

Foliar Method Trial Rates

- **Total Immerse Method**
- **Spray Drip Down™ Method**

A wide solution trial rate range is indicated for the Total Immerse and Spray Drip Down Methods. Ideal rates will vary according to specific plant variety, season, quality of the cuttings, and local growing conditions. Prior to large scale production, test a few plants at several rates within the range. If foliar application causes phytotoxicity, try basal applications and/or decrease rates. Use the lowest rate to produce the desired effect.

**TYPICAL SPRAY DRIP DOWN METHOD™
SOLUTION USE: 175-225 sq. ft./gallon**

Trial rates are *ppm* IBA using Hortus IBA Water Soluble Salts or Rhizopon AA Water Soluble Tablets (see pages 14-15 for conversion charts)

CUTTING TYPES	Hortus IBA Water Soluble Salts (<i>ppm</i> IBA)
Annuals, perennials, chrysanthemum	50-250
Herbaceous and hard to root perennial plant cuttings	250-1500
Woody ornamental cuttings	300-1500



Plant cuttings vary in quality. Trial rates shown are from specific lots under the grower's particular faculty and environmental controls. Growing facility and plant lots are different; always necessary to perform trials for plants in the specific facility.

Trial Rates:

Trial rates are *ppm* IBA using Hortus IBA Water Soluble Salts or Rhizopon AA Water Soluble Tablets (see pages 14-15 for conversion charts)

Woody Ornamental Plants Propagated by Spray Drip Down™ or Total Immerse Methods

Acer	1000-1500	Rosa, varieties	1000-1500
Cotoneaster	500-750	Rhus	500-750
Diervilla, paniculata	500-750	Spirea, Japonica	500-750
Hydrangea	500-750	Syringa	500-750
Juniperus, horizontalis	1000-1500	Thuja	1500-2000
Physocarpus, opulifolius	1000-1500	Viburnum	1000-1500
		Weigela	1000-1500

Trial Rates: Annual Plants Propagated by Spray Drip Down™ or Total Immerse Methods

Pelargonium geranium		Petunia sp.	150-200
sp. like "Balcon"	50-100	some colors	200-300
zonale	200-300	Osteospermum	150-200
peltatum	300-400	Verbena	200-300
Impatient New Guinea	15-50	Poinsettia	25-100
Fuchsia	15-50		



Trial Rates: Perennial Plants Propagated by Spray Drip Down™ or Total Immerse Methods

Trial rates are *ppm* IBA using Hortus IBA Water Soluble Salts or Rhizopon AA Water Soluble Tablets (see pages 14-15 for conversion charts)

Abutilon	750	Erodium		Origanum	500-750
Achillea	up to 1000	Dark Eyes	750	Paxistima	1000
Actinidia Arctic Beauty		Erysimum	750	Penstemon	500
	1000	Escallonia Comp	500	Persicaria	up to 1000
Ajuga	up to 1000	Eupatorium	500	Phlox	1000
Amsonia	1500	Euphorbia	1000	Phygelius	750
Anisodonte Tara's Pink		Gaillardia	500	Poinsettia	500-1000
	750	Galium		Polemonium	
Antennaria	up to 750	SweetWoodruff	1500	Bressingham purple	
Anthemis	1000	Geranium	1000		1000
Arabis Variegata	500	Geum Rivale	1000	Prunella Loveli.	750
Arctostaphylos	500	Gypsophila Viette'sDwrf		Rosmarinus	500
Armeria	1000		1000	Rudbeckia	750
Artemisia	up to 500	Hedera	1000	Ruellia	1000
Baptisia	3500	Helenium	500	Salvia	500-1000
Basil Kasar	500	Helianthemum	2000	Santolina	500
Buddleia	1000	Helianthus	1000	Saponaria	1000
Calamintha Var.	500	Helichrysum	500-1000	Saxifraga	750
Callicarpa	500	Heliopsis	1000	Scabiosa	1000
Campanula	500-1000	Hypericum	1000	Silene	500
Caryopteris	1000	Hyssop PinkDel.	500	Solly Boddy'sCh.	750
Ceanothus	500	Iberis	1000	Spilanthes	500
Ceratostigma	1500	Itea Little Henry	1000	Spiraea	1000
Chrysanthemum		Kerria	1000	Spiraea Gold Flame,	
	500-1000	Lamiastrum		Magic Carpet, Neon	
Chrysogonum	750	Herman Pride	1000	Flash	4000
Cistus	750	Lamium	up to 1000	Stachys	1000
Clematis	1000	Lavandula	1000	Stevia	
Clethra	1000	Leptospermum	500	rebaudiana	500
Coleonema	750	Linaria	500	Teucrium	1000
Convolvulus	750	Lithodora	2000	Verbascum	1000
Coreopsis	500-1000	Lonicera	1000	Verbena	750
Correa	500	Lychnis	1000	Vinca	1000
Cosmos	1000	Marjoram		Viola	1500
Cotoneaster		Compactum	500	Vitex	1000
Coral Beauty	500	Melissa	up to 500	Waldsteinia	1000
Delosperma	1000	Mentha	500	Weigela	1000
Erigeron	750-1000	Nepeta	500	Westringia	750
		Oenanthe	500		

Trial Rates for Basal Quick Dip Method

Make Rooting Solutions using Hortus IBA Water Soluble Salts or Rhizopon AA Water Soluble Tablets. Use the trial rate charts as a starting point.

Use on cuttings in the growing season and winter dormant cuttings.

- Immerse basal end of cuttings approximately 1" in Rooting Solution a few seconds.
- Stick immediately or store.

Trial rates are *ppm* IBA using Hortus IBA Water Soluble Salts or Rhizopon AA Water Soluble Tablets (see pages 14-15 for conversion charts)

CUTTING TYPES	Hortus IBA Water Soluble Salts (<i>ppm</i> IBA)
Annuals, soft perennial, tender cuttings from ornamental plants, tropical house plants	50-200
Herbaceous, perennials, pot rose cuttings	150-1500
Difficult to root herbaceous, perennials, tropical house plant cuttings	500-1500
Softwood cuttings	500-1500
Hardwood cuttings	500-2000
Difficult to root hardwood cuttings SEE THE NOTE BELOW	2000-10,000

Some cuttings are hard-to-root. This may be caused by the condition of the cuttings, the maturity of the cuttings, or the timing when cuttings are taken. Some growers *'think'* the answer is to use a high rooting hormones rate. They usually get *in-consistent rooting or no roots at all.*

A better answer is to use the Basal Long Soak Method. Even though low rates are used, the cuttings have more Rooting Hormone stored at the basal end so that rooting is successful.

Trial Rates for Basal Long Soak Method

Make Rooting Solutions using Hortus IBA Water Soluble Salts or Rhizopon AA Water Soluble Tablets. Use the trial rate charts as a starting point.

Use on cuttings in the growing season and winter dormant cuttings.

- Immerse basal end of cuttings approximately 1" in Rooting Solution for 12 to 48 hours.
- Stick immediately or store.

Trial rates are ppm IBA using Hortus IBA Water Soluble Salts or Rhizopon AA Water Soluble Tablets (see pages 14-15 for conversion charts)

CUTTING TYPES	Hortus IBA Water Soluble Salts (ppm IBA)
Hard to root annuals and perennials	25-100
Herbaceous cuttings	50-200
Woody ornamental cuttings, grape, roses	50-400

Typical annual, perennial and other herbaceous plants

Aeonium	Dahlia	Heliotropism
Araucaria	Delphinium	Hydrangea
(Norfolk Island pine)	Dracaena	Phaseolus
Aster	Dipladenia	Pittosporum
Azalea	Gypsophila (baby's breath)	Rosa (rose)
Cryptomeria (J. cedar)	Hedera (ivy)	Trachelium (throatwort)
Cupressus (cypress)		

Typical hardwood and softwood, difficult to root cuttings

Apple (malus) rootstock	Elaeagnus	Ribes (currant)
Aralia	Ficus (fig)	Robinia (false aralia)
Barberry	Forsythia	Salix (willow)
Callicarpa	Halesia (silverbell)	Redwood, coastal
Calocedrus	Holodiscus	Taxus (yew)
Carpinus (hornbeam)	Juniper	Thea (tea)
Cephalotaxus (J. plum yew)	Metasequoia (sequoia)	Theobroma (cacao)
Centaurea (knapweed)	Nerium (oleander)	Thuja
Chaenomeles	Olive	Thujopsis
(J. flowering quince)	Philadelphus (mock orange)	Torreya
Citrus	Physocarpus (ninebark)	Tsuga (hemlock)
Corylus (hazel)	Picea (spruce)	Ulmus (elm)
Cryptomeria (J. cedar)	Populus (poplar)	Viburnum
Cupressocyparis	Potentilla (cinfoil)	Vitis (grape)
(Leyland Cypress)	Prunus (peach rootstocks)	Weigela
Cytisus (broom)	Pseudotsuga (Douglas fir)	Wisteria
Derris (rubber)	Rhododendron	

Trial Rates for Dry Dip Method



Rhizopon® AA #1

Active ingredient 0.1% IBA

Pink Color Powder

Use on easy to root cuttings.

Rhizopon® AA #2

Active ingredient 0.3% IBA

Green Color Powder

An intermediate all purpose product.

Use on easy to more difficult to root cuttings

Rhizopon® AA #3

Active ingredient 0.8% IBA

White Color Powder

Use on more difficult to root cuttings

Rhizopon AA #1, #2 and #3 Dry Dip Rooting Hormones are not used to make Rooting Solutions.

SELECT THE RHIZOPON AA ROOTING POWDER FOR MANY TYPES OF PLANT CUTTINGS

SEASON	CUTTING TYPE	Rhizopon AA Dry Powder
In the growing season	Leafy cuttings: annuals	#1 or #2
	Leafy cuttings: perennials	#1, #2, or #3
	Leafy cuttings: woody ornamental and forestry	#2 or #3
All year	Tropical plants	#1 or #2
	Annuals	#1 or #2
	Perennials	#1, #2, or #3
	Woody ornamental and forestry plants	#2 or #3
Winter dormant cuttings	Woody ornamental and forestry plants	#2 or #3
All year	Hard to root cuttings	#2 or #3

Trial Rates for plants propagated by the Dry Dip Method using Rhizopon AA #1, #2 and #3

After the plant name is the product number for Rhizopon AA #1, #2 and #3 Dry Dip rooting hormones.

Various rates may be used for species dependent upon the variety, time of the year, condition of the stock plants, facility, environmental factors, and other variables.

Rhizopon AA #1, #2 and #3 Dry Dip Rooting Hormones are not used to make Rooting Solutions.

Abelia	#1	Chokeberry	#2 or #3	Franklinia	#2
Acanthopanax	#3	Chrysanthemum	#2	Fringe Tree	#2
African Violet	#1	Cinquefoil	#2	Fuchsia	#1
Ageratum	#1	Clematis	#2 or #3	Gardenia #1, #2 or #3	
Andromeda	#1	Clerodendron	#1	Geranium	#1
Apple, Malus	#2 or #3	Clockvine	#1	Germander	#2 or #3
Arborvitae	#2 or #3	Coleus	#1	Ginkgo	#2
Arbutus	#3	Cotoneaster	#3	Golden Chain	#2
Ardisia	#2	Crab Apple	#2 or #3	Grape	#3
Azalea var		Cape Myrtle	#1	Hawthorn	#3
	#1, #2 or #3	Crassula	#1	Hazelnut	#1 or #2
Barberry	#1	Creeper	#1	Heath	#3
Bayberry	#1	Croton	#1	Heather	#3
Beauty Bush	#3	Cryptomeria	#3	Hemlock	#2 or #3
Beauty Berry	#1	Currant	#1	Hibiscus	#2 or #3
Beech	#2	Dahlia	#2	Holly, Japanese	#2
Begonia	#1	Daphne	#1 or #2	Holly, American	#3
Birch	#3	Deutzia	#1	Honeysuckle	#2
Bittersweet	#3	Dew Berry	#1	Hydrangea	#2
Blackberry	#1	Dogwood	#3	Jetbead	#1
Bluebeard	#1	Douglas Fir	#3	Juniper var.	#2 or #3
Blueberry	#1 or #2	Dove Tree	#1	Kerria	#1
Bougainvillea	#3	Dracaena	#1	Knotwood	#3
Boxwood	#3	Dutchman's Pipe	#1	Laburnocytisus	
Broom	#1 or #2	Elder	#1 or #2		#1 or #2
Butterfly Bush	#1	Escallonia	#2	Lantana	#1
Camellia	#3	False Arborvitae	#2	Laurel	#3
Candytuft	#1	Firethorne	#1 or #2	Lavender	#2
Carnation	#3	Flowering Cherry	#1	Leucothoe	#2
Catalpa	#3	Flowering Quince	#3	Lilac	#3
Chaste Tree	#3	Fontanesia	#1	Lily Scales	#1 or #2
Chestnut	#3	Forsythia	#1	Linden	#1

Locust	#3	Periwinkle	#2	Spiraea	#1
Magnolia	#2 or #3	Petunia	#2 or #3	Springscent	#2
Manzanita	#3	Philodendron	#1	Spruce var.	#2
Maple, Japanese	#3	Phlox	#1	St. Johnswort	#1
Matrimony Vine	#3	Photinia	#3	Stevia	#1
Melastoma	#1	Pine var.	#2 or #3	Stewartia	#1
Mock Orange	#1	Poinsettia	#1	Sweet Leaf	#1
Mulberry	#1	Poplar	#1	Trumpet Creeper	#1
Ninebark	#3	Prickly Pear Cactus	#1	Tulip Tree	#3
Norway Spruce	#1	Privet	#3	Umbrella Pine	#3
Oak	#3	Raspberry	#1	Verbena	#1
Oleander	#2	Retinospora	#3	Viburnum	#1
Olive	#3	Rhododendron var.	#3	Waxmyrtle	#1
Orange, sour	#3	Rose	#1, #2 or #3	Weigela	#1
Orixa	#1	Russian Olive	#3	Willow	#1
Osage Orange	#1	Sage	#1	Wintergreen	#2
Osmanthus	#2	Sequoia	#2	Wisteria	#2
Pachysandra	#2 or #3	Snapdragon	#1	Witch Hazel	#2
Pea Shrub	#1	Snow Berry	#1	Yellow Wood	#2
Pear rootstocks	#3	Sourwood	#3	Yew var.	#3
Pecan	#3	Speedwell	#1	Zelkova	#2
Penstemon	#1				



Trial Rates using Rhizopon AA Water Soluble Tablets

To make Rooting Solutions using Rhizopon AA Water Soluble Tablets simply count the tablets and mix in water.

- Mix into ordinary water.
- Rhizopon AA Water Soluble Tablets are useful when a scale is not available to measure, and to mix small amounts of Rooting Solution.
- Use the Rooting Solutions by the foliar and basal methods shown in this book.

TRIAL RATES using Rhizopon AA Water Soluble Tablets.

(To use Hortus IBA Water Soluble Salts see pages 14-15 for conversion charts)

Spray Drip Down & Total Immerse Methods	Tablets/liter
Annual, perennial, chrysanthemum cuttings	1-5
Herbaceous and hard to root perennial plant cuttings	5-30
Woody ornamental cuttings	6-30

Basal Quick Dip Method	Tablets/liter
Annuals, soft perennial, tender cuttings from ornamental plants, tropical house plants	1-4
Herbaceous, perennials, pot rose cuttings	3-20
Difficult to root herbaceous, perennials, tropical house plant cuttings	10-30
Softwood cuttings	5-20
Hardwood cuttings	10-30
Difficult to root hardwood cuttings (or use Hortus IBA Water Soluble Salts at higher rates)	30

Basal Long Soak Method	Tablets/liter
Annual and perennial cuttings	1/2-2
Herbaceous cuttings	1-4
Woody ornamental cuttings, grape, roses	1-6

Selecting the Cuttings



Ivy stock plants in Holland

SELECT THE BEST POSSIBLE STOCK PLANTS

The best stock plants produce the best cuttings used for propagation. During each growing cycle, growers must select plants that exhibit the best growth characteristics; these are selected as 'stock plants'. 'Off-shore' cuttings are from selected and maintained stock plants. The same selection process can be done at one's own growing facility.

JUVENILE CUTTINGS

Cuttings taken from the newer *juvenile* parts of many plants root better than older *mature* parts. Shoots at the tops of the plant are physiologically older (*more mature*) than the shoots at the bottom of the plant (*more juvenile*). The top shoots have the characteristics of the more mature parts of the plant from which they originate. **Juvenile cuttings require lower plant rooting hormone rates compared to the 'older' cuttings.**

To maintain juvenality, annual and perennial cuttings should be taken from young stock plants. These stock plants, often a half year old, are used to produce the next generation stock plants from current cuttings. For woody plants 'hedging' can be done.

THE 'BEST' TIME TO TAKE CUTTINGS

Some plants, especially those which go dormant, have different rooting ability at different times of the year. Timing of a few weeks in taking of cuttings may have success or failure. After maturing to a certain age, often years, cuttings taken from certain plants may not be able to produce roots.

TYPICAL TIMING TO TAKE CUTTINGS

- **Herbaceous cuttings from greenhouse crops, annual and tropical plants: anytime.**
- **Deciduous and evergreen plant cuttings: early summer through early fall.**
- **Dormant hardwood cuttings: fall or winter.**

PREPARATION AND CARE OF CUTTINGS

Before taking cuttings, stock plants must be provided with good light and fertilization. This will boost stored carbohydrates used to feed the newly formed roots.

- **Herbaceous** plant cuttings should be treated and stuck soon after being taken. To prevent heat damage, in hot climates cuttings are put in coolers soon after being cut. Perennial and annual cutting suppliers may have offshore stock plant nurseries. When shipped, cuttings from these nurseries are kept chilled during transit using special cartons that protect the cuttings from temperature variation. The cuttings are packed in plastic bags to assure continued hydration. Shipping time is kept short, assuring prompt arrival at the rooting facility. Certain plants do not ship well; to assure propagation success, those stock plants should be grown near the rooting facility.
- Winter **woody cuttings** taken in the fall can be treated with rooting hormones, kept in plastic, stored in cold storage, then planted-out in the spring.
- Growers usually take plant shoot cuttings from plant growth of the current growing season. Generally, thin cuttings will root more easily than thick cuttings. No one cutting type is useful to propagate all plants.

TYPES OF CUTTINGS

STEM CUTTINGS

'Stem cuttings' are the out-growing stems, mature sprouts or tip cuttings. Growers may take many types of stem cuttings.

- **SOFTWOOD & HERBACEOUS CUTTINGS:** these are the fast growing soft tips of stems, usually taken in the spring. Herbaceous cuttings, sometimes called 'tip cuttings' or 'shoot cuttings', are taken from the young soft tips of stems.

Softwood and Herbaceous cuttings have many variations. Cuttings taken from annuals, herbaceous perennials, tropical plants and house plants are easier to propagate from cuttings than more hardened cuttings.

- **HARDWOOD CUTTINGS:** these are taken from the fully mature stems of deciduous shrubs and trees. Stock plants for these cuttings require careful selection and preparation before growers take the cuttings. Pruning of the stock plants allow them to produce new growth early in the growing season. The new growth can produce roots. Growers take these cuttings at the end of the growing season or during the dormant season.
- **GREENWOOD CUTTINGS:** these are the soft tips or stems after the spring growth has slowed. The stem is harder and woodier than the soft wood cutting.
- **SEMI-RIPE CUTTINGS:** these are taken during the late summer after the annual growth has slowed. The stem is harder than softwood or green wood cuttings.

SCION CUTTINGS

'Scion cuttings' are dormant 'ligneous' woody twigs.

EYE CUTTINGS

'Eye cuttings' are pieces of foliated or defoliated stalks with one or more eyes.

ROOT CUTTINGS

'Root cuttings' are parts of the root, usually annual. Growers take these from certain plants which have the capacity to regenerate stems from root parts.

LEAF CUTTINGS

'Leaf cuttings' are parts of the leaf. New roots develop at the base or veins of the cutting. Dry powder rooting hormones are usually used to treat these cuttings.

CUTTING NODES and DO NOT CUT LEAF TIPS

See the section in this book (article after numbered pages):

"Propagate Plants from Cuttings Using Foliar Applied Aqueous IBA Rooting Solutions. Tips: Do's and Don'ts",

Topic: "The Cuttings"

Handling Un-rooted Cuttings

- After taking cuttings, stick as soon as possible.
- **USE PLANT ROOTING HORMONES.**
- Do inspection.
- Reduce wilting during rooting.
- Maintain the appropriate environmental controls.
- Practice good sanitation.

HANDLING OFF-SHORE UN-ROOTED CUTTINGS

After receiving cuttings from off-shore sources, open all boxes immediately. Inspect the un-rooted cuttings for damage, dehydration, heat or freeze damage, breakage or rot. Report any missing items or damaged cuttings to the vendor. Do not allow the boxes to remain in sunny or hot places, or below freezing temperatures. Growers should stick the un-rooted cuttings into pre-moistened, well drained, soil-less media with 5.5- 6.5 *pH*. If not possible to stick the un-rooted cuttings immediately they can be held for several days in a cooler between 35-45°F. The cuttings will deteriorate rapidly at warm temperatures.

WOUNDING

- Hardwood cuttings may root better if a 1/2 to 3/4 inch long notch, “wound,” is made at the basal end before applying the plant rooting hormone.
- Tropical and other herbaceous cuttings are not ‘wounded’.

MEDIA

Stick cuttings as soon as possible after either taking cuttings or receiving off-shore cuttings. Use pre-moistened, well drained, soil-less media with 5.5- 6.5 *pH*. ‘Airy’ media allows oxygen to stimulate root growth. (See page 45 for notes.)

STICKING DEPTH

Stick the cuttings just deep enough that the medium anchors them. Thin cutting may be stuck 1/4-1/2 inch deep.

TRAY SIZE AND DIRECT STICKING

Tray sizes range from 36 to 128 cell. Larger cells are used for cuttings scheduled to remain in the starting tray longer. Un-rooted cuttings can also direct stick in the finishing container or sometimes beds.

Rooting Solutions, Rooting Powders and Methods

Hortus IBA Water Soluble Salts & Rhizopon AA rooting hormones are applied to cuttings from 'easy-to-root' to 'difficult-to-root'. Treated cuttings quickly form new uniform roots, strong root mass and homogenous propagation crops.

SOLUTION METHODS & CUTTING TYPES	Hortus IBA Water Soluble Salts (ppm IBA)
TOTAL IMMERSE & SPRAY DRIP DOWN METHODS Annual, perennials, chrysanthemum Herbaceous and hard to root perennial plant cuttings Woody ornamental cuttings	Trial rates 50-250 250-1500 300-1500
BASAL QUICK DIP METHOD Annuals, soft perennial, tender cuttings from ornamental plants, tropical house plants Herbaceous, perennials, pot rose cuttings Difficult to root herbaceous, perennials, tropical house plants Softwood cuttings Hardwood cuttings Difficult to root hardwood cuttings	Trial rates 50-200 150-1500 500-1500 500-1500 500-2000 2000-10,000
BASAL LONG SOAK METHOD Hard to root annuals and perennials Herbaceous cuttings Woody ornamental cuttings, grape, roses	Trial rates 25-100 50-200 50-400
DRY DIP METHOD & CUTTING TYPES	Rhizopon AA #1, #2, #3
In the Growing Season Leafy cuttings: annuals Leafy cuttings: perennials Leafy cuttings: woody ornamental and forestry All Year Tropical plants Annuals Perennials Woody ornamental and forestry plants, hard to root cuttings Winter dormant cuttings	Trial rates #1 or #2 #1, #2, or #3 #2 or #3 #1 or #2 #1 or #2 #1, #2, or #3 #2 or #3 #2 or #3

Control of the Growing Area

Raising selected stock plants under controlled conditions is important. When growers give their stock plants proper care, the plants will produce the best cuttings. 'Just taking' cuttings from random 'field plants' leads to marginal results. The same way, control of the propagation house is equally important to the propagation of new plants.

Before production, always perform trials on selected plants, within the same facility.



Inspection of cuttings

INSPECTION

Growers must inspect their crops regularly to observe both intended and undesired results. Records should be kept that include information of the methods, materials, and plants used, and the quality of stock plants and cuttings.

ROOTED CUTTING CARE

Early stage treatment of the cutting crop is essential to produce high quality finished plants. Do not allow the rooted cuttings to become over-rooted, dried-out, crowded or under-fertilized. These situations may reduce plant growth.

PROVIDING THE BEST POSSIBLE CONDITIONS FOR ROOTING

Cuttings given less than optimal rooting conditions will waste energy. The result will be inferior root systems. To produce its own store of carbohydrates a plant needs the raw materials of light, water, carbon dioxide and oxygen.

LIGHT

Growers should regulate the propagation house so that the cuttings are not under direct sunlight. The effect of direct sunlight and the resultant heat will cause stress to the cuttings. Light is necessary for photosynthesis. Un-rooted cuttings are not able to engage in much photosynthesis; a small amount of light, 100-125 μm PAR light, during the rooting process is sufficient. It is important at this stage is to provide a long period of light. A

photo-period of 16-18 hours is adequate. Artificial lights are useful to extend natural daylight hours. Natural lighting or artificial lights may cause a rise in ambient temperature. Growers must control the growing area to avoid high temperatures from light sources.

WATER CONTENT OF THE MEDIA

A plant must have a good root system in order for it to absorb water. Water is crucial while the cuttings begin to form roots. If the substrate that is too dry, the plant will have cell death. Dead cells increase the risk of rot. A very dry substrate encourages callus formation. Although many believe that callus is beneficial for root formation, this is not true. The callus hinders and slows root formation. Growers measure how much moisture in the soil with a tensiometer. For best rooting, the meter should display a reading between moist and wet. Another way is to weigh the trays regularly. By trial, the growers determine if the trays have the proper weight for the “the proper moisture level,” then provide water based on these observations.

CARBON DIOXIDE (CO²) IN AIR & OXYGEN IN MEDIA



Environmentally controlled chrysanthemum propagation house in Holland

Photosynthesis is important for cuttings. Photosynthesis requires sufficient **carbon dioxide** (CO²), light, and water. An advantage of an increased level of CO² in the air is that it reduces the transpiration, loss of water, through the plant. Cuttings in an environment with sufficient light and an increased CO² level (800-1000 ppm) will form better roots. CO² can be controlled using special generators. **Oxygen** is necessary for cell division and crucial for root formation. Growers

must stick the cuttings into a substrate that has a structure which is sufficiently open to allow air, containing oxygen, to reach the developing roots. Dense media inhibits oxygen stimulation.

AIR CIRCULATION & TEMPERATURE CONTROL

Good air circulation is necessary when rooting un-rooted cuttings. Shade to approximately 50% light conditions, or as required, to reduce temperature during high heat periods.

TEMPERATURE

Soil Temperature

Soil temperature has a direct influence on the speed of rooting. A soil temperature ranging between 68-77°F is ideal during the initial rooting stage. After this initial stage, growers can allow the temperature to drop a few degrees.

Air Temperature

To prevent excess transpiration, controlling the temperature is important. To reduce aerial growth, air temperature should be a bit lower than soil temperature. The cuttings should be encouraged to use their energy mainly for developing roots. Above ground growth will come later.

Light and Temperature Relationship

During the winter, when there is a low level of natural light, with no artificial lights, use a lower temperature. For example, cuttings will die if kept at temperatures near 74°F, short day and low light levels. Rooting activity in the soil will outpace its ability to do photosynthesis induced by the light.

FERTILIZATION

Follow fertilizer label instructions. Growers should fertilize un-rooted cuttings during propagation. Apply a complete N-P-K fertilizer. For many plants, use a fertilizer containing 300 ppm of nitrogen approximately two to three times a week. Start on the third day after sticking or when the callus is starting to form. Quality can suffer if the roots become rootbound. Fertilize the cuttings when planting. Apply liquid fertilizer solutions at a rate of 300 to 400 ppm immediately after planting.

INSECT AND DISEASE CONTROL

Good cultural practices and clean, well-ventilated growing space are your best defense against disease. Botrytis, the chief fungal threat, thrives in a moist, stagnant environment. Good air circulation and adequate light will reduce its harmful effects.

Apply appropriate fungicides, insecticides, and other control products following label instructions.

Humidity



Un-rooted cuttings must receive the highest amount of humidity. Temperature influences the ambient humidity. When the first roots appear, the humidity can be lowered; the rooted cuttings can adapt to the surroundings better.

MISTING GUIDELINES

Apply mist immediately and frequently to maintain turgidity and minimize wilting while roots develop. Extended days of high humidity may cause some plant cuttings to form aerial roots.

Typical mist cycle for fast to root annual and perennial cuttings	
1-3 DAYS AFTER STICKING	<ul style="list-style-type: none"> • Mist during daylight hours in all stages and the night for the first 3-4 days helps keep the cuttings turgid for optimum rooting. • Mist 10 seconds every 5-10 minutes.
4-7 DAYS AFTER STICKING	<ul style="list-style-type: none"> • Callus is being formed. • Mist 10 seconds every 20 minutes.
8-15 DAYS AFTER STICKING	<ul style="list-style-type: none"> • Roots are being formed. • Mist 10 seconds every 30 minutes. • Depending upon the plant variety, under ideal conditions, mist can be off 10 days after sticking.
AFTER 14 DAYS	<ul style="list-style-type: none"> • Fast to root cuttings can be ready to plant.



The Dutch growing system in this photo has controlled humidity by covering the propagation trays with either transparent or translucent plastic. Edges of the trays are sealed so that no air current at the sides affect the cuttings. No misting system is used.