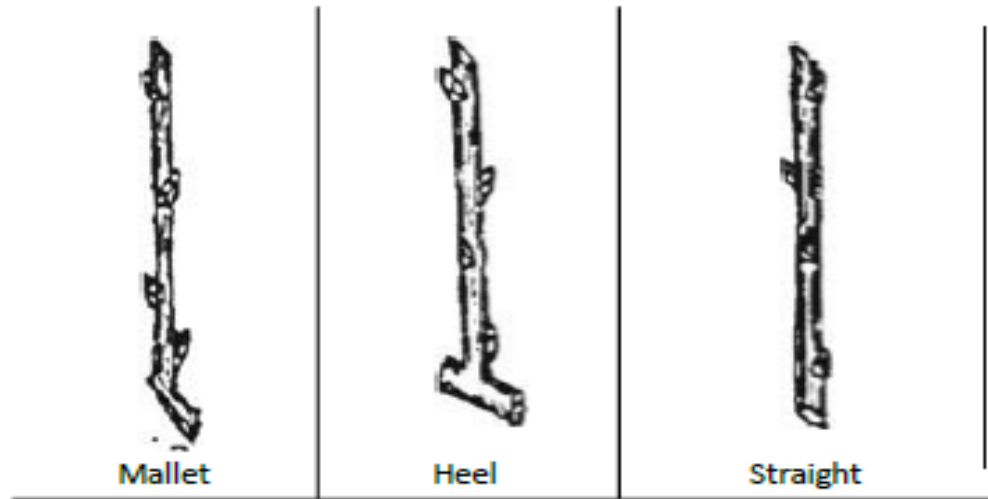
Cuttings should be planted upright with the top 2 – 3 buds above the medium. Hardwood cuttings vary in length from 4 to 20 inches with at least two nodes included in the cutting. The diameter of the cutting may range from  $\frac{1}{4}$  to 1 inch depending upon the species.

In case of difficult to root species treat the prepared cuttings with recommended growth regulators to induce rooting. Insert the cuttings in the hole such that at least two nodes are inside the soil. Take care of polarity while planting cuttings. After planting press the medium firmly around the cutting and water immediately.

**Eg:** *Grape, Fig, Pomegranate, Bougainvillea, Acalypha, Rose etc.*

Hard wood cuttings may be of three types: **Straight or simple cutting**, **heel cutting** and **mallet cutting**.

#### Types of Hard wood cuttings



#### Types of hard wood cutting

**Straight or simple cutting:** It consists of only the current year's wood and doesn't bear any older wood. Eg. Hibiscus, Nerium.

**Heel cutting:** A small piece of older wood is retained at the base of each cutting Eg. Rose

**Mallet cutting:** An entire section of the older wood is retained. Eg. Thuja.





**Semi-hardwood cuttings differ from softwood cuttings only in the maturity of the wood. They are collected later in the growing season when the lower portion of the cutting has become lignified (woody).** ○

Semi-hardwood cuttings of evergreen species are generally taken from new shoots 6 to 9 weeks after a flush of growth when the wood is partially matured. This can be any time from mid-spring to the end of the growing season. ○



**Semi-hard wood stem cuttings:** Semi hard wood cuttings are prepared from new shoots just after a flush of growth which is partially matured.

**Preparation and planting:** Select partially matured shoots from a healthy and vigorous growing plant and take out the terminal 7 to 15cm portion by giving a horizontal cut just below a basal node. Remove all the leaves towards the base of the shoot and retain only the terminal leaves. If the retained leaves are very large, reduce their size by cutting the top half portion. This facilitates planting the cuttings closer and also minimizes the loss of water from cutting. Plant the cuttings in the same way as hard wood cuttings are planted .Eg. Camellia,Citrus,Eranthemum,Acalypha,Geranium, Hibiscus, Jasmine, Lemon, olive etc.



**Softwood cuttings are taken from woody plants when growth is still relatively soft and succulent before tissues have matured and become woody.**

Softwood cuttings usually root easier and faster than other types of stem cuttings, taking about 6 weeks.

Softwood cuttings should be taken during the summer months when plants are still growing. The stems should be hardened enough to “snap” when bent.

**Soft wood cuttings:** Cuttings are prepared from the soft succulent new spring growth of species which are 4 to 6 months old.

**Preparation and planting:** Select the soft succulent shoots from a healthy and vigorous growing plant, growing in full sun light and take out the terminal 7 to 15cm portion by giving a horizontal cut just below a basal node. Don't remove the leaves except for the part to be buried inside the rooting media. Soft wood cuttings should be kept in green house or in moist chamber where a high humidity can be maintained which keeps the tissues in turgid condition. Plant the cuttings in the same way as hard wood cuttings are planted. Eg. *Nerium*, *crotons*, *Cranthemum*, *Graftophyllum* etc.







**Herbaceous cuttings are made from succulent, herbaceous (non-woody) plants such as geraniums, chrysanthemums, coleus, and carnations.**

Herbaceous cuttings are typically 3 to 5 inches in length with leaves retained at the upper end. Most florists' crops are propagated by herbaceous cuttings.



# LEAF CUTTINGS

Certain plants with thick and fleshy leaves have the capacity to produce plantlets on their leaves. In leaf cuttings, the leaf blade with or without petiole and axillary bud is used for starting new plants. Adventitious roots and shoots form at the base of the leaf and form in to a new plant.

The original leaf does not become a part of the new plant. Frequent watering and high humidity and bottom heating are desirable for better and rapidrooting of leaf cuttings.

Sand or sand and peat moss (1:1) are satisfactory rooting media for leaf cuttings.

For leaf cuttings, depending on the species the whole leaf blade, leaf blade sections or the leaf with petiole is used.

leaf cuttings can be classified in to:

- 1. Leaf blade cutting
- 2. Leaf vein cutting / Leaf slashing
- 3. Leaf margin cutting
- 4. Leaf bud cutting



## Leaf blade/Leaf section cutting:

*Preparation and planting:* Select a healthy leaf and Give a slanting cut towards the base of the leaf. Measure a length of about 7 to 10-cm and give a horizontal cut towards the terminal end. Prepare as many cuttings as possible from the selected leaf. Insert up to  $\frac{3}{4}$  of the prepared leaf cuttings in to the medium. Take care of polarity while planting the cuttings. Compress the soil around the leaf cuttings and water immediately. Eg. Sansevieria.

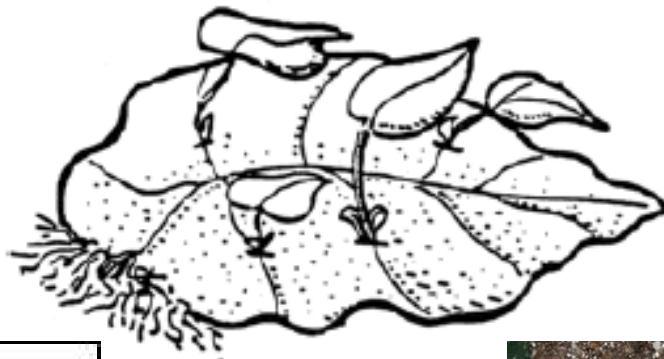


**Leaf Section cutting— *Sansevieria*.**



### Leaf vein cutting/Leaf slashing:

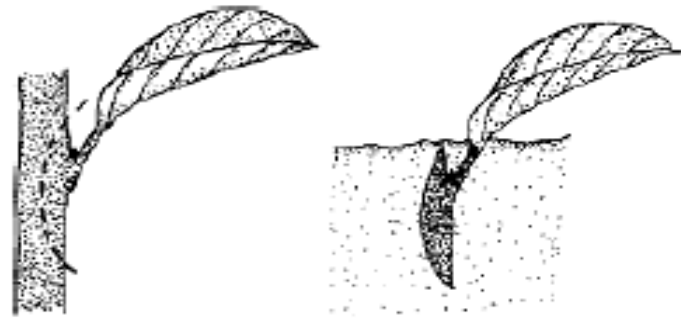
*Preparation and planting:* Select a healthy and full mature leaf and detach it from the mother plant. Give cuts to alternate veins closer to the petiole on the lower surface of the leaf. Keep the leaf flat on the medium in such a way that the lower portion comes in contact with the medium. Pin or hold down the leaf in some manner so as to expose the upper surface and to maintain the contact between the cuts on the vein and the rooting medium. Water the cuttings carefully Eg. Begonia rex.



Leaf vein Cutting



**Leaf bud cuttings:** This cutting consists of a leaf blade, petiole and a short piece of the stem with attached axillary bud. This is practiced in species that are able to initiate roots but not shoots from the detached leaves. In such case the axillary bud at the base of the petiole provides for the essential shoot formation.



**Leaf bud cutting**

Select a healthy and mature shoot with well developed buds and healthy active growing leaves. Separate each leaf along with the axillary bud and a small portion of the stem. Repeat the process until possible number of leaf bud cuttings are made. Treat if necessary the cut surface of the prepared cuttings with the recommended root promoting substance to stimulate rapid root formation. Insert the prepared cutting in the rooting medium so that the bud is 1.5 to 2.5 cm below the surface. Compress the medium around the cutting and water immediately. Eg. Black berry, Camellia, Lemon, Rhododendron and raspberry etc.





# SINGLE NODE CUTTINGS



## **Double-Eye Single Node Cutting (DE)**

- Healthier than SE
- Less disease attacks



## **Single-Eye Single Node Cutting (SE)**

- Largest no. cuttings/plant
- Slower development
- Higher mortality



Leaf Margin Cutting of *Bryophyllum*

**Leaf margin cutting:**

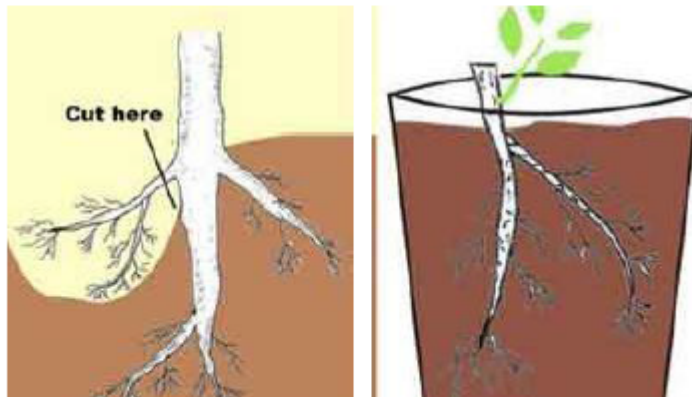
*Preparation and planting:* Select a mature and healthy leaf with the foliar embryos intact. Keep the leaf flat on the rooting medium. If the leaf is folded, just cut along the mid rib, so that the leaf can be kept flat on the medium. Keep some weight on the leaf or partially cover it with soil, so that the margin comes in contact with the medium. Water the cuttings carefully Eg. *Bryophyllum*.



# ROOT CUTTINGS

- The use of roots to reproduce plants.
- Should be spaced 3 inches apart in the rooting area.

Root cuttings: Plants which give rise root suckers freely are propagated by root cuttings.



Root cuttings



# PROCEDURE

- Gather Materials** ○
- Prepare Rooting Media** ○
- Remove Cuttings from Stock** ○
- Prepare Cuttings** ○
- Apply Rooting Hormone** ○
- Place Cuttings in Media** ○
- Label Cuttings** ○
- Follow Proper Safety and Sanitation Procedures** ○



**MANY TYPES OF MEDIA MAY BE USED FOR ROOTING BEDS INCLUDING SAND, PERLITE, PINE BARK AND VERMICULITE OR A COMBINATION OF THESE PRODUCTS. VERMICULITE, SHOWN HERE, MAKES A GOOD ROOTING MEDIA BECAUSE OF ITS COARSE TEXTURE, STERILE NATURE AND WATER AND AIR HOLDING CAPACITIES.**





**ROOTING MEDIA SHOULD BE FIRMED SO CUTTINGS MAKE GOOD CONTACT WITH THE MEDIA AND TO ELIMINATE LARGE AIR POCKETS. FIRMING CAN BE ACCOMPLISHED WITH CLEAN HANDS, A PIECE OF WOOD OR BY TAPPING THE CONTAINER ON THE BENCH. THE MEDIA SHOULD ALSO BE THOROUGHLY MOISTENED.**





**Many propagators take large pieces of stock from the field and move to an indoor location for final cutting preparation and sticking. In this case, place cuttings in a plastic bag and keep the cuttings out of the sunlight.**





**Select quality stock. Avoid stems with flowers and berries.**





**Make a basal cut just below a node at a 45 degree angle.**



**Cuttings should be 3” to 6” long, and uniform in size, although larger or smaller cuttings are used in certain situations. Cutting size is limited because the top of the cutting must be supported by the limited amount of moisture that can be absorbed through the base until rooting takes place.**

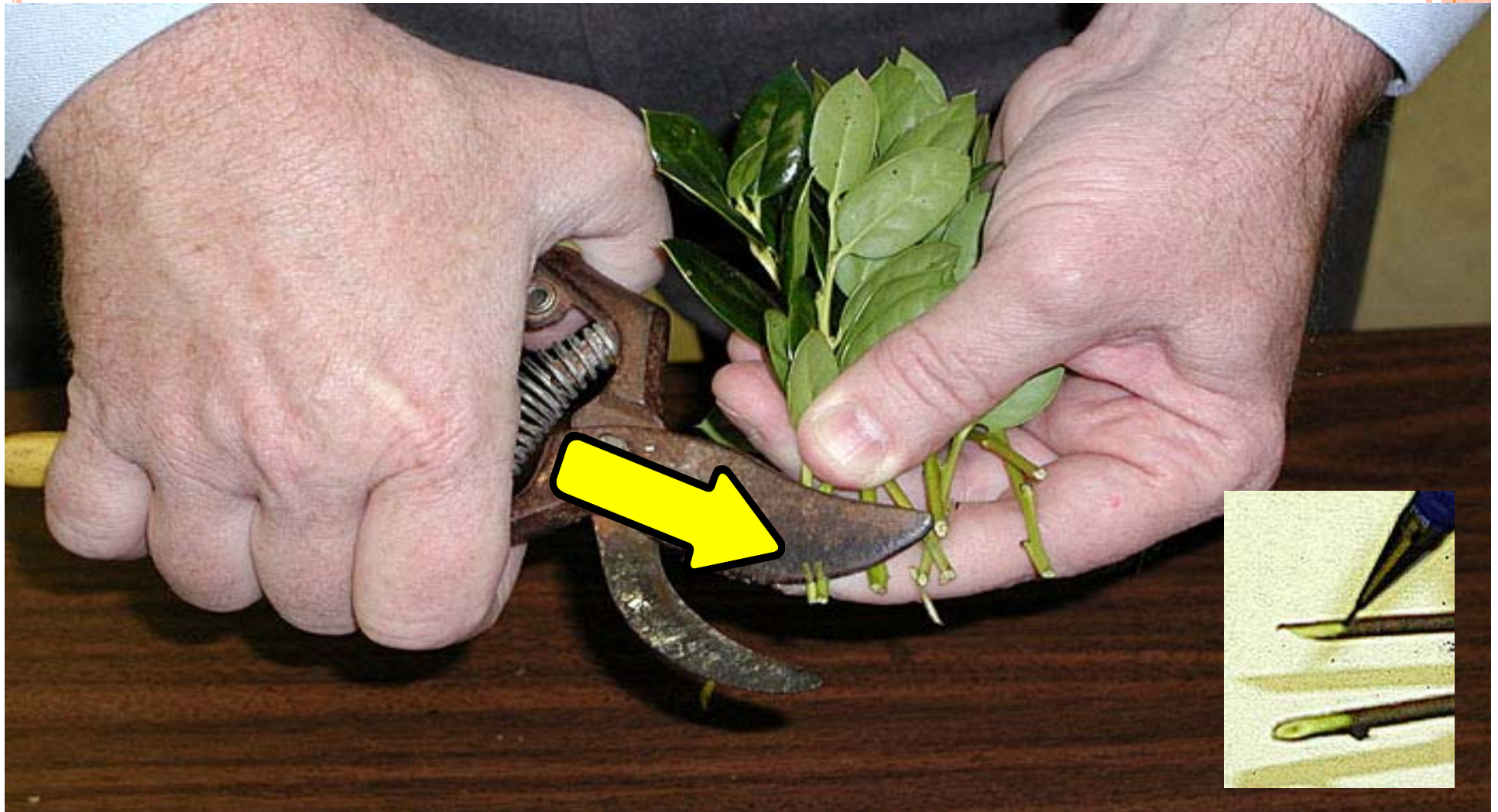




**Remove the bottom leaves from the cuttings. Leaves placed under the soil or in direct contact with the media may rot and cause disease.**



**Cuttings of harder-to-root plants are often wounded to expose more cambium and increase the chances of rooting while decreasing the time required to root.**





**The leaves of large-leaved cuttings may be trimmed before sticking to conserve propagation space.**





**Treating cuttings  
in IBA Solution  
(top)**



**Sticking IBA-  
treated cuttings in  
root substrate  
(bottom)**



**SEMI-HARDWOOD CUTTINGS -  
JOJOBA**

**Tap off the excess hormone powder. Be sure that the portion of the stem that will be under the media is coated.**





# INFLUENCE OF IBA ON SEMI-HARDWOOD CUTTINGS - CORDIA



**1-Control, 2-50% ethanol, 3-100 ppm, 4-1000 ppm, 5-2000 ppm, 6-4000 ppm, 7-6000 ppm, 8-8000 ppm, 9-10000 ppm IBA**



**Make holes in the growing media with a label or other clean tool.**





**Place cuttings into the media 1 to 2 inches deep. Hold each cutting with your fingers at the desired depth and push the cutting into the prepared hole or furrow until the desired depth is reached. Placing all cutting at the same depth helps in establishing uniformity.**



**The cuttings can also be firmed using a label or other clean tool.**





**To test for proper firmness of the media around the base of the cutting, give a light tug on the cutting. If the cutting slips easily from the media with little resistance, the cutting was not firmed properly.**



**Cuttings placed too close together, with overlapping leaves, hold moisture and prevent air circulation, allowing disease organisms to thrive.**



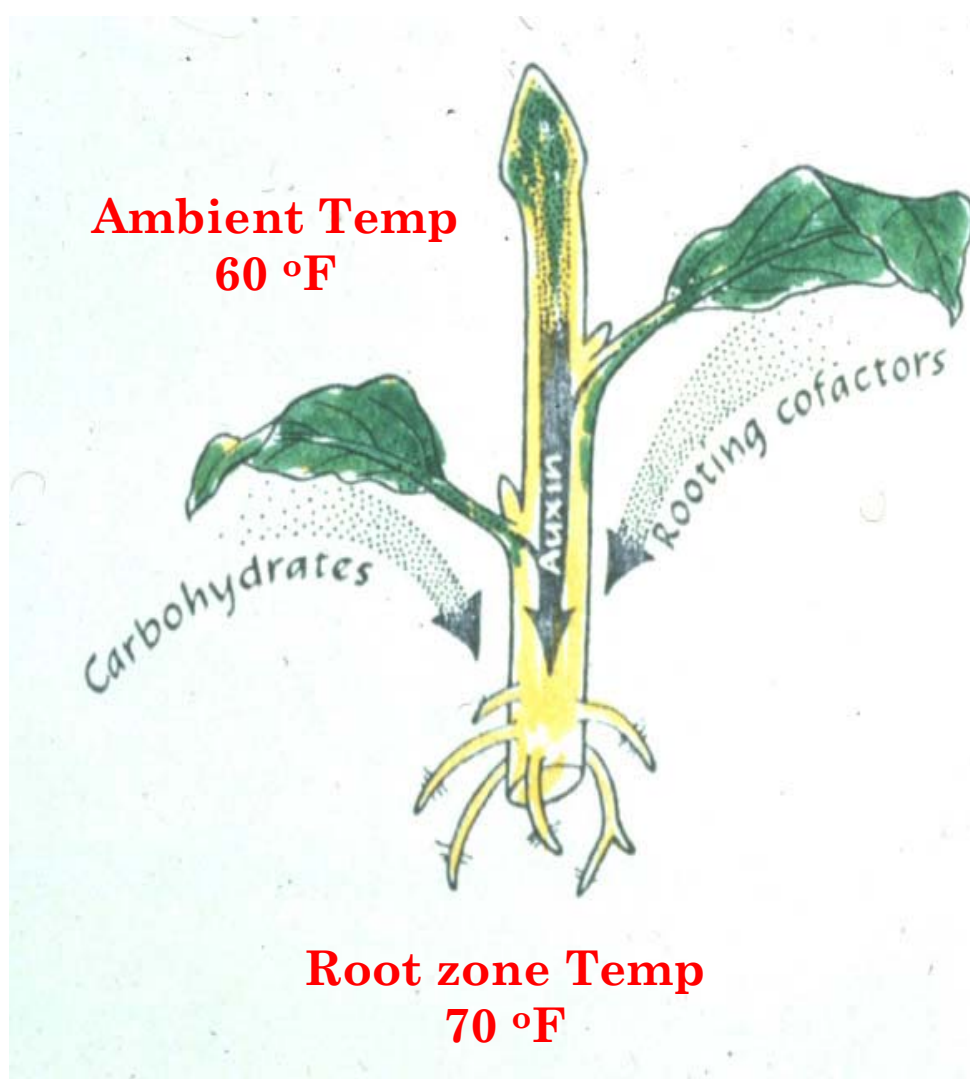


Place the label in the container with the plant name facing out for easy identification.





# TEMPERATURE DIFFERENTIAL HELPFUL FOR ROOT FORMATION



Rooting requires -  
carbohydrates  
(**energy**), auxin  
(**growth hormone**),  
and rooting  
cofactors  
(**enzymes**)

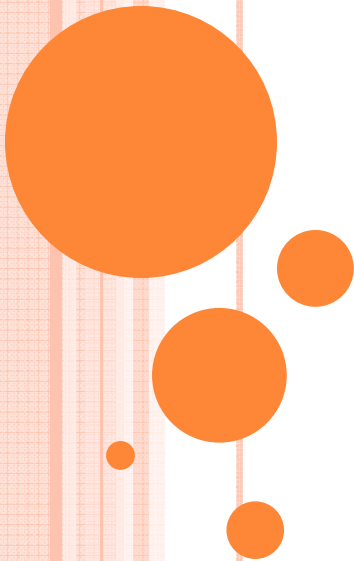
Temperature -  
differential (**10 °F**)  
between the  
ambient air and  
root zone is  
helpful for faster  
rooting



# BOTTOM HEAT SYSTEM FOR CUTTING BENCHES



# SAFETY AND SANITATION PROCEDURES





**NEVER cut toward hand or fingers!**





**Pruning shears should be closed when not in use.**





**Proper sanitation is essential to prevent disease. Alcohol or a 10% bleach solution may be used.**



**Discard remaining rooting hormone to prevent the spread of disease. DO NOT contaminate the main supply by returning used hormone to the original container.**





**DO NOT**  
use cutting materials that are dropped on the floor. The dropped  
materials may become contaminated with disease and infect the  
entire crop. Keep work areas neat, clean and free of debris.





**Good sanitation is  
important**

**Cutting on the left was  
infected with  
Alternaria and did not  
root**

**Cutting on the right  
was healthy and rooted  
well**

