Vegetative Perennials
propagation specifics

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??Questions to Ask??

• Should I propagate or buy in? depends on answer to...
• What is my interest? business focus?
• Do I “like” to propagate? retail?
• Greenhouse or nursery primarily?
• What is my target market?

You might propagate your own if...

• you have the facilities
• you have the labor/interest
• you have the time in your schedule
• you want more variety
• you have special/unique plants

Propagation options

• buy in all, or propagate all
• buy in easier, propagate harder
• buy in harder to propagate (vernalize), start easier on site
• buy in liners (rooted in media), or cuttings
  – rooted or unrooted

Crop specifics
for vegetative perennials

• Buying In
• Propagation
• Finishing
• Schedules
• Resources

Buying in-- considerations

• cost
• culture indexing
• timing
• size of plant/ rooted cuttings
• unrooted cuttings:source
  • domestic, offshore
Buying in --advantages

- saves time, labor, facilities (i.e. costs)
- especially for greenhouses
- shorter time to sale
- if “clean” material, less chance to carry over disease
- easier to schedule (liners)
  - rooting, vernalization (cold treatment for bloom) issues dealt with by propagator

Buying in-- disadvantages

- more costly if available facilities, labor, stock plants
- introduction of disease if not “clean”
- no propagation if desire to do so
- less cultivars of some plants
  - on other hand...others (patented, tc) often only available from licensed propagators
  - increasing number available (plugs too)

Buying in cuttings-- other disadvantages

- availability of desired selections
  - may need multiple sources
- shipping and customs costs
- some species not allowed into USA from offshore

Develop good communication with broker

Buying in liners-- timing to buy

- depends on type operation, schedules
- late summer-- pot, overwinter (vernalize) 28-41F (-2 to 5C) or outdoors
- fall-- overwinter covered
- early spring-- pot and finish for spring, force bloom?
- spring-- pot and finish for summer

Buying in liners-- size depends on

- type of operation
- schedules, space, other crops
- same choices as for propagation (16-128, often 30/50/70/90)
- cost to buy vs. cost for space/labor
- finish size
  - larger initially for larger pots, or several smaller per large pot
  - larger finish quicker

Buying in liners-- Nursery schedule

<table>
<thead>
<tr>
<th>Time</th>
<th>Liner</th>
<th>Pot</th>
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</thead>
<tbody>
<tr>
<td>Summer</td>
<td>90</td>
<td>jumbo</td>
</tr>
<tr>
<td></td>
<td>50/72</td>
<td>gal</td>
</tr>
<tr>
<td>Late Summer</td>
<td>32</td>
<td>jumbo-gal</td>
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<tr>
<td></td>
<td>50/72</td>
<td>jumbo</td>
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<td></td>
<td>2x72/90</td>
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<tr>
<td>Early Fall</td>
<td>32</td>
<td>jumbo</td>
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<tr>
<td></td>
<td>2x32/50</td>
<td>gal</td>
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Buying in liners--
Greenhouse schedule

<table>
<thead>
<tr>
<th>time</th>
<th>liner pot</th>
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<tbody>
<tr>
<td>summer*</td>
<td>32/50</td>
</tr>
<tr>
<td>72/90</td>
<td></td>
</tr>
<tr>
<td>early fall**</td>
<td>72/90</td>
</tr>
<tr>
<td>late fall**</td>
<td>any</td>
</tr>
<tr>
<td>spring</td>
<td>as finish</td>
</tr>
</tbody>
</table>

* for fall sales, ** overwinter

Buying in/own liners--
overwintering temperatures

<table>
<thead>
<tr>
<th>time</th>
<th>temperature range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-15 Oct</td>
<td>begin temp. drop from 60-65F (16-18C), 5F(3C) per week, 6 weeks</td>
</tr>
<tr>
<td>15-30 Nov</td>
<td>reach 28-41F (-2 to 5C) air</td>
</tr>
<tr>
<td>15-28 Feb</td>
<td>ramp temp. up</td>
</tr>
<tr>
<td>1-15 Apr</td>
<td>reach 65F (18C) day/55F (13C) night</td>
</tr>
</tbody>
</table>

• vernalization provided
• often combination with nursery

Buying in cuttings
offshore considerations

• unrooted cuttings
  • need facilities to root, so often left to propagators “rooting stations”
  • make sure clean, indexed
  • may take several days longer than domestic, possibly decreasing quality
    • excess respiration, light exclusion, moisture loss, pathogens, ethylene increase

Receiving cuttings

• act promptly
• verify varieties, count, quality
• check for consistency
  • size (length, diameter), age
• check for injury
  • pests, freeze, dehydration, rots
  • report problems then not later
• stick as soon as possible

Unrooted cutting storage

• only if necessary before sticking
  • buying in, or if taking own cuttings
  • reduce carbohydrate loss
  • one week or less best
  • cool 35-45F (2-7C)
  • high humidity (90% RH)
  • reduced oxygen, ethylene
  • increased carbon dioxide (CA storage)

Crop specifics for vegetative perennials

• Buying In
• Propagation
• Finishing
• Schedules
• Resources
10 keys to success with vegetative propagation

- Stock plants
- Propagules
- Media
- Hormones
- Humidity
- Temperature
- Light
- Water
- Fertility
- Sanitation

Propagation– stock advantages

- If retailer, also use for display
- maintain hard-to-find, not readily available selections
- you have a propagation “trick”
- maintain own selections, often from “sports”
- have the space, facilities, labor

Propagation– stock issues

- requires space to maintain
- may be carrying disease
  - within species, cultivars
  - to infect adjacent annual crops
- can get infected even if bought clean
- not set up to propagate
- may be difficult to coordinate
- maximum vigor, vegetative with scheduling (i.e. forcing)

Propagation– stock maintaining plants

- may grow indoors for access year round
- keep 2-3 years max, yearly better
- young is easiest to work, roots better, less chance for disease
- may repot to sell, root offsets
- buy “clean” starters, virus indexed, especially if greenhouse

Propagation– stock plant quality

- maximum carbohydrates
  - good nutrition (moderate nitrogen), high light, root restriction, no water stress, shoots where rapid growth ceased
  - 150ppm N after cutting, 75ppm N with shoot elongation, 0ppm few days prior to recutting
- free from disease, pests
- early morning cuttings may be best (more turgor–moisture content)

Propagation– stock the key to cutting success

- maximum carbohydrates
- Juvenile growth–uniform
  - Nodes of same age, slightly hardened
- consistency age, length, diameter
- otherwise less yield (rooting), less uniformity of crop
- hormones make up some for poor stock or cuttings
Propagation— stock range of methods

Certified, greenhouse Crates, nursery

Vegetative propagation—
methods, choices

- grower size
- plant habit
- timing
  - many plants provide choices, eg. *Achillea*
    by Division spring/fall, Stem cutting in mid-summer
  - forcing (vegetative), indoors extends cutting period

Vegetative propagation—
methods by grower size

- small:
  - often more of own media and methods,
  - diverse crops, seed plugs, own or bought
  - specialists, own cutting or tc
- medium: mix own, buy in liners/rooted cuttings/seed plugs
- large: unrooted cuttings, often offshore, own or contracted; seed plugs, own or bought

Vegetative propagation--
stem cuttings

- tip, terminal
  - cut just below node, avg. 3 nodes per cutting
  - eg. *Amsonia, Euphorbia, Phlox subulata*
- stem, leaf node, internodal
  - section of stem, root at leaf nodes
  - eg. *Agastache, Ajuga, Chelone, Lamium*
- leaf--leaf with small section of stem (eg. *Sedum*)
  - most common method
    - most further comments on

Vegetative propagation--
other cuttings

- basal-- at base of plant where tops join roots
  - if roots attached, root primordia, “heel” or “rooted” cuttings
  - early as plants sprout
  - eg. *Achillea, Aster, Coreopsis, Geranium*
- rhizome-- underground stem
  - treated similar to root cuttings
  - eg. *Bergenia, Darmera, Dicentra*
Vegetative propagation--root cuttings: which plants?

many possible in winter

Acanthus
Bergenia
Cimicifuga
Dictamnus
Eryngium

Ligularia
Lysimachia
Phlox paniculata
Pulmonaria species
(cultivars by division, tc)

Vegetative propagation--root cuttings: size

• thicker the better, pencil size ideal
• thicker the roots, more orientation seems to matter in placing upright in cells
  • Acanthus, Anchusa, Asclepias, Brunnera, Papaver
• mark roots with angle cut on bottom, straight tops
• take 1-2” long

Vegetative propagation--root cuttings: process

• stick thicker in 50-70 tray to root, orientation?
• scatter thin roots on mix
• make sure covered with mix
• water, keep fairly dry until rooted (4-8 weeks)
• alternative: throw in bag of just moist mix, remove and pot as root

Vegetative propagation--division

• pull offsets/rosettes from crowns with root initials
  • eg. Hemerocallis, Heuchera, Leucanthemum
• crown division
  • pull apart, cut woody crowns (eg. Astilbe, Epimedium)

Vegetative propagation--tissue culture considerations

• few do their own, often contracted or purchased rooted/acclimated
• many new cultivars, choice ones, fast
  • (eg. Heuchera, Tiarella, Hosta, Pulmonaria)
• requires skill, expensive lab
• possible mutations (pro or con)
• increasingly common source
Vegetative propagation--
handling tissue culture

4 stages
--differing hormones, environment for each
1. establishment in agar media
2. microshoot formation
3. root formation
   --usually obtained after stage 3 (rooted)
4. acclimation (to media, open)
   --begin with 75-80% shade, high RH, 14-16hr
days (fluorescent tubes)
   --reduce with new leaves

Vegetative propagation--
tissue culture stages

Stage 3  Stage 4

Vegetative propagation—
container type

• done in plug trays or open flats
  • plug trays--direct stick, more space on
    bench, most common
  • flats--need to transplant rooted, more labor
• open-mesh benches often best
  • more air so less disease
  • root pruning

Vegetative propagation—
container size

• unit size depends on plant size, habit,
  propagation method
  • generally 16, 30/32 (or deep), 48/50, 60, 72,
    94/96, 125/128
  • often two choices (small, large)
  • cuttings/tc take smaller, divisions larger
    (seeds even smaller)

Propagation– media choices

• There is no perfect media, only better
  or worse choices depending on
  growing system
• decisions often management and
  business as much as horticulture
• best: pick one, stick with it

Propagation– media
considerations

• if change, change practices?
• important, don't skimp--use best
• pasteurized
• just moist enough
• keys: maintain moisture, high levels
  of oxygen, hold cuttings upright
Propagation – media components

- some nutrients, more in growing-on mix
- peat-lite media commonly used
- sand, sand and peat (1:1), perlite, perlite and vermiculite (1:1)
- gritty (alpines): sand, peat, pea gravel (1:1:1)
- loamy (woodland, ferns): loamy soil, peat moss, perlite or vermiculite (1:1:1)
- foam cubes (more for other crops)

Propagation – media for cuttings

- fine texture often important
  - fine cuttings (eg Coreopsis Moonbeam)
- don’t want to break stems inserting
- want good media: cutting contact
  - 90% of cuttings water through stem

Propagation – hormones

- generally not need to root, but...
  - use of often decreases rooting time
  - increases rooting uniformity
  - helps offset poor cuttings, stock
- IBA or IBA-K main auxins used
  - promote root formation
- Liquid – dip cutting end, or spray w/in 24hrs
- Powder – dip cutting ends

Propagation – hormone considerations

- Powders – harder to apply uniform, variable results
- Liquids – IBA often alcohol base, can damage growing points
  - twisted foliage
- IBA-K salt dissolves in water, no phytotoxicity

Propagation – hormone specifics

- 500-1,500ppm, quick end dip
- Generally IBA works as well as IBA+NAA
- Hard to root: IBA 10,000ppm+NAA
  - Woody stems
  - 5 sec. end dip (not more)

Propagation – hormones combination

Some perennial cuttings respond well to IBA 10,000ppm+NAA:
- Aruncus
- Baptisia
- Echinacea
- Geranium
- Lavandula
- Phlox paniculata
- Thermopsis
- Tiarella (heel)
- Heuchera
**Propagation– humidity goals**
- reduce transpiration, prevent wilting
- high humidity
- decreased evaporation
- mist only as needed, wet not dripping
  - more water is not better
  - leaches nutrients, diseases, low oxygen in media reduces rooting

**Propagation– humidity means**
- until rooted turn off fans, mist or fog (watering insufficient), decreased light
- gradually increase air and light, decrease mist/RH with rooting
- average 7-10 days callus, root hairs; 2-4 weeks initial rooting
- 4-6 weeks fully rooted (72 or 128 cells)

**Propagation– humidity from mist**
- generally one to two weeks
  - depends on facility, season, location
  - longer intervals/stop as roots start
- may inject bromine into water, lessen algae and disease, alternative to chlorine
- timers or “leaf sensors”
  - better control, zones, too moist for some?

**Propagation– humidity from fog**
- commercial foggers (large scale), humidifers (short lived), orchid foggers
- less water loss than mist
- less nutrient leaching
- less effect on media temperatures
- may help hard-to-root, silver foliage (may rot under mist)
- keep light high or fewer roots

**Propagation– temperature rooting media**
- Key, air temp. less effect rooting
- often 10F (5C) below air temp.
- media 65-75F (18-24C), may reduce as roots develop
- higher promotes root initiation
- lower may promote root growth
- bottom heat, many methods
  - until roots reach cell bottom

**Propagation– temperature cool rooting media**
Some perennial cuttings respond well to cool media 58-65F (14-18C):
- **Aurinia**
- **Campanula**
- **Centaurea**
- **Centranthus**
- **Chrysogonum**
- **Delphinium**
- **Dicentra**
- **Erigeron**
- **Geranium**
- **Helianthemum**
- **Polemonium**
- **Tiarella**
Propagation— temperature

warm rooting media

Some perennial cuttings respond well to cool media 68-75F (20-24C):

- Agastache
- Asclepias
- Baptisia
- Eupatorium
- Gaura
- Helium
- Hibiscus
- Oenothera
- Penstemon
- Perovskia
- Rosmarinus
- Salvia

Propagation— air temperature

- Best: lower air than root temp.
  - Decrease stem elongation, less mist
- 70-80F (21-27C) day, 60F (15C) night, or with bottom heat 65-70F (18-21C) or w/out 75-80F (24-27C)
- higher promotes bud development
- don’t want buds before roots, uses up carbohydrates needed for roots
  - same issue as with daylength

Propagation— light levels

- balance not too much (<2000fc)
  - Evaporates moisture, dehydrate
- not too little (>1000fc)
  - Needs to make food for growth
- start low, increase as rooting
- summer: may need 50% shade
  - Ideal: remove if cloudy (curtains)
- winter: may need to supplement

Propagation— light duration

- most don’t control photoperiod
- varies, complex, LD often best
  - < 13hrs
- may affect bud/shoot growth also
- may be problem if out of season
- guide—light for vegetative growth
- some (eg Sedum) should be veg.

Propagation— water

- (mist) temperature 50-70F (10-21C)
- winter watering: less is best
- low salts, bicarbonates, alkalinity
  - these can delay rooting, lower quality
- sulfuric, phosphoric acids common
  - May react with calcium for residue
- nitric acid best to neutralize
  - Nutrients result, no residue

Propagation— fertility

- not during first few days
- begin low levels once rooting begins (7-10 days)
  - 50-100ppm N (nitrates) once/wk
- increase once rooted (2-4 weeks) or if chlorotic
- natives establish fine at low levels
  - species vs highly bred cvs.
Propagation– sanitation, insects

- in addition, not substitute, for proper environment and culture
- disinfect any/all surfaces/tools
  - Bleach (1:9 water ppv), products
- start with clean stock
- watch for fungus gnats
  - larvae eat roots
  - biologicals, IGRs, chemicals for larvae
  - apply early in propagation

Propagation– diseases

- watch for botrytis on young cuttings
  - some apply preventative broad spectrum fungicides, weekly until rooted, end of day with less mist
- many use fungicide drench in first week to prevent soilborne disease
- bacterial disease with high temps (85F/29C), excess mist, wet media
  - Copper-based fungicides

Crop specifics for vegetative perennials

- Buying In
- Propagation
- Finishing
- Schedules
- Resources

Finishing-- timing

- cell/unit size
- finish size
- plant or cultivar
- greenhouse temperature
  - avg. target 65F (18C) day, 55F (13C) night
- daylength

Finishing-- potting dates for 1 May sales, from 72 cells

<table>
<thead>
<tr>
<th>Finish size</th>
<th>Transplant</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-inch</td>
<td>21-28 Mar</td>
</tr>
<tr>
<td>quart</td>
<td>14-21 Mar</td>
</tr>
<tr>
<td>gallon*</td>
<td>15-28 Feb</td>
</tr>
</tbody>
</table>

*subtract 1-2 weeks if additional plant
Dates will vary with location, plant, culture

Finishing-- general schedule, Spring

- to 4-inch pot, from
  - 72: 4-5 weeks, 50: 3-4 weeks
  - to quart from 50, 72: 4-7 weeks
  - to gallon, from
    - 72: 8-10 weeks, 50 or larger: 5-8 weeks
    - add a plug, subtract a week or two
### Finishing--

#### potting dates for 1 May sales, from 50 cells

<table>
<thead>
<tr>
<th>Finish size</th>
<th>Transplant</th>
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</thead>
<tbody>
<tr>
<td>4-inch</td>
<td>1-7 Apr</td>
</tr>
<tr>
<td>quart</td>
<td>21-28 Mar</td>
</tr>
<tr>
<td>gallon*</td>
<td>1-21 Mar</td>
</tr>
</tbody>
</table>

*subtract 1-2 weeks if additional plant
Dates will vary with location, plant, culture

### Finishing--

#### fertility

- liquid: 20-10-20, 15-5-15 or similar
  - once/wk
  - 200ppm slow growers, 100ppm for fast
- controlled release fertility (CRF)
  - incorporate, top-dress, combine with half strength liquid
  - often better, faster growth than liquid alone

### Finishing--

#### light

- daylength extension for long day (LD) species (forcing into bloom earlier)
  - to 16 hours, incandescent
  - may vary with species, cv., cold
  - may help
    - *Astilbe, Coreopsis, Leucanthemum*, etc.
  - may be required for bloom
    - *Campanula, Coreopsis, Echinacea, Gaillardia, Oenothera, Phlox, Rudbeckia, Sedum*, etc.

### Finishing--

#### growth (height) regulation

- water less for some species, to initial wilt
- cut back 3 weeks prior to shipping
- DIF for many perennials
  - night=day temperature (65F avg., 18C)
  - sunrise, lower by 5-10F (3-6C) for 2 hours
  - less fertility (low P eg. 15-5-15, or alternate 20-10-20 and 15-0-15)
- end of day red light (similar to DIF)?
- thigmotropism--mechanical touch

### Finishing--

#### plant growth regulators (PGRs)

- generally only if other methods not possible
- most perennials/species not listed: trial
  - some specific plants in guides (eg. Ohio, Cornell, New England), labels
- A-Rest: many species, begin trial at 20-50ppm spray, 1-2ppm drench
- Bonzi: begin trial at 15ppm spray, 0.5ppm drench
- Sumagic: begin trial at lowest rates, 5-40ppm spray, 0.1-1.0ppm drench

### Crop specifics for vegetative perennials

- **Buying In**
- **Propagation**
- **Finishing**
- **Schedules**
- **Resources**
Vegetative propagation--
propagation timing

<table>
<thead>
<tr>
<th></th>
<th>cutting</th>
<th>division</th>
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<tbody>
<tr>
<td>winter</td>
<td>root</td>
<td>stock in</td>
</tr>
<tr>
<td>spring</td>
<td>stock in</td>
<td>stock out</td>
</tr>
<tr>
<td>summer</td>
<td>stem</td>
<td>stock out</td>
</tr>
<tr>
<td>fall</td>
<td>some</td>
<td>some</td>
</tr>
</tbody>
</table>

Easiest when plant wants to be vegetative and not reproductive

Vegetative propagation--
production timing

- winter: pot indoor stock divisions, root cuttings for same season sale
- spring: pot winter root cuttings, spring divisions, liners for same season sale
- summer: pot stem cuttings (as for buying-in liners), pot summer divisions
- late summer/early fall: pot cuttings as for buying-in liners, pot fall divisions

Vegetative propagation--
doing it better

- observe, keep good records
- helps refine, improve in future
- all details eg. stock, quality, temperatures, misting, chemicals, etc.
- don’t be afraid to try new approaches
- persistent, don’t give up
- share with others
- ideal: they’ll share, win:win for all

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For more information...
Perennial Plant Association
www.perennialplant.org

Perry’s Perennial Pages
perrysperennials..info

Perennial Solutions,
Paul Pilon

NRAES
607-255-7654
www.nraes.org